Can IT Services Drive Economic Growth: A Linkage Analysis of the ‘Pre-Industrial’ Production Context in Nigeria

Olayinka Babalola

Thesis submitted for the degree of PhD

2021

Department of Economics
SOAS, University of London

ABSTRACT

Several countries are pursuing a service-led structural transformation process inadvertently or by design. This thesis examines the process of structural change in a specific class of developing countries, termed 'pre-industrial'. It investigates whether the Information Technology (IT) service sector can catalyse economic growth, performing like the manufacturing sector in industrial economies. Pre-industrial countries such as Nigeria are undergoing 'pre-industrial deindustrialisation', whereby the share of manufacturing in employment and value-added declines at lower levels of per-capita income compared to industrialised countries.

In this thesis, the precipitating factors for the emergence of services in the pre-industrial context are investigated from the perspective of the interaction between deindustrialisation and tertiarisation processes. Service sector heterogeneity is re-examined from the viewpoint of IT producer service use in the production process, as not all services can drive economic growth. A composite index for IT Producer Services is developed using Principal Components Analysis (PCA) to facilitate evaluation of the contribution of IT services to production and economic growth in pre-industrial contexts.

A Hirschmanian linkage approach is employed to determine the growth-inducing effects of IT Producer Services at the firm level. Production, fiscal or consumption, financial and technological linkages, all of which aid linkage formation, are juxtaposed against technological capabilities in firms. In this thesis, a mixed methods approach is deployed involving case studies of selected firms, using results from a survey of IT firms in Lagos, and statistical analysis to develop a composite index.

This thesis finds that the deindustrialisation trajectory of a country and the drivers of deindustrialisation and tertiarisation are fundamental to the role of services in catalysing growth. These processes shape the producer services which emerge, the technological capabilities developed in producer service firms, the linkages formed between sectors and how IT producer services are utilised in the production process to generate economic growth.

ACKNOWLEDGMENT

The PhD Journey is one of self-discovery in which you discover hidden depths to your personality. Those personality traits, good, bad or banal, help you form a better picture of yourself. Much like any other, mine was full of highs and lows; however, I am grateful for the experience and doubly so for all those who assisted me on the way.

Firstly, I would like to thank my supervisor, Dr. Antonio Andreoni, who patiently guided me through the process and asked the most intriguing questions which helped shape and re-focus my research. I would never have completed the thesis without his friendship, support and guidance.

I would also like to thank the examiners at my viva Prof. Christopher Cramer and Prof. João Carlos Ferraz for patiently reading my thesis, making recommendations that improved it significantly and helping me view my thesis in a new light.

I would also like to thank Prof. Ben Fine and Dr. Pallavi Roy, members of my supervisory committee who got me through the upgrade process. Dr. Sophie Van Huellen and Dr. Satoshi Miyamura also provided valuable support which allowed me to submit my thesis on time.

I appreciate both the SOAS Economics community which created a conducive environment in which I could test my research approaches and learn from the work of others and the SOAS Doctoral School which gave me the flexibility to continue my work in a different environment and at my own pace.

The support and encouragement of my friends in ways financial, emotional and intellectual cannot be over-emphasised. The list is long, and I appreciate Adenike, Azza, Bayo, Bolarinwa, Bunmi G, Bunmi N, Chinny, Dapo, Hannah, Ilara, Ini, Jennifer, Julia, Rahila, Richard, Ritgak, Roland, Segun, Tony, Wale**,** Wuyi and Zanswat. I would also like to thank Marie Francoise, Jariya, John and Chief at the World Bank who pushed all the necessary levers to ensure I got my first student visa on time.

A special mention goes to Joseph Tegbe, Darams, Lolo, Ronke, Moustapha, Sile, Bisola & Yinka for their invaluable financial support when I most needed it. It took a village to get this done. I would also like to thank all the company CEOs that gave up their valuable time to answer my questions, particularly Anjola Badaru, Folorunsho Aliu, Pelumi Adeniran and Tokunbo Fagbamigbe.

None of this would have been possible without the strong support of my immediate and extended family which include my lovely parents, Prof. Ayodele Babalola and Mrs. Faramobi Babalola, my fantastic siblings Tolu, Jide and Tinuke and their families and my awesome Uncle Gbolahan.

Finally, I thank my Creator for providing, guiding and keeping me through the process while accommodating my neglect. Words are not enough, and I am eternally grateful.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

.NET	Dot Net
3-D	Three-Dimensional
ABP	Anchor Borrower's Program
AFJP	Agricultural for Food and Jobs Plan
ArcNET	Attached Resource Computer Network
ASEAN	Association of Southeast Asian Nations
BSC	Bachelor of Science
BA	Bachelor of Arts
BOP	Balance of Payments
BPO	Business Process Outsourcing
BVN	Bank Verification Number
CAC	Corporate Affairs Commission
CAD	Computer-Aided Design
CBN	Central Bank of Nigeria
CDMA	Code Division Multiple Access
CEO	Chief Executive Officer
CES	Constant Elasticity of Substitution
CIBN	Chartered Institute of Bankers of Nigeria
CIL	Communication Investments Limited
CIP	Core Industrial Projects
CM	Covariance Matrix
CNC	Computer Numerically Controlled
COVID-19	Coronavirus Disease of 2019
CPC	Central Product Classification
D-SI	Stochastic Single Imputation
DA	Data Augmentation
DEC	Digital Equipment Corporation network
DFS	Digital Financial Services
DMB	Deposit Money Bank
DVC	Domestic Value Chain
ECI	Economic Complexity Index
EMB	Expectation-Maximization with Bootstrapping
EMTS	Emerging Markets Telecommunications Services
EMV	Europay, MasterCard and Visa
EU	European Union
EVAD	Export Value Added Database
FC	Farm Crowdy

FCMB	First City Monument Bank
FCS	Fully Conditional Specification
FDI	Foreign Direct Investment
FEC	Federal Executive Council
FGN	Federal Government of Nigeria
FINTECH	Financial Technology
FIRS	Federal Inland Revenue Services
FTTH	Fibre to The Home
GAP	Good Agricultural Practices
GATS	General Agreement on Trade and Services
GDP	Gross Domestic Product
GE	General Electric
GMD	Group Managing Director
GPN	Global Production Network
GPS	Global Positioning System
GSM	Global System for Mobile Telecommunications
GSM	Global System for Mobile Communications
GSMA	Global System for Mobile Communications Association
HND	Higher National Diploma
HRM	Human Resource Management
HT	High Technology
HTS	High Tech Synergy
IBM	International Business Machines Corporation
ICT	Information and Communication Technology
ICT4D	Information Communication Technology for Development
ID	Industrial District
IFI	International Financial Institutions
IITA	International Institute of Tropical Agriculture
IMF	International Monetary Fund
INEC	Independent Electoral Commission
IPC	International Patent Classification
ISI	Import Substituting Industrialisation
ISIC	International Standard Industrial Classification
ISP	Internet Service Provider
IT	Information Technology
IV	Intravenous
IXPN	Internet Exchange Point of Nigeria
JTB	Joint Tax Board

KIBS	Knowledge-Intensive Business Services
KMO	Kaiser-Meyer-Olkin
KPMG	Klynveld Peat Marwick Goerdeler
LAN	Local Area Network
LD	Listwise Deletion
LLB	Bachelor of Laws
LLM	Master of Laws
LPS	Local Production System
LSETF	Lagos State Employment Trust Fund
M-TEL	Mobile Telecommunications Limited
MA	Master of Arts
MAN	Metropolitan Area Network
MAR	Missing At Random
MBA	Master of Business Administration
MCAR	Missing Completely At Random
MFP	Multi Factor Productivity
MNCs	Multi-National Corporations
MOU	Memorandum of Understanding
MSME	Micro, Small and Medium Enterprise
MTN	Mobile Telephone Network
MTS	Mobile Telecommunications Service
MVA	Manufacturing Value Added
MYSQL	My Structured Query Language
NACS	Nigeria Automated Clearing System
NBA	Nigerian Bar Association
NBS	National Bureau of Statistics
NCC	Nigerian Communications Commission
NCCD	Nigerian Communications Commission Decree
NDA	Non-Disclosure Agreement
NECO	National Examination Council
NET	Nigerian External Telecommunications Limited
NGX	Nigerian Exchange
NIBSS	Nigerian Inter-Bank Settlement System
NIMC	National Identity Management Commission
NIPC	Nigerian Investment Promotion Commission
NITDA	Nigerian Information Technology Development Agency
NITEL	Nigerian Telecommunications Limited
NMAR	Not Missing At Random

NSE	New Structural Economics
NSI	National Systems of Innovation
OCP	Office Chérifien des Phosphates
OECD	Organisation for Economic Cooperation and Development
OEM	Original Equipment Manufacturer
OND	Ordinary National Diploma
PCA	Principal Component Analysis
PHD	Doctor of Philosophy
PHP	PHP: Hypertext Preprocessor
PLC	Public Limited Company
POS	Point of Sale
PPP	Public Private Partnership
PVC	Polyvinyl Chloride Card
R&D	Research and Development
RIS	Regional Innovation Systems
S-SI	Deterministic Single Imputation
SAFE	Southern Africa –Far East- West Africa
SAP	Structural Adjustment Programme
SAT3	South Atlantic 3/
SITC 4	Standard International Trade Classification, Revision 4
SOAS	School of Oriental and African Studies
SOEs	State-Owned Enterprises
SSA	Sub-Saharan Africa
SSCE	Secondary School Certificate Examination
SSI	Sectoral Systems of Innovation
STEM	Science, Technology, Engineering, and Mathematics
STI	Science, Technology and Industry
T-KIBS	Technology Knowledge-Intensive Business Services
TAI	Technology Achievement Index
TDMA	Time Division Multiple Access
TFP	Total Factor Productivity
TIN	Tax Identification Number
TiVA	Trade in Value Added
UAT	User Acceptance Testing
UIS	UNESCO Institute for Statistics
UK	United Kingdom
UN	United Nations
UN Comtrade	United Nations International Trade Statistics Database

UNCTAD	United Nations Conference on Trade and Development
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
URL	Uniform Resource Locator
USSD	Unstructured Supplementary Service Data
USSD	Unstructured Supplementary Service Data
VAR	Value Added Reseller
VAS	Value-Added Services
VSAT	Very Small Aperture Terminal
WAEC	West African Examination Council
WAN	Wide Area Network
WASC	West Africa Submarine Cable
WDI	World Development Indicators
WIOD	World Input Output Database
WIPO	World Intellectual Property Organization
WITS	World Integrated Trade Solution
WPIIS	Working Party on Indicators for the Information Society
WTO	World Trade Organisation

1. CHAPTER 1: INTRODUCTION

1.1. Introduction

In the 2000s, many economies in Sub-Saharan Africa (SSA) benefited from what has been described as a commodity super cycle fuelled by increased demand from the booming manufacturing sector in China and other countries experiencing rapid manufacturing sector growth. During the high points of the boom, an 'Africa Rising' narrative gained traction; however; the downturn of this boom led to sharply declining commodity prices, in particular crude oil, and exposed the fragility of these economies due to their continued reliance on primary products as their main source of foreign exchange and fiscal earnings. This commodity dependence is particularly pronounced in the case of Nigeria as about 70% of general government revenues and over 90% of foreign exchange earnings are contributed by the oil and gas sector (NBS, 2022).

This economic fragility was further underlined by the COVID-19 pandemic as economies in lockdown contracted, with many experiencing a major fiscal and balance of payments crisis. Such an unanticipated event revealed the structural imbalance of these economies and the implications this might have for their ability to withstand external shocks and deliver strong and sustained economic growth. These contemporary events have given impetus to a call for diversification from primary commodities and a renewed search for new growth opportunities. On top of these, the traditional structural transformation narratives as resources move first from agriculture to manufacturing and then the services sector in response to productivity growth, have gained more traction recently. This has occurred as manufacturing economies like China dominate trade and the obstacles placed by current World Trade Organisation (WTO) rules constrain countries seeking to implement industrial policy (R. H. Wade, 2003, 2009). Other challenges include the implications of the movement to a Fourth Industrial Revolution when many countries in SSA are yet to experience the Third Industrial Revolution and difficulties entering the high-value added segments of Global Value Chains (Andreoni & Anzolin, 2019; Andreoni & Chang, 2018; Gereffi & Lee, 2016; Kaplinsky & Morris, 2016). Each of these challenges to manufacturing-led growth represent separate lines of inquiry, some of which will be explored further in this research, but they epitomise some of the key obstacles to manufacturing-led growth.

In light of these obstacles, several leapfrog narratives which suggest that countries can skip the manufacturing-led phase of structural transformation in and move directly to high value-added services have become very attractive for less developed countries, with many of these narratives citing the growth of India's Information Technology (IT) sector as the classic example (Beerepoot et al., 2017; Dasgupta & Singh, 2005, 2006; Eichengreen & Gupta, 2011, 2013; Ghani & O'Connell, 2014). This raises the question of whether countries in SSA have an IT sector which can drive growth in like manner to the manufacturing sector.

In the case of Nigeria, policy statements by government officials place emphasis on increasing expenditure on the agriculture sector to create low income jobs, and increasing spending on social services; however, infrastructure spending to drive industrialisation and diversification of the economy is also prioritised (Francis, 2021). Paradoxically, the Nigerian service sector is the largest and fastest growing in the economy; however, due to a bias towards manufacturing-led growth, shaped in large part by a structuralist standpoint on economic growth, government is disposed towards primary commodity-led industrialisation. This desire is in tension with growth statistics which show that the service sector accounts for more than 50% of the total economy and is growing faster than the oil sector. More importantly, the telecommunications & information services sub-sector, which in the rest of this thesis is referred to as the IT sector, grew by 5.9% in the second quarter of 2021, is a key driver of non-oil sector growth of 6.8% and real GDP growth of 5.01% over the same period. IT alone contributed 9.6% to GDP, the second largest contribution in the service sector (NBS, 2021). This growth trend of services and IT in particular, has persisted for more than 15 years.

These IT sector statistics raise an important question about the policy direction in Nigeria which places emphasis on primary commodity-led industrialisation, mainly through import substitution. This is also because the trajectory of the sector aligns with current thinking on service-led growth via high value-added services. This research intends to investigate whether the IT service sector can be a driver of economic growth by investigating the role played by firm-level capabilities in IT firms and linkages between these firms and other economic sectors in driving the growth process. Linkages and capabilities are relevant for analysis as they are some of the key features that distinguish the manufacturing sector from other economic sectors.

The investigation of capabilities and production, fiscal, consumption, financial and technological linkages emanating from the sector to the rest of the economy will draw from existing theoretical perspectives on firm-level capabilities and various configurations of production systems. These will be explored by triangulating various data sources, both primary and secondary, including primary data obtained through survey and case study methods. The technical analysis of production activities in the sector and at the boundaries of its interactions with other sectors will be complemented by an analysis of the context-specific conditions which have led to the sector's emergence, and which have the potential to either aid or impede its future development. This research will introduce new perspectives on the service sector in developing countries by revisiting prevailing views about the sector's potential for fostering growth, and relationship with the manufacturing sector and the rest of the economy. In particular, the factors that have precipitated the emergence of high-value-added services, such as the Information Technology (IT) sector in Nigeria, in a low development context, will be analysed. The heterogeneity of the service sector in which many disparate activities are homogenised under one category will also be addressed.

This chapter sets the context for the rest of the study with background information on the Nigerian experience with structural change in section 2 while section 3 documents the rise of the service sector in Nigeria. The challenges with the diversification process are reviewed in section 4 leading to the development of the problem statement in section 5. Section 6 introduces the research questions and the rationale for the research, section 7 sets out the methods and methodology for addressing the research questions while the structure of the rest of the thesis is presented in section 8.

1.2. Background of Nigeria

The African experience with economic growth and structural transformation continues to attract considerable attention and has provided fertile ground for the proposition of theories seeking to explain less than impressive growth outcomes. Explanations offered include Africa's colonial legacy, negative outcomes of Structural Adjustment Programmes (SAP) introduced in the 1980s, poor governance, and geographical challenges; however, none of these on their own seems persuasive (Noman et al., 2012; Stein & Nissanke, 1999). The introduction of Import Substitution Industrialisation (ISI) policies in the 1960s and 1970s enabled some countries on the continent to develop a manufacturing base initially focused on light manufacturing and the production of consumer goods as a pathway to heavy industry. The unsustainable nature of these policies due to reliance on imported inputs was exposed by the collapse of commodity prices in the 1980s[1] (Wangwe & Semboja, 2003). The implementation of SAP by the International Financial Institutions (IFIs) as these countries plunged into macroeconomic crisis in the early 1980s marked a turning point in growth trajectories. In particular, per capita incomes and manufacturing value added (MVA)

[1] The failures were beginning to emerge by the late 1970s when the manufacturing sector in many African countries were experiencing low returns, low-capacity utilisation and declining labour productivity.

declined and have failed to recover substantially till date (Mkandawire & Soludo, 1999; Stein & Nissanke, 1999).

In the specific case of Nigeria, the dominant narratives centre on the country's inability to translate its natural resource wealth to economic prosperity and improved livelihoods for its populace. Several causal factors have been proposed to explain the perceived dysfunction of the Nigerian State and society particularly with Dutch disease (Corden & Neary, 1982; Davis, 1995; Davis & Tilton, 2005; Van Wijnbergen, 1984) natural resource curse (Auty, 1994; Gelb, 1988; Sachs & Warner, 1995, 1997, 2001), rent-seeking (Gelb, 1988; Jomo & Khan, 2000; Krueger, 1974; Yates, 1996) and neo-patrimonialism (Diamond, 1983; Grugel, 2002; Olukoshi, 2003; Schatz, 1984) narratives gaining currency. These narratives on the failings of the State adopted various approaches to disentangling the impact of specific socio-political factors on the economic structure and growth trajectory in Nigeria. Some of these will be addressed through a historical review of the development of the Nigerian economy.

Prior to the discovery of oil in Oloibiri Local Government Area of Nigeria in present day Bayelsa state in 1956, the Nigerian economy was mainly agrarian. This economic structure was fostered under colonial rule when Nigeria was exploited for its agricultural produce while industry was suppressed so the nation could provide an outlet for manufactured imports from the United Kingdom (Ushie, 2010). In the colonial period, which culminated in independence in 1960, the fledgling Nigerian elite was able to negotiate for itself a greater role in ancillary service activities related to the facilitation of import and export trade, wholesale and retail trade, transport and distribution amongst others (Ushie, 2010).

Following independence, there was a clamour for the development of an indigenous manufacturing sector picking up on the nationalist fervour sweeping much of the developing world as nations began to push towards self-sufficiency with the development of manufacturing viewed as a benchmark of development. Import-substituting industrialisation was considered a viable path to the eventual development of capabilities in export-led industrialisation, a development path adopted by many African countries (Mkandawire & Soludo, 1999; Van Arkadie, 1995). Specific policies implemented to accomplish this include the imposition of high tariff and non-tariff barriers, import restrictions, an indigenisation policy (reserving specific categories of industrial activity in the services and manufacturing industries for Nigerians), and targeted investment in Core Industrial Projects

(CIP) which include iron and steel, paper, fertiliser, petrochemicals, oil refining, machine tools, liquefied natural gas and aluminium smelting (Ikpeze et al., 2004).

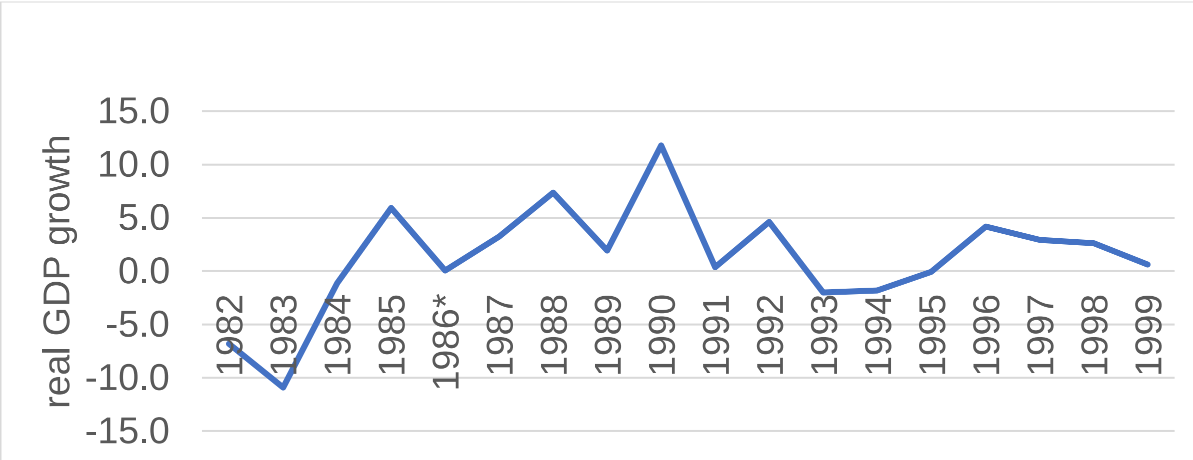
Nigeria developed a fledgling consumer product manufacturing sector to meet demands from its growing workforce as income from oil exports increased; however, its foray into 'hard sectors' such as steel manufacturing and oil refining were less successful (Olukoshi, 2003). Several explanations were put forward to explain this failure ranging from poor planning, lack of managerial capacity, absence of a nationalist orientation, undue influence of ethnic considerations in the selection and siting of projects, declining terms of trade and its negative impact on foreign exchange earnings and widespread corruption amongst others (Ikpeze et al., 2004; Okafor, 2013).

Many of these factors no doubt contributed to the demise of industry; however, the volatilities in the international oil market and the introduction of policies consistent with the World Bank and International Monetary Fund (IMF)-led SAP[2] are more plausible (Olukoshi, 2003). As the economy faltered and manufacturing, agriculture and public sector jobs began to disappear, much of the Nigerian workforce turned to informal service sector activities which tended to provide subsistence-level remuneration in many cases (Van Arkadie, 1995).

The policies introduced under the influence of IFIs were ostensibly to restore macroeconomic stability and stimulate manufacturing and agriculture mainly through the devaluation of the Naira to favour the tradeable sector, the adoption of a market-based approach for determining nominal foreign exchange rates[3], deregulation of interest rates, elimination of price controls, trade liberalisation, and the abolishment of commodity marketing boards. Other measures implemented include freezing of public sector wages and salaries, public expenditure reductions, and the withdrawal of subsidies (Olukoshi, 2003; Oluyemi-Kusa, 1994). These policies were implemented haphazardly, largely due to local resistance which led to some policy reversals. In the first four years of its implementation there was a recovery in GDP growth; however, by the end of military rule[4] the outcome was an economy in decline and a manufacturing sector which never quite 'took off' (Figures 1.1 and 1.2) (Olukoshi, 2003).

[2] Due to resistance by organized labour unions, university students, trade unions and other segments of the society, the government led by General Ibrahim Babangida surreptitiously passed off SAP policies as 'home-grown' policies (Olukoshi, 2003; Oluyemi-Kusa, 1994).
[3] The Naira is the local currency in Nigeria
[4] From 1966-1999 but with short-lived periods of democratic governance

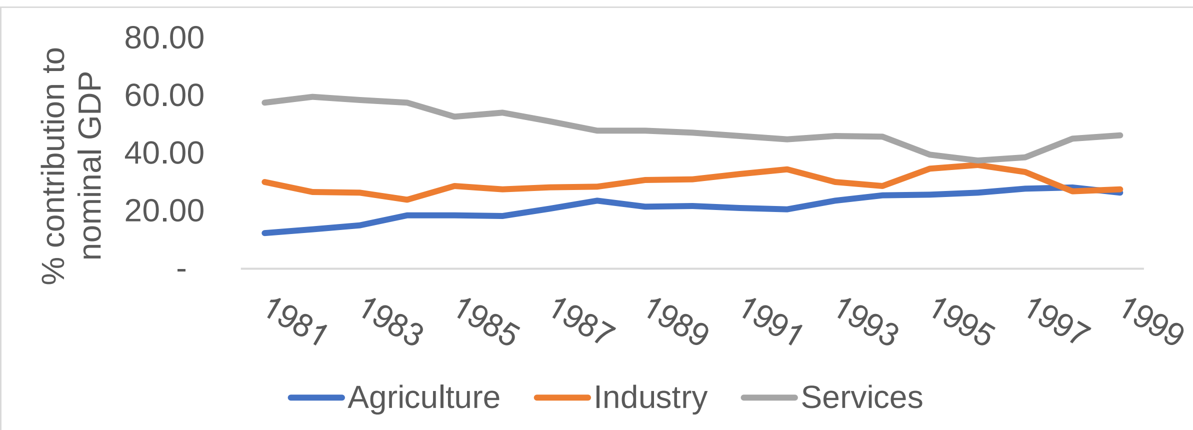
Figure 1.1: Real GDP Growth in Nigeria from 1982 to 1999



Source: National Bureau of Statistics (NBS), 2021

* start of SAP implementation in Nigeria

Figure 1.2: Sectoral Contribution to GDP growth in Nigeria (1981-1999)



Source: NBS, 2021

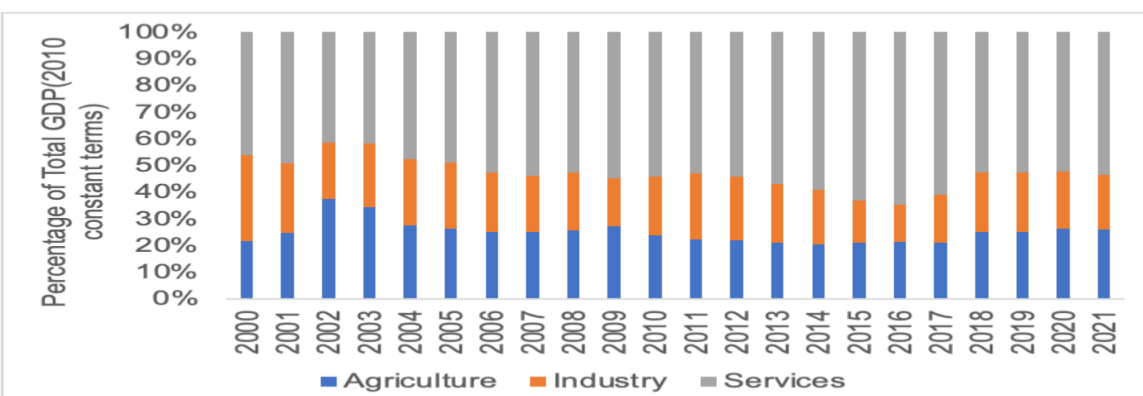
These conditions persisted until the restoration of a democratic system of government in 1999, at which time efforts to restore macroeconomic stability entailed a negotiated foreign debt relief package, adoption of counter-cyclical fiscal policies to manage volatilities in the international oil market, introduction of tax initiatives to tax the non-oil economy and the implementation of a broad swathe of socio-political reforms to address corruption and improve public sector accountability (Okonjo-Iweala & Osafo-Kwaako, 2007). In this period, economic indicators were on the upswing and the structure of the economy was undergoing significant change although this was obscured by outdated GDP data (see Figure 1.3).

1.3. The Rise of the Service Sector

The privatisation of the telecommunications sector in 2001 as part of the SAP process was a key milestone as it led first to the entry of new firms in the Global System for Mobile Telecommunications (GSM) space and the growth of the IT sector generally. The impact on national output was reflected to a limited extent in GDP numbers and pointed to a growing share of IT in the economy.

In contrast to the rest of the service sector, there has been a tendency for the IT sector to be viewed by policy makers as a catalytic force in the modernisation and diversification of the Nigerian economy on the basis of limited evidence (Federal Ministry of Budget and National Planning, 2017).[5] Regardless of the performance of the IT sector, manufacturing and agriculture are still considered as the main drivers of economic growth in Nigeria as reflected in a multiplicity of development plans (Federal Ministry of Agriculture and Rural Development, 2014; Federal Ministry of Finance, Budget and National Planning, 2021; Federal Ministry of Trade and Investment, 2014; National Planning Commision, 2009, 2011). However, the struggling oil and gas sector continues to be the main source of government revenues, foreign exchange and exports as reflected in budget implementation reports by the Budget Office of the Federation, Federal Ministry of Finance, trade reports by the NBS and statistical bulletins by the Central Bank of Nigeria (CBN) for the last ten years or more.

Figure 1.3: GDP growth by sector in Nigeria (2000-2021)



Source: NBS, 2000-21

[5] As an illustration, the last medium term National Development Plan titled the 'Economic Recovery and Growth Plan' recognizes that 'a vibrant telecommunications and ICT sector is required to drive and expand national production frontiers across all sectors of the economy'. IT sector activities are integrated into most sector plans; however, no evidence is provided on the sector's ability to drive growth (Federal Ministry of Budget and National Planning, 2017).

A long overdue GDP re-basing exercise in 2014[6] uncovered considerable restructuring of the Nigerian economy with agriculture and the oil and gas sectors contributing less to GDP than previously thought. Although the more than doubling of GDP numbers[7] subsequent to rebasing met with some scepticism, there is no doubt that it captures new activities in the economy that were non-existent at the time of the 1990 exercise (The Economist, 2014). The exercise brought to the fore growth in new service sector categories and revealed the sector's position as the largest in the economy, accounting for more than 50 percent of GDP (see Table 1.1). Nigeria is ranked as the largest economy in Sub Saharan Africa in terms of GDP with South Africa in second place on the basis of these numbers (International Monetary Fund, 2021).

Table 1.1: Share of Service Sector Categories in Total Services (2014-2020)

SERVICE SECTORS	2014	2015	2016	2017	2018	2019	2020
TRADE	17.64	19.15	20.37	18.97	17.16	15.61	13.86
ACCOMMODATION AND FOOD SERVICES	0.92	0.95	0.91	0.87	0.90	0.97	0.88
TRANSPORTATION AND STORAGE							
Road Transport	1.14	1.23	1.34	1.38	1.61	1.89	1.56
Rail Transport & Pipelines	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water Transport	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Air Transport	0.09	0.10	0.09	0.09	0.12	0.14	0.10
Transport Services	0.07	0.08	0.08	0.08	0.07	0.06	0.06
Post and Courier Services	0.03	0.03	0.03	0.02	0.02	0.02	0.01
INFORMATION AND COMMUNICATION							
Telecommunications & Information Services	8.34	8.65	8.40	7.53	7.57	8.25	8.73
Publishing	0.02	0.03	0.03	0.03	0.03	0.03	0.02
Motion Pictures, Sound recording and Music Production	1.13	1.21	1.18	1.10	0.98	0.90	0.83
Broadcasting	1.27	1.56	1.70	1.65	1.59	1.51	1.45
ARTS, ENTERTAINMENT AND RECREATION	0.20	0.22	0.24	0.23	0.21	0.20	0.18
FINANCIAL AND INSURANCE							
Financial Institutions	2.73	3.02	3.05	2.93	2.70	2.53	2.78
Insurance	0.41	0.44	0.49	0.44	0.43	0.41	0.33
REAL ESTATE	8.40	8.70	8.22	7.56	6.76	6.24	5.70
PROFESSIONAL, SCIENTIFIC AND TECHNICAL SERVICES	3.82	4.17	4.44	4.16	3.81	3.48	3.11
ADMINISTRATIVE & SUPPORT SERVICES	0.02	0.02	0.03	0.02	0.02	0.02	0.02
PUBLIC ADMINISTRATION	2.97	2.71	2.74	2.57	2.29	2.01	1.95
EDUCATION	2.03	2.25	2.41	2.28	2.14	2.06	1.78
HUMAN HEALTH AND SOCIAL SERVICES	0.69	0.73	0.73	0.69	0.64	0.62	0.62
OTHER SERVICES	2.89	3.50	3.93	3.80	3.53	3.28	3.00
TOTAL SERVICES	**54.82**	**58.76**	**60.42**	**56.38**	**52.57**	**50.22**	**46.97**

Source: NBS, 2014-21

[6] The exercise entailed updating the base year from 1990 to 2010 and increasing coverage of firms covered in enterprise surveys from 851,628 to 83,733 which include firms in emergent sectors such as telecommunications and the entertainment industry (NBS, 2014a)

[7] Comparison of GDP numbers prior to rebasing (1990 base year) and the rebased numbers (2010 base year) uncovers a 59.5 percent increase (NBS, 2014b)

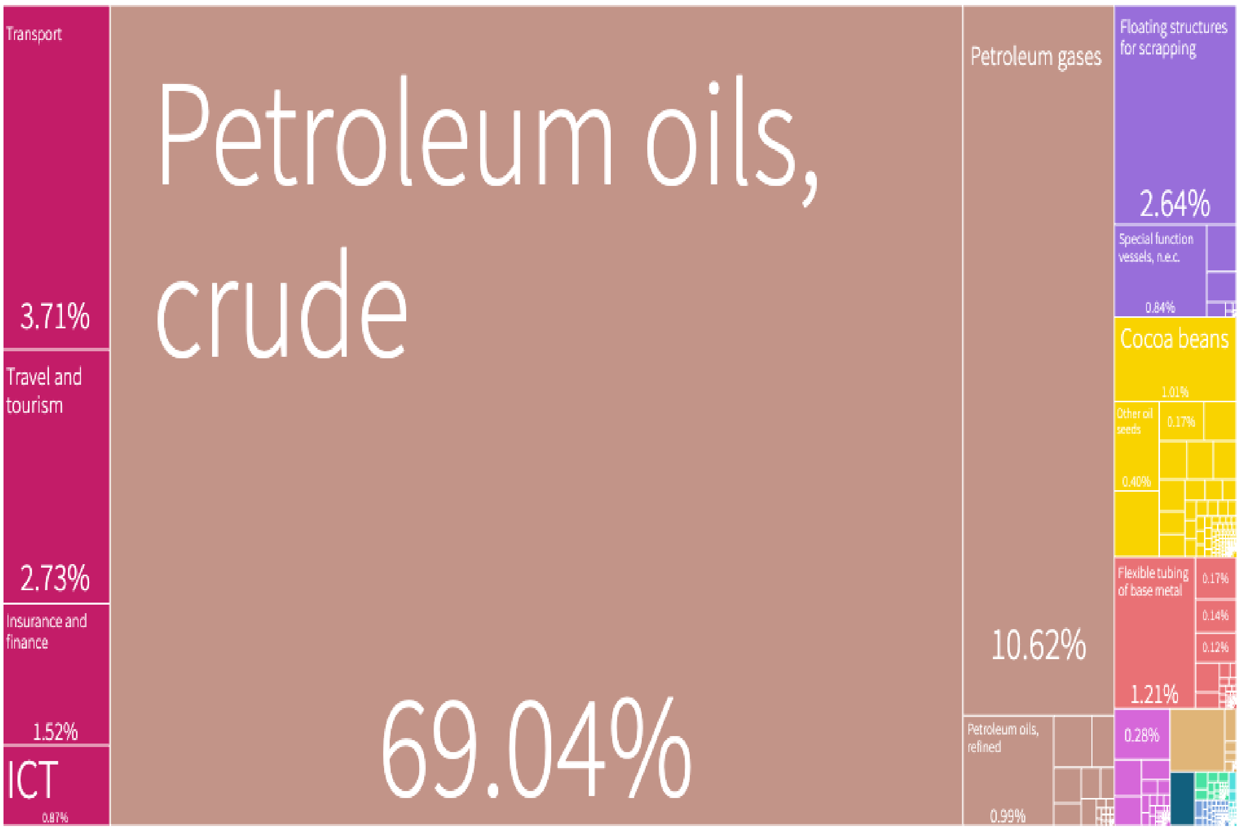
Incidentally, this new data was unveiled in April 2014, a few months before the slowdown in GDP growth on the back of declining oil prices. Fiscal and balance of payment pressures began to emerge from late 2014, have continued till date and these have placed a considerable squeeze on the economy. These pressures are due to rising debt service costs, the subsidy on petrol amongst others. External inflationary pressures resulting from the impact of COVID-19 on the global economy as well as supply chain challenges have intensified these fiscal pressures and impeded the delivery of goods and services.

1.4. Challenges with Diversification

Despite indications of a relatively more diversified economy, government revenues, exports and foreign exchange sources remained undiversified as the non-oil economy's contribution is not concomitant with its size. This state of affairs is resulting in a renewed search for growth opportunities; however, policy documents point to a continuing emphasis on increasing manufacturing and agriculture productivity to drive growth in exports (Federal Ministry of Agriculture and Rural Development, 2014; Federal Ministry of Budget and National Planning, 2017; Federal Ministry of Finance, Budget and National Planning, 2021; Federal Ministry of Trade and Investment, 2014; National Planning Commision, 2009, 2011).

A decomposition of Nigeria's export base shows which sectors are actually driving export growth. The mapping of Nigeria's export base presented in Figure 1.4 is based on the product space methodology developed by Hidalgo, Hausmann and their colleagues (Hausmann & Klinger, 2006; Hidalgo et al., 2007). As of 2019, the oil economy, represented by crude oil, liquefied natural gas and refined petroleum products, accounted for 80 percent of total exports (Figure 1.4). Nigeria's export complexity, based on the Economic Complexity Index (ECI) developed by Hausmann et al (2014), shows that Nigeria has a low ECI as most of the products exported can be made in other countries. In addition, the ECI declined in 2019. Aside from the oil and gas sectors, only a few services are recognised as contributing to total exports and these include transport (3.71%), travel and tourism (2.73%), insurance and finance (1.52%) and information and communications technology (ICT) (0.87%). This indicates that although services are making a significant contribution to the domestic economy, their impact on the global economy in terms of trade and potential for attracting much needed foreign exchange earnings is limited.

Figure 1.4: Nigeria's Export Basket in 2019 (SITC 4)



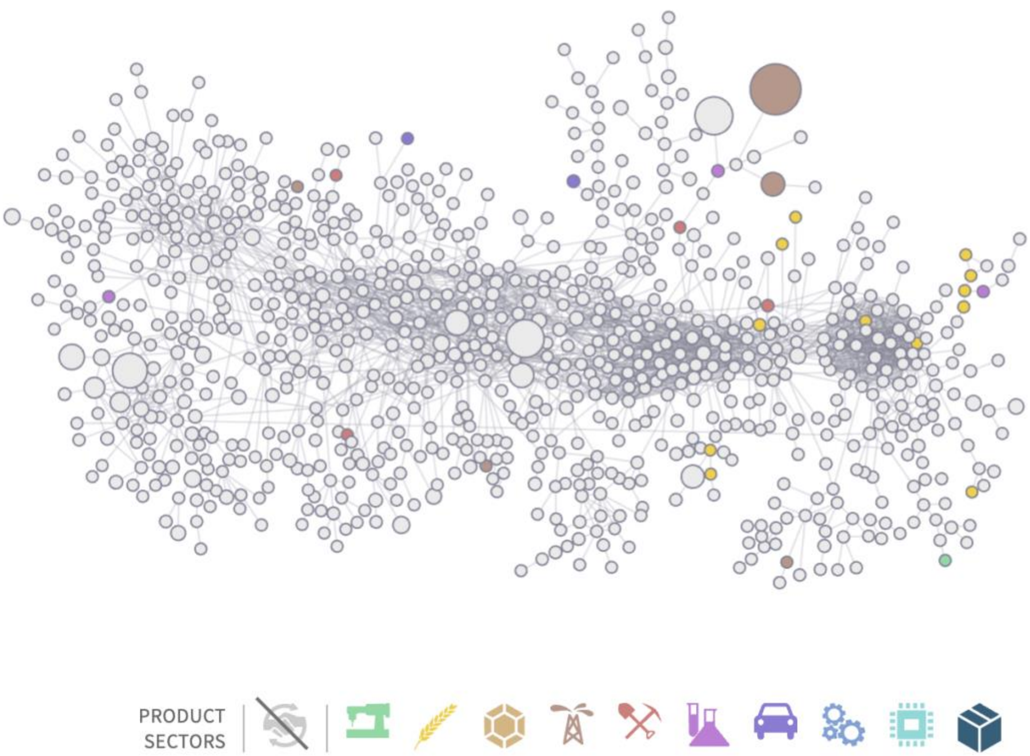
Source: Atlas of Complexity, Centre for International Development at Harvard University, 2021

With the product space visualisation, it is possible to view the connections between sectors and the rest of the economy. It displays where activities aggregate in the economy with the densely populated areas of the map showing where activities cluster and linkages form between activities. The sizing of the nodes represents the amount of trade from that sector to the rest of the world. Coloured nodes represent products the country exports while grey nodes are products not exported. Most of Nigeria's nodes are small and grey, indicating that exports emanate from very few sectors. As expected, the largest coloured nodes are for petroleum oils and gases, while the smaller coloured nodes are mostly metals and agricultural produce.

The sparsely populated product space for Nigeria provides evidence to support this lack of diversification in exports with its few significant primary exports located at the periphery where few linkages to other products are typically found (Figure 1.5). According to the product space methodology, countries have better chances of diversification when they transition into areas where they can build on their existing capabilities (Atlas of Complexity, 2019). Thus, Nigeria would require greater effort to move closer to the core of its map where higher value-added activities are located and stronger linkages can be developed according to product space theory (Hidalgo et al., 2007). IT and other services do not show up significantly in terms of contribution to international trade or contribution to linkages within the economy.

As stated earlier, Nigeria's supply of foreign exchange is limited, thus service sector-led growth as an alternative to manufacturing-led growth should contribute to an increase in foreign exchange reserves through its contribution to international trade. More importantly, it should be marked by linkages economy-wide and build on capabilities present in the economy or those which are not difficult to develop. This is also in consideration of the poor performance of the manufacturing sector which is typically characterised as the driver of economic growth in most countries (Kaldor, 1961).

Figure 1.5: Product Space for Nigeria 2019 (SITC 4)



Source: Atlas of Complexity, Centre for International Development at Harvard University, 2021

1.5. Problem Statement

Juxtaposing the rise of the service sector, in particular, IT Services and its increasing prominence within the domestic economy, against the limited linkages and the lack of contribution to exports as shown in the product space visualisation, questions are raised about the capacity of the sector to drive economic growth since both sets of data seem to be in opposition to each other. For this reason, the intent of this thesis is to investigate the nature of these capabilities in the IT sector and the linkages between it and rest of the economy. This will assist in answering the question of whether the IT sector can deliver the type of diversified growth which the oil-dependent structure of the economy has failed to deliver.

To do this the research will have to move from the macro and meso levels of analysis utilised in the product space mapping and the data on IT sector contribution to GDP growth to the micro level. By moving the analysis to the micro level, specifically to the level of the firm, it is possible to observe the capabilities available within the firm and how these capabilities impact the development of linkages. On this basis, the research questions for this thesis can be articulated by revisiting important strands of the discussion on service and manufacturing-led growth.

1.6. Research Questions

In an effort to situate the service sector contribution to economic growth, there is need for a deeper and nuanced understanding of the structure of the service sector and its relationships with other sectors, in particular manufacturing. There seems to be a conflation of the experience of structural change in the service sector in developed countries with that of developing countries when on further examination the patterns of change might be quite different. In advanced industrial countries, services utilised in the production process have appeared as an offshoot of manufacturing as these services have been externalised or outsourced so manufacturing firms can focus on their 'core competence' (H.-J. Chang et al., 2016; Syrquin, 2007). Thus, this category of services is seen as disguised manufacturing.

This does not seem to be the case for developing countries, particularly in many parts of Africa, where manufacturing activity never took off for reasons discussed previously. This raises the important question of where the impulse for service sector growth of the production-related and technology intensive type, such as IT Producer Services, originates from. The answer to this question also has important implications for understanding the capabilities within IT firms, and the nature of the linkages between these service types and manufacturing in African countries. If these production-related services developed in the absence of a strong manufacturing sector how this did occur and what production activities are they 'servicing'?

Further questions about the role of the service sector in economic growth have also arisen in the course of the discussion. The narrative on services suggests that untradeable services cannot assist in alleviating balance of payment constraints, a significant issue for developing countries which require imports of intermediate inputs and capital goods to kick-start manufacturing. However, the emergence of production-related services locally raises questions on the impact a lack of tradability might have played in allowing the emergence of specific production-related service sectors. Lastly, services were once perceived as low productivity activities; however, this perception seems to have arisen from the homogenisation of disparate service activities and the limited presence of technological progress in the sector. Thus, the heterogeneity of services is another question worth considering.

In recent times the introduction of IT in the production process in developed countries is countering this narrative; however, it is not clear if IT is being factored into production activities in the same manner in developing countries. This leads to the question of investigating how the use of IT services can be deduced. It raises the question of the possibility of developing a measure for ranking countries in such a way that the use of IT in production can be tracked over time. These observations have formed the basis for defining a set of research questions to revisit the role of the IT sector, in economic growth in Nigeria:

1. How are IT services employed in the production process in different development contexts and can an objective measure be developed to measure this?
2. Where do producer services such as IT services originate from in the developing country context and is this different from what prevails in advanced industrial country contexts?
3. What linkages exist between the IT sector and other parts of the economy and what are the implications for IT's role as a driver of economic growth?
4. How are capabilities developed within and across the IT sector and diffused through the economy via these linkages?

These questions point to the need to develop a methodology that allows the use of a variety of research methods given that the study of IT services involving service heterogeneity, and the examination of linkages and capabilities at the level of the firm are not covered extensively in the existing literature on structural transformation.

1.7. Methodology

A multi-faceted research process was adopted for answering the questions posed for this research. The methods applied to answering each of the questions are summarised as follows:

Question 1: ***How are IT services employed in the production process in different development contexts and can an objective measure be developed to measure this?***

In the absence of an existing measure for evaluating the use of IT Producer Services in the production environment, a composite index is developed using secondary data on IT services and other indicators relating to production. Although several indices exist for measuring the use of technology in specific countries, this approach is novel due to the introduction of an indicator representing the integration of IT services and manufacturing, the use of numerically controlled machines. The index is developed using multivariate analysis, specifically Principal Component Analysis (PCA).

Question 2: ***Where do producer services such as IT services originate from in the developing country context and is this different from what prevails in advanced industrial country contexts?***

This is not a question that has been addressed in the existing literature on services and for this reason, aside from a review of the literature to identify patterns indicating the different origins of services in different development contexts, case studies of three IT firms in Lagos, Nigeria were employed. These case studies demonstrate how the pattern by which deindustrialisation and tertiarisation occur and interact in a country shape the types of services which emerge. The firms were identified from an original survey of IT firms in Lagos, Nigeria.

Question 3: ***What linkages exist between the IT sector and other parts of the economy and what are the implications for IT's role as a driver of economic growth?***

Linkages are selected as the parameter of interest for answering the question at the core of this thesis on how services can be a driver of economic growth. Three IT firms operating in the agriculture, financial services and manufacturing sectors of the Nigerian economy are identified and case studies presented of the types of linkages between these firms and the sectors considered. The linkages investigated include technological, financial, consumption/fiscal, and production using a case study approach.

1.8. Structure of Thesis

This thesis is structured into seven substantive chapters, excluding the bibliography and appendices:

In **Chapter 1**, the research is introduced laying out the background for the work, the problem statement, research questions to be addressed and the methods and methodologies for answering the questions.

In **Chapter 2,** the literature on structural change theories is reviewed with a special emphasis on how services are conceived in this literature. Strategies for economic growth, which include manufacturing and service led growth, are considered in specific development contexts. The question of service classifications to address the heterogeneity of services are reviewed while the review concludes with an examination of the literature on firm-level capabilities and linkages.

Chapter 3 focuses on the development of a novel IT Producer Service Index. A theoretical framework underlying the composite index is developed, multivariate techniques are utilised in developing the index and the index is applied in ranking countries using real world data .

Chapter 4 investigates the origin of services in different contexts from the perspective of their deindustrialisation and tertiarisation trajectories. Three separate deindustrialisation trajectories are identified from an extensive review of the literature on the subject by focusing on the demand and supply side drivers responsible for the emergence of services in pre-industrial deindustrialising countries, the focus of this thesis. This analysis is supported with case studies of three IT firms in Lagos which document the demand-side and supply-side drivers responsible for their emergence.

Chapter 5 is an intensive exploration of linkage development and firm-level capabilities in the IT sector in Lagos, Nigeria. Technological, financial, consumption/fiscal, and production linkages are investigated in three IT firms in Lagos, Nigeria using a case study approach.

Chapter 6 builds on the work in Chapter 5 by synthesising the results of the linkage analysis and applying this in the development of a capabilities-linkage matrix building on existing work in this area.

Chapter 7 concludes and draws policy conclusions from the findings of the research.

2. CHAPTER 2: LITERATURE REVIEW

2.1. Introduction

The overarching question in this thesis is to ask whether services can be a driver of economic growth in Nigeria. This question is an emerging one in the development discourse and applies to all countries irrespective of their stage of economic growth; however, it is particularly relevant for low income and developing countries yet to or unable to undergo manufacturing-led structural transformation due to endogenous and/or exogenous structural impediments. To set the analytical framework by which this question will be answered, key themes discussed include the growth process from a developing country perspective, the nature of structural transformation via the interaction between economic sectors and a particular emphasis on shifting perspectives on the role of services in driving economic growth vis-a-vis manufacturing sector-led growth.

The study of the determinants of economic growth and development has fascinated and perplexed economists in almost equal measure since the early days of the discipline and will likely continue to do so for the foreseeable future. The process of growth is perplexing in situations when efforts to deconstruct growth and replicate actions interpreted as growth-stimulating in one context yield undesirable results in another. Sub Saharan Africa (SSA) has been a 'petri dish' for a variety of growth experiments and once a narrative of 'Africa rising' gains traction and explanatory factors are put forward to explain said growth, it is almost inevitable that an unanticipated event occurs that brings those very factors into question even as the growth decelerates and in some cases reverses.

In line with the search for the drivers of sustainable and broad-based growth, this thesis is revisiting some aspects of our understanding of the mechanism by which an economy undergoes dynamic changes in its structure and its implications for growth (Pasinetti, 1993). The literature on this subject is broad and diverse, but this review will trace some of the key movements on growth and development in the economic discipline from a structuralist perspective. The structuralist viewpoint allows a broadening of the lens by which growth is analysed by its paradoxical willingness to narrow down the analytical building blocks of to the productive sectors or 'structures' which drive economic growth. This is a very different approach to the neoclassical framework which has traditionally viewed the economy in aggregate and placed emphasis on uncovering the conditions necessary to move an economy towards equilibrium.

Thus, the key debates in the structuralist economics literature on the sequencing of investments in a developing country context, balanced and unbalanced growth approaches, will form the bedrock of this analysis. Key points raised include the multi-sectoral, dynamic and interdependent nature of growth. These perspectives on growth and structural transformation will be analysed from the perspective of service expansion and the interactions of services with other sectors of the economy with emphasis on the manufacturing sector. The importance of linkages in fostering these interactions, their operationalisation in Local Production Systems, and how these particular features are amplified in the context of service-led growth are discussed in this literature review.

Section 1 introduces the chapter while section 2 explores the main currents in the structuralist economics discussions on growth dynamics in underdeveloped countries. The review focuses on the dynamic nature of growth and explores competing theories of how to stimulate growth either by coordinating investments in specific sectors of the economy and taking advantage of the external economies and increasing returns generated or allowing growth to proceed by allowing disequilibria in these sectors to stimulate a process of circular cumulative causation. Section 3 considers the various strategies of economic growth covered in the literature and which are adopted by distinct categories of countries on the basis of their level of industrialisation. These strategies are of two main sorts, manufacturing-led growth and service-led growth and in this review, the 'pre-industrial' context is considered, leading to a realisation of the need for a deeper understanding of the heterogeneity of services.

Section 4 reviews the variety of approaches to service classifications with an emphasis on the knowledge and technology-intensive type of producer services. It highlights the limitations of this inward-looking approach to service heterogeneity in the context of production and points to a need for considering how services interact with other economic sectors. This leads to a review of the literature on linkages in section 5 which brings the review full circle, connecting with the exposition in section 2 of this review. The various means by which linkages are operationalised is discussed in the review, including the structures through which these occur, such as Global Value Chains and Local Production Systems, as well as the capabilities required to foster the linkages. Section 6 summarises the literature review.

2.2. Enter the Structuralists

Development economics in many ways developed as a separate area of study in the economics discipline. It is focused on the long-term problems associated with growth and development while the rest of the discipline narrowed down on issues related to exchange and equilibrium. Due to the complexity of the variables under consideration and its inductive approach, development economics is judged as more amenable to empirical facts whilst failing to develop robust theories to support its claims (Pasinetti, 1993). However, this is a limited understanding of the complexity of growth and development.

The structuralist school of economics, a major branch of development economics, grew in response to the failings of standard economic models to explain the problems of development after World War II. The early neo-classical models were typically aggregate one-sector models based on an abstract world far removed from real world complexities with its multiple sectors and interdependencies, the imperfect conditions in which these sectors operate and the institutional environment undergirding the entire structure (Pasinetti, 2012). Even in cases in which multi-sector variants were developed, they were still limited by the static nature of their analysis and placed emphasis on balanced growth (Pomini, 2012; Syrquin, 2012).

The use of the term 'structuralist' as a descriptor derives from the concept of structuralism which is a philosophical viewpoint that focuses on the whole rather than the individual, and advocates viewing objects as part of the larger structures they belong to and not in isolation (Barry, 2017). It has found application in the fields of literature, linguistics and social theory amongst others but was also extended to economics to address the shortcomings of prevailing mainstream modes of thinking. As defined in The New Palgrave Dictionary of Economics, it is based on an analysis of systems in their entirety and the interdependencies between elements of the system rather than individual entities (Blankenburg et al., 2017).

The limited use of mathematics in the expositions by structuralists and development economists more broadly is oftentimes considered a weakness; however, the tendency of neoclassical models to exclude from their models any variables that could serve as obstructions to the seamless functioning of markets resulted in unrealistic models devoid of implementable policy prescriptions (Chenery, 1975). The structuralist tradition engages with questions about the economic advancement of nations, which has always been important to the economics discipline but became the principal focus and took centre stage in the 1950s and 1960s. According to structuralists, these questions can only be addressed from a disaggregate view of the economic system. Thus, there is a need to move beyond the macro to the meso level of the economy where sectoral interactions can be observed and to a more granular micro level of further interdependencies amongst economic units

In the exposition that follows, main currents of thinking in the structural economics literature will be analysed. The main lines of thinking to be evaluated include the movement from a static to a more dynamic form of analysis, the development of the three-sector hypothesis and its implications, and finally the immiseration of developing countries through adverse terms of trade brought about by specialisation in primary commodities.

2.2.1. Growth From a Sectoral Perspective

Early inquiry into economic growth from the viewpoint of the three major sectoral groupings, primary (agriculture), secondary (industry, including manufacturing and mining) and tertiary (services) is attributed to Allan G.B. Fisher (1935) and was subsequently studied in the work of Colin Clark (1940) and Jean Fourastie (1951) amongst others. These sectoral categories, which were utilised in common parlance but formalised by Fisher, have become shorthand for categorising economic activity. Colin Clark's seminal work contributed to the unpacking of the meso-level interactions undergirding economic growth. His paper, titled 'The Conditions of Economic Progress' (Clark, 1940, p. viii), made mention of the inclination to cherry-pick facts to support already developed theoretical arguments and the encroaching of economics into the other social sciences while neglecting the central themes that should be of interest to economics.

While examining the trends in economic progress in different countries, he made the strong generalisation that countries with a high proportion of the working population engaged in tertiary production are associated with a high average level of real income per head. He went further to classify economic activity into three broad categories - Primary (agricultural and pastoral production, forestry, fishing and hunting), Secondary (manufacturing, mining, building construction and public works, gas and electricity supply) and Tertiary (distribution, transport, public administration, domestic services and other activities producing a non-material output). This classification method, which built on an observation made by Sir William Petty in 1691,[8] still undergirds major classification systems such as the widely adopted United Nations International Standard Industrial Classification (ISIC).

Allan Fisher used similar terminology to Clark's in describing the economic sectors and the three-sector model or Fisher-Clark hypothesis arose from their work (Fisher, 1952). The hypothesis is a dynamic representation of the major economic categories, describing how countries tend to advance

[8] 'There is much more to be gained by Manufacture than Husbandry; and by Merchandise than Manufacture.' (Bevan, 1894, p. 220)

through the stages from primary to tertiary as productivity increases. The mechanics by which activities shift from one sector to the other form the basis of the Fisher-Clark or Three-Sector hypothesis. The hypothesis was developed at a time when manufacturing as a share of total output and employment had begun to decline in many advanced countries and the tertiarisation process was already underway.

Several important theoretical and empirical findings emerged from these early studies, some of which were advanced for their time and opened further areas of research, many of which address the development of a means of classifying services in a manner that recognises their diverse characteristics. Fisher made a strong case for treating services as a separate economic category worth studying independently. He went further by recognising that not only was tertiary production already present at the primary and secondary stages of economic development based on his division of world economic history into three stages, but some of these service activities developed independently and not in support of manufacturing (Fisher, 1952). It was acknowledged that though most services at the time of his writing had not been affected by technical change, there was no obstruction to technical change affecting some services 'immediately and directly' (Fisher, 1952, p. 829).

Clark on his part viewed economic progress as a consequence of rising per capita income in either secondary or tertiary production as the working population migrates into either of these sectors from primary sector activities. This statement implies that in his view, economic progress did not necessarily emerge from only the secondary sector of the economy but could also occur in the tertiary sector, contrary to prevailing views on manufacturing as the prime mover of economic growth (Kaldor, 1966, 1985).

Fourastie (1951) adopted a similar classification approach but used the degree of intensity of technical progress to classify industries into three sectors, with the intensity increasing from primary to secondary. According to his thesis, technical progress is responsible for the migration of labour from primary to secondary activities. In contrast to Fisher and Clark, he considered the tertiary sector as a residual, reserved for those displaying nil or negligible technical progress. On this matter he differed from Fisher who felt many tertiary activities were imbued by technical progress in the primary and secondary stages and in fact some were direct benefactors of technical progress (Fisher, 1952). The exposition by Fisher and Clark marked a significant turning point in explorations of the problems of developing countries based on fundamental structural characteristics. It was also a departure from earlier growth models which identified a low level of savings and thus investment as the main cause of underdevelopment (Domar, 1946; Harrod, 1939).

The dual economy model of Arthur Lewis also focused on structural dynamics although employing different sectoral classifications from Fisher, Clark and Fourastie (Lewis, 1954). It is based on the classical tradition and utilised a capitalist (productive) and subsistence (unproductive) sector to describe the transformation that occurs within an economy as labour moves from a less to more productive sector (Lewis, 1954). Lewis took pains to point out that developing countries were unable to save, not because of their poverty but because of the small size of their capitalist sector. Essentially, the structure of their economies limited their ability to grow. His was considered the first formal model to address the problems of developing countries which received scant attention in the neoclassical growth models.

Rostow (1959) explored the various stages of economic growth from a historical perspective, also highlighting the shift from traditional to modern activities and seeking to develop a dynamic framework to describe the growth process. The build-up of social overhead capital, a technological revolution in agriculture and expansion in imports financed by improved production and marketing of natural resources were identified as the factors behind the successful transition through the stages.

Although presenting an interesting narrative interpreting historical events to explain how advanced economies moved through the various stages from traditional society through to the age of high consumption there was very little offered on how developing countries could replicate such experiences given the specific structural constraints they face. Rostow's exposition shares several similarities with that of Kuznets (1966; 1973) who identified six characteristics of modern economic growth, a high rate of structural transformation of the economy being the third. Both concluded that the technological backwardness of developing countries is a key reason for their lack of progress.

2.2.2. Immiseration of Developing Countries

The Prebisch-Singer hypothesis, developed independently by Raul Prebisch and Hans Singer, sought to answer the question of the failure of developing countries to grow their economies (Prebisch, 1950; Singer, 1950). Both drew attention to the long-term decline in the terms of trade for primary commodities, in which many developing countries specialised, in comparison to manufactured products. The uneven distribution of the gains of trade between the core, comprised of industrialised countries, and the periphery, those yet to industrialise and dependent on commodity exports, was at the heart of this hypothesis. The main proposal to counter this inequity was ISI by which developing countries build industrial capacity and substitute imports of manufactured goods with home production.

Industrialisation is treated as more than an end in itself by most structuralists, being the carrier of technical progress and the means for improving the welfare of the generality of the population. By trading in primary commodities, countries of the periphery are consigning themselves to a subjugate position due to the finding that contrary to expectations, increased productivity in manufactures was not resulting in lower prices relative to primary commodities. This is partly attributed to the low-income elasticity of demand for primary commodities. Thus, it seems the cards are stacked against the periphery in favour of the core.

Structuralist economics place developed and developing countries within a global framework that enables the disentanglement of the interactions between both groups, rather than assuming that what applies to industrialised countries can be extended to agrarian countries. This is a departure from the mainstream economics approach, yet, there is need to propose a suitable framework or working model on how developing countries can catch up with developed ones as put forward in the convergence hypothesis of mainstream economics (R. E. Lucas, 1990). The logical question to ask from all the foregoing, especially the disadvantages identified from specialisation in primary commodities, is 'how then do developing or periphery countries approach the process of development in view of these inequities?' This is where the question of balanced versus unbalanced growth enters the discussion.

2.2.3. Balanced versus Unbalanced Growth

Although there is broad agreement within the structuralist school that industrialisation is the most viable path to economic growth and prosperity, there is less consensus on how to approach the process. In proposing an industrialisation strategy for Eastern and South Eastern Europe, Rosenstein-Rodin advocated large scale investments, drawing on foreign capital when necessary, to grow complementary industries simultaneously, in other words, a big push (Rosenstein-Rodan, 1943). This approach is quite similar to that proposed by Ragnar Nurkse (1953, 1956) which involves spreading capital over a broad range of industries subject to increasing returns rather than on a single industry subject to diminishing returns and limited by the small size of its potential market. Indivisibilities in the production process, which must be overcome through a big push, gives rise to increasing returns and external economies (Rosenstein-Rodan, 1961). This exposition is of course based on an elastic supply of capital as opposed to the typical fixed proportions of neoclassical models, thus allowing the exploitation of complementarities between industries (Nurkse, 1956)

The concept of the big push and balanced growth borrow heavily from Allyn Young's analysis of increasing returns in which he describes how the increase in the supply of one commodity leads to an increase in demand for another commodity and how enlarging the market for a commodity has a positive net effect on the demand for other commodities (Young, 1928). Where he advocates for 'roundabout' production, in which capital goods are used to produce other capital goods as well as consumer goods, the balanced growth doctrine makes a case for large scale investment in industry. Young also focuses on external economies at the level of inter-industry operations while the balanced growth theories place emphasis on productivity growth at the level of the firm (Toner, 1999).

Balanced growth theories also have theoretical foundations in Adam Smith's description of the division of labour being determined by the extent of the market and Say's Law on supply creating its own demand. The fundamental requirement for the big push is a surfeit of capital which of course is not available to many developing countries. In this way it links back to the Prebisch-Singer hypothesis which shows that countries are not earning enough from the trade of primary commodities to pull themselves out of a low-equilibrium trap. Thus, in order to industrialise, countries would have to supplement their inelastic supplies of domestic capital with foreign capital.

Various critiques of the balanced growth doctrine have been put forward. Some question the multiplicity of conditions which must be satisfied for its success and suggest the vertical integration of industries involved in the same line of production might be more beneficial as they allow the exploitation of increasing returns in 'factor-producing' industries (Fleming, 1955). Also, the focus on consumer goods industries and public utilities as opposed to producer goods industries whose products can be targeted at export markets is queried (Paul Streeten, 1959; Toner, 1999). However, the strongest arguments are those advocating for unbalanced growth. For Streeten (1959), 'unbalance' creates new desires which in turn stimulate investment opportunities and in some cases, balance has to be sacrificed for growth. Intertemporal considerations in balanced growth also affect opportunities for scaling up investments.

A case for unbalanced growth as opposed to balanced growth was similarly developed by Hirschman who argued that the very skills in short supply in developing countries would be required to implement a program of balanced growth (Hirschman, 1958). Much like Streeten, he pointed out that development has followed a path in which the leading sectors stimulate activities in other sectors and disequilibria helps the development process. According to his exposition, unbalanced growth is premised on sequential investments by which the output from one investment induces investments in other sectors, creating complementarities. From this, the concept of backward and forward linkages and the input-output framework was developed to determine the size of these inducements (Toner, 1999). Thus, the inelasticity of factor supplies would be addressed by the backward linkages to sectors capable of providing the required inputs.

Although Hirschman was critical of balanced growth theories, his exposition was also based on the role of external economies which are foundational to both. Like Young, he focused on the capital goods sector and complementarities in production but Hirschman was more interested in the creation of sectors by which increasing returns and these other effects could be instigated rather than the circular cumulative effect by which the division of labour broadens the extent of the market (Toner, 1999). Several critiques point to the similarities between balanced and unbalanced growth noting that the distinctions relate largely to the scale of investment considered feasible with unbalanced growth favouring investments on a relatively smaller scale over a few industries (Nath, 1962).In spite of these critiques of balanced growth and the big push, Murphy, Shleifer and Vishny (1989) developed a multiple equilibria model much later on, in which a big push in industrialisation stimulates economy wide growth when a firm can raise the size of other firm's markets, even when its operating at a loss.

An important outcome of the debate on balanced versus unbalanced growth is the introduction of the concept of how 'one thing leads to another' as linkages are developed in the economy. The development of the concept of linkages is attributed to Hirschman and is a reaction to his dissatisfaction with balanced growth models. This will be discussed in depth later on in this literature review but for now the role of the State in the development of these models and structural economics more broadly will be briefly reviewed.

2.2.4. Structuralism and the Role of the State

In all the theoretical approaches to diagnosing the poor conditions of developing countries and proposing new approaches to growth, the role of the State is implicit. Development is presented from the perspective of Nation States driving the process and the role of the private sector is rarely referenced. This can be ascribed to the small size of the capitalist sector in most developing countries and the expectation it would assume a developmental role as its size increases (Lewis, 1954). However, from some perspectives, as presented in the paragraphs that follow, only the State can perform this role effectively.

For example, by adopting ISI, as proposed by Prebisch, the State is expected to drive the growth process and marshal public investment to achieve its aims (Prebisch, 1950). With its control over industry, the State would utilise returns from industry to expand the Welfare State and direct consumption towards durable consumer goods, the domestic production of which leads to widespread industrialisation and increased stature on the world stage (Rostow, 1959). For Rosenstein-Rodan (1943) and Nurske (Nurkse, 1953), an active role for the State was also a foregone conclusion and part of a new economic world order in which the State would harness growth to deliver desired outcomes. Hirschman was sceptical of the place for centralised planning in directing investment due to the belief that the external diseconomies and social costs generated would be internalised alongside external economies (Hirschman, 1958). He also saw the process of creative destruction, which is critical to the development process, as beyond the ability of the State. For Young, the State does not feature in any explicit form in the discussion on increasing returns although he referenced an 'industrial dictator' who could hasten the realisation of increasing returns (Young, 1928, p. 5).

The views held on the role of the State are complex and multi-faceted given that it is expected to play different roles depending on the circumstances. The roles ascribed include acting as a substitute for an underdeveloped capitalist sector, helping to bridge the gap between savings and investment as well as instigating disturbances in the economy that would stimulate growth (Hirschman, 1958). The limited administrative capabilities of many developing countries to implement development programs and the possible negative effects of government policy are also acknowledged (Chenery, 1960, 1975)

The main point that comes across from this review is the strong role given to the State in driving the process of development from the structuralist perspective; however, in practise outcomes have varied. For many countries in SSA, ISI did not lead to the development of significant manufacturing capacity while the outcomes in Latin America were mixed. The East Asian and other newly industrialising economies seem to have had greater success, depending on who is interpreting events.

One of the unfortunate outcomes of the experimentation with ISI, which coincided with adverse terms of trade, was a debt crisis in the 1980s to 1990s. This led to the intervention of IFIs and the design of the SAP, which exacerbated the debt and balance of payment crisis in many countries where they were introduced. SAP policies were ostensibly designed to address State failure and restore the market mechanism as the framework for economic interactions. The State was characterised as corrupt, bloated, inefficient and unable to read economic signals as well as the market, thus resulting in a need to restore the market to its rightful place. However, many countries were unable to sustain the implementation of SAP policies and the economic situation further deteriorated.

These developments eventually segued into the introduction of an additional set of policies to address what was viewed as the underlying causes of the failure of developing countries to properly implement the SAP. These were encapsulated in the 'Washington Consensus' and was the culmination of a long debate on the role of the State (J. Williamson, 1990, 2006). The ten reforms prescribed in the Washington Consensus are: fiscal discipline, reorder of the composition of public expenditure, introduction of tax reforms, liberalisation of interest rates, a competitive exchange rate, trade liberalisation, relaxation of capital account restrictions, including liberalisation of inward foreign direct investment, privatisation and deregulation (J. Williamson, 1990, 2006). Underlying these reforms is a drive to circumscribe the State and restore and strengthen the market mechanism. It also comes across as a type of neoliberal 'balanced growth'

These policy prescriptions have been critiqued and discredited, both due to the poor outcomes in the implementation of the policies in developing countries as well as their faulty foundations (Deraniyagala, 2003). In particular, the experience in SSA with both State-led intervention and the introduction of SAP led to outcomes that are not conducive to structural transformation (Nissanke, 2019). Yet, the consensus is one of the most overt signs of the neo-classical or neo-liberal counter-revolution against interventionist-type structuralist policies and influenced a re-interpretation of State-led interventions such as the East Asian Growth Experience.

The World Bank, one of the Washington institutions of the Washington Consensus, effectively repudiated the impact of State-led interventions in the so-called East Asian Miracle, instead attributing their success to market-friendly economic policies (Birdsall et al., 1993). The response to a report promoting this viewpoint was vociferous and the World Bank was effectively scolded and attempted to walk back some of its more worrying interpretations of events. Policy prescriptions arising from this reversal are characterised as a post-Washington consensus (Amsden, 1996, 1997; Fine et al., 2003; Lall, 1992; R. Wade, 1996).

Although the neo-liberal approach to growth and its determinants is an important discussion and impacts the eventual direction taken in the theoretical discussions on economic growth and development and structural change, especially the role of the State and industrial policy, this will not be given a full treatment in this thesis as it would be impossible to do it justice. The role of the State in development is too broad a subject to be covered comprehensively in this literature review; however, it was a sharp dividing line between neo-classical and structuralist approaches to growth.

2.3. Strategies for Economic Growth

According to the structuralist framework, growth is not an abstract process, it is dynamic and has a multi-sectoral quality. The three-sector hypothesis informs us of the three main sectors of the economy: agriculture, industry, of which manufacturing is the principal component, and services. These sectors have distinct characteristics in terms of productivity levels, technology usage and development and all these factors interact to determine the growth trajectory of each economy.

These sectors are not static but are in constant flux as they absorb, utilise and release labour and other production inputs; promote technological innovation and apply innovation acquired from other sources. They also interact with each other in the process and form linkages and interdependencies. These and other factors are considered in determining which sectors are more amenable to growth at specific stages of development. Structural change or transformation is a way of summing up how all these processes play out in the economy.

In this section, theories on the specific sectors of the economy will be explored with emphasis given to those related to the manufacturing and service economies. Thus, the manufacturing as engine of growth hypothesis, the nature of deindustrialisation and service-led growth or tertiarisation will be discussed.

Much of the existing literature in this regard super-imposes the experience of industrialised countries on those yet to be industrialised. Industrialised countries have followed a pattern of industrialisation and subsequent deindustrialisation that does not fit the case of less developed countries. This shortcoming will be addressed by drawing out strands of the literature that recognise that growth in a 'pre-industrial' context is necessarily different (Tregenna, 2015).

This discussion will be linked with the ongoing one on the potential for service-led growth as an alternative path for growth as the case will be made that tertiarisation, though an independent process, is also linked with the deindustrialisation process. In the review of the literature, the case will be made that the stage of development at which these processes play out is critical and influences the types of services which emerge in an economy.

2.3.1. Manufacturing as Engine of Growth

That industry more generally and manufacturing specifically, hold greater potential for productivity increase through economies of scale and increasing returns to scale, are better for technical progress and innovation compared to other economic sectors, is a well-established fact in economics. It was a unifying assumption in most structuralist postulations on economic growth that an economy must transition from primary production to more complex activities to increase incomes and improve welfare outcomes for its citizens. The three growth laws developed by Nicholas Kaldor were instrumental in giving prominence to the narrative of manufacturing as the 'engine of growth' (Kaldor, 1966, 1967)

By demonstrating that causality runs from manufacturing output to aggregate output; from manufacturing output to manufacturing productivity and pointing out the feedback effects from aggregate productivity to employment in manufacturing; a deep and nuanced relationship between total output and manufacturing output is uncovered. Kaldor demonstrated that productivity increase is a dynamic relationship that is not simply due to technological progress but also economies of scale which are unique to manufacturing. Thus, in this view, manufacturing is different from other economic activities in the sense that through manufacturing, a circular cumulative process is set up which triggers growth economy wide.

An entire 'industry' of studies testing these growth laws across several countries, regions and industries, even including services, has emerged. Although most studies have been of developed countries a number have focused on the less industrialised regions of the world. Many studies have tested or supported the manufacturing as engine of growth hypothesis using methods such as growth accounting, regression techniques and simple statistical analysis. The preponderance of studies find support for the continued importance of manufacturing for growth although the rising importance of services is acknowledged (Andreoni & Gregory, 2013; Haraguchi et al., 2017; Szirmai, 2012; Szirmai & Verspagen, 2010).

Most have found support for the broad statements made by Kaldor to varying degrees and these and other studies which attest to the uniqueness of the manufacturing sector, have contributed to a manufacturing-centric view of the process of economic growth. Thus, the perception of an industrialised economy as one with high shares of manufacturing in value-added and employment became synonymous with development.

In recent times, evidence from mature industrialised and emerging industrialised economies indicates that both these shares have begun to fall. As a corollary to these observations, the question of whether manufacturing holds the key to development has risen to the fore. The less than salutary experience of some countries, particularly in Sub Saharan Africa, which began to deindustrialise without ever industrialising, also amplifies the debate on whether industrialisation is truly a necessary condition for economic growth (Rodrik, 2016; Tregenna, 2015).

In response to the rising interest in service-led growth narratives, a renewed case for manufacturing as the engine of growth, termed Manufacturing 2.0 is being made. The arguments for service-led growth have been gaining traction due to the optimism generated by productivity increases and technological advances in some service industries. These service industries, for example IT and Professional, Scientific and Technical Services (PST) are not merely consuming or utilising technology intensively to increase their overall productivity but have themselves become producers of new technologies and innovation. Thus, these services are being treated as an alternative path to growth; however, this view is not widely shared and has reinvigorated strong arguments on the importance of manufacturing for development.

A key argument for this renewed case for manufacturing is the special ability of certain activities in the manufacturing process to serve as carriers of new technologies (Andreoni & Chang, 2018; Andreoni & Gregory, 2013; Fagerberg & Verspagen, 1999). The capital goods industry is assessed to be an engine of growth within the manufacturing industry since it enables the creation of other machines and has the capacity for 'self-reproduction (Andreoni & Gregory, 2013, p. 18) (Andreoni & Gregory, 2013, p. 18). Improvements made within the capital goods sectors are directly transferred to, not only the new goods produced, but related services that are rendered. This draws from Allyn Young's (1928) finding that roundabout means of production lead to increasing returns and virtuous circles of economic growth.

Another argument, which was earlier introduced, is that much of the observed service growth is a statistical illusion or disguised manufacturing. It is considered a statistical illusion in the sense that industrialised countries experiencing deindustrialisation are experiencing a steady and not drastic decline in the share of manufacturing in total employment and this decline took place in a context of high manufacturing productivity, output and contribution to value added (Andreoni & Gregory, 2013). Disguised manufacturing is seen as originating from the increased focus of manufacturing firms on their 'core competencies' and the outsourcing of ancillary services.

The increased level of productivity in manufacturing and the resultant demand it places on high productivity services is also put forward as a reason why manufacturing is still important for development. The interdependencies between manufacturing and services is at the core of this argument. This argument in many ways restates the debate, shifting the focus from a manufacturing or services view to one that highlights the feedback loops and linkages that occur at the manufacturing and services interface (Andreoni & Gomez, 2012; Andreoni & Gregory, 2013). At this interface, technological and production linkages are formed and exchanged, reinforcing each other and contributing to the upgrading of production value chains.

The Manufacturing 2.0 arguments push the discussion forward by highlighting the relationship between manufacturing and services, a view that was missing from earlier recommendations of manufacturing as the engine of growth.

The interdependency argument has greater resonance as for example, many of the advancements in the capital goods industry have come by way of IT improvements, mainly in the use of Computer Aided Design (CAD) and Computer Aided Manufacturing (CAM). These technologies were also developed utilising outputs and technology developments arising from manufacturing, thus demonstrating the feedback loop between manufacturing and services. The recent trends in servicification, by which manufacturing firms are increasing the use of services as inputs into the value chain, whether in the production process or pre and post production, also shows the blurring boundaries between both sectors and a need to refocus the argument to the exploration of these interdependencies (Lanz & Maurer, 2015).

However, the statistical illusion argument, which is more relevant for mature and premature deindustrialisers does not hold for many countries in SSA. These countries failed to develop a sufficiently large manufacturing base for the need to outsource services to arise. It has been discovered that many manufacturing firms in less developed countries are forced to self-provide end-to-end services given the poor quality of public infrastructure and the dearth of local firms capable of delivering such services at the required scale and level of efficiency

Yet, there is statistical evidence supporting the emergence of technology-intensive services, especially IT, in some developing countries even in the absence of a strong manufacturing sector (Cirera et al., 2016; Kayisire & Wei, 2016; Kyem, 2012; Niebel, 2018; Njoh, 2018). This leads to the question of what these services are servicing and where they emerged from. The available literature on service-driven growth does not provide satisfactory answers to this and other questions and this thesis intends to contribute to knowledge on high productivity service activities in the pre-industrialised context. To round up this discussion on sectoral growth strategies, the service-led arguments for growth will be considered next.

2.3.2. Service-Led Growth

Given the weight of literature putting forward empirical evidence and theoretical arguments to support the need for industrialisation as a path to economic prosperity, there is surprisingly strong support for service-led growth as a viable path to growth. Although the consideration of services has appeared in the literature on sectoral growth since the earliest theorising of the nature of growth, especially during severe episodes of deindustrialisation, this literature gained momentum in the last 25 years.

This shift seems to coincide with a change in the nature of services as they have become increasingly technology intensive, do not necessarily have to be delivered in person and consumed at the point of production, thus enhancing their tradability. In addition, an increased income elasticity of demand for services is put forward to explain structural change towards services but there are strong claims that this has not been borne out empirically. This marks a departure from earlier views describing services as either unproductive or stagnant and as the stepchild of economic research (Fuchs, 1968, p. 25; Wölfl, 2005). The literature on the relationship between service and manufacturing-led growth vis-a vis deindustrialisation and tertiarisation will not be discussed here but will form the basis for the conceptual review of these terms in Chapter 4. The exposition will centre on the heterogeneity of deindustrialisation and tertiarisation processes and for this reason, the next section will set the stage for the discussion by reviewing the heterogeneity of services and the development of service taxonomies and typologies to bring a semblance of order to a sector which oftentimes defies description.

2.4. Service Classification Schemes

Taxonomies and typologies are a common tool employed in sectoral growth analysis as they enable the grouping of economic activities into industrial classification categories. Taxonomies tend to be quantitative and are usually based on empirical data while typologies are mainly conceptual and qualitative (Bailey, 1994). Both classification approaches are useful in the reduction of complexity, the comparison of types and derivation of an exhaustive list of dimensions amongst other advantages. Yet they can be overly descriptive and become static rather than dynamic in nature, thus unresponsive to innovations in service characteristics (Bailey, 1994).

Of the three main categories of economic activity, the classification of service sector activities has attracted the most attention due to the high level of disparate activities in this category and the search for a way to organise these in a form amenable to analysis. According to George Stigler, 'there exists no authoritative consensus on either the boundaries or the classification of the service industries' (Stigler, 1956, p. 47). Very little has changed since that statement was made and as a result, a multiplicity of service taxonomies or typologies have been developed by researchers utilising various measurement parameters. Productivity increases in service activities, which have resulted in new service categories as technology use becomes pervasive, has also made dynamic classification approaches imperative so classifications are not rendered obsolete in a short amount of time.

The heterogeneity of services and the tendency to treat the service sector as a residual sector leads to several taxonomies and typologies functioning as a listing of activities rather than as a well-defined methodology for aggregating activities (Gershuny & Miles, 1983). However, some classification types have gone beyond mere descriptions and proven resilient with time. In this section, the implications of the heterogeneity of services will be reviewed from the point of view of service industry taxonomies and typologies.

The starting point for many service classifications is the three-sector economic model developed by Fisher (1952) and Clark (1940). An early effort to categorise services drawing from the Fisher-Clark hypothesis and Rostow's stages of growth model was made by Katouzian (1970) who classified the service sector into three categories. Unfortunately, these categories are highly time and context-specific and only suitable for the period for which they were developed:

i. **New services** were those which were stagnant before the period of 'high mass consumption' and include services such as education, consumption of modern clinical and medical services, and entertainment in general.

ii. The second category was termed **complementary services** meaning services complementary to the process of industrialization which include banking, finance, transportation, wholesale and retail trade.

iii. The third and final category were the **old services** which had gone into decline with the progression of industrialization.

Browning and Singelmann (1975) developed a six-sector scheme as an extension of the Katouzian and Fisher-Clark structure to address the limitations inherent in a classification of economic activities into broad categories. Economic activity was categorized as extractive, transformative, distributive, producer, social or personal. The extractive and transformative sectors are synonymous with the primary (agriculture) and secondary (manufacturing) sectors respectively while the service sector was classified into four categories: distributive (examples include transport, communication, trade), producer (banking, insurance, communication, engineering and architectural services), social (government, medical, education, non-profits) and personal services (include domestic, accommodation, entertainment).

The two most common factors applied in categorizing services are (Gershuny & Miles, 1983) :

i. the industrial production process in which these services are utilized and;

ii. how the services are consumed or a demand-based orientation.

The Browning and Singelmann scheme is an example of a service classification based on how the services are consumed. By their own admission, this classification structure was developed heuristically and not emanating from empirical observations or developed within a conceptual framework; however, it has remained resilient, is still widely used and has served as a model for further classification efforts.

Production-based classifications have been found to be much less dynamic due to the rapidly changing nature of production and the need to constantly redefine classification categories to accommodate these changes. Fuchs adopted a production-based classification approach but decided to include transportation, communications and public utilities under industry due to the use of complex technology and heavy capital equipment in delivering these services (Fuchs, 1968). Thus, in his estimation and based on the nature of services prevalent at the time, a typical service does not use technology and capital intensively. This highlights the limitations discussed by Gershuny and Miles, as service subcategories are now making wider use of technology and in some cases are influencing the development of new technologies.

Greenfield (1966) combined both approaches, classifying services into producer and consumer services, defining producer services as those services which business firms, non-profit institutions and governments provide and sell directly to a producer rather than a consumer. He included transportation, communications, public utilities, wholesale trade, finance, insurance, real estate, advertising, business services, industrial medical services, legal, engineering and other professional services and public administration as producer services. Other classification schemes based on the production approach include those developed by Thomas (1978), and Bowen and Barkin (1967).

Consumption-based classifications are more common and are variations of the Browning and Singelmann typology. Gershuny and Miles (1983) developed a classification scheme based on consumption, defining services as falling into four main categories namely intermediate, final, marketed and non-marketed services. Ofer (1967) included transport, communications and public utilities in his classification of services; Worton (1969) included transportation and communications but excluded public utilities like Lengelle (1966) who also excluded them.

Extending Singelmann's methodology, Castells taxonomy is based on which point in the production value chain the service is introduced (Castells, 2010). He created two indices of service-delivery employment/goods-producing employment, and of information-processing employment /goods-handling employment in the service sector. The former category includes mining, construction, manufacturing, transportation, wholesale and retail trade while the latter category is comprised of communications, finance, insurance, real estate and government activities.

Albin and Applebaum (1990) developed a taxonomy centred on information and knowledge intensity using US Bureau of Labour Statistics data. Both manufacturing and service sector activities were classified to include an information and knowledge category (I-K) and an 'other' category as a residual category for other activities. Miles et al (1995) developed a very influential definition of services on the basis of knowledge and technology. They defined three categories of services:

traditional professional services, which may be intensive users of new technology; new technology services, which create and use new technologies intensively; and other services as a residual.

The first two categories are referred to as Knowledge-Intensive Business Services (KIBS) while the residual category is termed non-KIBS. They go further to apply the appellation KIBS II or Technology Knowledge-Intensive Business Services (T-KIBS) to category 2. In the next section, our attention will be turned to KIBS and T-KIBS given their relevance to an exploration of IT services.

2.4.1. Knowledge and Technology-Based Classification Schemes

There is widespread agreement that the world is currently in a knowledge age enabled by technology and correspondingly, current industrial classification schemes are unequal to the task of reflecting the technology characteristics of economic activities. For this reason, modalities for technology-based classifications have been created to address this shortcoming and a few have proven particularly popular in the case of IT sector activities.

The Organisation for Economic Cooperation and Development (OECD) has taken a leading role on this and recognised early on that our understanding of the knowledge economy is based on the kind of indicators utilised in measuring knowledge and technology trends (OECD, 1996). Its Science, Technology and Industry (STI) Scoreboard is published biennially to explore how knowledge is affecting the structural transformation process across OECD countries, using OECD databases, methodology and indicators. It follows trends in the use of knowledge and technology across industries, the level of investment in knowledge, research and development (R&D) intensity amongst others.

The STI directorate has also been involved in the development of taxonomies and the Working Party on Indicators for the Information Society (WPIIS) under the STI was created in 1999 to take the lead in developing indicators and standards for measurement of the IT sector, in terms of goods and services. An industry definition for the sector, based on the ISIC and combining manufacturing and services sectors, was developed in 1998, and this was complemented by definitions for IT goods and services in 2003 and 2006 respectively (OECD, 2007). These industry definitions have been revised several times to meet both ISIC and Central Product Classification (CPC) specifications (OECD, 2009).

In 2016, a taxonomy of economic activities resulting from OECD research and based on R&D intensity was proposed (Galindo-Rueda & Verger, 2016). Using R&D intensity, five classification types were applied across manufacturing and non-manufacturing activities, ranging from low to high R&D intensity: High R& D Intensity Industries, Medium-High R&D Intensity Industries, Medium R&D Intensity Industries, Medium-Low R&D Intensity Industries and Low R&D Intensity Industries. The taxonomy, though useful in demonstrating the intensity of technology application in specific industries suffers from limitations associated with a data-intensive exercise of this nature ,as consistent data was not available for all countries in all the years covered. It covered 27 OECD countries plus Singapore and Taipei and focused on formal measures of R&D expenditure by firms. This is a significant step towards recognising that current industry classifications may no longer be applicable in the current knowledge economy.

Drawing on the previous classification exercises in 2007 and 2009, an updated IT taxonomy was developed by the OECD in 2017, relying on technology classes of the International Patent Classification (IPC) (Squicciarini & Inaba, 2017). It follows the methodology adopted by the Japanese Patent Office termed 'J tag' which defines 13 technology areas. The taxonomy is an improvement over previous efforts as it includes categories which had not been previously covered such as nano-technology use for information processing, storage or transmission; however, it is once again industrialised country-centric given that many of these new technologies are not available to developing countries.

With the intensive utilisation of knowledge and technology by more service categories, it is apparent that standard classification types, most drawing from the Browning and Singelmann methodology, are inadequate for capturing the full nature of these services. Many of these services fall under the category of producer services and more specifically the sub-category of business services and their prominence led to the development of a new class of services termed Knowledge Intensive Business Services (KIBS).

2.4.2. Knowledge-Intensive Business Services

The current understanding of the concept of knowledge is influenced by Michael Polanyi's (1958) seminal work on knowledge which distinguished between two types of knowledge: codified or explicit knowledge and tacit or implicit knowledge. His philosophical exposition of how 'we can know more than we can tell' has been extremely influential across many fields of study including economics (Polanyi, 1966, p. 4). Knowledge, in this exposition, goes beyond what can be formalised, codified and transmitted in a tangible and definable form to those actions which are tacit and are performed instinctually, many times without a realisation of the ability to do so.

These concepts have been applied to understanding what a knowledge society means and how organisations create, process, and use both tacit and codified knowledge (Nonaka, 1994). This expanded definition of knowledge is also applied to industrial activity classifications which brand some activities as more knowledge-intensive than others. Miles et al (1995) applied this broadened definition in classifying specific services as Knowledge-Intensive Business Services (KIBS) in the sense that these services not only use but produce and transmit both tacit and codified knowledge in the course of their operation.

The manner by which knowledge is acquired is also important as knowledge is not viewed in its static sense when it is delivered through formal learning or even learning by doing and/or learning by using but is developed through the cumulative process of learning by interacting or induced innovation (Hauknes, 2000). The proximity between the service provider and clients, a feature of services which had been considered negative, is one of the channels through which knowledge is developed and transmitted. Thus, KIBS are not just passive users of knowledge but active creators and carriers of knowledge (Hertog, 2000).

This calls into question the prevailing conception of services which had hitherto been described as passive, stagnant and unproductive, definitely not as potential creators of knowledge and technology. The distinction between information and knowledge and how information can become knowledge has also contributed to our understanding of the process by which KIBS manipulate knowledge (Machlup, 1980). Ancori, Bureth & Cohendet (2000) also contribute to this body of work by deconstructing four layers of knowledge which explain how it is created, appropriated, exchanged and managed amongst actors whose cognitive function is an integral element in these processes.

Miles et al (1995) helped to lay the foundation for how KIBS are defined by calling attention to the different ways services relate to technology. The process of innovation in KIBS firms was also clarified in their work as innovation tends to take a different form compared to traditional views of it occurring mainly in R&D departments of technology firms. Innovation tends to occur in the process of product development, especially when there is need for product customisation. Thus, both the service provider and user are intimately involved in the innovation process. Market research is also another avenue through which innovation occurs.

Innovation is treated as the principal force in the development of KIBS and exploring how it is developed and deployed through the creation and use of KIBS is important for this exposition. Innovation is a broad topic that cannot be comprehensively reviewed in this thesis; however, to set the framework for the subsequent discussion of innovation development and use in KIBS, it is necessary to briefly review the literature on innovation theory at this point in the exposition.

2.4.3. The Theory of Innovation and Systems of Innovation

Schumpeter laid much of the theoretical foundation of the concept of innovation as understood in economics (Schumpeter, 1947, 1983). In developing a theory of economic development and explaining departures from the circular flow of economic life, he explicated the role of innovation, by which new goods (product innovation), new methods of production (process innovation), new markets (market penetration innovation), new sources of supply (supply chain innovation) and new industry organisations (organisational innovation) are brought to life. These innovations are responsible for taking the economy away from a comfortable equilibrium and drive the dynamism present in the economy.

By distinguishing innovation from invention, Schumpeter opened the door for the expansion of the definition of knowledge to include its tacit forms and not only codified knowledge. The process of creative destruction, by which old routines and business models are replaced by new ones, was described in his analysis as the driving force behind innovation and a disruptive process which continues to drive economic life today. Research on innovation has flourished despite and probably because of Schumpeter's discursive approach to his analysis and the absence of mathematical modelling and formalisation in his work which meant his findings were not widely embraced in neoclassical circles.

Nelson and Winter (1982, 1993) birthed a Neo-Schumpeterian evolutionary approach to innovation which led to a resurgence in research on innovation (Dosi et al., 1988; Fagerberg, 2013; Kline & Rosenberg, 2009). Their work was developed in response to what was perceived as the inability of the neo-classical framework to explain how technological change takes place at the micro-level within its limited framework (Winter, 2017). By adopting an evolutionary approach which entails progressive change over long cycles or an extended period, they contributed to the literature examining structural dynamic change in the economy with the concept of National Innovation Systems as an extension of their work (Nelson, 1993).

The concept of National Systems of Innovation or National Innovation Systems, dates back to Friedrich List's work on national systems of production, although Christopher Freeman is credited with coining the phrase, National Innovation System (Hanusch & Pyka, 2007; B.-A. Lundvall, 1992).

It arises out of an understanding that nation states differ in their knowledge base and production systems, the features of both are not easily transferred, nor has there been a tendency towards convergence as postulated by neoclassical economics (B.-Å. Lundvall, 2016).

Following Whitley's definition of national innovation systems as "nationally distinct configurations of institutions and organizations that structure the development, diffusion, and use of new technologies, products, and processes in different ways", the elements of analysis become apparent (Balzat & Hanusch, 2007, p. 928). These include firms, inter-firm relationships, public sector organisations, the financial sector and institutions focused on R&D. Due to its emphasis on country variations the conceptual framework for NSI is flexible and elements studied vary across countries. This flexible framework is a common feature of studies of innovation, capabilities and production systems which tend to be cumulative and in many cases path dependent. The framework situates well with the NSI approach as the goal is not to define 'best practices' for the development of innovation systems as NSIs are context-specific and each study is unique and critically examines features peculiar to the NSI under study, rendering comparability difficult.

Early studies of NSI were mainly descriptive and tended to provide a detailed description of elements such as national institutions and organisations underlying the innovation system (Fagerberg et al., 2013; Nelson, 1993). Many of these studies focused on advanced and latterly middle-income countries where these national bodies are operational and easily observed. Developing countries were under-represented due to either the absence or nascent nature of such institutions. More recently, a dynamic approach to NSI has been adopted which maps out the technological dynamics or outputs of the innovation system and pinpoints the underlying forces impacting those outcomes (Fagerberg et al., 2013). By adopting a process approach, it hopes to be able to identify policy levers for adjusting the innovation system to an optimal position.

If the NSI approach is considered a treatment of innovation at the macro level, Sectoral Systems of Innovation (SSI) and Regional Innovation Systems (RIS) take a meso-level approach to innovation. RIS has its origins in regional science and economic geography and was developed by Cooke (Braczyk et al., 1998). It borrows from earlier work on clusters and Industrial Districts or Local Production Systems, concepts which will be introduced subsequently. As its name implies, SSI studies firms located in geographical proximity which develop networks through which knowledge flows and learning and innovation can take place[9]. It was developed to complement existing work on Regional Innovation Systems (RIS) and National Systems of Innovation (NSI). Given its focus on the sector, its analytical lens moves beyond the firm to examine the players interacting with the sector: firms and non-firm organisations (universities, financial institutions, R&D departments etc.), products, knowledge and learning processes, technologies, inputs, demand, complementarities, institutions (labour markets, regulatory bodies) and mechanisms of interactions between firms (Malerba, 2002). Its theoretical foundations are also rooted in the evolutionary approach to economic change and innovation theory developed by Schumpeter.

2.4.4. Innovation in KIBS

The innovation process in services is not unlike what obtains in the manufacturing innovation process yet there are some fundamental differences. The main differentiating factor is the involvement of clients as co-producers in the innovation process. Pavitt's (1984) three-part taxonomy of innovation in firms was instrumental in influencing the large body of work which has been produced on innovation in services generally and more specifically in KIBS given their key role in technology transfer.

Pavitt differentiated his methodology from traditional views that viewed innovation as embodied in capital equipment whereas in this case it could be transferred in the form of knowledge. In his analysis, most service firms are 'supplier-dominated' as their main source of technology is exogenous to the firm, mainly suppliers. Supplier-dominated firms are viewed as passive receivers of technological innovation from science-based, scale-intensive and specialised equipment suppliers. The appellation 'supplier-dominated' does not seem to take into consideration the co-production of innovation between service firms and their clients as exemplified in the process of 'learning by using' which incorporates both embodied and disembodied forms of knowledge (Rosenberg, 2008).

The ability to co-produce has been impacted by the spatial proximity of KIBS firms to suppliers, clients and other KIBS firms and it has been found that these firms tend to agglomerate in big cities (Keeble & Nachum, 2002; Koschatzky, 1999; Muller & Doloreux, 2009; Muller & Zenker, 2001). In mapping service innovation patterns it was contended that aside from the supplier-dominated pattern of innovation, there exists innovation within the service itself (endogenous), client-led

[9] The SSI term was initially coined as Sectoral Innovation Systems (SIS) by Franco Malerba (Breschi & Malerba, 2013) but was subsequently reformulated to Sectoral Systems of Innovation and Production and all three terms tend to be used interchangeably.

innovation, innovation through services (from service to client firm) and paradigmatic innovation which is complex, and pervasive innovation affecting all actors along the value chain (Den Hertog & Bilderbeek, 1999; Hertog, 2000).

The Pavitt taxonomy also aggregated all services within a single category and failed to consider the heterogeneity within service firms, a shortcoming which was addressed by subsequent disaggregate taxonomies which take into consideration the production of technological innovations in relations with suppliers of equipment, materials and information (Soete & Miozzo, 1989). However, this approach was criticised as being largely conceptual and requiring further empirical testing (Gallouj & Gallouj, 2000).

Another interesting critique of the way in which service innovation has been conceptualised in the literature is the claim that is has been too 'technologistic' or 'industrialistic', essentially viewing innovation from a manufacturing or industrial point of view rather than recognising the possibilities of other forms of innovation (Gallouj & Gallouj, 2000). To avoid this false dichotomy, (2000, p. 3) recommends that we view the relationship between services and manufacturing as a 'continuum' rather than drawing a dividing line between the two.

Barras (1986) developed a 'reverse product cycle' theory, the converse of the typical product cycle theory in manufacturing, to describe the innovation process in services. His work sought to understand how technology was transmitted from the capital goods sector to the service sector, moving through three phases as the technology is adopted by service firms: product innovation leading to improved efficiency and labour savings; process innovation which improves effectiveness and raises quality and the third phase in which new service products are developed.

This analysis was prescient in noting that information technology would lead the next technology revolution and be readily adopted in the services sectors. His approach was critiqued for not considering innovation in other non-technological service sectors; however, there is no doubt that much of this innovation, for example in the banking sector, is driven by IT (Gallouj & Gallouj, 2000). This leads to the question of how the application of technology and knowledge in KIBS or producer services more broadly can be assessed within contexts where formal and traditional measures of these concepts are unavailable.

The review of service has shown the limitations of current classification approaches to services, even with an incorporation of new service features which recognise the role of technology and innovation in more modern service conceptions a shortcoming that will be addressed later in the thesis. Service classifications focus on how they are utilised in production processes and /or consumed. The services do not act in isolation but relate with other sectors of the economy through the formation of linkages and the development of capabilities in using those services within local production systems. In continuation of the exposition of Hirschman's unbalanced growth theory which reached its apotheosis with the development of his linkage framework, a review of the thinking on linkages, capabilities and local production systems follows.

2.5. Linkages in Input-Output Frameworks

Although the term 'linkage' in the context of economic development is associated with Albert Hirschman, it is one of the underlying principles of the input-output methodology developed by Wassily Leontief to analyse economic relationships in the United States economy in the 1950s. Leontief's model is itself an extension of Quesnay's Tableau Economique (Leontief, 1936). It is built on accounting principles and represents all country economic activity in matrix form, detailing interconnections between sectors in the production of goods and services. Being a data-centric approach, input-output analysis is expected to lead to comprehensive and rigorous conclusions and allow for the manipulation of large cross-country datasets to produce information on the combination of sectoral inputs to generate economic output.

Due to the scale and scope of data required for input/output analysis, several simplifying assumptions must be made in order to render the analysis tractable (Miller & Blair, 2009). Beyond the loss of precision due to these necessary accommodations, the complexity and expense of data compilation, as well as the need for regular compilation of survey data implies that many developing countries are unable to carry out this analysis regularly due to the limited capacity of their statistical agencies.

Even where data is readily available, input-output analysis remains at a level which is absent of information on how the technical coefficients in a sector are represented at the firm level where production occurs as firms interact with other firms and institutions. It does not differentiate amongst the various types of linkages that can be formed between firms and offers no insight on the factors that allow a firm to develop linkages where another fails to do so. For example, no mention is made of technological externalities, acquisition of knowledge and skills through learning-by-doing, research and development and other processes which are instrumental to the formation of linkages (Toner, 1999)

Yet, despite the data constraints, the limited epistemic content of the analytical output and questions raised about the general equilibrium foundations on which it rests, input-output models still find extensive use as a tool for mapping out linkages across economies. In terms of sectoral analysis, the manufacturing and primary commodity sectors have received most attention; however, there is a burgeoning body of work on the investigation of linkages between the services and manufacturing sectors. As service linkages are central to the exposition in this thesis, much of the analysis to follow will focus on this sector.

Park (1989) and Park and Chan (1989) investigated the asymmetrical nature of linkages between the manufacturing and service sectors for a selection of countries using input/output data. They found that linkages to the manufacturing sector are stronger in production-related services, linkage formation is bi-directional, and the emergence of the IT sector fundamentally alters the structure of both service and manufacturing industries.

Business or producer services are found to exert a positive influence on manufacturing and other technology-intensive sectors for many OECD countries, with this influence increasing over time (Francois & Woerz, 2007). The important role of services as intermediate inputs in production is highlighted in this study as it serves as the mechanism through which skill and technology-intensive industries improve export performance.

Tregenna (2008) utilised a total flow matrix approach to explicate production linkages between the manufacturing and service sector in South Africa and prompted questions on the transference of capabilities from the IT sector to the rest of the economy and how these capabilities might contribute to productivity increases in other sectors.

Other studies using input-output techniques have also found that producer or business services are important inputs in the manufacturing process and are carriers of technological change.

Lopez Gonzalez et al (2019), using data from the World Input Output Database (WIOD), find that for an economy seeking to successfully enter export markets, a domestic base of services, in this case business services, is essential for the development of forward linkages to GVCs which utilise these services. The analysis covers major emerging economies such as Brazil, India and China; however, pre-industrial countries are subsumed in an aggregate group, limiting the opportunity to distinguish individual country effects.

In these studies, the need to distinguish between production-related and non-production service sector categories emerges as both are found to function differently in an economy. As mentioned previously, due to the aggregate level at which the analysis in most input-output studies have been placed, the results obscure important details on where the linkages are originating in individual sectors or at interstices between sectors and how these propagate further economic growth. This points to the need to supplement macro and meso analysis with a micro analysis of linkages.

Hirschman identified the limitations of attempts at comprehensive cross-sectional measurements of linkage effects and proposed the greater effectiveness of 'historically oriented studies' which study the development of linkages over time in an economy (Hirschman, 1977, p. 4). This recommendation was subsequently overlooked or at most partially adopted by researchers as many studies measuring linkage effects produced since then have adopted the former approach in a search for 'rigour', a term usually interpreted to denote complex quantitative analysis.

A key intent of the linkage thesis was to assist countries in identification of leading or growth sectors, industries or firms and this original goal seems to have been lost in a desire for generalizable results of the quantitative type. Linkages are specific to each local context, are dynamic in nature and require a broader understanding of the interacting forces impinging on them. Hirschman's approach to linkages is fundamental to this study and its main pillars are discussed in the next section.

2.5.1. Hirschmanian Linkages

Structural economics broadens our understanding of economic growth by adopting a more realistic rendering of the dynamic process of change, which occurs at differential speeds in the various economic sectors, instead of the static framework of neoclassical growth theory. The three-sector model of the economy developed by Fisher-Clark created analytical categories to aid the dynamic interpretation of growth. Yet, a sector-centric view of the economy is still several steps away from reality as actual economic outputs embody inputs from all sectors intersecting at various points along the production value chain. Thus, a more useful way of analysing economic interactions is from the viewpoint of interdependencies or linkages between sectors.

The conceptualisation of linkages as understood in development economics is an outgrowth of Albert Hirschman's challenge to growth models – endogenous, exogenous, balanced growth and big push models – and is a critical element of his 'unbalanced growth' perspective on development (Hirschman, 1958). Unbalanced growth acknowledges that development is not smooth, proceeding from one stage to the next uninterrupted. An understanding of the uneven and sometimes circuitous paths followed in the growth process led to Hirschman's questioning of the elevation of a search for equilibrium, an approach crucial to most growth theories. Hirschman in contrast proposed the antithesis, particularly the cultivation of 'tensions, disproportions and disequilibria' in the economy given their instrumentality in the development process (Hirschman, 1958, p. 66).

This characterisation of development placed Hirschman in conflict with both the neoclassical and structuralist schools. The former places a premium on market forces mediating supply and demand to reach an equilibrium price and views development in terms of equilibrating savings and investments to accumulate capital required for production. In Hirschman's reading, the limited coordination capabilities of developing countries in the first instance precludes their ability to achieve this level of coordination and 'get prices right'. Underdevelopment was treated as not simply due to a deficiency in resources or capabilities but as an a priori lack of information to guide the selection of the appropriate development path.

The structuralists saw it as imperative to correct structural imbalances in the economy by instigating the forces required to set a country on a virtuous path of development through direct and active government intervention given the limited capacity and foresight of private enterprise in underdeveloped countries. Yet in Hirschman's estimation, the State was not necessarily better placed than private entrepreneurs to marshal the critical elements required for development.

He regarded as more critical a close study of the economy to discover and facilitate linkage effects already at work in the economy. These linkages – forward and backward linkages,- jointly referred to as production linkages, and latterly extended to include consumption and fiscal linkages, fit within his unbalanced growth framework (Hirschman, 1958, 1977).

Production linkages for example do not follow a linear process and in the case of backward linkages they induce the creation of industries capable of supplying inputs to 'final sectors'. Consumption and fiscal linkages also do not necessarily work in direct ways. In the case of the former, foreign exchange earned from exports would encourage the creation of local industry to replace the very same imports induced by incomes from exports. Fiscal linkages, which would ordinarily be expected to help address the capital scarcity problem in developing countries, were also prevalent in primary sectors such as agriculture and mining, the sectors with the least potential for production linkages[10].

Linked to the concept of fiscal and consumption linkages are financial linkages which represent the means by which firms fund investment and how this shapes the organisation of production, what is produced and the development of further linkages. Although not making explicit reference to technological linkages, they were implied in Hirschman's analytical framework in recognition of the technological 'alienness' or 'strangeness' of new activities and how these further impact the technological jump required to facilitate backward linkages (Andreoni, 2018; Hirschman, 1977, pp. 180–181). Technological linkages determine the techniques applied in production, the ownership of these techniques and technologies and how firms acquire them.

The time element to how linkages are worked out through the economy was also a critical contribution by Hirschman to a movement to a dynamic view of the economy. This influenced his eschewal of an input-output framework for exploring linkages due to the synchronic nature of the I-O method (Hirschman, 2013). This time element is also reflected in his embrace of micro-Marxism to understand how linkages are manifested in production structures for various commodities at different points in time. An example with reference to pre-industrial countries is the dependency relationship between the core and periphery countries which placed countries in the periphery in the position to act as suppliers of primary commodities. In his view, the period of export-led growth of a variety of commodities deepened the development of linkages and productive forces than at any point in time.

Hirschman advocated for studying how linkages are worked out through an economy to determine where growth-inducing investments should be made rather than the usual practice of the state setting up an industry 'known' to maximise linkages, such as iron and steel. (Hirschman, 1958). This was another challenge to the Big Push and Balanced Growth approaches to growth and reflected a deep understanding of the dynamic and fluid nature of growth which leads to linkages developing at sectoral junctures at specific points in time.

---

[10] Although there has been widespread embrace of these concepts over time, critiques. persist Krugman (1994) although expressing admiration for Hirschman's brilliance in developing the concept of linkages albeit not the novelty of the concept, linked it with the 'decline in development economics'. He placed this squarely on the fact that economies of scale, an implicit assumption in linkage development, could not be easily represented in formal mathematical models. His critique was essentially about the tools of exposition adopted by Hirschman and the resulting impact his discarding of formal modelling tools had on the development discipline thereafter.

In line with the development focus of the linkage theory, Lopez Gonzalez et al (2019) extend the concept of Hirschmanian-type linkages to incorporate the Linder thesis, thus enabling the development of a more robust explanation for the factors precipitating the development of linkages in an economy, especially backward linkages. Although Linder's thesis is a theory of trade and income distribution, both he and Hirschman attribute special status to the manufacturing sector for its demand-pull effects on other sectors.

Linder views this from the perspective of trade, stating the need for 'representative domestic demand' for a product in order for that product to be exportable. Thus, countries develop capabilities in the production of a good to meet domestic demand and in the process build up export capabilities, thus extending linkages to both the domestic and foreign markets. The Linder-Hirschman hypothesis was developed by Lopez Gonzalez et al (2019) to test the instrumentality of both inter-sectoral linkages and domestic representative demand in determining a country's participation in GVCs.

Much of the GVC literature has lost some of its moorings in the development literature as it originated from an exploration of the core-dependency relationship between developed and developing countries (Gereffi & Evans, 1981). In Gereffi & Evans' analysis, the choices made in developing the production structure of an economy were found to influence the flow of FDI which in turn determines a country's position in the core-dependency configuration.

Elements of this developmental focus are still present in the GVC literature as seen in the study of the governance structure of chains, the institutional context in which GVCs develop as well as the process by which firms and in turn economies upgrade in existing GVCs (De Marchi et al., 2020; Gereffi, 1994; Gereffi & Fernandez-Stark, 2016; Giuliani et al., 2005). However, much of the GVC literature has reduced the theory on linkages to its most rudimentary elements and repurposed it from its original broader conceptualisation to fit within the current production framework of Global Value Chains (GVCs) (Andreoni, 2018).

2.5.2. Operationalisation of Linkages in GVC Analysis

The GVC literature is extensive and will not be fully reviewed in this thesis, yet it is essential to address the key messages and insights it offers in understanding how linkages are deployed in the production process. Much of the literature has focused on the top-down governance aspects of GVCs mediated through power and social relations and the upgrading process by which firms and countries move from lower to higher value-added segments of value chains (De Marchi et al., 2014, 2020; Gereffi, 1994; Gereffi & Fernandez-Stark, 2016; Kaplinsky & Morris, 2001; Marchi et al., 2013).

The upgrading literature does investigate the bottom-up micro-level changes which facilitate upgrading, especially in terms of how production structures are organised and capabilities developed in local economies seeking to integrate into chains (Gereffi, 1994; Gereffi & Fernandez-Stark, 2016; Milberg & Winkler, 2013). However the analysis does not sufficiently engage with how linkages developed between local firms enable or deter entry into GVCs (Andreoni, 2018; Beverelli et al., 2015).

This is not to downplay the importance of this literature in demonstrating how timing of entry and the ability to upgrade impacts the distribution of power along value chains. It represents a marked departure from mainstream international trade analysis which views comparative advantage as arising from the distribution of elements such as factor endowments and preferences in a static framework (Lopez Gonzalez et al., 2019; Milberg & Winkler, 2013). By allowing for upgrading, countries are given the opportunity to defy their comparative advantage and develop capabilities that can be applied to new industries.

With respect to developing countries yet to industrialise, Morris, Kaplinsky and Kaplan (2011) make a case for commodity-driven industrialisation through GVC integration as a viable path out of commodity dependence. State intervention through evidence-based strategic policies is encouraged in facilitating the development of linkages from primary commodity sectors to industry. Backward linkages in their view have been undervalued and provide an opportunity for firms to develop horizontal linkages which can be deployed in other industries.

The fragmentation of GVCs is also treated as an opportunity for developing countries to enter production chains and subsequently upgrade to higher value-added and skilled activities along the chain. These recommendations were initially made at the height of a sustained commodity boom driven by increased demand from China and India but contrary to the expectations of the authors, the boom was not sustained, and many commodity-based exporters experienced foreign exchange and balance of payment crises.

Although the commodity situation has stabilised since the late 2010s, this turn of events gives further impetus to the arguments against commodity-based industrialisation as price volatility seems to be a persistent feature of commodity production. In addition, fiscal linkages, which are also linked to the export of primary products, do not always lead to the kinds of development outcomes anticipated and, in many cases, have an immiserating effect on growth through resource curse and Dutch disease effects.

Entrants into commodity-driven value chains can become trapped in low value-added activities if a clear strategy for upgrading is not articulated and implemented. Aside from addressing the well catalogued structural imbalances in the economy, which is usually limited to physical infrastructure, human capital investment and the usual suspects, the development of production capabilities is often ignored.

Though mainly focused on industrial activities, the GVC literature is also important for producer services as their introduction at specific points along the value chain is integral to supporting the production process; however, the research on GVCs from a service perspective remains limited. Oyejide and Adewuyi (2011) and Kaplan (2012) find evidence of backward linkage development between producer services and mining sectors in Nigeria and South Africa respectively. Kordalska and Olczyk (2018) demonstrated that Baltic countries strengthened their position in GVCs by fostering linkages between the manufacturing and financial and transport services sectors. In their research on offshore services, Gereffi and Fernandez-Stark (2016) identify several upgrading trajectories for firms seeking to move from low to high value-added activities.

Yet a word of caution is sounded in embracing GVCs in business services as a potential for facilitating development. The need for Hirschman-linked manufacturing industries as a prerequisite for the development of competitiveness in business service GVCs is a common admonition in much of the literature on the subject (Kordalska & Olczyk, 2018; Lopez Gonzalez et al., 2019; Savona, 2015). This finding is critical for pre-industrialised economies which seek to leapfrog into services without first developing competencies in manufacturing production.

Yet, for all of this, the value chain literature is regarded as suffering from several deficiencies, particularly in terms of the prescriptions made to developing countries seeking to enter GVCs or upgrade to more complex activities (Barrientos et al., 2010; Gereffi & Lee, 2016). Emphasis is placed on the upgrading of firms either as individual units or actors in GVCs but the non-trivial prerequisite of developing capabilities and linkages within domestic networks prior to entry into GVCs is glossed over (De Marchi et al., 2017).

Essentially, a crucial step in value chain entry, which entails the development of capabilities and their transmission via linkages within production networks or Local Production Systems (LPS), has been ignored when it is through the LPS that linkages are activated (Andreoni, 2018). These linkages which include production, consumption and fiscal linkages but also technological linkages, can be developed through vertical linkages from lead transnational firms at the top of vertically integrated chains as well as horizontally between domestic firms.

Learning effects and diversification potential can be triggered through the development of these linkages and eventually address the phenomenon of the 'missing middle' and the concentration of micro firms in Sub Saharan Africa (Andreoni, 2018). The identification and development of linkages must also be situated within a deeper understanding of how the historical and political economy context within which these firms are located, shape and determine the allocation of rents and structuring of linkages (Andreoni, 2018). A reappraisal of the LPS and the opportunity created for capability and linkage development is warranted at this juncture to further enable the exposition.

2.5.3. Local Production Systems and Industrial Districts: Marshallian or Non-Marshallian

The LPS, which is oftentimes referred to as an Industrial District (ID) (Marshall, 1919), Cluster (Porter, 1998), Network or Agglomeration, has its roots in the early work of Alfred Marshall on the advantages arising from industrial district configurations. Research on regional groupings of industries can also be situated within this analytical framework (Best, 1990, 2001). These terms used to describe LPSs are used interchangeably in many instances; however, they are different ways of conceptualising the organisation of production.

Marshall's ideas focus on the unique features of industrial districts which encourage firms to specialise and develop rich networks to optimise production. He offered insight into how geography affects the location of industries and which goods are produced. The tendency for industries to agglomerate in large cities was also covered in his analysis with the importance of infrastructure, the influx of immigrant workers and the impact of local communities considered essential to the efficient working of these districts. The Third Italy Model of Industrial Districts (IDs) departs from this by emphasising unique socio-economic elements that distinguish IDs from any group of co-located small firms (Becattini, 1975, 1978; Becattini et al., 2009; Pyke et al., 1990; Staber & Morrison, 1999).

In much of the literature, LPS or Industrial Districts have been treated as more or less closed systems (Lombardi, 2003), industrial districts and the absence of an investigation of the linkages between the LPS and the rest of the economy limits a full understanding of the role of these systems in the economy (Alberti, 2010; Markusen, 1996). A new approach to our understanding of the LPS challenges many of these notions.

Clusters and industrial districts are increasingly being addressed in the GVC literature. De Marchi and Grandinetti (2014) documented the decline or transformation of Marshallian IDs into new configurations with the global-local or 'glocal' form of most interest for this thesis. In this case, the dynamic firms in the district act as gateways for knowledge transfer between the global network and the local ID. Gereffi and Lee (2016) develop an integrated framework which links clusters and GVCs and demonstrates how they undergo economic and social upgrading under differentiated governance structures. This is an extension of prior work on economic and social upgrading in Global Production Networks (GPNs) (Barrientos et al., 2010).

A related line of research draws on theoretical approaches which include value chain theory, NSI and cluster analysis amongst others to investigate the linkages between primary and manufacturing sectors in several African countries (Bloch & Owusu, 2012; Corkin, 2012; Fessehaie, 2011; Mbayi, 2011; Mjimba, 2011; A. Oyejide & Adewuyi, 2011; Teka, 2012; Terheggen & others, 2011). These are a more contemporary and differentiated narrative on the evolving nature of so-called enclave sectors which challenge long-held beliefs that their potential for linkage development with other sectors in the economy is limited. However, as is the case with studies of this nature, the underlying forces which have shaped the emergence of the linkages and their development through time are not connected systematically to an understanding of why some linkages have developed while others have been truncated.

In particular, while these studies refer to the symbiotic relationship between capabilities and linkages, the complexities in transferring capabilities from one sector to another (Mbayi, 2011) and the need to continuously upgrade capabilities (Bloch & Owusu, 2012; Terheggen & others, 2011) there was no further attempt to provide insight into how this interaction between linkages and capability development takes place. No mention was made of how capabilities are formed in the production process and the factors that may facilitate or impede their transference to other firms, yet these capabilities are instrumental to the development of linkages. In the absence of capabilities, linkage formation is hampered as the linkage is essentially a channel for acquiring, transferring and upgrading capabilities. The next section is an exposition of the capability development process at the micro level.

2.5.4. Capability Development in the Local Production System

Despite the interest of economics theorists in production and how factors of production lead to economic growth, there is limited curiosity on how these factors are organised within firms, production systems or networks. The abstract nature of theoretical modelling employed in growth analysis creates a barrier to the understanding of how labour, entrepreneurship, technology, capabilities and even capital are embodied in the real world and combined to generate output.

The problem begins with mainstream economics perspective on growth, production and organisational arrangements within the firm which enable production. It is this deficiency that is being addressed by a case study approach in this thesis. Linkages do not exist in a vacuum or in abstract and when sectoral interdependencies are referenced, these linkages are manifested as connections between LPS. The traditional view of the LPS or industrial district does not pay adequate attention to the capabilities underlying these linkages. In this section, new ways of conceptualising the LPS framework are proposed.

2.5.5. Firm-level Capabilities

Capabilities are the tools utilised by firms to differentiate themselves and gain competitive advantage over other firms. Richardson (1972) and Penrose (1959) amongst others, made significant contributions to the literature on firm level capabilities. In Penrose's exposition for example, the capabilities of the firm, its production and knowledge base are presented as an important determinant of its ability to take advantage of opportunities for diversification, a process critical for its survival

The capabilities literature adopts an eclectic approach in the development of its theoretical foundations and borrows from the theory of the firm, the evolutionary theory of innovation and firm competitiveness among others (Coase, 1937; Nelson & Winter, 1982; Penrose, 1959; Schumpeter, 1947; O. E. Williamson, 1979). Given the diverse elements engaged, there is no clear-cut agreement on terminology and typologies of capabilities. Teece (2017, p. 696) distinguishes between ordinary and dynamic capabilities, describing the former as 'doing things right' and the latter as 'doing the right things'. Ordinary capabilities are mainly operational skills and knowledge while dynamic capabilities are more strategic and forward looking (Teece et al., 1997).

Bell and Pavitt (1992) in their technology-based classification of firms focus on the distinct differences in how technology is acquired. Their work recognises the centrality of factor endowments, the cumulative mastery of technologies and the fostering of intersectoral linkages in technology accumulation by advanced industrialised countries. For newly industrialising countries, they find that the process of acquisition is complicated and requires a conscious effort to develop capabilities rather than a reliance on technology transfer through the use of available technologies

Capabilities are extended to the national level by Fagerberg and Srholec (2017) who re-introduce the concept of national technological and social capabilities, similar to national technological capabilities referenced in the work of Lall (1992) who outlined a critical role for government in helping to build the more difficult technological capabilities. Technological capabilities, as defined by Lall, refer to the efforts by firms to acquire and master technological knowledge. These capabilities are asymmetric in nature and vary across firms which might be identical in other respects.

Much like any other capability, technological capabilities are dependent on a base set of skills which are the starting point for the adoption of new technologies. In the context of a firm located in a developing country reliant on technology procured from advanced countries, the focus needs to be extended beyond 'learning by doing' to 'learning by using' and 'learning by interacting' (Rosenberg, 2008). To support this thesis, it is well documented that capital goods create opportunities for acquiring both embodied and disembodied technological knowledge (Arrow, 1962).

Lall's seminal work set up a framework for classifying technological capabilities according to the functional areas of industrial activity, namely investment and production, in which they are utilised, juxtaposed against the level of technological sophistication required to use these capabilities (Lall, 1992). He categorised firm capabilities by level of technological complexity:

- **Basic capabilities**: Simple, routine and experience-based capabilities which are based on existing technologies or processes acquired relatively easily through learning by using or doing.
- **Intermediate capabilities**: These require an additional level of skill or effort as reverse engineering of new products and processes developed by firms in advanced countries is required to unlock intermediate capabilities new to the firm or country.
- **Advanced capabilities**: Formal R&D processes are required for the development of advanced capabilities which tend to lead to the development of products or processes new to the world.

The matrix of capabilities developed by Lall draws on conceptual work by Dahlman et al (1987) who find that developing countries tend to reverse the order by which technological capabilities are acquired, progressing from production to investment and then innovation capabilities. This reversal is a consequence of less industrialised countries relying on already existing technologies purchased from industrialised countries. Thus, capabilities are initially acquired through learning by doing or using in the production process before investment and innovation can occur.

In an exploration of technology generation or technology search efforts in developing countries, Katz (1987) documents the evolutionary and non-trivial nature of technology acquisition. Developing country firms are deliberate in their selection of technologies for use in their local context given the implications for the deployment of other factors of production. Much like Dahlman et al, Katz finds that capabilities develop in a sequential order: firstly, product design capabilities, followed by process engineering and lastly production planning skills.

Lall's work built on these foundations and formalised them in a framework which has found broad application in a variety of country or firm level studies and forms part of the toolbox for differentiating industrial strategies on the basis of the capabilities present in the firm (Andreoni, 2011; Andreoni & Anzolin, 2019; Figueiredo & Piana, 2018; U. E. Hansen & Lema, 2019; Khan, 2019; Mazzi & Foster-McGregor, 2021).

Subsequent work improves on Lall's matrix and updates it for use in a more interconnected digital world. Sato & Fujita's (2009) capability framework integrate technological capabilities and GVC approaches from the unique perspective of Japan's industrialisation experience. They define their matrix in terms of *width* of functions along the value chain and *depth* of capabilities, distinguishing between routine and innovative capabilities. The approach is not dissimilar to Lall's despite attempts to distinguish it through the use of different descriptors.

Andreoni & Anzolin (2019) developed a capability matrix for digital industrialisation in the Fourth Industrial Revolution (4IR), building on Lall's framework and extending it to include integration into supply chains as one of the functional areas in which firms operate. Their digital capability matrix also defines the types of capabilities relevant to each functional area, categorising them according to their level of technical complexity. They distinguish three levels of firm capabilities with increasing levels of complexity from basic to advanced. These capabilities are those required for firms in developing countries seeking to engage effectively in the 4IR.

Peerally et al (2021) update the technology capability frameworks of Lall (1992) and Bell and Pavitt (1992) which were based on Third Industrial Revolution (3IR) technologies for the 4IR. Their approach is similar to Dahlman et al (1987), sequencing capability development from productive to innovation capabilities. By applying a systematic literature review, 155 illustrative capabilities are organised into 6 clusters which form the basis for matrix displays classifying the clusters into 4 levels by increasing level of complexity.

Much of the work on capabilities has understood the need to shift away from a bias towards formal measures of capability development such as R&D expenditure, patent systems and Intellectual Property Rights which reflects a predisposition towards technology originating from advanced industrialised countries. In pre-industrialised economies, informal structures are prevalent, R&D expenditure is limited and in the process of adoption of foreign technologies, firms adapt technologies to suit local conditions and contexts.

The theory of capabilities, technological, organisational and otherwise, addresses a knowledge gap in the theory of the firm; however, although linkages and GVCs are acknowledged, it tends to place greater emphasis on the actions that take place within the firm itself. A more complete theorising on capabilities must give prominence to interdependencies between firms, other firms and sectors through linkages. This elevates linkages as transmission devices for technological knowledge (Bell and Pavitt, 1992; Rosenberg, 1983). An extension of the concept of LPS combines theorising on linkages and capabilities into a form meaningful to pre-industrial countries.

2.5.6. The LPS in Linkage Perspective

By synthesising a new framework for understanding the LPS and its relation to linkages and capabilities, Andreoni (2018) reimagined the concept of the LPS within the contemporary context of spatially distributed production networks. His argument shifts the discussion from a desire for countries seeking to industrialise to integrate into GVCs to one that is focused on the cumulative learning and linkage development that takes place within the LPS. Thus, the development of capabilities facilitates the development of linkages prior to entry into production networks.

Using the linkage terminology developed by Hirschman and extending it to define various linkage types, namely, production, technology, consumption, and fiscal linkages, a new LPS approach for yet to be industrialised African countries is developed. This is in response to their unique mode of integration into GVCs through upstream integration which consigns them to the production of primary commodities and places them at the low value-addition end of production chains.

These linkages are arrayed and built up within the LPS and, given the fragmented nature of the LPS in Africa with its large number of micro firms and an absence of mid-size firms, the development of capabilities is difficult. The lack of mid-size firms, termed the 'missing middle', constrains connectivity between different-sized firms and limits the dispersal of the benefits from value-addition in the production process economy-wide.

Limited investment in technology and skills development and poor fiscal linkages to facilitate productive investments are further exacerbated by a difficult political economy situation in which the political settlement, or the manner in which institutions negotiate the distribution of power, is detrimental to development (Khan, 1995).

Beverelli et al (2015) use a different approach to Andreoni (2018) but make a similar proposition in arguing for the development of domestic linkages as a prerequisite for entry into GVCs. They find that Domestic Value Chains (DVCs) are fundamental to integration into GVCs, depending on the fragmentation costs incurred in segmenting production across the DVC and the switching costs associated with changing from domestic to foreign input suppliers. Higher fragmentation costs signify greater ease with entering into GVCs as high fixed costs are already addressed once and for all.

These findings are reached using an input-output model based on data for 59 countries and 26 industries. In their analysis, fragmentation costs are more important in determining entry into GVCs as the enabling effect of DVCs is found to be absent in cases where the fragmentation costs are low and switching costs are high. However, the placement of their analysis at the country and industry level leaves the linkage analysis at an aggregate level and excludes details on the firm capabilities required to build the linkages running through DVCs and GVCs.

Although the LPS framework has been applied in the development of a renewed approach to industrial policy, it has important lessons for the growth of high value-added services and more importantly for facilitating structures that recognise and cater to the interdependencies between services and the manufacturing sector. Much like the case of upward integration into GVCs, tertiarisation could easily devolve into a growth-retarding form if low value-added services are being developed. Thus, such an industrial policy framework would of necessity include growth-inducing services.

2.6. Summary

In this chapter, the various building blocks of literature which form the basis for the analysis in the rest of the thesis were explored in depth. Although some of the blocks of literature reviewed might seem superficially related to each other, the connections between them will be made apparent in the rest of the thesis. The review begins from the several efforts of the economic discipline to come to terms with the real nature of economic growth. Structuralist economics in particular is explored as it offers a useful framework for conceptualising the nature of growth in the developing context where the factors necessary for growth are not always available in the appropriate proportions. It also creates the analytical tools for analysing growth at the level of the sector, rather than in aggregate which allows the observation of services as a contributor to or driver of economic growth.

Several themes run through the analysis: the multi-sectoral, dynamic and heterogenous nature of growth. This underscores the need to move beyond a silo approach to growth, typifying it in terms of what can be achieved through one sector, to viewing it in its wholistic form, in the structuralist tradition, and recognise that interdependencies between sectors are highly critical in determining how growth proceeds.

The heterogeneity is especially pronounced in the context of services evidenced by the various efforts to create ontological categories of services for analysis; however, these classifications are of limited use in a pre-industrial context. Services can only be properly observed when they are deployed in the production process in interaction with other sectoral activities. Adaptation to fit the context is also required and this implies that evaluation of services in a country like Nigeria using the same measures as those for an advanced industrial country only leads to a fictional understanding of these services. The rest of this thesis will focus on developing appropriate tools and analytical frameworks for services in the pre-industrial context.

3. CHAPTER 3: ALL PRODUCER SERVICES ARE NOT THE SAME – THE HETEROGENEITY OF SERVICES

3.1. Introduction

Service taxonomies are an important tool for the development of analytical categories to explicate an economic sector comprised of diverse and seemingly unrelated activities. This is predominantly characteristic of the service sector and its treatment as a residual sector in which all other activities, excluding primary and secondary economic activities, are categorised. Current service taxonomies are inspired by the manner in which goods and services were differentiated from each other in the classical era of economics. The concept of materiality or tangibility was broadly applied to the classification of economic activities with little nuance and the consequence was a designation of goods as material or tangible and services as immaterial and intangible. Since it is now possible to store service outputs on physical media, over which ownership rights could be claimed, transmit and trade these services over long distances, these parameters for designating an activity as a service no longer strictly apply.

The requirement for co-location between the supplier and user of the service is another differentiating factor applied in service classifications that is absent for goods classifications. Yet, as services have taken on different characteristics with the introduction of new technologies which allow for remote service delivery, classification approaches have evolved from those based on how these services are consumed or how they are applied in the production process to how much knowledge and technology is deployed in the utilisation of services.

The review of literature on service taxonomies in Chapter 2 has made a strong effort to move the narrative on services beyond the 'productive' versus 'unproductive' dichotomy prevalent in much of the early literature on services. As a starting point, the heterogenous nature of the service sector was explored. The various typologies and taxonomies developed to bring a semblance of order to a sector comprised of disparate activities with different productivity levels, technology and knowledge intensities amongst other features was discussed.

The question of the production and deployment of technology in the services sector was a principal part of the review as this is one of the core elements considered in the separation between services and manufacturing. KIBS provided the framework in which to examine how thinking has evolved in this area to recognising that not all services are the same and some, such as producer services, have characteristics typically found in the manufacturing sector. KIBS are a specific service category, which demonstrates the interaction and exchange of knowledge and technology between the manufacturing and service sectors.

These interdependencies between the sectors reiterates the growing push to view economic sectors in terms of their interdependencies and linkages rather than as discrete blocks of activities. This is how production takes place within firms as embodied in each product or service is a combination of inputs from all sectors of the economy. This phenomenon is sometimes described as the convergence between services and manufacturing (Miles et al., 1995). In the rest of the chapter, these ideas will be developed in the development of a Producer Service Index which addresses some of the problems with current service taxonomies. It also seeks to define a way by which the convergence between services and manufacturing can be observed and measured.

In this chapter, the progression in service taxonomies is acknowledged, in particular the emergence of knowledge intensive services and producer services as distinct service types; however, the limitations of these service categories in defining IT services and theoretical considerations for addressing these limitations is explored. IT services are by definition knowledge and technology intensive and could function as producer services in specific contexts; however, the level of knowledge and technology intensity of an IT service cannot be determined by current taxonomies. In addition, an IT service which functions as an intermediate input in the production process in one production environment could serve a different function in another situation.

A theoretical framework for developing an IT Producer Service Index to differentiate IT services by degree of technology and knowledge intensity as well as application in the production value chain is proposed. An index is developed and is then applied to demonstrate its utility in identifying if a country's so-called high value-added services are truly adding as much value as hypothesised. It is important to state upfront the challenges involved in the creation of the index. Data essential to the development of an index that would include Nigeria and other pre-industrial countries was not available and attempts to develop an index excluding this data did not produce useful results. To address this problem, a possible solution is the collection of the required country-level data or appropriate proxies through a survey. Unfortunately, such an exercise is beyond the scope of this thesis and for this reason, the index is presented, excluding the pre-industrial countries that the exercise seeks to cover. This is done because even in its current limited form, the IT Producer Service Index produces a useful ranking of countries demonstrating the nature of interaction between IT and the manufacturing production environment in a particular country. This strong performance of the index when applied to real world data suggests there is potential for future research to improve upon it and extend its coverage to less developed countries.

Cases for the development of the IT Producer Service Index and the use of a composite indicator to do this are presented in sections 2 and 3. A theoretical framework for the index is proposed in section 4 while section 5 addresses the selection of indicators and what this implies for the development of an index of this nature. In sections 6, data challenges encountered in index development are discussed while section 7 presents the process of developing the index. Interpretation of the results and the application of the index to country data is presented in section 8. A chapter summary is provided in section 9.

3.2. The Case for an IT Producer Service Index - Service Taxonomies in Pre-industrial Contexts

Producer services, as the name implies, are services which function as intermediate inputs in the production process, differentiating them from consumer services utilised to satisfy a consumption need expressed by end users. Producer services include disparate categories such as financial, insurance, engineering, IT, logistics, legal, management consulting and real estate services. The word ‘producer’ connotes the making of things which contributes to a tendency to consider these services in the context of manufacturing or the production of goods; however, producer services are utilised in the production of both goods and services.

The servicification of manufacturing, essentially the increasing use of services as inputs in manufacturing production, also contributes to the difficulty in drawing a dividing line between manufacturing and service processes in the production value chain (Lanz & Maurer, 2015; Lodefalk, 2015). The approach in this thesis would be to treat producer services which are intermediate inputs as distinct from manufacturing operations which directly transform primary inputs.

Taxonomies are useful in addressing the heterogeneity of services by defining criteria for categorising services but in some cases, these categories obscure more than they reveal. Producer services are a useful but somewhat imprecise taxonomic category because in practice some producer services are also utilised by final consumers. Some key differences between the two uses of producer services as consumption or intermediate goods include the receiver of the service, the scale of consumption and mode of service delivery.

Distinguishing between the use of a producer service as an intermediate input or as a service addressing individual consumer needs can be challenging, especially in cases when an individual or firm uses a specific service both as a final consumer and in the further production of goods or services. This is a shortcoming in the use of the producer service taxonomy and is a difficult problem to address since the level of detail required to decipher service use at such a granular level is not measured in production statistics.

A similar problem is present if we move to a lower hierarchy of the producer service taxonomy. IT services, for example are a sub-category of producer services which are ubiquitous in production environments and in daily use by consumers. The rest of this discussion will focus on IT services given it is the subject of this thesis.

Statistics on IT services, such as its share in GDP, imports and exports convey limited information about the precise ways in which IT services are utilised as a production input. IT services could be consumption-focused, for example the use of a mobile phone to watch videos for entertainment, or producer-focused, the use of the same mobile phone to transact business with suppliers and vendors. These are very different uses, but it is impossible to differentiate between both at the level of aggregate statistics.

Even in a production value chain, the same IT service type can perform both simple and complex functions. For example, computer systems and networks facilitate the procurement of raw materials and monitoring of inventory. The same computer systems can be utilised in designing complex machinery and automating manufacturing processes. Unfortunately, measures of the value-added contribution of IT services do not include information on which of either functions the service is performing.

For example, in the case of Nigeria, IT contributed about 10% on average to total GDP in the last five years; however, this statistic, though useful, contains no information on what proportion of IT was consumption or production focused and whether it was utilised in generic or specialised processes.

This leads to the question of why a distinction between generic and specialised uses or consumption versus production-related applications of IT services is important. Differentiating between generic and specialised uses can give an indication of the technological sophistication of the IT service itself while consumption versus production-related distinctions indicates the industrial environment in which it is being utilised and what degree of technological capacity is harnessed in production applications where IT is an intermediate input. By exploring heterogeneities of this sort, the interaction between IT as an input in interaction with other sectoral activities and the ways in which IT can drive growth can be properly observed. Thus, the varieties of heterogeneity in the ways in which producer services are utilised in the production process is important (Albrieu et al., 2019).

IT services are particularly problematic to observe at this level of detail because although most IT services are technology and knowledge intensive by definition, the complexity of application of the service is dependent on how much of the service functionality is deployed in its application, the industrial context in which it is being utilised and the knowledge or skill level of the operator of the service (Albrieu et al., 2019). As an example, it is reasonable to expect that the use of IT in an economy with a deep industrial base would differ from one with little industrial capacity. Yet current taxonomies and statistics on services do not contain the necessary information to convey these distinctions. The argument will be made that at present, the application of IT services in manufacturing and non-manufacturing activities tends to be interpreted in its most generic and non-specific form, essentially as utilising all the technological functionality in its operation. This can be misleading and is due to the tendency to apply universally accepted taxonomies developed in industrial contexts to less industrialised contexts which are significantly different from those for which they were originally designed or defined.

Relating this to the discussion in the next chapter on the impact of the industrial context in which deindustrialisation occurs on the types of services that emerge, services that would be classified as producer services in a manufacturing environment in an industrialised country might be playing a different role in a similarly named manufacturing environment in a pre-industrial country. Thus, without an understanding of how the service interfaces with manufacturing processes, existing taxonomic categories may be utilised erroneously or may not suffice to explain how these services are utilised.

The central theme of this thesis is to investigate whether IT services can perform similarly as manufacturing in driving economic growth. An increased share of IT in GDP is absent of information on the capability of the types of IT services present in the economy to function as a driver of economic growth: increase innovation, foster increasing returns and economies of scale and create economy-wide linkages. The interface between sectors is where linkages are activated and can be observed. A multiplicity of interactions and processes occur at these interfaces, and it is essential to understand how these reinforce each other. It is at production interfaces that the exact functioning of an IT service as an intermediate input can be observed in the production process.

The complexity of the 'behaviour' of services within specific production contexts cannot be addressed by the expansion of current taxonomies to recognise technological change in services or by the creation of new taxonomies. This is mainly due to the context-specificity of the 'behaviour' of the service as well as the dynamism of services demonstrated when firm workers in specific countries transition from a rudimentary use of technology and knowledge in delivering services to becoming more technology and knowledge intensive in the service use over time. Thus, a new or expanded taxonomy would not address the challenge and might end up following the path of previous taxonomies, quickly becoming obsolete and not reflecting changes in real time. A solution proposed to this quandary is the creation of a composite indicator built up of individual indicators which measure the parameters of interest, namely technology and knowledge intensity of service use and include indicators describing the nature of the production environment in which the services are used. A composite indicator can reflect the dynamism within the service sector as the underlying indicators can be measured annually while the underlying indicators can also be substituted to reflect technological change.

A single indicator or variable cannot capture these interactions and the case will be made for the development of a composite indicator or index given the nature of the measurement problem to be addressed. Such an indicator must allow the differentiation of IT services in terms of complexity of use. The results from measuring and categorising IT services by means of this index can then be utilised in creating robust taxonomies for IT and other producer services.

3.3. Why Another Composite Indicator?

A composite indicator as the name suggests, is an aggregate indicator built from individual indicators based on an underlying theoretical framework (Joint Research Centre-European Commission, 2008). These indicators are qualitative and/or quantitative measures derived from observations and can be utilised in revealing the position of a country relative to others across time.

A composite indicator is defined mathematically as a weighted aggregation of several variables (Farrugia, 2007):

$$I_c = \sum_{j=1}^{m} w_j X_{cj} \tag{1}$$

where w_j is a weight with $0 \leq w_j \leq 1$;

$\sum w_j = 1;$ (2)

X_{cj} is the variable of country c in dimension j;

for any country c, the number of policy variables are equal to $j = 1 \dots, m$

The composite indicator is a tool utilised for managing complexity arising from the interrelationships amongst the indicators or characteristics under observation (Peruzzi, 2017). By nature of the mutual relationships between the components or indicators, they are irreducible to properties of the set of components, but a solution must be found to transform these relationships into a form that communicates the key underlying parameters of interest. Composite indicators are useful in the assessment of complex processes which cannot be adequately measured using single indicators and allow for the simultaneous measurement of several parameters.

Composite indicators, though a good measurement tool given the possibility of combining indicators in various configurations, also present shortcomings. A composite indicator must be based on a strong theoretical framework which guides the appropriate selection of indicators otherwise the wrong phenomena may be measured, and inaccurate results conveyed (Joint Research Centre-European Commission, 2008). Also, the composite index is only as good as the underlying data and serious problems in individual indicator selection can be masked by a composite value.

The selection of variables and the approaches to missing data, either through single or multiple imputation methods affects the robustness of the index. The weighting of the underlying variables forming the composite is also a well-documented factor for consideration and methods for weight selection which range from a rule of thumb approach to one derived from quantitative methods such as multivariate analysis are instrumental to the credibility of the resultant indicator (Barclay et al., 2019; Farrugia, 2007; Joint Research Centre-European Commission, 2008; Maggino, 2017). Uncertainty and sensitivity analysis are tests of robustness which measure the impact of input values on the structure of the index and how this source of uncertainty contributes to output variance (Joint Research Centre-European Commission, 2008). These factors for consideration are indicative of the non-trivial process of index construction and the potential for developing a non-subjective and structurally sound index.

The next section will outline the theoretical framework for the design of an IT Producer Service Index as a critical preliminary step in its development. Following this, the methodology will be described, taking into consideration the essential factors for consideration in building a credible, reliable and robust index.

3.4. Elements of Theoretical Framework for IT Producer Service Index

The construction of an IT Producer Index is more of an art than a science and for this reason, identifying the relevant parameters to include in a theoretical framework can be challenging Oftentimes, no singular theory will suffice, making it necessary to borrow from several theories to build a framework. This is not surprising as the argument for the development of a new index is usually to address a gap in existing knowledge which implies the absence of theory. Since the construction of the index entails entering relatively unexplored territory it will require theory building, drawing from several bodies of knowledge.

In this section, the argument will be made that an index that seeks to classify countries by their use of IT Producer Services will need to consider the technology and knowledge intensity of the production environment itself as well as of the users of the technology; the sectoral boundaries of the production value chain in which the service is being utilised and how this impacts the features of the service which are 'triggered' in production activities; and the contribution of the service to output or value-added. By considering these elements in the design of an index it is possible to compare IT Producer Service use in one context with another, using an objective and robust measure. The exposition of these three parameters follows:

a. IT Service Interface with Production Value Chain

As an initial step towards building a composite index, the exact phenomena under measurement and the circumstances in which it is being investigated must be clarified. The goal of the index is to enable the assessment of the use of IT services in a production environment by focusing on the interface between IT services and sectoral production activities so that categories of IT service usage can be defined and utilised in cross-country comparisons.

The environment in which the IT service is being utilised is a good starting point for determining the elements for constructing a theoretical framework. Since the use of IT services in production is the phenomena under investigation and there is interest in analysing interactions taking place in utilisation of these services, a production value chain approach is appropriate. This is because the various stages of production are set out in a value chain and the points where inputs are introduced into processes and outputs are created can be observed.

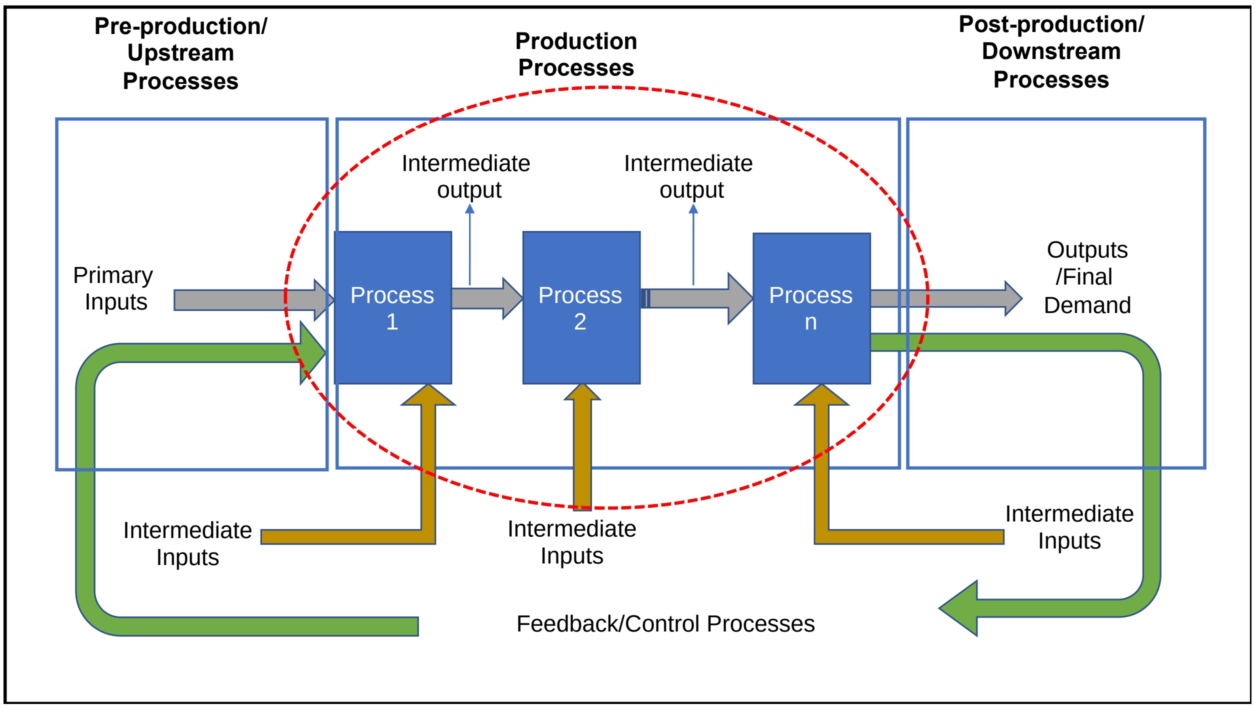
It raises the question of which type of production value chain to consider. Generic and specialised IT services are ubiquitous across all value chains which produce goods and/or services as outputs; however, a strong case can be made for selecting the manufacturing value chain as the preferred choice for this analysis.

Aside from the usual arguments on the uniqueness of the manufacturing sector, which have been mentioned in Chapter 2 of this thesis (Andreoni & Chang, 2018; Kaldor, 1967; Szirmai, 2012; Szirmai & Verspagen, 2010), manufactured products are the delivery mechanism through which IT services are delivered and interface with every other sector. They are also the vectors of services in trade in value added (Bohn et al., 2018). IT does not interact directly with activities in other economic sectors without the mediating influence of a manufactured product. Even the most basic use of IT, such as mobile telephony, requires a mobile phone, a manufactured good, to facilitate the making and receiving of phone calls, messages and other forms of communication. Software also cannot function on its own and is designed to transmit output via hardware. Unfortunately, there is a tendency to underestimate the role of IT services in the operation of manufactured devices as the deep integration of the two tends to obscure the importance of the less tangible component, IT services in this case.

Another argument for selection of the manufacturing-IT service interface for this exercise is that mapping the manufacturing production value chain is relatively straightforward in comparison to the service value chain. Value addition in the production of services is more difficult to identify as inputs and outputs are intertwined in many cases. Isolation of the production process from pre- and post-production activities is also complicated by the difficulty in separating the use of producer services as final demand as opposed to intermediate demand. Also, in the production of services, the activities which lead up to service delivery oftentimes take the form of a collection of network processes rather than a value chain in the conventional sense. Thus, for these reasons, a focus on the manufacturing-IT service interface is the best choice for this analysis.

The next question is to decide which point in the manufacturing production value chain is best for observing the interaction between IT services and manufacturing. IT use is present at every point in the value chain; however, at the pre-production and post-production stages, IT is also used to drive service activities such as design, research and development and marketing. At the production stage the manufacturing-IT service interface is much clearer and easier to isolate as shown in Figure 3.1. However, it must be acknowledged that sectoral activities are increasingly intertwined in production as evidenced with rising servicification which results in services being more embedded in manufacturing processes. This is even more apparent in trade where for example, a service such as software can attract import duties because it is embedded in a manufactured product even with an exemption of duties on services traded across borders (Lodefalk, 2015). Since emphasis is being placed on the manufacturing-service interface, the production stage of the value chain process is the best area of focus for this analysis.

Figure 3.1: Producer Service Interfaces in Production Value Chain



Source: Author's illustration

b. Knowledge and Technology Intensity of IT Services

Emphasising the manufacturing-service interface in the production value chain builds on the work of Andreoni and Gomez (2012) in developing an analytical framework which frames the interaction between services and manufacturing from a value chain perspective. They differentiate between production-related and non-production related services in developing a service taxonomy and distinguish services according to functional areas in which they are used and the extent to which service providers possess knowledge of the core production processes of their clients. Thus, services are classified not only in terms of their relative position in the value chain but the range of knowledge-intensity in the application of services is acknowledged.

Oftentimes knowledge and technology intensity are conflated. Although both terms are related, they display unique characteristics which are worth considering in a framework focused on manufacturing-service interactions. Abdal et al (2016) utilise both in their development of a new inter-sectoral typology which attempts to transcend the separation between manufacturing and services by integrating knowledge and technology intensity.

Knowledge and technology intensity are critical indicators in the development of a producer service index as the relative intensity of these concepts in a production process that utilises IT services is essential for developing a more nuanced approach to classifying IT services. There are significant overlaps between the definitions of knowledge and technology and the measurement of both concepts, with R&D use being critical to both; however, it can be argued that both concepts reinforce each other. Possession of knowledge provides a skills base for the development and application of technology. At the same time, technology enables the further development and effective use of knowledge. It is possible for IT services, typically understood to be technology or knowledge-intensive in an advanced industrial context, to take on a less knowledge or technology-intensive form in a pre-industrial context where technological infrastructure or knowledge is limited or absent. It is this very behaviour of IT services we are seeking to understand in greater depth.

Following the OECD definition, technology-intensity is indicative of the level of R&D embodied in a product (Hatzichronoglou, 1997). The production-centric definition of technology intensity means services are typically not included when this measure is applied. By measuring R&D intensity, many pre-industrial countries are left out of this classification as formal R&D investment in these countries is either low or inadequately tracked. Thus, a more inclusive approach to measuring technology intensity is required for this exercise.

Knowledge-intensity as applied in this context addresses the use of tacit and codified aspects of knowledge in the delivery of services. Traditional measures of knowledge-intensity tend to focus on what can be codified, such as the level of formal schooling, number of professional certifications etc. but more tacit forms are also important and these include knowledge acquired in the production process, interaction with vendors, suppliers and customers and other less tangible forms of knowledge transfer.

As regards placement in the production value chain, certain assumptions are made about the knowledge and technology-intensity of the services based on whether they are introduced at the pre-production, production or post-production part of the value chain. For example, as described by the

Smile curve, services at the upstream and downstream ends of the chain are considered to make higher contributions to value-added while those services which interface directly with manufacturing processes are considered to contribute less to value-added (Meng et al., 2020; Mudambi, 2008). However, the assessment of the level of knowledge and technology intensity in the application of these services along the value chain is not linear and varies depending on the industrial context. Also, because IT services utilised in the production stage tend to become standardised over time and are integrated with manufacturing devices they are oftentimes not treated as separate production inputs.

At present, there is no universally accepted or comprehensive classification system which categorises services based on knowledge or technology intensity although several institutional attempts have been made to develop such taxonomies. Eurostat developed a taxonomy which classifies services based on knowledge intensity. It is a useful classification system but still suffers from the challenge of not conveying adequate information on the extent of technology and knowledge intensity applied when these services are utilised in different contexts. It is similar to the case for manufacturing activities for which the technology classification of industries developed by the United Nations (UN) and the OECD, as well as the export product classifications developed by Lall (2000), building on the SITC, are indicators of the technology intensity of manufacturing industries and export products. Thus, a new approach to measuring technology and knowledge intensity of IT services is necessary, otherwise it might be misleading to apply these measures to less technologically progressive environments where the full potential of these services cannot be realised.

c. IT Service Contribution to Gross Output

In this analysis, the role of IT services as intermediate inputs in production and how this contributes to output is a direct indication of how services act in specific contexts. With the fragmentation of production across global value chains, the contribution of intermediate inputs to production is more apparent as the production process itself is divided into several stages in which value is incrementally added. In the standard production function, capital and labour, both primary inputs, are the principal production inputs considered while intermediate inputs are captured as part of the residual. This representation of production complicates the separation of intermediate inputs from other non-primary inputs such as energy and materials and makes it even more challenging to separate IT services as a distinct intermediate input.

Value-added is the preferred measure of output as it eliminates the problem of accounting for intermediate inputs. However, it must be acknowledged that value-added is not an easy concept to measure since in reality it is difficult to distinguish between value-added and intermediate inputs as value-added is not directly observable and is an artificial construct (Cobbold, 2003; Strobel, 2016). The standard approach to compute value-added is through growth accounting methods which enable the decomposition of the elements comprising gross output into constituent parts, deducting the contribution of intermediate inputs, such as IT services, to production output (Jorgenson, 1991; Jorgenson et al., 1987, 2005). However, this exercise though allowing a disaggregation to the level of IT services, offers no insight on what happens on the shop floor when these services are utilised. Thus, measures of IT service contribution to output which convey this information must be included in this index.

d. Summary

In summary, a conceptual framework can be developed setting out the production value chain and showing the interaction between IT services and manufacturing processes to create outputs at varying levels of knowledge and technology intensity. As shown technology and knowledge intensity, though separate processes are highly correlated and mutually reinforcing. The level of knowledge and technology intensity in the application of IT services in the production process affects the nature of the output produced.

To reiterate, the IT service interface with the production value chain, the technology and knowledge intensity of IT services, and the IT service contribution to output or value-added are the main building blocks for the creation of an IT Producer Service index. These are the top-level dimensions of the index and in the next section, the specific underlying indicators for each dimension will be selected and utilised in constructing the index.

3.5. Selection of Indicators

The IT Production Index is designed to evaluate and rank the use of IT in the production stage of the manufacturing process. The indicators for constructing the index will be used to rank countries according to the types of inputs introduced at the IT-manufacturing interface, the level of technology or knowledge intensity present in each country to enable the use of these inputs as well as the contribution of IT services to total value-added. As explicated previously, these indicators give a better indication of the manner by which IT services are deployed in the production process.

In selecting the indicators for the development of the index, the relevance of the indicator to the phenomena under observation is paramount, along with the availability of data for a wide cross-section of countries. Many of the indicators selected for this purpose are utilised in other composite indices which measure technology use in a country such as the Technology Achievement Index (TAI) (Desai et al., 2002); however, the originality of this index is the use of imports of numerically controlled machines, which are machine tools that embody the integration of IT and manufacturing technologies in a single object, as an indication of the interaction between IT and manufacturing in the production process. The list of indicators utilised in the creation of the index including the sources of data, the unit of analysis and the period covered are as follows:

Table 3.1 : Selection of Indicators for Development of IT Producer Service Index

S/N	Indicator	Unit	Source	Data Coverage
1	**IT Service Contribution to Gross Output**			
i	Domestic services value-added in manufacturing	US Dollars	OECD TiVA	till 2016
2	**Knowledge and Technology Intensity of IT Services**			
i	Research and development expenditure	US Dollars	UNESCO UIS	till 2018
ii	Charges for Use of IP	US Dollars	IMF BOP via WDI	till 2019
iii	Patents in force by filing office	Number	WIPO	till 2018
iv	High Technology Exports	US Dollars	UNIDO via WDI	till 2017
v	ICT Goods Exports	% of Total Goods Exports	UNCTAD via WDI	till 2017
vi	School Enrolment (Tertiary)	Number	UNESCO UIS via WDI	till 2018
3	**IT Service Interface with Production Value Chain**			
iii	Machine Tools Imports	US Dollars	UN Comtrade	till 2019
a	Shearing Machine	US Dollars	UN Comtrade	till 2019
b	Sharpening Machine	US Dollars	UN Comtrade	till 2019
c	Punching Machine	US Dollars	UN Comtrade	till 2019
d	Other Milling Machines	US Dollars	UN Comtrade	till 2019
e	Other Lathes	US Dollars	UN Comtrade	till 2019
f	Other Drilling Machines	US Dollars	UN Comtrade	till 2019
g	Boring-Milling Machines	US Dollars	UN Comtrade	till 2019
h	Milling Machines	US Dollars	UN Comtrade	till 2019
i	Bending Machines	US Dollars	UN Comtrade	till 2019
j	Other Grinding Machines	US Dollars	UN Comtrade	till 2019
k	Horizontal Lathe Machines	US Dollars	UN Comtrade	till 2019
l	Flat Surface Grinding Machines	US Dollars	UN Comtrade	till 2019

Although the selection of the indicators was based on the dimensions of interest for the construction of the index, the approach is to rely on PCA to determine the structure of the index and the sub-indices aggregating to generate the overall ranking of countries.

3.6. Data Challenges in Index Construction

The index is designed for use in ranking countries and comparing their performance based on the parameters in the overall index and sub-indices. The comparison can be between different countries for the same time period or across time for the same country or two or more countries. Thus, data should be available for the variables utilised in building the index for the range of countries to be compared. In this case, where the intent is to develop an index which allows the assessment of the use of IT Producer Services in the pre-industrial context, a complete data set is not available for any of the countries that are classified as pre-industrial. The incomplete data is of two types:

a. **No pre-industrial country data available:** This is the case for the Domestic Services Value-Added in Manufacturing variable; however, the data set utilised includes some African countries like Tunisia and South Africa.
b. **Too many missing data points for a variable:** For many pre-industrial countries, too many data points were missing for particular variables and for this reason the country date for the specific variables were excluded from the analysis.

The problem with incomplete data is extremely challenging for this analysis as it raises the question of whether the index is of any value. This data challenge is precisely the reason why the research on pre-industrial countries is very sparse. There is a tendency for researchers to decide what is worth researching on the basis of what data sets are available and this results in most of the research produced focusing on the advanced industrial countries.

The dearth of data also influenced the research methods adopted in this thesis. The limited research and data on IT firms in Nigeria influenced the decision to conduct a survey of firms in Lagos as a preliminary step towards selecting firms for a case study. Not every researcher is able to or willing to go to these lengths to obtain data and so the absence of pre-industrial countries from research on production activities at the firm level perpetuates itself and becomes a vicious circle.

For this reason, the decision was taken to proceed with the construction of the index adopting two approaches to deal with the incomplete data.

a. **No pre-industrial country data available:** The countries for which data was unavailable, the decision was taken to exclude them from the analysis. A more comprehensive way to address this challenge would be to conduct a survey of all countries, including pre-industrial countries, to obtain the data or proxies for this variable. Unfortunately, the resources to collect this data were not available at the time this research was conducted and data of this magnitude is best collected by institutions with global reach and coverage.

b. **Too many missing data points for a variable:** Missing data is a common problem in development work and there are standard approaches in statistics for dealing with the problem of missing data. These approaches are documented in Section 3.7.1 (b).

The challenges with data have far reaching implications as policy makers require quality research to guide their policy decisions. Some of these challenges with the role of the State in supporting growth and development will be addressed further in Chapter 6. Business decisions are also based on analysis about the industry in which a firm operates, the performance of competitors, the size of the market amongst other important metrics. Without access to such data, firms are unable to make informed decisions.

To address these problems, the State must invest in data collection through its statistical and research organisations, and it must also promote the analysis of such data and the production of research which is made publicly available. There is a lot of guardedness and secrecy around government-produced data in Nigeria and most likely in other pre-industrial countries. In cases where data is produced it is not in an accessible form for easy use. If the State takes this action, it will induce the same behaviour in firms and promote transparency around the sharing of data.

These constraints around data availability influenced the creation of the index and the general direction of the research and this should be considered in engaging with the work in this thesis.

3.7. Methodology for the Development of an IT Producer Service Index

Despite their ubiquity in policy and development circles, the methodology for development of an index is not a straightforward one, as the developer of the index is required to make several subjective and objective decisions in the process of construction. These decisions affect the outcomes of the process; however, there are several techniques for testing the robustness and sensitivity of the outcomes of the construction of the index.

Construction methods range from simple indices which compute the arithmetic or geometric mean of selected indicators measuring the phenomenon under investigation to the application of multivariate data analysis to identify the correlation structure of the underlying data utilised in construction. Although each method relies to some degree on the discretion of the developer of the index, the use of multivariate analysis is more objective as it is driven by the data and not the subjective choices of the developed (Joint Research Centre-European Commission, 2008).

The approach adopted in the development of the IT Producer Service Index follows that proposed in the Handbook on Constructing Composite Indicators: Methodology and User Guide (Joint Research Centre-European Commission, 2008) which also draws from the work done by Nicoletti et al (1999) in creating indicators of product market regulations and employment protection legislation for most of the OECD countries. The method entails the use of PCA in determining the contribution of each indicator to the overall variance in the data. These contributions or loadings are used to determine the weighting of each indicator in constructing the overall index.

3.7.1. Principal Component Analysis

PCA is used to explain the variance of observed data by reducing the original data to a few linear combinations of the data. If a data set has *Q* variables, with values of $x_1, x_{2......}x_Q$, the variation in the data can be accounted for by uncorrelated principal components of the original data, $Z_1, Z_{2......}Z_Q$ (Joint Research Centre-European Commission, 2008). These components can be further reduced to the principal components which show a significant portion of the cumulative variance of the original data.

The objective is to reduce the original data to principal components which indicate a lack of correlation with each other even though the original data is highly correlated. The principal components can be represented as:

$$Z_1 = a_{11}x_1 + a_{12}x_2 + \cdots + a_{1Q}x_Q$$

$$Z_2 = a_{21}x_1 + a_{22}x_2 + \cdots + a_{2Q}x_Q \quad (3)$$

$$\cdots \qquad \cdots \qquad \cdots$$

$Z_Q = a_{Q1}x_1 + a_{Q2}x_2 + \cdots + a_{QQ}x_Q$, where a_{ij} are the factor loadings (4)

The component or factor loadings are applied to the variables x_j in the above equation to ensure that the principal components Z_j are orthogonal and all the principal components account for the maximum possible variance of the set of xs.

The goal of PCA is to find the eigenvalues λ_j of the sample covariance matrix, CM. The eigenvalues of the matrix CM are variances of the principal components which can be found by solving the equation $|CM - \lambda I| = 0$ with I as the identity matric of the same order as CM and λ as the vector of eigenvalues.

$$CM = \begin{bmatrix} cm_{11} & cm_{12} & \cdots & cm_{1Q} \\ cm_{21} & cm_{22} & & cm_{2Q} \\ \vdots & & \ddots & \vdots \\ cm_{Q1} & cm_{Q2} & \cdots & cm_{QQ} \end{bmatrix} \tag{5}$$

The eigenvalues sum up to the diagonal elements of the CM such that:

$$\lambda = \lambda_1 + \lambda_2 + \cdots . + \lambda_Q = cm_{11} + cm_{22} + \cdots . + cm_{QQ} \tag{6}$$

a. Data Preparation

The first step was to obtain a sense of the distribution of the data, identifying the potential for outliers. This was confirmed from the descriptive statistics obtained, indicating the need for normalisation of the data prior to any analysis.

Table 3.2: Descriptive Statistics for Indicator Set I (2005-2007)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
ICTGoodExports1	40	5.4321E+9	2.738E+13	2.328E+12	4.868E+12
HTExports1	40	96700001.0	3.426E+11	2.963E+10	5.884E+10
DVA1	40	9216.82033	11595495.8	1925382.27	2631502.67
ChargesforIP1	40	22216038.5	2.814E+10	3.1982E+9	5.7708E+9
PatentInForce1	40	747.333333	484619.667	79537.1875	113756.145
RDExpenditure1	40	30028.0000	2.760E+10	754566378	4.3556E+9
MachineTool1	40	258336.36	1989938.35	816965.568	352394.640
SchoolEnrollment1	40	2692.00000	23102677.7	1876381.06	4248253.98
Valid N (listwise)	40				

Table 3.3: Descriptive Statistics for Indicator Set II (2014-2016)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Machine Tool3	58	106632.884	3070754.74	956776.998	596791.609
SchoolEnrollment3	58	6925.00000	43059232.0	2692688.90	6946186.47
RDExpenditure3	58	50809.9800	6.637E+10	2.1057E+9	9.7164E+9
PatentsInForce3	58	74.0000000	1949347.67	148504.385	343681.988
ICTExports3	58	754993666	5.595E+13	2.750E+12	8.161E+12
DVA3	58	433.927500	43570190.3	3049554.37	6400071.81
ChargesforIP23	58	19298250.1	7.225E+10	5.7532E+9	1.215E+10
HTExports3	58	60866907.3	6.336E+11	3.652E+10	9.023E+10
Valid N (listwise)	58				

To enable an intertemporal comparison of countries ranking, two periods were selected for construction of the index.: 2005 to 2007 and 2014 to 2016. The selection of these periods is based mainly on data availability but also ensure the exclusion of periods such as the 2008 financial crisis when performance on the indicators could have deviated from the overall trend. For each of the two periods, a simple average of each indicator for each period was calculated, for example:

$$High\ Technology\ (HT) Exports_{2005-7} = \frac{HT\ Exports\ _{2005} + HT\ Exports\ _{2006} HT\ Exports\ _{2007}}{3} \qquad (7)$$

All the indicators, with the exception of ICT Goods Exports, which is expressed as a percentage of Total Goods Exports, are expressed in absolute numbers. It was necessary to convert ICT Goods Exports to an absolute number by multiplying it by Total Goods Exports data, also from the World Bank's WDI.

In the case of data on numerically controlled machine tool imports, imports into each country for domestic use were computed by subtracting re-imports from total imports. Unit costs for each machine tool were computed by dividing total trade value of imports by the quantity of items imported. These were then aggregated to form a single machine tool import index.

The initial data preparation was done in Microsoft Excel; however, subsequent preparation of the data was completed in SPSS as it was necessary to merge the various indicators by country. By so doing, the missing values per indicator became apparent and a method for addressing the missingness of data prior to preparation of the index became necessary.

b. Treatment of Missing Data

In the handling of cross-country data, the question of missing data is one that is difficult to avoid. A complete dataset is required for PCA, and various approaches can be adopted depending on the type of 'missingness' encountered. Three types of missingness are identified in the literature:

i. **Missing Completely At Random (MCAR)**: In this case, missing values are not dependent on the variable of interest or any other observed variable in the data set (Joint Research Centre-European Commission, 2008).

$$\Pr(R|D) = \Pr(R) \qquad (8)$$

where D is $n \times p$ data, where n is the sample size and p is the number of variables where R is a response indicator matrix with the same dimension as D. Whenever D is observed, $R = 1$; otherwise, $R = 0$

ii. **Missing At Random (MAR):** Missing values are not dependent on the variable under study but are conditional on other variables in the data set (Joint Research Centre-European Commission, 2008).

$$Pr(R|D) = Pr(R|Y_{obs}) \quad (9)$$

where Y_{obs} is observed data

iii. **Not Missing At Random (NMAR):** In this case, missing values depend on the values themselves.

$$Pr(R|D) \neq Pr(R|Y_{obs}) \quad (10)$$

where Y_{obs} is observed data.

Based on the characteristics of the data, the missing values are assumed to be MAR. No statistical test is available to test for NMAR and in cases where data is NMAR, an explicit model must be developed and included (Joint Research Centre-European Commission, 2008). MAR data on the other hand can be ignored and various methods are adopted for missing data when this is the case (Takahashi, 2017):

i. **Listwise Deletion (LD) or Case Deletion:** any rows with at least one missing value are deleted.

ii. **Deterministic Single Imputation (D-SI):** missing values are replaced based on a reasonable guess. This could be achieved with a regression model or by replacing with the mean, median or mode of the dataset.

iii. **Stochastic Single Imputation (S-SI):** a regression model is used to predict missing values, also including random components from the residual distribution.

iv. **Multiple imputation algorithms:** these include Data Augmentation (DA) algorithm, Fully Conditional Specification (FCS) algorithm, and Expectation-Maximization with Bootstrapping (EMB) algorithm.

In this analysis, to eliminate all missing values and ensure a complete dataset for the analysis, a combination of LD and D-SI was applied. A threshold for the number of missing indicators allowable for each country was determined. In the case of the full index, countries with more than 3 out of 7 variables missing were excluded while the missing values for the retained variables were imputed with the mean values from two of the years not more than 3 years following the year with the missing data. It must be acknowledged that this approach to handling missing data might introduce some bias into the analysis; however, this can be addressed through uncertainty and sensitivity analysis.

c. Normalisation of Data

Normalisation of data prior to PCA is required to make it possible to compare the variables constituting the index. It is a necessary stage prior to aggregation as the variables have different measurement units and normalisation reduces them to the same unit. Several approaches to normalisation are suggested in the literature and these include (Joint Research Centre-European Commission, 2008) :

i. **Ranking** – arranging indicators by their relative scores.

$$I_{qc}^{t} = Rank\ (x_{qc}^{t}) \tag{11}$$

ii. **Standardisation (using z-scores)** – converts variables to a common scale with a mean of zero and standard deviation of one.

$$I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc=\bar{c}}^{t}}{\sigma_{qc=\bar{c}}^{t}} \tag{12}$$

iii. **Min-Max** – reduces indicators to an identical range between 0 and 1 by subtracting the minimum value and dividing by the range of the indicator values.

$$I_{qc}^{t} = \frac{x_{qc}^{t} - min_c(x_q^{t_0})}{max_c\left(x_q^{t_0}\right) - min_c(x_q^{t_0})} \tag{13}$$

iv. **Distance to a reference** – this measures the relative position of a given indicator to a reference point.

$$I_{qc}^{t} = \frac{x_{qc}^{t}}{x_{qc=\bar{c}}^{t_0}}\ or\ \frac{x_{qc}^{t} - x_{qc=\bar{c}}^{t_0}}{x_{qc=\bar{c}}^{t_0}} \tag{14}$$

v. **Transformation to a categorical scale** – this method assigns a score to each indicator. Many times, the scores are based on the percentiles of the distribution of the indicator across countries.

$$I_{qc}^{t} = \begin{cases} 0\ if\ x_{qc}^{t} < P^{15} \\ 20\ if\ P^{15} \leq\ x_{qc}^{t} < P^{25} \\ 40\ if\ P^{25} \leq x_{qc}^{t} < P^{65} \\ 60\ if\ P^{65} \leq x_{qc}^{t} < P^{85} \\ 80\ if\ P^{85} \leq x_{qc}^{t} < P^{95} \\ 100\ if\ P^{95} \leq x_{qc}^{t} \end{cases} \tag{15}$$

vi. **Indicators above or below the mean** – these are transformed such that values around the mean are assigned a value of 0 while those above or below a certain threshold are assigned 1 and -1 respectively

$$I_{qc}^{t} = \begin{cases} 1\ if\ w > (1+p) \\ 0\ if\ (1-p) \leq w \leq (1+p) \\ -1\ if\ w < (1-p) \end{cases} \tag{16}$$

vii. **Cyclical indicators** - the results of business tendency surveys are combined into composite indicators to reduce false signals, and better forecast cycles in economic activities (Nilsson, 2000)

$$I_{qc}^{t} = \frac{x_{qc}^{t} - E_t(x_{qc}^{t})}{E_t(|x_{qc}^{t} - E_t(x_{qc}^{t})|)} \tag{17}$$

viii. **Balance of opinions** – this is achieved by equating the positive and negative opinions of experts in the related field.

$$I_{qc}^{t} = \frac{100}{N_e} \sum_{e}^{N_e} sgn_e(x_{qc}^{t} - x_{qc}^{t-1}) \tag{18}$$

ix. **Percentage of annual differences over consecutive years** - represents the percentage growth with respect to the previous year rather than the absolute level.

$$I_{qc}^{t} = \frac{x_{qc}^{t} - x_{qc}^{t-1}}{x_{qc}^{t}} \tag{19}$$

After considering the various approaches to normalisation, standardisation using z-scores and conversion to a categorical scale where attempted. The former has the drawback of giving indicators with extreme values a larger impact on the indicator while the latter can flatten out the variation in the data. The categorical scale option was eventually adopted as the data was characterised by outliers, making it difficult to interpret the results from the z-transformation. To enable cross-comparison of data, each indicator was normalised by grouping it into 5 percentiles giving the indicators a similar mean and standard deviation.

The results from the normalisation of the two sets of data, the first for the 2005-7 period and the second for 2014-16 are presented in the table below:

Table 3.4: Normalised Indicator Data for Period I (2005-2007)

Descriptive Statistics			
	Mean	Std. Deviation	Analysis N
ICTGoodExports2 (Binned)	3.00	1.432	40
HTExports2 (Binned)	3.00	1.432	40
DVA2 (Binned)	3.00	1.432	40
ChargesforIP2 (Binned)	3.00	1.432	40
PatentInForce2 (Binned)	3.00	1.432	40
RDExpenditure2 (Binned)	3.00	1.432	40
MachineTool2 (Binned)	3.00	1.432	40
SchoolEnrollment2 (Binned)	3.00	1.432	40

Table 3.5: Normalised Indicator Data for Period II (2014-2016)

Descriptive Statistics			
	Mean	Std. Deviation	Analysis N
Machine Tool4 (Binned)	3.02	1.433	58
SchoolEnrollment4 (Binned)	2.98	1.445	58
RDExpenditure4 (Binned)	2.97	1.426	58
PatentsInForce4 (Binned)	2.98	1.433	58
ICTExports4 (Binned)	2.98	1.445	58
DVA4 (Binned)	2.97	1.426	58
ChargesforIP24 (Binned)	3.02	1.408	58
HTExports4 (Binned)	2.97	1.426	58

3.7.2. Principal Component Analysis Tests

PCA was performed to determine how the variables are associated and change in relation to each other (Joint Research Centre-European Commission, 2008). The suitability of the data for structure detection was determined by two tests:

a. **The Kaiser-Meyer-Olkin Measure of Sampling Adequacy:** this indicates the proportion of variance in the variables that might be a result of underlying factors. It tests whether the partial correlations among variables are small. High values (close to 1.0) indicate that a factor analysis may be appropriate for the data but if the value is less than 0.5, the results of the factor analysis might not contain useful information (IBM Knowledge Center, 2015).

b. **Bartlett's test of sphericity:** it tests the hypothesis that the correlation matrix is an identity matrix, which would indicate that the variables are unrelated and not suitable for structure detection. Small values (less than 0.05) of the significance level indicate that a factor analysis may be useful with your data (IBM Knowledge Center, 2015).

The results of both tests indicate the suitability of the data for analysis for the two periods as the KMO Measures of Sampling Adequacy for both sets of data are above 0.8 while the significance levels are less than 0.

Table 3.6: Suitability Tests for Index 1 (2005-2007)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.803
Bartlett's Test of Sphericity	Approx. Chi-Square	272.687
	df	28
	Sig.	0.000

Table 3.7: Suitability Tests for Index 2 (2014-2016)

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.824
Bartlett's Test of Sphericity	Approx. Chi-Square	344.957
	df	28
	Sig.	0.000

The negatives of the partial correlation coefficients are contained in the anti-image correlation matrix while the anti-image covariance matrix contains the negatives of the partial covariances (IBM Knowledge Center, 2015). In a suitable factor model, most of the off-diagonal elements will be small. The measure of sampling adequacy for a variable is found on the diagonal of the anti-image correlation matrix. If the values on the principal diagonal of the anti-image matrix are close to 1 it signifies that the measures being analysed are appropriate.

Table 3.8: Anti Image Matrices for Index 1 (2005-2007)

Anti-image Matrices

		ICTGoodExports2 (Binned)	HTExports2 (Binned)	DVA2 (Binned)	ChargesforIP2 (Binned)	PatentInForce2 (Binned)	RDExpenditure 2 (Binned)	MachineTool2 (Binned)	SchoolEnrollment2 (Binned)
Anti-image Correlation	ICTGoodExports2 (Binned)	.818[a]	-0.230	-0.301	-0.426	0.377	0.049	0.205	0.223
	HTExports2 (Binned)	-0.230	.894[a]	-0.381	-0.271	0.064	-0.102	0.167	0.225
	DVA2 (Binned)	-0.301	-0.381	.802[a]	-0.145	-0.351	0.027	-0.335	-0.625
	ChargesforIP2 (Binned)	-0.426	-0.271	-0.145	.850[a]	-0.554	-0.042	-0.093	0.042
	PatentInForce2 (Binned)	0.377	0.064	-0.351	-0.554	.796[a]	-0.108	0.246	0.207
	RDExpenditure2 (Binned)	0.049	-0.102	0.027	-0.042	-0.108	.847[a]	-0.335	-0.425
	MachineTool2 (Binned)	0.205	0.167	-0.335	-0.093	0.246	-0.335	.434[a]	0.241
	SchoolEnrollment2 (Binned)	0.223	0.225	-0.625	0.042	0.207	-0.425	0.241	.657[a]

a. Measures of Sampling Adequacy(MSA)

Table 3.9: Anti Image Matrices for Index 2 (2014-2016)

Anti-image Matrices

		Machine Tool4 (Binned)	SchoolEnrollment4 (Binned)	RDExpenditure 4 (Binned)	PatentsInForce 4 (Binned)	ICTExports4 (Binned)	DVA4 (Binned)	ChargesforIP24 (Binned)	HTExports4 (Binned)
Anti-image Correlation	Machine Tool4 (Binned)	.788[a]	0.017	-0.244	-0.213	-0.165	0.089	-0.067	0.155
	SchoolEnrollment4 (Binned)	0.017	.802[a]	-0.476	0.138	0.032	-0.466	0.008	0.069
	RDExpenditure4 (Binned)	-0.244	-0.476	.792[a]	0.101	0.021	0.029	-0.146	-0.046
	PatentsInForce4 (Binned)	-0.213	0.138	0.101	.814[a]	0.039	-0.589	-0.467	0.046
	ICTExports4 (Binned)	-0.165	0.032	0.021	0.039	.825[a]	0.014	-0.117	-0.683
	DVA4 (Binned)	0.089	-0.466	0.029	-0.589	0.014	.813[a]	-0.012	-0.405
	ChargesforIP24 (Binned)	-0.067	0.008	-0.146	-0.467	-0.117	-0.012	.910[a]	-0.067
	HTExports4 (Binned)	0.155	0.069	-0.046	0.046	-0.683	-0.405	-0.067	.808[a]

a. Measures of Sampling Adequacy(MSA)

In order to identify the number of components explaining the variation in the data, the total variance explained by each of the 8 components generated was analysed. Following the approach in Joint Research Centre-European Commission (2008), a cut-off of 1 was adopted. The eigenvalues of the first 2 components explain most of the variance in the data with 78.3% for index 1 and 73.6% for index 2.

Table 3.10: Total Variance Explained Index 1: 2005-2007

Total Variance Explained							
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.922	61.521	61.521	4.922	61.521	61.521	4.744
2	1.336	16.698	78.219	1.336	16.698	78.219	2.860
3	0.740	9.248	87.467				
4	0.387	4.832	92.299				
5	0.323	4.043	96.342				
6	0.149	1.866	98.208				
7	0.079	0.989	99.198				
8	0.064	0.802	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 3.11: Total Variance Explained Index 2: 2014-2016

Total Variance Explained							
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.837	60.462	60.462	4.837	60.462	60.462	4.648
2	1.052	13.148	73.609	1.052	13.148	73.609	2.990
3	0.834	10.425	84.034				
4	0.506	6.323	90.357				
5	0.359	4.484	94.841				
6	0.210	2.622	97.463				
7	0.124	1.544	99.008				
8	0.079	0.992	100.000				

Extraction Method: Principal Component Analysis.

This is confirmed in the Scree plots which indicate that two components are above the eigenvalue cut-off point of 1. Scree plots are visual representation of the eigenvalues derived from the analysis which are plotted sequentially. The recommendation is to retain all eigenvalues in the sharp decline prior to the point on the line where they start to stabilize (Cattell, 1966). Once the components are selected, the data must be rotated to interpret the components generated by the analysis.

Figure 3.2 Scree Plot Index 1: 2005-2007

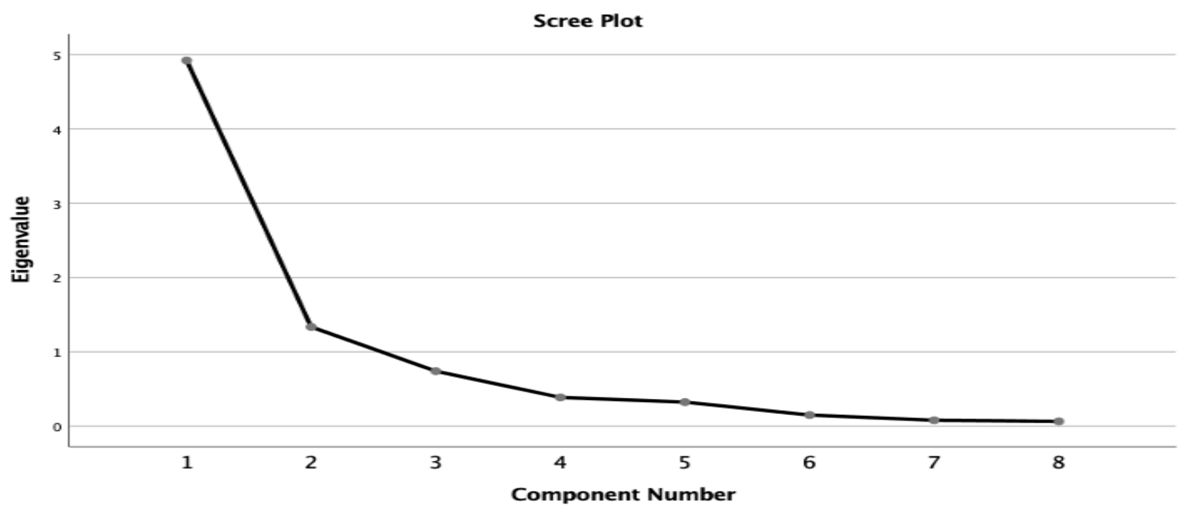
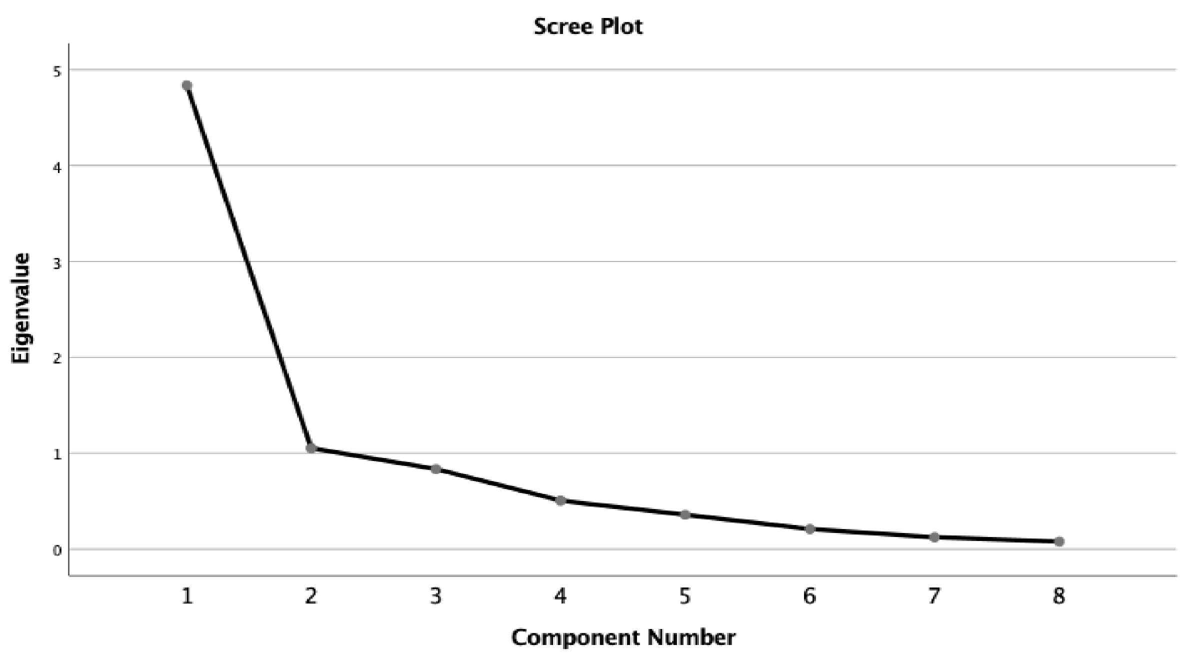


Figure 3.3 Scree Plot Index 2: 2014-2016



3.7.3. Promax Rotation

Rotation of factors is performed as part of factor analysis to allow the interpretability of results by changing the axes of the eigenvalues (Joint Research Centre-European Commission, 2008). It also minimises the number of factors with a high loading on the same factor (Nicoletti et al., 1999). According to Thompson (1984), factors are rotated to improve interpretability even though the original results may be a fitting solution. Rotation can be either oblique or orthogonal with the former providing for correlations amongst the latent factors constructed by rotating them such that the angles between the factors are greater or less than the 90 degree angle (Kieffer, 1998). In the case of orthogonal rotation, a 90-degree angle is maintained in the factor space. Examples of orthogonal rotation methods include Varimax, Quartimax, Equamax, while oblique approaches include Promax and Direct Oblimin.

Given that the indicators are highly correlated to each other, Promax, an oblique rotation method was utilised. It can be calculated more quickly than the Direct Oblimin method (IBM Knowledge Center, 2015). To group the components into dimensions, a cut off of 0.4 was applied to the rotated component matrix as per the recommendation of the IBM Knowledge Centre (2015). Component values with values above 0.4 indicate the significance of the variable to the component. In cases where a variable appears under more than one component it is difficult to interpret that variable and it might be prudent to exclude it from the results interpretation. The grouping of the variables under the two components were the same for both periods.

Table 3.12: Components from PCA

Component 1	Component 2
ICT Goods Exports High Tech Goods Exports Domestic Services Value-Added in Manufacturing Exports Charges for IP (Payments) Patents in Force	R & D Expenditure School Enrolment (Tertiary) Machine Tool Imports

A taxonomy of the dimensions and sub-dimensions of the IT Producer Service Index is available in Figure 3.4 using the distribution of components from the PCA. The interpretation of the distribution of the variables between the two sub-dimensions is subjective; however, an assessment of the distribution shows that sub-dimension 1 variables are ‘outward-facing’ as they require exchange with countries or firms outside the pre-industrial country through trade of goods or services. Variables included in sub-dimension 2 are 'inward-facing' as they require an investment in the local economy.

Table: 3.13 Pattern Matrix Index 1: 2005-2007

Pattern Matrix[a]		
	Component	
	1	2
ICTGoodExports2 (Binned)	0.975	-0.211
HTExports2 (Binned)	0.964	-0.064
DVA2 (Binned)	0.809	0.268
ChargesforIP2 (Binned)	0.961	-0.002
PatentInForce2 (Binned)	0.849	0.038
RDExpenditure2 (Binned)	0.184	0.770
MachineTool2 (Binned)	-0.312	0.863
SchoolEnrollment2 (Binned)	0.181	0.690

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

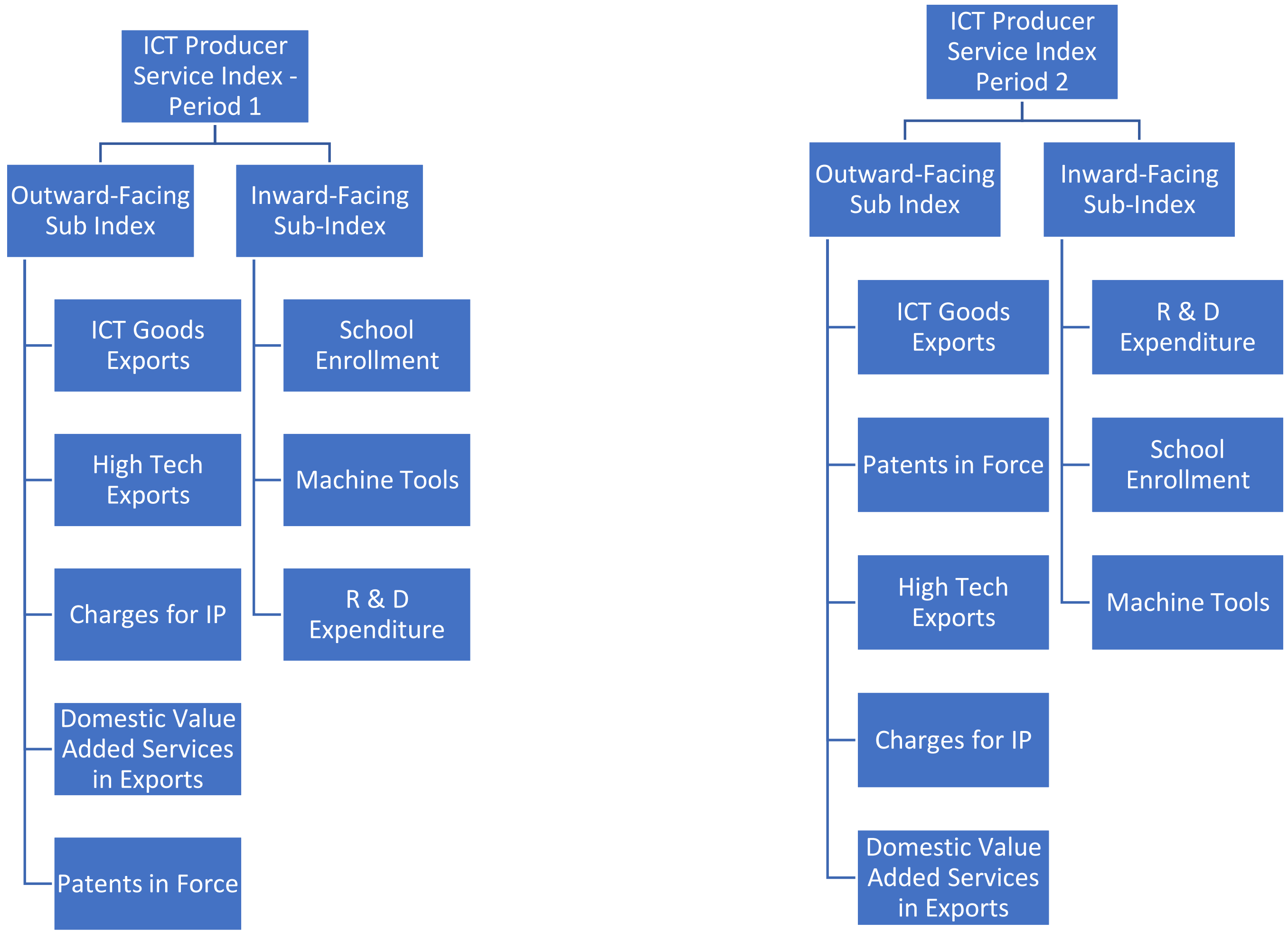
Table 3.14: Pattern Matrix Index 2: 2014-2016

Pattern Matrix[a]		
	Component	
	1	2
Machine Tool4 (Binned)	-0.108	0.750
SchoolEnrollment4 (Binned)	0.328	0.572
RDExpenditure4 (Binned)	-0.055	0.893
PatentsInForce4 (Binned)	0.844	0.074
ICTExports4 (Binned)	0.936	-0.138
DVA4 (Binned)	0.885	0.091
ChargesforIP24 (Binned)	0.786	0.124
HTExports4 (Binned)	0.995	-0.140

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

Figure 3.4: Taxonomy of Producer Service Index for Period 1 and Period 2



3.7.4. Aggregation of Results

As a step towards aggregating the results, the squared factor loadings scaled to unity sum are calculated following the method of Nicoletti (1999). The weights, which are obtained by squaring and then normalising the factor loadings, can be interpreted as the proportion of the total variance of the sub-dimensions of the index which are further aggregated to obtain the proportion in the IT Producer Service Index. Applying these weights to the categorical scores for each of the countries for the two periods under investigation allows us to score and rank each country. The results are presented in tables below:

Table 3.15: Factor Analysis Results for Index 1: 2005-2007

	Component		**Extracted components**		**Squared factor loadings**		**Squared factor loadings, scaled to unity sum**	
	1	**2**						
ICTGoodExports2 (Binned)	0.98	-0.21	0.98		0.95		0.23	
HTExports2 (Binned)	0.96	-0.06	0.96		0.93		0.22	
DVA2 (Binned)	0.81	0.27	0.81		0.65		0.16	
ChargesforIP2 (Binned)	0.96	0.00	0.96		0.92		0.22	
PatentInForce2 (Binned)	0.85	0.04	0.85		0.72		0.17	
RDExpenditure2 (Binned)	0.18	0.77		0.77		0.59		0.33
MachineTool2 (Binned)	-0.31	0.86		0.86		0.74		0.41
SchoolEnrollment2	0.18	0.69		0.69		0.48		0.26
Total					**4.18**	**1.81**	**1.00**	**1.00**
Eigenvalues							4.92	1.34
Total % of explained variance of data							**61.52**	**16.70**
Total % of explained variance of extracted components							**0.79**	**0.21**

Table 3.16: Factor Analysis Results for Index 2: 2014-2016

	Component		Extracted components		Squared factor loadings		Squared factor loadings, scaled to unity sum	
	1	2						
Machine Tool4 (Binned)	-0.11	0.75	0.75		0.56		0.33	
SchoolEnrollment4 (Binned)	0.33	0.57	0.57		0.33		0.19	
RDExpenditure4 (Binned)	-0.06	0.89	0.89		0.80		0.47	
PatentsInForce4 (Binned)	0.84	0.07		0.84		0.71		0.18
ICTExports4 (Binned)	0.94	-0.14		0.94		0.88		0.22
DVA4 (Binned)	0.89	0.09		0.89		0.78		0.20
ChargesforIP24 (Binned)	0.79	0.12		0.79		0.62		0.16
HTExports4 (Binned)	1.00	-0.14		1.00		0.99		0.25
Total					**1.69**	**3.98**	**1.00**	**1.00**
Eigenvalues							4.84	1.05
Total % of explained variance of data							**60.46**	**13.15**
Total % of explained variance of extracted components							**0.82**	**0.18**

Table 3.17: Scoring and Ranking of Countries Based on Squared Factor Loadings – Sub-Dimensions – Period 1 (2005-2007)

Country	Rank Sub-Dimension 1	Rank Sub-Dimension 2
Austria	3.78	1.73
Belgium	3.71	1.36
Bulgaria	1.04	0.76
Canada	4.75	1.81
Chile	1.62	1.59
China	5.22	2.27
China, Hong Kong SAR	3.79	1.49
Colombia	1.21	1.96
Croatia	1.04	1.16
Cyprus	1.41	0.45
Czechia	3.19	1.32
Denmark	3.31	1.20
Estonia	1.28	0.64
Finland	3.37	1.09
France	4.99	1.81
Greece	1.80	0.96
Hungary	3.42	1.66
India	3.06	2.27
Ireland	4.25	0.72
Israel	2.50	1.51
Italy	4.75	1.67
Korea	4.99	1.89
Lithuania	1.28	0.94
Luxembourg	2.11	0.45
Malta	1.51	0.45
Mexico	4.81	1.37
Netherlands	5.22	0.99
Norway	2.32	1.76
Poland	3.12	1.67
Portugal	2.74	1.03
Romania	1.85	1.15
Russian Federation	3.65	2.27
Singapore	4.70	0.79
Slovakia	2.15	0.94
Slovenia	1.28	1.01
Sweden	4.18	2.03
Switzerland	4.17	1.43
Thailand	3.89	1.60
Turkey	2.65	1.82
United Kingdom	5.22	1.37

Table 3.18: IT Producer Service Index Based on Squared Factor Loadings - Period 1 (2005-2007)

Rank	Country	Dimension
1	China	4.59
2	United Kingdom	4.40
3	Korea	4.33
4	Netherlands	4.32
5	France	4.31
6	Canada	4.13
7	Italy	4.09
8	Mexico	4.08
9	Singapore	3.86
10	Sweden	3.72
11	Switzerland	3.59
12	Ireland	3.49
13	Thailand	3.40
14	Russian Federation	3.36
15	Austria	3.34
16	China, Hong Kong SAR	3.30
17	Belgium	3.21
18	Hungary	3.05
19	India	2.89
20	Finland	2.89
21	Denmark	2.86
22	Poland	2.81
23	Czechia	2.79
24	Turkey	2.48
25	Portugal	2.37
26	Israel	2.29
27	Norway	2.20
28	Slovakia	1.89
29	Luxembourg	1.75
30	Romania	1.70
31	Greece	1.62
32	Chile	1.61
33	Colombia	1.37
34	Malta	1.29
35	Slovenia	1.22
36	Lithuania	1.21
37	Cyprus	1.20
38	Estonia	1.15
39	Croatia	1.07
40	Bulgaria	0.98

Table 3.19: Scoring and Ranking of Countries Based on Squared Factor Loadings – Sub-Dimensions – Period 2 (2014-2016)

Country	Rank Sub-Dimension 1	Rank Sub-Dimension 2
Argentina	4.16	7.08
Australia	7.03	4.83
Austria	7.65	4.27
Belgium	7.52	4.27
Brazil	6.23	6.52
Brunei Darussalam	1.99	1.69
Bulgaria	3.67	4.26
Canada	9.02	6.52
Chile	3.35	6.10
China	9.95	8.44
China, Hong Kong SAR	5.77	5.86
Colombia	3.05	6.43
Costa Rica	3.23	5.77
Croatia	2.30	3.61
Cyprus	1.99	1.69
Czechia	6.90	5.86
Denmark	6.33	6.66
Estonia	3.28	2.81
Finland	5.97	4.50
France	9.95	6.75
Germany	9.95	7.64
Greece	4.34	3.70
Hungary	5.66	7.46
Iceland	1.99	4.64
India	7.91	7.88
Indonesia	5.61	7.88
Ireland	7.88	3.94
Israel	6.02	6.99
Italy	8.71	5.95
Japan	9.95	7.88
Kazakhstan	2.88	5.30
Korea	9.95	7.88
Latvia	2.92	2.25
Lithuania	2.92	3.94
Luxembourg	3.98	2.25
Malaysia	7.48	4.27
Malta	2.30	2.25
Mexico	8.36	5.39
Netherlands	9.56	3.70
New Zealand	3.79	3.94
Norway	5.22	4.97
Peru	2.69	2.67
Philippines	5.85	4.59
Poland	7.96	5.95
Portugal	4.73	3.38
Romania	4.91	4.83
Russian Federation	7.38	8.44
Singapore	8.84	2.49
Slovakia	5.74	1.69
Slovenia	2.92	3.37
South Africa	5.39	3.94
Spain	7.91	4.59
Sweden	7.96	7.78
Switzerland	8.68	5.30
Thailand	7.68	6.19
Tunisia	2.43	2.02
Turkey	6.22	6.84
United Kingdom	9.95	4.27

Table 3.20: IT Producer Service Index Based on Squared Factor Loadings - Period 2 (2014-2016)

Rank	Country	Dimension
1	China	8.71
2	Russian Federation	8.25
3	Japan	8.25
4	Korea	8.25
5	Germany	8.05
6	India	7.88
7	Sweden	7.82
8	Indonesia	7.47
9	France	7.32
10	Hungary	7.14
11	Canada	6.96
12	Israel	6.81
13	Turkey	6.73
14	Denmark	6.60
15	Argentina	6.56
16	Brazil	6.47
17	Thailand	6.46
18	Italy	6.45
19	Poland	6.31
20	Czechia	6.05
21	Mexico	5.92
22	Switzerland	5.90
23	China, Hong Kong SAR	5.84
24	Colombia	5.82
25	Chile	5.61
26	Costa Rica	5.32
27	United Kingdom	5.28
28	Australia	5.22
29	Spain	5.19
30	Norway	5.02
31	Austria	4.87
32	Kazakhstan	4.87
33	Belgium	4.85
34	Romania	4.84
35	Malaysia	4.84
36	Philippines	4.82
37	Finland	4.76
38	Netherlands	4.75
39	Ireland	4.64
40	South Africa	4.20
41	Iceland	4.17
42	Bulgaria	4.16
43	New Zealand	3.91
44	Greece	3.82
45	Lithuania	3.76
46	Singapore	3.62
47	Portugal	3.62
48	Croatia	3.38
49	Slovenia	3.29
50	Estonia	2.90
51	Peru	2.67
52	Luxembourg	2.56
53	Slovakia	2.41
54	Latvia	2.37
55	Malta	2.26
56	Tunisia	2.09
57	Brunei Darussalam	1.74
58	Cyprus	1.74

3.7.5. Robustness and Sensitivity Test – Limitations of Analysis

The range of tests that can be applied to assess the robustness and sensitivity of the results to changes in parameters of the PCA modelling are numerous. In this case, two adjustments were made to the approach for developing the IT Producer Service Index to test the robustness of the results and sensitivity to change:

a. Substitution and Exclusion of Key Variables

The original intent of the development of an IT Producer Service Index was to determine a measure that allows the assessment of IT use in the pre-industrial economies, with particular focus on the manufacturing sector due to the complementarities between both sectors. An examination of the developed index shows that very few pre-industrial countries were included in the analysis due to the lack of data.

In particular, the variable measuring the Domestic Value-Added Share of Gross Manufacturing Exports is not captured for most pre-industrial countries. A sub-index was created excluding this variable. In addition, data on patents in force was sparse for these countries and was substituted with patent applications.

These substitutions reflected the sensitivity of the analysis to the selection of variables as only one component resulted from the analysis, indicating a lack of variation in the dataset.

Table 3.21: Total Variance of Sub-Index for Period 1 (2005-7)

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.670	66.717	66.717	4.670	66.717	66.717
2	.890	12.711	79.429			
3	.596	8.520	87.949			
4	.437	6.243	94.192			
5	.236	3.374	97.566			
6	.096	1.366	98.931			
7	.075	1.069	100.000			

Extraction Method: Principal Component Analysis.

Table 3.22: Total Variance of Sub-Index for Period 2 (2014-16)

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.727	67.533	67.533	4.727	67.533	67.533
2	.843	12.040	79.573			
3	.633	9.044	88.617			
4	.407	5.813	94.430			
5	.200	2.852	97.282			
6	.111	1.587	98.869			
7	.079	1.131	100.000			

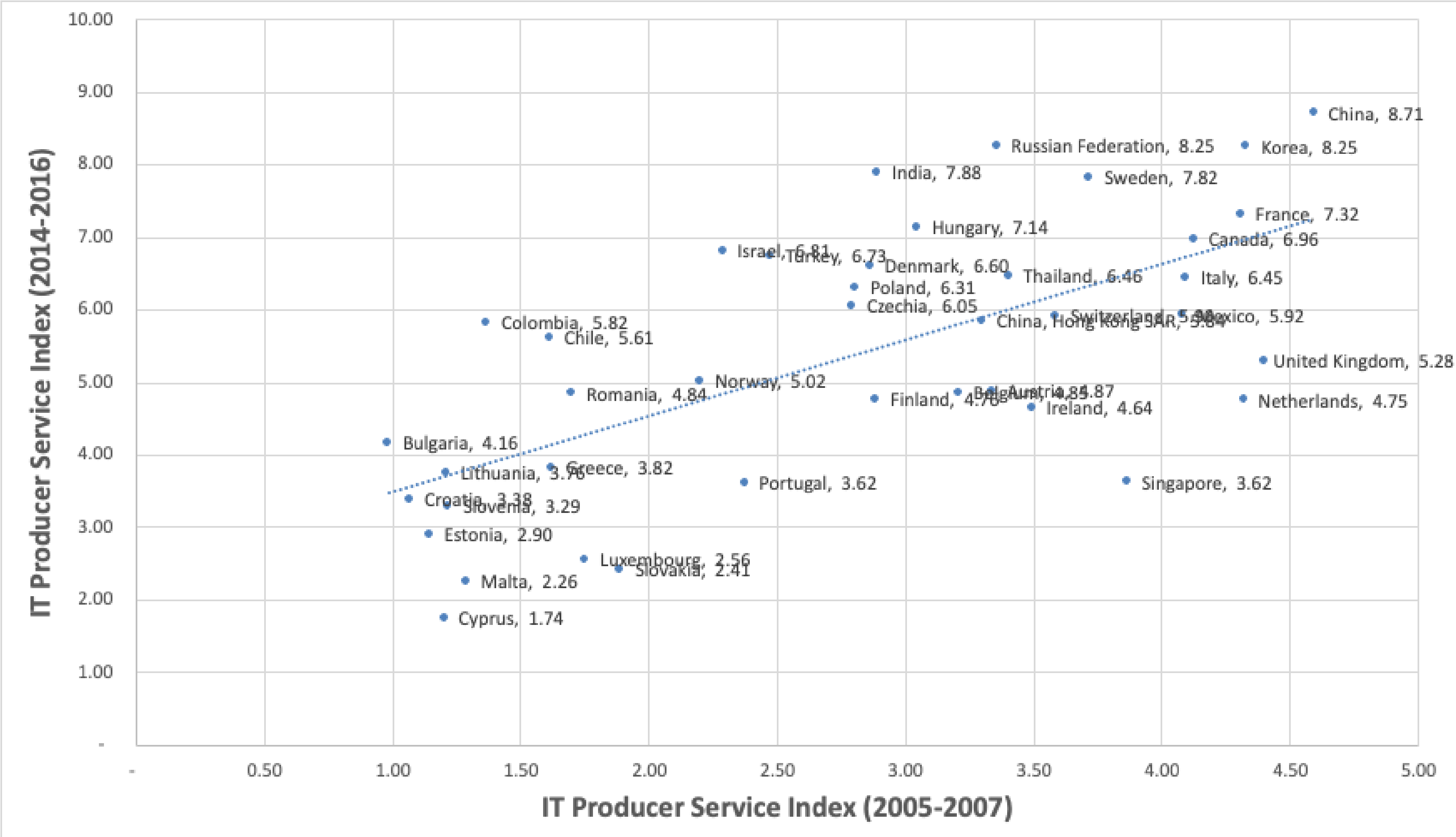
Extraction Method: Principal Component Analysis.

The full results are presented in Appendix 5. This also points to the limitation of the PCA approach as it is quite data-intensive and the very countries to be measured cannot be included in the index due to challenges with data collection. The results are in Appendix 9.11.

b. Change in Normalisation Process

Rather than use categorical data in the PCA, the variables were normalised using z-scores. By so doing, each of the data points was given a mean of zero and standard deviation of 1. The results were quite similar to those from the categorical scale analysis with the exception being that the Domestic Services Value-Added in Manufacturing Exports was captured in both components; albeit with a higher value for Component 1, consistent with the categorical data analysis. See Appendix 9.12 for the results.

Figure 3.5: Plot of Relationship Between Producer Service Indices for Period 1 and 2



3.8. Interpretation of Results

A cursory glance at the table shows that as expected, countries with a significant manufacturing and IT sector are situated at the top of the rankings. In the first period, advanced industrialised countries tend to dominate the rankings but in the second period, countries like India have moved up the table. Although it would not be possible to compare all the countries as some of them do not feature in both periods, a visual representation of transition of countries along the IT Producer Service Index can offer more insight In Figure 3.5, a scatter plot shows the IT Producer Service Index for Period 1 on the x-axis and Period 2 on the y-axis. The trendline is positive indicating a positive correlation between the indices for the two periods as expected. The relative performance of countries over time can be observed; however, care must be taken in interpreting the results as the scale for the two periods are different.

3.8.1. Intra-Country Changes in Rankings

In this section, the intra-country movement in rankings from period 1 to period 2 are analysed. China and India are selected for this review of performance on the IT Producer Index.

a. China

If we consider the case of China, which is at the top right quadrant of the chart, its ranking rose from 4.59 in period 1 to 8.71 in period 2. In both cases, China was number 1 in the rankings. The position on the rankings in both periods and the increase in ranking is not surprising given the emergence of China as the manufacturing hub of the world. This includes not just the manufacturing of capital goods and other machines but manufacture of much of the world's IT hardware such as computers, smartphones and other high-tech equipment. As world demand for these products have increased, China has built its capacity and invested in STEM education, acquired IP and increased its own capacity to develop IP amongst other strategic investments.

In terms of the sub- indices, China's performance on sub-index 1 is higher than sub-index 2. The variables that constitute each of the sub-indices are reproduced below as follows:

Outward Facing Index 1: ICT Goods Exports, High-Tech Goods Exports, Domestic Services Value-Added in Manufacturing Exports, Charges for IP (Payments) and Patents in Force.

Inward Facing Index 2: R&D Expenditure, School Enrolment Tertiary, Machine Tool Imports

Given China's export-driven growth development, it is not surprising that the outward-facing index performs better than the inward-facing one. As China refocuses inward to serve its domestic market, there is a possibility that the inward facing index would rise in relative performance.

b. India

The case of India, which is a country usually cited when arguments are put forward for service-led growth, is an interesting one. India rose from 2.89 in period 1 to 7.88 in period 2, rising rapidly in the rankings from position 19 to 6. This movement does not only suggest an improvement by India as it could also reflect the relative movement of other countries in the rankings. The upward movement in rankings suggests that the type of IT growth experienced in India is one which has become more technology and knowledge intensive, contributes more to gross output and has a stronger interface with the production process. This is a generalisation because the index subsumes all its constituent elements; however, an examination of the sub-indices will shed more light on what factors influenced this movement.

An analysis of the sub-indices indicates that in period 1, India performed better on the Outward-Facing Index than the Inward-Facing Index. The performance on sub-index 1 was 3.6 while for sub-index 2 it was 2.27 in period 1. In period 2, sub-index 1 recorded 7.91 while sub-index 2 was 7.88. It can be observed that the relative distance between sub-indices 1 and 2 decreased over time, suggesting greater investment in or performance on R&D Expenditure, School Enrolment Tertiary and Machine Tool Imports relative to the components which constitute sub-index 1. This improvement in performance on the IT Producer Service index and its sub-indices is not unexpected given the data on India IT services and its manufacturing sector.

Interestingly, even countries like Bulgaria, Cyprus and Malta that are on the lower spectrum of the chart saw their performance on the index improve over time.

3.8.2. Inter-Country Changes in Rankings

For this review of performance on the index, Estonia and South Korea's performance will be compared. South Korea moved downwards from number 3 on the index in period 1 to number 4 in period 2. In the case of Estonia, it dropped from number 38 on the rankings to number 50 in period 2. For South Korea, the index rose from 4.33 to 8.25 while Estonia rose from 1.55 to 2.90. So, although both countries improved their performances between periods 1 and period 2, both countries dropped in the rankings with South Korea's increment in performance higher in comparison to that of Estonia.

In period 1 and period 2, South Korea outperformed Estonia on both sub-indices and for both countries, sub-index 1 was higher than sub-index 2. The performance of South Korea relative to Estonia is not surprising as though Estonia is known for having a growing IT sector, it is less well known for its manufacturing sector, unlike the case with South Korea.

This comparison between the two sub-indices mirrors the performance in the intra-country review. For the countries examined, performance on the outward facing sub-index is better than the inward-facing index. This is an interesting result which suggests that activities which requires the State to make an internal investment in the country to build technological capacity as measured by the IT Producer Index are more difficult to achieve than the outward facing investments which tend to be the province of the firms engaged in exporting goods and services. This does not necessarily indicate that the State is incompetent in any of these countries but could imply that the State is required to take on the more difficult and complicated of the two broadly defined tasks.

Although these are preliminary results which require further analysis in which variables that ensure the coverage of pre-industrial countries are included, the initial findings are already compelling. They show that the IT Producer Index not only performs at the aggregate level in helping us determine how countries are deploying IT services but can also give an indication of how outward and inward facing variables are instrumental in achieving this overall result.

3.9. Summary

The creation of an IT Producer Service Index is instrumental to the determination of whether the IT sector can be a driver of economic growth as it assigns a value to how IT is employed in the production process within a country. Although the focus of this index is on the employment of IT services in the manufacturing sector, with the selection of the appropriate variables, the index can be extended to measure its use across other sectors of the economy. The ranking produced in this analysis demonstrates that the level of industrialisation in a country is a critical factor in determining how IT is deployed and interacts with other variables measuring the use of IT in the economy, either through the capacity to utilise IT Producer Services in tools utilised in production or in the export of High Technology and IT Goods.

The results produced are sensitive to the variables selected and for this reason the results produced in this chapter are indicative and require additional work in the revisiting of the theoretical framework and the widening of the number key variables selected, especially those for which data on pre-industrial countries is available. As already mentioned, pre-industrial countries were not included in the data sets due to the non-availability of dat. Addressing this gap would have required the conduct of bespoke surveys due to the limitation of existing cross-country data sets. Yet, despite these challenges, the Index already uncovers compelling patterns and trends in the way countries deploy IT Producer Services vis-à-vis their manufacturing sectors. The sub-indices, one which is comprised of outward-facing variables and the other of inward facing ones, gives insight into how countries perform on both. In aggregate, it is clear that most countries perform better on the outward-facing ones, where firms are typically the ones driving the investments in these areas and the inward facing ones, where the State takes on the larger and more difficult role. This Firm-State dynamic will be explored more in the firm-level case studies in Chapter 4 which show how service firms emerge in specific industrial contexts. It will also be explored in the linkage analysis and accompanying case studies in Chapter 5. The role of the State in the development of capabilities and linkages also forms an important part of the analysis in the development of the capabilities-linkage matrix in Chapter 6.

Thus, the IT Producer Service Index is part of a broader exploration of the shape of service firms, their interconnectedness with other sectors, especially manufacturing, and the firm capabilities required for a service firm to be a driver of economic growth. Despite the limitations of the index, this chapter has added to efforts involved in determining the instrumentality of IT to economic growth. It is for this reason that the next chapter will examine what makes IT services behave differently as we move from one context to the next as a step towards developing a more robust analytical framework for measuring IT use economy wide.

4. CHAPTER 4: WHERE DO SERVICES COME FROM IN THE PRE-INDUSTRIAL CONTEXT?

4.1. Introduction

There is a tendency to describe the growth of the service sector or tertiarisation, either in terms of output or employment, from the perspective of its relationship with the manufacturing sector. When this is juxtaposed against the subordinate position often accorded to services vis-à-vis manufacturing in the discourse on growth and production, what results is a treatment of tertiarisation not as a positive or independent process but as a spillover of the deindustrialisation process. Expansion of the service sector is many times treated as the obverse of deindustrialisation or in terms relative to it and not as the transformation of an autonomous sector of the economy due to a change in endogenous or exogenous factors.

Although it must be acknowledged that tertiarisation or detertiarisation and industrialisation or deindustrialisation are interrelated economic processes, there has been insufficient effort in the economics discipline to examine how these processes interact and the diversity of outcomes that can result from this interaction. The tertiarisation-industrialisation relationship is well recognised in the economics literature; however, tertiarisation is typically treated as a downstream activity to industrialisation, the final stage in the process of structural change. The relationship between deindustrialisation and tertiarisation is treated as an inverse one, with the rise in one activity signifying a decline in the other. However, it is a multi-faceted process and can be observed when manufacturing firms outsource services to specialist service firms, a process also called externalisation. It is also present in the embedding of services in final products by manufacturing firms.

In this chapter, this relationship will be re-examined to find out what types of services emerge when these four processes, namely tertiarisation, detertiarisation, industrialisation and deindustrialisation, interact within a specific developmental context. Specifically, it will be shown that services are shaped by how a country deindustrialises as the level of manufacturing capacity built up in a country prior to the onset of tertiarisation matters. The context of interest in this analysis is the pre-industrial deindustrialisation case in which deindustrialisation sets in before a significant level of manufacturing capacity is built. Tertiarisation of the economy in the presence of insignificant industrialisation is an important process that has not received enough attention in the structural transformation literature.

In the limited literature on tertiarisation, many of which are case studies of diverse countries or country groups, there has been little effort to draw out analytic categories that expatiate on why service sector expansion has taken divergent paths in specific country contexts. More importantly, there has been little accounting of how services, especially of the high value-added and technology and knowledge-intensive type classified as producer services, emerge in a pre-industrial situation as these services embody characteristics unique to the deindustrialisation context from which they emerged.

Producer services are services which act as intermediate inputs in the production process, signifying the presence of linkages between services and manufacturing. These linkages could be production linkages of the forward and backward type, fiscal or financial linkages and technological linkages. In the industrialised setting, producer services have typically emerged as a distinct category as a by-product of the outsourcing of services by manufacturing firms. The outsourcing process is a form of tertiarisation as service firms specialise in the provision of these producer services. However, in a pre-industrial context it is not clear how producer services have developed in the absence of concrete ties to manufacturing processes. It raises the question of what these 'services are servicing' and what type of production is being supported in the absence of industrial or manufacturing activity.

The tendency has been to assume that the industrialised country experience of tertiarisation explains the growth of services in countries which are yet to industrialise or are following an alternative industrialisation path; however, this explanation does not suffice as raised in the above-mentioned paragraph. To address this gap in the literature on structural transformation and answer the questions raised, it will be necessary to understand 'where services come from'. This will entail identifying the economic drivers on the demand and supply side that have precipitated tertiarisation and differentiating these drivers on the basis of the deindustrialisation context under which they emerged.

This chapter seeks to address this shortcoming in the literature by demonstrating that the inherent heterogeneity of the deindustrialisation process impacts the types of services which emerge. This will be achieved by investigating the interaction between deindustrialisation, the emergence of specific service types, the characteristics of these services and the push and pull drivers underlying the tertiarisation and deindustrialisation processes in pre-industrial countries. Although tertiarisation and deindustrialisation can be mutually exclusive events and one is not necessarily impacted by changes in the other, the ways in which deindustrialisation interacts with the emergence of different types of services in specific country contexts is an important phenomenon worth exploration.

The need for this analysis is underscored by the blurring boundaries between service and manufacturing activities and the overlaps between tertiarisation and deindustrialisation. Thus, in this exploration, service categories, by their proximity to the manufacturing process, naturally lend themselves to such an assessment. Producer services meet this requirement and are the most appropriate service type for the exposition in this chapter. These services are located at the interface between services and manufacturing, serve as linkage points between both sectors and thus share characteristics of both sectors. Producer services are particularly germane given the broader goal of this thesis to investigate whether IT, a producer service, can drive economic growth in Nigeria.

In this chapter, it will be demonstrated that the nexus between service emergence or decline and manufacturing growth or decline is multifaceted. The rise (tertiarisation) or decline (detertiarisation) of the tertiary sector interacts with the rise (industrialisation) or decline (deindustrialisation) of the manufacturing sector in specific ways and leads to different outcomes in terms of the nature and type of producer services developed as these processes unfold. At this nexus, there are several linkages being formed, a finding which will be expounded upon in Chapter 5 of this thesis.

It will also be demonstrated that to perceive these interactions, each of these processes must be viewed in absolute rather than relative terms. For example, rather than view tertiarisation as the growth in the share of services value-added or employment in services relative to similar measures for manufacturing and agriculture, it should be viewed in terms of the absolute growth of the indicators. By so doing, it will be possible to isolate and observe the growth or decline of sectors.

Subsequent to this theoretical discussion, supported with the review of empirical evidence from secondary sources, a case study of Nigeria will be presented to further buttress the claim that the level of manufacturing or industrial development and conversely, how a country deindustrialises, shapes the type of services that emerge. Most importantly, it has implications for the linkages formed between these services and the broader economy. With the presentation of this evidence, this chapter will serve as a critical analytical block in the development of a framework for examining IT services and their role in driving economic growth in cases where a country is yet to industrialise.

In Section 2, the tertiarisation-deindustrialisation dichotomy will be explored, and the definitions of both concepts will be expanded. Deindustrialisation typologies and trends will be reviewed in section 3 to show the heterogeneity of the process while section 4 will apply the various categories of deindustrialisation to laying out tertiarisation trajectories. The tertiarisation-deindustrialisation nexus will be developed in section 5 with the aid of secondary data from multiple sources. Section 6 will present a case study of the Nigerian IT sector detailing its historical expansion while in section 7 an overview of a survey of IT companies in Lagos performed to identify cases for further analysis is presented. In section 8, firm-level case studies of Nigerian IT firms, selected from the survey results, will provide evidence to support the assertions made in previous chapters.

4.2. The Tertiarisation-Deindustrialisation Dichotomy

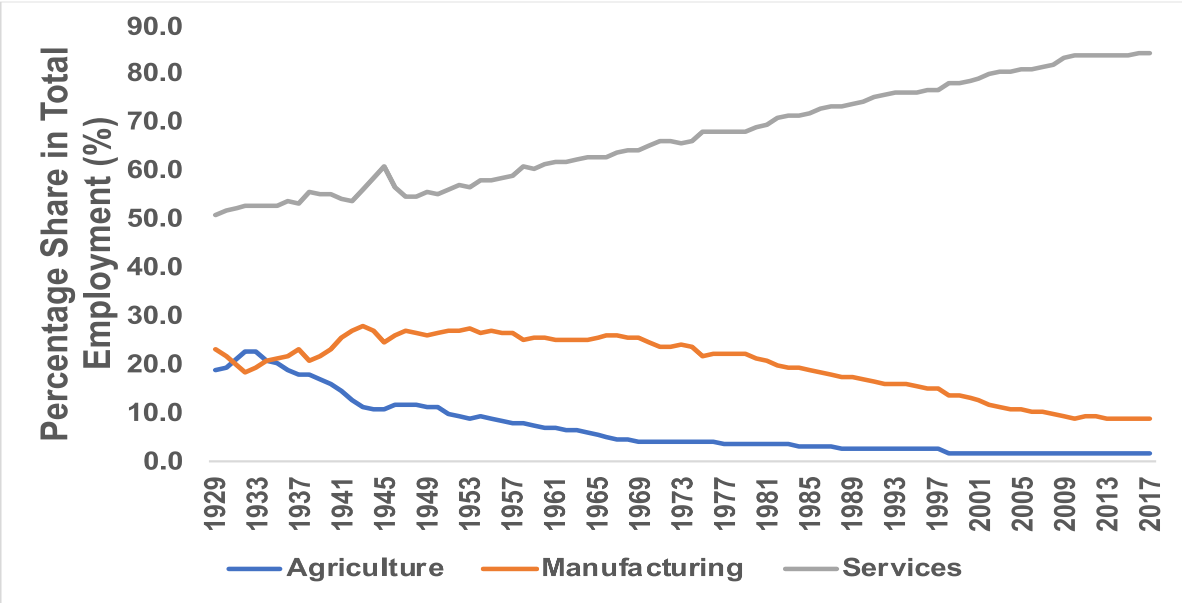
Tertiarisation and deindustrialisation are concepts originating from a structuralist standpoint which in considering economic growth gives weight to sectoral contributions to growth, the long run transitions occurring within and between those sectors and how these interactions shape the process of growth (Clark, 1940; Fisher, 1952; Kuznets, 1930, 1957, 1966; Lewis, 1954; Pasinetti, 1993). The structuralist view stands in contrast to neoclassical growth theory, both endogenous and exogenous, which portray growth as sector-agnostic and arising from an interaction of factors of production, labour, capital and technological progress, with macroeconomic variables such as savings and investment (R. E. J. Lucas, 1998; Romer, 1986; Solow, 1956).

Although the structuralist school of thought is a significant break from the 'black box' approach to the mechanics of the growth process, the treatment of tertiarisation and deindustrialisation as 'flip sides' of the same coin in most of the structuralist literature is predetermined by the tone set in early studies of both concepts (Montresor & Marzetti, 2011). These initial studies sought to develop precise definitions of deindustrialisation and tertiarisation while exploring the underlying dynamics in the manufacturing and service sectors and how the interaction between both sectors result in tertiarisation, deindustrialisation or the simultaneous incidence of both processes.

However, there is a need to consider tertiarisation or deindustrialisation in absolute and not only in relative terms to ensure that the variable being studied is the growth or decline of the sector under measurement and not the impact of the decline or growth of other sectors based on their respective weighting.

In simple terms, the typical path of structural transformation, as shown in Figure 4.1, entails a continuous process in which activities in the primary sector decrease relative to the others as labour and capital migrate out of the sector and become increasingly utilised in the secondary sector and subsequently in high value-added tertiary activities at later stages of economic development (Pasinetti, 1993).

Figure 4.1: Stylised pattern of structural change in industrialised countries: United States (1929-2017)



Source: US Bureau of Economic Analysis

4.2.1. Redefining Tertiarisation

Tertiarisation is the final stage of the long-term structural transformation of an economy and is marked by labour and other production factors migrating from the secondary into the tertiary sector of the economy. This transformation is driven by several factors, of which two are frequently cited in the literature, namely productivity differentials between the manufacturing and service sectors and increased demand for services due to rising incomes.

The impact of productivity differences between both sectors, which is a supply-side factor, is ascribed to the movement of labour out of manufacturing as technological progress makes it possible to use less inputs to produce the same amount of output (Baumol, 1967; Baumol et al., 1985; Ramaswamy & Rowthorn, 1997). Additional studies have corroborated Baumol's findings, treating productivity differences as a more plausible explanation for the rise of the service sector than demand from rising incomes. Some of the reasons for this include the rise in service prices in consumption being seen as an illusion since it disappears when the increase is measured in constant rather than current prices (Kravis et al., 1983; Ngai & Pissarides, 2007).

Given productivity differentials, excess labour can be absorbed into the service sector due to its lower rate of productivity. This movement of labour from manufacturing into the tertiary sector is a process which commences even at the initial economic transformation stage as labour moves not only from the primary into the secondary sector but also directly into tertiary activities (Ramaswamy & Rowthorn, 1997).

In the case of movement from the primary to secondary sector, it is typically to take advantage of higher wages as productivity differentials deepen between both sectors; however, this is not necessarily the case with respect to the tertiary sector. In developed countries where high value-added tertiary activities are prevalent, this could be the driving cause of tertiarisation, but in many developing countries where the tertiary sector is marked mainly by low value-adding activities, the sector serves as the 'employer of last resort' (Mc Millan et al., 2017; Rodrik, 2016)

The process of tertiarisation gains momentum when productivity in manufacturing reaches a 'peak', the ability to absorb excess labour in manufacturing declines and the shift of labour out of both the primary and secondary sectors accelerates. The factors that lead to the peak or turning point in manufacturing employment and output generation will be examined in the discussion of deindustrialisation; however, the coincidence of the contraction of the secondary sector with tertiary sector expansion is an important observation and a major reason for the tendency to conflate both processes. This conflation has amplified the inclination to view the expansion of the tertiary sector as a major causative element in the decline of the secondary sector.

The second prominent factor driving tertiarisation is the higher income elasticity of demand for services compared to manufactured goods, a demand-side process termed Engel's law (Engel, 1857). This empirical regularity in the way consumption changes with income shows that as real wages rise, typically during the industrialisation process, the price of manufactured goods fall in response to the increasing embodiment of technological progress. The proportion of income spent on food decreases and due to improved labour productivity embodied in these goods, consumers increase their demand for services. Clark (1940) and Fourastie (1951) were early adopters of this stylised fact, extending it to explain the shift from demand for agricultural produce and manufactured goods towards services.

Although principally utilised in explaining the transition from an agrarian-based economy to an industrial one, Engel's law also explains the shift away from manufactures during the process of deindustrialisation as well as the increasing demand for services as tertiarisation gains momentum and consumption patterns shift to favour services relative to manufactures (Chenery, 1960; Katouzian, 1970; Kongsamut et al., 2001; Pasinetti, 1993; Stigler, 1956; Szirmai & Verspagen, 2015; Wölfl, 2005). This explanation is primarily based on the premise that demand for services is income-elastic, rising more than one to one with income, but is also attributable to demographic factors which affect changes in taste and consumption patterns (Cuadrado-Roura, 2013; Wölfl, 2005).

Kuznets took a nuanced approach to interpreting Engel's law in respect of services showing that demand for service types in response to rising incomes vary and is also impacted by a country's level of development (Kuznets, 1957). In answering questions on long term changes in the distribution of income, he linked the effects of inter-industrial shifts arising from economic growth to the changes in income distribution amongst groups in the economy (Kuznets, 1955).

As countries shift away from agriculture to industry, which Kuznets characterises as lower-income and higher-income industries respectively, income shares increase for members in each income group within the population undergoing that transition. His main finding was the lessening of income inequality at this later stage of industrialisation as lower income groups in the industrial sector receive a rise in their income share, thus offsetting any increase in income equality in the overall population.

Kuznets used an illustration to show that while large proportions of income could be spent on professional, recreational and business services in developed countries, lower proportions are typically spent on similar categories of services in developing countries. He found that the converse could be true for services such as money lending, fortune telling and domestic services where a larger proportion of income could be spent on such services in developing countries and much less in developed countries (Kuznets, 1955). This displays an understanding of the heterogeneity of services, both in terms of categories and the development context in which those services are employed.

Kravis, Heston and Summers (1983) further developed this theme of service heterogeneity in different development contexts and its effect on the demand for services by analysing per capita absorption of GDP in the form of services for 36 countries grouped by income level. It was concluded that there are no a priori reasons to expect services to have higher income elasticities of demand than goods. The durability of manufactured goods, in comparison to services which tend to be consumed at the point of provision and require periodic replenishment, also explains this tendency towards increased service demand.

These two explanations for tertiarisation, the higher income elasticity of demand for services compared to manufactured goods and the effect of productivity differences between both sectors on supply, are the most ubiquitous. However, additional explanations have proliferated, and these include the positive impact of technological change on productivity in certain service activities as well as the effects of globalisation and liberalisation on tradability of services.

The definitions and drivers of tertiarisation are particularly important given that tertiarisation and industrialisation and the converse of both terms are measured in relative terms to movements in other sectors. As a result, a decline in industrial output or employment can suggest a widening of the tertiary sector as it employs excess labour from the secondary sector; however, the service sector could also be growing independently as a result of technical change and the resultant creation of new service activities. Given that the total supply of labour is not fixed and is constantly changing as workers enter and leave the labour market, the sector could be a direct recipient of new members of the workforce. Thus, tertiarisation is not always the direct consequence of deindustrialisation and there is need to consider its growth and contraction on its own terms and not necessarily in terms of movements in the primary and secondary sectors.

4.2.2. Conceptualisation of Services in the Economics Discipline

In the study of the service sector produced by Clark, he confirmed the trend towards service-dominance in many industrialised countries from as early as the beginning of the twentieth century in Great Britain and France with the United States, Germany, Japan and Switzerland following close behind (Clark, 1940). This study was a precursor for further analysis of trends in employment and productivity in the service sector.

In exploring some of these studies, two dissimilar approaches to characterising the sector can be observed. The first, exemplified by Fisher (1935), Clark(1940), Stigler (1956) and Fuchs (1968), takes a positive or neutral approach to its assessment of the sector and in investigating its interactions with other sectors, treats services as an autonomous sector.

The second approach adopted by Baumol (1967), portrays the emergence of services and the decline of the manufacturing sector as a zero sum game where service expansion is presented in terms of its deleterious impact on manufacturing. The causal factors driving tertiarisation will be further explored later in this chapter but at this point, the positive and less positive conceptions of tertiarisation as an economic process will be presented in the rest of this section.

a. Positive or Neutral Conception of Services

George Stigler (1956) in his study of employment trends in services provided evidence to show that service industry growth in terms of employment in the US was accelerating in the 1940s and 1950s and had been on an upward trend since the 1920s. The income elasticity of demand hypothesis was given as an explanatory factor for this trend, showing that as incomes rose, a greater proportion of it was being spent on services. Urbanisation, the spread of higher education, aging of the population and increased specialisation were also found to be major contributors to the rise of service industries.

In recognition of the multiplicity of factors driving the growth of the sector, the difficulty in making generalisations about the trend in employment in services was highlighted by Stigler and further study of individual service activities recommended before broad conclusions could be made. As part of the study, in-depth studies of retail, personal, professional and business service categories were presented as evidence of the heterogeneity of services, the difficulties in developing a standard classification structure for services and the need for a definition of clear borders between services and manufactured goods.

A little over a decade later, Victor Fuchs (1968) corroborated many of the findings by Stigler, stating that the tertiarisation of the US economy was not a recent phenomenon but a long term trend which had been underway for as long as labour force records by industry type had been maintained. According to Fuchs, the US became a service economy after World War II, evidenced by the growth of the sector's share in employment from 40 per cent in 1929 to over 55 per cent in 1967, a trend that was replicated in other industrialised countries. The heterogeneity within services was central to the analysis as 18 service sub-sectors in the personal services and retail trades were evaluated in measuring productivity in services. This was also supported with case studies of three categories of services: retail trade, barber and beauty shops and medical care.

The study of the possible factors responsible for growth of the sector was approached by analysing the demand profile of output from the sectors, either as final or intermediate demand, as well as productivity increases in the service sector. Fuchs found that contrary to a widely held position, the income elasticity of demand for services was not a major driver of the increase of employment in the service sector relative to industry. Neither was it due to an increase in demand for intermediate services, although there was evidence of some increase. The major factor responsible for the increase in service employment was discovered to be the slower growth of output per worker in services in comparison to agriculture and manufacturing. Productivity increase in manufacturing was much faster than in services; however, in contrast to previous assertions of an unproductive sector, there was evidence of substantial productivity increase in some service activities in the personal services and retail trades.

Both studies by Fuchs and Stigler increase focus on a much-neglected sector, especially as both include detailed analyses of service sub-sectors which were rare at the time. Although providing different explanations for service sector trends, the general conclusions include: an irreversible trend towards tertiarisation in developed countries, barring any major economic upheavals; the prospect of new evidence from further explorations of individual service categories; and the positive implications of strengthening productivity measures of the service sector.

By approaching the study of services from an unbiased perspective and not framing the discussion in terms of the changes taking place in manufacturing while acknowledging the impact of these changes, it was possible to understand the internal workings of the service sector and its response to stimuli from the domestic and global economy.

b. Negative or Non-Neutral Conception of Services

A less optimistic and manufacturing-centric outlook was presented in Baumol's (1967) study on the lack of productivity in the service sector, which in his view was accompanied by accelerating costs in the service sector, eventually culminating in the crowding out of manufacturing activity. Starting with the assumption of an unbalanced two-sector economy, one sector in which labour productivity was constant and the other with productivity growing cumulatively at a constant compounded rate, it was shown that with wages rising in tandem in both sectors, an attempt to move the economy towards balance would lead to overall growth rapidly approaching zero.

The major finding was that productivity increase in manufacturing, the sector experiencing cumulative productivity growth, and the resulting increase in wages would place upward pressure on wages in the unproductive service sector leading to a cumulative increase in costs in the service sector. This phenomenon is termed Baumol's Cost Disease.

In the model adopted in this study, services were characterised as stagnant, prone to constant labour productivity and inconducive to innovation, economies of scale and capital accumulation. In summary, services were presented as the opposite of manufacturing. The potential outcomes of unbalanced growth, due to the rapidly rising costs associated with services, were treated as a cause for concern, given the continued tertiarisation of the US economy, and the potential for an eventual slowdown of the economy if labour continued to migrate into services.

These findings were influenced by limited knowledge of the service sector, given its treatment as a homogenous set of activities rather than an economic category comprised of disparate activities with different productivity profiles. This oversight was addressed in a follow-up to this study which moderated some of the conclusions earlier reached. In this latter work, heterogeneity in services was acknowledged with three service categories identified based on productivity rates: progressive (communications, trade and real estate), stagnant (finance and insurance, live concerts, television performance or program production, software development) and asymptotically stagnant (television broadcasting and electronic data processing) (Baumol et al., 1985).

Progressive services were found to have productivity rates close to progressive goods sectors and were marked by slower growth in the labour force than stagnant services. These progressive and stagnant features were found to be simultaneously present in some service activities designated as a separate category termed 'asymptotically stagnant' services (Baumol et al., 1985, p. 806). A consequence of this revised study was the recognition that not all services are the same; however, the initial findings of the illusory nature of the rise of services in the 1967 paper was restated.

c. Summary

These two distinctive approaches to studying the service sector did much to set off the research agenda on services in different directions, the former more optimistic and unbiased approach leading to a rich array of studies seeking to understand the nature of services without the presupposition that the rise in prominence of this sector constitutes a threat to the growth of industry. In contrast, the latter treats service expansion as a disquieting trend which leads to deindustrialisation and reduces prospects for economic dynamism and growth in affected economies. The use of descriptors such as 'disease', 'stagnant' and 'parasitic' is emblematic of the disposition towards services in these latter studies.

The dearth of studies on the service sector in developing countries is pronounced and brings into question the tendency to generalise results for the developed country context. This will be addressed subsequently in this thesis with a case study of the IT sector in Nigeria. However, to round out the discussion at this point, the introduction of the study of deindustrialisation into the structural transformation literature and how this has shaped the tertiarisation-deindustrialisation dichotomy will be explored in the next section.

4.2.3. What is Deindustrialisation?

The deindustrialisation phenomenon, initially observed in advanced industrialised economies, is presently a global trend with more recently industrialised and yet to be industrialised countries undergoing the process at earlier stages of the industrialisation process. At present, there are two well recognised approaches to defining deindustrialisation: as a secular decline in manufacturing either as a share of employment or as a share of total value-added. In some cases, a combination of both definitions is applied. It is also defined as a decline in the share of manufactured goods in trade and although this third definition helps to focus attention on its negative impact on the balance of payments, it can be treated, not as a separate definition, but as one of the outcomes of the deterioration in manufacturing output or employment (Cairncross, 1978).

Neither of the two widely used definitions of deindustrialisation is without its drawbacks as acknowledged by Škuflić & Družić (2016) and Tregenna (2009, 2011). With respect to the employment definition, in some cases a decline in industrial employment can coexist with rising output if productivity is high enough. In terms of value-added, relative price changes in the manufacturing and service sectors could indicate deindustrialisation when neither a decline in output nor employment is occurring. In the final analysis, Škuflić & Družić (2016) find that the definition based on employment is less problematic given that at least one of the variables, that is, either employment or output would be on a downward trajectory.

In her study of deindustrialisation, Tregenna (2011) makes a case for utilising both definitions in descriptions of the phenomenon as various dynamics could be driving the deindustrialisation process and there is a need to present these clearly. This was achieved by decomposing the probable causes of specific deindustrialisation episodes between 1985 and 2005 into two stages. In the first, the decline in the share of manufacturing in employment is decomposed into the impact of changes in the value-added of the sector and changes in labour intensity. In the second stage, the three components under observation are changes in manufacturing labour-intensity, share of manufacturing in GDP, and aggregate labour-productivity.

The main finding from this breakdown is that manufacturing decline as a fall in its share of employment can result from a reduced labour intensity of production or from a reduction in manufacturing output. Although deindustrialisation in terms of manufacturing employment is declining in both cases, a reduction in labour intensity in manufacturing production cannot be properly characterised as deindustrialisation as reduced labour intensity could imply increased labour productivity, an outcome that would normally be considered positive.

This implications of these definitions of deindustrialisation points to the heterogeneity of deindustrialisation processes which will be further discussed and is instrumental in developing the main arguments in this chapter. At present, definitions of deindustrialisation in terms of employment and value-added are used in the literature; however, there is greater preference for the employment definition.

4.2.4. Early Views of Deindustrialisation

In one of the earliest studies on the subject, Singh (1977) examined the process of deindustrialisation in the British economy by tracking its progress from the 19th century. Given that the changing British approach to international trade was treated as a reason for manufacturing decline, deindustrialisation was viewed in terms of its impact on the competitiveness of British manufactures in comparison to other countries and the effects on the trade balance and balance of payments. However, on inspection of the probable causes of deindustrialisation in Britain, it was concluded that supply-side factors in the local economy were responsible for the loss of employment in the manufacturing sector and not external factors as previously thought. Non-price factors such as lower quality and design of products and inefficiencies in the production system were found to result in the loss of competitiveness.

Singh took a nuanced approach to exploring the phenomenon of deindustrialisation, recognising that it was the symptom of underlying economic disequilibria, in this case a weak balance of payments position and loss of competitiveness in production systems and not a cause of the disequilibria itself. By carefully distinguishing between the decline in manufacturing employment and manufacturing output, which had been growing steadily and only began to decline since 1973, close to the end of the period being examined, his conclusions points to the need for precise definitions of deindustrialisation that distinguish between cause and effect which will become useful when the pre-industrial context is considered.

In many ways, Singh's contribution has been characterised as part of a tradition which views the loss of manufacturing capability as worrying, which in some respect is accurate. He concluded that deindustrialisation was not a problem per se but only became one given the position of manufacturing as the main source of foreign exchange earnings for the British economy. When this analysis was published in the late 1970s, the UK was already becoming a service-based economy, a transition which was acknowledged; however, the case was made that manufacturing exports had a greater effect on the balance of payments and manufacturing itself was special due to its structural characteristics which positioned it for productivity growth and technical progress.

Thus, in Singh's estimation, services, even tradeable services such as tourism, sea transport and civil aviation, city and financial services which were sources of foreign exchange, could not substitute for manufacturing. This was in line with Kaldor's contribution on manufacturing as being subject to increasing returns, agriculture and mining to decreasing returns and services to constant returns (Kaldor, 1966). Cairncross (1978), making similar arguments also made a connection between Britain's declining terms of trade and deindustrialisation, terming this the Cambridge view of deindustrialisation.

Bacon and Eltis (1978), took their analysis of changes in the United Kingdom (UK) economy in a different direction by characterising services, public services in particular, as the main factor driving deindustrialisation in the UK economy. Much like other positions of their time, they held a negative perception of the effects of deindustrialisation and the problems being faced by British producers but saw the main cause as the crowding out effects of a rise in non-marketed or non-tradable services, especially those provided by the public sector. Though recognising that some services were tradable and thus considered productive, Bacon and Eltis were sharply critical of the rise in public sector activities in the UK, considering them to be parasitic and a drain on the economy. Thus, from the perspective of manufacturing, service expansion was perceived as a negative trend which instigated deindustrialisation, thus placing limits on an understanding of its broader role in economic growth.

These studies on deindustrialisation give examples of how services were viewed from the viewpoint of deindustrialisation. It is reasonable to conclude that the tendency to view services in more negative terms in comparison to manufacturing as presented in Singh's work to a lesser extent and to a greater extent by Baumol and Bacon and Eltis, is due to a limited understanding of the heterogeneity of services, is a carryover of outdated notions of what constitutes 'productive activity' and reflected the state of technical progress in the service sector at the time.

In terms of technological progress, it is essential to look beyond services as a broad category and instead observe the changes taking place at the level of service sub-categories where technological change is not only apparent in some services but is also being reproduced, as is the case with IT.

The question of productivity in services is a complex one as it is notoriously difficult to isolate service inputs from outputs for proper measurement; however, as stated by Triplett and Bosworth (2003), Baumol's disease has been cured given there is evidence of service industries growing at the same rate as the rest of the US economy and in some cases showing evidence of accelerating productivity due to IT capital deepening and Multi Factor Productivity (MFP) growth.

Tradability of services is more difficult to address given the ephemeral nature of most services and the need for the service provider and end-user to be co-located in many cases; however, technology has enabled the conversion of certain service products, such as software applications, professional and technical services amongst others into tangible formats which can be transmitted electronically. Yet, many services still remain in the low value-added category and are not amenable to this transformation and mode of transmittal.

From this analysis, it can be surmised that the recognition of service heterogeneity is central to an even-handed understanding of the sector and its interactions with the broader economy. The foundational studies of the tertiary sector by Fisher, Clark, Stigler and Fuchs by properly highlighting this fundamental feature, helped to create a different frame of reference for understanding and analysing the changes taking place in this often-misunderstood sector.

However, a missing piece in the tertiarisation versus deindustrialisation discussion is the exact nature of interaction between both processes in shaping the type of services which emerge in specific contexts. This is largely due to a focus of the literature on the industrialised context and a lack of acquaintance with how the heterogeneity of industrialisation and thus deindustrialisation processes shape the nature of services.

Emerging strongly from the literature review of the early studies on tertiarisation and deindustrialisation is the acknowledgement that services are heterogenous and some services are more productive than others. Baumol's need to revisit his earlier conclusions on the Cost Disease also points to the dynamic nature of productivity in services as technologically enabled services replace outmoded means of service provision over time (Baumol et al., 1985). As Fisher (1952) alluded, technical change could affect services directly and not necessarily through the manufacturing sector.

To fully explore the service-manufacturing or tertiarisation-deindustrialisation dynamic and how this process shapes technical progress in services, a more detailed exposition of deindustrialisation and tertiarisation process will be presented in the next section. The analytical lens will be widened to consider more recent deindustrialisation experiences in catch-up and latecomer countries which missed the first wave of the industrial revolution.

4.3. Are We All Deindustrialising?

Since the industrial revolution took off in the United Kingdom in the late 18th century and spread worldwide, the novel manufacturing production processes and technologies it ushered in have been adopted with varying degrees of success. Several countries have struggled with the creation of a viable industrial sector capable of reproducing itself and spreading innovation economy-wide while others, by constantly innovating, have emerged as new industrial leaders. Yet, even as industrialisation stagnates or goes into reverse at low levels of manufacturing output and employment in many developing countries, it has become apparent that a global deindustrialisation trend has set in.

Deindustrialisation has been observed not only in the advanced industrial countries which are maturing into service economies, but also in the countries which industrialised in subsequent periods. Even more disquieting is the case of deindustrialisation in economies where industrialisation never took off yet is already in decline. This decline is evident in the inverted U-shaped relationship between per capita income and the share of manufacturing in total employment, a well-documented empirical regularity, especially as the turning point at which deindustrialisation sets in is occurring at much lower per capita income levels (Palma, 2005; Rodrik, 2016; R. Rowthorn & Coutts, 2013; Tregenna, 2015).

In this section, the argument will be made that deindustrialisation is a heterogenous process and takes on distinctive characteristics dependent on the level of industrialisation when the process commences and the prevailing conditions in the local and global economy. Secondly, it will be put forward that there is a tertiarisation and deindustrialisation nexus, which has either been ignored or in some cases trivialised to treating tertiarisation as purely a causal factor or negative outcome of deindustrialisation. The interaction of these two processes shapes the type of services that emerge in an economy and their interconnectedness to the industrial or manufacturing sector and the rest of the economy. The nexus will be developed in a subsequent section.

The starting point for this discussion is a review of deindustrialisation trends and how the process has taken shape in contexts beyond the advanced industrialised country experience covered in the previous section. The various typologies of deindustrialisation and the heterogeneity of the deindustrialisation experiences of countries at varied levels of development will be reconsidered. This will form the basis for understanding the interaction which takes place at the deindustrialisation-tertiarisation nexus.

4.3.1. Deindustrialisation Trends

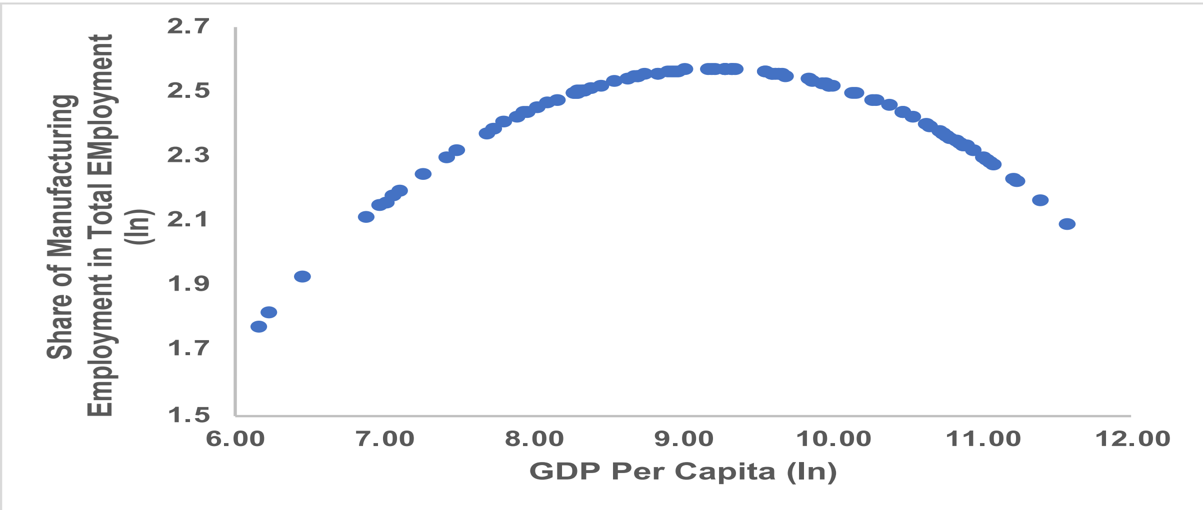
Following the discovery of compelling evidence of deindustrialisation in the United Kingdom and other industrialised countries from the late 1940s to 1960s, a global pattern of deindustrialisation is becoming evident. Empirical evidence of the severity of deindustrialisation varies and is dependent on the measurement criteria, the period of analysis and which country or country groupings are being studied. For most industrialised countries, when measured in terms of manufacturing output in current terms, there is greater evidence to support deindustrialisation compared to the measurement of the same variable in constant terms which tends to show a muted decline (Lavopa & Szirmai, 2015; Ramaswamy & Rowthorn, 1997; Rodrik, 2016; Singh, 1977). However, despite the different criteria applied in measurement, the consensus is that many 'under-industrialised' countries have been deindustrialising in terms of both measures since the 1980s (Rodrik, 2016).

An important relationship indicating deindustrialisation is that between the level of per capita income and the manufacturing share of employment. The rise in per capita incomes with an increase in the manufacturing share of employment and evidence of an inverted U or hump-shaped relationship between both variables is well recognised in the development literature

(Chenery, 1960; Clark, 1940; Kuznets, 1957). This correlation between both terms is taken as evidence that once industrialised countries reach a peak in manufacturing employment, the loss of jobs to the tertiary sector follows as employment in manufacturing declines. A similar phenomenon occurs with respect to output and is attributed to Engel's law.

Using the specification in Tregenna (2015)[11], a simple regression was run to demonstrate the inverted-U relationship between GDP per capita and the share of manufacturing in total employment. Utilising data for 2015, the natural log of the share of manufacturing employment in total employment is the dependent variable while the log of GDP per capita and GDP per capita squared are the explanatory variables. For a sample of 99 countries, the turning point of the regression was found to be US$10,212 which corresponds to a 12.9% share of manufacturing in total employment. This relationship between both variables is presented in Figure 4.2 and the results are summarised in Appendix 9.2.2.

Figure 4.2: Inverted-U pattern: relationship between manufacturing share of employment and per capita GDP



Source: Author's calculations, GDP data from UN National Accounts, Employment data from ILO.

There is a broad literature analysing the relationship between per capita incomes and manufacturing output and employment, given that manufacturing is widely considered to be the engine of economic growth and thus affects living standards significantly. In reviewing the seminal literature in this regard, the main findings emerging are that the turning point when the manufacturing share of employment begins to decline shows up very distinctly in the data. The turning point is found to be occurring at lower levels of per capita income and manufacturing as

[11] Based on Rowthorn (1987)

a share of employment compared to historical patterns and in the case of pre-industrialised countries is setting in even before industrialisation has reached appreciable levels.

A summary of the literature documenting these trends, in particular, the magnitude of the turning point in terms of per capita income, when it occurs and the causal factors driving deindustrialisation is presented in Appendix 9.2.1.

The main findings that can be drawn from the summary include the following:

1. **Manufacturing as a share of employment is considered a more reliable indicator of deindustrialisation than manufacturing value-added or share in output.** Rodrik (2016), using a dataset of 42 developed and developing countries, including major economies in Latin America, Asia and Sub-Saharan Africa, from the 1940s to early 2010s, discovered that the manufacturing share of employment peaks earlier than manufacturing in value-added. Felipe, Mehta & Rhee (2018) also found that high manufacturing employment precedes economic prosperity and is a better predictor of prosperity than manufacturing as a share of output.

2. **The turning point at which the manufacturing share of employment begins to decline shows up clearly in the data**. The level of per capital income can also be determined. This finding was originally attributed to Rowthorn and Wells (1987) and was further replicated in other studies using varying specifications as summarised in Table 4.1.

3. **The turning point has shifted downwards and leftwards over time as countries reach a lower turning point at lower per capita income levels**. Palma (2005) observed, drawing from earlier work by Rowthorn and Wells, that the original impulse for deindustrialisation came from this fall in the inverted U-shape relationship over time and was expected given the potential for productivity catch up for late industrializing countries. Tregenna (2015) also found that the later industrialisation begins in a country, the earlier the onset of deindustrialisation.

4. **Various causal factors drive deindustrialisation**. To disentangle each of these factors it is necessary to understand the various ways in which deindustrialisation manifests. These typologies and the causal factors responsible will be discussed in section 4.3.2.

5. **The trend in the inverted U relationship changes when countries are considered in aggregate rather than on an individual basis.** When these trends are considered for all developing countries in aggregate, Haraguchi, Cheng & Smeets (2017) discover that although the country average MVA share in GDP in constant terms for developing countries has been on the decline since 1991 it has been rising in aggregate terms for a 43-year period, between 1970 and

2013. According to their results, the global aggregate share of manufacturing employment has remained stable since 1970.

From the review of studies on trends in deindustrialisation, it is apparent that the manufacturing share in employment is the preferred measure of industrialisation while the manufacturing share in output is less utilised due to its limited explanatory power. Although the exact turning point at which the manufacturing employment share in comparison to per capita income differs from one study to the next and is dependent on the countries being studied, the period covered, the data set utilised and the estimation methods adopted, there is consensus that industrialisation is peaking at lower shares of manufacturing as a share of total employment and at much lower income levels than obtained for the early industrialised countries. This leads one to question the causal factors responsible for this shift over time. In answering this question, it will be necessary to approach it from the perspective of the types of deindustrialisation as it is a heterogenous process driven by a variety of causes.

4.3.2. Typologies of Deindustrialisation

Typifying deindustrialisation is not straightforward due to the multiplicity of factors driving the process and the diverse ways in which these factors play out in different country contexts. In this section, a survey of the typologies in the structural transformation literature is presented. Table 4.1 summarises the typologies and also draws out any reference to the impact of deindustrialisation on tertiarisation.

Dasgupta and Singh (2006) in their study of deindustrialisation in India identified two types of deindustrialisation using terminology borrowed from Cairncross (1978) who described deindustrialisation in the UK as a pathological condition since it limited the utilisation of resources to realise the country's growth potential. The first type of deindustrialisation is described as a non-pathological type exemplified by the Indian case in which manufacturing employment was expanding in the informal sector and not the formal sector. The second was characterised as a pathological form of deindustrialisation associated with Latin American and African nations in the 1980s and 1990s due to their abandonment of ISI for Washington Consensus policies. The term 'premature deindustrialisation' was introduced based on the observation that deindustrialisation, in terms of output and employment, was taking place at lower levels of per capita income in comparison to previous trends.

Gabriel Palma (2005) asserted that deindustrialisation had become a stylised fact of the post-World War II period. As extensively discussed in the previous section, the turning point had taken place in the 1960s and 1970s for the mature deindustrialisers, much like the observation made by Singh and others, but was occurring in the 1980s for the East Asian and Latin American countries. In his analysis, Palma (2005) identified several typologies of deindustrialisation arising from multiple sources. The first source is the decline in manufacturing employment which takes place when countries reach a certain level of per capita income. The second is the continuous decline over time in the relationship between manufacturing employment and per capita income. The third source of deindustrialisation is due to a huge drop in income per capita corresponding to the turning point of the regressions relating manufacturing employment to income per capita since 1980. The fourth is the Dutch disease effect which is an additional effect on top of the other three and not just a simple overshooting of deindustrialisation. On this basis, several typologies of deindustrialisation were identified, as summarised in Table 4.1.

Rowthorn and Wells (1987) treat deindustrialisation not as a pathological condition but an inevitable process that accompanies economic progress. They defined two types[12] of deindustrialisation outcomes, the first, termed positive deindustrialisation, is a situation in which productivity growth in manufacturing results in output expansion and the movement of labour into a service sector with the capacity to create new jobs. Negative deindustrialisation occurs when falling output or an increase in manufacturing productivity leads to an outflow of labour which cannot be absorbed into services. Thus, the ability of the tertiary sector to accommodate changes in the secondary sector is perceived as instrumental in defining deindustrialisation outcomes.

The heterogeneity of deindustrialisation was underscored in Tregenna's analysis using a Marxian framework which defines productive labour as that which produces surplus value (Tregenna, 2014). Examples of non-surplus value producing activities include personal services, production of goods for personal use and circulatory activities such as finance while surplus value producing activities include most forms of mining, agriculture and manufacturing carried out under capitalistic modes of production.

Tregenna (2015) revisited the concept of premature deindustrialisation, questioning the use of the term in describing the experience of countries where industry had stagnated and in some cases never reached levels described by Dasgupta and Singh (2005). Most of the stagnating countries in Sub-Saharan Africa were found to be experiencing a phenomenon described as 'pre-industrialisation deindustrialisation' since deindustrialisation was taking place before the benefits of industrialisation had fully permeated the economy (Tregenna, 2015, p. 28). This is an

[12] They discuss trade-induced deindustrialisation, but this can be treated as a type of negative deindustrialisation.

important finding and the identification of this special category of deindustrialisation will feature prominently in subsequent analysis in this thesis.

Table 4.1: Typologies of Deindustrialisation

	Author(s)	Country or Region of Study	Deindustrialisation Impact on Tertiarisation	Typologies of deindustrialisation
1	Rowthorn & Wells (1987)	UK and other OECD countries	Links positive deindustrialisation with the absorption of excess labour from industry into the manufacturing sector which is not the case with negative deindustrialisation.	1.Positive deindustrialisation: the normal result of sustained economic growth in a fully employed and highly developed economy. 2. Negative deindustrialisation: a pathological phenomenon which can occur at any stage of development and represents economic failure and manufacturing problems. 3. Trade-related deindustrialisation: due to changes in structure of foreign trade.
2	Palma (2005, 2014)	105 countries	Conflates deindustrialisation with growth of the service sector. Expansion of service sector through the absorption of excess labour from manufacturing could be outcome of deindustrialisation but service sector could be expanding for other reasons.	Several typologies of deindustrialisation which include : 1) Upward - mature economies switching to services 2) Downward - policy induced such as in Latin America 3) Dutch Disease - found in countries able to generate a trade surplus in primary commodities and services.. 4) Reverse - found in SSA and other countries in 1980s and 90s where level of per capita income was below the turning point.
3	Dasgupta & Singh (2006)	48 developing countries with focus on India	See deindustrialisation as an opportunity for new services leveraging technology to replace or complement manufacturing as an engine of growth.	Premature deindustrialisation - introduce the concept of premature deindustrialisation which occurs when the fall in the share of manufacturing in employment or absolute fall in manufacturing employment takes place at lower levels of per capita income than previously observed. Also reference pathological deindustrialisation.
4	Tregenna (2015)	103 countries	Notes that pre-industrial deindustrialisation negatively affects the development of an advanced and dynamic service sector and jeopardises potential for services to act as an alternative engine of growth.	Form I deindustrialisation: refers to a relative decline in manufacturing and relative increase in non-surplus-value-producing activities Form II deindustrialisation: there is a relative shift from manufacturing to other types of surplus-value-producing activities Pre-industrial deindustrialisation - introduces the concept which is experienced by many developing countries, particularly in Sub Saharan African.

Source: Author's compilation from multiple sources

From the review of trends and typologies of deindustrialisation in this chapter it is evident that deindustrialisation experiences are diverse and are now occurring much earlier in the structural change process than in previous periods. For the rest of the discussion in this thesis, the three main categories of deindustrialisation that have been identified thus far will be utilised as analytical categories in interrogating tertiarisation processes. In explicit terms, the factors driving the tertiarisation-deindustrialisation interplay in the mature deindustrialisation, premature deindustrialisation and most importantly, pre-industrialisation deindustrialisation identified in the literature will be reviewed and categorised in the next section of this chapter[13].

In carrying out this review, emphasis will be given to producer services as they tend to sit at this nexus; however other service categories will also be considered as the analysis will be driven by the focus on extant literature on the subject. By reviewing the causal factors driving each type of tertiarisation process in each separate category, the groundwork is being laid to strengthen the argument that how the tertiary sector emerges matters. More importantly, it determines the kind of services that emerge and the interlinkages between them and the productive sectors of the economy.

4.4. Diversity in Tertiarisation Paths: Service Trajectories

In conducting a review of the existing literature on tertiarisation, focusing on pre-industrialisation deindustrialisation related tertiarisation, it will be demonstrated that the timing of deindustrialisation, especially the depth of industrial capacity already existing within a country, shapes the nature of producer services that emerge.

In the pre-industrial context, the drivers of services will be explored to give an answer to the question of where these services originate. The case will be made that even when 'producer services' are developed, many times these services cannot be considered producer services in the real sense of serving as intermediate inputs in the production process given there is limited manufacturing activity in pre-industrial countries. Thus, a service cannot be considered a producer service based purely on its taxonomic definition but must be defined as one by virtue of its function vis a vis other sectors of the economy. The argument will be made that so-called producer services do not always act as producer services and in some cases, are principally geared towards supporting purely consumption activities.

[13] This is not an exhaustive listing of deindustrialisation patterns as for example, the experiences of Post-Communist countries are distinct and can be termed over-industrialisation deindustrialisation (Stare, 2007; Zalewska & Mickiewicz, 2002). These countries have entered a phase of deindustrialisation following an excessive focus on industry to the detriment of other sectors during the Communist era. However, given that this is a niche type of deindustrialisation that applies to only a few countries, it will not feature in this analysis.

4.4.1. Context- Specific Drivers of Tertiarisation

There is little dispute that several factors, and not a single one, have contributed to the current tertiarisation trend in most economies. Oftentimes, there is difficulty in isolating specific 'tertiarising' factors as many of these are interlinked and there is a tendency for causality to run in several directions. However, there are some commonly cited factors found in the literature on structural transformation to explain the growth of the service sector relative to other economic sectors. The principal factors driving tertiarisation in the literature can be categorised into supply and demand-side drivers; however, given that demand and supply side pressures can be at work concurrently in the same driver and in some instances instigate a process of circular cumulative causation (Toner, 1999), this categorisation will not be applied in a rigid fashion in this analysis. Thus, the sorting of drivers into demand and supply side categories in the rest of this analysis is essentially being employed as a heuristic (Cuadrado-Roura, 2013; Wölfl, 2005).

The key demand-side drivers based on a literature review are:

i. **Increased final demand for services due to changes in tastes and consumption patterns as incomes rise in line with Engel's Law** (Baumol et al., 1985; Cuadrado-Roura, 2013; Dale W. Jorgenson & Marcel P. Timmer, 2011; Falvey & Gemmell, 1996; Ferrucci & Picciotti, 2017; Francisco J. Buera & Joseph P. Kaboski, 2012; Fuchs, 1968; Iscan, 2010; Kuznets, 1957; Stigler, 1956)
ii. **Increase in use of services as an intermediate input** (Cuadrado-Roura, 2013; Fuentes, 1999; Greenhalgh & Gregory, 2001; Pilat & Wölfl, 2005; Wölfl, 2005)
iii. **Internalisation of markets and international trade** (Cuadrado-Roura, 2013; Lawrence et al., 1993; Malchow-Møller et al., 2015; Maroto-Sánchez, 2012; Rubalcaba, 2007)
iv. **Rise in demand for public services** (Cuadrado-Roura, 2013; D'Agostino et al., 2006; Ferrucci & Picciotti, 2017; Gundlach, 1994; Messina, 2004)

The key supply-side drivers which recur in the literature include:

i. **Productivity differentials between services and manufacturing** (Baumol, 1967; Baumol et al., 1985; D'Agostino et al., 2006; de Souza et al., 2016; Fuchs, 1968; Kongsamut et al., 2001; Kravis et al., 1983; Ngai & Pissarides, 2007; Rubalcaba, 2007; Rubalcaba-Bermejo, 1999; Wölfl, 2004, 2005)
ii. **Externalisation/Outsourcing of Services** (Cuadrado-Roura, 2013; de Souza et al., 2016; Fixler & Siegel, 1999; Fuchs, 1968; Oulton, 2001; Sasaki, 2007)
iii. **Convergence and integration between goods and services** (Ferrucci & Picciotti, 2017; Maroto-Sánchez, 2012; Rubalcaba-Bermejo, 1999)

iv. **Technological progress** (Cuadrado-Roura, 2013; Maroto-Sánchez, 2012; Rubalcaba-Bermejo, 1999; Stigler, 1956)

Other less common factors include the increase in public services, especially as populations in industrialised countries age; the rise in female participation in the labour force and other demographic changes such as urbanisation (D'Agostino et al., 2006; Fuchs, 1980).

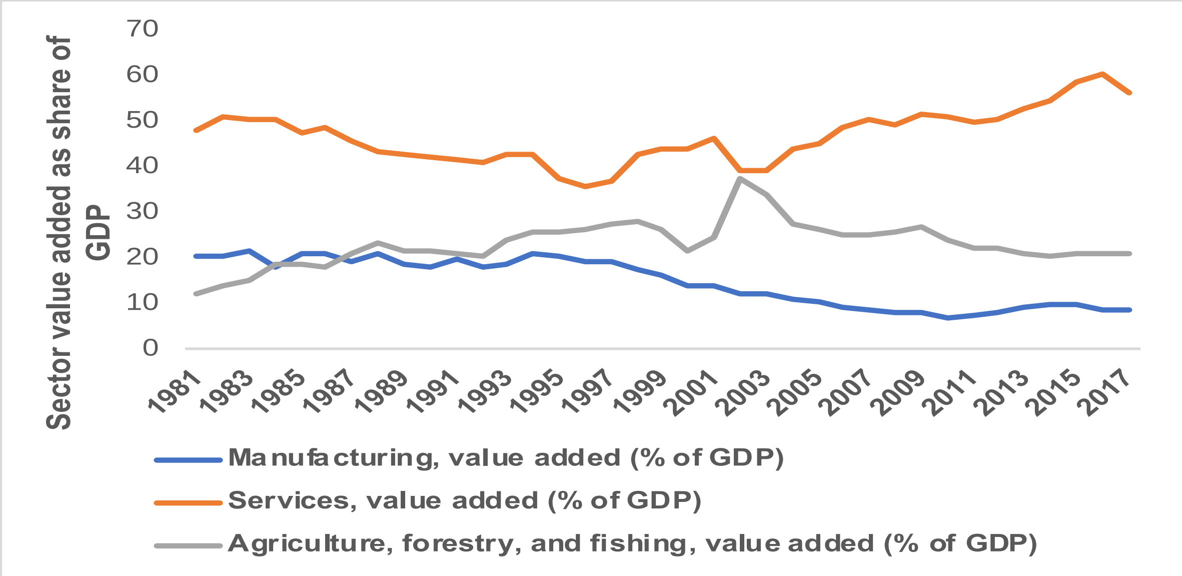
These factors have traditionally been derived from the mature industrialised experience and subsequently extrapolated to explain the rise in services in both the premature deindustrialisation and pre-industrial deindustrialisation situations. In practice, the way these factors manifest in the latter two contexts is distinct from the mature industrial situation and has implications for the type of tertiary industry that emerges. Thus, the main supply and demand-side drivers of tertiarisation will be critically examined for the pre-industrial deindustrialisation context in the next section.

It will be shown that in line with the heterogeneity of the deindustrialisation processes and as a corollary to it, the various tertiarisation outcomes are also heterogenous. The review will demonstrate that in the pre-industrial deindustrialisation case, the adoption of neoliberal reforms, particularly liberalisation and privatisation, have been more instrumental to the expansion of the service sector.

4.4.2. Tertiarisation in Pre-Industrial Deindustrialisers

Pre-industrial deindustrialising countries are marked by a disproportionately large service sector in comparison to their industrial and agriculture sectors, given their level of development and per capita income. The size of the service sector vis á vis the current stage of structural transformation in these countries does not align with the stylised facts of structural transformation. These economies have transitioned from agrarian to service economies without passing through a meaningful industrial phase, which is the main feature that distinguishes them from the premature deindustrialisers. Figure 4.3 shows the trend in value-added shares of GDP for Nigeria, displaying the pre-industrial pattern of structural change.

Figure 4.3: Structural Change in Nigeria (1981-2017)



Source: World Development Indicators (WDI)

In these countries, the agricultural sector is still a significant share of both employment and GDP. The absorption of labour into services is not driven by productivity differentials between agriculture and manufacturing or increased demand for services given the small size of the manufacturing sector and the structure of the service sector. Service employment and output in many pre-industrial deindustrialisers is marked by low value-added and low skilled services; however, significant high value-added producer services exist side-by-side in many cases. The co-existence of these disparate service categories with an underdeveloped manufacturing sector is paradoxical and this unusual pattern of structural transformation warrants additional study.

Regrettably, the literature on the service sector of pre-industrial deindustrialisers is sparse as there is an implicit assumption that there is little worth exploring as low value-added services are prevalent in this context. Table 4.2 provides a summary of the supply and demand side drivers in the tertiarisation process from a review of the literature. Given the push for industrialisation as the only viable path for economic transformation, there is also a strong bias in the literature towards manufacturing as a means to an industrialisation end (Carmignani & Mandeville, 2014; Rodrik, 2016; Szirmai & Verspagen, 2010).

Much like the premature deindustrialisation case, the impact of government reform is the most commonly cited factor for the growth of the service sector. The principal factor highlighted in most of the literature on countries in this category is the impact of neo-liberal reforms promoting privatisation, liberalisation of markets, trade openness and deregulation (Beerepoot et al., 2017; Behuria & Goodfellow, 2018; Hoekman, 2017; Lambregts et al., 2015; T. A. Oyejide & Bankole, 2001; Uwitonze & Heshmati, 2016).

Many of these policies were introduced as part of the suite of reforms promoted by the IFIs in response to the balance of payments and external debt crisis in many countries in SSA and other parts of the developing world. However there are some exceptions such as the case of Rwanda where the role of the developmental state in driving public investment in IT, tourism and real estate is diametrically opposed to the situation in other countries in SSA where IFIs are driving the reform programs (Behuria & Goodfellow, 2018).

Other factors found to support tertiarisation include a trained workforce and increased access to finance, which was found to have enabled the growth of entrepreneurial activities in the service sector in Rwanda (Behuria & Goodfellow, 2018; Uwitonze & Heshmati, 2016). In the case of Nepal, access to finance had a statistically significant impact on service sector expansion (Dahal, 2018). The entry of females into the labour force also had a positive impact on services in Rwanda (Uwitonze & Heshmati, 2016) and Ethiopia (Kabeta, 2017).

Yet, the literature on services in the pre-industrial context is made more intriguing by the factors that are absent than by those presented as drivers of tertiarisation. Demand for services as final or intermediate demand is barely referenced as a key driver of service expansion due to the low and stagnating levels of per-capita income and the limited industrial base in these countries. The impact of rising incomes on demand for services is only cited in the case of Ethiopia (Kabeta, 2017).

Productivity differentials between manufacturing and services is also absent from the literature due to the lack of significant manufacturing activity. However, the impact of technological change is cited in the case of IT, which is the crux of the issue under investigation as this is occurring in low manufacturing capacity environments. This underscores the need to investigate the nature of high value-added or producer services emerging from these countries in the absence of strong links to the manufacturing sector.

There is a subset of literature which views the tertiary sector as an alternative path to growth. Early versions of this literature put forward a 'leapfrog' proposal largely based on the Indian IT experience (Dasgupta & Singh, 2005; Ghani & O'Connell, 2014). In an initial response to this, the case was made that the type of tertiarisation taking place in SSA was growth-reducing rather than enhancing as most of the change was driven by labour movement into low value-added services (McMillan & Rodrik, 2011).

However, a new strand of this literature is emerging to make the case for services as a viable path to growth in view of the challenges faced by countries seeking to integrate into global production networks while seeking to abide by WTO rules. The global trends quoted as presenting renewed hope for SSA include: increased potential for trade in services, 'servicification' of manufacturing production, the rise in global value chains, and technological developments (Newfarmer et al., 2018). Agro-industrial and horticultural value chains; tourism; and business and trade services (including IT services and transport, and logistics) are the key service sub-sectors recognised as benefitting from these global trends.

Although the studies present some evidence of progress in service outputs and export shares, much of the discussion is forward-looking and speculative (Hoekman, 2017). Optimistic predictions are made about potential growth that can be harnessed when structural barriers such as a poorly educated labour force, high transport costs, inconsistent and unreliable energy, limited access to finance and high data access and internet connectivity costs, are addressed. Yet these are the same structural barriers that have impeded growth of the agriculture and the manufacturing sector, and it is not clear from the studies in this volume how the services revolution will overcome or at least circumvent these obstacles.

An important finding on telecommunications and IT trade is in regards to the connectivity frontier.[14] It has been discovered that although African countries are increasing data transmission speeds and telecommunications coverage, the relative gap between them and industrialised countries is widening (Frischtak, 2018). Thus, as efforts are being made to close the digital divide, the gap is widening. Unfortunately, without providing insight into how technologies and innovations are being utilised and created by IT firms in SSA, a clear diagnosis of the blockages in the process cannot be presented.

Although the review so far covers a wide range of countries and industries, the analysis remains at the macro and meso level and there is reluctance to engage with happenings at the micro-level that could lend credence to the arguments being made in the volume. The discussion is rarely prefaced by an analysis of the causal factors instrumental in the growth of service activities. Without engaging with how these services have emerged and how the factors that have led to their growth shape the characteristics of the services and their interaction with other sectoral activities, the claim that services can be a driver of growth becomes hollow. It is to avoid this pitfall that a micro-level case study of the IT sector in Nigeria is presented in Section 7.

[14] The distribution of countries across the internet use—average speed gap.

In summary, the main drivers of tertiarisation in the pre-industrial deindustrialisation case are the impact of policy reforms such as liberalisation and the privatisation of service sectors. These policies are typically promoted by IFIs, and the resulting service sector expansion is mostly limited to the domestic market as cases of outsourcing and offshoring are rarely cited.

The pre-industrial deindustrialisation case has been presented as a distinct form of deindustrialisation with unique features, of which the lack of vibrant industrial activity is a marker. The review of literature in this case points to areas of growth in specific industries and countries while identifying constraints to growth. However, a major shortcoming in these studies is the non-recognition that services perform different functions within different production environments.

Thus, services in all contexts, mature, premature and pre-industrial countries have been conflated. Where there is recognition of differences, the analysis has not been systematic and a coherent explanation for these differences does not emerge from the discussion. In the next section, this shortcoming will be addressed through the development of a theoretical framework for interrogating the tertiarisation-deindustrialisation nexus with a view to broadening the typification of services to include those formed in a pre-industrial economy.

Table 4.2: Pre-industrial Deindustrialisers: Summary of Supply and Demand-side Factors

	Author	Country or Region of Study	Demand-Side Factors		Others
			Rise in Per-Capita Incomes	*Internalisation of Markets/International Trade*	
1	Badiane, Ulimwengu & Badibanga (2012)	Sub Saharan Africa			Growth of the non-agricultural sector, of which the service sector is the largest component, is being driven by the productivity differentials between it and the agricultural sector.
2	Beerepoot & Keijser (2014)	Ghana			
3	Behuria & Goodfellow (2019)	Rwanda			
4	Dahal (2018)	Nepal		Strong export performance was found to have a positive effect on the service sector in contrast to imports which had a negative impact.	
5	Diao, Harttgen & McMillan (2017)	Sub Saharan Africa			

Table 4.2: Pre-industrial Deindustrialisers: Summary of Supply and Demand-side Factors (continued)

	Author	Country or Region of Study	Supply-Side Factors				
			Lack of industrialisation	*Technological progress*	*Government Policies/Reforms*	*Access to finance*	*Human capital development*
1	Badiane, Ulimwengu & Badibanga (2012)	Sub Saharan Africa					
2	Beerepoot & Keijser (2014)	Ghana			Implementation of the Government's development partner-supported Accelerated Development Policy is believed to be a main driver of ICT development in Ghana.		
3	Behuria & Goodfellow (2019)	Rwanda		The adoption of ICT applications is cited as a contributory factor to tertiarisation.	The developmental state in Rwanda is driving public investment in the service sector, especially in the ICT and Tourism and Real Estate sub-sectors. Improvements to the tax system have been instrumental to the growth of services.	Increased access to finance has enabled the growth of entrepreneurial activities in services	Training of personnel in the service sector is one of the factors underlying service growth.
4	Dahal (2018)	Nepal			Government investment in infrastructure was found to have a positive impact on service sector expansion.		An educated workforce was also found to have a statistically significant positive effect on service sector output.
5	Diao, Harttgen & McMillan (2017)	Sub Saharan Africa	Structural change in Africa has been marked by a movement of labour out of agriculture into services and not manufacturing.				

Table 4.2: Pre-industrial Deindustrialisers: Summary of Supply and Demand-side Factors (continued)

	Author	Country or Region of Study	Demand-Side Factors		Others
			Rise in Per-Capita Incomes	*Internalisation of Markets/International Trade*	
6	Kabeta (2017)	Ethiopia	An upward trend in the growth of incomes is found to be a major factor driving sector growth.		Increased female labour force participation found to be instrumental changes in the structure of demand in the service sector.
7	Grabowski (2016)	Indonesia and Sub Saharan Africa			
8	Hoekman (2017)				
9	Lambregts, Beerepoot, & Kloosterman (2015)	Not country specific			
10	Oyejide & Bankole (2001)	Nigeria		Nigeria's ascension to the General Agreement on Trade in Services consequently facilitated rapid growth of the sector.	
11	Uwitonze & Heshmati (2016)	Rwanda		Trade openness also found to be significant to service sector growth.	The promotion of gender equality found to be an important factor in tertiarisation.

Table 4.2: Pre-industrial Deindustrialisers: Summary of Supply and Demand-side Factors (continued)

	Author	Country or Region of Study	Supply-Side Factors				
			Lack of industrialisation	*Technological progress*	*Government Policies/Reforms*	*Access to finance*	*Human capital development*
6	Kabeta (2017)	Ethiopia					
7	Grabowski (2016)	Indonesia and Sub Saharan Africa	Perceives growth of the service sector in Sub Saharan Africa to be the result of an outflow of labour from the agricultural sector into low value-added or non-tradable services due to lack of an industrial sector. Sees no potential for services to be a growth escalator, unlike manufacturing.				
8	Hoekman (2017)			Technological progress is facilitating trade in services.	Government polices to support trade liberalisation have spurred the growth of certain service sub-sectors such as tourism.		
9	Lambregts, Beerepoot, & Kloosterman (2015)	Not country specific			In response to neo-liberal policies which enabled the segmentation of production and offshoring of services, countries which have not developed a strong manufacturing sector, many in Africa, are engaging in high value-added services.		
10	Oyejide & Bankole (2001)	Nigeria			The implementation of policy reforms under the Structural Adjustment Programme of the 1990s led to the liberalisation/privatisation of Nigeria's service sector.		
11	Uwitonze & Heshmati (2016)	Rwanda		The development of knowledge and skills in the workforce through increased labour force training as well as the application of ICT are found to be contributory factors to tertiarisation.	The collection of Value Added and Income Tax was found to have positive effects on the development of the service sector. The exact mechanism by which this works was not explained.	Access to finance is found to be conducive to the expansion of the service sector.	

4.5. The Tertiarisation-Deindustrialisation Nexus

In the foregoing discussion, several references were made to the need to view the interaction between tertiarisation and deindustrialisation from a different perspective than the commonly held one of treating tertiarisation as the inevitable or sometimes even negative outcome of the deindustrialisation process. As alluded to previously, this is partly due to the 'manufacturing as driver of growth' position but is also influenced by the indicators utilised in measuring both processes. The limitations of these measures and the tendency to arrive at incorrect assumptions based on how they are deployed will be discussed in this section.

At the core of this discussion is the need to interrogate what takes place at the nexus between tertiarisation and deindustrialisation. The use of alternative indicators for measuring both processes assist us in this regard. In this section, the case is being made for the use of absolute measures in determining this. Absolute measures of both processes help us to identify when real growth is taking place rather than an implied growth based on relative movements between sectoral indicators. In the case of tertiarisation, once we are able to establish that real growth or decline is occurring, we can then proceed to further interrogate what types of services are being created. This interrogation is of course informed by our knowledge of the drivers that have influenced this growth as discussed in the previous section.

Armed with this knowledge, the goal is to distinguish 'good services' from 'bad services' and on this basis determine which good services, which are growth-inducing and bad services, which are growth-reducing are present. Although services can develop from different stimuli, the focus of this thesis and of this section are those services that emerge at the interface between manufacturing and services and thus at the tertiarisation and deindustrialisation nexus. These are commonly called producer services. In view of the limitations in the 'producer service' descriptor in the case of pre-industrial societies where these services are supporting little production, a new way of differentiating between a service that aids production and one that does not is essential.

The alternate measures for tertiarisation and deindustrialisation will be proposed next while the challenges with developing a heuristic for differentiating between growth-inducing or good services and growth-retarding or 'bad' services will follow.

4.5.1. Alternative Measures of Deindustrialisation and Tertiarisation

National accounts typically adopt the three-sector hypothesis and for this reason, the industrial, agriculture and services sectors are aggregated to depict the entire economy. As a result, the indicators utilised in measuring changes to each sector are relative measures based on shares of a total. Given that economy-wide effects are being considered, there is a strong argument for utilising relative measures to highlight the relative impact of a sector on the aggregate measure utilised. However, these measures can be misleading and misinterpreted to imply that growth in one sector is due to a decline in another sector when several processes could be occurring.

In the case of the three main sectors of the economy, a decline in the employment or value-added share manufacturing sector would result in an increase in the relative shares of services and agriculture when in fact both sectors could be stagnating. In addition, growth in the tertiary sector could be driven by creation of new jobs to respond to demands pressures or could result from the creation of novel job categories through the application of new technologies. This reliance on relative measures in many ways supports the false dichotomy created between tertiarisation and deindustrialisation and obscures the changes taking place in each sector.

Absolute measures of growth in value-added and employment help us to narrow our focus to the changes taking place within each sector. This allows us to determine if what is occurring is deindustrialisation or tertiarisation and on this basis we are able to correctly diagnose, in the case of tertiarisation what drivers are behind this growth, From this narrow focus, it is then possible to expand our view to explore what types of services are emerging, which sectoral interactions are shaping them and how these services are being utilised in the economy. Thus, although absolute measures are useful, they are not granular enough to aid our understanding of how services are developed.

Figure 4.4: Mature Deindustrialisers: Annual Growth in SVA and MVA vs. SVA and MVA in Total GDP

Source: WDI

An illustration of this is shown in Figure 4.4 in which annual growth of Service Value Added (SVA) and Manufacturing Value-Added (MVA) is placed alongside SVA and MVA shares in total GDP. It can be observed for a sample of mature deindustrialisers that manufacturing VA is relatively lower than service VA over the 1998-2016 period. This is expected based on the stylised facts of structural transformation[15]. However, annual growth in SVA and MVA show that MVA has been more volatile and was for example more responsive to the 2008-9 global financial crisis than SVA while services, though experiencing a slight dip during the crisis was not as affected.

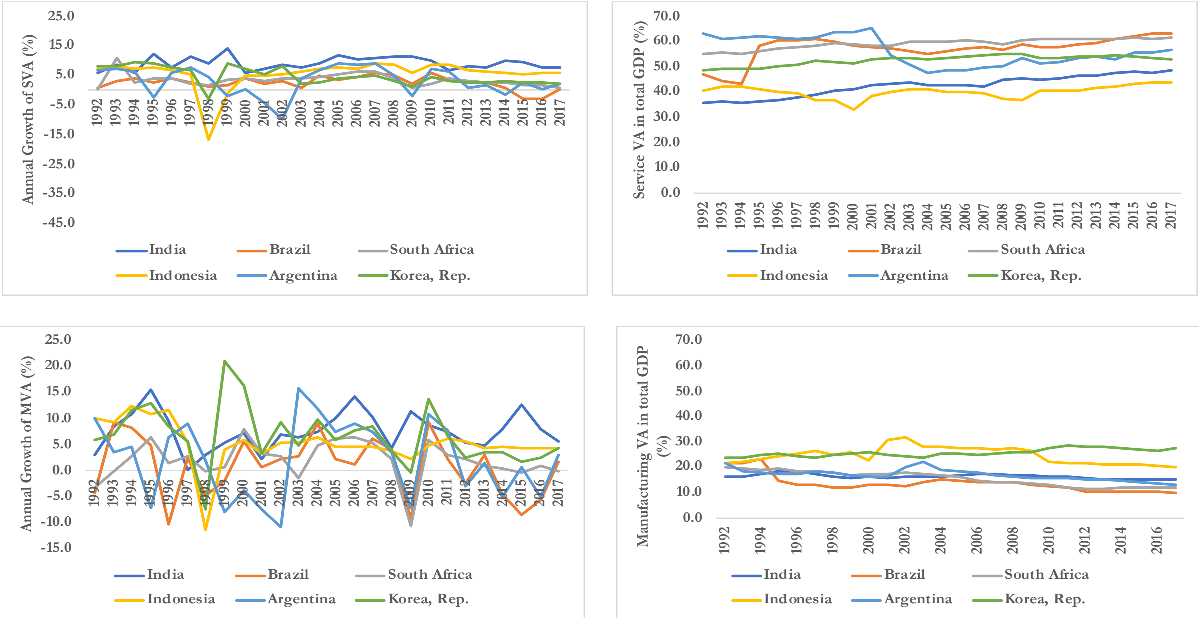
In recent years, the volatility has reduced and both SVA and MVA seem to be growing at similar rates. Most of the selected countries are moving in tandem, with Sweden exhibiting the most volatility in growth of MVA and the United States the least. Thus, from the charts it seems exogenous and possibly endogenous factors impact growth in services and manufacturing in different ways.

A similar volatility is displayed in the case of annual growth in MVA for premature deindustrialisers as shown in Figure 4.5 while service growth has proceeded in a steadier manner. However, the impact of the global financial crisis is present, has a larger impact for MVA than SVA but is less pronounced than the case of mature deindustrialisers.

Both growth rates are higher in comparison with mature countries, which is as expected; however, there is indication that both tertiarisation and deindustrialisation are occurring at the same time with most of the premature deindustrialisers in this sample. Of note is that the manufacturing sectors in Brazil and Argentina have been on an upswing since 2015 and 2016 respectively while Indian manufacturing is trending downwards and displays a high level of volatility

[15] Due to the limited time period for which comparable data is available for all countries, it is not possible to show the full trajectory of structural change in the economy.

Figure 4.5: Premature Deindustrialisers: Annual Growth in SVA and MVA vs. SVA and MVA in Total GDP



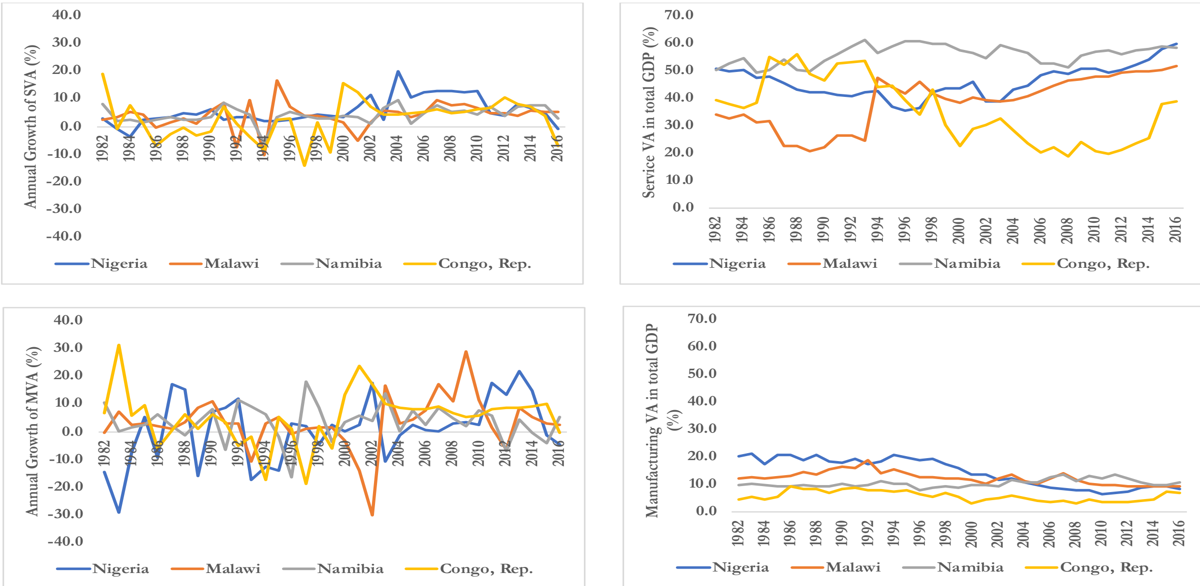
Source: WDI

In the case of pre-industrial deindustrialisers, the service sector is much larger as a share of total GDP than the manufacturing sector. As shown in Figure 4.6, between 2007 and 2016, MVA hovered around 10% for most countries in this sample, with Namibia reaching the highest level of 13.7% in 2011. The same pattern of volatility is observed with larger swings apparent in the case of MVA growth compared to SVA growth. Growth rates of SVA and MVA are much higher than the mature and premature deindustrialisers which is expected in the case of MVA as these countries are growing from a small base. SVA has tapered off in the last few years of the observed period, yet SVA in total GDP is on an upswing.

The co-existence of high growth rates of SVA and high shares of MVA in total GDP at such low levels of development is paradoxical and is one of the empirical observations being investigated in this thesis. These divergent results for SVA give impetus to the need for considering both relative and absolute measures in determining if tertiarisation is actually taking place. The charts do not tell a complete story as the selection of countries for each case has been on the basis of the availability of data. For example, China would have been an interesting case to explore otherwise.

In summary, a review of the data on SVA and MVA in absolute and relative terms for a small sample of countries that fall into the three categories of deindustrialisers over a limited timeframe has uncovered interesting results. It shows the need to consider a broader set of indicators before concluding that deindustrialisation or tertiarisation or the converse of the two is taking place. It also shows that one process is not necessarily the reverse of the other as both the manufacturing and service sectors were growing in the premature deindustrialisers observed. In the next section, the interactions between service growth/decline and manufacturing sector growth/decline will be investigated to further unpack how these processes interact.

Figure 4.6: Preindustrial Deindustrialisers: Annual Growth in SVA and MVA vs. SVA and MVA in Total GDP



Source: WDI

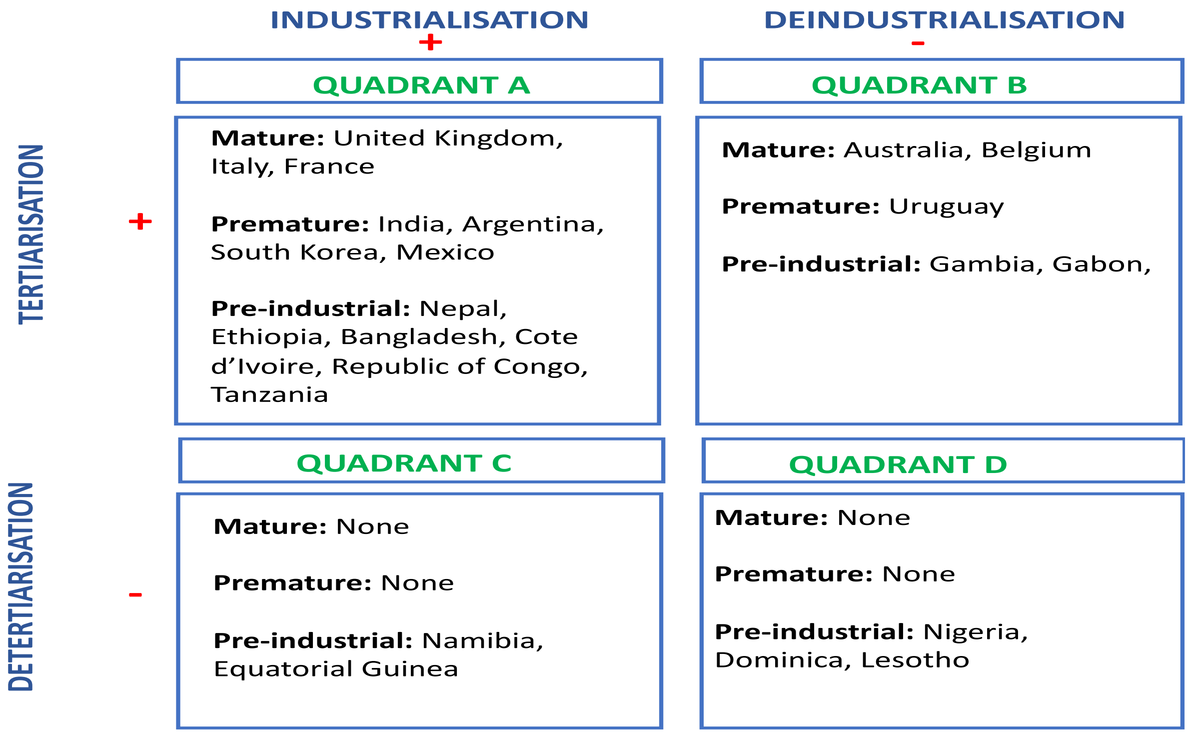
4.5.2. Structural Change Interdependencies

On the basis of these trends in annual SVA and MVA growth, a schematic with four quadrants each depicting tertiarisation, detertiarisation, industrialisation and deindustrialisation is useful for furthering the analysis. On this basis, it is then possible to classify countries based on their annual SVA and MVA growth. Drawing on the methodology applied in Andreoni and Tregenna (2018) and using data for 170 countries in 2017, the cut-off was placed at 0%: growth above 0% signifies industrialisation or deindustrialisation while that below 0% is an indication of detertiarisation or deindustrialisation. The positions of selected countries that fall within each quadrant is shown in Figure 4.7.

Interestingly, quadrant A was the most heavily populated, indicating that in 2017, most countries were industrialising and tertiarising simultaneously. No premature or mature countries fit into quadrants C and D which suggests that tertiarisation and industrialisation tend to move in tandem for these countries while for pre-industrial countries they are not strongly linked processes.

Movement from one quadrant to another over time can also be demonstrated by selecting another year for comparison and a different cut-off point; however, this preliminary analysis shows the information that can be gleaned by analysing annual growth in SVA and MVA. Although the results from this analysis are not conclusive as it is dependent on the period and cut off point selected, it gives a new perspective to our understanding of these processes and raises questions that can be addressed with a more granular level of analysis.

Figure 4.7: Schematic of Structural Change Interdependencies (2017)



Source: Author's illustration based on WDI data

The schematic of structural change interdependencies helped in answering some of the questions raised in the previous question on how these processes interact at the country level. An interesting finding is the connection between industrialisation and tertiarisation suggested for mature and premature deindustrialisers which is absent for the preindustrial deindustrialisers.

Yet, the question of the services appearing at the interfaces between these processes cannot be addressed with these aggregate data and the results of the search for a more granular approach will be presented in the next section. This analysis indicates the need for a deeper look at what types of services are being formed at the manufacturing-services nexus to understand what is driving these trends. Yet, once again the heterogeneity of services poses a challenge to finding an indicator that would be suitable for classifying service categories along these lines and an alternative must be sought.

4.5.3. What is a 'Good' Service

It is now widely acknowledged that services are highly heterogenous, both in terms of function and productivity. The limited potential for economies of scale in services given the customised nature of most services and the need for co-location in service delivery is a major reason for discounting service productivity, yet this is not the case for all services (Sorbe et al., 2018).

As repeated several times in this thesis, services of a personal nature which tend to have low skill and technology requirements, are vastly different from IT services, especially in the presence of new technologies such as artificial intelligence, big data and cloud computing amongst others (Inklaar et al., 2005; Maroto-Sánchez, 2012). Yet, even the category, 'IT services' is itself a portmanteau of various activities which can range from simple assembly of generic hardware to complex activities such as the new technologies described above. Hence, there is a need to look beyond standard taxonomies of services to determine how services are arrayed across the economy.

Productivity measures are typically utilised in differentiating economic activities and would have addressed the limitations espoused above in categorising the services created at the tertiarisation-deindustrialisation nexus. However, services are notoriously difficult to measure, largely due to the heterogenous nature of services which would require the development of specific input and output indicators for each service type. Challenges with measuring quality improvements in services and separating volumes and prices is also a complicating factor (Sorbe et al., 2018; Triplett & Bosworth, 2000).

Technology embodiment of services would also have been a useful metric. However, unlike the case of primary and secondary exports, for which the technology classification of the SITC categorises exports by technology level, there is no equivalent for services. There have been proposals to classify services by technology level such as the OECD's work on the STI scoreboard as well as efforts to classify IT services by level of R&D intensity (Galindo-Rueda & Verger, 2016; OECD, 1996, 2007). However, these efforts have not been widely adopted and have been limited to only IT services when technology can transform the delivery of any service. Thus, beyond the various taxonomies for services, many of which have not found universal usage, and which is covered in depth in Chapter 3 of this thesis, the productivity or technology-based measures are limited.

The Export Value Added Database (EVAD) which is available through the World Integrated Trade Solution (WITS) is a potential tool for creating an appropriate measure. It provides data on the domestic value-added content of output and exports for 118 countries for the years 1997, 2001, 2007 and 2011. It covers 27 economic sectors which include 9 commercial services sectors, 3 primary sectors, and 14 manufacturing sectors. Although this does not address the productivity and technology questions, information on intersectoral linkages seems to be precisely the kind of data needed to determine which services are growth-inducing or growth-retarding.

The data set includes several indicators, each of which measures the amount of value added (forward or backward) in a sector's production or exports. The direct and indirect indicators measure the intermediate use of the sector's output or exports in production. In the case of services, the variable of interest is the forward value-added. In addition, the contribution to domestic production is the focal indicator for this analysis. A summary of the total domestic value added utilised as an input to the rest of the economy for the 8 commercial service categories of interest in all 118 countries is presented in Table 4.3.

Table 4.3: Total domestic value-added- forward linkages (in US$ billions)

	Service Category	1997	2001	2004	2007	2011	Average
1	Other services	5,344	6,332	9,318	11,625	14,976	9,519
2	Other Business & ICT	2,670	2,907	5,156	6,705	7,759	5,039
3	Distribution & Trade	3,522	3,830	4,318	5,553	7,162	4,877
4	Finance	1,114	1,249	1,807	2,336	2,997	1,901
5	Transport	1,224	1,258	1,602	1,970	2,853	1,781
6	Other consumer services	1,198	1,210	1,159	1,480	1,869	1,383
7	Communications	541	585	857	1,126	1,437	909
8	Insurance	359	354	507	635	780	527

Source: WITS

A cursory examination of the data already brings up a complication as over a third of the data is captured in the 'Other services category. Also, given the separation of IT from communications it is difficult to know which services are included in either category. However, the 'Other Business & ICT' category of services is in second place in terms of its forward linkages to the domestic economy and could be termed as a 'good service', Insurance which sits at the bottom of the Table has the characteristics of a 'bad service' while Finance and Transport are located in the middle of the distribution. However, these are broad generalisations driven by the aggregate nature of the data.

Focusing on the 'Other Business & ICT' category and grouping the data into quartiles yields Table 4.4. As expected, all of the mature deindustrialisers fall into the fourth quartile with the strongest linkages. The premature deindustrialisers are spread across the fourth and third quartiles while the pre-industrial have the weakest forward linkages and can be found in quartiles 2 and 1.

Table 4.4: Total domestic value-added- forward linkages in quartiles (in US$ billions)

Q4		Q3		Q2		Q1	
Country	Total VA (fwd)	Country	Total VA (fwd)	Country	Total VA (fwd)	Country	Total VA (fwd)
United States	1,286.10	Hong Kong, China	22.20	Costa Rica	2.72	Senegal	0.74
Germany	503.26	Colombia	22.03	Cyprus	2.62	Jamaica	0.71
Japan	450.87	Singapore	21.95	Guatemala	2.53	Belarus	0.71
France	402.66	Argentina	16.50	Croatia	2.50	Namibia	0.66
United Kingdom	365.87	Czech Republic	16.26	Lithuania	2.39	Albania	0.61
Italy	339.00	Hungary	15.53	Estonia	2.36	Jordan	0.54
Spain	121.91	Turkey	13.85	Brunei	2.14	Botswana	0.54
Netherlands	119.07	Chile	13.81	Nigeria	2.03	Nicaragua	0.53
China	115.09	New Zealand	12.83	Vietnam	1.90	Nepal	0.43
Canada	109.43	Iran, Islamic Rep.	12.70	Ecuador	1.87	Bolivia	0.43
Mexico	108.85	Saudi Arabia	12.20	Morocco	1.82	Malta	0.40
Australia	87.78	United Arab Emirates	11.58	Cameroon	1.82	Ghana	0.37
Brazil	86.57	Venezuela	10.02	Dominican Republic	1.82	Uganda	0.35
Sweden	74.18	Malaysia	9.50	Oman	1.51	Paraguay	0.32
Russian Federation	56.89	Kazakhstan	8.67	Panama	1.47	Zimbabwe	0.27
Korea, Rep.	56.14	Slovak Republic	7.73	Tunisia	1.30	Georgia	0.25
Belgium	55.99	Peru	7.56	Bangladesh	1.14	Madagascar	0.22
Austria	51.83	Egypt, Arab Rep.	7.18	Kenya	1.11	Benin	0.22
Poland	43.35	Ukraine	7.17	Ethiopia(excludes Eritr	1.08	Mozambique	0.16
India	40.21	Philippines	6.14	Azerbaijan	1.02	Burkina Faso	0.15
Norway	37.29	Luxembourg	5.37	Sri Lanka	1.02	Cambodia	0.15
Switzerland	36.01	Indonesia	5.36	Mauritius	1.00	Zambia	0.14
Denmark	32.40	Qatar	5.35	Bahrain	0.96	Guinea	0.14
Greece	31.42	Thailand	5.04	Uruguay	0.92	Rwanda	0.12
Finland	27.53	Bulgaria	4.92	Honduras	0.89	Mongolia	0.10
South Africa	24.06	Pakistan	4.91	Trinidad and Tobago	0.87	Malawi	0.09
Ireland	23.70	Slovenia	4.32	El Salvador	0.82	Togo	0.05
Israel	23.54	Kuwait	3.95	Latvia	0.81	Kyrgyz Republic	0.05
Portugal	23.17	Puerto Rico	3.30	Tanzania	0.81	Lao PDR	0.03
Taiwan, China	23.04	Cote d'Ivoire	2.97			Armenia	0.03

Source: WITS

Although broad statements can be made about service types across the three sets of deindustrialisers, the aggregate nature of this data precludes any further analysis at this stage[16]. For the purposes of the arguments being made in this chapter, the limitations of the available data on services point to the need for micro-level analysis.

In summary, the analysis of the annual growth of SVA and MVA highlighted important trends which were further explored and aided the categorisation of countries by the interactions between the structural change processes occurring. In trying to identify the growth-inducing or growth-retarding services present in each context, EVAD data on forward linkages in domestic economies was explored.

Although an elementary analysis of the EVAD data shows that 'Other Business & ICT' is a sector worth exploring, it does not tell us which precise services under this broad category are

[16] The intersectoral linkages between these services and other sectors of the economy will be analysed using these and other data sources in Chapter 4 of this thesis.

growth-inducing and which are growth-retarding. As discussed earlier, IT services are heterogenous and this level of aggregation does not allow us to understand which specific types of IT services can be found in each deindustrialisation context and which are placed at the tertiarisation-deindustrialisation nexus. For an answer to this question, a micro-level analysis at the country and firm level will be necessary and the case of the Nigerian IT sector is presented in the next section of this chapter.

4.6. Case Study: Development of Nigeria's IT Sector

The discussion in the foregoing sections is intended to assist in the development of a new paradigm for interrogating the structural transformation process with respect to services. The intent has been to highlight the heterogeneity of the structural transformation process, especially the ways in which deindustrialisation and tertiarisation unfold in specific developmental contexts. The interaction between tertiarisation and deindustrialisation and the ways in which these processes impinge on each other is an important outcome of this discussion. The conclusion is that it is necessary to look beyond current typologies and taxonomies for describing services and investigating how the aforementioned processes have shaped the particular services that emerge. As an illustration, although IT is usually classified as a producer service, it does not always act as a producer service in the production process.

To further elucidate these conclusions, the IT sector in Nigeria is presented as a case study. The intent is to give an instance of a service which fits into a certain taxonomic category, in this case, producer services, and serves a different function in a specific developmental context. To achieve this, the historical development of the sector tracing its origins, the drivers that have shaped its trajectory and interaction with other sectors in the economy will be examined. Specific cases of IT firms in Nigeria, detailing their origins, trajectory over time and the growth impact of the common drivers explaining tertiarisation in the literature will be presented as an illustration of how services function in the pre-industrial context.

4.6.1. History of the Nigerian IT Sector

The emergence and subsequent growth of the Nigerian IT sector is intricately linked with the transformation trajectory of Nigeria's key economic sectors, particularly, industry and two of its key sub-sectors, manufacturing and oil and gas. The oil and gas sector is significant for Nigeria as its main source of foreign exchange earnings and government revenues while the manufacturing sector, though constituting a small share of the economy, represents the aspirations of the economy to become industrialised, diversify and create jobs for the population.

Following a period of strong economic performance on the back of high oil prices in the early to late 1970s, Nigeria experienced a downturn in the 1980s as oil prices sharply declined. The volatilities in the international oil and gas market impacted GDP growth broadly and the key sectors in specific ways. It resulted in the long-term decline of Nigeria's incipient manufacturing sector.

Import restrictions arising from foreign exchange shortages, especially on industrial inputs, hastened this decline (T. A. Oyejide et al., 1985). The agricultural sector was already stagnating prior to the crisis as food imports, subsidised by unsterilized inflows of foreign exchange from oil earnings into the economy, increased and crowded out local farmers (Iwayemi & Adeyemo, 1995). Adverse terms of trade soon compounded these problems, leading to further decline. The service sector, which at this time constituted mainly low skill and low value-added services, and which formed a large part of the informal sector, was also squeezed by the economic downturn.

The resultant debt and balance of payments crisis due to the oil price shock served as an entry point for the enactment of neoliberal policies through the SAP advocated by the IFIs, the World Bank and IMF. These policies had economy-wide effects but impacted the service sector in distinct ways. On one hand, the service sector became a sink for surplus labour from the struggling agricultural and manufacturing sectors, providing employment in low-skill and low-wage service jobs. Concurrently, the subsequent liberalisation of the sector laid the framework for the growth of new service activities such as IT. To provide context for the trajectory of IT services in Nigeria, the sequence of events which led to this outcome will be reviewed in the next section.

4.6.2. Liberalisation of Telecommunications and IT Growth

The development of telecommunications operations in Nigeria is central to the narrative of the emergence of the IT sector. The Nigerian External Telecommunications Limited (NET) and the telecommunications unit of the Posts and Telecommunications (P&T) department, both government-owned monopolies jointly responsible for the provision of telecommunications services in Nigeria, were merged to create the Nigerian Telecommunications Limited (NITEL) in 1984 (Olutayo & Omobowale, 2011)[17].

NITEL was established as a limited liability company and held a monopoly over telecommunications operations in Nigeria. The quality-of-service provision by NITEL was sub-optimal by most standards with congestion on telephone exchanges and long waiting periods for

[17] The postal division of the P&T was hived off to create the Nigerian Postal Services (NIPOST).

phone line installation being the norm. Poor billing practices by NITEL also resulted in only about a fifth of subscribers receiving regular phone bills with only 7% of revenues generated collected (Afeikhena, 2002).

In line with the laissez faire policy climate prevalent in Nigeria at the time, the Federal Government of Nigeria (FGN) concluded that the adoption of market-driven incentives was the only path towards increased efficiency in the operations of NITEL. NITEL was commercialised in 1992 as a preliminary step towards full privatisation; however, all shares were held by the FGN (Afeikhena, 2002). NITEL entered into a joint venture with Digital Communications Limited (DTL), a US company, to form Mobile Telecommunications Service (MTS) in an effort to extend NITEL's analogue operations to cover mobile cellular services. The partnership was terminated in 1995 due to escalating debts arising from the accumulation of unpaid telephone bills by subscribers amongst other challenges (Orji, 2018).

Subsequently, NITEL established its own analogue mobile cellular communications arm, Nigeria Mobile Telecommunications Limited (M-TEL) in 1992; however, M-TEL was only able to extend coverage to three cities in Nigeria: Lagos, Enugu and Abuja. Thus, the need for additional telecommunications operators had become urgent and the full liberalization of the sector became imperative.

Several policy reforms were introduced under the SAP that impacted the service sector and the telecommunications sector directly. Many of these were encapsulated in Nigeria's commitment to the General Agreement on Trade and Services (GATS) in 1994. Under these commitments, restrictions on market access and national treatment[18] in terms of cross-border supply, consumption abroad, commercial presence, and presence of natural persons were lifted for the sale/installation of terminal equipment, operation of pay phones and value-added services (WTO, 1994).

Some restrictions were left in place for mobile communications (voice and data) in recognition of the NITEL monopoly operating at the time; however, an eventual move towards privatisation and competition in the sector was expected. With respect to the financial sector, restrictions were also lifted on the acceptance of deposits, lending, issuance of guarantees and commitments, and leasing. Most importantly, non-nationals were now allowed to retain 100% ownership in any enterprise.

---

[18] The national treatment obligation under Article XVII of the GATS is to accord to the services and service suppliers of any other Member treatment no less favourable than is accorded to domestic services and service suppliers (WTO, 1994).

These commitments were institutionalised in the Nigerian Investment Promotion Commission (NIPC) Decree[19] No. 16 of 1995 which removed the 40% equity participation ceiling formerly placed on foreign firms and allowed investment in a broader range of sectors, only placing limits on 'forbidden' areas such as production of arms and ammunition, narcotic drugs and the oil and gas sector amongst others (T. A. Oyejide & Bankole, 2001).

Prior to these commitments, the Nigerian Communications Commission Decree (NCCD) 75 of 1992 had already made considerable steps towards liberalising various areas of telecommunications that had solely been the remit of NITEL. These include the installation, operation and repairs of telecommunications equipment and facilities, provision of fixed and mobile telephony as well as radio and satellite communications. Thus, the removal of these restrictions allowed the entry of both domestic and foreign operators in the telecommunications space and also facilitated the entry of foreign capital into the sector.

Building on these policy changes, specific actions were taken to actualize the liberalization of telecommunications. Several missteps and reversals occurred in the process; however, a major outcome was the elimination of NITEL's monopoly and the widening participation of private sector operators through the allocation of frequency bands in the electromagnetic spectrum to operators via licensing operations. These actions set the stage for the expansion of IT services in Nigeria and key milestones are summarised in Table 4.5.

Table 4.5: Timeline of Liberalisation of Nigeria Telecommunications Sector

	DATE	EVENT
1.	**1992**	Liberalisation of telecommunications sector under auspices of SAP leads to creation of Nigerian Communications Commission (NCC) to regulate sector and encourage private sector participation.
2.	**1993**	NCC issues licences to private telecommunications companies to provide public payphones, public switched telephony, public mobile communications, Very Small Aperture Terminal (VSAT)[20] services amongst other services[21].

[19] These decrees were converted to acts at the end of military rule and return to democratically elected government.
[20] VSAT is a satellite communications system used to transmit data.
[21] Some of the companies licensed include Multi-Links Ltd., Intercellular Ltd., Mobitel Ltd. and EMIS. These companies introduced Code Division Multiple Access (CDMA) and Time Division Multiple Access (TDMA) digital cellular technologies.

	DATE	EVENT
3.	**Mid-1990s to 2000**	First attempt by NCC to grant Global System for Mobile Communications (GSM)[22] Licences – 6 licences issued between 1994 and 1998, 27 licences issued between January and May 1999[23]
4.	**1999**	Cancellation of the 33 GSM licences issued by new democratically elected government due to non-performance.
5.	**2000**	Re-issuance of 6 GSM licences which were subsequently cancelled due to non-performance[24]
6.	**2000**	Revision of National Telecommunications Policy to encourage FDI into the sector through: - elimination of restrictions on foreign equity participation; - reduction of duties on telecommunications equipment from 25 to 5 percent for a two-year period; - the granting of pioneer status to eligible telecommunications investors; - reduction of procedures for import of telecommunications equipment; - granting of fiscal incentives for local manufacture of telecommunications facilities.
7.	**2001**	Successful issuance of GSM licences using an ascending clock spectrum auction[25]. The final bid amount was US$285 million, and the auction raised US$855 million in total. 5 bidders pre-qualified, 3 companies were successful, and licences were issued to: 1. Econet Wireless Nigeria Ltd 2. MTN Nigeria Communications Ltd 3. Communication Investments Ltd (CIL)[26]

[22] According to the Global System for Mobile Communications Association (GSMA), GSM is an open, digital cellular technology used for transmitting mobile voice and data services.
[23] About 100 licenses in total were issued covering VSAT, cellular, fixed wireless, paging and other services by 1999.
[24] None of the licensees were able to launch operations due to inability to secure interconnectivity with NITEL, Nigeria's sole national gateway carrier.
[25] NITEL was excluded from the bid process but was allocated a GSM licence and paid the licence fee arising from the auction.
[26] The unsuccessful bidders include MSI-Celtel Nigeria Ltd. and United Networks Mobile Ltd.

	DATE	EVENT
8.	**2001**	CIL Licence revoked[27].
9.	**2002**	NCC grants 24 fixed wireless licences to private operators.
10.	**2002**	South Atlantic Telecommunications cable no.3/West African Submarine Cable/ South Africa Far East (SAT3/WASC/SAFE)[28] was launched[29].
11.	**2002**	Globacom awarded second national operator licence.
12.	**2003**	Revoked CIL GSM licence awarded to Globacom, a Nigerian-owned telecommunications company.
13.	**2007**	NCC introduces the Unified Access Service Licence (UASL)[30]and grants a licence to Emerging Markets Telecommunication Services Limited (EMTS) also known as Etisalat.
14.	**2007**	3G Mobile licences granted to Celtel (operating the license formerly awarded to Econet Wireless), MTN, Globacom and Alheri Mobile Services[31].
15.	**2007**	The Nigeria Internet Exchange Point (IXPN) created to connect Internet Service Providers (ISPs) and reduce connectivity costs.
16.	**2007**	NCC awards 800 MHz spectrum licence[32] to Visafone.
17.	**2009**	NCC awards 2.3 GHz spectrum licences to Spectranet and Mobitel and UASL and 850 MHz spectrum licence to Smile Communications.

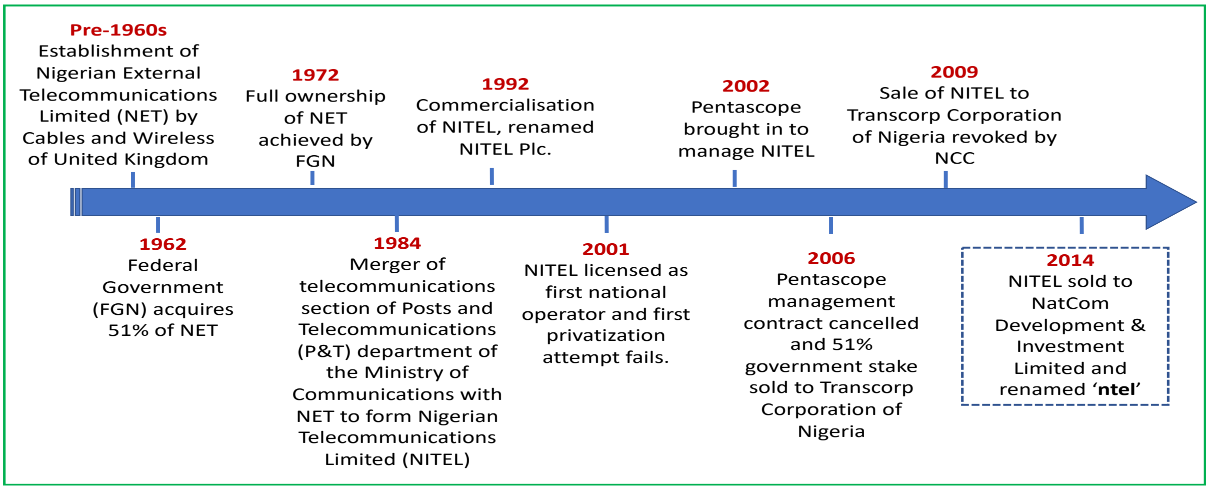
[27] CIL, though successful, was unable to pay the license fee by the stipulated date due to controversies on existing litigation on the spectrum it was awarded. Its license was revoked in March 2001.
[28] SAT3/WASC/SAFE is a submarine cable laid on the ocean bed which links Europe with Africa and facilitates telecommunications connectivity.
[29] NITEL has an equity stake as part of the 36-nation consortium which owns the cable.
[30] The UASL was introduced following the expiration of the five-year exclusivity period given to digital mobile operators. It was an upgrade to the GSM license and covers a range of services that include: Fixed telephony (wired or wireless); Digital mobile services; International gateway services; National long-distance services; and Regional long-distance services.
[31] Alheri Mobile Services was a subsidiary of Dangote Industries Limited. It was subsequently acquired by Etisalat in 2010 in order to gain access to its 3G mobile licence. Dangote Industries set up Dancom, a subsidiary providing in-house IT services to replace Alheri.
[32] Wireless broadband services can be provided on the 800-megahertz, 850 megahertz and 2.3 gigahertz frequency bands.

	DATE	EVENT
18.	**2009**	Glo-1 submarine cable, owned by Globacom, lands in Nigeria[33].
19.	**2010**	MainOne submarine cable lands in Lagos[34]
20.	**2014**	NCC awards 2.3 GHz spectrum licence to Bitflux Communications.

Sources: (Afeikhena, 2002; Doyle & McShane, 2003; Olutayo & Omobowale, 2011; Orji, 2018)

Figure 4.8 traces the path from the creation of NITEL to its eventual privatisation in 2014. This is critical as the fortunes of NITEL have impacted the sector significantly and affected the trajectory of private operators. As an example, NITEL's intransigence with respect to providing gateway access to private operators, the poor service and high costs associated with its services, including the SAT3/WASC/SAFE submarine cable; inadvertently created competition, the lowering of costs and stimulated innovation in the sector.

Figure 4.8: Timeline of NITEL's Existence: From Creation to Privatisation



Sources Author's illustration based on multiple sources[35]

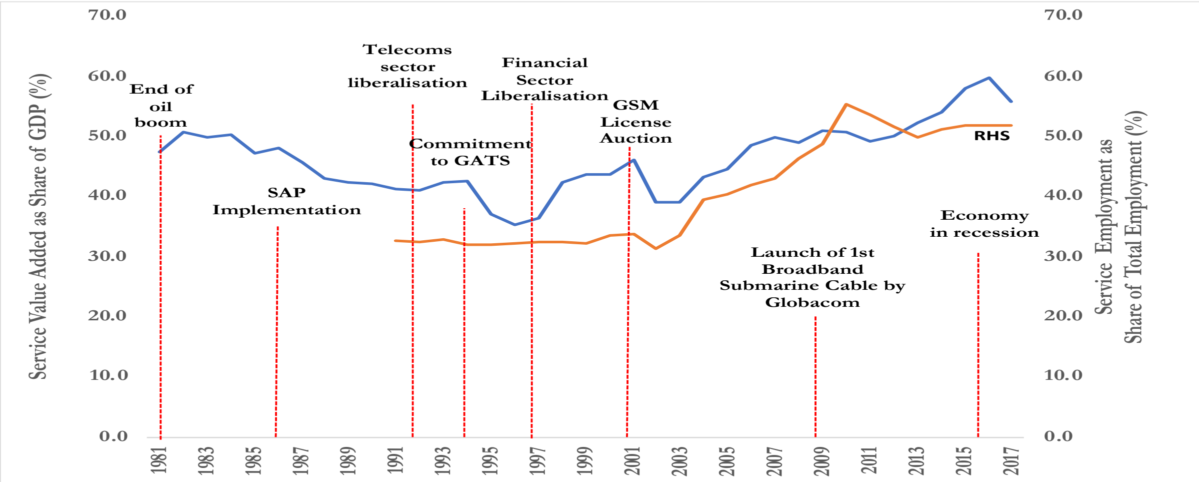
These milestones in the development of the telecommunications sector, side by side with the liberalisation of the service sector more broadly were instrumental to the rapid growth of the service sector. Figure 4.9 is an attempt to juxtapose these milestones against movements in key

[33] The cable runs between the UK and Africa with several landing points.
[34] The cable runs between Portugal and South Africa with several landing points and was owned by Main Street Technologies, a Nigerian broadband infrastructure company, which was recently acquired by Equinix, a US MNC specialising in data centres, in a deal worth US$320 million.

[35] (Afeikhena, 2002; Olutayo & Omobowale, 2011)

indicators of tertiarisation, namely services value added as a share of GDP and service employment as a share of total employment. Growth in both variables coincides with the liberalisation of services in Nigeria; however, this growth cannot be causally linked with the expansion of the IT sector.

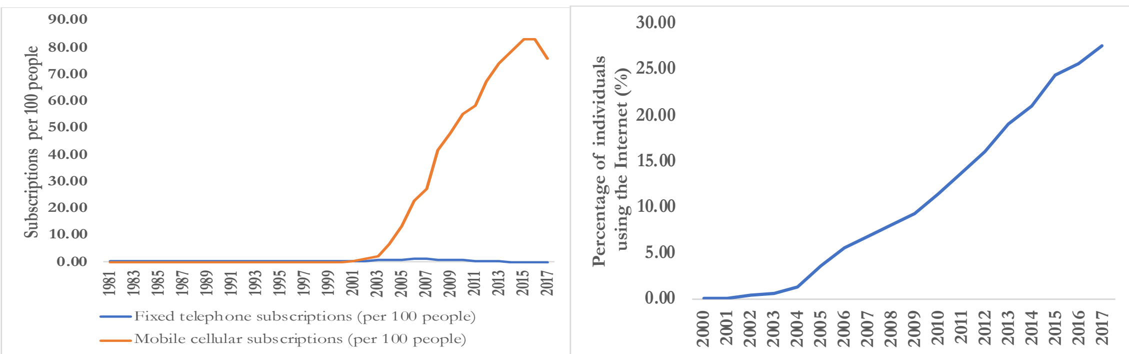
Figure 4.9: Trends in Service Sector in Nigeria (1981-2017)



Source: Author's illustration

Trends in telecommunications usage indicate a sharp rise in the number of subscribers following the auction of GSM licences. Fixed and mobile line subscriptions as well as internet use by individuals has been on an upward trend as shown in Figure 4.10. Anecdotal evidence suggests that there has been a sharp drop in prices over the years and this is an indication of increased competition with the entry of new firms into the sectors.

Figure 4.10: Growth in internet use and cellular and fixed line subscriptions in Nigeria



Source: International Telecommunications Union (ITU)

In summary, the underlying factors that led to the growth of the IT sector in Nigeria align with the review of literature on the pre-industrial deindustrialisation context presented prior. The impact of IFI-led policy reforms was the initial driving force for the entry of domestic and foreign operators into the industry. The actions taken by government, especially the telecommunications regulator in many cases set the tone for the sector's trajectory. These findings will be complemented by case studies of firms that emerged at specific points in the timeline of the industry's growth in the next section; however, prior to the introduction of the case studies, it is important to give an overview of the survey completed to identify the firms to be assessed in the case studies.

4.7. Overview of Survey of IT Firms in Lagos

The Nigerian Exchange (NGX), following its demutualisation by which it transitioned from a non-profit making, mutually owned entity to a profit-making investor-owned company, has only 156 listed companies (The Cable, 2021). Of this total number, only 9 IT companies are listed. For a country of Nigeria's size, this is a very small number of companies raising capital through the stock market. The implication of this is that most of the IT firms in Nigeria are private limited companies, and so very few IT companies are legally required to make public their financials and any other information related to their business. The research output on the IT sector in Nigeria is also very limited, doubtless constrained by this lack of information, and so secondary sources of data are difficult to find. Some of these challenges were anticipated going into this research but the intention was to gather data that could be used to identify a sample of firms from industry associations, industry regulators, the statistical agency, NBS, or any other government agencies. Unfortunately, none of these efforts yielded good results.

Efforts to collate data for firm identification during fieldwork included approaching the FIRS for a classification of IT firms on the basis of their tax payments; querying the directory of IT firms on the NCC website to classify firms, approaching industry organisations for data on their members and also scanning for information on the website of the Nigerian Exchange (NGX). Unfortunately, none of these efforts were successful. The FIRS declined to release information due to confidentiality issues, and the directory of IT firms on the NCC database was biased towards the telecommunications sector and included no information by which the firms could be classified. The directories of industry organisations also had no distinguishing metrics which could be applied to classify firms. This data constraint placed limits on the identification and selection of appropriate firms for the case studies as it was difficult to identify a suitable metric for classifying and selecting firms.

For this reason, the decision was taken to conduct a survey of IT firms in Lagos, posing questions on their ownership structure, sources of financing, linkages to other sectors, innovation processes, and capabilities, all of which are of interest for the case studies. The type of firm of interest for this study would be a 'leading firm' in its area of operation, which displays innovation capabilities. Questions were included in the survey asking the firms to identify the leading firms in their sector and with this, it was possible to collate the answers to get a sense of the top firms in the various areas of specialisation. To identify the firms to complete the survey, a snowballing technique was adopted, starting with firms listed in the Information Communication Technology for Development (ICT4D) Strategic Action Plan Implementation Status and Update report produced by the Nigerian Information Technology Development Agency (NITDA) in 2017. Industry leaders, entrepreneurs and analysts in the sector as well as IT industry reports and blogs were also consulted in compiling a list of over 100 potential firms.

Contact persons identified in each of these firms via phone calls, emails, and Linkedin messages were invited to participate in the survey and these persons helped to establish contact with additional firms. Unfortunately, none of the three GSM firms in the industry, which represent the bulk of the activity in the sector given their role in building out much of the infrastructure on which the sector runs, consented to completing the survey and participate in the case studies. Of the 53 firms successfully contacted, 40 completed the survey, a 75.4% response rate. The firms selected for the survey are listed in Table 4.6. The questionnaire of 45 questions with sub-sections, is in Appendix 9.2.3; however, the key sections of the survey are reproduced as follows:

1. **Introduction** – personal introduction, purpose of survey, confidentiality issues
2. **General Information** – company name, contact information, respondent information
3. **Legal and Financial Information** – ownership structure, sources of financing, markets served, sales & turnover
4. **Company Capabilities** – skill level & distribution
5. **Product, Process & Innovation** – top products & services, benchmark with peers
6. **Linkages** – forward & backward, fiscal, financial and technological

The survey was presented to the firms in an electronic format, using the Smart Survey software application. A pilot survey of three firms was conducted to ascertain the ease of completion of the survey, if the respondents interpreted the questions correctly and if the questions were appropriate for the firms being surveyed. The questionnaire was revised based on the response to the pilot survey.

Each respondent was sent a link to the e-survey by email, text message or WhatsApp messaging. In two cases, the answers to the questions were collated via phone and later uploaded to the online survey web page. Obtaining responses from the 40 firms surveyed required many follow up emails and phone calls over several weeks. In several cases, the questions to the survey were not answered by the respondents either due to lack of information or a reluctance to share what is considered proprietary information. Despite the challenges associated with the completion of the survey, useful information was collected which enabled the identification of case study subjects for this and the subsequent chapter. It must be noted that in some cases, the most appropriate respondent was not selected as a case study subject as some firm representatives indicated a reluctance to be studied in such detail and others were unavailable for an in-depth interview. This was a challenge that affected confirming the representativeness of the selected firms for their specific areas of specialisation in IT; however, each of the cases selected provide useful information on the operations within their sectors. Also, efforts were made to cross-reference the survey responses with publicly available information. In the next few sections, a statistical analysis of the case study reports is presented.

Table 4.6: List of IT Firms Surveyed[36]

	Business Name	Head Office Address	Company Website URL (if any)	Name of Respondent	
1	Farmcrowdy Limited	Plot 5A, Block 114, Akiogun Street (Oniru Market Road), Oniru, Lekki Phase 1, Lagos, Nigeria	https://www.farmcrowdy.com/	Onyeka	Akumah
2	Konga Online Shopping Mall	1, Redemption crescent, UPS Bus stop, Gbagada, Lagos	https://www.konga.com	Akinboyewa	Akindolani
3	ConSol Limited	ConSol House, Plot C Block 2 ConSol Close, Ilupeju Industrial Estate, Oshodi Lagos, Nigeria	www.consollimited.com	Oladamoye	Oyesiku
4	Tenece Professional Services Ltd	Lagos	www.tenece.com	Emmanuel	Madubuike
5	Flutterwave Technology solutions	Plot 8 The Providence Street, lekki, Phase 1 Lagos	www.flutterwave.com	Oluwadamisi	Busari
6	UnoTelos Limited	Plot 11 Block 29 Mayaki Usman Street	https://unotelos.com	Jude	Egbokwu
7	Whogohost Limited	3A, Olumuyiwa Street off Oba Babington Ashaye Crescent Omole Phase 1, Ikeja	www.whogohost.com	Omotola	Adeyina
8	Rack Centre Limited	Jagal Close Oregun Ikeja	www.rack-centre.com	Ayotunde	Coker
9	Avanti Satellite Communications Services Limited	7th Floor Mulliner Towers Alfred Rewane Ikoyi Lagos	www,avantiplc.com	Jane	Egerton-Idehen
10	Descasio Limited	87 Allen Avenue	www.descasio.com	Tobi	Adenuga
11	Finn Labs Limited	1b Raymond Duru Crescent, Sunshine Garden State, Lekki -Epe Expressway, Lagos	www.nestbank.ng	Dolapo	Sanusi-Ola
12	Heckerbella	9th Floor, Ibukun House, 70 Adetokunbo Ademola Street, VI	www.heckerbella.com	Olayemi	Keri
13	Tranzelu Technology Limited	34 Mcneil road, Yaba, Lagos, Nigeria	www.beatdrone.co	Confidence	Odionye
14	High Tech Synergy	1D Aderibigbe Shitta Street Maryland ikeja	Www.hts.com.ng	Akinpelumi	Adeniran
15	iTECO Nigeria Limited	242, Kofo Abayomi Street, Victoria Island, Lagos, Nigeria	www.telnetng.com	Folorunso	Aliu
16	Mall for Africa	Lagos, Nigeria	www.Mallforafrica.com	Tope	Folayan
17	Mines.io	-	www.mines.io	Adia	Sowho
18	Enterprise Wallet Payments Limited	6, 1B, Mobolaji Johnson, Lekki	www.wallet.ng	Yvonne-Faith	Elaihwu
19	Cotta & Cush Limited	109 Awolowo Road, Ikoyi, Lagos	www.cottacush.com	Olatokunbo	Fagbamigbe
20	ElePhab Co	Plot A, Block 3, Apapa-Oshodi expressway, Ilupeju, Lagos.	www.elephab.co	Anjola	Badaru
21	ChamsSwitch Limited	No. 8, Louis Solomon Close Off Ahmadu Bello Way Victoria Island Lagos	www.chamswitch.com	David	Iwuchukwu
22	MainOne Cable Company Nigeria Limited	3B, Fabac close, Ligali Ayorinde street, Victoria Island, Lagos.	www.mainone.net	Adekunle	Anjorin
23	Paga	176 Herbert Macaulay Way Yaba	www.mypaga.com	Bolaji	Iwayemi
24	Wizer Consulting Services LLP	78B Lafiaji Way, Dolphin Estate, Ikoyi	www.wizerconsulting.com	Lanre	Akinbo
25	Systemspecs Nigeria Limted	4th-8th Floor, 136 Lewis Street, Lagos, Nigeria.	http://www.systemspecs.com.ng	Iyare	Diagboya
26	Sophia ERP Limited	19 Sinari Daranijo Street Victoria Island	www.sophiaerp.com	Conrad	Adigwe
27	Resourcery PLC	18 Adeola Hopewell Street Victoria Island Lagos	www.resourcery.com	Olugbenga	Adanlawo
28	Dancom Technologies Limited	Union Marble House 1 Alfred Rewani Street LAGOS Nigeria	https://dancom.tech	Prasanna	Buri
29	Paystack Payments Limited	3A Ladoke Akintola, GRA Ikeja, Lagos	www.paystack.com	Charles	Idem
30	Stampar3D Ltd	Ogunye Zone, Magodo, Lagos	www.stampar3d.com	Akinwole	Akinpelu
31	Tizetii	Suite C7, God is Able Plaza, 24 Road, Festac Town, Lagos, Nigeria	https://www.tizeti.com	Kendall	Ananyi
32	Netcom Africa Limited	1 Adeola Odeku Street, 6th Floor SAPETRO Tower, Victoria Island	www.netcomafrica.com	Moses	Ayokunle
33	QSHIP	admiral oduwaye street, omole phase 2, ikeja, lagos	www.qship.ng	Oludare	Dipe
34	ikOOba Technologies	No 16 Ishawu Adewale Street, Surulere, Lagos	www.ikooba.com	Sam	Afemikhe
35	Coregrade Solutions Ltd	127 Obafemi Awolowo Way Ikeja Lagos	www.coregradesolutions.com	Deji	Kuye
36	Manqala Ltd	1st Floor, Dulux Building, KM 18 Lekki-Ajah Expressway, Lagos. Nigeria	www.manqala.com	Chude	Osiegbu
37	MAX.ng	25B, Bisola Durosinmi Etti, Lekki Phase 1. Lagos	www.max.ng	David	Idunnuoluwa
38	SoftBase Nigeria	Surulere, Lagos	www.softbaseng.com	Udochukwu	Nwaogbo
39	Digital Pulse Technologies Limited	12 Abiodun Oshowole close, Opp. Calaba kitchen, Ikeja	www.digitalpulse.ng	Ibrahim	Tijani
40	Interswitch	Plot 1648C, Oko-Awo Close,Victoria Island Lagos Nigeria	https://www.interswitchgroup.com	Emmanuel	Nwalor Jnr.

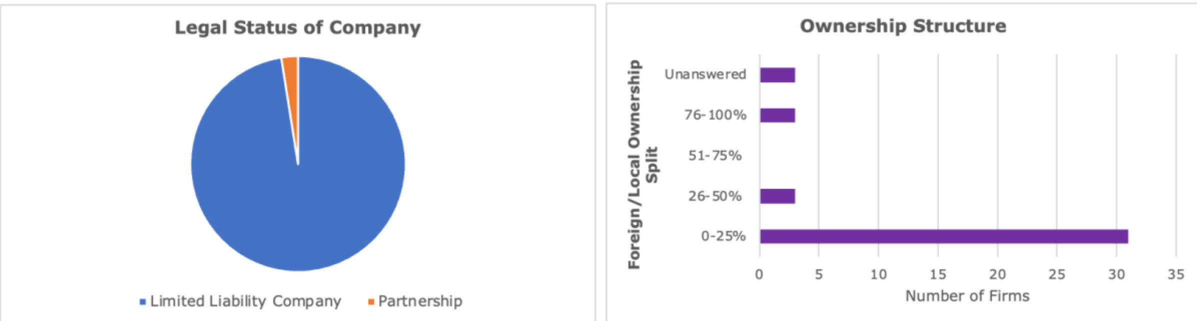
[36] Given the rapid rate of change in the sector, please note that some of the listed firms are no longer in existence, while others have been absorbed into other firms, changed their line of business or undergone a name change.

4.7.1. Legal and Operational Structure of the Surveyed Firms

Most of the firms surveyed were limited liability companies under sole ownership with very few operating legally as partnerships. In addition, majority of the firms are owned by Nigerians with more than 78% of firms surveyed confirming this in their response. It should be noted that subsequent to the completion of the survey, the positions of some of the firms in terms of ownership structure and legal structure changed: Paystack was acquired by Stripe, a global fintech firm (TechCrunch, 2021) for US$200 million while MainOne Cable company was also acquired in a US$320 million deal by Equinix, a US MNC in the data centre and infrastructure sector. Visa also reportedly took a US$200 million stake in Interswitch leading to its US$1 billion valuation (Quartz Africa, 2019).

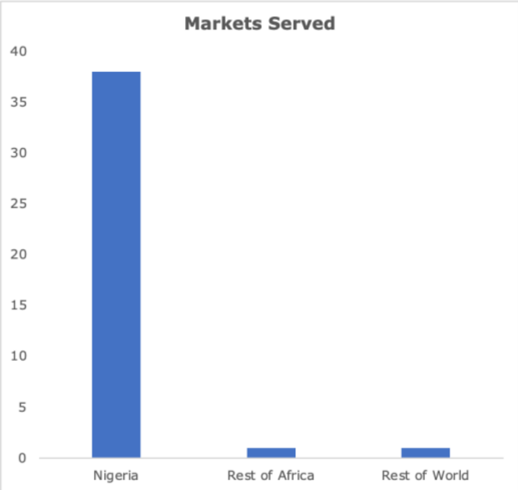
The legal status and ownership structure of the firms surveyed, though not representative of the entire industry give an indication of the structure of the dynamic mid to small sized firms operating in the industry. The rapid change in some of the firms within a few years is also indicative of the dynamic and potential of the sector to grow into larger operations with continental and in some cases, global scope.

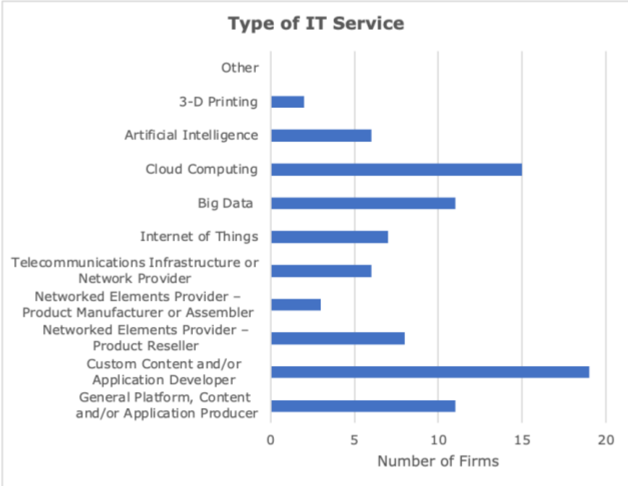
Figure 4.11 Legal Status and Ownership Structure of Surveyed Firms



For most of the firms, the scope of market operations was limited to the Nigerian market with only 1 firm reaching beyond Nigeria to the rest of Africa and the World. As mentioned previously, this has changed since the time of the survey as more of the IT firms in the fintech space attract international interest. As posited previously, the shape of IT firms in Nigeria has mirrored the shape of the Nigerian economy where the firms struggle to provide services to oil and gas firms due to the multinational structure, have little scope for engagement with the small manufacturing sector but have opportunities in services, particularly financial services, which is a sector mostly owned by Nigerians. Of the firms surveyed, 40% of them classify themselves as fintech and given that financial transactions underlie every area of business and personal lives, and access to finance is a perennial problem yet to be fully addressed, investing in fintech is considered a safe bet by many foreign investors.

Figure 4.12: Markets Served and Types of IT Services





The response to the question of the types of IT services provided by the firms was distributed across a broad spectrum of sub-sectors with custom content and application creation and cloud computing as main areas of specialisation. As expected, 3-D printing and the provision of networked elements, either as a product manufacturer or assembler were less popular, with only 2 and 3 firms respectively confirming operations in these areas. This is not surprising given the underdeveloped Nigerian manufacturing sector and the difficulty in developing linkages with the existing sector. An examination of the financial structure of the firms also contributes to this analysis.

4.7.2. Financial Operations of Surveyed Firms

The questions related to finance were some of the most difficult to structure. From the pilot survey, it became apparent that IT firms in Lagos were not keen to share information on their financials. As many of these firms are privately owned, they are not required to share this information. Thus, the solution was to create broadly defined categories for annual turnover which of course impacted the preciseness of the collected information. The financing structure of the surveyed companies is very informative with domestic equity and personal savings representing about a third of financing for most of the firms. The weight given to domestic equity is surprising as foreign equity contributions tend to make news headlines while information on domestic equity is muted. With the limited information sharing by firms in the sector it is a bit difficult to triangulate financial data.

The distribution of firms in terms of annual turnover is quite spread out. It should be noted that the cut off points were originally in Naira but converted to the US Dollar at a rate of $1 to ₦411. Four firms reported turnover above US$140 million, with another 2 firms in the US$31 million to US$ 140 million range. The majority of the firms lie in the middle of the distribution, but 9 firms have annual turnover of between US$3,000 to US$140,000. The responses signal the diverse nature of the firms surveyed but unfortunately, the range of categories makes a granular level of analysis difficult.

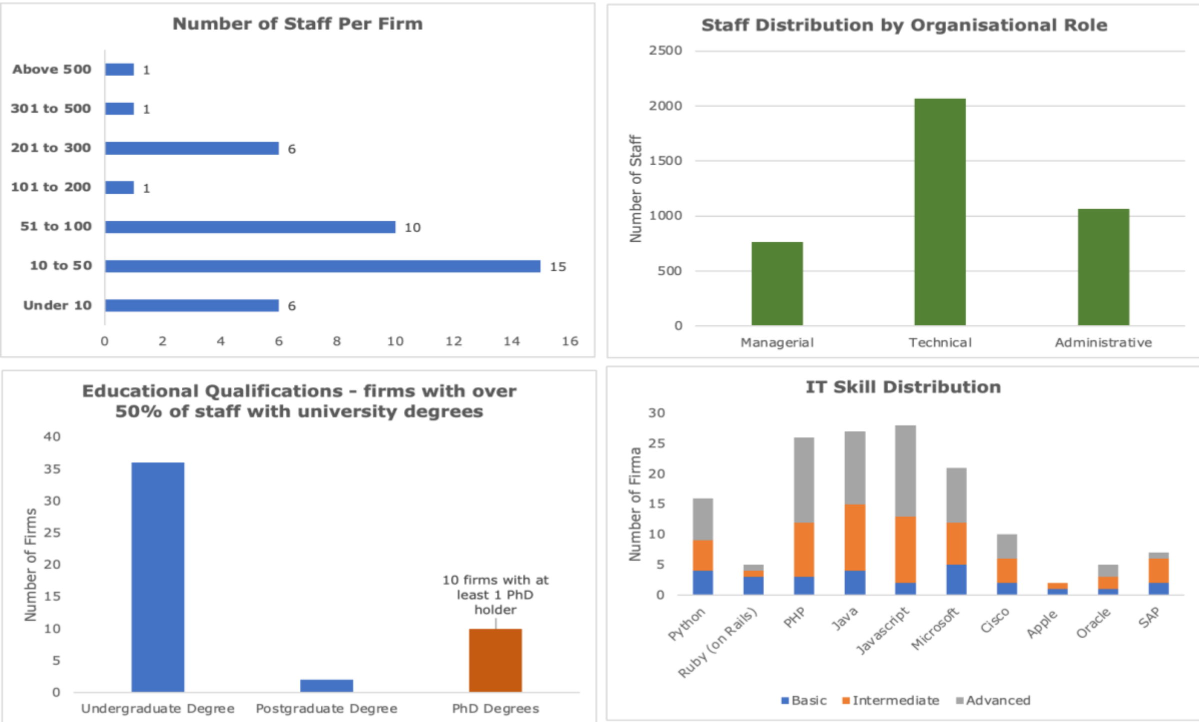
Figure 4.13: Financial Information of Firms

4.7.3. Firm Capabilities

Regarding capabilities, the focus in the questionnaire was on the educational qualifications and the IT skills of the staff in each of the firms. As a starting point, based on the definitions of the Bank of Industry (BOI) in Nigeria, 6 of the surveyed firms are micro, 15 are small-sized firms, 11 are medium firms while 8 firms are large-sized firms. Once again, this points to the diversity in the firms selected. In most of the firms, technical staff dominate other staff categories, which is expected of technology-oriented firms. 36 of the 40 firms surveyed have at least 50% of their staff holding undergraduate university degrees. Ten of the firms have PhD holders on staff. This points to the high skill level of workers in the IT sector, unlike the manufacturing industry where workers on assembly lines might have only primary school qualifications. In a country like Nigeria with a large unskilled and unemployed population, it is not clear IT can create the jobs needed for this population segment.

The high skill level required is also reflected in the specialised skills of staff in the sector. The respondents to the questionnaire indicated that the majority of the staff in their firms possess intermediate to advanced skills in the core programming languages and database development skills in the industry. Java and Javascript were the most popular skills reported and this is not surprising as they are the core languages required for the development of web-based applications. Although computer programming is a relatively advanced skill, these skills can be acquired without a university degree or even training in a formal school as they can be learned through free or paid online courses on the internet. This is important for a country like Nigeria where many people do not have access to formal education as Nigeria has the highest number of out of school children with one in five children out of school(UNICEF, 2022). Yet, it still does not address the large proportion of Nigerians without a primary school education that would signal an ability to read, write and perform simple arithmetic.

Figure 4.14: Skills and Educational Qualifications in Firms



4.7.4. Product and Process Innovation

The data provided in this section on product and process innovation will be reviewed in depth the case studies in the latter part of this Chapter and in Chapters 5 and 6. The main findings from this part of the questionnaire are that most of the firms with bespoke products derive the bulk of their expenditures from a few of those products; only 12 firms hold or are in the process of acquiring International Organisation for Standardisation (ISO) certifications and two of the firms hold patents. This result is not surprising as many of the firms utilise and adapt already existing programming languages and platforms to run their products. As expected, online searches were the most common source for keeping updated on developments in their sectors while collaboration with research institutes is the least popular. Given the underdeveloped research and development ecosystem in Nigeria and other pre-industrial countries this is an expected outcome.

4.7.5. Linkages

The questions in this section sought to uncover the types of production, fiscal, consumption, financial, and technological linkages which emanate from the 40 firms surveyed. To give information on production linkages, the firms were asked which percentage of their company's sales were purchased by companies or clients in the other economic sectors in the first three years of operation and in the last financial year. The defined sectors were derived from the System of National Accounts (SNA) 2008 adopted in Nigeria. Reviewing the number of firms with over 30 percent of total sales from a particular sector, the main finding was that majority of the linkages were to service firms with 40 firms reporting linkages to service firms. 3 firms had linkages to the agriculture sector, 11 to industry, of which 5 were to manufacturing firms.

This supports the hypothesis that IT firms in the pre-industrial context are 'servicing other services' and not the manufacturing sector as found in advanced industrial countries where externalisation is a driver of tertiarisation. Additional questions related to backward linkages were explored in the case studies. From Table 4.7, we can see that the linkages are strongest to telecommunications firms with 13 firms reporting linkages, followed by 10 firms reporting financial service linkages.

In terms of technological linkages, 20 out of 40 firms had technical partnerships with local firms with the partnerships taking the form of either co-provision of services or infrastructure provision. 21 out of 40 firms reported technical partnerships with foreign firms, mostly with the firms acting as resellers of hardware or software from foreign firms. There is considerable overlap between both groups as firms with no local partnerships tend to have no foreign partnerships. The firms reported very few linkages to research institutes, local or foreign.

In terms of financial linkages, hubs, incubators or accelerators were not important sources of financial or other types of assistance. As stated previously, this might have changed considerably since the research was conducted given the rapid evolution of the sector. Only 2 firms received incentives, subsidies or waivers from government agencies and 4 firms received assistance in the form of subsidies, waivers or grants/transfers from foreign governments or companies. This last question sheds some light on the weakness of fiscal and consumption linkages. The analysis of linkages presented here are very rudimentary as the nature of linkages will be further developed in Chapters 5 and 6 of this thesis.

4.7.6. Summary

Although the intent of this survey was to develop a means of identifying the firms to be profiled in the case studies that form the core of this thesis, the information gleaned from the survey contributes immensely to answering the research question on whether services can be a driver of economic growth. From the results presented, it can be seen that the selection of firms was diverse with different-sized firms included. The key findings from the survey show that most of the firms are limited liability companies which depend on domestically sourced funds. Firm capabilities are reliant on foreign technologies, although many firms are adapting these technologies to create innovative products. The review of the survey shows that linkages to the manufacturing sector are weak and many IT firms in Lagos, Nigeria, are servicing other service firms. The question of linkages and capabilities were also explored and form the foundation for the case study discussion in Chapters 5 and 6 of this thesis.

Table 4.7: Firms with production linkages to economic sectors (over 30% of total sales)

	Economic Activity	No. of Firms
1	Crop Production	2
2	Livestock	1
3	Forestry	0
4	Fishing	0
5	Crude Petroleum & Natural Gas	4
6	Metal Ores, Coal Mining, Quarrying and Other Minerals	0
7	Oil Refining	1
8	Cement	1
9	Food, Beverage and Tobacco Manufacturing	0
10	Textile, Apparel and Footwear Manufacturing	1
11	Wood and Wood Products Manufacturing	1
12	Pulp, Paper and Paper Products Manufacturing	0
13	Chemical, Chemical Products and Pharmaceutical Products Manufacturing	0
14	Plastic and Rubber Products Manufacturing	0
15	Electrical and Electronics Manufacturing	2
16	Basic Metal, Iron and Steel Manufacturing	0
17	Motor Vehicles Manufacturing or Assembly	0
18	Non-Metallics Products Manufacturing	1
19	Utilities - Electricity, Water Supply or Waste Management	0
20	Construction	0
21	Trade	4
22	Telecommunications, Computer Programming & Consultancy and Information Services	13
23	Publishing, TV, Motion Picture, TV, Radio Production, Programming and Broadcasting	0
24	Transport	4
25	Finance	10
26	Insurance	1
27	Real Estate	1
28	Legal activities	0
29	Professional, Scientific & Technical Activities	0
30	Administration and Support Activities	0
31	Education, Human, Health and Social Activities	3
32	Government/Public Sector	4

4.8. Firm-Level Case Studies

The discussion in this chapter thus far has shown there are differentiated drivers which influence the emergence of services in different industrialisation contexts. This has been demonstrated through a review of the literature on deindustrialisation and tertiarization and a historical review of the emergence of the IT sector in Nigeria. A review of the trajectory of the sector indicates three specific episodes instrumental to the sector's development:

1) Telecommunications sector liberalisation: 1992

2) GSM Licence Auction: 2001

3) Landing of 1st broadband submarine cable in Nigeria 2009

To supplement these meso-level studies of the emergence of services, case studies of IT firms which emerged at each of these three junctures will be presented in this section and contribute to answering the question of where services come from in the pre-industrial context. The cases were selected based on their responses to the survey and the availability of the respondents for interviews. The information presented in these case studies were obtained via phone interviews with the Managing Director/Chief Executive Officers of iTECO Limited, a subsidiary of Telnet Nigeria, Mr. Folorunsho Aliu; Pelumi Adeniran the Chief Executive Officer (CEO) of High-Tech Synergy Limited and Olatokunbo Fagbamigbe, the CEO of Cotta and Cush. Each interviewee was asked the same questions using a questionnaire (Appendix 9.2.4). This was supplemented with information from the survey which all three firms completed, and secondary data available on the internet.

4.8.1. Telnet Group: Impact of Telecommunications Sector Liberalisation

a. Background Story of Telnet

The narrative on the emergence of Nigeria's IT sector is incomplete without the inclusion of the story of the Telnet Group. This claim could easily be dismissed as hyperbole; however, it holds true in this case. Telnet was an early pioneer in the IT space and although it has since lost its prime position as a first mover and innovator in the sector, it has outlasted many of its competitors and still retains a relevant position in the industry.

Telnet was founded in 1986 by Dr. Burian Carew and Dr. Nadu Denloye, both electrical engineers with PhDs from McGill University in Canada and the University of Hull in the United Kingdom respectively. Both co-founders returned to Nigeria in the 1980s and met while employed at T-CAS, an engineering consultancy in Lagos. The initial motivation for the establishment of Telnet was to fill the gap left by multi-national companies in the telecommunications sector leaving a sector marked by mounting debts and poor management.

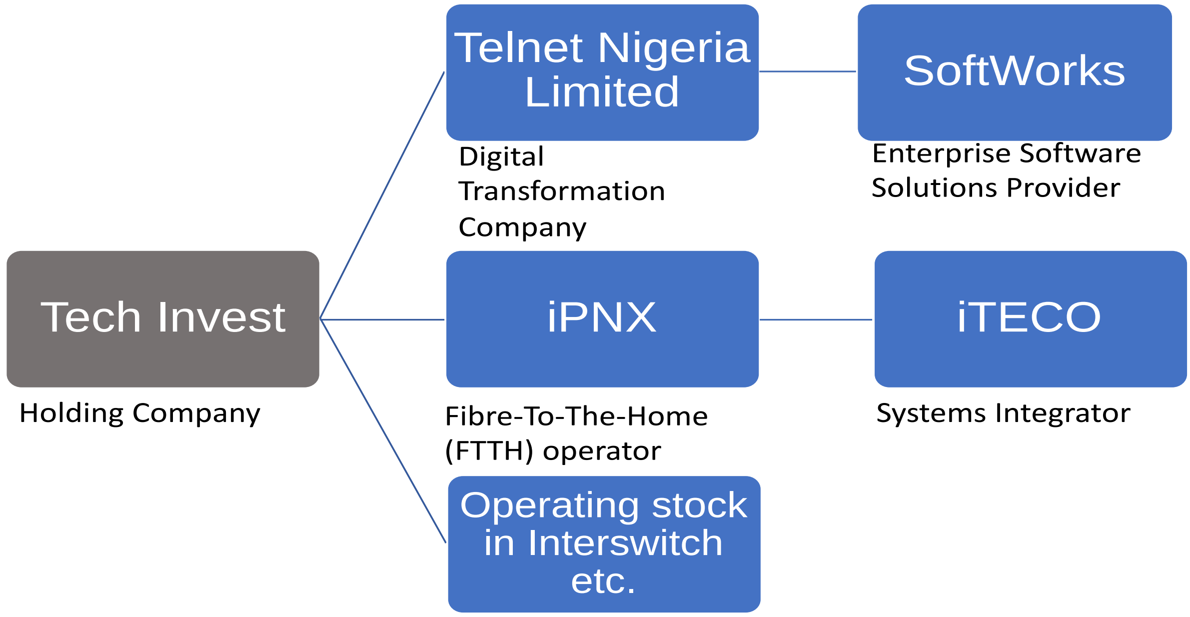
According to Mr. Folorunso Alliu, the Group Managing Director (GMD) of the Telnet Group, in its initial years of operation it was difficult for Telnet to acquire clients; however, paradoxically, an opportunity was created when a foreign telecommunications firm entered the Nigerian market and sought a local firm to provide infrastructure services. In addition, Telnet took advantage of latent demand for telephony services as only 0.25 fixed telephone subscriptions per 100 people were available in Nigeria at the time. As referenced in the historical account of the growth of the IT sector in Nigeria, the poor services offered by NITEL, the government-owned operator with a monopoly of the market meant that new entrants into the telecommunications space had a large, willing clientele eager for improved services. Yet, Telnet struggled to acquire clients, most likely due to its being owned by Nigerian locals. It was only able to penetrate the market effectively when it partnered with a foreign telecommunications firm. This implies a lack of trust of 'locally owned' telecommunications firms at the time given their bad experience with NITEL, the country's flagship operator. This lack of trust dissipated over time as more indigenous firms entered the space and earned the trust of consumers based on the quality of service provided.

b. The Growth of the Telnet Brand

The Telnet brand expanded to take advantage of business opportunities arising in the IT space in Nigeria. A business development group was created to drive the creation of new subsidiaries and spin-off companies. Telnet introduced leased lines into the Nigerian telecommunications market. These were dedicated point-to-point telecommunications connections capable of carrying data and voice traffic and run on existing NITEL infrastructure. The leased line solution was marketed to firms in the financial services and oil and gas sectors to facilitate communications between headquarters and branches. Firms like Telnet were able to capture a large clientele by using the existing infrastructure built by NITEL to offer to their clientele telecommunications services which were not necessarily the most efficient or the most advanced technologies in the world at the time. Leased lines were 1970s technologies but given the limited infrastructure present in Nigeria at the time, it was a cheap solution for firms seeking to connect their locations over dedicated lines compared to VSAT technology, the only other alternative in Nigeria at the time.

Telnet, through its first subsidiary, Telnet Network Services (TNS), also pioneered the use of modems and multiplexers to carry multiple data streams over a single cable and was one of the first firms in Nigeria to introduce protocols such as Digital Equipment Corporation NETwork (DecNET), Attached Resource Computer NETwork (ArcNET) as well as technologies such as ethernet networks and star network cabling to connect Local Area Networks (LANs), and Very Small Aperture Terminal (VSAT) technologies to connect Wide Area Networks (WANs). Although these were technologies already in wide usage in more advanced countries, the process of implementing them locally was not trivial for Telnet and its peers in the industry. These technologies were adapted to a local market still running on legacy infrastructure from NITEL and in a country with persistent power outages and limited human capital to deploy the technology. A lot of learning-by-doing and learning-by-using was taking place as these technologies were being deployed.

Figure 4.15: Structure of Tech Invest Holding Company



Source: Telnet Website

To forestall unnecessary network downtime, Telnet pioneered the use of the star network cabling system to connect network devices to a central switch in a daisy chain configuration rather than end-to-end connections which was the norm at the time. Telnet was also responsible for deploying the first network infrastructure for most of the banks in Nigeria, mainly using local talent and ingenuity and depending on support from the suppliers of many of its equipment. Building on its success and in recognition of the rising demand for data services in Nigeria, a subsidiary company, ITECO Nigeria Limited was established to provide data and other enterprise services (routing, switching, security etc.). Telnet partnered with global MNCs such as Cisco, serving as its first domestic partner, and facilitated its entry into Nigeria. Wale Adetugbo, the Group Executive Director of Telnet Nigeria was the first Cisco Certified Internetwork Expert (CCIE) in Sub Saharan Africa. Although Telnet was not bringing 'new products to market' it was innovating by introducing new technologies to the Nigerian consumers and acquiring knowledge on how best to deploy these technologies to suit the business and infrastructure landscape in the country.

While developing competency in network infrastructure installation, the opportunity to enter into the software market by providing solutions powered by the infrastructure being provided by

Telnet, was identified. This led to the establishment of a new subsidiary, Softworks, in the late 1990s. In many ways, the growth of Telnet was opportunistic as the firm identified other client needs in the process of deploying its solutions and was quick to capitalise on this knowledge by quickly building new units within the firms to respond to these needs. Most of its staff learned on the job as the talent pool for local IT knowledge was only being developed at the time. Softworks which initially provided end-to-end services which include the procurement and installation of hardware and software, subsequently narrowed to a focus on provision of server infrastructure and eventually expanded to data centre infrastructure services. These changes in the service offering by Softworks and other future subsidiaries and spin-offs of Telnet were an adaptation to the evolving needs in the IT landscape in Nigeria.

The potential for creation of a payment solution was proposed by the business development group at Telnet. An opportunity for payment switching was identified by the Mitchell Elegbe-led business development group in the firm and in conjunction with input from management consultants at Accenture Nigeria, Interswitch Nigeria Limited was created in 2002. This was an important turning point for Telnet in Nigeria as it marked a change in the Nigerian banking landscape by building interconnectivity between banks and setting the stage for the development of the Fintech sector in Nigeria. Interswitch was set up as the first large-scale transaction switching and electronic payment company, connecting the Deposit Money Banks (DMBs) or commercial banks in Nigeria.

Previous attempts to build transaction switching infrastructure in Nigeria were not as successful and only resulted in limited coverage and use of the card products deployed. By backing Mitchell Elegbe in the creation of Telnet and providing some of the seed capital required for its operations, Automated Teller Machines (ATMs) were deployed in Nigeria for the first time and internet-based transactions became possible. Initially, Interswitch was part-owned by the DMBs with Telnet retaining an equity stake in the company. Mitchell Elegbe, the CEO of Interswitch and most of the foundation staff of Interswitch are former staff of the Telnet Group. At present, the company is operating in Nigeria, Kenya, Uganda, Gambia and Germany. It has over 190,000 active businesses transacting daily on its platform and has more than 22 million cards activated on Verve, its payment card network (Interswitch Group, 2022). Interswitch became Africa's second 'unicorn'[37] when Visa, one of the largest global payments firm, took a 20% stake worth US$200 million in the company (Quartz Africa, 2019).

[37] Unicorns are software companies valued at over $1 billion by public or private market investors. The term was popularised by Aileen Lee, then founder of Cowboy Ventures, a seed-stage fund that backs entrepreneurs reinventing work and personal life through software (TechCrunch, 2013)

Another successful spin off by Telnet is its former subsidiary called PayCom a company established to process retail financial transactions on mobile devices. PayCom is said to have pioneered the use of the Unstructured Supplementary Service Data (USSD) communications protocol in Nigeria and was one of the first licensed payment platforms in Nigeria. In April 2018, PayCom was purchased by Opera Software AS, a Norwegian software company and was renamed OPay. The company is currently funded by 14 investors, mostly of Chinese origin, with 3W Capital and Softbank Ventures Asia as the most recent investors. It has raised US$570 million over 3 funding rounds with the latest being a Series C round funding in August 2021 (Crunchbase, 2022). OPay was managed by a former staff of Telnet, Ini Akpan from 2018 to 2022.

These successful spin-offs by Telnet are non-trivial. In an uncertain business landscape, the company was willing to take risks and provide the initial backing for the establishment of new technologies and business ventures in Nigeria. In many ways it has contributed to developing the building blocks on which the IT sector in Nigeria runs. To manage its subsidiaries and interests in various ventures, Telnet formed a holding company, TechInvest, to manage its shares in Telnet, iPNX and Interswitch. iPNX absorbed the staff of TNS and focused on provision of data connectivity to retail clients. The subsidiaries retained under the Telnet Group are Softworks and iTECO.

c. Business Operations

In its initial years of operation, Telnet's main clients were mainly from the oil and gas and financial services sectors. A few manufacturing firms were on Telnet's client roster which include Guinness Nigeria Plc, Patterson Zochonis (PZ) Cussons Nigeria and the Nigerian Bottling Company (NBC). Telnet provided network connectivity for these clients and was not involved in supporting the production processes of these manufacturing firms. At present, about 60 percent of the firm's clients are financial services providers. This sectoral distribution of Telnet's clientele mirrors the structure of the Nigerian economy with most of the growth at the time emanating from the oil and gas and financial services sectors.

Partnerships with foreign companies were instrumental in the growth of the Telnet brand. iTECO was the largest Cisco partner until 2014 when it shifted its focus to developing its own proprietary products. It maintained a value-added reseller relationship with Cisco and other foreign Original Equipment Manufacturers (OEMs) like IBM, Hughes and Microsoft. Thus, it received training from this companies and was able to sell, install and maintain products created by these companies. According to the Managing Director of iTECO, the partnership was a major source of learning for the staff of Telnet; however, with time, Telnet staff were offering unique solutions developed to address specific IT needs in Nigeria to Cisco support staff to be used in solving problems in other locations. These partnership arrangements, especially with Cisco, served Telnet till 2009 when about 97 percent of iTECO's sales was of Cisco products. As Cisco established its own presence in Nigeria, OEM sales have dropped to less than 1 percent of total iTECO sales.

d. Drivers of Growth

On examination of the key drivers of growth which enabled the emergence and continuous existence of Telnet in the Nigerian IT ecosystem, both demand side and supply-side drivers are relevant.

i. Demand-Side Drivers

A rising demand for the products of the Telnet Group as an intermediate input in the production process of other companies, a rising demand from end users as well as an increase in public services were instrumental to the growth of the company. In the early days of the firm, there was pent-up demand for IT services due to the dearth of operators in the sector. Although oil and gas firms were among the initial clients of Telnet, there was limited scope to expand service offerings to these firms given that most of them were MNCs running on the technology platforms of their parent companies with headquarters located in industrialised countries. An example is the case of work done by Telnet for Shell Petroleum to replicate a standardised desktop environment in its Nigerian offices in line with the desktop environment at its Head Office in the Netherlands.

The financial services sector, dominated by local firms, provided scope for greater work in the early days of the Telnet Group as many DMBs were in the process of growing their branch networks and required connectivity. Thus, Telnet installed leased lines and VSAT connections to enable communications across their networks. Demand from the manufacturing sector was limited to the provision of ancillary services to support Human Resource Management (HRM) operations as was the case with Cadbury Schweppes Nigeria while core production processes were handled from the headquarters.

In recent years, public sector demand has provided the greatest revenue opportunities for Telnet. Telnet assisted in the rollout of the Tax Identification Number (TIN), a unique number issued to individuals and firms for the purpose of tax remittance by the Joint Tax Board (JTB) in Nigeria. Telnet led a consortium of firms including a South African and Canadian company to deliver this $5m project and managed the core infrastructure. Subsequently, the JTB decided to liaise directly with the foreign firms which were responsible for delivering the core infrastructure for the project. In 2005, Telnet also built a tax collection platform for the Federal Inland Revenue Services (FIRS) to collect taxes in Nigeria. International trade, a major demand-side driver, has not played a role in the expansion of Telnet as its operations are domiciled in Nigeria.

ii. Supply-Side Drivers

The liberalisation of the telecommunications and financial services sector as part of the package of reforms tailored on the SAP was highly instrumental to the growth of Telnet Nigeria. It created positive externalities such as the demand for telecommunications services by other economic sectors and a relative drop in the price of these services. The liberalisation of the sector in conjunction with other government policy actions is also intrinsically connected to technological progress within the sector with the entry of GSM companies and availability of broadband technology as critical turning points. Technological progress also placed downward pressure on prices and enabled the entry of new players into the telecommunications space, some of which are now outperforming Telnet in terms of innovation and market share. However, government intervention in the sector is not always beneficial as some regulations have stifled growth by placing onerous demands on operators in the sector. Examples of such negative interventions include exorbitant licensing fees and price controls.

The impact of human capital development has been mixed in the case of Telnet. Although reverse brain drain has been instrumental to the emergence of IT companies such as Telnet, the belief is that many of the opportunities created in the sector have been taken up by foreign nationals. Technology transfer from foreign IT firms to local staff has also been limited with most key positions in these firms reserved for citizens of the originating countries.

Unlike the case in industrialised countries, the manufacturing sector has a limited role in the expansion of IT in Nigeria and Telnet's operations. Nigeria's manufacturing sector has stagnated since the early 1990s and as a result little to no productivity growth has occurred. As a corollary, offshoring of services by MNCs in the manufacturing space and subsequent outsourcing of these services is not a key driver in the expansion of Telnet's operations.

e. Analysis of Drivers of Tertiarisation in Telnet

In line with the review of literature of tertiarisation drivers in the pre-industrial context, government reforms and policies, technological progress and a lack of industrialisation were the key drivers of the growth of Telnet. The typical drivers of tertiarisation in mature and premature deindustrialisers such as the rise in per-capita income (Engel's Law), the use of services as an intermediate input and internalisation of markets on the demand-side and productivity differentials and externalisation/outsourcing of services on the supply-side; were not instrumental to the growth of Telnet. The growth of the firm was specific to the Nigerian pre-industrial context where few manufacturing/industrial firms of appreciable size operate. Nigeria was experiencing a long-term process of pre-industrial deindustrialisation at the time of Telnet's emergence and the IT sector was one of the few high value-added services that emerged alongside, but not in response to this process as there were few manufacturing firms to service and IT firms like Telnet emerged in response to sector liberalisation. There was no outsourcing of service activities from manufacturing firms to explain the emergence of Telnet and the ties to manufacturing were weak. The large-sized manufacturing and oil and gas firms in operation in Nigeria at the time of its emergence and subsequent growth were branches or subsidiaries of MNCs and for this reason depended on IT services from their headquarters. This left little business opportunities for local IT firms like Telnet seeking to acquire these firms as customers. Despite these challenges, Telnet was able to provide some ancillary services to these companies outside of their core business and production operations; however, the expansion of the company was through its engagement with financial service firms.

The IT and financial services sectors were both liberalised following SAP reforms and although both sectors have grown at different rates, increased competition, the entry of foreign capital into the sectors and expansion of demand for their operations informed the increased demand for IT services. The role of technological progress was important to the expansion of the sector as the company gained its footing by deploying older technologies developed in advanced economies and not yet present in the Nigerian market to sign on its initial customers. As the staff of the firm developed skills through learning-by doing and learning-by-using, it was able to use more cutting-edge technology and eventually 'seed' the growth of innovative companies in the Fintech space. This analysis further buttresses the point that drivers of tertiarisation are context-specific and are shaped by the heterogenous interactions at the nexus of deindustrialisation and tertiarisation.

4.8.2. HTS – Gaining from GSM License Auction

a. Background Story of HTS

Established by Pelumi Adeniran in 2006, HTS or High-Tech Synergy is a software development company operating in Lagos, Nigeria. The founder, Mr. Adeniran graduated from the University of Ibadan, Nigeria in 2001 with a Bachelor of Science degree in Electrical/Electronics Engineering. He worked as a business consultant in the technology advisory unit of KPMG Nigeria for four years after which he decided to start his own firm based on a strong desire to become an entrepreneur like his father. The opportunity to start his business arose from an introduction to a business owner through the owner's wife, a staff of MTN Nigeria, while attending a training organised by KPMG for staff of both companies. Mr. Adeniran was hired to automate business processes for the firm, Biswal, a site acquisition and site construction company for telecommunications companies. Based on his performance, he received referrals to other businesses owned by the founder of Biswal as well as to other firms run by family members of the Biswal founder. As these opportunities increased, Mr. Adeniran left KPMG to start his own business.

b. The Growth of HTS

According to Mr. Adeniran, during his time working with KPMG Nigeria as a technology consultant he realised several of their clients were dissatisfied with the 'theoretical' nature of the technology consulting solutions provided by big-sized firms like KPMG. These client firms were inundated with '200-page documents' of solutions which never got implemented or which did not provide practical solutions to their problems. In addition, the large size consulting firms were quite expensive, creating an opportunity for small firms like HTS to develop practical solutions at a much-reduced cost. HTS was able to fill a gap in the technology consulting that came to Mr. Adeniran's attention through engagement with clients.

HTS was financed through the personal savings of Mr. Adeniran; however, the relationship with Biswal was instrumental to the growth of the company. This was not only due to referrals given but also a retainership arrangement between Biswal and HTS. The services provided were considered critical to the operations of the company and for this reason a monthly fee was paid to HTS. Theis regular payment enabled HTS to operate profitably and expand at its own pace. The relationship with Biswal led to opportunities to work with Petrolex Oil and Gas Limited and JB Farms, all companies run by family members of the owner of Biswal.

HTS has grown to service clients in the telecommunications space which include MTN Nigeria, MTN Ghana, Glo Ghana and Glo Benin. It is a privately held limited liability company fully owned by Nigerians. Most of the company's operations are Nigeria-based with 20% originating from the rest of the world, specifically Ghana, Benin and the United Kingdom. The issuance of GSM licenses to firms like MTN Nigeria stimulated demand for support activities necessary to drive its operations. As these GSM telecommunications firms stepped into new territory in Nigeria, they relied on the expertise of local firms familiar with the business environment to develop customised solutions that would address the needs of the Nigerian customer. HTS was one of the many firms that leveraged on its experience working with one of the largest audit and management consulting firms in Nigeria to address this need.

c. Business Operations

In the first two years of operation, Mr. Adeniran hired two colleagues from KPMG Nigeria to run the training and recruitment and business process arms of the company while he focused on software development. After four years of operation, the decision was taken to streamline operations and focus on software development due to the unprofitability of the other business lines.

HTS only works with private sector clients due to negative experiences working with clients in the Nigerian public sector. The main challenge was the demand for bribes to obtain government contracts, a practice which HTS was not amenable to performing. As of July 2019, the firm had a staff strength of 30 with technical staff comprising 85% of the total staff of the company. The firm has developed proprietary business application software with the top three products named Swift Mini, HTS Financials and Swift Ledger which account for 50%, 30% and 20% of sales respectively. In the first 3 years of operations, the bulk of the company's revenues derived from the telecommunications sector (50%) followed by the oil and gas sector (40%). In the 2018 financial year, operations diversified to the agriculture, trade and paper products manufacturing sectors as the share of the oil and gas sector in sales shrank to 5% while telecommunications still retained 40% of revenues. As of the 2018 financial year, total revenues ranged between 100 to 500 Million Naira.

d. Drivers of Growth

Both demand and supply-side drivers were instrumental to the growth and expansion of HTS

i. Demand-Side Drivers

HTS operates a Business to Business (B2B) model providing services which serve as intermediate inputs in the operations of its clients. For this reason, a rising demand for its products by intermediate users has been a major driver of growth. Two years into its operations, the opportunity to automate the distribution and retail chains of telecommunications companies like MTN Nigeria arose. HTS developed a software solution to enable this process and due to the success of the solution, similar software applications were developed for Etisalat and Glo, both competitors of MTN in Nigeria and the West

African region. This also led to an opportunity to develop a solution to automate the business transactions of a UK company engaged in building gaming applications.

Unlike the case in advanced industrialised countries, demand from the manufacturing sector was not a driver of growth for HTS. Negative experiences while attempting to work with public sector agencies in Nigeria have made the company restrict its operations to private sector clients. These negative experiences include contract award reversals due to change of top management in a government agency, request for an 80% of contract sum 'kickback' by a State Government to secure a contract and intellectual property theft by a government agency under the guise of demonstration of proof of concept. These experiences are replicated across the IT sector in Nigeria.

ii. Supply-Side Drivers

Technological progress is an important supply-side driver with the availability of technology platforms for the development of mobile and web applications. This is attributed firstly to the entry of GSM firms into the telecommunications space in Nigeria and more importantly, the launch of broadband in Nigeria. As connectivity became cheaper and more ubiquitous it became possible to develop offline and online solutions which offer clients 'services on the go'.

Offshoring and outsourcing of services did not play a role in the company's expansion; however, productivity growth in other economic sectors played a critical role. The growth of the gaming sector in Nigeria offered the opportunity to develop an accounting solution for gaming companies such as Premier Lotto as the demand for end-to-end service automation grew in the country. The impact of 'reverse brain drain' or brain gain of the firm is limited as all the staff, including the founder, obtained their educational and work qualifications locally. According to the founder, 'returnees' are considered expensive hires.

The experience with government policies and regulation is mixed. There is acknowledgement that HTS is benefitting from the liberalisation of the telecommunications and financial services sectors under the SAP; however, the GSM auction sale and the rollout of broadband access country-wide was of greatest direct benefit to the company. The introduction of a cashless policy by the CBN which is targeted at moving financial transactions online to reduce the amount of cash in circulation has benefitted the company, allowing it to create and integrate payment solutions in its applications. Yet, some government policies have ben detrimental to the firm's success such as fines imposed by the government on firms like MTN which resulted in a scale back on services from firms like HTS as these fines significantly affected the profitability of these firms. Multiple taxation is also a major problem with government agencies at the federal, state and local government levels collecting similar taxes.

f. Analysis of Drivers of Tertiarisation in HTS

Similar to the Telnet experience, the traditional drivers of tertiarisation were not relevant in the growth and emergence of HTS. The firm's emergence can be clearly linked to the licensing of GSM firms in Nigeria as the company benefited tremendously by providing services to these firms. The founder's engagement as a technology consultant by KPMG was also linked to GSM entry into Nigeria as this business line was developed by KPMG to service the needs of MTN, its major telecommunications client. Unlike Telnet, HTS emerged at a time when the GSM companies were deploying the infrastructure on which the company rolled out its services and the client acquisition process was easier due to the high and growing demand for its services.

Technological progress that accompanied the entry of GSM firms into Nigeria also created opportunities for HTS. The specific 'democratic' characteristics of the underlying technologies driving IT and telecommunications specifically made it possible for firms like HTS to acquire programming skills online and utilise those skills to create technologies adapted to the Nigerian context. The open-source nature of many of these technologies or the relatively low cost of acquiring the software and hardware required to deploy these solutions is very different to the manufacturing sector where technologies tend to be proprietary, require a larger capital outlay and increased engagement with government agencies.

The manufacturing sector was not instrumental to the emergence of the sector, much like Telnet as the firm was not aware of or able to benefit from externalisation opportunities given the small size of the manufacturing sector in Nigeria prior to its deindustrialisation. The deepening tertiarisation of the Nigerian economy through the growth of IT and telecommunications services spurred the growth of the firm. As the share of high value-added services in the tertiarisation trajectory of the Nigerian economy increased, software firms like HTS were well positioned to take advantage of the opportunities presented. It is also important to note that unlike firms like Telnet which developed units focused on meeting the hardware needs of their clients, the maturity of the IT sector allowed the emergence of firms like HTS which focused mainly on software provision, leveraging on the infrastructure provided by the telecommunications firms. This limited need for hardware acquisition allowed the growth of small software development firms like HTS at this point in the trajectory of the sector.

4.8.3. Cotta & Cush – Growth driven by Broadband Expansion

a. Background of Cotta & Cush

Cotta & Cush is the most recently established of the three firms profiled in this chapter. The firm was incorporated in 2015 by Olatokunbo Fagbamigbe. Mr. Fagbamigbe graduated with a B.Sc. in Engineering Physics from the Obafemi Awolowo University in Ile-Ife, Osun State, Nigeria and an MBA from the Cranfield University in the United Kingdom. Prior to establishing Cotta & Cush, Mr. Fagbamigbe worked with technology firms in Nigeria and abroad. These include MTN Nigeria and Konga, a major e-commerce firm in Nigeria, as well as Google, IBM and British Sky Broadcasting in the United Kingdom.

He returned to Nigeria in 2010 to explore opportunities in the Nigerian technology space after completing his MBA in the United Kingdom. This was due to the growth of the 'Africa Rising' narrative and the positive performance of the Nigerian economy at the time marked by an increasing number of MNCs setting up operations in the country. After a stint with Konga, he eventually set up Cotta & Cush, a content and applications development firm, in 2015. By this time, the Nigerian economy was experiencing challenges and the depreciation and eventual devaluation of the Naira made Nigerian software development firms relatively competitive in comparison to Indian competitors to which most of these services were previously outsourced. Cotta & Cush was able to take advantage of this opportunity to offer its services to clients who now had limited access to foreign exchange to pay foreign IT firms.

b. The Growth of Cotta & Cush

The initial focus of the firm was the development of a software product for sale to end users; however, due to a dearth in sales, the firm pivoted to technology consulting to finance its software development operations. The company is financed through personal savings and all its operations are for private sector clients in Nigeria. Its initial clients were Access Bank Plc. a DMB with operations in Nigeria and other parts of Africa and CourierPlus, a logistics company. The firm's core competencies were in software development, project management and web infrastructure deployment bundled with software development.

In its initial years of operation, Cotta & Cush developed bespoke software for CourierPlus, replicating work done previously for Konga to replace outdated logistics technology. Access Bank was seeking to establish itself as the collecting agency for companies with e-commerce capabilities and an inventory of goods. It built and operated the e-commerce front end for SLOT Systems, a reseller of mobile phones, computers, accessories in Nigeria. Cotta & Cush was hired by Access Bank to develop a mobile app and e-commerce site for SLOT Systems, one of its clients. Unfortunately, the business proposition was not successful due to the reluctance of customers to use their debit cards for online transactions. Cotta & Cush also implemented business transformation processes for Access Bank to replace some of its paper-based processes. The company was able to leverage relationships with former classmates and colleagues to prospect business opportunities.

c. Business Operations

Cotta & Cush mainly developed solutions for firms in the financial services sector. In the first few years of operation, 50% of sales were from the finance sector with telecommunication and insurance accounting for 30% and 20% of sales respectively. Over time, the distribution of sales has shifted across these sectors with the share of telecommunications growing to 50% followed by the insurance sector with a 40% share while finance shrank to 10%.

As of 2019, the company employed 22 staff with 75% being technical staff. The main platforms utilised by the firm include Agile, PHP (PHP: Hypertext Preprocessor) and Android while most of the staff possess intermediate to advanced skills in the use of Python, PHP, Java and Javascript programming languages. The firm's application for telecommunications companies, adKandi, is responsible for 50% of sales while Tufa-Pi an insurance solution accounts for 25% and consulting services covers the residual.

d. Drivers of Growth

The impact of demand and supply side drivers is similar to the case of the other firms profiled in this section.

i. Demand-Side Drivers

An increase in the demand for the company's products by both end users and intermediate users contributed to its growth. This was accomplished by automating manual processes, for example, the firm developed a mobile application to enable agents in the insurance sector sell products to customers.

Demand from the manufacturing sector is not a growth enabler and efforts to develop an inventory solution for a company with a large share of the cheque manufacturing and printing market in Nigeria did not yield positive results. The company requested a bespoke solution but balked at the service fee after a feasibility study was completed by Cotta & Cush. The company hired an Indian IT firm at a lower cost, but further investigation revealed an inferior product was being offered and the project was discontinued. This unwillingness to engage domestic IT firms because of fee disputes was found to be common with many firms wanting to pay a flat fee and not a daily rate as obtains in advanced industrialised countries. Mr. Fagbamigbe was of the opinion that IT services are not properly priced and valued and without access to short-term financing, many IT companies struggle to retain talent.

Much like HTS, the company took the decision not to transact business with public sector clients due to perceived corruption. Although international trade opportunities are few, the company is seeking opportunities outside Nigeria.

ii. Supply-Side Drivers

Most of the firm's clients are in the financial services sector and as the sector has expanded, so have business opportunities. At the time of the interview, the firm was seeking to diversify to other sectors such as construction. Outsourcing and offshoring of services by MNCs have not provided business opportunities for the company. Human capital development has also been challenging with the reverse brain drain in the technology sector in Nigeria making it difficult to retain talent as foreign companies are able to offer higher renumeration to software engineers. Cotta & Cush view this as an opportunity to train local talent for foreign companies for a fee. Cotta & Cush eventually established a company called Dufuna, a software engineering and training company which provides a pipeline of skilled software engineers for foreign companies and MNCs.

The impact of technological progress on the company's expansion has been significant as the increased availability and affordability of data services following the rollout of broadband nationwide created business opportunities to develop mobile solutions which are an improvement over paper-based processes. With respect to government policies, the company is benefitting from liberalisation of the sector and the entrance of telecommunications firms following the GSM license auction. Tax holidays and pioneer status incentives offered by the government would have been beneficial to Cotta & Cush but a capital investment of about N10 million in equipment was required to qualify according to Mr. Fagbamigbe who saw this as a lack of understanding of the technology sector. Investments in human capital development and software was not accepted in lieu of this. In his opinion, it was better not to engage with policy makers on this and rather focus on innovating past burdensome government regulations. He also cited the relocation of several Nigerian IT companies to other African countries like Kenya and the registration of many seemingly 'Nigerian IT firms' in tax havens as evidence of the difficult business and regulatory environment in Nigeria.

e. Analysis of Drivers of Tertiarisation in Cotta & Cush

With Cotta & Cush, the importance of broadband expansion on the service offerings of the firm are evident. These benefits accrued to older firms like Telnet and HTS as well; however, Cotta & Cush emerged in the Nigerian IT space at a time when the broadband capacity in Nigeria increased significantly. As with the other firms profiled, the typical demand-side and supply-side drivers of tertiarisation in the advanced industrialised country context were less instrumental to the firm's emergence and growth. The company benefitted from the infrastructure expansion following the liberalisation of the telecommunications sector in Nigeria. The entrance of the GSM operators allowed customers to access relatively cheaper services using their mobile phone services; however, the entry of broadband technology led to faster speeds and greater opportunities in software development in the e-commerce space as an example. Thus, technological progress, not necessarily in terms of the development of 'new to the world' technologies by Nigerians but through the leveraging of 'new to the market' technologies to develop innovative solutions adapted to the needs of Nigerians.

The manufacturing sector also did not feature in the emergence and expansion of the firm as it developed in response to rising demand for its services from the telecommunications and financial services space. The Cotta & Cush case study provides further evidence that tertiarisation processes in Nigeria were not driven by industrialisation but actually occurred in response to reforms and changes in government policies. Unlike low value-added services which tended to replace manufacturing jobs as Nigeria deindustrialised, high value-added services emerged in response to increased competition in the sector and in response to technological progress. Eventually, these jobs did substitute for manufacturing jobs as based on anecdotal evidence, many engineering graduates from Nigerian universities found employment in the telecommunications and software development space. It is also interesting to note that the IT sector in Nigeria is constantly evolving and where in the case of Telnet, a brain drain was instrumental to the growth of the firm, by the time Cotta & Cush was expanding its operations, a reverse brain drain was taking off, with Nigerian IT firms losing their staff to firms in advanced industrial countries. This is another challenge which a constantly evolving and resilient sector must address to guarantee its continued growth.

4.9. Summary

In this section, a conceptual discussion of terms was presented to address the question of where services come from. The services in question are IT services which are technology and knowledge intensive producer services, and which are not expected to be found in a pre-industrial context where manufacturing activity is limited. By revisiting the concepts of deindustrialisation and tertiarisation from a pre-industrial context, the relativity in the movements of both processes with a decline in one signifying a rise in the other and vice-versa was successfully challenged to show that tertiarisation is a process which can take off autonomously without being instigated by deindustrialisation. In particular, the popular explanation of externalisation, where manufacturing firms hive off service activities as they consolidate operations, is not found to apply in the pre-industrial deindustrialisation context. Rather, an examination of the deindustrialisation-tertiarisation nexus points to a heterogenous set of possible outcomes. To provide context to this conceptual discussion, empirical evidence was provided using the Nigerian case as a case study. The evidence was drawn from primary data from the conduct of a survey of 40 IT firms in Lagos Nigeria, case studies of three select firms using a questionnaire and secondary data from multiple sources.

Examination of the case studies points to similarities in the factors driving the growth of the firms profiled. They all cite the liberalisation of the telecommunications sector following the introduction of SAP and the entry of mobile telephony firms following the GSM license auction as catalysts for growth of the IT sector in Nigeria. Technological progress through the introduction of mobile platforms and increased digital data access with the penetration of broadband nationwide also enabled the proliferation of web and mobile applications, especially in the case of Cotta & Cush, the youngest of the firms which benefited from broadband growth. Although Telnet benefitted first-hand from the SAP policies, the trickledown effects were felt by the other firms.

The manufacturing sector was also absent as a growth driver in all cases, albeit to a lesser extent in the case of Telnet which emerged at a time the manufacturing sector was performing relatively well. The financial services and telecommunications sectors were key drivers for the younger firms, Cotta & Cush and HTS while Telnet was more amenable to working with public sector clients although this has not been without its challenges. All the firms cite specific government regulations as detrimental to growth due to policy inconsistency, multiple taxation and exorbitant licensing fees. Thus, the impact of government policies is mixed with the liberalisation of the sector instrumental to its growth but subsequent government policies to regulate and tax the sector considered as a hindrance to further growth.

The key growth drivers identified for the three firms profiled in these case studies are consistent with the typical pre-industrial deindustrialiser growth drivers identified in the review of literature on the tertiarisation process in these countries. This gives further support to the need to consider pre-industrial countries as a distinct conceptual category from the premature and mature deindustrialising case where outsourcing and offshoring opportunities in manufacturing firms and productivity growth in the manufacturing sector have been critical. The analysis answers the question of where services come from in the pre-industrial context and for this reason IT services in this context must be treated differently.

These findings further buttress the argument that the manner in which a country deindustrialises affects the type of tertiary sector which emerges. In the case of the Nigerian IT sector, deindustrialisation occurring while manufacturing as a share of value-added and employment was very low resulted in a tertiarisation process that is not reliant on the performance of the manufacturing sector. IFI-driven policy reform which influenced government policies and technological progress were the main drivers of growth. For this reason, many of the IT service companies in Nigeria and possibly other pre-industrial countries were providing services to other sectors liberalised through these reforms, such as telecommunications and financial services. Hence, these IT Producer Services are not servicing the manufacturing sector but are 'servicing other services'. Unfortunately, the analysis of the linkages between IT services and other sectors is limited by the aggregate nature of the data and for this reason, the analysis will be further supported by the investigation of linkages between the IT sector and other economic sectors in Nigeria in the next chapter. By so doing, we can further unravel where the relationships between sectors are the thickest or the weakest.

5. CHAPTER 5: IT'S ALL ABOUT LINKAGES

5.1. Introduction

A persistent theme emerging in the discussion in this thesis is the greater utility derived from analysing sectors from the perspective of interdependencies between sectors as opposed to a study of sectors in isolation. This line of thought was elaborated in the review of theories of structural change and economic growth in Chapter 2, especially in the exposition of structuralist economics theories. It was referenced in the development of an IT producer index in Chapter 3, and the examination of the heterogeneity in patterns of sectoral growth in Chapter 4, which acknowledges the importance of linkages, in this case between the manufacturing and IT service sector.

Earlier in this thesis, a case was made for conceptualising growth as a system of interdependencies involving sectors interacting and stimulating other sectors to induce further growth in a process of circular cumulative causation (Toner, 1999). The theory on linkages, especially as developed by Hirschman, is fundamental to analysing economic growth from this perspective. In this section, the question of whether the IT sector in Nigeria can drive economic growth is assessed by examining the linkages it has formed with some of the key economic sectors in Nigeria. The capabilities which enable the formation of these linkages are also examined in detail. The sectors reviewed are agriculture, manufacturing and financial services.

The oil and gas sector, which is the largest contributor to government revenues and foreign exchange earnings in Nigeria, is excluded from this analysis. This is partly due to the enclave nature of this sector with most firms in the sector being MNCs, receiving production inputs from headquarters and exporting output with little interaction with the local economy (M. W. Hansen, 2014). Few employment opportunities for Nigerians are created in the oil and gas sector and it contributes less than 10% to nominal GDP[38] (NBS, 2016). These observations are borne out in the responses to the survey of IT firms in Lagos, Nigeria conducted for this thesis in which very few firms reported linkages with the oil and gas sector. These features of the oil and gas sector in Nigeria and the lack of information from the survey justify the decision to exclude it from this study of intersectoral linkages.

The standard approach to measuring intersectoral linkages is input-output analysis, a meso-level tool for mapping out interdependencies between economic sectors. It rests on the computation of technical coefficients as a measure of how inputs from various sectors are combined to

[38] In the most recent job creation report by the NBS, no jobs were created in the oil and gas sector in the second and third quarters of 2016

generate outputs. This reduces it to a mechanistic exercise with little regard for the factors precipitating the formation of linkages. It also offers negligible insight on how capabilities are developed in firms, how firms interact with other external actors to acquire and transfer these capabilities and how the linkages, which serve as transmission channels for capabilities, are developed. In this chapter, case studies are selected as the more appropriate analytical framework for observing these characteristics at the firm and sector level as they allow for in depth analysis of these important linkage characteristics. In addition, a framework for identifying and classifying the capabilities required for the formation of linkages is developed in this chapter.

Production linkages, both forward and backward; financial; fiscal/consumption; and technological linkages are examined for three profiled IT firms selected from the firms surveyed. The intent is to demonstrate if and how IT is driving growth in other sectors and to strengthen the argument for a viewpoint of growth which develops by first cultivating an understanding of the different economic sectors and then observing the interactions occurring at the interface between sectors.

The case studies presented are largely descriptive as the intention is to provide an insight into the way Nigerian firms in the agriculture, financial services and manufacturing sectors utilise IT and develop linkages to the sector. These is a dearth of case studies of African firms and these rich narratives on Nigerian firms demonstrate not only linkage development but the adaptations and innovations these firms adopt to remain competitive. It must also be acknowledged that since many of these firms are limited liability companies, there is limited opportunity to counter the narratives built from the survey and interviews to critique the narratives. The information required to do so is hard to source and although media sources are referenced in this chapter, they are not the most reliable sources. For each case study, the production, financial, fiscal/consumption and technological linkages are presented in turn over sections 3 to 8. Section 9 summarises the findings from the case studies.

5.2. Linkage Analysis at the Firm Level - Case Studies

Although linkages can be measured at the meso level using input-output analysis tools, the discussion in the literature review in Chapter 2 has demonstrated that the harnessing of capabilities in an LPS is instrumental to the full development of linkages across sectors. The structure of the LPS determines a firm's potential for upgrading and this is best observed at the micro level where endogenous and exogenous factors interact to promote linkage formation or instigate the breakdown of linkages. Besides, the aggregate nature of sector data, especially for services, precludes the examination of linkages at the level of the IT sector, the subject of this thesis.

A micro-level examination of linkages is appropriate for the study of how the IT sector in Nigeria is linked to the other economic sectors as a determinant of the sector's potential for driving economic growth. Using the Hirschmanian framework of linkages, the variety of linkage types are best observed using the case study approach. The argument for case studies as an appropriate tool of analysis has already been made in Chapter 4 and will not be repeated here.

In this section, case studies of linkages between the IT sector and the main economic sectors in Nigeria are presented. The sectors selected are manufacturing, agriculture, and financial services. The firms profiled have been selected on the basis of their response to the survey of IT firms in Lagos conducted for this research, especially in response to the questions on the proportion of sales made to all the economic sectors. The decision to exclude the oil and gas sector from this examination of linkages is due to its weak connection to the Nigerian IT sector as reflected in the survey responses. Few IT firms reported linkages to this sector and the linkages reported were trivial and too insignificant to justify a case study.

The case studies will examine production, technological, fiscal/financial and consumption linkages formed in the production process. The word 'production' is typically associated with firms that produce a good, usually manufacturing firms; however, service firms also 'produce', even if their final product can be intangible. Value chain analysis is one of the standard tools applied to study production at the micro level as it enables the splitting up of the production chain into distinct steps, enabling study of the introduction of primary inputs, the incremental value added along the chain as intermediate inputs are further introduced and the final output at the end of the chain.

In conceptualising the configuration of service firms for production, especially firms which use IT, a network approach has been proposed as a more appropriate tool for mapping out inter-firm relationships. There is merit to this argument as service firms tend to facilitate exchange and problem-solving within a network of producers and users. Yet, a value chain approach remains valid given the aim is to identify the inputs utilised and the value they bring to the production process. Thus, both approaches are utilised as appropriate in analysing production and other linkages for the cases in this study.

5.2.1. Research Methods

The absence of comprehensive and reliable data is a well-documented constraint on the production of quality research in many developing and pre-industrial countries like Nigeria. The

IT sector in Nigeria in particular is not sufficiently covered in official statistics by the NBS, the NCC, which regulates the sector, or the Federal Ministry of Communications and Digital Economy and its agencies with the responsibility of sector oversight.

Potential case study subjects for each of the major economic sectors under consideration were selected based on the response to the survey of IT firms in Lagos. The questions on the proportion of the company's sales in the previous financial year derived from the agriculture, oil and gas, financial services and manufacturing sectors were particularly relevant. The three firms were selected based on having some of the highest percentage of sector sales to the key sectors under investigation and the willingness of the firm to participate in the study. Each of the firms was contacted and both structured and semi-structured interviews were held with assigned senior staff members. The findings from the interviews were then triangulated against publicly available information on each of the firms. The findings from the interviews and subsequent analysis are presented in the rest of the chapter.

5.3. Case for Study of Financial Sector Linkages

Although representing about 4% of nominal GDP, Nigeria's financial sector and its linkages to the IT sector receive a disproportionate amount of attention in the media, policy and academic discussions (NBS, 2020). The expansion of Digital Financial Services (DFS) or 'Fintech' (Financial Technology) across SSA has accelerated the pace of financial inclusion by moving transactions out of traditional banking institutions into the digital space, mainly via mobile phones. In comparison to other regions, mobile money penetration in SSA is the deepest in the world with over 20 percent of adults owning mobile money accounts while for other regions the measure is below 10 percent (Klapper et al., 2019).

The rapid expansion in fintech is due to a combination of factors which include the liberalisation of the financial sector since the late 1980s, changes in the regulatory environment and increased Foreign Direct Investment (FDI) in IT services and infrastructure. Despite the improvement in the speed and reach of banking services through fintech adoption, structural problems that have kept interest rates high and resulted in poor performance on most macro-economic and socio-economic indicators persist.

The growth in IT adoption in Nigeria in general and fintech expansion more specifically is marked by large scale investment in IT infrastructure. Payment and transaction switching platforms, which interconnect payment providers and allow real-time digital transactions are an important infrastructure component for fintech expansion in Nigeria. For this reason, ChamsSwitch, one of the early entrants into the fintech space in Nigeria, is selected for the case study on linkages between the IT and financial services sector.

In its response to the survey on IT firms in Nigeria, Chams Plc and its subsidiary, ChamsSwitch, self-described as a fintech firm with 35% of sales attributed to the financial services sector.[39] The firm is a pioneer in transaction switching and identity management in Nigeria and was pivotal to the integration of digital technology and financial service activities.

In the following section, an introduction to Chams Plc and its subsidiary, ChamsSwitch will set the context for the linkage analysis that follows. This will include a history of the company and critical events in its growth, an analysis of its financial performance and a description of how knowledge, learning and innovation occur in the company. Aside from the familiar production linkages, this study will examine the technological, fiscal, consumption and financial linkages emanating from ChamsSwitch to the financial services sector. Several sources have contributed to the findings presented in this case study and this includes information from the survey completed by David Iwuchukwu, Head of Merchant Acquiring at ChamsSwitch, an interview of Chijioke Iwuagwu, Head of Operations at ChamsSwitch, as well as desk research of publicly available information on the firm.

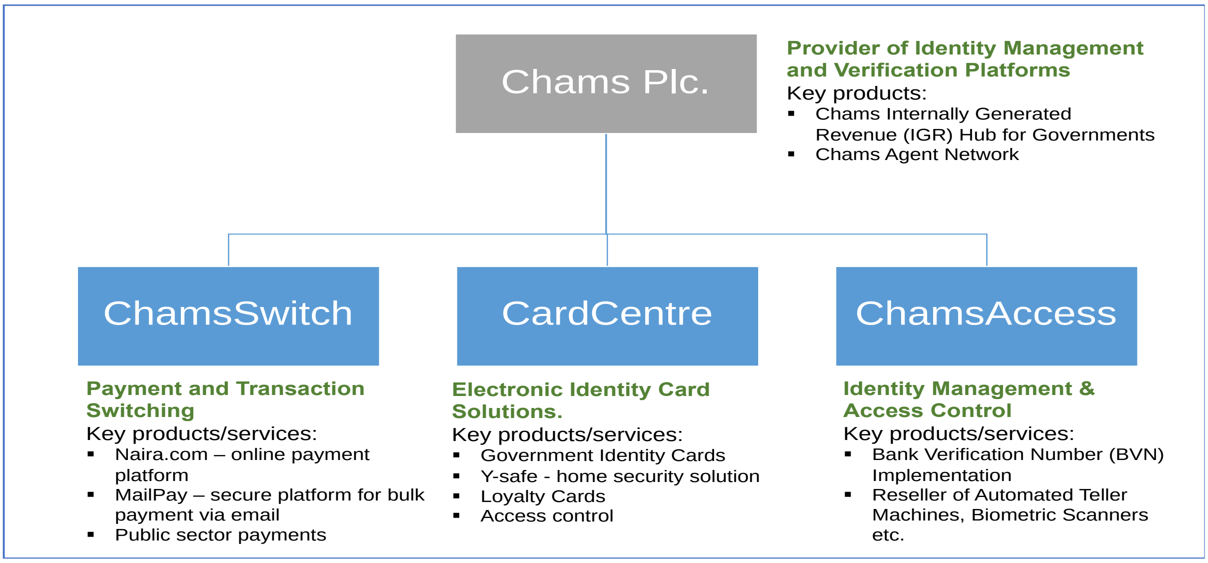
5.4. ChamsSwitch: Pioneer in Identity Management & Transaction Switching in Nigeria

5.4.1. Firm Background

Chams Plc. was founded by Ademola Aladekomo as a limited liability firm on September 10, 1985 and subsequently listed on the NGX in 2007 (Nigerian Exchange, 2019). Mr. Aladekomo earned a Bachelor of Science degree in Computer Engineering from the University of Ife (now Obafemi Awolowo University) in Osun State Nigeria in 1982 and in 1984 obtained a Master of Business Administration Degree from the University of Lagos also in Nigeria. Chams Plc. is one of only nine IT companies listed on the NGX . It operates a holding firm structure with three subsidiaries, ChamsSwitch, a transaction switching firm; CardCentre, a smartcard solutions provider and ChamsAccess, an identity management and access control firm. ChamsSwitch is the subject of this case study; however, background information on Chams Plc sets the context for the case.

[39] Although 40 % of sales are made to the government/public sector, all the sales are of fintech products with strong linkages to the financial services sector

Figure 5.1: Organisational Structure of the Chams Group



Source: Author's illustration using information from https://chamsplc.com

Chams Plc is an identity management and e-payment firm based in Lagos, Nigeria; however, the firm got its start in computer hardware maintenance and installation of Local Area Networks (LAN), Metropolitan Area Networks (MANs) and Wide Area Networks (WANs) (Aladekomo, 2014). Chams led the consortium credited with the creation of SmartCard Nigeria Limited[40], the first e-payment platform in Nigeria using smart card technology. It achieved this in collaboration with six major commercial banks in Nigeria and under this arrangement, the first Europay, MasterCard and Visa (EMV) chip and pin cards were issued in Nigeria in 1996. Although SmartCard was the first smart card technology product introduced in Nigeria, it did not gain traction due to the limited spread of infrastructure outlay by the company and the inability to achieve connectivity across all DMBs. Interswitch eventually cornered a large part of the online payment market for a while prior to the entry of the current dominant players, Flutterwave and Paystack.

According to Mr. Aladekomo, the firm's founder, the transition to e-payments and identity management was motivated by challenges in the delivery of a Wide Area Network (WAN) to link branches of the Commercial Bank Credit Lyonnaise in 1991 (Aladekomo, 2014). To circumvent challenges in linking infrastructure country-wide, Chams Plc. proposed the integration of smart card and identity management technology to give customers access to their bank accounts from other bank branches. To achieve this, a Polyvinyl Chloride Card (PVC) holding digital banking and identity information simultaneously on an embedded chip was developed by Chams Plc for

[40] The firm was renamed ValuCard and subsequently Unified Payment Services Limited.

the Nigerian market following two years of research on how the technology was being implemented in advanced industrialised countries.

Although smartcard technology was in use globally, this was a major innovation for a developing country like Nigeria because at the time bank customers could only transact business at the bank branch in which their accounts were domiciled. The Dangote Group was the first corporate client of Chams' to adopt this technology in 1994 and it marked the entry of Chams as an innovator in the e-payments and identity management sector in Nigeria.

Subsequent to this product innovation, Chams was awarded a US$38.4 million contract by the Federal Government of Nigeria in 1999 to resuscitate a failed 1976 attempt to develop an identity card system for Nigerian citizens. Chams completed a pilot of the relaunched project, issuing 1 million out of 52.5 million cards awarded under the contract; however, the project was not fully realised before a new government administration took office. A subsequent attempt was made to revive the project in 2006 under the newly created National Identity Management Commission (NIMC). Chams was one of two companies selected to implement the project under a Public Private Partnership (PPP) concession model following a competitive bidding process.

To raise capital for the venture, Chams listed on the NGX and adopted a holding company structure with three subsidiary firms. The project became mired in controversy with Chams alleging its technical partner, Mastercard Asia/Pacific Pte Ltd, committed intellectual property theft, breach of contract amongst other claims. Chams claims that Mastercard contravened the partnership agreement between both companies and reneged on this agreement by contracting directly with NIMC to solely deliver the project.

Chams has sought compensation for losses incurred in the roll-out of infrastructure for the project, especially the construction and equipping of its ChamsCity locations nationwide, by petitioning the federal government to intervene in the dispute. The firm and its consortium partners in the project filed an ex parte motion against Mastercard in 2019 seeking US$113 billion in damages but the case is yet to be resolved.

Despite the financial difficulties from the national identity card project, Chams has delivered several government projects in Nigeria. It led a consortium which won the CBN bid to develop a biometric identification system for all bank account holders in Nigeria in 2014. All holders of bank accounts in Nigeria are required to register for a unique Bank Verification Number (BVN) through this project and more than 40 million people had enrolled on the scheme by 2019.

The Independent Electoral Commission (INEC), the body responsible for administering government elections in Nigeria, also engaged ChamsSwitch to produce voter's cards for the 2007 election at short notice when foreign firms engaged for the project could not deliver cards within the expected time frame. Following this process, Chams developed an e-voting solution (VOTA) which corporate organisations like the Nigerian Bar Association (NBA) and Chartered Institute of Bankers of Nigeria (CIBN) have used in conducting elections (Chams Plc., 2019).

The negative experience of ChamsPlc in ensuring the terms of its contract with Mastercard in the execution of a public sector project lends credence to the reluctance expressed by HTS and Cotta & Cush to work with public sector firms.

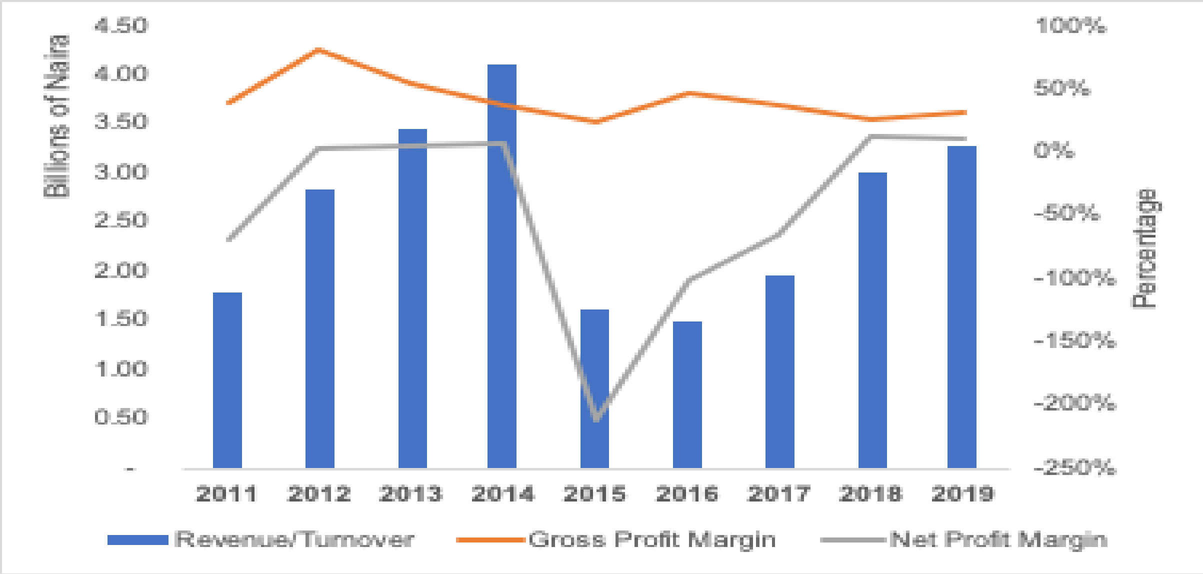
a. Financial Performance

A key initial financing source for many IT firms in Nigeria is contributions from family and friends. Aside from the multi-national IT firms, very few firms have successfully raised funds in the capital market. Due to the fiduciary obligations from its listing on the NGX, the financial information of Chams Plc and its subsidiaries is publicly available. Unfortunately, it is not possible to perform a comparative analysis of Chams Plc performance with its peers as most are limited liability companies and none of the listed IT firms can be considered as operating within the same segment of the IT sector as Chams. Thus, the analysis of the firm's financials is limited to observing trends for selected financial indices over the 2011-2019 period for which data is available.

Chams Plc experienced a steady increase in turnover till the 2015 financial year when it declined by 61%. The net profit margin growth has followed a similar but more pronounced pattern, declining precipitously by 211% between 2014 and 2015. During the same period the gross profit margin grew by 24% compared to 38% the previous year.

The firm's unstable performance can be attributed to several factors, namely the general slowdown in business activities in Nigeria prior to the 2015 elections and the delay in the appointment of government ministers to the Federal Executive Council (FEC) by the Buhari administration until over 5 months after taking office (Chams Plc., 2016). This was especially relevant for Cham's Plc as the public sector is a major segment of its clientele and the absence of ministers led to the suspension of contract awards and funds disbursement for existing contracts.

Figure 5.2: Chams Plc Performance on Key Indicators (2011-2019)



Source: Author's calculations from 2012-2019 Financial Statements of Chams Plc.

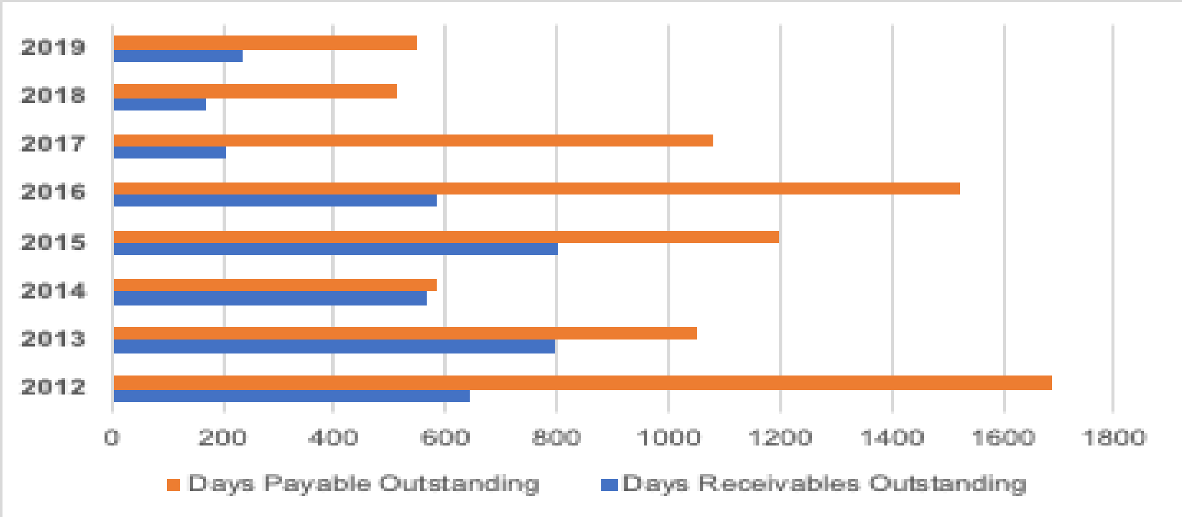
.

The uncertainty caused by the delay in the formation of FEC was further exacerbated by a difficult macro-economic environment as a drop in oil prices led to a sharp decline in foreign exchange earnings and government revenues, precipitating a fiscal crisis at all levels of government which eventually tipped the country into recession.

These exogenous factors were further compounded by the closure of ChamsCity offices, originally set up nationwide for the implementation of the national identity card management contract, a contract which Chams lost to Mastercard Asia/Pacific Pte Ltd. The outstanding balance on investments made on this project were written off in the 2015 financial year, thus deepening the already poor performance that year. The decline in performance continued into 2016, although the net profit margin improved in 2016, but overall profitability only recovered from 2018 as the economic environment improved and the firm restructured its business, reducing its reliance on public sector projects (Chams Plc., 2018).

The trend in the management of outstanding accounts, measured by days receivables and payables outstanding, follows a pattern similar to the key financial indicators assessed thus far. After an improvement between 2012 and 2014, the number of days outstanding on settling receivables and payables grew between 2015 and 2016 before a gradual reduction from 2017. The improvement in government finances no doubt improved the firm's receivables given the Nigerian public sector's notoriety for delays in paying for goods and services received.

Figure 5.3: Chams Plc Receivables & Payables Outstanding (2012-2019)



Source: Author's calculations from 2012-2019 Financial Statements of Chams Plc.

Despite the limited information on the performance of Chams Plc. it can be construed that despite a challenging business environment in Nigeria, the firm made efforts to return to profitability by adapting its business model. The creation of subsidiaries is key to the firm's adaptation and at this point, the focus of this case study will shift to ChamsSwitch, a subsidiary of Chams Plc and the subject of this case study.

ChamsSwitch was incorporated in 2008 when its parent company, Chams Plc., was listed on the NGX. It is a fintech firm which specialises in facilitating electronic payments implemented on its transaction switching platform. Its products enable payments through multiple payment channels, including by mobile phone, online, and through Point of Sale (POS) terminals (ChamsSwitch, 2019). Services provided include online bill payment via web and mobile apps, funds transfer, virtual top-up of mobile airtime, payment gateway internet service for web processing and, transaction management for public sector organisations (ChamsSwitch, 2019).

Naira.com, its online payment platform, enables clients to pay bills, transfer funds and carry out other financial transactions. The firm also provides other value-added services such as its MailPay product which allows customers to make scheduled payments using an email platform. ChamsSwitch pioneered the use of the USSD[41] (Unstructured Supplementary Service Data) protocol in Nigeria. USSD is one of the most ubiquitous and accessible platforms for money transfer in Nigeria using a string of numbers and symbols on a mobile phone. The technology has been adopted by most commercial banks using platforms provided by telecommunications firms in Nigeria and is pivotal to the increased funds transfer speed.

[41] USSD is a communications technology enabled by mobile network operators which facilitates the provision of mobile financial services to end users (Hanouch & Chen, 2015).

ChamsSwitch operations are focused on the Nigerian market and the firm serves both public and private sector clients with about 70% of its sales to the public sector directed at wholesale customers while the same percentage of private sector customers are retail. ChamsSwitch is also integral to the Chams Plc brand as it maintains the infrastructure on which the activities of the other subsidiaries are deployed.

b. Knowledge, Learning & Innovation

Although continuous knowledge and skill development is central to ChamsSwitch's functioning as an IT firm and its ability to maintain its competitive edge, the process of learning and knowledge acquisition is ad-hoc and mostly self-directed. The survey implemented for this thesis completed by a staff member of ChamsSwitch indicates that as of 2018 all company staff have an undergraduate degree while about 5% of these hold a Master's degree. Although these university qualifications are important, certifications from major software and hardware companies, such as Microsoft and Cisco, as well as knowledge of programming languages are considered fundamental to good job performance and career progression in the IT sector.

All technical staff possess knowledge of JavaScript, a scripting language for web application development trademarked by Oracle. 20% have knowledge of Java, a general-purpose scripting language also owned by Oracle while 40% are skilled in PHP, another scripting language for web development developed by the PHP group. Microsoft and Cisco certifications are also essential with 60% and 20% of staff respectively, holding these certifications. Beyond these standard qualifications, any additional efforts at upskilling are largely left to the discretion of staff members.

At ChamsSwitch, there is no formal R&D function or dedicated R&D budget, and the firm does not benefit from publicly funded R&D. Most R&D occurs either informally through the personal efforts of staff, as a by-product of the solutions development process and through interactions with clients, vendors and other third parties.

Beyond technology transfer through the use of hardware, programming languages and platforms created in advanced industrialised countries, direct interactions with vendors have also led to knowledge sharing. An example is the case of a foreign vendor that recommended solutions not yet available in Nigeria to ChamsSwitch staff which was adapted for use in the local market.

Returnees from industrialised countries have been a good source of knowledge on new technologies and trips by staff to advanced industrialised countries have inspired the development of new products based on technologies observed on these trips. In one case, ChamsSwitch adapted a 'check-out' application created by a foreign technology firm for use in a financial inclusion package developed for local use. The check-out application included a unique payment system to deduct or add to the value of goods purchased by customers and this was adapted for the withdrawal or deposit of funds from the accounts of remote clients via mobile phone applications.

Interactions with local vendors have also been beneficial, especially in the case of third-party software developers engaged by ChamsSwitch to design solutions for clients with conditions set out in Memoranda of Understanding (MOUs) and Non-Disclosure Agreements (NDAs). Competitors are also a source of knowledge transfer in cases where products can be 'reverse-engineered' and adapted to suit local conditions.

Innovations have occurred through interactions with clients. An example cited is the opportunity created for ChamsSwitch to improve on a payment collection application developed by a competitor in the course of product development for a client. The client asked ChamsSwitch to improve on the competitor's product and pointed out the limitations of the competitor's product. Using this information, an improved product was developed which was then included as a new ChamsSwitch product offering.

The value addition to the process was insight into the customer experience gained through access to the competitor's product. In this particular case, ChamsSwitch was able to simplify access to the platform by eliminating the requirement for the customer to leave his premises, print out physical documents, submit these documents and have them verified.

Although these examples of knowledge transfer and innovation might seem trivial from the perspective of firms in advanced industrialised societies, the ability to replicate and reverse-engineer existing technologies is an important production capability and is critical to the development of more advanced innovation capabilities (Lall, 1992). By listening to and learning from its clients, ChamsSwitch is able to develop products the client wants. Although the firm is developing products that are new to the market and not to the world, it is adapting them specifically to fit the local context, thereby innovating.

The lack of enforcement of Intellectual Property (IP) rights allows IT firms like ChamsSwitch to 'copy' the products of both local and foreign firms without fearing litigation. There are advantages and disadvantages to this as it speeds up the learning and innovation process but as these firms mature and develop proprietary products, it makes it difficult to exercise IP rights over their innovations. Unless the judiciary system is strengthened to allow IP protections, it will disincentivise transformative innovation and limit the growth of the sector.

5.4.2. Production Linkages

To identify the production linkages formed in the delivery of services, the product development process at ChamsSwitch is outlined in this section. As applies to most service firms, the service production process is highly customer centric as most products are customised and designed to meet client needs. The design and development process are also highly collaborative and requires active involvement of clients.

a. Production Stages

i. Concept Development Stage

After the client acquisition process, the client meets with the product development staff at ChamsSwitch to set out the project requirements and the client need the firm seeks to address. A problem statement is developed and analysed to determine the type of software solution best suited to the client need. Concurrently, a business case is prepared to determine the commercial viability of the project. Once the amenability of the problem statement to a software solution and the commercial viability of the project is ascertained, product design commences.

ii. Product Design Stage

The product design stage is the point at which a software solution is designed. The greatest value addition in the production process occurs at this stage as it sets the frame for the production of the product or service. According to ChamsSwitch, a revenue sharing model is a standard design feature of their software products. This is to ensure a mutually beneficial long-term relationship with the customer rather than a one-off design process.

The primary inputs utilised at this stage include the hardware elements employed in the development of the process such as computers, servers, networking elements and other peripherals and the knowledge input of the software developers and other members of the design team. None of the hardware components are produced locally; however, assembly, installation and deployment are achieved using local talent. In some cases, ChamsSwitch is responsible for procuring and installing the hardware, especially when non-standard hardware components supplied by ChamsSwitch partners are required to deliver the solution. This usually entails the acquisition of technology licenses or technical partnerships with local and foreign technology firms. In an alternative situation, the software solution developed by ChamsSwitch is incorporated into the client's already existing infrastructure set up, voiding the need for additional hardware procurement.

The main programming languages utilised in designing software applications, which include Java, JavaScript and PHP, are also technologies developed and owned by industrialised country firms; however, these languages are utilised by local software development teams in creating unique proprietary codes to achieve the program design objectives for their clients in the domestic market.

ChamsSwitch tends to engage third-party software application developers to design its products. These developers could be hired as individual contractors from local software development companies or firms could be contracted. A Memorandum of Understanding (MOU) and Non-Disclosure Agreement (NDA) sets out the relationship between ChamsSwitch and third-party developers.

In the design phase, discussions are held with other third-party entities involved in the granting of licenses and other permissions as well as intermediate parties involved in the use of the product. Depending on the product, this could include commercial banks; Nigerian Inter-Bank Settlement System (NIBSS), the CBN and other regulatory bodies. The capability to manage relationships with third parties, especially government regulatory agencies, is a non-trivial activity necessary for a successful product development process.

The design process is iterative and requires continued engagement with the client to ensure the client expectations are met. The output from this stage is a software application ready for testing before final adoption by the client.

iii. Implementation Stage

An implementation committee is formed, comprising ChamsSwitch staff, any third-party contractors as well as representatives of the client firm. At this stage, the completed product is run in a test environment. User Acceptance Testing (UAT) is carried out iteratively and once this is completed successfully the product is moved to a live environment. External Penetration Testing of the product environment and tests of the structural integrity of the power system undergirding the hardware and other infrastructure are also completed at this stage. At the conclusion of this stage, a product presentation is made to the customer and once sign-off is obtained, the product is ready for use.

The key inputs at this stage of the process are similar to those at the design stage. The key output is a fully functional software application. Examples of such applications include direct debit systems, payment processing applications and USSD systems which provide switching services to banks. These outputs are typically utilised as intermediate inputs in the value chain of

ChamsSwitch clients. For example, ChamsSwitch developed a collections platform utilised by a major conglomerate in Nigeria for streamlining its sales revenue collections process.

iv. Application Support Stage

Unlike the case with manufactured goods, where after-sales support tends to take the form of a warranty or service period on a needs basis, ongoing support to the client is an integral part of the value chain of software application development. Applications are structured to ensure that the interaction with the customer is not 'one-off', and support can be provided to the customer as long as the application is in use. This requires product lifecycle management and support covers all peripheral products and applications on the client site and in other locations necessary to keep the application in operation. Critical licenses such as payment gateway licensing are secured and bundled with the product at this stage. This is possible due to value-added reseller relationships which allows firms to combine proprietary products with already existing technologies licensed by other technology firms.

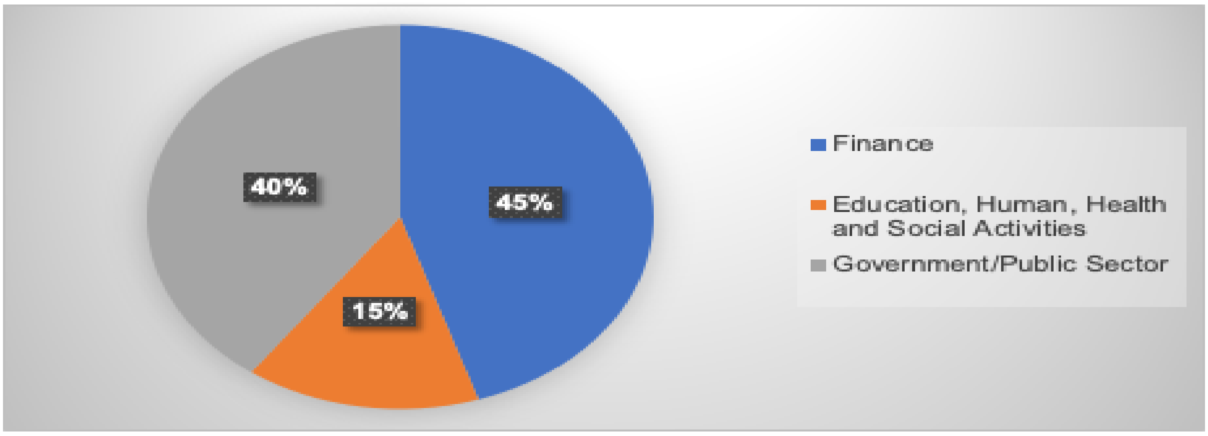
b. Backward and Forward Linkages to Other Sectors

The software application development process is an iterative one with strong backward linkages to the foreign and local software design community. The software languages utilised in developing the application are created by developers in advanced industrialised countries while the personnel utilising the languages to develop applications are mostly Nigerian. Backward linkages to the global hardware and infrastructure industry are also strong and this is completely dominated by foreign companies as local capacity in hardware development is fledgling and limited to resale of imported hardware, assembly of knocked down components, installation and maintenance. The lack of hardware production capacity in the IT sector in the Nigerian IT sector is not surprising as it reflects limited manufacturing capacity and a lack of enabling infrastructure in the broader economy to support manufacturing activities.

Although forward linkages are mainly to the financial service industry in Nigeria as expected for a fintech firm, the public sector is also a major client base. In its first three years of operation, majority of the firm's clients were in the financial services and public sector, with a few in the education, human, health and social sector. In the 2018 financial year, the firm's strategic plan to expand its private sector clientele was apparent in its more diverse client base covering financial services; the public sector; the education, human, health and social sector; chemical, chemical products and pharmaceutical products manufacturing; real estate; and professional, scientific & technical activities. The services provided to these sectors include bulk money transfer solutions, payroll automation and scheduled payments for small-sized organisations using its MailPay application.

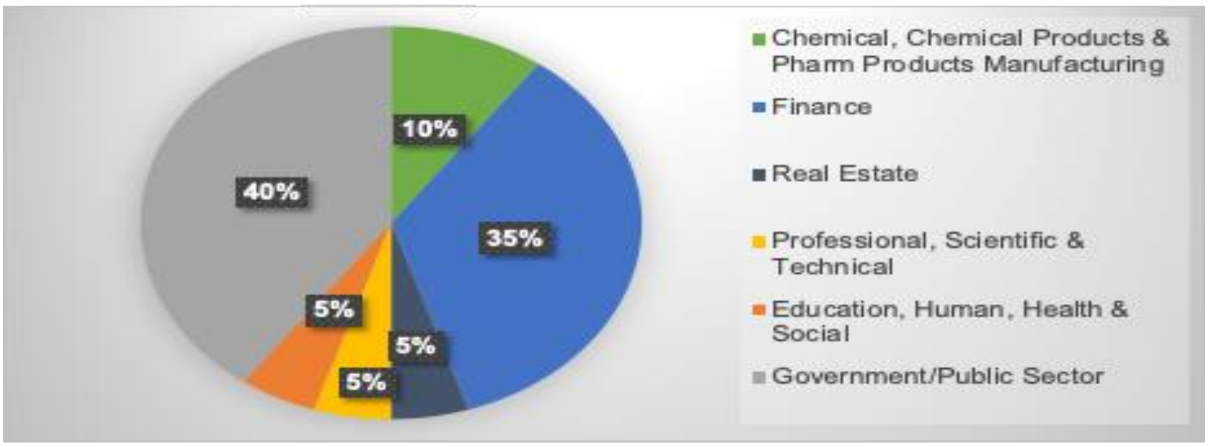
Interestingly, although Chams Plc has expressed its intention to diversify away from the public sector to private sector activities, its clientele base in the 2018 financial year indicates diversification was achieved by shrinking its activities in financial services and the education, human, health and social sector. The public sector share of its business remained unchanged at 40%. This is surprising given the firm's negative experience with executing public sector contracts; however, this might be an indication of the firm's inability to compete favourably with younger and more nimble payment service providers. These younger firms are more in tune with newer technologies and have an increased flexibility due to their smaller size and flatter operating structures. For this reason, the firm might be left with little choice but to continue to serve public sector clients.

Figure 5.4: Chams Plc – Proportion of Sales by Sector (Year 1-3 of operation)



Source: Author's illustration from survey results

Figure 5.5: Chams Plc - Proportion of Sales by Sector (2018 Financial Year)



Source: Author's illustration from survey results

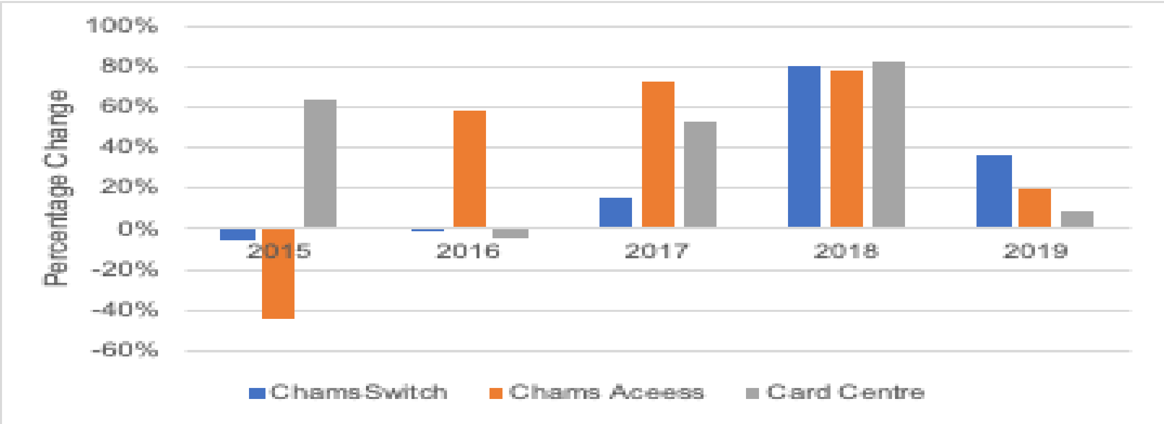
5.4.3. Financial Linkages

Chams Plc is one of the few IT companies listed on the NGX , thus its main source of financing is the capital market supplemented by loans from local financial institutions. As ChamsSwitch and its parent firm are not start-ups, they have no access to funds from incubators and accelerators, recent important sources of financing for IT firms in Nigeria. Foreign and local venture capitalists also tend to favour investments in newcomers in the fintech space, thus excluding established companies like Chams Plc. The leadership of ChamsSwitch also expressed an unwillingness to further dilute its ownership structure and for this reason has not explored investment from incubators or venture capitalists. This limits the firm's ability to expand its operations.

a. Financial Performance of Chams Switch

The trend in profit margins and turnover of the three subsidiaries of Chams Plc between 2014 and 2019 give an indication of the financial difficulties the firm faced during the economic recession in Nigeria. These difficulties were further compounded by the firm's decision to write off the outstanding balance on investments made for the cancelled national identity card project in the 2015 financial year. Recovery has been slow for the group, but ChamsSwitch has recovered faster than the other subsidiaries, recording a 23% net profit margin in 2019 in comparison to 9% for Chams Access and 1% for the Card Centre. Although turnover by ChamsSwitch is about a tenth of the other subsidiaries, growth in turnover was much higher at 36% compared to 19% for Chams Access and 8% for the Card Centre. However, turnover declined significantly in 2019 indicating a decline in the transactions being processed by the firm. Gross profit margins for the three subsidiaries converged to a low level as of 2019, signalling the declining profitability of the firm and its subsidiaries. The declining profitability of ChamsSwitch is most likely due to pressure from other emerging fintech firms which are offering substitute products and competing away its share of the fintech market in Nigeria. This has resulted in a diversification of the firm to other sectors, most likely to make up this loss of market share in the sector driving growth of the IT sector in Nigeria. There is no indication that this performance will improve over the short to medium term without a significant injection of capital and talent.

Figure 5.6: Growth in Turnover (2014-19)

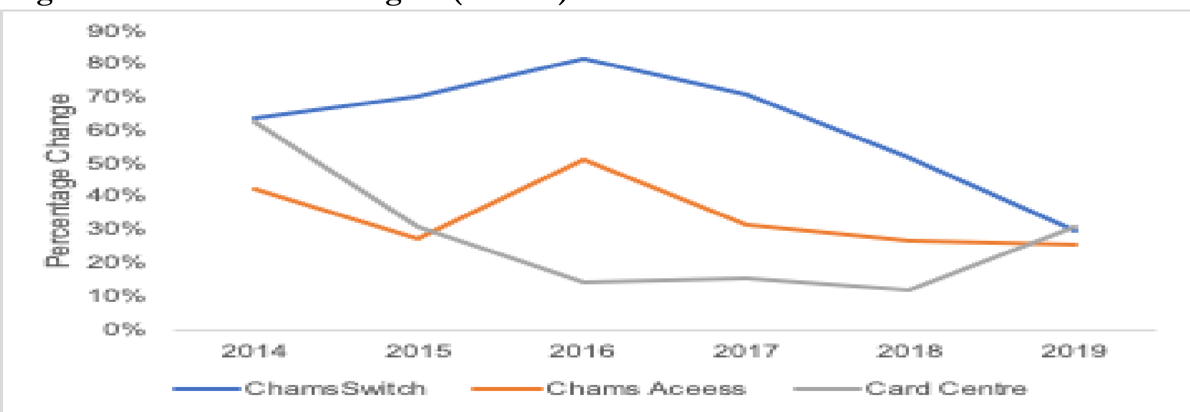


Source: Author's calculations from 2012-2019 Financial Statements of Chams Plc

It is difficult to rank ChamsSwitch against other transaction switching and payment gateway companies in Nigeria since it is the only firm in this category listed on the NGX. Other companies in this category such as Interswitch, Paystack and Flutterwave, are not required to disclose corporate performance information. The financials for ChamsSwitch and the other subsidiaries points to a struggling firm very slowly returning to profitability and it is the expectation of firm management that its performance will improve in subsequent years as it diversifies away from public sector contracts to providing services to private clients.

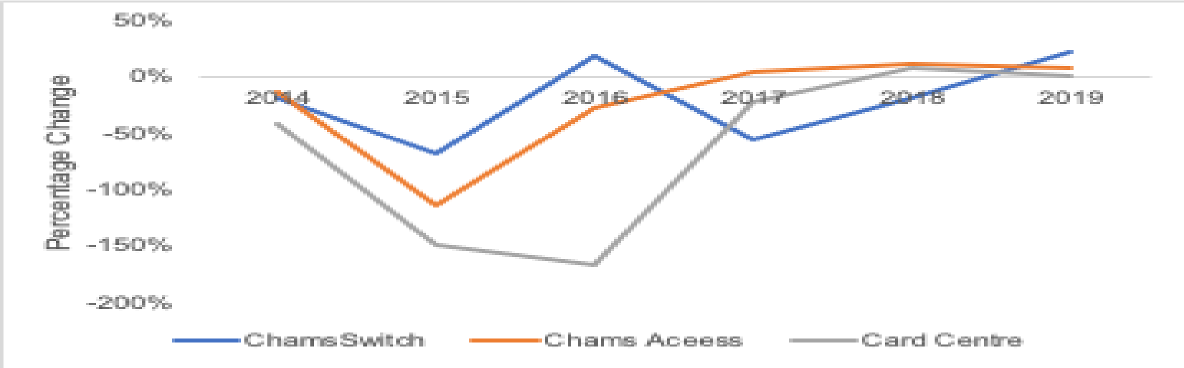
As earlier mentioned, it is not clear that ChamsSwitch can outcompete its younger rivals with access to funding denominated in foreign currency from venture capitalists, accelerator firms and the acquisition of equity by MNCs, which an 'established' and less nimble firm like ChamsSwitch cannot access. This has become even more relevant in Nigeria as the Naira has been continuously depreciating since at least 2015 and most of the hardware equipment, software and licenses are fees are denominated in foreign currency.

Figure 5.7: Gross Profit Margins (2014-19)



Source: Author's calculations from 2012-2019 Financial Statements of Chams Plc

Figure 5.8: Net Profit Margins (2014-19)



Source: Author's calculations from 2012-2019 Financial Statements of Chams Plc

5.4.4. Consumption/Fiscal Linkages

Consumption linkages as defined by Hirschman (2013), are the roundabout way in which revenues from the sale of primary export commodities stimulate demand for import goods, many of which are then produced locally through import substitution. In the case of Nigeria, these consumption linkages can be analysed side-by-side with fiscal linkages as revenues from the sale of oil and gas commodities represent about 70% of general government revenues and over 90% of foreign exchange earnings (NBS, 2020). Sales from agricultural commodities are also relevant given they constitute almost 25% of GDP.

As applies to many firms in the IT sector, the linkage between ChamsSwitch and the fiscal revenues arising from the sale of oil and gas and agricultural commodities is not directly observable. The firm reported no direct relationship with oil and gas and other export commodity sectors. It receives no subsidies from the state and is not eligible for the pioneer status incentive, duty waiver on imports and tax deductions which the NITDA is empowered to grant to IT firms which meet stipulated requirements.

Much of private sector activity in Nigeria is reliant on government patronage and 40% of Chams Plc sales are to a public sector run on oil and gas revenues, indicating the existence of consumption linkages. There is also little doubt that the investment of oil and gas revenues in the economy has increased demand for the types of IT services which companies like ChamsSwitch provides. In addition, the expansion of public services by the federal and state governments has stimulated demand for goods and services provided by Chams Plc, such as the national identity card and BVN registration projects.

However, this relationship between the firm and the public sector is not without its setbacks as demonstrated by the losses incurred by Chams Plc from the cancellation of the national identity card contract awarded to Chams Plc. Despite the prudent decision by the management of Chams Plc to diversity its customer base, the public sector will remain a key client for the foreseeable future given the under-developed private sector and the difficult business environment.

5.4.5. Technological Linkages

The cases of knowledge transfer observed in the study of ChamsSwitch are an indirect outcome of interactions with customers, vendors and competitors and do not occur through a direct cultivation of technological linkages. The technology ecosystem in Nigeria is relatively diffuse with very few cases of technological linkages between industry and research organisations. This is particularly pronounced in the case of the IT sector as the knowledge gap between the industry in Nigeria and local research organisations is wide. ChamsSwitch has no relationships with domestic or foreign research organisations and the absence of an in-house R&D department, or a dedicated R&D budget indicates this is not a priority for the firm at present.

Chams Plc. maintains a technical partnership for its card management system with Brain Behind Limited, a UK based software solutions development firm. The firm maintains the ChamsSwitch card management system and although the relationship has led to the transfer of knowledge to technical staff of ChamsSwitch responsible for maintaining the system, this can be considered a weak technological linkage. This assessment is due to Brain Behind Limited retaining control of the proprietary technology and limiting knowledge sharing to what is essential for the efficient running of the card management system.

Chams Plc. has technical partnerships with some local firms which include Instiq Technologies for its core banking application, the NIBSS [42] for its electronic payments and collections system and Supersoft Technologies for transaction switching. These arrangements are similar to those with Brain Behind Limited with very little knowledge transfer occurring.

The underdeveloped technological linkages between ChamsSwitch and potential sources of knowledge are emblematic of fintech firms in Nigeria judging by the response to the survey implemented for this study. Most firms acquire foreign technology, utilise these in developing products sold to customers and update their knowledge through training, attendance of workshops, conferences and seminars, online searches and other interactions already discussed. This limits the potential for companies like ChamsSwitch to lead fundamental technological change in the markets served.

[42] A consortium including the CBN and all licensed banks in Nigeria which operates the Nigeria Automated Clearing System (NACS), facilitates the electronic clearing of cheques and other paper-based instruments, electronic funds transfer, automated direct credits and automated direct debits.

With no deliberate plan to invest in R&D or product development, the firm is limited to 'constrained reverse engineering' of products already in the market place. The reverse engineering of the firm is constrained because it has next to no access to the 'backend' of products it copies. It can only observe the 'frontend' operations and mimic the operations of these products in an imperfect way. Despite these limitations, the capabilities developed in the process of acquiring these skills is foundational to the development of stronger capabilities.

5.5. Case for Study of Manufacturing Sector Linkages

The manufacturing sector is the archetypal sector in the study of linkages. This thesis is predicated on finding evidence to challenge the claim that manufacturing is the engine of growth by considering if the IT sector, with its similarities to manufacturing, can be an alternative driver of economic growth. Thus, an examination of linkages between IT and the manufacturing sector is fundamental to this thesis.

As a pre-industrial economy, the manufacturing sector in Nigeria accounts for only 8.8% of nominal GDP, a proportion that has remained relatively stable over much of Nigeria's history (NBS, 2020). As expected at this stage of Nigeria's development, food, beverage and tobacco manufacturing represents more than half of manufacturing's contribution to GDP while advanced manufacturing activities, such as electrical and electronics manufacturing, represents less than 1% of GDP (NBS, 2020).

Given these numbers, the expectation would be for non-existent or weak linkages between the manufacturing and IT sectors. This expectation is supported by the results from the survey of IT firms in Lagos as few firms reported links to the manufacturing sector. However, there were a few instances of firms operating at the interface of manufacturing and IT in Lagos. One of these examples is Elephab, a 3-D (Three-Dimensional) printing/additive manufacturing start-up. A linkage analysis of the firm is presented in the next section and is based on the responses to the firm survey and interview completed by Anjola Badaru, the Chief Executive Officer (CEO) and a co-founder of the firm as well as desk research.

5.6. Elephab: Building Replacement Parts by 3-D Printing

5.6.1. Firm Background

Elephab was founded by Anjola Badaru and Damilola Akinniyi in 2017. Both men graduated from the Federal University of Technology, Akure, Ondo state, Nigeria, Mr. Badaru with a Bachelor of Technology degree in Industrial Design in 2014 and Mr Akinniyi with a Bachelor of Engineering degree in Electrical/Electronics Engineering in 2010. Prior to this, Mr. Badaru completed a Bachelor of Science degree in Computer Science at Bowen University in Osun State Nigeria.

The co-founders' participation in a General Electric (GE) Lagos Garage program afforded them the opportunity to acquire skills in advanced manufacturing technologies using 3-D printers and CNC (Computer Numerically Controlled) machines (General Electric Garage, 2012). The GE Lagos Garage was created in 2012 as an innovation hub for budding entrepreneurs to receive training in new manufacturing and production technologies. The permanent installation for the garage was launched in 2016 and is co-located with the GE office in Lagos.

Skills acquired at the program inspired the co-founders to create a 3-D manufacturing firm in Lagos to address a gap in the market for locally made replacement components for use in the manufacturing and transport sectors amongst others. Utilising seed funding from Beta Ventures, an early-stage investment firm run by Nigerians but based in the United States, Elephab commenced operations in 2017.

Firms like Elephab challenge the conventional use of the three main sectoral categories to classify firms due to the deep integration between IT and traditional manufacturing techniques in the machines used in creating output. This case study enables a close examination of the linkage formation between these two closely interrelated sectors.

a. Knowledge, Learning & Innovation

A small but close-knit community of entrepreneurs in additive manufacturing is emerging in Lagos state. Due to the novelty of the technology and the common challenges these companies face, there is free exchange of knowledge and sharing of equipment and other resources. Both co-founders of Elephab have industrial design and/or engineering backgrounds and leveraged this knowledge to maximise the learning opportunity given by the GE Lagos Garage program. Elephab is considered one of the success stories of the program and the firm is prominently featured on the program website.

All staff of the firm have at least a bachelor's degree and hold Microsoft certifications. Several staff members also have knowledge of Ansys, Arduino and Raspberry Pi, programming languages which are essential for 3-D design. The firm makes use of all available opportunities to acquire knowledge, and this includes online resources, subscription to industry journals, attendance of conferences, trade fairs or exhibitions, membership of industry associations and information from suppliers.

In response to the relatively high cost of imported inputs, the management of Elephab took a decision to scale back operations in 2018 and invest most of its seed funding in R&D to develop methods for producing inputs locally. To accomplish this, 80% of total expenditure was committed to R&D. Plastic filaments previously imported are now produced using locally manufactured plastic pellets. The filaments are fabricated using the Field Filament Method which involves melting and layering the plastic to create a filament.

The firm took the decision to clone 3-D printers from its already existing printers, reducing the cost of its principal key input significantly. The firm also benefits from a global open-source environment where online instructional videos are available and designs and code uploaded on online application and hardware development communities such as GitHub can be used to produce most of the components for the machines, importing only components which cannot be printed.

This management decision was not costless as funds which were intended for operations were diverted into R&D; however, the firm considers this investment a necessary and beneficial one as it reduced the cost of filaments by about 90%, making the firm's products more competitive. The firm was also able to retain its clients during this production break and ascribes this to the quality and pricing of its products. This innovation has also elevated the firm's status in the 3-D printing community in Lagos. Although regret was expressed at converting operating capital to R&D, this decision was ascribed to a lack of experience but was seen as a necessary step to ensure the firm's viability.

Learning by doing and learning by using are the key approaches for knowledge acquisition at the firm. This mode of learning also impacts the choice of technology utilised by the firm. The firm does not use resins in its design although this would result in a higher quality product. Resins are a viscous substance that can be converted into rigid polymers. The main reason given for this choice is a preference for the ease of knowledge transfer as the process of mastering the use of resins involves a steep learning curve and the CEO expressed a preference for all technical staff to understand the production technologies utilised. Other considerations in technology selection include access to raw materials, speed of production and cost of knowledge acquisition.

Elephab has demonstrated its resilience and adaptation to a difficult operating environment. 3-D manufacturing technology is relatively new to the Nigerian market with few companies offering the service. Given the difficulties of the operating environment, the limited local knowledge and lack of government support for the industry, the few firms operating in the sector while competing also provide support and assistance to each other. This allows the firms to overcome some of the challenges in the local operating environment.

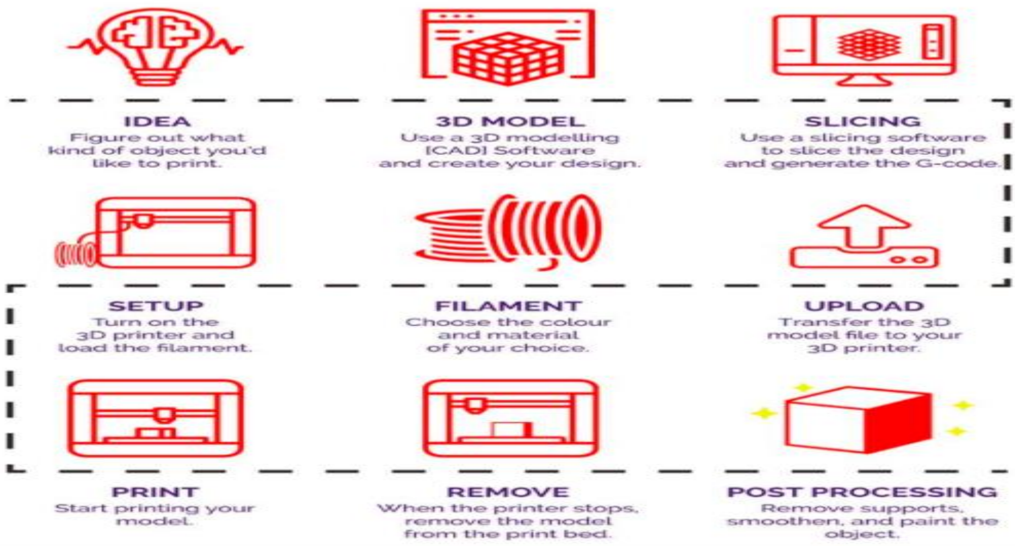
The production, fiscal, financial, consumption and technological linkages between Elephab and the Nigerian manufacturing sector are discussed in the next section.

5.6.2. Production Linkages

The limited local manufacturing capacity in Nigeria has created latent demand for cheap intermediate components for manufactured products. Several studies of the Nnewi automotive cluster in Anambra state in South East Nigeria refer to the decline in the late 1990s of a growing automotive components manufacturing industry in Nigeria (Abiola, 2008; Oyelaran Oyeyinka, 2001). Many manufacturers in Nnewi and other manufacturing clusters in Nigeria rely on imported inputs but persistent depreciation of the Naira, high tariffs, limited access to finance, onerous custom processes and duties led to the closure of many firms that could not compete with cheap imports, mainly from China (Abiola, 2008).

This demand for intermediate components is currently met by a thriving market for used or 'second-hand' components and cheap sub-standard imports. The founders of Elephab set themselves the goal of providing quality alternatives to the available options by replicating components using 3-D printing techniques. Rather than the traditional approach of injection moulding, the object for reproduction is modelled using Computer-Aided Design (CAD) software or a 3-D scanner. The resulting image is 'sliced', a process by which the 3-D model is converted into machine-readable instructions. The image file is transferred to the printer, the filament used to create the model is loaded and the item is built in layers (Figure 5.9). Once post-processing is completed the item is delivered to the client.

Figure 5.9: 3-D Printing Process Flow



Source: Stempedia, 2018

Each stage of the production process summarised earlier is considered next to identify the production linkages present.

a. Production Process

i. Concept Development Stage

Since the firm is typically creating a replica of an already existing product, the design specifications are usually available. In the few cases when the client makes a request for modifications to a specified design, the needs of the client are considered, and various design options produced. At this stage, reference is made to already existing product designs available online that can be modified for the client. The GitHub platform, an online repository where software developers store and share software code and product designs, is a key source of inspiration in conceptualising designs to serve client needs.

ii. Product Design Stage

The firm designs the items it produces using CAD technology. This involves modelling the item, cutting the 3-D design generated using the 'slice' command into the distinct layers to be printed and generating the instructions for interpretation by the 3-D printer using G-code, a programming language for control of CNC machines. Designs can also be created using 3-D scanners, but at the time of the interview, only one 3-D scanner, owned by Nigerian Foundries Limited, was operational in Nigeria. A 3-D scanner is a faster and precise method for building three dimensional models as it collects point data which serves as an input for printing.

Only 35% to 40% of Elephab's clients approach the firm with their own designs as the production request often involves the production of a design. Elephab is in the process of developing a mobile software application by which customers can photograph the items to be reproduced from various specified angles and send these to the firm digitally. The resulting images would then be cross-referenced against a database of already existing products, the specifications confirmed with the client and the transaction concluded on the application.

It is critical for the firm to understand the production process of customers who utilise the components produced as intermediate inputs in their value chains. This makes it possible to introduce design alterations to suit client needs. Adjustments must also be made to designs in cases where the plastics utilised vary from the original design. Customer feedback is essential at this stage, as demonstrated in a case where a product fractured after a few uses and a vertical frame was added for strength and stability to an original design comprised entirely of horizontal frames. Another example is the case of production of chocolate moulds for a Nigerian chocolatier which required research into the use of food-grade plastics (polycarbonates), an area the firm had not explored previously.

iii. Production Stage

This stage involves printing the completed design with a 3-D printer. Thermoplastic filaments of various diameters and lengths are used as feedstock for printing. Previously, the firm used imported filaments but found this was not cost-effective as it tied up scarce capital in inventory since items were produced in small batches and filaments are sold in large spools. A decision was taken to source for raw plastic pellets locally for stringing into filaments using extruder machines.

Constraints in the local environment have also resulted in several design alterations in the course of production. The internet-capability features in the 3-D printers which would have allowed remote printing cannot be activated given the high cost of internet subscriptions and instability of internet connections in Nigeria. The unstable and irregular power supply in Nigeria also necessitates the constant monitoring of print jobs although the power consumption by the 3D printers is relatively low, enabling the powering of two printers off a single solar panel for a daily production run.

The ambient temperature in Nigeria is also a key consideration as it is necessary to ensure the machines do not over-heat. The melting point of locally produced plastics must also be considered in design development as they are found to vary from specifications in designs found online. The firm sources plastic pellets from SABIC and Bayer distributors in Nigeria and purchased its first set of 3-D printers from BTN 3D, a Spanish firm and Airwolf 3D, an American manufacturer of 3-D machines.

Products designed by Elephab include electronic consoles, front grilles for vehicles, shoe lasts, gears and the casing for a medical device. Although these could be considered trivial and technically uncomplicated items, developing proficiency in the manufacturing of these parts has led to opportunities for innovation which are discussed in the section on technological linkages. Unlike the case with advanced industrial countries where it is cost-effective to replace tools and machines outright rather than undertake costly repairs due to the relatively higher cost of services compared to pre-industrial countries, there is a thriving market for replacement component parts in Nigeria. Given that many Nigerians can only afford ‘used’ or ‘second-hand’ manufactured goods such as vehicles, electricity generators, household electronic equipment amongst others, there is a constant need for replacement parts. The asymmetry of information in the market for used products and the resulting opportunities for fraud represents a risk which can be curtailed by procuring 3-D printed components based on original design specifications and using known materials; however, it is doubtful that Elephab can compete on cost with imports from countries like China given the small scale of operations and the inability to benefit from economies of scale, the high cost of inputs and the difficult operating environment in terms of infrastructure, access to finance and onerous government regulations.

Figure 5.10: Elephab Products

Source: Elephab (2018)

iv. Post-Production Support Stage

Elephab provides after-sales support to customers as the concept of 3D technology is new to most of its customers. The firm tries to make the delivery process as seamless as possible and partners with delivery firms to ensure clients receive their products in a good state. As Elephab is currently focused on the production of relatively simple replacement parts the level of post-production support provided is rudimentary.

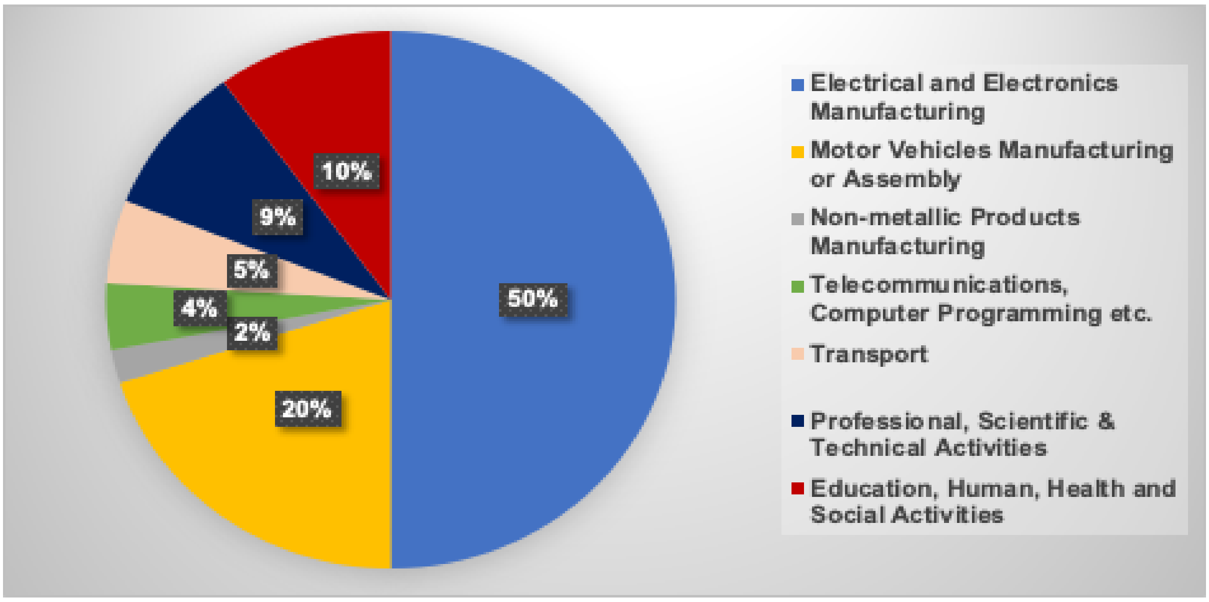
b. Backward and Forward Linkages

Given the restructuring of the business to use locally produced plastic filaments, links to the Nigerian plastic and rubber products manufacturing sector are being deepened; however, given the relatively limited scale of production activities by the firm, the impact is small and it doubtful that the firm is able to negotiate competitive prices based on low volumes. Although the initial set of 3-D printers used by the firm were imported from Spain and the United States of America, most of the component parts of subsequent printers have been digitally printed, resulting in a lowering of input costs. Codes for printing a new 3-D printer from an existing 3-D printer are available online and the co-founders have been able to print additional printers by leveraging on their engineering and design background to implement the online instructions.

Elephab serves a modestly diverse set of customers, mainly in the manufacturing sector. It serves both wholesale and retail clients although the former represents the bulk of clients at 89%. The firm mainly serves private sector clients as only 1% are from the public sector. In the first year of operation, the firm served clients in the manufacturing (electrical and electronics, motor vehicle manufacturing or assembly and non-metallic products manufacturing); telecommunications; computer programming & consultancy and information service; transport; professional, scientific & technical; and education, human, health and social sectors.

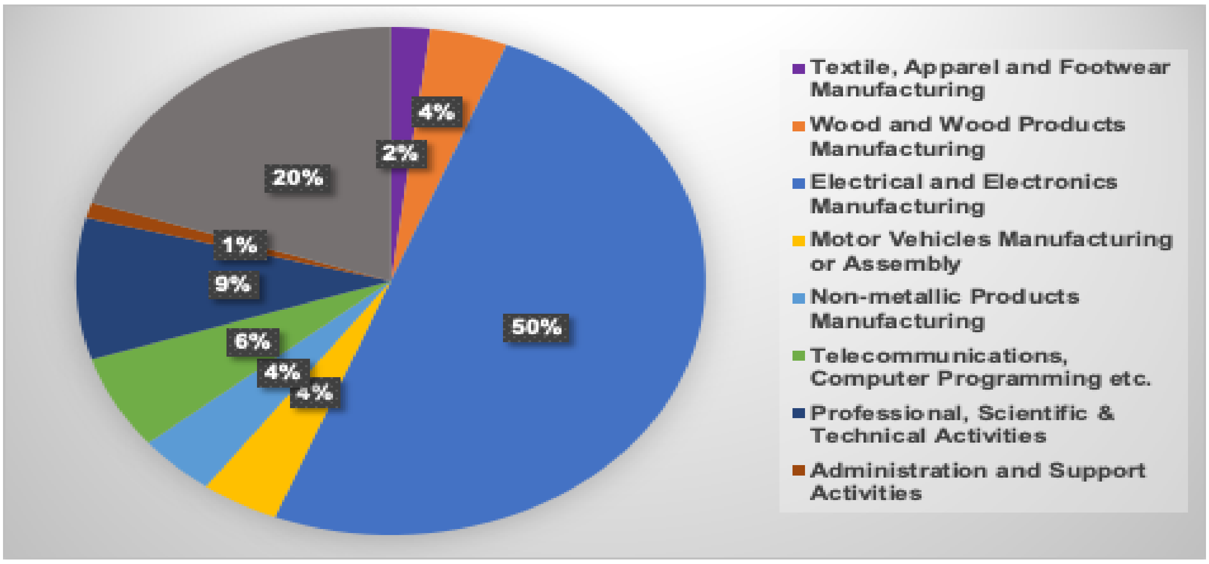
It continues to serve these sectors but has expanded its reach to textile, apparel and footwear manufacturing; wood and wood products manufacturing; and administration and support sectors. At present, the main product manufactured by the firm is consoles for electronic devices, but firm management has identified new opportunities in other sectors.

Figure 5.11: Proportion of Sales by Sector (Year 1 of operation)



Source: Author's illustration from survey results

Figure 5.12: Proportion of Sales by Sector (Year 1 of operation)



Source: Author's illustration from survey results

5.6.3. Financial Linkages

As a limited liability firm, Elephab is not required to disclose its financial records. Aside from the initial seed funding the firm received from Beta Ventures in its first year of operations, it has relied on personal savings and contributions from friends and family. 86% of its start-up capital was provided by Beta Ventures, 5% from family and friends and 9% from personal savings.

Some of the firm's initial fixed costs were also covered by partners. In the first year of operation the firm operated out of the GE Lagos Garage in Victoria Island, Ikoyi Lagos. It benefitted from stable and regular power supply in this location, a non-trivial factor in a country where irregular power supply is one of the main constraints faced by businesses. Subsequently the firm moved to its own location on the Lagos Mainland where power supply is less stable and has impacted business operations negatively.

The firm currently re-invests its earnings in the business and has no immediate plans to seek another round of funding from financial institutions, venture capitalists or other funding sources. Most of the venture capital funding directed to Nigeria is targeted at the fintech sector and for this reason Elephab has struggled to raised capital. This lack of fund which required the firm to suspend operations to develop locally manufactured inputs must have cost the firm some of its clientele and created some distance with its competitors.

5.6.4. Fiscal/Consumption Linkages

Due to the bureaucratic processes involved in engaging with the federal or state governments, Elephab has not benefitted from any subsidies, waivers and other government incentives. The firm attempted to apply for funding from the Lagos State Employment Trust Fund (LSETF) but considered the process unduly onerous and decided not to pursue it further.

Given this negative predisposition towards government-run programs, the firm's founder is unaware of its eligibility for existing programs. This is not an uncommon attitude amongst IT entrepreneurs and Micro, Small and Medium Enterprise (MSME) owners in Nigeria as many view the government as an impediment to business rather than an enabler. The firm did not benefit from import waivers when importing its equipment as 3-D printers are treated as personal printers and not as manufacturing equipment. As a result, the full import duty was charged on these machines. This misapplication of import duties on imported equipment is prevalent in Nigeria and is an additional cost that firms face.

Given the importance of the oil and gas sector as a source of government revenues and foreign exchange, the firm indirectly benefits from the growth of the sector. Linkages to the agriculture, mining and other primary sectors are less observable given that much of the contribution of these sectors to GDP is driven by subsistence activities. At the time of the interview, the firm was not serving clients in the primary commodity sectors but ascribed this to information asymmetry. Acknowledgement of potential opportunities to provide replacement components for equipment used in these sectors and a desire to explore these was expressed.

5.6.5. Technological Linkages

Much like the case of ChamsSwitch and the fintech sector more broadly, Elephab has no technological linkages with domestic or foreign research institutes. 3-D Printing is a relatively new technology in Nigeria and given the limited research capacity of universities in Nigeria there is very little opportunity for collaboration. Elephab continues to leverage its original relationship with GE Labs which provided the technology and knowledge which allowed the firm to create its business. It also provided office space in the first year of the firm's operations and the co-founders continue to rely on GE Labs for technical support.

Beyond the support it receives from GE Labs, it leverages relationships developed with other founders in the additive manufacturing space and utilises online resources to develop its knowledge base. The community of entrepreneurs in additive manufacturing share knowledge and resources but not enough to compromise the competitiveness of each firm. Thus, to a large extent Elephab is yet to develop strong technological linkages within the technology space in Nigeria.

5.7. Case for Study of Agricultural Sector Linkages

The Nigerian agriculture sector employs almost 40% of the Nigerian population, many of them as subsistence farmers producing mainly for own consumption (World Bank, 2020). The sector contributes almost 25% to GDP, with crop production as the largest sub-sector; however, it operates below its potential (NBS, 2020). Sector challenges include high cost of farm inputs, an outdated land tenure system that limits access to land (1.8 ha/farming household), poor irrigation development (less than 1 % of cropped land under irrigation), limited use of research findings and technologies, poor access to credit, inefficient fertilizer procurement and distribution, inadequate storage facilities and poor access to markets (FAO, 2020).

The constraints in the sector cover a wide range of areas; however, a lack of application of widely available knowledge and technology is a critical factor impeding the sector's growth. The current Nigerian government has prioritised the sector in its long-term development plan, although this has not been matched by a commensurate level of funding or appropriate policy action. The CBN has also extended beyond its core mandate of maintaining monetary and financial stability to directly fund several agriculture investment schemes through low interest loans. The effectiveness of these schemes is the subject of debate as media reports point to a high default rate on the loans (Punch Nigeria, 2021).

The increased focus on agriculture by the government incentivised the development of several IT-enabled agriculture investment programs. Many of these IT-agro programs are 'crowdfunding' efforts which aggregate funds from retail investors for investment in agriculture projects via web-enabled applications. These platforms support the monitoring of investments and facilitate transmission of critical information to farmers. The lockdowns instituted in the early months of the COVID-19 pandemic in 2020 and increased clashes between nomadic herdsmen and farming communities across Nigeria made access to farm sites challenging leading to several of the 'agric technology companies' operating in the sector defaulting in pay-outs to investors.

Farmcrowdy was the first technology-enabled agrotech firm in Nigeria to adopt the crowdfunding model. In response to the security and access challenges in the farming sector, the firm took pre-emptive steps to restructure its business model from crowdfunding and now invests at several points along the agriculture value chain. The linkages between agriculture and IT as demonstrated in the firm's transition to its new operating model and its approach to technology use and deployment will be presented in a case study.

Information for this case study was sourced from the survey completed by Onyeka Akumah, the founder and CEO of the company; a questionnaire completed by Folake Akintimehin, People Operations Manager; phone interviews of Obi Luya, Head of FC (Farm Crowdy) Aggregation and Emmanuel Torty, Head of Technology; and desk research of publicly available information on the firm.

5.8. Farmcrowdy: Revolutionising Agriculture with Technology

5.8.1. Firm Background

Launched in 2016 as a digital agriculture platform to connect farmers with investors, Onyeka Akumah, the CEO and founder[43] saw Farmcrowdy as an opportunity to address funding challenges and increase youth participation in the agriculture sector. Onyeka earned a Bachelor of Science degree in Applied Information Technology at Sikkim Manipal University in India and worked in senior management roles in several IT companies in Nigeria, including major e-commerce firms Jumia and Konga, and online travel companies Wakanow and Travelbeta.

The impetus to establish the firm arose from the founder's inability to track investments he made in a farm and ensure quality inputs and appropriate technologies were being deployed by the farmer. He discovered these problems were widespread as he became aware of potential investors with limited access to information on the sector and farmers with limited access to

[43] Co-founders are Ifeanyi Anazodo, Akindele Philips, Christopher Abiodun, and Temitope Omotolani

credit and no appropriate mechanisms to match both parties. Technology was seen as a means to address this information asymmetry and bridge the divide between farmers and investors.

In its first year of operation, Farmcrowdy operated as a digital marketplace where investors could invest in agriculture projects such as poultry farming, cultivation of staple or cash crops and aquaculture, expecting a return on their projects at specified interest rates and within an agreed period. The opening and termination of agricultural projects were made to coincide with planting and gestation cycles of the produce and investors could access investment information on the firm's mobile phone application. At the closing of each project, the profit-sharing formula agreed at inception is applied and each party receives its profit share.

Farmcrowdy operated this business model successfully for about a year but was compelled to restructure its business model for reasons previously detailed. Faced with the possibility of huge losses, the decision was made to diversify risk by adopting a vertical integration model and operate at various points along the agricultural value chain. Farmcrowdy consolidated Farmgate Africa, a separate trading platform it created for wholesale and corporate off-takers of agricultural produce, under the Farmcrowdy Group. Following the consolidation, six divisions were created namely:

1. FC Structured Finance: raises capital for investment in farms;
2. FC Aggregation: amasses output from farms to sell wholesale to agro processors;
3. FC Foods: sells farm produce to retail customers;
4. FC Insurance: provides insurance to farmers;
5. FC Technology and Data: runs the technology infrastructure that gathers analytical data for use in business decisions and connects the Farmcrowdy community;
6. FC Marketing: manages publicity for the firm.

Plans are underway to further expand the business by launching a commodity trading platform, develop an ago-processing unit, and eventually transition into export markets. Thus, in a few years Farmcrowdy has evolved from a crowdfunding platform, created to address the problem of access to finance for farmers, to a firm with subsidiaries/divisions which operate at key points of the agriculture value chain.

a. Knowledge, Learning and Innovation

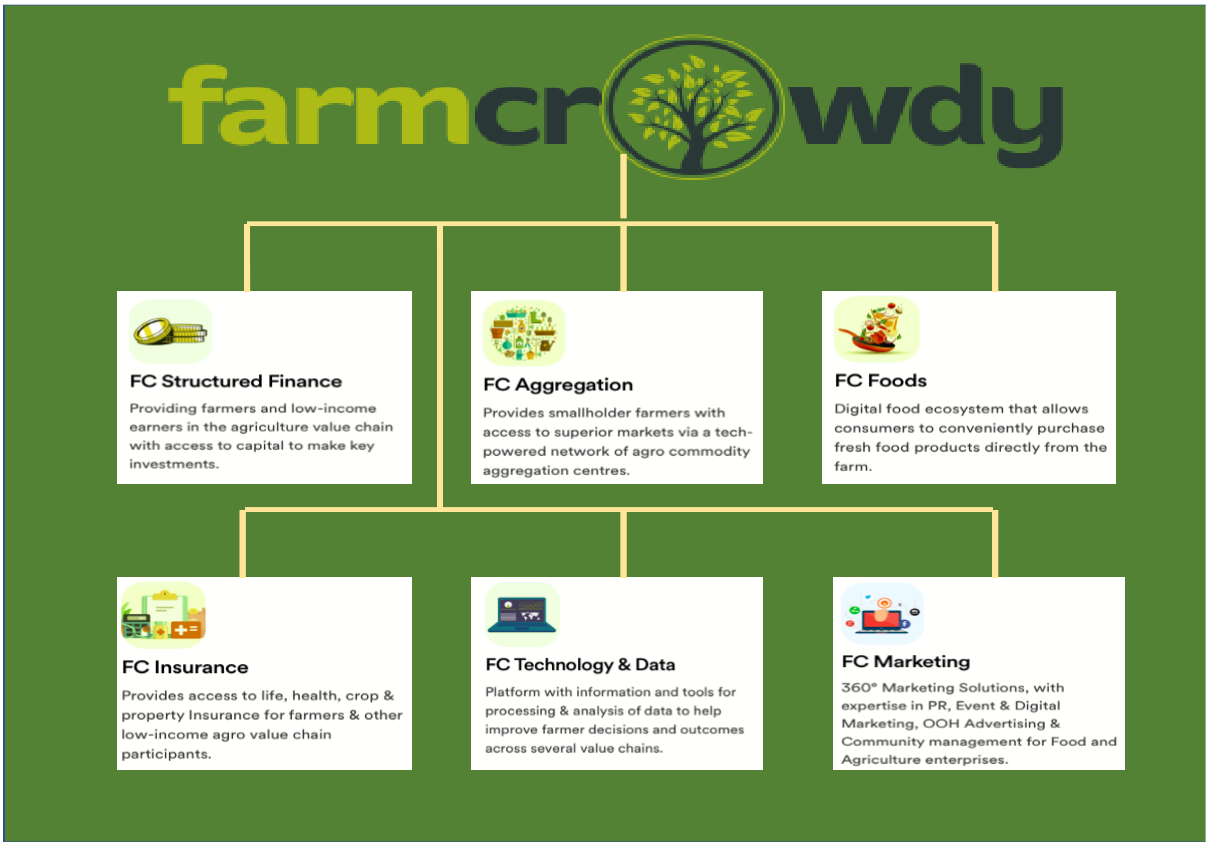
Farmcrowdy maintains an 'open knowledge' culture where both knowledge and information are shared across all levels of the organisation and the free exchange of ideas is encouraged.

Information is disseminated to staff members through town hall meetings, WhatsApp group chats and other forms of technology. All forms of learning available are used by the firm, with an emphasis on learning by using and learning by doing. This is evidenced by the firm's responsiveness to changes in its operating environment and adjustments to its operating model.

Training programs are both 'on the job' and tailored specifically to meet the needs of the staff but some training programmes are targeted at all staff. For example, all staff have received training in business law to ensure all contracts and agreements meet the requirements of the law. The technology staff also receive training specific to the tasks they perform. Unlike the other two cases, Farmcrowdy takes a more deliberate approach to training its staff and states that it does not leave training to the discretion of staff members.

With this background information on the firm, the production, financial, fiscal/consumption and technological linkages between Farmcrowdy and the agriculture sector in Nigeria are assessed in the following section.

Figure 5.13: Farmcrowdy Corporate Structure



Source: Author's illustration using information on the Farmcrowdy website

5.8.2. Production Linkages

In the analysis of production linkages between Farmcrowdy and the agricultural sector, a value chain approach is adopted as each division of the firm provides support at specific points in the production value chain.

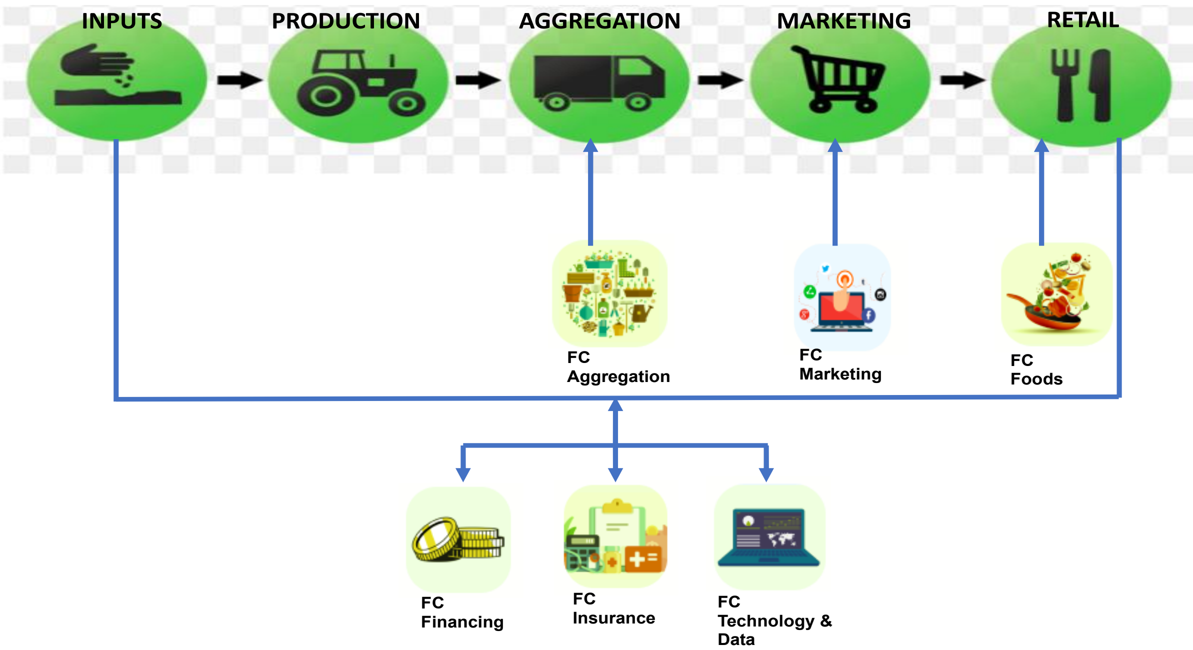
a. Production Process

i. Stage 1: Input

- **The Farmer Acquisition Process**

Launching a farm project is typically a 2-to-3-month process for Farmcrowdy. It involves selecting a crop for cultivation guided by metrics such as climate and weather patterns, existing demand for the crop and farm location. Once the crop for planting is selected, potential farm partners are identified. Rather than work with individual farmers, Farmcrowdy partners with farming communities or associations to mitigate risk and benefit from economies of scale and scope.

Figure 5.14: Farmcrowdy contribution to agricultural value chain



Source: Author's illustration using images from (Farmcrowdy, 2020) and (FAVPNG, 2018)

Prior to the registration of a farming community with Farmcrowdy, reconnaissance visits to the farm or other agricultural establishment of the individual members are conducted. These visits are to ensure there is no dispute over ownership of the land or other property and to determine the suitability of the farm for the production of the earmarked produce as determined by soil and other tests. The farmer's years of experience and creditworthiness are also considered and metrics such as the farm geo-coordinates obtained.

Field agents employed by Farmcrowdy visit the farms and collect data via a mobile app which can be saved on the app and uploaded to the firm's database subsequent to the visit. Data is compiled on land size using the Global Positioning System (GPS) functionality of the app, on expected yield and land availability and on this basis, potential partners are identified and contracted to provide mechanisation services and farm inputs. On completion of the registration of the farming community and identification of partners, the financing of the project commences.

- **Project Financing & Insurance**

Farmcrowdy initially depended on retail investors or 'sponsors' through its crowdfunding application to finance its farming projects. It pioneered the use of technology to raise funds for farming investments in Nigeria but with the entry of other firms into the space, the decision to look beyond retail clients to seek long term sources of financing was taken. The inconsistency in repayment of loans by farmers also contributed to a decision to pivot towards long-term funding from wholesalers and large agro-processing firms. The crowdfunding app has been spun off as a separate investment platform named Crowdyvest, where retail investors can still sponsor farm projects and other 'impact-driven' projects. In recent times, Crowdyvest has faced challenges with meeting its obligations to customers and ascribes this to debt acquisition, failed projections and default by partners. It is not clear the operating model adopted by Crowdyvest was sustainable in the Nigerian environment where DMBs charge high interest rates to cover operating costs and costs associated with defaulting customers (Nairametrics, 2022).

The funds to finance projects are not paid directly to farmers but are utilised in financing the projects end-to-end: improved seeds, extension services, fertiliser, labour, mechanisation, land preparation etc. These inputs are sourced through partners such as Hello Tractor (mechanisation), Sygenta (seeds and agrochemicals), Notore and the Office Chérifien des Phosphates (OCP) Group (fertiliser), Agricultural Services Training Centre in Vom, Plateau (extension services) amongst others. Farmcrowdy has adopted this model to counter challenges in Nigeria where credit registers and bureaus are in infancy and the cost of litigation to recover debt is high.

All farm projects developed by Farmcrowdy are insured by its partner, Axa Mansard Limited, in collaboration with commercial banks in Nigeria. The penetration rate of agricultural insurance amongst farmers in Nigeria is relatively low; however, the need for insurance was validated by the clashes between herdsmen and farmers in many farming communities across the country which escalated in 2015, has persisted since and led to the destruction of crops and reduced access to farms (J. W. Hansen et al., 2017). For this reason, Farmcrowdy ensures all farmers on its network are covered by life, health, crop, goods-in-transit and property insurance.

As previously mentioned, the lockdowns instituted in many states in Nigeria to curtail the coronavirus pandemic also reduced access to farms and impeded transport to markets. This led to losses for farmers and some of the agricultural tech platforms investing in the sector. For example, in October 2020, Thrive Agric, a technology-driven agricultural firm, was unable to fulfil investment claims by its clients resulting in the intervention of one of its key investors, Ventures Platform, and the appointment of Adia Sowho, an IT veteran, as interim CEO to restructure the firm and bring it to profitability. The decisions taken by Farmcrowdy to seek long term financing and diversify risk seem to have forestalled similar problems for the firm.

ii. Stage 2: Production

At the production stage, all the inputs marshalled by FC Financing are utilised in the planting of crops, farming of aquaculture and rearing of poultry and other livestock. Farmcrowdy supports the entire production process end-to-end, from planting to transportation to end users and ensures farmers are supported at every stage of the process. Farmcrowdy raised US$15 million for 25,000 farmers between 2016 and 2019, which has been used to cultivate over 17,000 acres of farmland, raise 3,000,000 chickens and process 2,000 bulls (Farmcrowdy, 2020).

Farmcrowdy works with farming communities through its technical partners to ensure inputs are delivered to farmers on a timely basis and are properly deployed to ensure maximal yield. All of the inputs are sourced locally or from local firms with Farmcrowdy coordinating the procurement process end-to end. Farmcrowdy does not hand over cash directly to farmers to reduce moral hazard risks but partners with First City Monument Bank (FCMB) to provide mobile wallets on an app developed for the farmers through which they can procure farming inputs alone. Talks are ongoing with Eyowo, a company which provides mobile banking services, to improve the wallet's functionality. Technical field specialists work with the farmers and provide training on good agronomic practices. At present, the firm works in all of the 36 states in Nigeria and plans to expand its operations across the continent using the same business model.

Sponsors can invest in projects with a minimum of N20,000[44]. The investment period aligns with the crop cycle and can run from 3 to 5 months for poultry and 9 months for cassava (Atuahene-Gima & Amuzu, 2019). Sponsors monitor progress on the farm through the Crowdyvest mobile application by which they receive updates, usually bi-weekly. In addition, periodic field visits are scheduled for sponsors to monitor progress on the farms.

At the conclusion of the farming season, profits realised on the farming projects are shared in a 40:20:20 split between the farmer, investor and Farmcrowdy. This rate can vary based on the rate of return agreed with the investor upfront (Sorunke, 2019). According to Farmcrowdy, its interventions have allowed farmers remain on their farms and expand their operations five-fold on average by enabling the use of previously uncultivated land. This has resulted in an 80% increase in income for farmers since the firm launched in 2016.

iii. Stage 3: Aggregation

A critical binding constraint for farmers in Nigeria and other countries in SSA is access to markets. This includes lack of infrastructure for processing and storing produce, poor transport links from farmgate to markets and limited knowledge of potential off takers for produce. Farmcrowdy has created an aggregation platform to solve these problems by creating 101 aggregation centres in 8 states where large-scale off takers and processing factories can purchase produce directly from farmers at farmgate prices. The intention is to eliminate middlemen and guarantee better returns for farmers (Farmcrowdy, 2020).

These aggregation centres where Value-Added Services (VAS) such as input disbursement, produce procurement, financial services and Good Agricultural Practices (GAP) training are provided are managed by young entrepreneurs from the local communities. Farmcrowdy utilises the 'Grainpoint' mobile phone application to facilitate these VAS and connect farmers with off takers. Grainpoint was developed in partnership with Novus Agro. At present the data collected via the Grainpoint application and in conjunction with the Farmer's app is used in setting product prices.

As of early 2020, 38,000 smallholder farmers utilise the Grainpoint application and the 'minimum commodity aggregation capacity' is 12,000 metric tonnes (Farmcrowdy, 2020). The firm has plans to expand its operations to agro-processing and access export markets directly and is currently in talks with potential partners to facilitate this process.

[44] Equivalent to US$ 52.77 at official exchange rate of N1 to US$0.0026 as of October 2020

iv. Stage 4: Marketing

The goal of the marketing arm of Farmcrowdy is to create brand awareness for food and agriculture enterprises through public relations, advertising and digital marketing. One of the main platforms to achieve this goal is its online community of agricultural enthusiasts, Agricsquare. According to the firm, about 25,000 people had signed on to the platform by early 2020. Users on the platform share information, seek and receive agriculture tips and engage with sub-communities discussing subjects of interest. A review of the community website shows a high level of engagement by users and knowledge sharing on farming techniques, funding opportunities and advertisements of work opportunities.

FC Marketing is the newest arm of the Farmcrowdy business and is managed in-house with the use of technology.

v. Stage 5: Retail

A decision was taken by Farmcrowdy's management to extend its operations to e-commerce to serve the retail end of the market. Data on consumer patterns acquired through the firm's apps, market surveys and focus groups are used in the projection of future consumer behaviour and to drive investment decisions and identify potential yield and profit opportunities. FC Foods is an online marketplace where produce from the farms, as well as locally produced and imported processed foods, are sold to consumers. At present FC Foods has no physical outlets and all sales are completed online and delivered to customers through logistics partners.

Farmcrowdy expanded the scope of its retail operations to meat products through the acquisition of Best Foods L&P Limited in February 2020. Best Foods operations cover livestock processing (Best Food Livestock and Poultry), crop production (Best Food Fresh Farms), and marketing of agricultural produce (Naijapride, Best Food Dairy and Multi-Concepts). It runs one of the largest meat processing companies in Nigeria with the capacity to process 120-200 bulls daily (TechcityNG, 2020). These meat products are sold on the Meat Hub via the FC Foods platform.

b. Backward and Forward Linkages

Farmcrowdy's business model involves operating along the entire agricultural value chain. In only 4 years of operations, it adjusted its business model to form strong backward linkages to the agriculture sector by developing partnerships with the providers of inputs in the cultivation of crops. These partnerships have created job opportunities upstream while allowing the firm to focus on its core strengths of building community and addressing the binding constraints to agriculture in Nigeria all with the aim of generating returns for investors.

At present, forward linkages have been developed downstream to retail and wholesale trade and export markets. Agro-processing companies are some of the key off-takers from Farmcrowdy farmers and the firm intends to develop future capacity for food processing.

The partnership model under implementation implicitly reflects a linkage approach. In the early years of operation, the focus was on using technology to encourage investment in agriculture. In short order there was a realisation that technology alone could not overcome the deficits in the agriculture sector and the entire value chain would need strengthening to ensure profitability. Rather than attempt to provision all the inputs required in the value chain, the firm leveraged relationships with established partners in each input area to supply inputs and address the challenges encountered by farmers.

It is difficult to assess the success of these production linkages as the company is privately held and information to counter the narrative by the firm is unavailable; however, there have been no reports of disgruntled farmers or unsatisfied investors.

5.8.3. Financial Linkages

The transition from a high-risk retail investor model to long-term structured financing by Farmcrowdy was made possible by local and foreign investors. Farmcrowdy has raised US$2.4 million in five funding rounds with a total of 13 investors (Crunchbase, 2020). Initial interest in the firm was created during a visit to Nigeria by a scouting team from TechStars Atlanta , an accelerator based in Atlanta, USA (Disrupt Africa, 2017). Farmcrowdy was one of 10 firms, and the only African firm selected to participate in Techstar's 13-week accelerator programme. Completion of the programme was accompanied by seed funding of US$1 million which was utilised in expanding the firm's operations across Nigeria.

As the firm gained more traction it received additional investment from various sources which include a US$325,000 grant from the GSMA Systems Accelerator which was tied to the use of technology in its operations, specifically the development of mobile applications.

Table 5.1: Funding Rounds by Farmcrowdy

S/N	Date	Transaction Name	Number of Investors	Investor	Investor Location	Money Raised (US$)
1	July 10, 2017	Pre-Seed Round	2	1. Techstars Atlanta, COX Enterprises Social Impact Accelerator 2. Techstars	Foreign	0
2	August 1, 2017	Convertible Note	1	Right Side Capital Management	Foreign	100,000
3	December 18, 2017	Seed Round	10	1. Tyler Scriven 2. Techstars Atlanta, COX Enterprises Social Impact Accelerator 3. Techstars 4. Social Capital 5. Michael Cohn 6. Josephine Group 7. Hallett Capital 8. FC Agro Allied SPV 9. Cox Enterprises 10. Christof Walter	Foreign	1,000,000
4	February 26, 2018	Grant	1	1. GSMA Ecosystem Accelerator	Foreign	325,000
5	March 21, 2019	Seed Round	3	1. Techstars 2. Cox Enterprises 3. Ajayi Solutions	1.Foreign 2. Foreign 3. Domestic	1,000,000
	Total					**2,425,000**

Source: Crunchbase (2020)

Interestingly, most of the firm's investments are from foreign investors with its only local investor to date, Ajayi Solutions, coming in through a seed round in 2019. This is a paradoxical finding in the Nigerian IT sector as based on publicly available information domestic investors seem reluctant to invest in the sector; however, the results of the survey indicate that they are an important funding source.

Farmcrowdy has assisted registered farmers participating in the CBN's Anchor Borrower's Program (ABP) and the Agricultural for Food and Jobs Plan (AFJP) established by the Federal Government to mitigate the negative impact of the coronavirus pandemic. The ABP provides farmers with inputs through low interest loans and connects the farmers to off takers (anchors) to guarantee a market for their produce. The AFJP also provides input financing, but at zero interest rates and is intended to reach 1.1 million farmers across the country. The funds from these programmes are disbursed directly to the farmers and Farmcrowdy only assists the farmers in meeting the eligibility criteria for accessing the funds. The assessment of the success of these programmes is pending; however, Farmcrowdy has helped its farmers access the loans without bearing the risk of covering any potential default.

Farmcrowdy is seeking to extend its operations beyond Nigeria. An insurance company in Jamaica has expressed interest in its Farmer's app, by which farmers purchase insurance. The firm is also trying to integrate this app with its mobile wallet to allow seamless operations.

5.8.4. Consumption/Fiscal Linkages

Although the agriculture sector represents the largest sector share of GDP in Nigeria, its contribution to tax revenues and foreign exchange is limited due to the large concentration of smallholders in the sector. Although it is the main source of livelihood for many Nigerians, low yields, limited access to finance amongst others have impeded the sector's growth and done little to stimulate consumption linkages in the economy.

The link between the oil and gas sector and the agriculture industry is evidenced by the investment of government in the sector. This link takes the form of fiscal rather than horizontal linkages as all levels of government commit significant resources to the sector. The CBN, which should ordinarily be concerned with monetary policy, has expanded its developmental role and made large investments in the sector since the 1970s.

There are conflicting reports on the successes of the various government schemes and given the absence of impact evaluations by the CBN to determine the effects of its interventions, it is difficult to determine if the support has been beneficial. Available information on food inflation, unemployment and underemployment in Nigeria, all of which are trending upwards, do not give an optimistic picture of the interventions by the government and its agencies in the agricultural sector.

5.8.5. Technology Linkages

Farmcrowdy was originally conceived as a firm utilising technology to address bottlenecks and stimulate growth in Nigeria's agriculture sector. It was an innovator in the use of crowdfunding via a mobile application to aggregate investment in agriculture in Nigeria. Technology underlies each of the subsidiaries of the group and this feature has been a major selling point for the group, especially with foreign investors. The grant from GSMA for example, was predicated on the firm's use of technology to improve farming practices.

The firm was initially known for developing a mobile app for connecting investors with farmers but has expanded to using IT to create other tools deployed to improve productivity. These include data analysis, market analysis, pricing decision-making, yield projections and optimization, and GPS and weather tracking tools. The firm maintains a large in-house IT team, FC Technology and Data, which develops the apps and maintains the technologies used by the firm.

Specific applications developed include the Farmcrowdy web platform, FC Foods web platform and mobile apps (Android and iOS), the Meathub web platform and mobile app, Grainpoint mobile app and off taker/processor web platform, an inventory management system for the Best Foods facility and the Farmcrowdy Farmers mobile app. The Grainpoint app was originally developed for Novus Agro but is now in use by Farmcrowdy for its aggregation activities. Other technologies utilised are deployed by technical partners and these include drones to map out large farms and soil-testing equipment to produce soil temperature maps to determine the ideal soil temperature for crop cultivation and high yield.

Key technology platforms utilised in building applications include MySQL, Laravel and Java while programming languages such as Java, PHP, JavaScript and Python are used in coding. This has enabled the development of innovative apps and other products to connect famers to sponsor and also to share information utilised in making timely planting and investment decisions.

The group makes a modest investment in R&D, committing 2% of expenditures in 2017 and doubling this to 4% in 2018. Technical partnerships are maintained with organisations such as the International Institute of Tropical Agriculture (IITA) and the Pan-African University in Lagos to introduce farmers to innovative and cost-efficient agricultural practices. The absence of government support or intervention is discernible as the firm has not benefitted directly from public R&D funding or technical partnerships mediated through the government.

5.9. Summary

This chapter is devoted to the examination of linkages as defined by Hirschman between selected firms in the IT sector and the agriculture, manufacturing and financial services sectors in Nigeria. Although the linkages, namely production, fiscal/consumption, financial and technological are either Hirschmanian or are inspired by his exposition, the methods applied in unpacking the linkages do not necessarily follow the input/output approach which he espoused (Hirschman, 1958). However, it must be noted that Hirschman himself acknowledged that linkages are worked out through time and stressed the limits of the use of input-output approaches (Hirschman, 1958, 2013). For this reason, a narrative approach was adopted in the analysis of linkages in this section. As indicated in the introduction, the exposition tends to lean towards the descriptive as there is need for rich descriptions of firm operations in the pre-industrial context. Due to the small size of many pre-industrial firms with very few of them listed on any stock exchange, access to information is very limited and it is difficult to obtain additional data points by which the information released by firms can be cross-referenced. Despite these limitations, the intent is to add to the case studies on firm-level analysis of linkages from the perspective of pre-industrial or less developed countries.

In the next chapter, a synthesis of all three case studies is provided, giving prominence to the capabilities of the firm and a capabilities-linkage matrix is developed as a means of re-examining the information presented in the case study.

6. CHAPTER 6: CAPABILITIES-LINKAGE MATRIX

6.1. Introduction

Linkage analysis is incomplete without addressing the question of the factors inherent to the firm which enable the development of these linkages. The technological capability framework developed by Lall (1992) and the digital production technologies framework of Andreoni and Anzolin (2019) are utilised in this chapter to identify firm capabilities, classify them according to their level of technological complexity and observe at which points they interact with the linkages presented in chapter 5. This synthesis of linkages and the capability framework is combined to develop a capabilities-linkage matrix which is applied to the firm case studies. In section 2, the case studies presented in Chapter 5 are synthesised while the matrix is developed in section 3. The matrix is operationalised in section 4 using the case studies while section 5 summarises the findings in the chapter.

6.2. Synthesis of Case Studies – IT as a Driver of Economic Growth

The three case studies presented in Chapter 5 demonstrate the diversity of outcomes in linkage formation between some of the key economic sectors in Nigeria and the IT sector. Although the results might seem specific to the firms or to the Nigerian case, some findings from the studies hold general lessons that apply to the pre-industrial context. It provides insight into the development of firm capabilities and formation of linkages in countries with small, underdeveloped manufacturing sectors. A review of the key findings from the cases and how this relates to the question of whether the IT sector can drive economic growth from the viewpoint of linkages is essential.

6.2.1. Production Linkages

The depth and intensity of production linkages fostered by IT is determined by the nature of the value chains operating in each sector. In all the cases, production linkages are present but not well developed, even for the sectors where the inputs are available locally. Most importantly, the linkages are expected to instigate activities downstream and upstream to the operations of these firms.

In the case of Farmcrowdy, the absence of an efficient agricultural value chain led to the company rethinking its business model significantly. The firm was compelled to develop new capabilities and enter into strategic partnerships with input providers to fill the gaps along the agricultural value chain. In essence, Farmcrowdy has found itself trying to singlehandedly develop an LPS to facilitate its business operations in the Nigerian market as a precursor to expanding to foreign markets. The firm saw this as the only way to ensure the business remained profitable. IT was critical in leveraging data gathered from farming operations to create knowledge inputs for better decision making by farmers. It also assisted in the development of forward linkages through the firm's Grainpoint application which was developed to address to some extent the problem of access to markets.

Time will tell whether this wholistic approach adopted by Farmcrowdy will be successful. In an advanced industrial context, firms are able to focus on their areas of core competence and plug themselves into existing value chains but in Nigeria and other emerging and less developed countries, markets do not always exist and when they do, they are usually not properly linked. Efforts by government to intervene and create these markets and linkages are not always successful. Farmcrowdy has taken on the onerous task of building out the value chain and developing the linkages connecting the blocks of the chain. Unless the firm can develop capabilities to operate each block competently, it might find itself stretched too thin, leading to the collapse of the value chain.

For Elephab, a decision was taken to locally produce key inputs for production as the alternative option of importation was proving financially unsustainable. Elephab was successful in reducing its input costs by sourcing these inputs at a reduced cost locally. Unfortunately, Elephab is operating in an unstable macro-fiscal environment where access to foreign exchange to source inputs, rising inflation and a high cost of utilities can easily render firms uncompetitive. Imports from markets like China tend to compete very favourably with locally produced inputs as the infrastructure to support manufacturing is present and producers are able to offer lower prices due to economies of scale. Unless the demand for its product increases, it is doubtful that a firm like Elephab producing small volumes can compete favourably.

Given that ChamsSwitch is supporting operations in financial services, mapping of its production linkages is not as straightforward. Aside from the skills of the software programmers which create the applications, all the inputs, both in terms of software applications and hardware are sourced from advanced industrial economies. The extent of development of backward linkages is to support the training of software engineers who develop the products; however, ChamsSwitch has not invested in this and left it to the discretion of the engineers. The firm can do much more to support the training and development of its firms as the products developed are innovative and adapted to suit the local conditions in Nigeria. In terms of the development of forward linkages to the 'production' activities of the sectors the firm is servicing, there is scope for this economywide as Fintech activities continue to expand; however, ChamsSwitch seems to be struggling to compete with local businesses such as Interswitch, Paystack and Flutterwave offering similar services. As already indicated, it is difficult to conduct an independent evaluation of this as none of these firms are publicly listed and attempts to gather precise numbers on the scale of operations and profitability through the survey of IT firms for this thesis yielded limited results.

For all three case studies there is a reliance on foreign technology inputs for the key processes driving its operations. None of the technologies driving the activities of the three firms is developed locally, both in terms of the hardware components and software underlying the applications. A critical step towards the substitution of foreign for domestic technological inputs is the adaptation of foreign technologies for local use which is evident in the development of applications to solve specific local challenges; however, the lack of activity in the hardware end of the market due to lack of access to finance, poor infrastructure to support manufacturing activities, and limited access to foreign exchange to source capital goods, constrains this trajectory.

Considering the production linkages for the three cases evaluated in this thesis from the perspective of their ability to take advantage of complementarities to trigger economic growth, Farmcrowdy is the most successful at triggering this. Its activities have led to the building out of backward and forward linkages to the agricultural and financial services sector in particular. The success of this approach cannot be reviewed at present, but it is doubtful that firms like Farmcrowdy can successfully take on the responsibility of building Nigeria's agricultural value chain.

6.2.2. Financial Linkages

The strength of financial linkages is dependent on the depth of the financial markets in Nigeria. Limited access to finance is a recurring constraint to business in Nigeria in surveys of firms in Nigeria. ChamsSwitch represents an older generation of IT firms which raise funds through more conventional means, principally through loans from commercial banks and in few cases from the capital market. Although the firm is listed on the NGX, it has not been very successful in raising capital through the stock markets. Venture capital and accelerator funds are a source of funding for the younger generation of IT firms in Nigeria and while Farmcrowdy has benefitted from these funding opportunities, ChamsSwitch and Elephab have been less successful. Financial linkages proceeding outwards from the firm are apparent in the case of Farmcrowdy. The firm's value chain expansion is driven by the funding it receives and by its activities it has funded the procurement of inputs for farmers on its platforms and created aggregation centres for farming produce which helps to guarantee higher prices and a market for farmers.

Although ChamsSwitch has faced challenges in attracting investment, competitors like Flutterwave and Paystack seem to be doing much better. This indicates the rapid turnover in the fintech space as older firms are replaced by younger firms which are nimbler, more in tune with newer technologies and also more attractive to foreign investors. Although Nigerian customers are benefitting from the expansion of these companies, it is not clear if they are stimulating activity in the local financial markets as the financial linkages seem to run mainly from foreign investors to the fintech companies who use the funds to expand their operations.

Data on venture capital investment in Nigeria is incomplete and fragmented as there is no requirement for public disclosure by either the investors or firms receiving investment. Partech Partners reports that US$2.02 billion was raised by 234 African tech start-ups in 250 equity rounds in 2019, representing 629% growth between 2015 and 2019 (Partech Africa Team, 2020). Nigerian technology firms received the highest amount of funding on the continent, representing 37% of total funding (US$747 million) with 62% of this funding targeted at fintech. Flutterwave, a payments platform raised an additional $250 million in Series D funding in 2022 which places the company's valuation at over $3 billion, making it another Nigerian unicorn (The Cable, 2022). Paystack, a Nigerian company in a similar line of business was acquired by Stripe, a global fintech firm in a deal worth about US$200 million (TechCrunch, 2021). The firm is now expanding its operations beyond Nigeria to Ghana and South Africa. Given the rapid pace of change through acquisitions, and capital raising in the IT scene in Nigeria and on the African continent, it is certain that these numbers will soon be surpassed.

The seeming lack of participation by domestic investors in financing the IT sector in Nigeria in comparison to the increasing enthusiasm by foreign investors is intriguing. Preliminary explanations would suggest a preference for low-risk high yield returns from investing in sovereign instruments and the obscurity of information on potential returns from investment in start-ups which contributes to the risk calculus. However, the survey shows that domestic equity is more important than previously thought. As financial markets continue to change and VC investment in the sector continues to grow, this trend deserves further investigation.

In summary, the financial linkages between these IT firms and other economic sectors in Nigeria seem incomplete, and it is doubtful they are sufficient to deepen the financial markets in Nigeria and create a pool of funds which can be utilised to fund local businesses.

6.2.3. Consumption/Fiscal Linkages

Despite the importance of the oil and gas sector to the Nigerian economy, its enclave nature has limited its direct connections to the local economy as reflected in the three case studies. None of the firms have benefited directly from government financing, even for those sectors which are identified as priorities in the country's long term development plans. The perception by the firms of the difficulty in engaging with and benefitting from government programmes leads to a self-fulfilling prophecy. Although government agencies in the IT space in Nigeria such as NITDA have introduced incentives such as tax breaks and export waivers, none of the firms profiled have benefited from these arrangements and in some cases have shunned them due to the onerous nature of the application process and a general distrust of the State. The absence of institutional support from government or the State through subsidies, waivers etc. applies to all the cases. Neither Farmcrowdy nor Elephab have applied to government programmes for which they possibly qualify and ChamsSwitch belongs to an older generation of firms and for this reason does not qualify for these waivers and incentives.

It is difficult to draw a link between fiscal revenues earned from oil and gas exports and increased demand for previously imported goods leading to their local production. There is little doubt that IT is instrumental to the success of each of the firms profiled in this chapter; however, despite the sophistication of the IT solutions, the institutional framework within which these firms operate is a limiting factor on what IT can accomplish. This institutional framework should be developed by the State building strong consumption and fiscal linkages to the domestic economy. The reasons for the limited fiscal and consumption linkages will require a political economy analysis which is beyond the scope of this thesis; however, the conclusion can be made that although IT is a necessary condition for economic growth and development in the 21st century, it is not a sufficient condition to enable growth in a pre-industrial context as it cannot substitute for the State.

The weak regulatory environmental is also an additional constraint on businesses. ChamsSwitch suffered significant financial losses due to the weak regulatory and legal environment which made contract enforcement impossible. This led to a decision to diversify towards private sector clients, the implementation of which is not yet fully realised.

Going back to Hirschman's conception of unbalanced growth and the role of linkages in specific industries stimulating growth, it is doubtful that consumption and fiscal linkages can lead to positive outcomes in the Nigerian case. Fiscal and consumption linkages are very distinct categories of linkages but in the Nigerian case they are interrelated as most of the fiscal revenues in Nigeria are earned from the export of primary commodities. Hirschman himself acknowledged that fiscal linkages in particular do not always lead to economic development and given the evidence from the case studies these are linkages that are not yet fully developed in Nigeria (Hirschman, 2013).

6.2.4. Technological Linkages

The technological linkages, especially to domestic actors, in all the cases were weak. Aside from Farmcrowdy's partnership with local research institutes, none of the other firms are linked to knowledge centres in Nigeria or even internationally. Knowledge acquisition and learning is self-directed and acquired mainly through learning-by-doing and learning-by-using. All the technologies used in all the cases were developed in advanced industrial countries and have been adapted for the local environment. There is emphasis on the development and transfer of knowledge in all three firms, but this is usually employee-driven and informal in nature except in the case of Farmcrowdy. It is important to note that the difficulties in the local environment induced the development of innovative solutions and models by each firm in order to remain in business. These innovations are beneficial to the domestic economy in terms of products that are adapted to suit the peculiarities of the Nigerian situation and the particular needs of Nigerian customers. As these products become popular and stimulate the demand for more of such products, it also stimulates the growth of the software development community and other ancillary sectors. However, at present, the current technology linkages do not break the barrier that prevent the development of software languages and platforms by Nigerian developers and more importantly, an entry into the hardware development market.

It can be surmised from the response to the survey and the selected case studies which drill down into the experiences of the individual firms that they are not incentivised to partner with agencies such as NITDA and several agencies under the Federal Ministry of Science and Technology responsible for fostering these technological linkages. These agencies include the National Board For Technology Incubation (NBTI), the National Centre For Technology Management (NACETEM), the National Office For Technology Acquisition And Promotion (NOTAP) amongst others. The perception from the firms is that the red tape involved in engaging with these agencies is not worth the effort, especially as they are perceived as not being at the cutting edge of technology.

In the case of technology linkages, the influence of all the other linkages in allowing the development of the conditions necessary for the creation of the appropriate environment that allows technology to thrive is apparent. The university system in Nigeria is dominated by public universities and the poor funding of universities by government is unequivocal evidenced by the constant strike actions by the Academic Staff Union of Universities (ASUU). This poor funding is linked to the poor development of fiscal linkages. Poor consumption linkages to stimulate growth of domestic industry which would place a demand on development of context-specific technologies can also be linked to weak fiscal linkages. There is a bright light on the horizon with the increase in private universities and there is anecdotal evidence to show that a number of the founders of prominent IT firms in Lagos are graduates of these private universities but there is no data to determine if they are in the majority. As these universities are not subsidised by government and are for profit, students from low-income households are denied entry into these schools. Thus, if private universities represent a path for creating a technology ecosystem, it leads to an imbalance and could deepen societal inequalities.

6.2.5. Summary

From the analysis of the linkages across all three firms, it is emerging that all of the linkages are somewhat interconnected and the failure of one can lead to the failure of the others. From the analysis, it can be seen that each firm is taking ingenious steps to address the breaks in the production, financial and technological linkages in their ecosystems; however, as long as the fiscal and consumption linkages which lie in the domain of the State are weak or non-existent, the firms eventually reach a breaking point where their efforts are insufficient. The fiscal linkages in particular are responsible for building the hard and soft infrastructure required for these firms to function optimally.

This synthesis allows the comparison of linkage development across the various firms profiled in this chapter; however, an ad-hoc approach based on the answers posed in the questionnaire and survey has been adopted in achieving this objective. Given the focus of this section on the development of linkages by firms, a capabilities-linkage matrix in the style of Lall's (1992) technological capabilities matrix and Andreoni and Anzolin's (2019) capability matrix for digital industrialisation is presented to allow a systematic analysis of how firm capabilities interact with linkages.

6.3. Capabilities-Linkage Matrix for IT Producer Services

Linkage formation is acknowledged as a critical functional activity undertaken by firms in the production process. The capability matrices reviewed in Chapter 2 acknowledge the non-trivial nature of linkage formation and define the firm capabilities, ranging from basic to complex, required to facilitate the formation of these linkages (Andreoni & Anzolin, 2019; Bell & Pavitt, 1992; Dahlman et al., 1987; Lall, 1992; Peerally et al., 2021; Sato & Fujita, 2009). Despite the existence of these matrixes, there is need for a focused framework, matching capabilities to the specific linkages which they influence. Using the same approach originally developed by Lall, these capabilities can be explicated by complexity level so firms can identify their position along the continuum and identify which capabilities must be developed to move to a higher level.

Drawing on evidence from the three case studies presented in Chapter 5, the capability frameworks reviewed, as well as findings from studies on related subjects such as innovation systems and industrial policy, a linkage-capability framework is developed to identify specific capabilities required for development of production, technological[45], financial and fiscal/consumption linkages. Although the capabilities-linkage matrix draws on the experience of firms operating in the IT space, it can also be modified for other sectors in the pre-industrial context. The coverage of linkage types can also be amended to meet specific sector or country requirements. Following the development of the framework, it will be tested on the firms presented in the case studies in this chapter as a means to operationalise it and assess its usefulness for the pre-industrial context.

The matrix follows a similar approach to the Lall (1992) and Andreoni and Anzolin (2019) framework, the latter of which focuses on digital capabilities for the fourth industrial revolution (4IR) which are closely related to the technological capabilities required in an IT firm. As earlier mentioned, the linkage types placed on the horizontal axis of the matrix are the same as outlined in the case studies and are defined at the firm level except for the fiscal linkages which are defined at the State or Country level. Consumption linkages will not be evaluated in this analysis as they are not easy to evaluate directly, and strong fiscal linkages are required for strong consumption linkages. This approach is taken due to the limited agency of firms in affecting the development and intensification of fiscal linkages in comparison to the State. As a result, the onus is primarily with the State to determine the characteristics of the linkages and the capabilities required for their emergence and growth.

In the case of production, financial and technological linkages, several actors, including the State, are involved in the acquisition of capabilities; however, the firm can play a primary, independent and delineated role in acquiring them (Banga & te Velde, 2019). In the case of fiscal linkages, the firm capabilities required are of an amorphous nature and have a strong political economy component as fiscal revenues and the externalities arising from it, such as the development of consumption linkages, are primarily mediated and determined by the State. Thus, firms have little

[45] Due to the nature of the types of production activities in which IT producer services are utilised there will most likely be an overlap between production and technological linkages.

agency in this case and must act within the socio-economic and political structures imposed by the State. For this reason, it is more beneficial to focus on the capabilities the State should acquire at each level of complexity to create the environment for linkage development.

Several bodies of literature were consulted in developing the framework for examining the State role in acquisition of capabilities required for the creation of fiscal linkages. Although focused principally on innovation, the NSI adopts a framework for assessment of appropriate State intervention in the economy consistent with the objectives of this framework (Dosi et al., 1998; Fagerberg, 2004, 2013; Fagerberg & Srholec, 2017; Freeman, 1995a, 1995b; Lehmann & Schenkenhofer, 2020; B.-A. Lundvall, 1992; Nelson & Winter, 1982, 1993; Winter, 2017). Reference is also made to literature on industrial policy and the entrepreneurial state in which the State takes a proactive role through policy making, direct investment and intervention in sectors to create a thriving production environment (Amsden, 1997; Andreoni, 2015; Andreoni & Chang, 2018; H. Chang & Andreoni, 2020; H.-J. Chang & Andreoni, 2019; Mazzucato, 2013, 2018)

The categorisation of capabilities follows the Lall framework with basic capabilities for the firm being simple, routine and experience based. These capabilities require the ability to use existing knowledge, technologies, products and processes without the need for significant adaptation. At the state-level, these capabilities are within the purvey of the state and are fundamental to the development of linkages within the local economy.

Reverse-engineering capabilities are required at the intermediate level for the firm. At this stage the capabilities to disassemble products and processes for replication or improvement should be present. Technical partnerships are expected to progress beyond reselling packaged products and processes to adding value to these products to address particular needs in the local production ecosystem. These are termed value-added reseller partnerships. A novelty introduced in the capabilities-linkage matrix is a recognition that at this level of complexity, firms are able to gain easier access to export markets. This is even more important when viewed from the perspective of upgrading strategies for advancement in GVCs. This does not invalidate the likelihood that some firms with basic capabilities might already be able to do so; however, it is expected that the increase in such activities would be marked at the intermediate level.

From the viewpoint of the State, the capability to invest in Science, Technology, Engineering, and Mathematics (STEM) education for example should complement firm efforts to improve engineering and other science-based skills. As a corollary to the increase in trade activities by firms at the intermediate level, the State is also expected to develop capabilities to facilitate trade.

It should be noted that the framework does not presuppose a predilection for outward looking development strategies such as export promotion as the capabilities to reverse-engineer products and processes is also critical for import substitution and other inward-looking strategies.

At the advanced level, firms have progressed to developing formal R&D capabilities which are required for the introduction of products and processes which are new to the world. In addition, firms take a more aggressive role in the identification and creation of new markets for their products and are able to access more sophisticated financial products to finance investment. This is complemented by increased State capabilities to fund R&D and take an active role in bridging the gap between firms and public sector research institutes.

Finally, the linkage-capabilities matrix is merely indicative and does not pretend to present an exhaustive list of capabilities. Also, it is possible for firms to exist in an intermediate point between stages.

Table 6.1: Linkage-Capabilities Matrix

Capabilities	Linkage Types			
	Production	**Technological**	**Financial**	**Fiscal**
	Firm Capabilities	**Firm Capabilities**	**Firm Capabilities**	**State Capabilities**
BASIC (Simple, Routine, Experience Based)	• Market and Competitor Analysis[b] • Acquisition of Technology Licenses • Recruitment of Skilled Personnel[b] • Procurement of Hardware • Procurement of Network Infrastructure Services	• Technical Partnerships - Local Technology Firms • Technical Partnerships - Foreign Technology Firms	• Financial Flows Management[b] • Payment Process Management (Domestic or Local) • Knowledge of Compliance, Regulatory and Risk Management Requirements for Raising Capital Through Commercial Banks • Relationship Management With Local and Foreign	• Revenue Management[c,m] • Budget Implementation[c, g,m] • Debt Management[c, g,m] • Infrastructure Investment to Support Production Activities[a,c,e, k, l] • Facilitation of a Local Production Ecosystem[c, e, l] • Investment in Basic Technologies[c, l] • Development of a Learning

Capabilities	Linkage Types			
	Production	**Technological**	**Financial**	**Fiscal**
	• Client Acquisition • Revenue/Profit Sharing Model Development • Demand Forecasting[b] • Inventory Management[b] • Other Material/Input Sourcing[b] • Relationship Management • Standards Compliance • Product Packaging &		Incubators or Accelerators	Economy[h] • Economic Management for Macro-Fiscal Stability[a,c, e, g, h] • Investment in Social and Human Capital Development[a,c,h] • Job Creation Activities[g] • Promotion of a Stable and Predictable Regulatory Environment[a] • Facilitation of Access to Finance with Long-Term or 'Patient' Capital[a,d,g] • Promotion of FDI[a,e, i, j]

Capabilities	Linkage Types			
	Production	Technological	Financial	Fiscal
	Logistics[b] • Supply Chain Management • Delivery Management[b] • Sales Distribution[b] • Product and Process Marketing[b] • Waste Management[b] • Product Lifecycle Management[b]			• Creation of Legal Framework Protecting Property Rights[a,e] • Conflict Management between Productive Coalitions[e]

Capabilities	Linkage Types			
	Production	**Technological**	**Financial**	**Fiscal**
INTERMEDIATE (Adaptive, Duplicative)	• Export Licensing • Franchising • Export Market Knowledge • Compliance With Regulatory Standards In Export Markets • Knowledge of Production Process of Input Suppliers • Knowledge of Production Process of Intermediate Consumers of	• Value Added Reseller (VAR) Partnership Development With Local Technology Firms • Value Added Reseller (VAR) Partnership Development With Foreign Technology Firms • Engineering Skills Acquisition and Development • Open-Source Software and Hardware Development Community Engagement	• Cross-Border Payment Process Management • Relationship Management With Venture Capitalists and Private Equity Firms • Knowledge of Compliance, Regulatory and Risk Management Requirements for Raising Funds Through Public Listing On Domestic Stock Exchange	• Investment in STEM Education[a] • Facilitation of Export Credit & Insurance • Support for Trade Finance • Trade Facilitation[g] • Export Promotion[a,g] • Promotion of Ease of Access to Foreign Exchange[e] • Facilitation of Investment in Port Handling Facilities

Capabilities	Linkage Types			
	Production	**Technological**	**Financial**	**Fiscal**
	Products Or Processes			

Capabilities	Linkage Types			
	Production	**Technological**	**Financial**	**Fiscal**
ADVANCED (Innovative, Risky, Research Based)	• Market Creation Techniques • Big Data Analysis for Decision Making	• In-House Process and Product Innovation Skills • Technical Partnerships With Local and Foreign Research Institutes	• Knowledge of Compliance, Regulatory and Risk Management Requirements for Raising Funds Through Public Listing On Foreign Stock Exchange	• Investment in Domestic R&D Activities[a,c,e,f] • Facilitation of Integration Between Industry and Research Community[e; h]

[a] Lall (1992)
[b] Andreoni & Anzolin (2019)
[c] Mazzucato (2018)
[d] Mazzucato (2013)
[e] Chang & Andreoni (2020)
[f] Nelson & Winter (1993)
[g] Amsden (1997)
[h] Lundvall et al (2002)
[i] Filippetti et al (2017)
[j] Borensztein et al (1998)
[k] Fagerberg et al (2018)
[l] Lopes and Willem te Velde (2021)
[m] Nissanke (2016)

6.4. Operationalisation of Linkage-Capabilities Matrix

Although most of the elements in the linkage-capabilities matrix borrow from standard technological capabilities already defined in the literature and explored in the previous section, some of the elements introduced are an outcome of findings from the case study, in essence a grounded theory approach. The operationalisation of the matrix will focus on the 3 case study subjects presented in this chapter, all from the viewpoint of firm capabilities. The State capabilities will not be included in this application of the framework as the review of capabilities of the Nigerian State from such a broad perspective, covering areas of government operations outside of the IT sector, is beyond the scope of this research. The capabilities positioning of each of the firms is summarised while fiscal linkages will be assessed based on the firm's perception of the State's performance in this area.

6.4.1. ChamsSwitch

a. Production Linkage Capabilities - BASIC

ChamsSwitch is assessed as operating at the basic capability level; however, it has not attained all the basic capabilities in the matrix but has acquired some intermediate capabilities. At the time of fieldwork for this research, no imminent plans to expand into markets beyond Nigeria were mentioned as this would necessitate the development of intermediate capabilities for accessing export markets. Reverse engineering capabilities are present in the firm as many of its products are a modification of already existing products.

The client acquisition at ChamsSwitch is well defined with personnel in the firm understanding in which sectors of the economy prospective clients can be found and building relationships to facilitate access to these clients. In terms of developing backward linkages, production inputs which include the traditional hardware and software components as well as the infrastructure or platforms on which the technology is deployed are acquired through contracts and agreements with the provider of these services. In the Nigerian context, many of these providers are located in advanced industrialised countries.

In terms of the human inputs, in this case primarily software developers, ChamsSwitch has developed in-house capability through its hiring processes while third-party developers are brought in to supplement these skills when necessary. At the time interviews were held and information compiled for this case study, most third-party developers were hired locally. Development of a revenue sharing model beneficial to the client and the firm is intrinsic to the way business is conducted and this occurs through formalised processes requiring client sign-off. ChamsSwitch does not carry out demand forecasting as firm capabilities have not extended to the gathering and analysis of datasets on sales and other important metrics by which future demand can be forecast. Inventory management is also not relevant to the types of activities conducted by the firm.

Given that ChamsSwitch operates in a highly regulated environment, relationship management and standards compliance is fundamental to its success. This is also reinforced by the firm's past negative experiences with business partners which necessitated intervention by regulators. Relationships with input suppliers, clients and other players are also considered crucial by the firm. Capabilities such as supply chain management, product packaging, and waste management are not as highly developed or relevant to the firm's business lines.

Logistics and delivery management, product and process distribution and marketing are mostly managed in-house with third party contractors brought in when service delivery entails a significant hardware or infrastructure component. Product lifecycle management or after-sales services are provided by the firm to its clients as this is a strategic way to ensure client retention and extraction of value for products developed for clients.

b. Technological Linkage Capabilities - BASIC

ChamsSwitch operates in a production environment where much of the technology on which its products or services are run are developed in advanced industrial countries. Thus, it must develop technical partnerships to gain access to these technologies at preferential and beneficial rates. Its technological linkage capabilities are assessed as basic. Capabilities to develop partnerships with foreign input suppliers such as Brain Behind Limited, a UK based software solutions development firm and Instiq Technologies amongst others enables the firm to use these technologies for a fee. On the domestic front, the firm has developed capabilities to negotiate beneficial contracts with firms such as NIBSS as well as third-party software developers who work on developing applications. Non-Disclosure Agreements are maintained with these developers to ensure it can retain its intellectual property.

c. Financial Linkage-Capabilities – BASIC/INTERMEDIATE

ChamsSwitch has attained most of the basic capabilities in the matrix and progressed to attaining one of the intermediate capabilities required for building financial linkages. Thus, it lies somewhere on the spectrum between basic and intermediate capabilities. It is one of the few IT firms listed on the NGX, a process which requires the firm to meet regulatory and reporting standards. The firm has capabilities in financial flows management and has built a substantial knowledge base in meeting compliance, regulatory and risk management requirements for raising capital through commercial banks and the capital market. The firm is in the business of developing domestic payment process management software and applies this in its own operations. As discussed in the case study, ChamsSwitch belongs to an earlier generation of IT firms in Nigeria which did not have access to incubators or accelerators at their inception and are over-qualified for such facilities at its level of operation. Given the boundaries of its operations, the firm has not developed cross-border payment management capabilities and indicated no plan to raise funds from venture capitalists, private equity or via international stock exchanges.

d. Fiscal Linkage Capabilities

From the firm's vantage point, it has not benefited from the fiscal linkages maintained by the State; however, there is a general acknowledgment that some of the positive externalities generated by the management of fiscal revenues have accrued to the development of linkages instigating demand for the firm's products.

6.4.2. Elephab

a. Production Linkage Capabilities – BASIC/INTERMEDIATE

The production linkage capabilities developed by Elephab locate it within the basic capabilities box of the matrix; however, its reverse engineering skills indicate some level of intermediate capability development. The firm understands its potential clientele and seeks ways to reach out to them, mainly through word of mouth and referrals given its small size. The competitive environment within which it operates is also small and at this stage is more communal and supportive rather than competitive. Many of the firm's competitors have an affiliation with GE Lagos Garage, making it an important hub for facilitating these linkages. The technological infrastructure on which additive manufacturing runs is foreign-based and where the firm is not able to acquire these as open-source inputs, it purchases from foreign suppliers. The staff of the firm are locally trained, either acquiring skills through 'learning by production' or from training obtained at the GE Lagos Garage. All the personnel at the firm are locally hired.

The firm does not operate a revenue or profit-sharing model and its small level of output generation makes demand forecasting moot. Inventory management and materials and input sourcing has led to the development of linkages with local suppliers rather than a dependence on foreign suppliers. This was not a trivial process and required the firm shutting down its operations for a period of time to identify these suppliers and transform these inputs into usable material. Relationship management and standards compliance are at a very rudimentary stage given that additive manufacturing is a technology new to the Nigerian market and is yet to attract the attention of government regulators or large-scale clients. The small scale of operations has also inhibited the development of capabilities for product packaging & logistics, supply chain management, delivery management, sales distribution, product and process marketing and waste management. Product lifecycle management is also irrelevant at this stage of operations as component parts are replaced as they suffer degradation due to wear and tear.

b. Technological Linkage Capabilities -BASIC/INTERMEDIATE

Elephab relies on open-source software and technology and where it procures hardware or software it is usually a one-off transaction that does not require an ongoing partnership. Even with the hardware components, the firm took the decision to reduce input costs by using additive manufacturing technology to produce much of this hardware through reverse engineering. This requires engineering knowledge which the firm has developed in its staff members, through formal university training and skills acquired through the GE Lagos Garage. The firm has no relationships with local R& D institutes given the novelty of its technology; however, it makes use of online communities to acquire and exchange technical knowledge.

c. Financial Linkage Capabilities - BASIC

This is the area in which Elephab is the weakest. It largely depends on contributions from family and friends although it was able to leverage a grant it received from a local accelerator program. This financial linkage was facilitated through its engagement on the GE Lagos Garage program and ongoing relationship with the program. The firm has not developed linkages with the local or foreign financial sector and most of its running capital is from the re-investment of earnings. This hesitance is largely due to the small scale of its operations and its inability to strongly demonstrate to potential financiers the viability and short to medium-term profitability of its operations.

d. Fiscal Linkage Capabilities - BASIC

Although Elephab could benefit from the pioneer investor program of the NITDA, its reluctance to engage with government agencies has forestalled this possibility. Much like other firms operating in Nigeria, its existence can be linked to the development of fiscal linkages from oil and gas revenue earnings; however, it has not benefited directly from these linkages and has not developed capabilities to do so.

6.4.3. Farmcrowdy

a. Production Linkage Capabilities – BASIC/INTERMEDIATE

Of all the firms assessed for this study, Farmcrowdy has made the most progress in developing production linkage capabilities. Challenges in the local operating environment necessitated a change to its business model and the development of backward linkage capabilities using local partners to assist in input supplies. It has developed capabilities for technology acquisition and recruiting skilled personnel as conversations with personnel of the firm uncovered a unique 'Farmcrowdy ethos' amongst its senior management. Its client acquisition skills are well developed leading to its pivot away from supplying purely to the retail market to the wholesale and export markets. The changes to its revenue/profit sharing model are foundational to the firm's growth story and was in response to the challenges in the local market which required it to work with faming cooperatives/communities rather than individual farmers.

The firm collects a substantial amount of data through its Farmer and Grainpoint applications and has developed capabilities in interpreting trends, determining prices, managing inventory and demand forecasting, all of which facilitate linkage development with input suppliers, output customers and other partners in the production process. Relationship management is crucial to the success of the firm given the web of linkages it continues to develop. It works closely with farmers and farming cooperatives and cooperates with the CBN to ensure farmers gain access to inputs provided through the CBN's several agriculture schemes. Due to a recognition that it must work with input suppliers with subject expertise, the firm developed linkages with insurance firms, banks, local technology firms and extension service providers. Plans to expand its operating model internationally has led to the initiation of conversations with an insurance firm in Jamaica. Produce from the farms are also being exported, requiring the development of general export market knowledge and compliance with regulatory standards in export markets.

b. Technological Linkage Capabilities - BASIC

Farmcrowdy's main area of expertise is in facilitating the functioning of agricultural value chains, leveraging on technology. Although the software, hardware and network infrastructure upon which its applications are hosted are owned by foreign firms, the applications are developed locally by the firm's in-house technology team. Based on feedback from interviews with the technology lead, the firm essentially uses off-the-shelf technology which does not require the development of value-added partnerships with technology providers. Farmcrowdy invests in R&D; however, it is not clear if this is R&D in the sense of developing technology new to the world.

c. Financial Linkage Capabilities - BASIC

Farmcrowdy has registered much success with raising capital from foreign incubator/accelerator programs, mainly in the form of grants and seed funding. As of the time of fieldwork, only one domestic investor had invested in the firm. Linkages have been developed with the domestic financial sector through partnerships with banking and insurance firms which provide services to farming communities on its program. At present, there is no indication the firm intends to be listed on NGX or international stock exchanges or seek funding from venture capitalist or private equity firms.

d. Fiscal/Consumption Linkage Capabilities

The links between the firm's operations and activities in the oil and gas sector in Nigeria are tenuous as best given that the firm seeks to empower indigent farmers who are disconnected from the flow of oil and gas revenues. The firm has displayed a willingness to partner with government agencies such as the CBN and views the public sector as an important actor in the achievement of its objectives.

6.5. Summary

A key finding that applies to the cases presented in this chapter is the realisation that IT cannot substitute for or overcome the structural failures in an economy. IT can facilitate some linkages between sectors, but a well-developed LPS is imperative for the development of capabilities and the transmission of those capabilities through linkages. In the cases reviewed, although one of the firms has entered into export markets, there is no mention of a deliberate strategy for entry into GVCs as many IT firms are struggling to overcome the constraints that prevent the development of production, financial, technological, consumption/fiscal linkages. This further highlights the role of the State in the facilitation of capability-linkage development.

The capability-linkage matrix is an important tool for identifying which capabilities are present in firms, which are absent but essential and the responsibilities of the two main actors considered, the firm and the State in fostering capabilities and the resulting linkages.

In reference to the original research question which considers whether IT can be a driver of growth in similar fashion as the manufacturing sector from the viewpoint of linkages, the cases show that IT is extremely useful but operates within a wider production environment which sets limits on its usefulness. In essence, IT has enabled the emergence of firms in underdeveloped sectors such as agriculture and created tools for fostering linkages between stakeholders in these sectors; however, it is just another input in the production process and must be built around an entire ecosystem of production based on hard and soft infrastructure to reach its full potential.

7. CHAPTER 7: CONCLUSION

7.1. Introduction

The stated purpose of this thesis is to determine if services can be a driver of economic growth in like manner as the manufacturing sector in a pre-industrial context. Although a seemingly straightforward question, research into this question required the selection of specific characteristics of growth to contemplate, in this case, firm-level capabilities and the development of linkages between IT Producer Services and the rest of the economy. It also required an explication of what a pre-industrial context is and the factors, both on the demand and supply side, responsible for the emergence of a specific type of producer service in this context.

Once these foundational parameters were defined, it was possible to use both primary and secondary data to develop tools for answering the research questions posed in the introductory chapter to this thesis.

An IT Producer Service Index was developed using a number of variables, including the import of machine tools to proxy for the interdependence between IT Producer Services and manufacturing processes, a key relationship of interest. The other variables used in developing the index show how IT is utilised in terms of its knowledge and technology intensity, its interface with the production process and contribution to value-added. The purpose of the index is to go beyond standard measures of IT use, which give no indication of which elements of the IT service are deployed in production, to a measure that allows insight into this. Unfortunately, due to a lack of data on pre-industrial countries, the index could not be applied to these countries; however, the index was applied to the countries for which data was available and hopefully lays a foundation for further work that seeks to understand the role of IT services in production

Case studies exploring the trajectory of IT service firms in Lagos, Nigeria were also developed, and this confirmed the hypothesis that the way in which a country deindustrialises and 'tertiarises' shapes the services that emerge. The cases showed the specific demand and supply-side drivers leading to the emergence of IT firms in Lagos, making a case that context matters. For these firms, the common demand and supply-side drivers mentioned in the literature did not apply and the effects of liberalisation and government policies and reforms were found to be more relevant.

The exploration of production, financial, fiscal, consumption and technological linkages through in-depth case studies demonstrate the ingenuity of IT firms in fostering linkages where they are not fully developed or even non-existent. The linkages were analysed side by side with technological capabilities using a capabilities-linkage matrix to identify whether the firms possessed basic, intermediate or advanced capabilities. The matrix revealed that most of the capabilities were in the basic to intermediate stage. More importantly, it showed that IT services model the structure of an economy and do not substitute for the development of State capabilities in the case of Nigeria, fiscal linkages by which earnings from oil and gas earnings are invested in soft and hard infrastructure that supports the production environment. It shows that no matter the level of adaptation and innovation in firms, they will eventually reach the limit of their capabilities if the State does not perform its role.

Thus, the answer to the question, 'Can IT Services Drive Economic Growth in a Pre-Industrial Context?' is conditional on the presence of strong and deep linkages economy-wide, in particular to the 'production centres of the economy'. It also requires the presence of State and firm-level technological capabilities. The investigation of the IT sector in Nigeria using a case study of Lagos shows that these enablers of growth are not present in sufficient quantity to drive economic growth. The corollary to this question is to uncover the policy implications of these findings, identify the limitations of the research and potential areas for further exploration. These are presented in Sections 3 and 4 of this chapter respectively while Section 2 draws out the key findings of the research.

7.2. Key Findings of the Research

The original research questions posed in the introduction to this research will be re-appraised in this section as a means of drawing out the key findings.

Question 1: *How are IT services employed in the production process in different development contexts and can an objective measure be developed to measure this?*

To answer this question, it was necessary to revisit the vast literature on service classifications and heterogeneity. Despite recent efforts to include knowledge and technology intensity in recent service taxonomies, the limitations of these classification approaches were discovered. It was hypothesised that producer services are not always used to 'produce' and even when they are, the ways in which they are used in production vary from one industrial context to another on the basis of the ways in which they integrate with the tools and machines used in production, the level of knowledge and technology intensity in a country and their contribution to output.

The development of an IT Producer Service Index using PCA was used to validate these hypotheses and the sub-indices, which arrange themselves in terms of the 'outward facing and 'inward facing' qualities of the index, was interesting. It was possible to use the IT Producer Service Index to rank countries based on the theoretical framework developed, with countries with a deep industrial sector integrated with the IT sector placed at the top of the rankings and those with smaller less integrated sectors, at the lower end of the table. In addition, the index was intertemporal in nature and showed a positive trajectory over time, indicating an increasing use of IT in production by most countries. Unfortunately, due to the absence of pre-industrial or developing countries in the data set used to construct the index, these countries were not included in the analysis. Including them in the data set would have required the commissioning of bespoke surveys which were not possible given the limited resources available for this research. Despite this, the methodology applied in the construction of the index can be improved for further work to include pre-industrial countries.

Question 2: *Where do producer services such as IT services originate from in the developing country context and is this different from what prevails in advanced industrial country contexts?*

The deindustrialisation-tertiarisation trajectory of countries was explored in answering this question. An extensive literature review revealed that not only are there specific deindustrialisation trajectories but the demand and supply-side drivers affecting the tertiarisation process under each trajectory are unique. Drawing from a term developed by Tregenna (2015), it was demonstrated that the 'pre-industrial deindustrialisation' context, which represents the Nigerian case, and the tertiarisation process appearing alongside, is largely driven by government policy, in particular the liberalisation of specific sectors in the economy and not the growth and decline of the manufacturing sector as was the case with mature and premature deindustrialisers. These findings were buttressed by the case studies of three IT firms in Lagos which emerged at three specific points, all related to the telecommunications sector liberalisation in Nigeria. These cases were selected from a survey of 40 IT firms in Lagos conducted for this purpose. Although these firms faced similar challenges, such as the negative impacts of government regulation on the IT sector, there were specific factors unique to their emergence, technological progress being one of the most important, alongside the effects of government reforms. The depth of these case studies shed light on the processes by which the IT sector in a developing country context and pre-industrial context like Nigeria emerged.

Question 3: *What linkages exist between the IT sector and other parts of the economy and what are the implications for IT's role as a driver of economic growth?*

The review of the literature on linkages pointed to technological, production, financial and consumption/fiscal linkages as the key ones to consider in answering this question (Hirschman, 1977, 2013). Using the output of the survey, three firms with strong linkages to the agricultural, manufacturing and financial services sectors in Nigeria were presented as case studies. In exploring the depth and strength of the linkages in these firms, the technological capabilities driving the linkages were also considered using existing approaches in the literature (Andreoni & Anzolin, 2019; Lall, 1992). A linkages-capabilities matrix was utilised to show how both interact drawing from the case study findings. This assisted in demonstrating that linkages, though critical are not sufficient to drive economic growth and the correct mix of State and technological capabilities must be present. This leads to the question of the policy implications of this research for pre-industrial countries.

7.3. Policy Implications of Research

Now that is established that the question of IT services driving economic growth is a non-trivial one which requires an interplay of several prerequisites for this to occur, the implication of the research for policy making must be considered. This is especially relevant as the leapfrog narrative which instigated this research is oftentimes repeated by policymakers in pre-industrial countries without question.

7.3.1. The Myth of Leapfrogging

This myth can only be questioned if policymakers have a deep understanding of the industrial structures of their countries. The sustained growth of the IT sector also clouds the judgement of policy makers as there is very little examination of how IT firms fit into a pre-existing economic structure and which parts of the economy the IT sector is servicing. This knowledge is essential for determining where additional State support is required to support the growth of the sector. It should fit into the industrial policy of the State as industrialisation is not simply about the manufacturing sector but requires insight into the type and strength of linkages between manufacturing and other sectors which either provide intermediate inputs to the sector or receive output from it.

In the case of Nigeria and other African countries, much of the expansion of IT services are occurring in financial services and the rise of fintech has created much excitement and optimism about the potential for growth. As stated earlier, the interest in fintech mirrors the structure of the economy and is an area where investors feel investment risks are less pronounced. In a country that has expressed an interest in commodity-led industrialisation, this is not necessarily the pattern of IT growth required to achieve this aim. The findings from this research show that an examination of capabilities and linkages in the IT sector and the interactions between it and the key sectors of the economy are critical for leapfrogging to deliver the growth expected.

7.3.2. State Capabilities

The State plays a critical role in fostering linkages and firm-level technological capabilities, but it must develop its own capabilities to allow the IT sector to grow in a way that creates jobs and spurs growth in other sectors. These capabilities, in addition to soft and hard infrastructure, are prerequisites for economic growth as IT infrastructure cannot substitute for health and education, examples of soft infrastructure and roads, ports and sustainable power, critical hard infrastructure categories. The capabilities-linkage matrix developed in this thesis is a good tool that can be used to assess the State's level of readiness for supporting the growth of firm-level technologies. It classifies both the State and firms on whether the intersection between capabilities and linkages are at the Basic, Intermediate or Advanced Level. This allows the state to develop a plan of action on how to move the economy to a higher level.

The IT Producer Service Index can also be included in the State toolbox to determine how well IT is supporting its development priorities. In this case, an IT Producer Index was developed for the case where the focus is on manufacturing, but it can be adapted for interrogating the interactions between any two sectors in the economy. Ultimately, the recommendation is that industrial policy, development plans or any desire by the State to guide the direction of the economy should not be based on speculation but draw on data and tools developed based on empirical evidence, both qualitative and quantitative.

7.3.3. Manufacturing Still Matters

The arguments advocating for the manufacturing sector as the driver of economic growth remain salient in the current knowledge and information-driven environment. As discovered in the construction of the IT Producer Service Index in Chapter 3 of this thesis, machines, which are manufactured, are the tools for embodying knowledge and information and for this reason manufacturing is a key enabler of the IT sector. They are the delivery mechanisms by which we are able to utilise services. Although the traditional economic sectors of manufacturing, agriculture and services are losing their relevance as these sectors become more integrated, advanced technologies such as automation through robotisation, the Internet of Things amongst others give manufacturing an important and key role. Thus, it is important for policy makers in pre-industrial contexts to find sustainable ways to lay a strong industrial foundation to ensure they are not left behind in future industrial and technological revolutions.

7.3.4. Sectoral Categories Are Disappearing

Although manufacturing does matter, the separation between sectors is becoming less relevant as sectors become more integrated and the boundaries between them blur. This theme was central to this research, both in terms of the theoretical discussions and the empirical work. The impetus to investigate how IT services interact with other sectors in the manufacturing process came from this understanding. In selecting IT firms for review, the challenge of deciding in which sector to place a firm recurred. This realisation of the blurring of sectoral boundaries is important for the State as the United Nations SNA, which promotes the use of sectoral categories, is still utilised in the presentation of GDP data. The use of these categories reduces the accuracy of data as there is potential to ignore those areas of the economy that fall in between categories and are difficult to measure. It would be beneficial for policy makers to transition from these hard categories to a more flexible conception of economic growth that takes the production process into consideration. Sectoral activities rarely, if ever ,work in isolation of other sectors in the production process and it only makes sense for statistics and data to be presented in a way that reflects this reality.

7.3.5. All Sectors are Heterogenous

This is related to the discussion on sectoral categories disappearing but is a point worth making on its own. Within sectors, activities are heterogenous. This is acknowledged for services but is the same for other sectors. In manufacturing there are low, medium and high-tech manufacturing categories for example and the same applies to agriculture where categories such as crop production, fishery, forestry are some examples. However, as was done for services in this research, these broad categories need to be uncovered based on metrics such as technology, knowledge intensity amongst others as they hide a wide range of activities.

This adds to the point that the way policymakers conceive economic activities should mirror reality, where the same activity with the same activity heading can differ from one context to the next. The points where sectors interact are even more important as demonstrated in the research which shows a diversity of outcomes at the deindustrialisation and tertiarisation nexus. These interactions are taking place at various junctures across the economy and so policymakers should develop new tools for detecting and interrogating these interactions.

7.3.6. Data, Data and More Data

A limiting constraint for this research was the absence of complete datasets for pre-industrial countries. This affected the research in two specific ways. Firstly, there were few existing studies produced on IT services in countries like Nigeria that this research could reference. Secondly, it required an adaptation of the original plan for the research, requiring the conduct of a survey to identify firms for the case studies and limiting the usefulness of the IT Producer Service Index.

Although the alternate path taken provided the opportunity to uncover new information, it did affect the direction of the research.

Investment in data is very important for policy makers. The process of developing and implementing industrial policy or a development plan is non-trivial and requires an abundance of data that can be analysed to inform decisions. Paradoxically, pre-industrial countries, which are desperately in need of economic transformation, tend not to make a significant investment in data collection or processing. This will support the production of evidence-based analysis representative of the realities of the economy and responsive to changes in the global economy.

With the increasing interconnectedness of countries through trade, the splitting of production activities that would have been initiated and completed within one country across GVCs and the blurring of boundaries between economic sectors, the data requirements are only increasing. Firms also require data on their industries, their competitors and opportunities for investment. Given that not all firms are able to fund the collection of data, the State should take the lead on this. For pre-industrial countries to catch-up with more developed countries, it is critical that policymakers prioritise data generation and collection to guide the production of relevant research, utilising this data to design policy which is relevant to their specific contexts.

7.4. Limitations and Areas for Further Research

With data as the key limiting factor, the scope of this research was significantly reduced, affecting the robustness of the findings. For the areas of further research to be possible, the issue of data, both qualitative and quantitative, must be addressed. In view of this, the following areas are proposed for further research.

7.4.1. The Political Economy Context of IT Development

IT sector development does not proceed in a vacuum and requires a conducive and stable political and economic environment to flourish. The existing structure of the economy and the power brokers in the economy are of critical importance in determining how much support is given to this fledgling sector. Anecdotal evidence from Nigeria shows that the younger segment of the population, typically below the age of 40, are the main players driving IT sector growth in Nigeria. Hypothetical reasons for this include the relatively smaller investments in 'hard infrastructure' required to establish an IT company which enables entrepreneurs in this space to avoid the red tape and corruption perceived as fundamental to government bureaucracy. The nature of the political settlement required for an IT sector which is linked to the key sectors of the economy in a pre-industrial context is an important area for further research.

7.4.2. The Growth of Fintech

A cursory examination of the news on investments in the IT sector on the African continent places Fintech at the top of every list. Less investment is directed to other areas where IT interfaces with the economy. There is an abundance of research extolling this phenomenon; however, there is very little explaining why this imbalance has emerged, what effects it is having on economic development and how it can be redirected to grow other sectors of the economy by redirecting capital to areas where it is lacking or where it can drive economic growth. This would be an important area of research that could contribute both to the literature on development and the policy debate on potential areas of growth for pre-industrial countries.

7.5. Summary

This thesis covered a broad range of subjects related to structural transformation with a specific focus on the often-neglected service sector. The research sought to revisit theories on services in relation to other sectors, particularly manufacturing, as part of an initial step for developing a conceptual framework for answering the research questions. The overarching question, 'Can IT Services Drive Economic Growth' was addressed through several methods which include a conceptual review of terms, case studies, multivariate analysis and a survey. These methods were adapted in response to data shortcomings, which have been explained and addressed throughout the thesis. All of the methods applied converged on a few main points which have been further developed in this sector.

The answer to the question is that IT services can drive growth, but it requires a reimagination of how services operate in the economy in relation to other activities in the economy. Linkages are important in stimulating this growth and they should be analysed to a micro-level of detail which reveals activities taking place at the firm level. Technological capabilities within the firm and those developed by the State are also important and both actors must collaborate and complement each other to stimulate growth.

8. BIBLIOGRAPHY

1. Abdal, A., Torres-Freire, C. E., & Callil, V. (2016). Rethinking sectoral typologies: A classification of activity according to knowledge and technological intensity. RAI Revista de Administração e Inovação, 13(4), 232–241.
2. Abiola, B. O. (2008). The Nnewi Automotive Components Cluster in Nigeria. In D. Z. Zeng (Ed.), Knowledge, Technology, and Cluster-Based Growth in Africa.
3. Afeikhena, J. (2002). Public enterprise reform in Nigeria: Evidence from the telecommunications industry (Vol. 129). African Economic Research Consortium Nairobi.
4. Aladekomo, A. (2014, October 23). Identity Management: A Catalyst for the New Economic and Financial Service Transformation. 2014 Annual Lecture of the Chartered Institute Of Bankers Of Nigeria (CIBN), Ijewere Hall, Bankers House, PC 19, Adeola Hopewell Street, Victoria Island, Lagos, Nigeria. https://chamsplc.com/wp-content/uploads/2015/11/2014-cibn-lecture-final-web-1.pdf
5. Alberti, F. (2010). The concept of industrial district: Main contributions. 12.
6. Albrieu, R., Brest López, C., Rapetti, M., Ferraz, J. C., Nogueira de Paiva Britto, J., Kupfer, D., & Torracca, J. (2019). The Adoption of Digital Technologies in Developing Countries: Insights from Firmlevel surveys in Argentina and Brazil.
7. Amsden, A. H. (1996). Why Isn't the Whole World Experimenting with the East Asian Model to Develop?: Review of The East Asian Mracle. WORLD DEVELOPMENT, 7.
8. Amsden, A. H. (1997). Editorial: Bringing production back in — Understanding Government's economic role in late industrialization. World Development, 25(4), 469–480. https://doi.org/10.1016/S0305-750X(96)00124-6
9. Ancori, B., Bureth, A., & Cohendet, P. (2000). The economics of knowledge: The debate about codification and tacit knowledge. Industrial and Corporate Change, 9(2), 255–287. https://doi.org/10.1093/icc/9.2.255
10. Andreoni, A. (2011). Productive capabilities indicators for industrial policy design. UNIDO Working Paper Series, 17/11.
11. Andreoni, A. (2015). The political economy of industrial policy: After the crisis, back on the agenda. In U. Mattei & J. D. Haskell (Eds.), Research handbook on political economy and law. Edward Elgar Publishing.
12. Andreoni, A. (2018). A Generalized Linkage Approach to Local Production Systems Development in the Era of Global Value Chains, with special reference to Africa. 40.
13. Andreoni, A., & Anzolin, G. (2019). A revolution in the making? Challenges and opportunities of digital production technologies for developing countries (Working Paper No. 7/2019; Inclusive and Sustainable Industrial Development). UNIDO.
14. Andreoni, A., & Chang, H.-J. (2018). Industrial Policy and the Future of Manufacturing. 16.
15. Andreoni, A., & Gomez, C. L. (2012, January). Can we live on services? Exploring manufacturing-services interfaces and their implications for industrial policy design. DRUID Academy 2012, Cambridge, United Kingdom. http://conference.druid.dk/acc_papers/j2uc1c7qnybes5rm57hueffrhhaj.pdf

16. Andreoni, A., & Gregory, M. (2013). Why and How Does Manufacturing Still Matter: Old Rationales, New Realities. Revue d'économie industrielle, 143, 21–57. https://doi.org/10.4000/rei.5613

17. Andreoni, A., & Tregenna, F. (2018). Stuck in the Middle: Premature Deindustrialisation and Industrial Policy.

18. Appelbaum, E., & Albin, P. (1990). Differential Characteristics of Employment Growth in Service Industries. In E. Appelbaum & R. Schettkat (Eds.), Labour Market Adjustments to Structural Change and Technological Progress. Praeger.

19. Arrow, K. J. (1962). The Economic Implications of Learning by Doing. The Review of Economic Studies, 29(3), 155. https://doi.org/10.2307/2295952

20. Atlas of Complexity. (2019). Nigeria's Product Space. https://atlas.cid.harvard.edu/countries/159/paths

21. Atuahene-Gima, K., & Amuzu, J. (2019). Farmcrowdy: Digital business model innovation for farming in Nigeria. Emerald Emerging Markets Case Studies.

22. Auty, R. M. (1994). Industrial policy reform in six large newly industrializing countries: The resource curse thesis. World Development, 22(1), 11–26.

23. Bacon, R., & Eltis, W. (1978). Britain's economic problem: Too few producers. (Vol. 2). Macmillan.

24. Bailey, K. D. (1994). Typologies and taxonomies: An introduction to classification techniques. Sage Publications.

25. Balzat, M., & Hanusch, H. (2007). Fundamentals of the concept of national innovation systems. In H. Hanusch & A. Pyka (Eds.), Elgar Companion to Neo-Schumpeterian Economics. Edward Elgar Publishing. http://www.elgaronline.com/view/9781843762539.xml

26. Banga, K., & te Velde, D. W. (2019). Preparing developing countries for the future of work: Understanding skills-ecosystem in a digital era. Pathways Commission.

27. Barclay, M., Dixon-Woods, M., & Lyratzopoulos, G. (2019). The problem with composite indicators. BMJ Quality & Safety, 28(4), 338–344.

28. Barrientos, S., Gereffi, G., & Rossi, A. (2010). Economic and Social Upgrading in Global Production Networks: Developing a Framework for Analysis. Capturing the Gains Working Paper, 3, 25.

29. Barry, P. (2017). Beginning theory: An introduction to literary and cultural theory. Oxford University Press.

30. Baumol, W. J. (1967). Macroeconomics of Unbalanced Growth: The Anatomy of Urban Crisis. The American Economic Review, 57(3), 415–426.

31. Baumol, W. J., Batey Blackman, S. A., & Wolff, E. N. (1985). Unbalanced Growth Revisited: Asymptotic Stagnancy and New Evidence. The American Economic Review, 75(4), 806–817.

32. Becattini, G. (1975). Lo sviluppo economico della Toscana. Con particolare riguardo all'industrializzazione leggera. A cura di Giacomo Becattini. Istituto regionale per la programmazione economica della Toscana. IRPET.

33. Becattini, G. (1978). The development of light industry in Tuscany: An interpretation. Economic Notes, 2(3), 107–123.

34. Becattini, G., Bellandi, M., & De Propis, L. (2009). A Handbook of Industrial Districts. Edward Elgar Publishing. https://doi.org/10.4337/9781781007808

35. Beerepoot, N., Lambregts, B., & Kleibert, J. (Eds.). (2017). Globalisation and Services-driven Economic Growth: Perspectives from the Global North and South. Routledge.

36. Behuria, P., & Goodfellow, T. (2018). Leapfrogging Manufacturing? Rwanda's Attempt to Build a Services-Led 'Developmental State'. The European Journal of Development Research. https://doi.org/10.1057/s41287-018-0169-9

37. Bell, M., & Pavitt, K. (1992). Accumulating Technological Capability in Developing Countries. The World Bank Economic Review, 6(suppl 1), 257–281. https://doi.org/10.1093/wber/6.suppl_1.257

38. Best, M. (1990). The new competition: Institutions of industrial restructuring. Harvard University Press.

39. Best, M. (2001). The new competitive advantage: The renewal of American industry. Oxford University Press.

40. Bevan, W. L. (1894). Sir William Petty: A study in English economic literature (Vol. 9). American economic association.

41. Beverelli, C., Koopman, R. B., Kummritz, V., & Neumueller, S. (2015). Domestic Foundations of Global Value Chains. Available at SSRN 2708980.

42. Birdsall, N. M., Campos, J. E. L., Chang-Shik, K., Corden, W. M., Pack, H., Page, J., Sabor, R., & Stiglitz, J. E. (1993). The East Asian miracle: Economic growth and public policy: Main report [World Bank policy research report]. World Bank. http://documents.worldbank.org/curated/en/975081468244550798/Main-report

43. Blankenburg, S., Palma, J. G., & Tregenna, F. (2017). Structuralism. In The New Palgrave Dictionary of Economics (pp. 1–8). Palgrave Macmillan UK. https://doi.org/10.1057/978-1-349-95121-5_1278-2

44. Bloch, R., & Owusu, G. (2012). Linkages in Ghana's gold mining industry: Challenging the enclave thesis. Resources Policy, 37(4), 434–442. https://doi.org/10.1016/j.resourpol.2012.06.004

45. Bohn, T., Brakman, S., & Dietzenbacher, E. (2018). The role of services in globalisation. The World Economy, 41(10), 2732–2749.

46. Borensztein, E., De Gregorio, J., & Lee, J.-W. (1998). How does foreign direct investment affect economic growth? Journal of International Economics, 45(1), 115–135.

47. Bowen, T., & Barkin, S. (1967). Manpower problems in the service sector. Organisation for Economic Co-operation and Development, Manpower and Social Affairs Directorate, Social Affairs Division.

48. Braczyk, H.-J., Cooke, P., & Heidenreich, M. (Eds.). (1998). Regional innovation systems: The role of governances in a globalized world. Psychology Press.

49. Breschi, S., & Malerba, F. (2013). Sectoral Innovation Systems: Technological Regimes, Schumpeterian Dynamics and Spatial Boundaries. In C. Edquist (Ed.), Systems of innovation: Technologies, institutions and organizations. Routledge.

50. Browning, H., & Singelmann, J. (1975). The emergence of a service society: Demographic and sociological aspects of the sectoral transformation of the labor force in the USA.

51. Cairncross, A. (1978). What is de-industrialisation? In F. Blackaby (Ed.), De-industrialization. Heinemann Educational Books.

52. Carmignani, F., & Mandeville, T. (2014). Never been industrialized: A tale of African structural change. Structural Change and Economic Dynamics, 31, 124–137. https://doi.org/10.1016/j.strueco.2014.09.002

53. Castells, M. (2010). The rise of the network society (2nd edition with a new preface). Wiley-Blackwell.

54. Cattell, R. B. (1966). The scree test for the number of factors. Multivariate Behavioral Research, 1(2), 245–276.

55. Chams Plc. (2016). Chams PLC 2015 Annual Report and Accounts [Annual Report]. Chams Plc. https://chamsplc.com/wp-content/uploads/2015/11/Chams-2015-Annual-Reports-and-Accounts.pdf

56. Chams Plc. (2018). Chams PLC 2018 Annual Report and Accounts [Annual Report]. Chams Plc. https://chamsplc.com/wp-content/uploads/2019/07/Chams-2018-Annual-Report-final-web.pdf

57. Chams Plc. (2019, April 4). Williams: Chams' Restructuring Exercise Has Paid Off. https://chamsplc.com/chams-restructuring-exercise-has-paid-off/

58. ChamsSwitch. (2019, September 7). ChamsSwitch Profile. About ChamsSwitch. https://www.chamsswitch.com/about-our-company/

59. Chang, H., & Andreoni, A. (2020). Industrial policy in the 21st century. Development and Change, 51(2), 324–351.

60. Chang, H.-J., & Andreoni, A. (2019). Institutions and the process of industrialisation: Towards a theory of social capability development. The Palgrave Handbook of Development Economics, 409–439.

61. Chang, H.-J., Hauge, J., & Irfan, M. (2016). Transformative industrial policy for Africa. Addis Ababa, Ethiopia: Economic Commission for Africa.

62. Chenery, H. B. (1960). Patterns of Industrial Growth. The American Economic Review, 50(4), 624–654.

63. Chenery, H. B. (1975). The Structuralist Approach to Development Policy. The American Economic Review, 65(2,). http://www.jstor.org/stable/1818870

64. Cirera, X., Lage, F., & Sabetti, L. (2016). ICT Use, Innovation, and Productivity: Evidence from Sub-Saharan Africa. 7868, 55.

65. Clark, C. (1940). The Conditions of Economic Progress. Population (French Edition), 15(2), 374. https://doi.org/10.2307/1525990

66. Coase, R. H. (1937). The Nature of the Firm. Economica, 4(16), 386–405.

67. Cobbold, T. (2003). A comparison of gross output and value-added methods of productivity estimation. Productivity Commission Research Memorandum, Canberra.

68. Corden, W. M., & Neary, J. P. (1982). Booming sector and de-industrialisation in a small open economy. The Economic Journal, 92(368), 825–848.

69. Corkin, L. (2012). Chinese construction companies in Angola: A local linkages perspective. Resources Policy, 37(4), 475–483. https://doi.org/10.1016/j.resourpol.2012.06.002

70. Crunchbase. (2020). Farmcrowdy Financials. https://www.crunchbase.com/organization/farmcrowdy/company_financials

71. Crunchbase. (2022, March 13). OPay Highlights. https://www.crunchbase.com/organization/opay-operapay/company_financials

72. Cuadrado-Roura, J. R. (2013). Towards Increasingly "Tertiarised" Economies: Facts, Factors and Prospects. In J. R. Cuadrado-Roura (Ed.), Service Industries and Regions. Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-35801-2

73. D'Agostino, A., Serafini, R., & Ward-Warmedinger, M. (2006). Sectoral explanations of employment in Europe: The role of services (Working Paper No. 625; ECB Working Paper). European Central Bank. http://hdl.handle.net/10419/153059

74. Dahal, M. P. (2018). Stride of Service Sector in Nepal's Trajectories of Structural Change. Economic Journal of Development Issues, 21(1–2), 69. https://doi.org/10.3126/ejdi.v21i1-2.19024

75. Dahlman, C. J., Ross-Larson, B., & Westphal, L. E. (1987). Managing technological development: Lessons from the newly industrializing countries. World Development, 15(6), 759–775.

76. Dale W. Jorgenson & Marcel P. Timmer. (2011). Structural Change in Advanced Nations: A New Set of Stylised Facts. The Scandinavian Journal of Economics, 1, 1. https://doi.org/10.1111/j.1467-9442.2010.01637.x

77. Dasgupta, S., & Singh, A. (2005). Will Services be the New Engine of Indian Economic Growth?: Services: The New Engine of Indian Economic Growth? Development and Change, 36(6), 1035–1057. https://doi.org/10.1111/j.0012-155X.2005.00449.x

78. Dasgupta, S., & Singh, A. (2006). Manufacturing, Services and Premature Deindustrialization in Developing Countries: A Kaldorian Analysis. In G. Mavrotas & A. Shorrocks (Eds.), Advancing Development (pp. 435–454). Palgrave Macmillan UK. https://doi.org/10.1057/9780230801462_23

79. Davis, G. A. (1995). Learning to love the Dutch disease: Evidence from the mineral economies. World Development, 23(10), 1765–1779.

80. Davis, G. A., & Tilton, J. E. (2005). The resource curse. 29(3), 233–242.

81. De Marchi, V., Di Maria, E., & Gereffi, G. (2017). Evolutionary Trajectories of Industrial Districts in Global Value Chains. In V. De Marchi, E. Di Maria, & G. Gereffi (Eds.), Local clusters in global value chains: Linking actors and territories through manufacturing and innovation. Routledge.

82. De Marchi, V., Di Maria, E., Golini, R., & Perri, A. (2020). Nurturing international business research through global value chains literature: A review and discussion of future research opportunities. International Business Review, 101708.

83. De Marchi, V., Di Maria, E., & Ponte, S. (2014). Multinational firms and the management of global networks: Insights from global value chain studies. In Orchestration of the global network organization. Emerald Group Publishing Limited.

84. De Marchi, V., & Grandinetti, R. (2014). Industrial Districts and the Collapse of the Marshallian Model: Looking at the Italian Experience. Competition & Change, 18(1), 70–87. https://doi.org/10.1179/1024529413Z.00000000049

85. de Souza, K. B., de Andrade Bastos, S. Q., & Perobelli, F. S. (2016). Multiple trends of tertiarization: A comparative input–output analysis of the service sector expansion between Brazil and United States. EconomiA, 17(2), 141–158. https://doi.org/10.1016/j.econ.2015.10.002

86. Den Hertog, P., & Bilderbeek, R. (1999). Conceptualising Service Innovation and Service Innovation Patterns. Research Programme on Innovation in Services (SIID) for the Ministry of Economic Affairs, Dialogic, Utrecht. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.102.9390&rep=rep1&type=pdf

87. Deraniyagala, S. (2003). From Washington to post-Washington. In B. Fine, C. Lapavitsas, & J. Pincus (Eds.), Development policy in the twenty-first century: Beyond the post-washington consensus. Retrieved from https://ebookcentral.proquest.com.

88. Desai, M., Fukuda-Parr, S., Johansson, C., & Sagasti, F. (2002). Measuring the technology achievement of nations and the capacity to participate in the network age. Journal of Human Development, 3(1), 95–122.

89. Diamond, L. (1983). Class, ethnicity, and the democratic state: Nigeria, 1950–1966. Comparative Studies in Society and History, 25(3), 457–489.

90. Disrupt Africa. (2017, August). Nigeria's Farmcrowdy joins Techstars Atlanta accelerator. https://disrupt-africa.com/2017/08/nigerias-farmcrowdy-joins-techstars-austin-accelerator/

91. Domar, E. D. (1946). Capital Expansion, Rate of Growth, and Employment. Econometrica, 14(2), 137. https://doi.org/10.2307/1905364

92. Dosi, G., Freeman, C., Nelson, R. R., & Soete, L. (1988). Technical Change and Economic Theory. Pinter.

93. Dosi, G., Teece, D. J., & Chytry, J. (1998). Technology, Organization, and Competitiveness. Oxford University Press. https://doi.org/10.1093/0198290969.001.0001

94. Doyle, C., & McShane, P. (2003). On the design and implementation of the GSM auction in Nigeria—The world's first ascending clock spectrum auction. Telecommunications Policy, 27(5–6), 383–405.

95. Eichengreen, B., & Gupta, P. (2011). The Service Sector as India's Road to Economic Growth (No. w16757). National Bureau of Economic Research. https://doi.org/10.3386/w16757

96. Eichengreen, B., & Gupta, P. (2013). The two waves of service-sector growth. Oxford Economic Papers, 65(1), 96–123. https://doi.org/10.1093/oep/gpr059

97. Engel, E. (1857). The production and consumption conditions of the Kingdom of Saxony. J. Stat. Bur. R. Sax. Minist. Inter, 8–9.

98. Fagerberg, J. (2004). Innovation: A Guide to the Literature. 22.

99. Fagerberg, J. (2013). Innovation A New Guide.

100. Fagerberg, J., Lundvall, B.-Å., & Srholec, M. (2018). Global value chains, national innovation systems and economic development. The European Journal of Development Research, 30(3), 533–556.

101. Fagerberg, J., Martin, B. R., & Andersen, E. S. (Eds.). (2013). Innovation studies: Evolution and future challenges (1st ed). Oxford University Press.

102. Fagerberg, J., & Srholec, M. (2017). Capabilities, economic development, sustainability. Cambridge Journal of Economics, 41(3), 905–926. https://doi.org/10.1093/cje/bew061

103. Fagerberg, J., & Verspagen, B. (1999). 'Modern Capitalism' in the 1970s and 1980s. In M. Setterfield (Ed.), Growth, Employment and Inflation (pp. 113–126). Palgrave Macmillan UK. https://doi.org/10.1007/978-1-349-27393-5_9

104. Falvey, R. E., & Gemmell, N. (1996). ARE SERVICES INCOME-ELASTIC? SOME NEW EVIDENCE. Review of Income and Wealth, 42(3), 257–269. https://doi.org/10.1111/j.1475-4991.1996.tb00182.x

105. FAO. (2020). Nigeria at a glance. http://www.fao.org/nigeria/fao-in-nigeria/nigeria-at-a-glance/en/

106. Farmcrowdy. (2020, July). Empowering Farmers with Technology.

107. Farrugia, N. (2007). Conceptual issues in constructing composite indices.

108. FAVPNG. (2018, January). Food Chain—Agricultural Value Chain Agriculture Agribusiness Supply Chain. https://favpng.com/png_view/food-chain-agricultural-value-chain-agriculture-agribusiness-supply-chain-png/6zrTKnxG

109. Federal Ministry of Agriculture and Rural Development. (2014). Agricultural Transformation Agenda: We Will Grow Nigeria's Agricultural Sector. Federal Ministry of Agriculture and Rural Development.

110. Federal Ministry of Budget and National Planning. (2017). Economic Recovery & Growth Plan 2017-2020. Federal Ministry of Budget and National Planning.

111. Federal Ministry of Finance, Budget and National Planning. (2021). National Development Plan (NDP) 2021-2025.

112. Federal Ministry of Trade and Investment. (2014). Nigeria Industrial Revolution Plan. Federal Ministry of Trade and Investment.

113. Felipe, J., Mehta, A., & Rhee, C. (2018). Manufacturing matters…but it's the jobs that count. Cambridge Journal of Economics. https://doi.org/10.1093/cje/bex086

114. Ferrucci, L., & Picciotti, A. (2017). From economic dualism to local variety: The development of service industries in Italian regions. Local Economy: The Journal of the Local Economy Policy Unit, 32(1), 14–33. https://doi.org/10.1177/0269094216686943

115. Fessehaie, J. (2011). Development and Knowledge Intensification in Industries Upstream of Zambia's Copper Mining Sector. Pdf], MMCP.

http://commodities.open.ac.uk/8025750500453F86/(httpAssets)/6D572F58F7E2A83B80257 87E003A7258/$file/Enhancing%20linkages%20of%20oil%20and%20gas%20industry%20in%20the%20Nigerian%20economy.pdf

116. Figueiredo, P. N., & Piana, J. (2018). Innovative capability building and learning linkages in knowledge-intensive service SMEs in Brazil's mining industry. Resources Policy, 58, 21–33.
117. Filippetti, A., Frenz, M., & Ietto-Gillies, G. (2017). The impact of internationalization on innovation at countries' level: The role of absorptive capacity. Cambridge Journal of Economics, 41(2), 413–439.
118. Fine, B., Lapavitsas, C., & Pincus, J. (Eds.). (2003). Development policy in the twenty-first century: Beyond the post-washington consensus. Retrieved from https://ebookcentral.proquest.com.
119. Fisher, A. G. B. (1935). The Clash of Progress and Security. Macmillan.
120. Fisher, A. G. B. (1952). A Note on Tertiary Production. The Economic Journal, 62(248), 820. https://doi.org/10.2307/2226528
121. Fixler, D. J., & Siegel, D. (1999). Outsourcing and productivity growth in services. Structural Change and Economic Dynamics, 10(2), 177–194. https://doi.org/10.1016/S0954-349X(98)00048-4
122. Fleming, M. (1955). External Economies and the Doctrine of Balanced Growth. The Economic Journal, 65(258), 241. https://doi.org/10.2307/2227895
123. Fourastie, J. (1951). Productivity and Economics. Political Science Quarterly, 66(2), 216. https://doi.org/10.2307/2145502
124. Francis, N. (2021, July 16). COVID-19 Impedes FG's Economic Diversification Drive, Says Ahmed. This Day. https://www.thisdaylive.com/index.php/2021/07/16/covid-19-impedes-fgs-economic-diversification-drive-says-ahmed/
125. Francisco J. Buera, & Joseph P. Kaboski. (2012). The Rise of the Service Economy. The American Economic Review, 102(6), 2540–2569.
126. Francois, J. F., & Woerz, J. (2007). Producer Services, Manufacturing Linkages, and Trade. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.993361
127. Freeman, C. (1995a). The economics of technical change. 52.
128. Freeman, C. (1995b). The 'National System of Innovation'in historical perspective. Cambridge Journal of Economics, 19(1), 5–24.
129. Frischtak, C. R. (2018). Telecommunication and ICT-Based Services Trade. Industries without Smokestacks: Industrialization in Africa Reconsidered, 48.
130. Fuchs, V. (1968). The service economy. National Bureau of Economic Research [etc.] ; [distributed by] Columbia University Press.
131. Fuchs, V. (1980). Economic Growth and the Rise of Service Employment (No. w0486). National Bureau of Economic Research. https://doi.org/10.3386/w0486
132. Fuentes, D. D. (1999). On the Limits of the Post-Industrial Society Structural Change and Service Sector Employment in Spain. International Review of Applied Economics, 13(1), 111–123. https://doi.org/10.1080/026921799101760

133. Galindo-Rueda, F., & Verger, F. (2016). OECD Taxonomy of Economic Activities Based on R&D Intensity (OECD Science, Technology and Industry Working Papers No. 2016/04). https://doi.org/10.1787/5jlv73sqqp8r-en

134. Gallouj, C., & Gallouj, F. (2000). Neo-Schumpeterian Perspectives on Innovation in Services. In M. Boden & I. Miles (Eds.), Services and the Knowledge-Based Economy. Continuum.

135. Gelb, A. H. (1988). Oil windfalls: Blessing or curse? Oxford university press.

136. General Electric Garage. (2012). GE Lagos Garage. https://gelagosgarage.com/aboutus

137. Gereffi, G. (1994). The Organization of Buyer-Driven Global Commodity Chains: How U.S. Retailers Shape Overseas Production Networks. In G. Gereffi & M. Korzeniewicz (Eds.), Commodity chains and global capitalism. Praeger.

138. Gereffi, G., & Evans, P. (1981). Transnational corporations, dependent development, and state policy in the semiperiphery: A comparison of Brazil and Mexico. Latin American Research Review, 16(3), 31–64.

139. Gereffi, G., & Fernandez-Stark, K. (2016). Gereffi & Fernandez Stark_GVC Primer_2016.pdf (2nd Edition). Duke Center on Globalization, Governance and Competitiveness at the Social Science Research Institute.

140. Gereffi, G., & Lee, J. (2016). Economic and social upgrading in global value chains and industrial clusters: Why governance matters. Journal of Business Ethics, 133(1), 25–38.

141. Gershuny, J., & Miles, I. (1983). The New Service Economy. Praeger.

142. Ghani, E., & O'Connell, S. D. (2014). Can Service Be a Growth Escalator in Low-Income Countries? The World Bank. https://doi.org/10.1596/1813-9450-6971

143. Giuliani, E., Pietrobelli, C., & Rabellotti, R. (2005). Upgrading in global value chains: Lessons from Latin American clusters. World Development, 33(4), 549–573.

144. Greenfield, H. I. (1966). Manpower and the Growth of Producer Services. Columbia University Press.

145. Greenhalgh, C., & Gregory, M. (2001). Structural change and the emergence of the new service economy. Oxford Bulletin of Economics & Statistics, 63(5), 629–646.

146. Grugel, J. (2002). Democratization in Historical Perspective. Democratization: A Critical Introduction, Palgrave, New York.

147. Gundlach, E. (1994). Demand bias as an explanation for structural change (Kiel Working Paper No. 594) [Working Paper]. Kiel Institute for the World Economy.

148. Hanouch, M., & Chen, G. (2015). Promoting Competition in Mobile Payments: The Role of USSD [Brief]. Consultative Group to Assist the Poor(CGAP). https://www.cgap.org/sites/default/files/researches/documents/Brief-The-Role-of-USSD-Feb-2015.pdf

149. Hansen, J. W., Àràbà, D., Hellin, J., & Goslinga, R. (2017). A roadmap for evidence-based insurance development for Nigeria's farmers.

150. Hansen, M. W. (2014). From enclave to linkage economies? A review of the literature on linkages between extractive multinational corporations and local industry in Africa. DIIS. http://hdl.handle.net/10419/122285

151. Hansen, U. E., & Lema, R. (2019). The co-evolution of learning mechanisms and technological capabilities: Lessons from energy technologies in emerging economies. Technological Forecasting and Social Change, 140, 241–257.

152. Hanusch, H., & Pyka, A. (Eds.). (2007). Elgar Companion to Neo-Schumpeterian Economics. Edward Elgar Publishing. https://doi.org/10.4337/9781847207012

153. Haraguchi, N., Cheng, C. F. C., & Smeets, E. (2017). The Importance of Manufacturing in Economic Development: Has This Changed? World Development, 93, 293–315. https://doi.org/10.1016/j.worlddev.2016.12.013

154. Harrod, R. F. (1939). An Essay in Dynamic Theory. The Economic Journal, 49(193), 14. https://doi.org/10.2307/2225181

155. Hatzichronoglou, T. (1997). Revision of the high-technology sector and product classification (Working Paper No. 02; OECD Science, Technology and Industry Working Papers). Organisation of Economic Cooperation and Development. https://dx.doi.org/10.1787/134337307632

156. Hauknes, J. (2000). Dynamic Innovation Systems. In M. Boden & I. Miles (Eds.), Services and the Knowledge-Based Economy. Continuum.

157. Hausmann, R., Hidalgo, C. A., Bustos, S., Coscia, M., & Simoes, A. (2014). The atlas of economic complexity: Mapping paths to prosperity. Mit Press.

158. Hausmann, R., & Klinger, B. (2006). Structural Transformation and Patterns of Comparative Advantage in the Product Space. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.939646

159. Hertog, P. (2000). Knowledge-Intensive Business Services as Co-Producers of Innovation. International Journal of Innovation Management, 4(4), 491–528. https://doi.org/10.1016/S1363-9196(00)00024-X

160. Hidalgo, C. A., Klinger, B., Barabási, A.-L., & Hausmann, R. (2007). The product space conditions the development of nations. Science, 317(5837), 482–487.

161. Hirschman, A. (1958). The Strategy of Economic development. London: Yale University Press.

162. Hirschman, A. (1977). A Generalised Linkage Approach with Special Reference to Staples. In The Essential Hirschman. Princeton University Press.

163. Hirschman, A. (2013). The Essential Hirschman. Princeton University Press.

164. Hoekman, B. (2017). Trade in Services: Opening markets to create opportunities (Working Paper No. 31; WIDER Working Paper Series). United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

165. IBM Knowledge Center. (2015, August 15). KMO and Bartlett's Test. https://www.ibm.com/support/knowledgecenter/SSLVMB_23.0.0/spss/tutorials/fac_telco_kmo_01.html

166. Ikpeze, N. I., Soludo, C. C., & Elekwa, N. N. (2004). Nigeria: The Political Economy of the Policy Process, Policy Choice and Implementation. In C. C. Soludo, M. O. Ogbu, & H.-J. Chang (Eds.), The Politics of trade and industrial policy in Africa: Forced consensus? IDRC.

167. Inklaar, R., O'Mahony, M., & Timmer, M. (2005). ICT and Europe's Productivity Performance: Industry-Level Growth Account Comparisons with the United States. Review of Income and Wealth, 51(4), 505–536. https://doi.org/10.1111/j.1475-4991.2005.00166.x

168. International Monetary Fund. (2021). Regional Economic Outlook: Sub-Saharan Africa One Planet, Two Worlds, Three Stories. International Monetary Fund. https://www.imf.org/en/Publications/REO

169. Interswitch Group. (2022, March 13). The Gateway to Africa's Payment Ecosystem [Company Website]. Interswitch. https://www.interswitchgroup.com/

170. Iscan, T. (2010). How Much Can Engel's Law and Baumol's Disease Explain the Rise of Service Employment in the United States? The B.E. Journal of Macroeconomics, 10(1). https://doi.org/10.2202/1935-1690.2001

171. Iwayemi, A., & Adeyemo, R. (1995). Introduction. In A. Iwayemi (Ed.), Macroeconomic policy issues in an open developing economy: A case study of Nigeria. National Centre for Economic Management and Administration.

172. Joint Research Centre-European Commission. (2008). Handbook on constructing composite indicators: Methodology and user guide. OECD publishing.

173. Jomo, K., & Khan, M. (2000). Rents, Rent-Seeking and Economic Development: Theory and the Asian Evidence.

174. Jorgenson, D. W. (1991). Productivity and economic growth. 19–118.

175. Jorgenson, D. W., Gollop, F. M., & Fraumeni, B. M. (1987). Productivity and US Economic Growth.

176. Jorgenson, D. W., Ho, M. S., & Stiroh, K. J. (2005). productivity, Volume 3: Information technology and the American growth Resurgence. MIT Press Books, 3.

177. Kabeta, Z. E. (2017). Structure and Growth of Service Sector in Ethiopia. http://rgdoi.net/10.13140/RG.2.2.15343.28325

178. Kaldor, N. (1961). Capital Accumulation and Economic Growth. In The Theory of Capital. Macmillan & Co.

179. Kaldor, N. (1966). Causes of the slow rate of economic growth of the United Kingdom: An Inaugural lecture. Cambridge University Press.

180. Kaldor, N. (1967). Strategic Factors in Economic Development (1st ed.). N. Y. State School of Industrial & Labor Relation.

181. Kaldor, N. (1985). Economics without equilibrium. M.E. Sharpe.

182. Kaplan, D. (2012). South African mining equipment and specialist services: Technological capacity, export performance and policy. Resources Policy, 37(4), 425–433. https://doi.org/10.1016/j.resourpol.2012.06.001

183. Kaplinsky, R., & Morris, M. (2001). A Handbook for Value Chain Research. 113.

184. Kaplinsky, R., & Morris, M. (2016). Thinning and Thickening: Productive Sector Policies in The Era of Global Value Chains. The European Journal of Development Research, 28(4), 625–645. https://doi.org/10.1057/s41287-016-0009-8

185. Katouzian, M. A. (1970). The Development of the Service Sector: A New Approach. Oxford Economic Papers, New Series, 22(3), 362–382.

186. Katz, J. M. (1987). Technology generation in Latin American manufacturing industries. Springer.

187. Kayisire, D., & Wei, J. (2016). ICT Adoption and Usage in Africa: Towards an Efficiency Assessment. Information Technology for Development, 22(4), 630–653. https://doi.org/10.1080/02681102.2015.1081862

188. Keeble, D., & Nachum, L. (2002). Why Do Business Service Firms Cluster? Small Consultancies, Clustering and Decentralization in London and Southern England. Transactions of the Institute of British Geographers, 27(1), 67-.

189. Kevin M. Murphy, Andrei Shleifer, & Robert W. Vishny. (1989). Industrialization and the Big Push. Journal of Political Economy, 97(5), 1003–1026.

190. Khan, M. H. (1995). State Failure in Weak States: A Critique of New Institutionalist Explanations. In J. Harriss, J. Hunter, & C. Lewis (Eds.), The new institutional economics and third world development. Psychology Press.

191. Khan, M. H. (2019). Knowledge, skills and organizational capabilities for structural transformation. Structural Change and Economic Dynamics, 48, 42–52.

192. Kieffer, K. M. (1998). Orthogonal versus Oblique Factor Rotation: A Review of the Literature regarding the Pros and Cons.

193. Klapper, L., Ansar, S., Hess, J., & Singer, D. (2019). Sub-Saharan Africa Series: Mobile Money and Digital Financial Inclusion (No. 1; The Findex Notes: Sub-Saharan Africa Series). Development Research Group, The World Bank. https://globalfindex.worldbank.org/sites/globalfindex/files/referpdf/FindexNote1_062419.pdf

194. Kline, S. J., & Rosenberg, N. (2009). An Overview of Innovation. In N. Rosenberg, Studies on Science and the Innovation Process (pp. 173–203). WORLD SCIENTIFIC. https://doi.org/10.1142/9789814273596_0009

195. Kongsamut, P., Rebelo, S., & Xie, D. (2001). Beyond Balanced Growth. The Review of Economic Studies, 68(4), 869–882.

196. Kordalska, A., & Olczyk, M. (2018). Linkages between services and manufacturing as a new channel for GVC growth: Evidence from CEE countries.

197. Koschatzky, K. (1999). Innovation networks of industry and business‐related services—Relations between innovation intensity of firms and regional inter‐firm cooperation. European Planning Studies, 7(6), 737–757. https://doi.org/10.1080/09654319908720551

198. Kravis, I. B., Heston, A., & Summers, R. (1983). The share of services in economic growth. Global Econometrics: Essays in Honor of Lawrence R. Klein, 188–218.

199. Krueger, A. O. (1974). The political economy of the rent-seeking society. The American Economic Review, 64(3), 291–303.

200. Krugman, P. (1994). THE FALL AND RISE OF DEVELOPMENT ECONOMICS. Rethinking the Development Experience: Essays Provoked by the Work of Albert O. Hirschman, 39–58.

201. Kuznets, S. (1930). Secular movement in production and prices: Their nature and their bearing upon cyclical fluctuations. Houghton Mifflin and company, Boston.

202. Kuznets, S. (1955). Economic Growth and Income Inequality. The American Economic Review, 45(1), 1–28.

203. Kuznets, S. (1957). Quantitative Aspects of the Economic Growth of Nations: II. Industrial Distribution of National Product and Labor Force. Economic Development and Cultural Change, 5(S4), 1–111. https://doi.org/10.1086/449740

204. Kuznets, S. (1966). Modern economic growth: Rate, structure and spread. Yale University Press.

205. Kyem, P. A. K. (2012). Is ICT the panacea to sub-Saharan Africa's development problems? Rethinking Africa's contentious engagement with the global information society. Progress in Development Studies, 12(2–3), 231–244. https://doi.org/10.1177/146499341101200309

206. Lall, S. (1992). Technological capabilities and industrialization. World Development, 20(2), 165–186. https://doi.org/10.1016/0305-750X(92)90097-F

207. Lall, S. (2000). The Technological structure and performance of developing country manufactured exports, 1985-98. Oxford Development Studies, 28(3), 337–369.

208. Lambregts, B., Beerepoot, N., & Kloosterman, R. C. (2015). Service-sector driven economic development from a historical perspective. In B. Lambregts, N. Beerepoot, & R. Kloosterman (Eds.), The Local Impact of Globalization in South and Southeast Asia: Offshore Business Processes in Service Industries. Routledge, Taylor & Francis Group.

209. Lanz, R., & Maurer, A. (2015). Services and global value chains: Servicification of manufacturing and services networks. Journal of International Commerce, Economics and Policy, 6(03), 1550014.

210. Lavopa, A., & Szirmai, A. (2015). Industrialisation in Time and Space (UNIDO/UNU-MERIT Background Papers for the UNIDO, Industrial Development Report 2016 WP 6; IDR).

211. Lawrence, R. Z., Slaughter, M. J., Hall, R. E., Davis, S. J., & Topel, R. H. (1993). International Trade and American Wages in the 1980s: Giant Sucking Sound or Small Hiccup? Brookings Papers on Economic Activity. Microeconomics, 1993(2), 161. https://doi.org/10.2307/2534739

212. Lehmann, E. E., & Schenkenhofer, J. (2020). National Systems of Innovation. In Oxford Research Encyclopedia of Business and Management.

213. Lengelle, M. (1966). Growth of the commerce and service sector in Western Europe. In Manpower Problems in the Service Sector, Supplement to the Report. Paris: OECD.

214. Leontief, W. W. (1936). Quantitative Input and Output Relations in the Economic Systems of the United States. The Review of Economics and Statistics, 18(3), 105. https://doi.org/10.2307/1927837

215. Lewis, W. A. (1954). Economic Development with Unlimited Supplies of Labour. The Manchester School, 22(2), 139–191. https://doi.org/10.1111/j.1467-9957.1954.tb00021.x

216. Lodefalk, M. (2015). Servicification of manufacturing firms makes divides in trade policymaking antiquated.

217. Lombardi, M. (2003). The evolution of local production systems: The emergence of the “invisible mind” and the evolutionary pressures towards more visible “minds”. Research Policy, 32(8), 1443–1462. https://doi.org/10.1016/S0048-7333(02)00157-9

218. Lopes, C., & Willem te Velde, D. (2021). Structural transformation, economic development and industrialization in Post-Covid-19 Africa. New York, NY: Institute for New Economic Thinking.

219. Lopez Gonzalez, J., Meliciani, V., & Savona, M. (2019). When Linder Meets Hirschman: Inter-Industry Linkages and Global Value Chains in Business Services. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2744553

220. Lucas, R. E. (1990). Why doesn’t capital flow from rich to poor countries? American Economic Review, 80(2), 92–96.

221. Lucas, R. E. J. (1998). On the Mechanics of Economic Development (1987). In D. P. Jacobs, E. Kalai, M. I. Kamien, & N. L. Schwartz (Eds.), Frontiers of Research in Economic Theory (pp. 61–70). Cambridge University Press. https://doi.org/10.1017/CCOL0521632226.005

222. Lundvall, B.-A. (Ed.). (1992). National systems of innovation: Toward a theory of innovation and interactive learning. Anthem Press.

223. Lundvall, B.-Å. (2016). The Learning Economy and the Economics of Hope. Anthem Press. https://doi.org/10.26530/OAPEN_626406

224. Lundvall, B.-Å., Johnson, B., Andersen, E. S., & Dalum, B. (2002). National systems of production, innovation and competence building. Research Policy, 31(2), 213–231.

225. Machlup, F. (1980). Knowledge and Knoweldge Production (Knowledge ; v.1): Vol. I. Princeton University Press.

226. Maggino, F. (Ed.). (2017). Complexity in Society: From Indicators Construction to their Synthesis (Vol. 70). Springer.

227. Malchow-Møller, N., Munch, J. R., & Skaksen, J. R. (2015). Services trade, goods trade and productivity growth: Evidence from a population of private sector firms. Review of World Economics, 151(2), 197–229. https://doi.org/10.1007/s10290-014-0208-3

228. Malerba, F. (2002). Sectoral systems of innovation and production. Research Policy, 31(2), 247–264.

229. Marchi, V. D., Maria, E. D., & Micelli, S. (2013). Environmental strategies, upgrading and competitive advantage in global value chains. Business Strategy and the Environment, 22(1), 62–72.

230. Markusen, A. (1996). Sticky Places in Slippery Space: A Typology of Industrial Districts. Economic Geography, 72(3), 293. https://doi.org/10.2307/144402

231. Maroto-Sánchez, A. (2012). Productivity in the services sector: Conventional and current explanations. The Service Industries Journal, 32(5), 719–746. https://doi.org/10.1080/02642069.2010.531266

232. Marshall, A. (1919). Industry and Trade. 679.

233. Mazzi, C. T., & Foster-McGregor, N. (2021). Imported intermediates, technological capabilities and exports: Evidence from Brazilian firm-level data. Research Policy, 50(1), 104141.

234. Mazzucato, M. (2013). Financing innovation: Creative destruction vs. Destructive creation. Industrial and Corporate Change, 22(4), 851–867.

235. Mazzucato, M. (2018). The value of everything: Making and taking in the global economy. Hachette UK.

236. Mbayi, L. (2011). Linkages in Botswana's Diamond Cutting and Polishing Industry. Cape Town, University of Cape Town, Making the Most of Commodities Programme (MMCP) Discussion Paper, 3. http://www.cssr.uct.ac.za/sites/cssr.uct.ac.za/files/pubs/MMCP%20Paper%203.pdf

237. Mc Millan, M., Rodrik, D., & Sepulveda, C. (2017). Structural change, fundamentals, and growth: A framework and case studies. The World Bank.

238. McMillan, M. S., & Rodrik, D. (2011). Globalization, structural change and productivity growth. National Bureau of Economic Research.

239. Meng, B., Ye, M., & Wei, S. (2020). Measuring smile curves in global value chains. Oxford Bulletin of Economics and Statistics, 82(5), 988–1016.

240. Messina, J. (2004). Institutions and Service Employment: A Panel Study for OECD Countries. Labour, 19(2), 343–372. https://doi.org/10.1111/j.1467-9914.2005.00298.x

241. Milberg, W., & Winkler, D. (2013). Outsourcing Economics: Global Value Chains in Capitalist Development. Cambridge University Press. doi: 10.1017/CBO9781139208772

242. Miles, I., Kastrinos, N., Flanagan, K., Bilderbeek, R., Huntink, W., & Bouman, M. (1995). KNOWLEDGE-INTENSIVE BUSINESS SERVICES Users, Carriers and Sources of Innovation- a report to DG13 SPRINT-EIMS -. 117.

243. Miller, R., & Blair, P. (2009). Input-output analysis: Foundations and extensions. Cambridge University Press.

244. Mjimba, V. (2011). The nature and determinants of linkages in emerging minerals commodity sectors: A case study of gold mining in Tanzania. Unpublished Working Paper Prepared for Making the Most of Commodities Workshop. http://www.cssr.uct.ac.za/sites/cssr.uct.ac.za/files/pubs/MMCP%20Paper%207.pdf

245. Mkandawire, P. T., & Soludo, C. C. (1999). Our continent, our future: African perspectives on structural adjustment. Idrc.

246. Montresor, S., & Marzetti, V. G. (2011). The deindustrialisation/tertiarisation hypothesis reconsidered: A subsystem application to the OECD7. Cambridge Journal of Economics, 35(2), 401–421. https://doi.org/10.1093/cje/beq009

247. Morris, M., Kaplinsky, R., & Kaplan, D. (2011). "One Thing Leads to Another" – Commodities, Linkages and Industrial Development: A Conceptual Overview. Open Research Online, 44.

248. Mudambi, R. (2008). Location, control and innovation in knowledge-intensive industries. Journal of Economic Geography, 8(5), 699–725.

249. Muller, E., & Doloreux, D. (2009). What we should know about knowledge-intensive business services. Technology in Society, 31(1), 64–72. https://doi.org/10.1016/j.techsoc.2008.10.001

250. Muller, E., & Zenker, A. (2001). Business services as actors of knowledge transformation and diffusion: Some empirical findings on the role of KIBS in regional and national innovation systems. Research Policy, 30(9), 1501–1516.

251. Nairametrics. (2022, February 1). Crowdyvest's Cash Crunch: Debt acquisition & Failed Projections, lead to Payment Delay. https://nairametrics.com/2022/02/01/ill-advised-debt-acquisition-failed-projections-defaults-by-partners-the-cause-of-delayed-payment-to-investors-crowdyvest/

252. Nath, S. (1962). The theory of balanced growth. Oxford Economic Papers, 14(2), 138–153.

253. National Planning Commision. (2009). Nigeria Vision 20: 2020. National Planning Commission.

254. National Planning Commision. (2011). Transformation Agenda. National Planning Commission.

255. NBS. (2014a). Measuring Better: Frequently Asked Questions on the Rebasing / Re-Benchmarking of Nigeria's Gross Domestic Product (GDP). National Bureau of Statistics. http://www.nigerianstat.gov.ng/report/200

256. NBS. (2014b). Measuring Better: Presentation of Preliminary Results of the Rebased Nominal Gross Domestic Product (GDP) Estimates for Nigeria 2010 to 2013 Delivered by The Statistician General of the Federation & Chief Executive Officer. National Bureau of Statistics. http://www.nigerianstat.gov.ng/report/199

257. NBS. (2016). Job Creation Survey, 2nd and 3rd Quarters 2016 Summary Findings and Selected Tables. National Bureau of Statistics.

258. NBS. (2020). Nigerian Gross Domestic Product Report (Q2 2020) (GDP Report). National Bureau of Statistics. https://nigerianstat.gov.ng/elibrary

259. NBS. (2022). Nigerian Gross Domestic Product Report (Q4 2021) (GDP Report). National Bureau of Statistics. https://nigerianstat.gov.ng/elibrary

260. Nelson, R. R. (Ed.). (1993). National innovation systems: A comparative analysis. Oxford University Press.

261. Nelson, R. R., & Winter, S. G. (1982). An evolutionary theory of economic change (digitally reprinted). The Belknap Press of Harvard Univ. Press.

262. Nelson, R. R., & Winter, S. G. (1993). In search of useful theory of innovation. Research Policy, 22(2), 108. https://doi.org/10.1016/0048-7333(93)90053-K

263. Newfarmer, R. S., Tarp, F., & Page, J. (Eds.). (2018). Industries without smokestacks: Industrialization in Africa reconsidered. Oxford University Press.

264. Ngai, L. R., & Pissarides, C. A. (2007). Structural Change in a Multisector Model of Growth. The American Economic Review, 97(1), 429–443.

265. Nicoletti, G., Scarpetta, S., & Boylaud, O. (1999). Summary indicators of product market regulation with an extension to employment protection legislation.

266. Niebel, T. (2018). ICT and economic growth – Comparing developing, emerging and developed countries. World Development, 104, 197–211. https://doi.org/10.1016/j.worlddev.2017.11.024

267. Nigerian Exchange. (2019, September 6). Company Details of Chams Plc. http://www.nse.com.ng/issuers/listed-securities/company-details?isin=NGCHAMS00001

268. Nilsson, R. (2000). Confidence indicators and composite indicators. Paris: OECD.

269. Nissanke, M. (2016). Macroeconomic Framework for Structural Transformation of African Economies. Commissioned by the UNECA, as the Single Background Paper for Its Report under the Title Macroeconomic Policy and Structural Transformation.

270. Nissanke, M. (2019). Exploring macroeconomic frameworks conducive to structural transformation of sub-Saharan African economies. Structural Change and Economic Dynamics, 48, 103–116.

271. Njoh, A. J. (2018). The relationship between modern Information and Communications Technologies (ICTs) and development in Africa. Utilities Policy, 50, 83–90. https://doi.org/10.1016/j.jup.2017.10.005

272. Noman, A., Botchwey, K., Stein, H., & Stiglitz, J. E. (2012). Good growth and governance in Africa: Rethinking development strategies. Oxford University Press.

273. Nonaka, I. (1994). A Dynamic Theory of Organizational Knowledge Creation. Organization Science, 5(1), 14–37.

274. Nurkse, R. (1953). Problems of capital formation in underdeveloped countries. Oxford Basil Blackwell.

275. Nurkse, R. (1956). Balanced Growth on Static Assumptions. The Economic Journal, 66(262), 365. https://doi.org/10.2307/2227995

276. OECD. (1996). The Knowledge-Based Economy. 1996 Science, Technology and Industry Outlook, 3(3), 77–82. https://doi.org/10.1007/s12117-998-1085-8

277. OECD. (2007). Information Economy Sector Definitions Based on the International Standard Industry Classification (ISIC 4). OECD.

278. OECD. (2009). Information Economy Product Definitions Based on the Central Product Classification (version 2) (OECD Digital Economy Papers No. 158). https://doi.org/10.1787/222222056845

279. Ofer, G. (1967). The service industries in a developing economy: Israel as a case study. Published in cooperation with the Bank of Israel by Praeger.

280. Okafor, E. E. (2013). Corruption and implications for industrial development in Nigeria. African Journal of Business Management, 7(29), 2916–2924.

281. Okonjo-Iweala, N., & Osafo-Kwaako, P. (2007). Nigeria's economic reforms: Progress and challenges. Brookings Global Economy and Development Working Paper, 6.

282. Olukoshi, A. (2003). The elusive prince of Denmark: Structural adjustment and the crisis of governance in Africa. In C. C. Soludo & P. T. Mkandawire (Eds.), African voices on structural adjustment (pp. 161–187). Africa World Press.

283. Olutayo, A., & Omobowale, A. (2011). Public Service Reforms and the Nigerian Telecommunications (NITEL) PLC. Development and Society, 40(2), 335–349.

284. Oluyemi-Kusa, A. (1994). The Structural Adjustment Programme of the Nigerian State. In A. O. Olukoshi, O. Olaniyan, & F. Aribisala (Eds.), Structural Adjustment in West Africa. Published by Pumark Nigeria Limited (Educational Publishers) for The Nigeria ….

285. Orji, U. J. (2018). Telecommunications law and regulation in Nigeria. Cambridge Scholars Publishing.

286. Oulton, N. (2001). Must the growth rate decline? Baumol's unbalanced growth revisited. Oxford Economic Papers, 53(4), 605–627. https://doi.org/10.1093/oep/53.4.605

287. Oyejide, A., & Adewuyi, A. (2011). Backward linkages in the manufacturing sector in the oil and gas value chain in Angola. The Open University, Accessed April, 16, 2013.

288. Oyejide, T. A., & Bankole, A. S. (2001). Liberalisation of the Services Sector in Nigeria: Implications of Unilateral and Multilateral Approaches. African Economic Research Consortium. http://siteresources.worldbank.org/INTRANETTRADE/Resources/ServicesNigeria.pdf

289. Oyejide, T. A., Soyode, A., & Kayode, M. (1985). Nigeria and the IMF. Heinemann Educational Books (Nigeria).

290. Oyelaran Oyeyinka, B. (2001). Networks and Linkages in African Manufacturing Cluster: A Nigerian Case Study. Networks.

291. Palma, J. G. (2005). Four sources of de-industrialisation and a new concept of the Dutch-Disease. In J. A. Ocampo (Ed.), Beyond Reforms: Structural dynamic and macroeconomic vulnerability. Stanford University Press and the World Bank.

292. Park, S.-H. (1989). Linkages between industry and services and their implications for urban employment generation in developing countries. Journal of Development Economics, 30(2), 359–379. https://doi.org/10.1016/0304-3878(89)90009-6

293. Park, S.-H., & Chan, K. S. (1989). A cross-country input-output analysis of intersectoral relationships between manufacturing and services and their employment implications. World Development, 17(2), 199–212. https://doi.org/10.1016/0305-750X(89)90245-3

294. Partech Africa Team. (2020). 2019 Africa Tech Venture Capital Report. https://partechpartners.com/news/2019-partech-africa-report-here-and-its-best-yet-us-2-02-b-raised/

295. Pasinetti, L. (1993). Structural Economic Dynamics: A theory of the economic consequences of human learning. Cambridge University Press.

296. Pasinetti, L. (2012). Structural Dynamics and Economic Growth (R. Arena & P. L. Porta, Eds.). Cambridge University Press; Cambridge Core. https://doi.org/10.1017/CBO9781139059930

297. Paul Streeten. (1959). Unbalanced Growth. Oxford Economic Papers, New Series, 11(2), 167–190.

298. Pavitt, K. (1984). Sectoral patterns of technical change: Towards a taxonomy and a theory. Research Policy, 13(6), 343–373. https://doi.org/10.1016/0048-7333(84)90018-0

299. Peerally, J., Santiago, F., De Fuentes, C., & Moghavvemi, S. (2021). Towards a firm-level technological capability framework to endorse and realize the Fourth Industrial Revolution in developing countriesPeerally (Working Paper No. 2/2021). UNIDO.

300. Penrose, E. (1959). The Theory of the Growth of the Firm. Oxford University Press.
301. Peruzzi, A. (2017). Complexity: Between Rhetoric and Science. In F. Maggino (Ed.), Complexity in society: From indicators construction to their synthesis (Vol. 70). Springer.
302. Pilat, D., & Wölfl, A. (2005). MEASURING THE INTERACTION BETWEEN MANUFACTURING AND SERVICES STI WORKING PAPER 2005/5 Statistical Analysis of Science, Technology and Industry. 47.
303. Polanyi, M. (1958). Personal Knowledge: Towards a Post-Critical Philosophy. Routledge & Kegan Paul.
304. Polanyi, M. (1966). The Tacit Dimension. The University of Chicago Press.
305. Pomini, M. (2012). Structural Dynamics in Historical Perspective. Structural Dynamics and Economic Growth, 49–68.
306. Porter, M. (1998). Clusters and the New Economics of Competition. Harvard Business Review, 76(6), 77–90.
307. Prebisch, R. (1950). The economic development of Latin America and its principal problems. Economic Bulletin for Latin America, 7(1), 1–22.
308. Punch Nigeria. (2021, November 10). Anchor Borrowers: Farmers owe CBN N463bn as defaults rise. https://punchng.com/anchor-borrowers-farmers-owe-cbn-n463bn-as-defaults-rise/#:~:text=Farmers%20who%20subscribed%20to%20the,Report%20for%20April%20have%20shown.
309. Pyke, F., Becattini, G., & Sengenberger, W. (Eds.). (1990). Industrial districts and inter-firm co-operation in Italy. International Institute for Labour Studies.
310. Quartz Africa. (2019, November 11). Nigeria's top fintech company is set to be Africa's first home-grown unicorn with Visa investment. https://qz.com/africa/1746031/visa-buys-stake-for-200-million-in-nigerias-interswitch/
311. Ramaswamy, R., & Rowthorn, R. (1997). Deindustrialization: Causes and Implications. IMF Working Papers, 97(42), 1. https://doi.org/10.5089/9781451975826.001
312. Rodrik, D. (2016). Premature deindustrialization. Journal of Economic Growth, 21(1), 1–33. https://doi.org/10.1007/s10887-015-9122-3
313. Romer, P. M. (1986). Increasing Returns and Long-Run Growth. Journal of Political Economy, 94(5), 1002–1037. https://doi.org/10.1086/261420
314. Rosenberg, N. (2008). Inside the Black Box: Technology and Economics. Cambridge University Press.
315. Rosenstein-Rodan, P. N. (1943). Problems of Industrialisation of Eastern and South-Eastern Europe. The Economic Journal, 53(210/211), 202. https://doi.org/10.2307/2226317
316. Rosenstein-Rodan, P. N. (1961). Notes on the theory of the 'big push'. In Economic Development for Latin America (pp. 57–81). Springer.
317. Rostow, W. (1959). The Stages of Economic Growth. The Economic History Review, 12(1), 1. https://doi.org/10.2307/2591077

318. Rowthorn, R., & Coutts, K. (2013). De-industrialisation and the balance of payments in advanced economies. Cambridge Journal of Economics, 28(5), 767–790. https://doi.org/10.1093/cje/beh034

319. Rowthorn, R. E., & Wells, J. R. (1987). De-industrialization and foreign trade. Cambridge University Press.

320. Rubalcaba, L. (2007). The New Service Economy: Challenges and Poicy Implications for Europe. Edward Elgar.

321. Rubalcaba-Bermejo, L. (1999). Business services in European industry: Growth, employment, and competitiveness. Office for Official Publications of the European Communities ; Bernan Associates [distributor].

322. Sachs, J. D., & Warner, A. (1995). Natural resource abundance and economic growth.

323. Sachs, J. D., & Warner, A. M. (1997). Fundamental sources of long-run growth. The American Economic Review, 87(2), 184–188.

324. Sachs, J. D., & Warner, A. M. (2001). The curse of natural resources. European Economic Review, 45(4–6), 827–838.

325. Sasaki, H. (2007). The rise of service employment and its impact on aggregate productivity growth. Structural Change and Economic Dynamics, 18(4), 438–459. https://doi.org/10.1016/j.strueco.2007.06.003

326. Sato, Y., & Fujita, M. (2009). Capability matrix: A framework for analyzing capabilities in value chains. Inst. of Developing Economies, Japan External Trade Organization.

327. Savona, M. (2015). Global Structural Change and Value Chains in Services. A Reappraisal. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2744533

328. Schatz, S. P. (1984). Pirate capitalism and the inert economy of Nigeria. The Journal of Modern African Studies, 22(1), 45–57.

329. Schumpeter, J. A. (1947). The Creative Response in Economic History. The Journal of Economic History, 7(02), 149–159. https://doi.org/10.1017/S0022050700054279

330. Schumpeter, J. A. (1983). The Theory of Economic Development: An inquiry into profits, capital, credit, interest and the business cycle. Transaction Publishers.

331. Simon Kuznets. (1973). Modern Economic Growth: Findings and Reflections. The American Economic Review, 63(3), 247–258.

332. Singer, H. (1950). The Distribution of Gains between Investing and Borrowing Countries. The American Economic Review, 40(2,). http://www.jstor.org/stable/1818065

333. Singh, A. (1977). UK industry and the world economy: A case of de-industrialisation? Cambridge Journal of Economics, 1(2), 113–136.

334. Škuflić, L., & Družić, M. (2016). Deindustrialisation and productivity in the EU. Economic Research-Ekonomska Istraživanja, 29(1), 991–1002. https://doi.org/10.1080/1331677X.2016.1235505

335. Soete, L., & Miozzo, M. (1989). Trade and Development in Services: A technological perspective (report for UNCTAD). UNU-MERIT.

336. Solow, R. M. (1956). A Contribution to the Theory of Economic Growth. The Quarterly Journal of Economics, 70(1), 65. https://doi.org/10.2307/1884513

337. Sorbe, S., Gal, P., & Millot, V. (2018). Can productivity still grow in service-based economies?

338. Sorunke, R. M. (2019). Bolster Efficiency in Agricultural Value Chains in Nigeria.

339. Squicciarini, M., & Inaba, T. (2017). ICT: A new taxonomy based on the international patent classification (OECD Science, Technology and Industry Working Papers No. 2017/01). https://doi.org/10.1787/ab16c396-en

340. Staber, U., & Morrison, C. (1999). The Empirical Foundations of Industrial District Theory. 26.

341. Stare, M. (2007). Service development in transition economies: Achievements and missing links. In J. R. Bryson & P. W. Daniels (Eds.), The handbook of service industries. Edward Elgar Publishing.

342. Stein, H., & Nissanke, M. (1999). Structural adjustment and the African crisis: A theoretical appraisal. Eastern Economic Journal, 25(4), 399–420.

343. Stempedia. (2018, December 8). Getting Started with 3-D Printing. The Stempedia. https://thestempedia.com/tutorials/getting-started-with-3d-printing/

344. Stigler, G. (1956). Trend in Employment in the Service Industries. Princeton University Press.

345. Strobel, T. (2016). ICT intermediates and productivity spillovers—Evidence from German and US manufacturing sectors. Structural Change and Economic Dynamics, 37, 147–163.

346. Syrquin, M. (2007). Key Issues for the 21st Century: Economics, Economies, and the Global Economy. Key Issues for the 21st Century: Economics, Economies, and the Global Economy, 1000–1011.

347. Syrquin, M. (2012). Two approaches to the study of structural change and economic development: Kuznets and Pasinetti. In R. Arena & P. L. Porta (Eds.), Structural Dynamics and Economic Growth (pp. 37–48). Cambridge University Press. https://doi.org/10.1017/CBO9781139059930.003

348. Szirmai, A. (2012). Industrialisation as an engine of growth in developing countries, 1950–2005. Structural Change and Economic Dynamics, 23(4), 406–420. https://doi.org/10.1016/j.strueco.2011.01.005

349. Szirmai, A., & Verspagen, B. (2010). Is Manufacturing Still an Engine of Growth in Developing Countries? Productivity and Economic Growth, 1, 295–297. http://www.iariw.org

350. Szirmai, A., & Verspagen, B. (2015). Manufacturing and economic growth in developing countries, 1950–2005. Structural Change and Economic Dynamics, 34, 46–59. https://doi.org/10.1016/j.strueco.2015.06.002

351. Takahashi, M. (2017). Statistical inference in missing data by mcmc and non-mcmc multiple imputation algorithms: Assessing the effects of between-imputation iterations. Data Science Journal, 16.

352. TechcityNG. (2020, February). Farmcrowdy acquires Best Foods L&P Ltd – one of the largest meat processors in Nigeria. https://www.techcityng.com/farmcrowdy-acquires-best-foods-lp-ltd-one-of-the-largest-meat-processors-in-nigeria/

353. TechCrunch. (2013, November 2). Welcome To The Unicorn Club: Learning From Billion-Dollar Startups. https://techcrunch.com/2013/11/02/welcome-to-the-unicorn-club/)

354. TechCrunch. (2021, May 6). Paystack expands to South Africa seven months after Stripe acquisition. https://techcrunch.com/2021/05/06/paystack-expands-to-south-africa-seven-months-after-stripe-acquisition/

355. Teece, D. J. (2017). Towards a capability theory of (innovating) firms: Implications for management and policy. Cambridge Journal of Economics, 41(3), 693–720. https://doi.org/10.1093/cje/bew063

356. Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic Capabilities and Strategic Management. Strategic Management Journal, 18(7), 509–533.

357. Teka, Z. (2012). Linkages to manufacturing in the resource sector: The case of the Angolan oil and gas industry. Resources Policy, 37(4), 461–467. https://doi.org/10.1016/j.resourpol.2012.06.009

358. Terheggen, A. & others. (2011). The tropical timber industry in Gabon: A forward linkages approach to industrialisation. Making the Most of Commodities Discussion Paper, 10. http://commodities.open.ac.uk/8025750500453F86/(httpAssets)/CFA3AA4EDFD15763802 5787E0039BAC5/$file/The%20Tropical%20Timber%20Industry%20in%20Gabon.pdf

359. The Cable. (2021, March 16). EXPLAINER: What to know about NSE Demutualisation. https://www.thecable.ng/explainer-what-to-know-about-nse-demutualisation

360. The Cable. (2022, February 16). Flutterwave now valued above $3bn after securing fresh $250m funding. https://www.thecable.ng/breaking-flutterwave-now-valued-above-3bn-after-securing-fresh-250m-funding

361. The Economist. (2014, April 12). Nigeria's GDP, Step change: Revised figures show that Nigeria is Africa's largest economy. The Economist. http://www.economist.com/news/finance-and-economics/21600734-revised-figures-show-nigeria-africas-largest-economy-step-change

362. Thomas, D. (1978). Strategy is different in service businesses. Harvard Business Review, 56(4), 158–165.

363. Thompson, B. (1984). Canonical correlation analysis: Uses and interpretation (Issue 47). Sage.

364. Toner, P. (1999). Main currents in cumulative causation: The dynamics of growth and development. Palgrave Publishers. https://ebookcentral.proquest.com/lib/soas-ebooks/detail.action?docID=3027446.

365. Tregenna, F. (2008). Sectoral engines of growth in South Africa: An analysis of services and manufacturing. UNU-WIDER. http://hdl.handle.net/10419/45157

366. Tregenna, F. (2009). Characterising deindustrialisation: An analysis of changes in manufacturing employment and output internationally. Cambridge Journal of Economics, 33(3), 433–466. https://doi.org/10.1093/cje/ben032

367. Tregenna, F. (2011). Manufacturing Productivity, Deindustrialization and Reindustrialization (Working Paper No. 2011/57). United Nations University - World Institute for Development Economics Research (WIDER).

368. Tregenna, F. (2014). A new theoretical analysis of deindustrialisation. Cambridge Journal of Economics, 38(6), 1373–1390. https://doi.org/10.1093/cje/bet029

369. Tregenna, F. (2015). Deindustrialisation, structural change and sustainable economic growth (Working Paper No. 032; UNIDO/UNU-MERIT Background Papers for the UNIDO, Industrial Development Report 2016: IDR 2016 WP 4). Maastricht Economic and social Research institute on Innovation and Technology (UNU-MERIT).

370. Triplett, J. E., & Bosworth, B. P. (2000). Productivity in the Services Sector. American Economic Association Meetings, 9, 26.

371. Triplett, J. E., & Bosworth, B. P. (2003). "Baumol's Disease" Has Been Cured: It and Multifactor Productivity in U.S. Services Industries. 45.

372. UNICEF. (2022, January 25). Education UNICEF Nigeria. https://www.unicef.org/nigeria/education

373. Ushie, V. A. (2010). Petroleum Dependence and Structural Change in Nigeria: A Linkage-agency Perspective, 1960-2008.

374. Uwitonze, E., & Heshmati, A. (2016). Service Sector Development and Its Determinants in Rwanda. 43.

375. Van Arkadie, B. (1995). The state and economic change in Africa. The Role of the State in Economic Change in Africa, 187–214.

376. Van Wijnbergen, S. (1984). TheDutch Disease': A disease after all? The Economic Journal, 94(373), 41–55.

377. Wade, R. (1996). Japan, the World Bank, and the Art of Paradigm Maintenance: The East Asian Miracle. 34.

378. Wade, R. H. (2003). What strategies are viable for developing countries today? The World Trade Organization and the shrinking of 'development space'. Review of International Political Economy, 10(4), 621–644. https://doi.org/10.1080/09692290310001601902

379. Wade, R. H. (2009). Rethinking industrial policy for low income countries. African Development Review, 21(2), 352–366.

380. Wangwe, S. M., & Semboja, H. H. (2003). Impact of Structural Adjustment on Industrlisation and Technology in AFrica. In C. C. Soludo & T. Mkandawire (Eds.), African voices on structural adjustment: A companion to our continent, our future. Africa World Press.

381. Williamson, J. (1990). What Washington Means by Policy Reform. Latin American Adjustment: How Much Has Happened, 1, 44.

382. Williamson, J. (2006). The Washington Consensus as policy prescription for development. Choice Reviews Online, 43(05), 43-2896-43–2896. https://doi.org/10.5860/CHOICE.43-2896

383. Williamson, O. E. (1979). Transaction-Cost Economics: The Governance of Contractual Relations. The Journal of Law & Economics, 22(2), 233–261.

384. Winter, S. G. (2017). Pursuing the evolutionary agenda in economics and management research. Cambridge Journal of Economics, 41(3), 721–747. https://doi.org/10.1093/cje/bex009

385. Wölfl, A. (2004). Productivity Growth in Services Industries: Is There a Role for Measurement? 8, 15.

386. Wölfl, A. (2005). The Service Economy in OECD Countries (OECD Science, Technology and Industry Working Papers No. 2005/03). https://doi.org/10.1787/212257000720

387. World Bank. (2020). World Development Indicators [Data]. World Bank. https://databank.worldbank.org/source/world-development-indicators

388. Worton, D. A. (1969). The Service Industries in Canada, 1946-66. In Production and Productivity in the Service Industries (pp. 237–286). National Bureau of Economic Research [etc.] ; [distributed by] Columbia University Press.

389. WTO. (1994). General Agreement on Trade in Services: NIGERIA Schedule of Specific Commitments. World Trade Organisation.

390. Yates, D. A. (1996). The rentier state in Africa: Oil rent dependency and neocolonialism in the Republic of Gabon. Africa World Press.

391. Young, A. A. (1928). Increasing Returns and Economic Progress. The Economic Journal, 38, 527–542.

392. Zalewska, A., & Mickiewicz, T. (2002). Deindustrialisation. Lessons from the Structural Outcomes of Post-Communist Transition. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.311410

9. APPENDICES

9.1. Appendices: Chapter 3

9.1.1. Results of Sub-Index Construction for Pre-Industrial Countries

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Machine Tools SI1 (Binned)	3.46	1.728	69
HTExports SI1 (Binned)	3.46	1.711	69
ICTGoodExports SI1 (Binned)	3.48	1.737	69
RDExpenditure SI1 (Binned)	3.46	1.703	69
PatentApplications SI1 (Binned)	3.48	1.703	69
ChargesforIP SI1 (Binned)	3.49	1.694	69
SchoolEnrollment SI1 (Binned)	3.45	1.720	69

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.866
Bartlett's Test of Sphericity	Approx. Chi-Square	408.702
	df	21
	Sig.	0.000

Anti-image Matrices

		Machine Tools SI1 (Binned)	HTExports SI1 (Binned)	ICTGoodExports SI1 (Binned)	RDExpenditure SI1 (Binned)	PatentApplications SI1 (Binned)	ChargesforIP SI1 (Binned)	SchoolEnrollment SI1 (Binned)
Anti-image Covariance	Machine Tools SI1 (Binned)	0.558	-0.082	0.043	-0.019	-0.078	0.023	-0.036
	HTExports SI1 (Binned)	-0.082	0.106	-0.073	0.004	-0.014	-0.045	-0.014
	ICTGoodExports SI1 (Binned)	0.043	-0.073	0.148	0.009	-0.003	-0.052	0.072
	RDExpenditure SI1 (Binned)	-0.019	0.004	0.009	0.606	-0.089	-0.026	-0.095
	PatentApplications SI1 (Binned)	-0.078	-0.014	-0.003	-0.089	0.299	-0.032	-0.126
	ChargesforIP SI1 (Binned)	0.023	-0.045	-0.052	-0.026	-0.032	0.128	-0.065
	SchoolEnrollment SI1 (Binned)	-0.036	-0.014	0.072	-0.095	-0.126	-0.065	0.381
Anti-image Correlation	Machine Tools SI1 (Binned)	.895[a]	-0.336	0.150	-0.032	-0.190	0.086	-0.078
	HTExports SI1 (Binned)	-0.336	.833[a]	-0.580	0.015	-0.078	-0.381	-0.067
	ICTGoodExports SI1 (Binned)	0.150	-0.580	.805[a]	0.032	-0.016	-0.378	0.303
	RDExpenditure SI1 (Binned)	-0.032	0.015	0.032	.939[a]	-0.210	-0.094	-0.199
	PatentApplications SI1 (Binned)	-0.190	-0.078	-0.016	-0.210	.913[a]	-0.164	-0.372
	ChargesforIP SI1 (Binned)	0.086	-0.381	-0.378	-0.094	-0.164	.880[a]	-0.295
	SchoolEnrollment SI1 (Binned)	-0.078	-0.067	0.303	-0.199	-0.372	-0.295	.844[a]

a. Measures of Sampling Adequacy(MSA)

Communalities

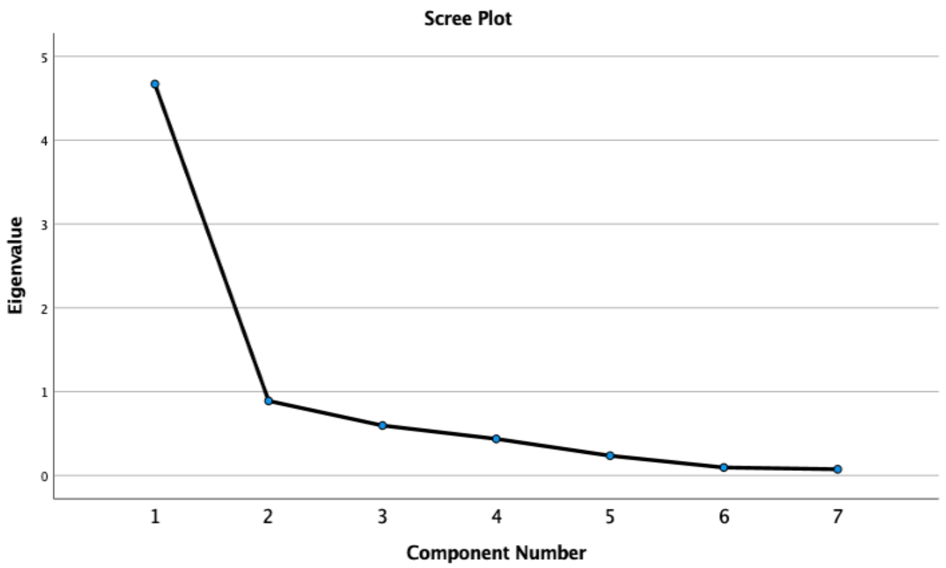
	Initial	Extraction
Machine Tools SI1 (Binned)	1.000	0.490
HTExports SI1 (Binned)	1.000	0.841
ICTGoodExports SI1 (Binned)	1.000	0.689
RDExpenditure SI1 (Binned)	1.000	0.442
PatentApplications SI1 (Binned)	1.000	0.764
ChargesforIP SI1 (Binned)	1.000	0.859
SchoolEnrollment SI1 (Binned)	1.000	0.584

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.670	66.717	66.717	4.670	66.717	66.717
2	0.890	12.711	79.429			
3	0.596	8.520	87.949			
4	0.437	6.243	94.192			
5	0.236	3.374	97.566			
6	0.096	1.366	98.931			
7	0.075	1.069	100.000			

Extraction Method: Principal Component Analysis.



Component Matrix[a]

	Component
	1
Machine Tools SI1 (Binned)	0.700
HTExports SI1 (Binned)	0.917
ICTGoodExports SI1 (Binned)	0.830
RDExpenditure SI1 (Binned)	0.665
PatentApplications SI1 (Binned)	0.874
ChargesforIP SI1 (Binned)	0.927
SchoolEnrollment SI1 (Binned)	0.764

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Rotated Component Matrix[a]

a. Only one component was extracted. The solution cannot be rotated.

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Machine Tools SI2 (Binned)	3.48	1.726	92
HTExports SI2 (Binned)	3.47	1.719	92
ICTExports SI2 (Binned)	3.47	1.719	92
RDExpenditure SI2 (Binned)	3.47	1.719	92
Patent Applications SI2 (Binned)	3.50	1.713	92
ChargesforIP SI2 (Binned)	3.48	1.706	92
SchoolEnrollment SI2 (Binned)	3.47	1.719	92

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.848
Bartlett's Test of Sphericity	Approx. Chi-Square	554.978
	df	21
	Sig.	0.000

Anti-image Matrices

		Machine Tools SI2 (Binned)	HTExports SI2 (Binned)	ICTExports SI2 (Binned)	RDExpenditure SI2 (Binned)	Patent Applications SI2 (Binned)	ChargesforIP SI2 (Binned)	SchoolEnrollment SI2 (Binned)
Anti-image Covariance	Machine Tools SI2 (Binned)	0.616	-0.042	0.029	-0.066	0.002	-0.087	0.013
	HTExports SI2 (Binned)	-0.042	0.123	-0.106	0.001	-0.008	-0.050	-0.014
	ICTExports SI2 (Binned)	0.029	-0.106	0.172	0.013	-0.018	-0.011	0.023
	RDExpenditure SI2 (Binned)	-0.066	0.001	0.013	0.610	0.006	-0.038	-0.134
	Patent Applications SI2 (Binned)	0.002	-0.008	-0.018	0.006	0.165	-0.070	-0.137
	ChargesforIP SI2 (Binned)	-0.087	-0.050	-0.011	-0.038	-0.070	0.202	0.024
	SchoolEnrollment SI2 (Binned)	0.013	-0.014	0.023	-0.134	-0.137	0.024	0.262
Anti-image Correlation	Machine Tools SI2 (Binned)	.932[a]	-0.153	0.090	-0.108	0.006	-0.248	0.033
	HTExports SI2 (Binned)	-0.153	.818[a]	-0.730	0.002	-0.054	-0.319	-0.081
	ICTExports SI2 (Binned)	0.090	-0.730	.820[a]	0.041	-0.109	-0.061	0.108
	RDExpenditure SI2 (Binned)	-0.108	0.002	0.041	.907[a]	0.019	-0.109	-0.336
	Patent Applications SI2 (Binned)	0.006	-0.054	-0.109	0.019	.834[a]	-0.383	-0.658
	ChargesforIP SI2 (Binned)	-0.248	-0.319	-0.061	-0.109	-0.383	.899[a]	0.106
	SchoolEnrollment SI2 (Binned)	0.033	-0.081	0.108	-0.336	-0.658	0.106	.799[a]

a. Measures of Sampling Adequacy(MSA)

Communalities

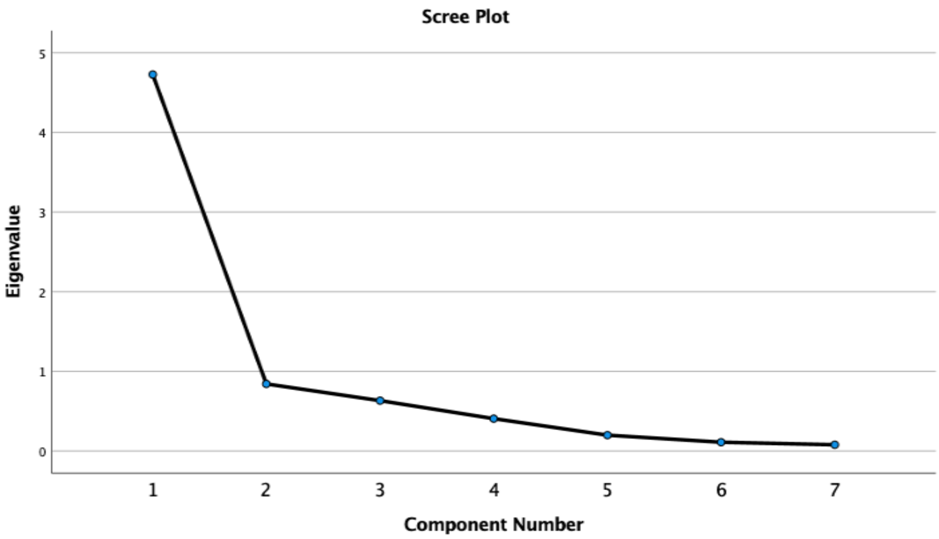
	Initial	Extraction
Machine Tools SI2 (Binned)	1.000	0.445
HTExports SI2 (Binned)	1.000	0.827
ICTExports SI2 (Binned)	1.000	0.728
RDExpenditure SI2 (Binned)	1.000	0.407
Patent Applications SI2 (Binned)	1.000	0.831
ChargesforIP SI2 (Binned)	1.000	0.835
SchoolEnrollment SI2 (Binned)	1.000	0.655

Extraction Method: Principal Component Analysis.

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.727	67.533	67.533	4.727	67.533	67.533
2	0.843	12.040	79.573			
3	0.633	9.044	88.617			
4	0.407	5.813	94.430			
5	0.200	2.852	97.282			
6	0.111	1.587	98.869			
7	0.079	1.131	100.000			

Extraction Method: Principal Component Analysis.



Component Matrix[a]

	Component
	1
Machine Tools SI2 (Binned)	0.667
HTExports SI2 (Binned)	0.909
ICTExports SI2 (Binned)	0.853
RDExpenditure SI2 (Binned)	0.638
Patent Applications SI2 (Binned)	0.911
ChargesforIP SI2 (Binned)	0.914
SchoolEnrollment SI2 (Binned)	0.809

Extraction Method: Principal Component Analysis.

a. 1 components extracted.

Rotated Component Matrix[a]

a. Only one component was extracted. The solution cannot be rotated.

9.1.2. Results of PCA Using Z-Scores

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
Zscore: Machine Tool3	.0000000	1.00000000	58
Zscore (SchoolEnrollment3)	.0000000	1.00000000	58
Zscore(RDExpenditure3)	.0000000	1.00000000	58
Zscore(PatentsInForce3)	.0000000	1.00000000	58
Zscore(ICTExports3)	.0000000	1.00000000	58
Zscore(DVA3)	.0000000	1.00000000	58
Zscore(ChargesforIP23)	.0000000	1.00000000	58
Zscore(HTExports3)	.0000000	1.00000000	58

Communalities

	Initial	Extraction
Zscore: Machine Tool3	1.000	.437
Zscore (SchoolEnrollment3)	1.000	.684
Zscore(RDExpenditure3)	1.000	.769
Zscore(PatentsInForce3)	1.000	.782
Zscore(ICTExports3)	1.000	.786
Zscore(DVA3)	1.000	.929
Zscore(ChargesforIP23)	1.000	.234
Zscore(HTExports3)	1.000	.910

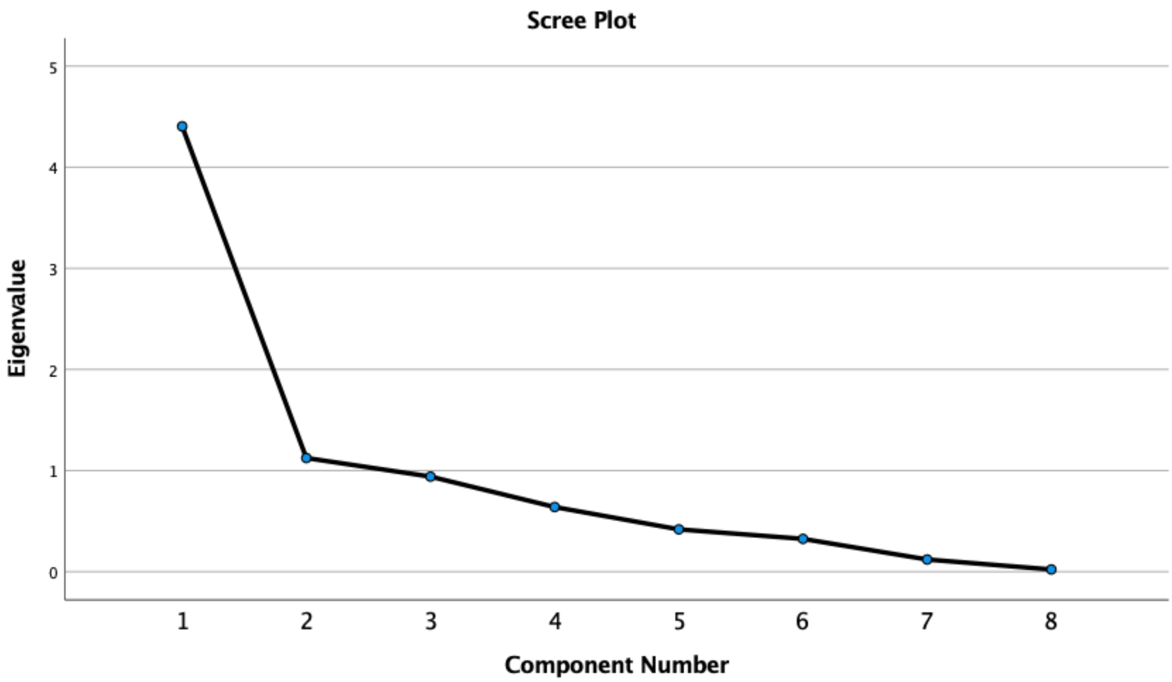
Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	4.405	55.063	55.063	4.405	55.063	55.063	4.307
2	1.125	14.063	69.126	1.125	14.063	69.126	2.233
3	.941	11.765	80.891				
4	.640	8.002	88.894				
5	.419	5.242	94.135				
6	.325	4.066	98.202				
7	.121	1.516	99.718				
8	.023	.282	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.



Component Matrix[a]

	Component 1	Component 2
Zscore: Machine Tool3	.597	-.283
Zscore (SchoolEnrollment3)	.780	-.274
Zscore(RDExpenditure3)	.247	.841
Zscore(PatentsInForce3)	.796	.384
Zscore(ICTExports3)	.878	-.121
Zscore(DVA3)	.960	-.091
Zscore(ChargesforIP23)	.380	.299
Zscore(HTExports3)	.953	-.053

Extraction Method: Principal Component Analysis.

a. 2 components extracted.

Pattern Matrix[a]

	Component 1	Component 2
Zscore: Machine Tool3	.721	-.195
Zscore (SchoolEnrollment3)	.881	-.150
Zscore(RDExpenditure3)	-.319	.966
Zscore(PatentsInForce3)	.471	.572
Zscore(ICTExports3)	.870	.036
Zscore(DVA3)	.925	.084
Zscore(ChargesforIP23)	.151	.399
Zscore(HTExports3)	.894	.124

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.[a]

a. Rotation converged in 3 iterations.

Structure Matrix

	Component	
	1	2
Zscore: Machine Tool3	.637	.117
Zscore (SchoolEnrollment3)	.816	.231
Zscore(RDExpenditure3)	.098	.828
Zscore(PatentsInForce3)	.718	.775
Zscore(ICTExports3)	.886	.412
Zscore(DVA3)	.961	.484
Zscore(ChargesforIP23)	.323	.464
Zscore(HTExports3)	.947	.510

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Component Correlation Matrix

Component	1	2
1	1.000	.432
2	.432	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

9.2. Appendices Chapter 4

9.2.1. Summary of Literature on Deindustrialisation Trends

	Author(s)	Country or Region of Study	Measure(s) of Deindustrialisation	Date of Turning Point	Per-Capita Income at Turning Point	Causes of deindustrialisation
1	Singh (1977)	United Kingdom	Labour force employed in manufacturing Share of manufacturing in output Trade ratio for manufactures	Late 1960s for the labour force in manufacturing. Early 70s for share of manufacturing in output in constant terms	Not mentioned	Deindustrialisation observed only in terms of employment and not in output. Possible explanation for fall in manufacturing employment given supply side problems in UK production systems such as lower quality, design and general performance of products relative to other countries
2	Rowthorn & Wells (1987)	UK and other OECD countries	Manufacturing employment as share of total employment	Late 1960s for the UK and between 1953 and 1978 for other OECD countries	average of $3,800 in 1975 prices	Positive deindustrialisation arises from productivity differences between manufacturing and service sectors. Negative deindustrialisation manifests when the manufacturing sector is under performing and this may be caused by changing trade patterns. Trade-related deindustrialisation is caused by shifting of net exports from manufacturing towards other goods and services. This is a type of negative deindustrialisation.
3	Ramaswamy & Rowthorn (1997)	21 OECD countries	Manufacturing employment as share of total employment	mid 1960s for the US mid 1970s in Japan 1970s for EU-15 late 1980s for Korea and Taiwan Province of China 1970s for Hong Kong	$8,185 (+/_$990) in 1986 US Dollars	Attribute deindustrialisation mainly to the tendency for productivity in manufacturing to grow faster than in services. Other factors playing a lesser role include, lower investment, shifts in consumption patterns, externalisation of services by manufacturing firms to specialised service firms, North-South trade effects.
4	Rowthorn & Ramaswamy (1999)	18 countries - Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, the United Kingdom, and the United States.	Manufacturing employment as share of total employment	Late 1960s to early 1970s	About $9,000 in 1986 prices	Same as in Ramaswamy & Rowthorn (1997) but give more prominence to shifts in the pattern of demand between manufactures and services.
5	Palma (2005, 2014)	105 countries	Manufacturing employment as share of total employment	after 1973 for EU end of the 1960s and the beginning of the 1970s for most industrial countries 1980s for high-income developing countries (such as the rapidly industrializing economies of East Asia) and some Latin American countries for different reasons	Noted that since the beginning of the 1980s there has been a drop in the level of income per capita at which the downturn in manufacturing employment begins: from US$20,645 in 1980, to just US$9,805 in 1990 and US$8,691 in 1998; (all in 1985 international U.S. dollars).	A statistical illusion caused by the reallocation of labour from manufacturing to services. Rapid productivity growth in manufacturing due to the new technological paradigm of microelectronics. The fallout of the new international division of labour as labour-intensive processes are relocated to developing countries. Impact of change from post WWII Keynesianism to monetarist-oriented deflationary policies.

Source: Author's compilation from various sources

	Author(s)	Country or Region of Study	Measure(s) of Deindustrialisation	Date of Turning Point	Per-Capita Income at Turning Point	Causes of deindustrialisation
6	Dasgupta & Singh (2006)	48 developing countries with focus on India	Manufacturing employment as share of total employment	Not indicated	The turning point has dropped to per capita income of $3,000 (current prices).	Many developing countries are experiencing a pathological form of deindustrialisation which arises from the adoption of Washington Consensus policies proposed by International Finance Institutions which have resulted in countries specialising in their current comparative advantage rather than their long-term dynamic comparative advantage. This has led to industrial failure and the inability to develop modern services.
7	Rowthorn & Coutts (2013)	US and UK	Manufacturing employment as share of total employment	1970 or well before then.	About $10,500 (1995 PPP) per capita	Find that on average more than half of deindustrialisation in employment terms is explained by internal factors, such as above average productivity growth in the manufacturing sector and shifting patterns of domestic expenditure. The outsourcing of labour-intensive manufacturing to low-wage countries through North-South trade also played a significant role, accounting for between one sixth and one quarter of the decline in the share of manufacturing.
8	Tregenna (2015)	103 countries	Manufacturing employment as share of total employment. Manufacturing GDP share in total GDP.	From about 1990 but earlier for higher income countries and somewhat later for lower income countries.	US$16,582 (2005 international dollars, PPP)	1. Mature deindustrialisation - Rising income per capita, import penetration in manufacturing, productivity rising faster in manufacturing than in other sectors in the same economy, and outsourcing of jobs from manufacturing to services. 2. Premature deindustrialisation - Policy changes such as exchange rate, interest rate and trade policies. Policy -induced deindustrialisation is more likely to kick in before the full benefits of deindustrialisation have been obtained.
9	Rodrik (2016)	42 developed and developing countries, including major economies in Latin America, Asia and Sub-Saharan Africa	Manufacturing employment as share of total employment. Manufacturing value added as a share of output (constant prices) Manufacturing value added as a share of output (current prices)	Used 1990 as a breakpoint and showed turning points for pre and post 1990 periods.	1. Representative country with median population of sample: manufacturing share of employment peaks at US$5,500 (in 1990 US Dollars; manufacturing output at constant prices: peaks at above US$70,000 (in 1990 US Dollars) 2. Pre 1990: manufacturing share of employment: US$12,088; manufacturing value added as a share of output (constant prices): US$49,021. 3. Post-1990: manufacturing share of employment: US$4,447; manufacturing value added as a share of output (constant prices): US$22,026.	1. Advanced countries: Technological progress is a large part of the story behind employment deindustrialisation in advanced countries. 2. Developing countries: Trade and globalisation played a comparatively bigger role in deindustrialisation.
10	Haraguchi, Cheng, & Smeets (2017)	All sovereign countries	Aggregate manufacturing employment as share of total employment. Aggregate manufacturing GDP share in total GDP.	None mentioned.	None mentioned.	Alludes to the impact of policies and failure to focus on comparative advantage; however, identifying causes of deindustrialisation not main focus of analysis.
11	Felipe, Mehta, & Rhee (2018)	135 countries	Manufacturing employment as share of total employment		Per capita GDP at peak manufacturing employment share at the end of these decades: 1970: US$30,486 1980: US$21,471 1990: US$15,121 2000: US$10,649 2010: US$7,500	Puts forward unconditional convergence as explanation for deindustrialisation at lower income levels in developing countries. Asserts that outsourcing of manufacturing activities can explain part of the premature deindustrialisation trend especially in terms of manufacturing employment shares but does not show up in output shares.

9.2.2. Regression Results: Inverted-U pattern: relationship between manufacturing share of employment and per capita GDP

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.346910005
R Square	0.120346552
Adjusted R Square	0.102020438
Standard Error	0.447175636
Observations	99

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	2	2.626331484	1.31316574	6.56694348	0.00212304
Residual	96	19.19674071	0.19996605		
Total	98	21.8230722			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-4.701579606	1.967153575	-2.39004197	0.01879897	-8.60634859	-0.79681	-8.60635	-0.79681
Per Capita GDP (ln)	1.573287919	0.43798287	3.59212204	0.00051943	0.70389879	2.442677	0.703899	2.442677
Per Capita GDP Squared (ln)	-0.085214684	0.024053753	-3.54267728	0.00061346	-0.13296101	-0.03747	-0.13296	-0.03747

9.2.3. Sample Questionnaire for Survey of IT Firms

Questionnaire for Survey of Information and Communication Technology Companies in Nigeria

---

1. Introduction

My name is Olayinka Babalola, and I am studying for a PhD in Economics at the School of Oriental and African Studies (SOAS), University of London. The aim of my research is to investigate if the Information and Communication Technology (ICT) Sector in Nigeria can be a Driver of Economic Growth. My research is focused on ICT companies in Lagos and with the aid of this survey, my goal is to understand the following: the structure of the Nigerian ICT ecosystem, which includes the companies, suppliers, customers, regulators and other key stakeholders; capabilities in the ICT sector; if and how companies in the sector innovate; and the production, technological, fiscal and financial linkages of the ICT sector to the rest of the Nigerian economy.

The survey is arranged into five sections, and it should take no longer than 5 minutes to complete each section. Sections 1, 2 and parts of section 3 are best completed by a member of staff with knowledge of the administrative, financial, and human resource functions of your company. The rest of section 3 and all of sections 4 and 5 will require technical knowledge. Responses to the questions can be saved and completed later and do provide approximate answers in cases where precise information is not available. Please be assured that your responses will be treated with confidentiality and the anonymity of the respondents will be preserved. If your company is part of a multinational group, please answer all questions only relating to the operations of your company in Nigeria. Thank you for your participation in this survey.

2. General Information

In this section, you will be asked general questions about the company and respondent.

Q1. Please provide the following information about your company:

Company Information	
Business Name:	
Corporate Affairs Commission (CAC) Registration Number:	
Date of Incorporation:	

Company Information	
Head Office Address:	
Telephone Number:	
Company Website URL (if any):	
Company Email Address (if any):	
Social Media Handles (if any)	

Q2.Please provide the following information about yourself (the respondent):

Respondent Information	
First Name:	
Last Name:	
Email Address:	
Telephone Number:	

Q3.Please select your gender

Gender:	1. Male 2. Female 3. Other

Q4.What is your role in the company? Please select as many as apply.

Role in company (circle as many as apply):	1. President or Group Managing Director 2. Managing Director/Chief Executive Officer (CEO) 3. Executive Director 4. Director 5. General Manager 6. Manager 7. Other, please specify:

3. **Legal and Financial Information**

In this section you will be asked questions about the legal, financial and organisational structure of your company.

Q5. What is the current legal status of your company? Please select as many as apply:

a. Publicly listed company
b. Privately held, limited company
c. Sole proprietorship
d. Partnership
e. Other, please specify

Q6. What is the current ownership structure of your company? Please select as applies:

a. Full Domestic-Ownership (100 percent owned by Nigerians)
b. Majority Domestic-Ownership (more than 50 percent owned by Nigerians)
c. Subsidiary of a Domestic Conglomerate
d. Subsidiary of a Multinational Corporation (MNC)
e. Other, please specify

Q7. What proportion of your company is foreign-owned? Please select as applies:

a. 0-25% foreign equity/debt share
b. 26-50% foreign equity/debt share
c. 51-75% foreign equity/debt share
d. 76-100% foreign equity/debt share

Q8. In what markets does your company operate? Please state as a percentage of total sales.

Markets	Percentage of Sales (%)
1) Nigeria	
2) Rest of Africa	
3) Rest of the World	
Total Sales	

Q9. What are the sources of financing for your company? Please state as a percentage of total financing.

Type of Financing	Percentage of Financing (%)
1) Personal Savings	
2) Family & Friends	
3) Debt (domestic sources other than 1 & 2)	
4) Debt (foreign sources)	
5) Equity (domestic sources other than 1 & 2)	
6) Equity (foreign sources)	
7) Other, please specify	
Total Financing	

Q10. What type of ICT services does your company provide? Please select all that apply.

a. Financial Technology or 'Fintech'

b. General ICT Services

c. Other (please specify)

Q11. In what part of the ICT ecosystem does your company operate? Please select as many as apply.

a. General Platform, Content and/or Application Producer e.g., Facebook, Google, Amazon

b. Custom Content and/or Application Developer e.g., Infosys, Compusoft

c. Networked Elements Provider – Product Reseller e.g., Best Buy

d. Networked Elements Provider – Product Manufacturer or Assembler e.g., Cisco, Samsung

e. Telecommunications Infrastructure or Network Provider e.g., Ericsson, Vodafone

f. Internet of Things

g. Big Data

h. Cloud Computing

i. Artificial Intelligence

j. 3-D Printing

k. Other, please specify

Q12. What proportion of your company's total sales are bought by the following categories of customers or clients? **Please state percentage of total sales from each category.**

Customer Categories	**Percentage of Sales (%)**	
	Public Sector Clients	**Private Sector Clients**
a) Wholesale		
b) Retail		

Q13. What proportion of your company's total sales are bought by the following categories of customers or clients? **Please state percentage of total sales from each category.**

Customer Categories	Percentage of Sales (%)	
	Public Sector Clients	**Private Sector Clients**
a) Domestic		
b) Foreign		

Q14. What was the total turnover of your company in the last financial year? **Amounts are stated in naira (=N=)**

Range	Total Turnover
1) 1 to 50 million	
2) 51 to 100 million	
3) 101 to 500 million	
4) 501 million to 1 billion	
5) 2 to 10 billion	
6) 11 to 50 billion	
7) Above 50 billion	

Please state financial year for above:

Q15. In what month does the financial year of your company end? Month:

4. Company Capabilities

In this section, you will be asked questions about the skills and technologies present in your company.

Q16. How many staff does your company employ?

Q17. What is the distribution of your staff across the various organisational roles? Please indicate percentage of staff for each role.

Organisational Role	Percentage of total staff (%)
1) Managerial	
2) Technical	
3) Administrative	
Total Staff	

Q18. What is the highest education level of the owner/CEO of your company? Please state.

Q19. Does the owner/CEO of your company have experience in other industries prior to engagement in the ICT sector? Please answer Yes or No.

Q20. If Yes to the previous question, please state previous industry experience

Q21. What is the educational profile of your staff members? Please complete table below and enter in '0' where applicable.

Highest Educational Qualification	Percentage of total staff (%)
West African Examination Council (WAEC) Certificate, National Examination Council (NECO) Certificate or Secondary School Leaving Certificate (SSCE)	
Ordinary National Diploma (OND)	
Higher National Diploma (HND)	
Undergraduate Degree (BSc, BA, LLB etc.)	

Highest Educational Qualification	Percentage of total staff (%)
Postgraduate degree (MSc, MA, MBA, LLM etc.)	
Postgraduate degree (PhD)	
Other (please specify)	

Q22. What type of ICT platforms/technologies does your company use in its operations e.g., Java, .NET, SAP, Oracle, Agile/Lean, CAD? Please list the top three and state Yes or No in the 'Proprietary' field. **Please enter N/A in any fields for which there is no answer.**

Name	Name of Platform/Technology	Proprietary	Cost (US$)
Platform/Technology 1			
Platform/Technology 2			
Platform/Technology 3			

Q23. What type and level of ICT proficiency does your staff have? **Please state percentage of staff for each skill type and enter in 0 where none of your staff possesses the skill**. For skill types not included in the list please fill in other skill types, level of proficiency and staff percentage in the comment box.

IT Skills	Percentage of total staff (%)		
	Basic	**Intermediate**	**Advanced**
1) Python			
2) Ruby (on Rails)			
3) PHP			

IT Skills	Percentage of total staff (%)		
4) Java			
5) Javascript			
6) Microsoft certification			
7) Cisco certification			
8) Apple Certified Macintosh Technician			
9) Oracle certification			
10) SAP certification			
11) Other ICT Skills			

5. Product, Process and Innovation

In this section, you will be asked questions relating to the products and processes developed by your company and how your company innovates.

Q24. What are the top three (3) products or services, in terms of percentage of sales, that your company produces? **Please list and enter N/A in any fields for which there is no answer.**

Products or Services	Name of Product	Percentage of total sales (%)
Product/Service 1		
Product/Service 2		
Product/Service 3		

Q25. How do you rate the performance of your company in comparison with your Nigerian competitors? Please select appropriate performance level for each key performance indicator that applies to your company.

	Very High Performance	High Performance	Mid Performance	Low Performance	Very Low Performance
Key Performance Indicators					
1) Market Share					
2) Turnover					
3) Net Profit					
4) Number of Innovations					
5) Number of Subscribers/Customers/ Clients					
6) Volume of Transactions					
7) Level of Investment (Domestic)					
8) Level of Investment (Foreign)					

Q26. Which are the top five Nigerian-owned companies in your ICT sub-sector (based on your answer to question 11) in terms of market share or profitability? Please list and enter N/A in any fields for which there is no answer.

Top Five Companies
1)
2)
3)
4)
5)

Q27. Which are the top five foreign-owned companies in your ICT sub-sector (based on your answer to question 11) in terms of market share or profitability? **Please list and enter N/A in any fields for which there is no answer.**

Top Five Companies
1)
2)
3)
4)
5)

Q28. Who are your top five competitors in Nigeria? **Please list and enter N/A in any fields for which there is no answer.**

Top Five Competitors
1)
2)
3)
4)
5)

Q29. Please state the proportion of your total expenditure allocated to Research and Development (R&D) in the last 3 financial years or the most recent year for which you have information?

	Financial Year	**Percentage of Total Expenditure**
R & D Expenditure		
R & D Expenditure		
R & D Expenditure		

Q30. Please list any International Organisation for Standardisation (ISO) certifications held by your company.

Q31. Please list any patents held by your company.

Q32. How does your company keep abreast of new developments in your sector? Please select as many as apply.

a. Subscription to industry journals

b. Conferences, trade fairs or exhibitions

c. Professional or industry associations

d. Online searches

e. Collaboration with research institutes

f. Information from suppliers

g. Information from customers

h. Other, please specify:

Q33. Please list the top three (3) products or processes your company customised from foreign technologies (product, process etc.) on behalf of your clients? State Yes or No in Product or Process Customisation fields.

	Name of Products or Processes	**Product customisation**	**Process customisation**
Product/Process 1			
Product/Process 2			
Product/Process 3			

Q34. Please list any new products or services your company developed or introduced into the Nigerian market in the last 3 financial years? (Please exclude the simple resale of new products purchased from other companies and minor changes that only alter the appearance of the product.)

Category	Name of Product or Service
New or significantly improved products	
New or significantly improved services	

6. Linkages

In this section, questions relating to the production, technological, and financial linkages of your company will be asked.

Q35. What percentage of your company's sales were purchased by companies or clients in the following sectors in the last financial year? **Please enter percentage of total sales for each category that applies.**

Activity	Percentage of Sales (%)
Crop Production	
Livestock	
Forestry	
Fishing	
Crude Petroleum & Natural Gas	
Metal Ores, Coal Mining, Quarrying and Other Minerals	
Oil Refining	
Cement	

Activity	**Percentage of Sales (%)**
Food, Beverage and Tobacco Manufacturing	
Textile, Apparel and Footwear Manufacturing	
Wood and Wood Products Manufacturing	
Pulp, Paper and Paper Products Manufacturing	
Chemical, Chemical Products and Pharmaceutical Products Manufacturing	
Plastic and Rubber Products Manufacturing	
Electrical and Electronics Manufacturing	
Basic Metal, Iron and Steel Manufacturing	
Motor Vehicles Manufacturing or Assembly	
Non-Metallics Products Manufacturing	
Utilities - Electricity, Water Supply or Waste Management	
Construction	
Trade	
Telecommunications, Computer Programming & Consultancy and Information Service Activities	
Publishing, TV, Motion Picture, TV, Radio Production, Programming and Broadcasting	
Transport	

Activity	**Percentage of Sales (%)**
Finance	
Insurance	
Real Estate	
Legal activities	
Professional, Scientific & Technical Activities - includes engineering, architectural, industrial design and management consultancy activities	
Administration and Support Activities	
Education, Human, Health and Social Activities	
Government/Public Sector	
Total	
Other Services, please specify:	

Q36. Please list the main sectors to which the customers that purchased your top three (3) products and/or services belong. **Please use the list in the previous question as reference and enter N/A in any fields for which there is no answer.**

	Name of Product/ Service	**Name of Sector**
Product/Service 1		
Product/Service 2		
Product/Service 3		

Q37. What percentage of your company's initial sales in the first 1 to 3 years of operation of your company came from the following sectors? **Please enter percentage of total sales for each category that applies.**

Activity	**Percentage of Sales (%)**
Crop Production	
Livestock	
Forestry	
Fishing	
Crude Petroleum & Natural Gas	
Metal Ores, Coal Mining, Quarrying and Other Minerals	
Oil Refining	
Cement	
Food, Beverage and Tobacco Manufacturing	
Textile, Apparel and Footwear Manufacturing	
Wood and Wood Products Manufacturing	
Pulp, Paper and Paper Products Manufacturing	
Chemical, Chemical Products and Pharmaceutical Products Manufacturing	
Plastic and Rubber Products Manufacturing	
Electrical and Electronics Manufacturing	

Activity	**Percentage of Sales (%)**
Basic Metal, Iron and Steel Manufacturing	
Motor Vehicles Manufacturing or Assembly	
Non-Metallics Products Manufacturing	
Utilities - Electricity, Water Supply or Waste Management	
Construction	
Trade	
Telecommunications, Computer Programming & Consultancy and Information Service Activities	
Publishing, TV, Motion Picture, TV, Radio Production, Programming and Broadcasting	
Transport	
Finance	
Insurance	
Real Estate	
Legal activities	
Professional, Scientific & Technical Activities - includes engineering, architectural, industrial design and management consultancy activities	
Administration and Support Activities	

Activity	Percentage of Sales (%)
Education, Human, Health and Social Activities	
Government/Public Sector	
Total	
Other Services, please specify:	

Q38. Please list any Nigerian-owned companies with whom you have technical partnerships and the type of partnership.

	Name of Company	Type of Technical Partnership
Company 1		
Company 2		
Company 3		

Q39. Please list any foreign-owned companies with whom you have technical partnerships and the type of partnership.

	Name of Company	Type of Technical Partnership
Company 1		
Company 2		
Company 3		

Q40. Please list any Nigerian universities or research institutes with whom you have technical partnerships and the type of partnership.

	Name of University/Research Institute	Type of Technical Partnership
University/Research Institute 1		
University/Research Institute 2		
University/Research Institute 3		

Q41. Please list any foreign universities or research institutes with whom you have technical partnerships and the type of partnership

	Name of University/Research Institute	Type of Technical Partnership
University/Research Institute 1		
University/Research Institute 2		
University/Research Institute 3		

Q42. Please list any trade, professional or technical associations of which your company is a member.

Q43. If your company has received assistance from any technology hubs, incubators or accelerators please provide the name of the technology hub, incubator or accelerator, whether it is domestic or foreign and the type of assistance.

Name of Hub, Incubator or Accelerator	Name of Hub, Incubator or Accelerator	Domestic or Foreign
Co-location Facilities		
Seed Funding		
Series A to C Funding		
Coaching & Mentoring		
Create Access to Markets		

Q44. Please list any benefit your company has derived from any of the following government policies specific to the ICT sector granted by the National Information Technology Development Agency (NITDA) or any other government agency?

	Granting Agency	Period Received
Pioneer Status Incentive		
Duty Waiver on Imports		
Tax deductions/breaks, other than Pioneer Status Incentive		
Other, please specify		

Q45. Please list any assistance in the form of subsidies, waivers or grants/transfers your company has received from any foreign government or company

Foreign Assistance	Granting Agency	Period Received
Subsidies		
Waivers		

Foreign Assistance	Granting Agency	Period Received
Grants/Transfers		
Other, please specify		

9.2.4. Sample Questionnaire for Case Study of IT Firms

Case Study: Where Do Services Come From?

The aim of this interview is to establish the drivers that have led to the emergence of ICT companies in Nigeria. In many advanced industrialised countries, service companies grew out of manufacturing companies focusing on their core competencies and outsourcing services that had previously been provided in-house. In this section, the background of the founder, the nature of business operations in the initial days of operation and subsequent years as well as demand and supply-side drivers of growth, most importantly the role of government policy, will be interrogated to determine how services have emerged in the case of Nigerian ICT companies.

I. Founder's Background

1. Who are the founders of your company?
    a. What is their professional and educational background?
    b. Are any of them returnees from study or work in advanced industrialised countries.
2. What motivated the founder(s) return to Nigeria if they are returnees from advanced countries?
3. What specific market opportunities did the founders of the company discover and benefit from in the initial operational phase of the company?

II. Business Operations

4. Who were the main customers of the company in its initial years of operation? – company names and economic sectors.
5. Who were the company's key competitors in its initial years of operations?
6. What were the core competencies of your company in its initial years of operation?
    a. What services or products did the company provide?

7. How did business relationships and partnerships enable the commencement of operations and how were they instrumental to the company's growth? -domestic and foreign.

III. Drivers of Growth

8. To what extent did the following factors facilitate the establishment and subsequent growth of the company. Please describe the precise mechanisms by which each of the factors relevant to your company facilitated the entry of the company into the ICT sector and its expansion.

    i. Demand-Side Drivers

    a. Rising demand for the company's products by end-users (include sectoral classifications in the case of companies).

    b. Rising demand for the company's products as intermediate inputs in the production process of other companies.

    c. Demand from the manufacturing sector in Nigeria

    d. International trade opportunities.

    e. Impact of increased demand for public services i.e., services provided by government agencies.

    ii. Supply-Side Drivers

    a. Effect of productivity growth in other economic sectors: manufacturing, oil and gas, agriculture, financial services etc.

    b. Offshoring of services to Nigeria by MNCs in the manufacturing sector

    c. Outsourcing opportunities created by the offshoring of services to Nigeria by MNCs

    d. Outsourcing of services by manufacturing and other companies in Nigeria.

    e. Increase in supply due to impact of integration between manufactured goods and services.

    f. Technological progress e.g., broadband service availability.

    g. Human capital development e.g., through reverse brain drain

    iii. Government policies and regulation

    a. SAP policies - telecommunications and financial sector liberalisation

    b. GSM license auction.

c. Launch of broadband submarine cable in Nigeria

d. Government regulation

e. Global regulations on data protection

IV. Company Trajectory

9. What are the major turning points in the activities of your company in terms of profitability and business lines?

10. How did the factors selected from question 8 affect these turning points?

11. Which of these factors do you think was most instrumental in the initial success of your company?

12. Which of these factors is presently instrumental to the continued success of your company?

13. How has the company changed over time in terms of the following factors and what factors led to this change?

    a. Product/Service Lines

    b. Customers

    c. Technologies

14. What do you consider as the key impediments to the growth of the ICT sector in Nigeria, both from a company and industry perspective?

9.3. Appendices Chapter 5

9.3.1. Sample Questionnaire for Case Study of IT Firms

Case Study: It's All About Linkages

The aim of this interview is to identify the nature of the linkages between your firm and key sectors of the Nigerian economy. The focus is on production (forward and backward), technological, consumption, fiscal and financial linkages

I. Production Linkages

A. In-House Production Process

1. Describe the process by which your company transforms inputs into outputs which are delivered to end users as intermediate or final services?

a. Identify the key stages in your production or service delivery process from product design to after-sales support.

2. Is your company vertically or horizontally integrated? - if yes to either, please give examples of how your company has pursued this strategy.
3. What is your company's level of involvement in the design phase of your key products?
4. What are the main inputs utilised in your production or service delivery process?
5. Where are these inputs sourced from? - local or foreign, names of companies and sectors.
6. Do you receive any subsidies or other aid in the procurement of these inputs?
7. At which stage of your production or service delivery process does the greatest value addition occur?
8. Is there manufacturing activity at any stage of your production or service delivery process?
    a. What type of manufacturing processes are involved?
    b. Does this activity occur in-house or is it performed by an external party?

B. Production Process of Customers

9. What role do customers play in your production process?
10. What are the main outputs produced by your company?
11. Which key sectors and/or companies purchase your company outputs and how important are these services to your customers?
12. Are your services sold to end users or utilised as intermediate inputs in the production or service delivery processes of other companies? If your outputs are utilised as intermediate inputs:
    a. Do you know at which point in their production process other companies utilised your products?
    b. Do you have knowledge of the production processes of intermediate users?
    c. Has this knowledge affected product design?
13. Are your services embedded with any manufacturing product or other service?
    a. Please name any and describe the process by which this occurs?
14. How do you deliver services to your customers? - physical or remote delivery

15. What kind of after-sales support do you provide to your customers?
16. What role do customers play in the service delivery process?

II. Technological Linkages

A. Learning and Technology Transfer Processes

1. Please describe the main ways in which learning takes place in your company: learning by doing, learning by using, investment in training etc.
2. Have customer relationships resulted in any form of technology transfer to your company? Please name examples.
3. Have interactions with foreign vendors resulted in any form of technology transfer to your company? Please name examples.
4. Have interactions with local vendors resulted in any form of technology transfer to your company? Please name examples.
5. Have interactions with competitors resulted in any form of technology transfer to your company? Please name examples.
6. What role has the Nigerian diaspora or recent returnees to Nigeria from advanced industrialised countries played in facilitating technology transfer to your company?
7. How does your company store, process, diffuse and retain knowledge within the organisation?
8. What do you consider to be the main impediments to technology transfer and innovation in your company and the Nigerian ICT sector in general?

B. Innovation

9. What type of improvements has your company made to a product or service originally developed by another domestic company in the course of utilisation of the product or service?
10. What type of improvements has your company made to a product or service originally developed by a foreign company in the course of utilisation of the product or service?
11. In what ways have feedback from customers resulted in product or process improvements? Please name examples.

12. Has any government agency, either at the state or federal level played any role in fostering innovation in your company? If not, how has government impeded innovation in your company?
13. Does your company invest in R&D and if so, how has this:
    a. fostered innovation
    b. served as an input into product development
    c. led to improvements in business operations
    d. improved profitability
14. In what ways has your company benefitted from public R&D or public-private R&D partnerships?
15. What factors does your company consider in making a choice amongst competing technologies?

III. Consumption, Fiscal/Financial Linkages

A. Consumption Linkages

1. Please describe any connection between the demand for your company's products or services and activities in the oil and gas, other mineral resources and/or agricultural sectors?
2. Do any of your services/products act as substitutes for those which were previously imported in Nigeria? Please name the top 3.
3. Does your company receive funding from any oil and gas or other mineral resources and/or agricultural funds or programs? Please name the funds or programs.

B. Local Fiscal/Financial Linkages

4. Which local financial institutions have provided financing to your company? – what types of instruments were utilised?
5. Have you received financing from federal or state governments and their agencies and if so, how have these funds been instrumental to the growth of your company?
6. How have funds received from local venture capitalists, incubators or accelerators been instrumental in the growth of your company?

C. Foreign Fiscal/Financial Linkages

7. Which foreign financial institutions have provided financing to your company? – what types of instruments were utilised?
8. How have funds received from foreign governments been instrumental in the growth of your company?
9. How have funds received from foreign venture capital investors, incubators or accelerators been instrumental in the growth of your company?
10. What role have development partners, donors and other international finance institutions played in providing access to finance?
11. If none of the above apply, please provide information on the main financing sources for your company.