# Oil, Manufacturing Efficiency and Economic Growth in Iran: a Microeconometric Approach

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## Declaration

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## Abstract

This research provides a microeconometric study of production efficiency in Iranian manufacturing sector within a broader political economy context which helps delineate the conditioning factors that are included in the model. The study is also a contribution to the literature on economic growth in oil rich economies. The existing literature mainly discusses the impact of oil revenues in terms of either sectoral misallocation of resources away from traded goods sectors or underinvestment in production sectors. We argue that these models fall short of explaining the growth experience of oil economies such as Iran. We show that the main obstacle to Iran's economic growth is the inefficiency of investment. This is done by measuring production efficiency in the manufacturing sector using firm-level data.

We assess the context of Iranian political economic structure and the importance of factors that can explain efficiency. We look at the productivity of Iranian economy and compare it with the performance of South Korea and Turkey. Our findings suggest that the productive performance of Iran has deteriorated not only in comparison to these countries but also with regards to its own trend prior to the 1979 revolution. To establish the reason for this dismal performance, we explore the production efficiency of the Iranian manufacturing sector. We find production efficiency for manufacturing producers in 2007 to be around 66%. Our results also confirm that some of the institutional features of the Iranian economy play a significant role in explaining production efficiency. These are characteristics of firms that benefit most from higher subsidies and support from the oil revenues. We also find that firms that export and those that are larger tend to be more efficient. These findings have important policy implications, most notable of which is the creation of a more competitive environment for successful long-term growth.

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## List of Abbreviations and Acronyms

| | |
|---|---|
| B | Booming Sector (in Dutch Disease) |
| CBI | Central Bank of Iran |
| CIA | Central Intelligence Agency (United States) |
| CPI | Consumer Price Index |
| DEA | Data Envelopment Analysis |
| DMU | Decision Making Unit |
| EIA | Energy Information Administration (United States) |
| EU | European Union |
| GDP | Gross Domestic Product |
| GCF | Gross Capital Formation |
| IEA | International Energy Agency |
| IMF | International Monetary Fund |
| IRGC | Islamic Revolutionary Guards Corps (Sepah-e Pasdaran-e Enghelab-e Eslami) |
| IRMF | Islamic Revolution’s Mostazafan Foundation |
| ISIC | International Standard Identifying Code (of all economic activities) |
| ISNA | Iranian Students’ News Agency |
| L | Lagging Sector (in Dutch Disease) |
| LBD | Learning By Doing |
| LHS | Left Hand Side (of equation) |
| LR | Likelihood Ratio |
| MENA | Middle East and North Africa |
| ML | Maximum Likelihood |
| MKO | Mojahedin-e Khalgh Organisation |
| N | Non-tradable Sector (in Dutch Disease) |
| NDF | National Development Fund (Iran) |

| | |
|---|---|
| OSF | Oil Stabilisation Fund (Iran) |
| PPP | Purchasing Power Parity |
| PWT | Penn World Tables |
| R&D | Research and Development |
| RHS | Right Hand Side (of equation) |
| SAVAK | Sazman-e Etelaat Va Amniat-e Keshvar (Intelligence and Security Agency– pre 1979 Iran) |
| SCI | Statistical Centre of Iran |
| SFA | Stochastic Frontier Analysis |
| SOE | State Owned Enterprise |
| SWF | Sovereign Wealth Fund |
| TFP | Total Factor Productivity |
| UN | United Nations |
| UNCTAD | United Nations Conference on Trade and Development |
| UNIDO | United Nations Industrial Development Organisation |
| USD | United States Dollar |

# Chapter 1 Introduction

## 1.1 Motivation and Hypotheses

The economic and development experience of oil-rich countries has been rather mixed. The diverse experience of different countries range from success stories such as Norway all the way to 'failed states' such as today's Iraq. While the experience of each country is influenced by a myriad of other historical, cultural and political factors that are unique to each country, harnessing the power of oil (or other natural resources) can go a long way in improving the welfare of inhabitants of these countries. Form an economic point of view, this type of income is considered a rent since it is based on a wedge between the cost of obtaining this factor of production and the amount it is valued in the global markets. In other words it constitutes a source of 'unearned income'. Nevertheless, the real-world examples of countries which have managed to benefit from these sources of rent confirm that they are not intrinsically harmful to the economy. Thus, the actual challenge should lie in the processes of their extraction, investment and redistribution. As these incomes almost entirely accrue to the government of the oil-rich countries, the role that they play in reaping the benefits of oil rents can be vital for these economies. There are numerous channels through which the government's mismanagement and lack of foresight can influence the absorption and reallocation of this resource wealth. Furthermore, it can be argued that such sources of rent can be so powerful that they can redraw political lines and even change the governments themselves. These explanations highlight the importance of appropriate management of these revenues.

*Cursed Blessings?*

There has been a wide body of research dealing with the effects of countries' natural resource endowments on their growth and development paths. Numerous hypotheses, both economic and political, have been proposed and tested in the literature. The most widely discussed theories include economic approaches such as the 'Dutch Disease', the 'Resource Curse' and 'Rentier State' theory. The Dutch Disease theories hypothesise that the interplay of economic factors and resource income can lead to overvaluation of the exchange rates and de-industrialisation. On the other hand, the more general Resource Curse discourse consists of growth models with rather ad-hoc choice of variables that aim to explain how resource incomes can negatively influence economic growth. The channels discussed include factors such as institutional quality, rent-seeking behaviour and volatility of resource revenues. Furthermore, the Rentier State literature adopts a more political narrative to explain the sources of misfortunes for resource-abundant nations. These studies predominantly provide a more state-centric explanation by focusing on the possibility that the presence of the resource revenues can affect the very structure of the state and hence lead to undesirable social and economic consequences.

While there seems to be some justification for each of the explanations provided by these approaches, the recent surge in empirical interest in this field has presented mixed and at times inconsistent results. Some findings have clearly challenged a number of these explanations entirely. Other analyses have shown that these explanations tend to be insufficient in providing a complete account of the developments for a given country due to their restrictive assumptions. This has been particularly true in the case of a number of developing countries. For example, as we will demonstrate, the experience of the Iranian economy does not conform to the predictions of the Dutch Disease framework. In fact in the presence of oil booms there seems to be an expansion and growth in profitability rather than the contraction of manufacturing.

Iran has long been one of the main oil and gas producers and currently with 9.4% and 18% share of the world's proven oil and gas reserves respectively (BP, 2013), she is likely to remain a major producer in the foreseeable future. Thus, exploring the effect of oil revenues will have important implications for the long-term growth of Iran. The empirical evidence in the case of Iran suggests that the problems of growth are not due to the crowding out of the traded goods sectors as suggested by the Dutch Disease theories, nor do they appear to be associated with low levels of investment in the economy as suggested by some of the Resource Curse theories. In this thesis we argue that the low efficiency of investment rather than its level or sectoral allocation may be a more important problem associated with oil economies in general and Iran in particular. This is demonstrated by undertaking a microeconometic study of production efficiency in the manufacturing sector in Iran using firm-level data.

We further argue that the impact of oil revenues on production efficiency is mediated through the institutional set up in the economy and hence can be highly context specific. In order to investigate the determinants of production efficiency in Iranian manufacturing, we therefore need to first conduct a political economy analysis of the economic institutions that emerged in post-revolution period in Iran. These institutions determine the transmission mechanisms through which oil revenues affect manufacturing inefficiency. The econometric model of manufacturing efficiency which is estimated in the thesis incorporates these specific determining factors as well as other more general factors suggested in the literature.

### *Why Manufacturing Sector?*

The role of industrialisation has long been highlighted in the growth and development literature. Most noticeably, manufacturing sector has received considerable attention due to its linkages and other characteristics that can enhance growth in the entire economy (e.g. Kuznets, 1957; Kaldor, 1967). Furthermore, a number of theories regarding oil and development, such as the Dutch Disease literature, also discuss the role of industries in the development experience of resource-rich countries. Therefore, this research takes a closer look at this aspect of growth and identifies the characteristics of manufacturing firms in the context of an oil producing country. Focusing on the behaviour of manufacturing firms also bridges the gap in the literature for a more micro-level explanation on the consequences of the role of oil on growth potentials of a resource-rich economy. It provides a clear framework of assessing the effect of prominent economic policies of oil-rich countries on their productive performance. These policies include emphasis on large scale and capital intensive production, greater public ownership and pursuing import substitution policies; all of which rely on the availability of the oil income. In the case of post-revolutionary Iran, we will show that these measures have been implemented through the country’s unique political economic structure.

In light of the above passage, the main hypothesis that is tested in this thesis is whether the oil revenues have adversely impacted the production performance of manufacturing firms. To examine this, the role of important determinants of production efficiency (also referred to as technical efficiency) is explored. A number of these determinants are themselves a product of the political economic features of

Iran. As mentioned above, these features have been largely moulded by the effect of oil income on the economic policies and institutions. We empirically test the effect of ownership of manufacturing firms on their efficiency index and see if the public sector is truly less efficient as it is generally concluded in most studies on Iran. This will help determine if oil revenues have reduced the role of private sector in favour of less efficient public ones. Next, we examine the hypothesis that exporter firms tend to be more efficient than those who only serve the domestic market. Exporters receive a number of benefits from cheaper exchange rates and other government benefits. Nevertheless, a positive influence of exports on efficiency could also highlight the importance of export promotion strategies which is exemplified by the experience of the Asian Tigers. Other direct interventions of the government in production such as factor price subsidies to producers especially in their energy bills might not only cause allocative problems but it can act as a determent to the efficiency of production. Thus, a variable of fuel expenditure can shed light on this hypothesis. The effect of other factors such as size, agglomeration and capital intensive production which are the salient features of oil-abundant countries could also explain the negative productive capacity of industries due to the presence of such revenues. Exploring the importance of other factors such as market share, Research and Development (R&D) expenditure and composition of the labour force will also allow us to control for other sources of efficiency heterogeneity.

The research deals with the unique anatomy of the Iranian state and will shed light on the performance of the Iranian manufacturing firms using a microeconometric framework. It will be a contribution to the existing oil and economic growth literature by looking at the effects of oil revenues through channels which shape the production behaviour of individual firms in the manufacturing sector. The micro-level efficiency analysis on the Iranian industry provides both a theoretical and an empirical contribution to the literature. The theoretical contribution is providing a disaggregated account of the dynamics at play and an alternative to the oil and development literature by linking it with the efficiency analysis literature. Empirically, this thesis provides evidence on the sources of productivity disparity in the Iranian economy. Furthermore, to our knowledge accurate estimates of manufacturing efficiency are non-existent in the productivity literature of Iran. These estimates can provide a benchmark in a number of other fields such as managerial aspects of production.

## 1.2 Chapter Summary and Key Objectives

This thesis is divided into nine chapters. Here we will provide an overview of the remaining eight chapters and their main aims.

The next chapter (Chapter 2) explores the main theoretical and empirical literature regarding the frameworks of oil and economic growth. The prominent paradigms are discussed in this chapter, including the Dutch Disease theory of Corden and Neary (1982) who initially suggested a static model of how oil revenues affect the economic structure of a resource dependent country. We review the other variations of the basic Dutch Disease model, and examine their assumptions and limitations. Next, we present an overview of the Resource Curse literature which gained prominence by the work of Sachs and Warner (1995). We discuss the main explanations that are provided in these studies to explain the impact of resource revenues on economic growth of countries. We critically appraise these models' econometric approach and investigate the compatibility of their conclusions with findings of empirical studies especially with regard to oil-rich countries. We explain why a number of their limiting assumptions make them incapable of explaining the experience of many developing countries. We also review the literature on Rentier States that was spearheaded by the work of Mahdavy (1970). We emphasise the important contribution of this literature suggesting the necessity of context specificity in any meaningful research on the role of oil on growth and development of a given country.

After the review of the resource literature we discuss a neglected component of economic growth theory literature to the context of our interest. We explain how efficiency analysis can assist in clarifying the channels through which oil revenues influence the productivity of an oil-rich country. While both allocative and technical aspects of efficiency can be influenced by oil expenditure in the economy we propose investigating technical efficiency measures since as we will see in Chapter 3 and Chapter 4, this seems to be a more long-term challenge to the Iranian economy and has yet to be addressed in depth by the existing literature.

In Chapter 3, we provide an overview of the political structure of the Iranian state after the revolution. We explain the principles that this arrangement has been built upon and highlight its consequences for economic institutions and their impact on the economy. We briefly provide an overview of the political economic history of the Islamic Republic where we focus on the issue of factionalism which has been at the forefront of political and economic instability with important implications for the management of oil revenues. We then discuss the institutional developments with important economic consequences by focusing on the economic evidence regarding the role of state owned enterprises (SOEs), parastatal organisations (bonyads) and traditional merchants (bazaaris). We show that these unique institutional attributes of the Iranian economy are paramount factors that have to be considered in any analysis regarding the effect of oil revenues on Iran's economic growth.

In Chapter 4, we explore the historical growth trends of the Iranian economy and compare the Iranian case with the prediction of theories discussed in Chapter 2. We empirically investigate the relationship between real GDP and oil growth rates in order to demonstrate the extent of dependence of growth rates on oil and gas revenues. We discuss the findings of studies researching the effects of oil revenue volatility on the economy. We argue that political competition has translated into volatility in government expenditure despite recent measures such as the oil stabilisation fund (OSF) which itself has seen amendments partly as a result of such factionalism. Next, we investigate the performance of manufacturing growth vis-à-vis the oil income in order to assess the empirical relevance of the Dutch Disease framework in Iran. To see the underlying dynamics of the manufacturing sector we employ a markup model for cost-price relationships. We compare the labour productivity and product wage trends and explain the consequences of government subsidies for the productive performance and competitiveness of manufacturing firms. We compare Iran's per capita growth trend with other countries and demonstrate how the government's policies have led to inefficient modes of production in the economy which is evident in indexes such as energy intensity.

To have a broad picture of the economy's performance and the importance of all inputs in production, we look at total factor productivity (TFP) of Iran's economy in Chapter 5. We construct a capital stock trend for Iran and use this to obtain growth accounting estimates of TFP growth for the 1966-2007 period. We analyse the trend based on the main periods of the economy and especially assess the difference between the pre and post-revolutionary performance of the aggregate economy. We estimate the aggregate productivity of South Korea and Turkey for the same period and compare their performance with the estimates for Iran. In order to understand the reasons for the difference between Iran and these countries' performance we draw our focus back to Iran's manufacturing sector which we argue can be the engine of growth and job creation in Iran. Finally, we look at manufacturing structure and see how the shift of manufacturing production towards heavy industry has been obtained through government intervention and backed by oil rents. We argue that a more sustainable trend is only possible through improvement of productive efficiency. This will lead us to establish how productivity of the aggregate sector is determined by the efficiency of production at the micro-level in manufacturing production The measurement and analysis of production efficiency at the microeconomic level is the subject of the following three chapters.

Chapter 6 provides both a theoretical and an empirical discussion on the efficiency analysis literature. After critically evaluating the different notions of efficiency in economics, we focus on technical efficiency and explain why this is an important measure to investigate regarding Iranian manufacturing production. We next examine various methodologies of estimating technical efficiency. We identify two important approaches: the econometric (stochastic frontier analysis) and non-parametric (data envelopment analysis) methods of estimation. We compare the benefits and drawbacks of each method. Eventually, we opt for the stochastic frontier analysis method due to better statistical properties and an organic relationship with the TFP estimation methodology. This is in line with most studies in economics and in contrast to fields such as operations research which use non-parametric methods. We also review the theoretical models of identifying sources of technical inefficiency. Next, we look at the empirical literature to gather a list of important determinants of efficiency and explore key rationales for the incorporation of such variables in the models. A number of these determinants are used in Chapter 8 to test our hypotheses regarding the sources of inefficiency in the manufacturing sector. Finally, we compare and contrast different empirical models with regards to the choice of functional form, definition of variables and other implicit assumptions of such models.

In Chapter 7, we introduce our frontier model and variables. Next, we provide a brief overview of the dataset used in our efficiency estimation which consists of a census of firms with more than 50 employees and sample survey of smaller manufacturing firms in 2007. After discussing key indicators and some stylised facts of the data, we estimate both Cobb-Douglas and Translog production frontiers and obtain estimates of technical efficiency for each. We test if the Cobb-Douglas function is nested in the Translog function and use the more appropriate estimates as our preliminary results. We assess the relative success of the manufacturing sector by looking at our initial estimates. Finally, we summarise the efficiency scores based on important categories such as type of industry and ownership and investigate the presence of heterogeneity among different firms. This will assist us in identifying the potential determinants of technical efficiency in our sample.

The objective of Chapter 8 is to arrive at our final model and identify the sources of technical inefficiency in a more robust manner. We start this chapter by discussing a list of key determinants from the literature and those particularly relevant to the institutional set up of the Iranian economy. We then list the key variables affecting the production performance of firms in Iranian industries and incorporate nine key determinants based on the theoretical and empirical literature and allowed by the limitations of the dataset. These factors include ownership, fuel intensity, industry share, labour composition, agglomeration effect (main industrial provinces of Tehran and Esfahan), export and research intensities, size and capital-labour ratio. We then use two main methods of incorporating the determinants within our estimating model. We identify the statistically significant determinants in the two-stage method but reserve the final judgement for the second method which is more econometrically robust. The second method or the single stage estimation follows Battese and Coelli (1995) in which the efficiency scores are estimated alongside the effects of exogenous factors on these efficiencies. Thus, first we compare the new adjusted efficiency estimates with our initial findings in the previous chapter. After this, we explore the results and comment on the significant determinants. We explain the channels through which oil has affected these variables and subsequently the efficiency performance of manufacturing firms.

In the final chapter (Chapter 9), we provide a summary of the important conclusions of this research. We then reflect on the significance of these findings with the current body of empirical and theoretical literature and important policy implications. Finally, we identify the limitations of our analysis and based on this propose the important directions for prospective research.

# Chapter 2 Frameworks of Oil Revenues and Development

## 2.1 Introduction

The main challenge of oil-rich economies is managing the proceeds of their natural fortunes both in terms of investment and controlling for the income fluctuations that are associated with revenues based on such commodities. With the current increase of oil prices the importance of oil in the growth literature has rather intensified.

Different explanations have attempted to shed light on the nature of challenges of resource-based economies using arguments drawn from both economics and politics disciplines. Until the early 1950s development economists largely held that natural resource exporting countries had the luxury of overcoming their capital shortages and consequently maintain high investment rates. This would ideally materialise in high levels of investment and ultimately translate into higher growth rates in resource-rich countries compared to those that are not resource-abundant. Other infrastructural shortfalls and investment bottlenecks could also gradually be alleviated. On the other hand, in 1950s a minority of others (mainly Structuralists) argued that this might not be the case. Their main reasons were deteriorating terms of trade (Prebisch, 1950), unreliable government and foreign exchange reserves due to high price fluctuations (Nurske, 1958) and lack of investment by the multinational extractors in other sectors of the economy (Hirschman, 1958). Since then the true consequence of natural resource wealth has been a hotly contested issue in the field. Consequently, in hope of finding evidence ascertaining the true relationship, research in this field has gradually become less theoretical and more empirical which is applied to various different contexts while employing a range of diverse models and approaches.

The current literature can be divided into three main groups including Dutch Disease, Resource Curse and Rentier State theory. In this chapter we will review these prominent frameworks that are used to explain the possible negative effects of resource abundance/dependence for the resource-rich countries. We will start by surveying each literature's main results and critically assess their strengths and weaknesses. After this we discuss the relevance of efficiency analysis in providing a new approach to the question at hand. Finally, we will conclude this chapter with our proposed synthesis of the discussed literatures.

## 2.2 Dutch Disease

The so called 'Dutch Disease' concept is one of the popular theoretical frameworks trying to explain why revenues from non-renewable resources such as oil, gas and minerals may ironically induce lower growth rates in the economy. This framework can be considered as a relatively separate literature from the more general Resource Curse literature since the channels of the resource effect and its empirical investigation are explained in a distinctively different manner.

The earliest written document using the term was The Economist magazine, in November 26th 1977, in an article about the overvaluation of the then Dutch currency (Guilder) in the 1960s. A sudden boom of revenues from the natural gas reserves at that time was followed by a shift in the structure of the Dutch economy (crowding out of the manufacturing sector and drop in export share in GDP) and thus this process was termed as the Dutch Disease. The literature consists of a limited number of different models but is riddled with a wide number of empirical applications explaining the curse of resource abundance. What makes the Dutch Disease argument to be widely discussed, in comparison to the more general Resource Curse discourse, is its clear analytical structure. It allows for a logical foundation based on which not only cross-country studies become comparable but it methodically discusses the dynamics and structural rearrangements within the economy.

There have been different frameworks presenting the problem, each having relatively different essential assumptions which can be a make-or-break element in their discussions. All models try to explain the coexistence of a booming and lagging sector and the consequences that shifts in one might entail for the other.

### 2.2.1 The Core Model

The core model suggested by Corden (1982), Corden and Neary (1982) and elaborated by Corden (1984), is explained through assuming three sectors in a small open economy. These are the booming sector (B), normally oil/mineral sector, which is the source of a sudden increase in export revenues, the lagging sector (L) such as manufacturing or agriculture and the non-tradable sector (N) such as utilities or transportation. Production in each sector is undertaken by a factor specific to that sector and labour. The core model suggests three reasons for a sudden boom:

increase in the price of the exported good, important technological advances in B and an increase in capital flows from outside the country (Corden, 1984).

The core model relies on a number of critical assumptions. It assumes full and efficient employment of factors of production. This can be obtained by assuming that labour is truly mobile thus it can move freely between sectors and be employed relatively easily. Consequently, wages in different sectors will be equal. Factor prices are assumed to be flexible in the country but the factors themselves are immobile between countries. This implies full employment in the economy. Furthermore, the analysis talks about a one off initial revenue or technical change. In other words, post-boom it relies on the assumption of fixed technology. Additionally, it is implied in this framework that the tradables produced by L and their foreign counterparts are homogenous or perfect substitutes. The other assumption is the small country assumption so that a contraction or expansion of L does not change world prices.

The two main consequence of the sudden boom are termed as the ‘spending effect’ and the ‘resource movement effect’. The spending effect happens when the additional revenues are spent either by the B or the government which obtains additional revenue via taxes. If the income elasticity of demand for the goods is positive, it will induce a greater demand in the economy both for tradables such as manufacturing and non-tradable goods such as construction. This will entail a pull on the price of non-tradables whereas the price of tradables stays constant since it is determined by world prices since the economy is assumed to be small. Therefore, the relative price of non-tradables to tradables or the real exchange rate increases. The appreciation happens in the form of nominal exchange rate appreciation if the country has a floating exchange rate and as inflation if the exchange rate is fixed. What follows this is the resource movement effect. The windfall will lead mobile factors of production such as labour to leave L for B due to their higher marginal product in that sector which now has a higher factor demand. This movement is referred to as the direct deindustrialisation. Moreover, at constant real exchange rates, labour is expected to also leave N for B, which results in additional movement of labour away from the L towards N to cover the excess demand for non-tradables. This is called indirect deindustrialisation. Ultimately, this results in a contraction in the less competitive tradable production hence the term lagging sector which is normally referred to manufacturing or agriculture. It is worth mentioning that there might be an additional increase in labour wages if the non-tradable sector expands compared to pre-boom levels. However, not all the above effects necessarily materialise, for example, in oil booms since the oil sector is not labour intensive, the more important effect tends to be the spending effect (e.g. Bruno and Sachs, 1982).

### 2.2.2 Relaxing the Core Model Assumptions

Corden (1984) consolidates the literature that followed and attempts to relax some restrictions and explain theoretical gaps such as immigration and endogenous terms of trade. It then goes on to provide solutions for protecting the lagging sector.

He argues that if it is assumed that apart from labour, other factors of production are now mobile the resource movement effect could have paradoxical results. To further clarify, if it is assumed that B still has its own specific factor of production but the two other sectors use labour and capital in different proportions under a mini-Heckscher-Ohlin model, in this setting and at constant real exchange rate, resource movement will result to the capital-intensive sector's expansion due to labour movement out of L and N into B. Now if L is capital intensive it will mean that based on the resource movement alone it will expand. Even though the real appreciation of the spending effect might counter this due to labour and capital leaving L for N, the final result might be unclear yet it might mean L expanding. It is clear under similar rationale that if N is capital-intensive then N could experience a contraction and a real depreciation might follow.

Going back to the core model, this time if we relax other factor mobility for the two main subsectors of L, similar to the above, it might be that the subsector which is capital-intensive will expand and the labour-intensive one will contract, even though the sector as a whole might contract (Corden, 1984). Clearly, this might mean that the results and policy implications of Dutch Disease under this form will be considerably different and might not be as bad in certain scenarios.

### 2.2.3 Other Dutch Disease Models

A slightly different model is that of van Wijnbergen (1984) in which he introduces the productivity enhancing importance of 'Learning by Doing' (LBD) in the tradable sector as an additional caveat for the Dutch Disease model. He argues that if the oil (mineral resource) revenues are not spent on buying foreign assets (he initially assumes that there are no international capital flows) then the government should intervene and subsidise the tradables sector. This is because LBD is not internalised by the firm that initially train and obtain the experience and its social spillover accrues to the whole industry.

Alternatively, Krugman (1987) presents a slightly different framework to explain the Dutch Disease. Instead of a Heckscher-Ohlin type of model, he presents a framework based on the comparative advantage model of Dornbusch et al. (1977). Relying on increasing returns to scale trade theory (due to LBD being assumed to be external to manufacturing firms), he argues that the temporary export boosts can have a lasting impact and even some industries disappear or contract in an irreversible manner.

Matsuyama (1992) employs an endogenous growth model (also referred to as the 'linkages approach') in which manufacturing is assumed to experience LBD. However, the benefit of this learning process does not spillover the rest of the economy. He demonstrates that when labour (the only mobile factor in his model) moves away from agriculture and manufacturing it will have a detrimental effect on the growth rate.

### 2.2.4 Dutch Disease Limitations

The models proposed by the Dutch Disease literature are heavily dependent on their assumptions making them rather abstract models and in reality often being the exception. Clearly, if we relax any of these conditions the situation would be different. This has meant that even though it provides a framework to show the mechanism the effects of oil windfalls on the whole economy it remains abstract.

It is relatively easy to observe why Dutch Disease might not be robust in developing countries. The assumption of full employment of production factors is an inappropriate assumption for these economies (and most other economies). The resource revenue allows these countries to import the necessary capital and machinery and overcome such shortcomings. Furthermore, in light of these productivity-enhancing investments and the consequent higher levels of technology (in contradiction to fixed capital assumption), it can well be the case that the output of the tradable sector also increases along with the non-tradables. Similar arguments can be made with regards to the full-employment assumption since these countries are often plagued with large amounts of surplus labour. For example, in a panel of eight developing oil-exporting countries Fardmanesh (1991) contests that the spending effect and the world price effect (changes in relative world price of agricultural commodities to manufactures) in the 1966-1986 period only contracted agriculture and not manufacturing. Furthermore, Gelb (1988) confirms resource movement from agriculture and manufacturing to the resource sector for only four out of the seven oil exporters during the oil boom period of 1971-1983.

Furthermore, in oil-rich but capital-poor economies the increased productivity can be so overwhelming that leads to real exchange rate depreciation and hence the so called curse would not seem apparent (Sachs, 2007). Bearing in mind that aid inflows technically have the same effect as oil windfalls, the experience of poor African aid-receiving countries show real exchange rate depreciations.

Another issue is the time horizon that the Dutch Disease deals with. The model is only equipped to explain a short-term account. The paradigm is mainly based on a single shock to the economy and how thing take hold from then onwards. However, this is clearly inadequate (if not misleading) for a large number commodity exporters especially oil economies, which possess large amounts of resources lasting a long period of time and therefore experience numerous booms and busts in their revenues in the medium and even short term due to the fluctuations in export prices. For example, Michaels (2011) assesses the long run consequences of oil revenues in the United States' southern states in the period between 1940 and 1990 and finds a positive effect for the resource-abundant counties. He argues that the higher wages lead to greater population directed to these regions leading to greater infrastructure investments. This will entail higher productivity not only for sectors directly related to the oil sector but also other sectors which offset the high factor prices and resource price volatility.

Additionally, the literature often implies that if the government takes appropriate measures to minimise the effects of Dutch Disease the consequences will be temporary and the economy will soon follow its previous trajectory. However, if the lagging sector such as manufacturing operates under economies of scale or LBD, then the return to pre-boom state after a long period of contraction would be very costly and the effects of such a scenario might not be so temporary.

In a recent study Kuralbayeva and Stefanski (2013) provide empirical evidence regarding the sectoral productivity changes due to resource windfalls. The authors show that regions with higher resource wealth (resource revenue to GDP ratio) tend to have productive but small manufacturing sectors and large unproductive non-manufacturing sectors. They claim that resource movement effect leads to this dynamic. They argue that as a result of a self-selection process, the less-skilled workers in the manufacturing sector leave for the non-manufacturing sector. This means that a more skilled workforce increases the productivity of the manufacturing sector and a less specialised labour reduces the productivity of the non-tradables, ultimately leading to a change in sectoral productivity.

While this shows the productivity changes of resource movement it fails to clarify how the production process itself is affected. In other words similar to previous literature it focuses on resource reallocation as a detriment to aggregate productivity and not the production process itself. Apart from the indirect reference of Dutch Disease models that rely on LBD assumptions the literature ignores the question of economic inefficiency in other sectors and how this affects the growth trajectories of these countries. This issue will be the crux of our argument and is addressed in the last part of this chapter.

Finally, a note of caution seems warranted regarding models which assume a separate traded and non-traded sector. While any abstraction is done for the sake of arriving at a simplified model, in the case of Dutch Disease such restrictive sectoral classification has increasingly become meaningless and incompatible with reality. It is increasingly hard to find examples of a fully non-traded goods sector. For instance, offshoring of services to other countries or employment of foreign labour in large construction projects is only two examples that come to mind for non-traded goods. Similarly, traded-goods sectors such as manufacturing can be protected to the extent that they can be considered as non-traded goods due to import restrictions. For example, as Davies et al. (1994) point out, this is commonly observed in sub-Saharan countries due to heavy import restrictions. In this light, we argue that a more micro perspective that can provide an alternative framework on the effect of oil revenues can help address this issue.

## 2.3 Oil and Economic Growth - Resource Curse

The other strand of literature dealing with the effect of resources consists of a relatively large number of studies which try to examine the validity, cause and severity of the so called ‘Resource Curse’ hypothesis. The more general ‘Resource Curse’ (also referred to as the ‘Paradox of the Plenty’) literature normally relies on empirical econometric growth regression; the majority of which are mainly cross-sectional cross-country regressions trying to measure the extent and direction of a resource abundance (or dependence) variable on the overall growth variable. These studies attempt to first evaluate the growth experience of the group of countries they study and then relate this to the growth trend in their corresponding resource sector. Sachs and Warner (1995, 1997 and 2001) are amongst many in the literature suggesting a negative relationship between the resource dependence and economic growth. A number of reasons have been put forward in explaining this paradox including governance, excessive debt, currency overvaluation and inequality, only to name a few.

As mentioned above, the research on the impact of natural resources has been a hotly contested topic, especially since the 1950s. Case studies including Gelb (1988) and Auty (1993) which indicated a negative relationship paved the way for more work. This was in light of the fact that some of these studies where cautious on the implications of their results and suggested they could not be treated as general binding rules but rather as a plausible possibility (Auty, 1993).

Probably the most influential study attempting to verify these claims was that of Sachs and Warner (1995), in which the growth determinants of ninety-seven countries in a nineteen year period was studied and a negative relationship between resource intensity (ratio of natural resource exports to each country’s GDP in 1971) and growth was concluded. In this cross-sectional model it is suggested that even after controlling for other variables affecting growth such as trade policy, investment rate, initial per-capita income, income distribution and terms-of-trade volatility, the results hold. They further find a robust relationship after excluding six slow-growing but oil-rich countries (Iraq, Bahrain, United Arab Emirates, Oman, Kuwait and Saudi Arabia) in their study period of 1971-1989. These results are confirmed once again in Sachs and Warner (1997) after changing the base year to 1970 and extending the period to 1990 in which they conclude nearly a 1 percent growth reduction for every one standard deviation increase in the resource variable. In the first paper they propose four different hypotheses or 'pathways' for abundance of resources possibly hindering growth. One hypothesis is that more resources lead to more rent-seeking behaviour which would show itself in a lower value for the 'bureaucratic efficiency' variable (an index of judicial independence, corruption and red tape in each country). They model this index to influence economic growth directly and indirectly by affecting the investment variable. Their second hypothesis is that more resources lead to states pushing for protectionist policies which is claimed to reduce investments and growth indirectly but also independently after controlling for investment. The third explanation is that the higher demand caused by the resource rents leads to higher relative price of non-traded goods which might change the relative price of investment goods and ultimately affect investment and thus growth. Finally, they suggest higher aggregate demand can draw labour away from sectors with high levels of LBD reducing labour productivity and growth (similar to Dutch Disease). These explanations are vaguely presented and the exact possible channels of such effects are not elaborated and thus they seem to be more a tentative guess rather than concrete theoretical rationale. The authors explicitly state this by claiming that they directly include the resource variable in the growth model to measure the mentioned affects 'as well as further unspecified effects' (Sachs and Warner 1995, p.18). This drawback is the most evident unifying characteristic of almost the entire general Resource Curse literature.

Rodriguez and Sachs (1999) argue that the resource-growth relationship might be affected by the fact that resource-rich countries tend to overspend. They postulate that due to the exhaustible nature of the resources these industries cannot grow at the same rate as the non-resource industries. Therefore, especially in the initial stages of production the habit of increasing revenues might lead these countries to make large expenditures and carry on to do so as they are arriving at a more steady state. Rodriguez and Sachs (1999) assume the Venezuelan oil sector between 1972 to1993 as a sector with a fixed output while other sectors can expand by employing more capital and labour. They find negative overall growth due to the presence of oil incomes causing the country to arrive at its expected steady state from above. They state that their model will apply if the resource revenues are not invested in foreign capital assets with fixed interest rates and using the annuities as the source of expenditure. On the other hand, it is argued by Manzano and Rigobon (2001) that the over spending of these governments can have further negative implications. For example, over leveraging against the oil asset ultimately leads to large debt burdens and unfinished projects which are obstacles to economic growth

Bulte et al. (2005) investigate the relationship between a number of welfare indices (including HDI and life expectancy) and the natural resource variable for which they find a weak relationship. However, they demonstrate that the indirect effect of the resource income on welfare via affecting institutions is more robustly negative.

A number of studies (Lane and Tornell, 1996; Tornell and Lane, 1999; Torvik 2002, Halvor et al., 2006) suggest a rent-seeking rationale for the overall detrimental effect of resources on the economy. They suggest that a country's resource abundance might lead to increasing rent-seeking activities in the economy instead of productive ones. This problem seems to be more acute especially when there are multiple main powerful groups. Lane and Tornell (1996) explain that under this setting and especially in the absence of strong institutions the fiscal demands of these interest groups have to be sourced by some type of taxation of the rest of the economy which will cause savings, rate of return and investment to fall and thus reduce production growth. Furthermore, the negative effect of competition for fund appropriation between these powers can surpass the overall increase of income for the resources causing actual growth reduction (the voracity effect). Tornell and Lane (1999) divide the economy into a formal and shadow sector (e.g. offshore bank accounts). They hypothesize that the formal sector employs productive technology, has efficient investment and is taxed whereas the shadow sector uses less productive technology and thus lower rates of returns but is not taxable by the domestic authorities. Based on this model they contest that even though an increase in the raw rate of return such as a resource windfall or even a positive productivity shock in the formal sector means better profitability for that sector, it ironically reduces overall growth due to factionalism and competition for fiscal rents which can be taxed and redistributed to the informal sector. The negative effect is shown to offset the windfall disproportionally. Thus, the lower rate of return of the informal sector means that under a discrete mechanism of rent redistribution, overall growth of the economy suffers. Torvik (2002) also concludes that the drop in income due to the rent-seeking activities offsets the increase of income from the natural resource and thus ultimately reduces overall growth. Furthermore, in an extension to his main model, the author proposes that when only the non-traded sector is subject to increasing returns to scale and the natural resource is the only export good, in an open economy setting the additional rents leads to additional rent-seeking and reduced actual production. Thus, this retards productivity in the non-traded sector. This is in contrast to the Dutch Disease models which instead suggest traded-sector to be the main culprit of decreased productivity.

Other studies directly focus on institutions as the main focal point of their arguments. Mehlum et al. (2006) focus on the role of institutional quality as a predetermined or fixed factor affecting growth. They argue that the outcome of the competition between entrepreneurs who compete for rents to use in production purposes and those who engage in rent-seeking depends on the type of institutions. After dividing the countries of their study into two groups of those with bad or grabber friendly institutions and those with good or production friendly institutions, they find a stronger negative relationship for the former group and an insignificant one for the latter. In a different approach a number of studies including Leite and Weidmann (2002) postulate that the institutions themselves are affected by resource abundance. Therefore, they suggest that rather than a direct channel it is the indirect channels that resource rents hinder growth by shaping bad institutions. Two main rent-seeking explanations are provided by Isham et al. (2004) for why point resources (i.e. resources concentrated in small geographical area such as oil) can retard growth. First, it is suggested that the elites in charge of such resources would resist industrialisation to avoid their power base being undermined with the emergence of urban labour, urban middle class and industrialists who will try to get hold of the rents. Thus, a lag in progress and growth is created by this conflict of interests. Secondly, they suggest that the social inequality effect of point resources can create a hierarchical relationship which leads to clientelism and reduces the possibility of collective demands by horizontally equal classes (who might have distrust for each other) for better governance. This ultimately contributes to worse economic growth. Sala-i-Martin and Subramanian (2003) assert that it is exactly the lack of controlling for the institution variable that leads to the conclusion of a negative relationship between resources and growth.

Despite the vast number of explanations and empirical analyses, the literature has displayed mixed results. A string of studies argue that while this might be the case for other resources, the oil-rich countries have definitely experienced a positive relation between oil booms and economic growth (Spatafora and Warner, 1995; Yang and Lam, 2007). Other studies question the robustness of Sachs and Warner findings and find a positive relation once resource abundance is used instead of resource dependence (e.g. Ding and Field, 2005; Alexeev and Conrad, 2007). Stijns (2005) suggests that the results are not as robust as they are claimed to be and are often ambiguous due to the presence of both positive and negative channels through which resources (except land) can affect economic growth.

From an econometric point of view, the majority of earlier studies have mainly relied on cross-sectional analysis thus time effects have been left unexplored. Furthermore, cross-sectional growth regressions might be problematic due to problems of omitted variable bias and endogeneity of the resource variable. More recently, the employment of better estimation methods and employment of better panel-data techniques have to some extent improved results but heterogeneous panel estimators are yet to be widely applied (Mohaddes and Pesaran, 2014).

Technical estimation deficiencies aside, it still remains that the main drawback of the models in the Resource Curse literature apparently stems from the fact that relatively ad-hoc growth regressions with vague theoretical rationale which seem inadequate in illuminating the complex relationship between resource abundance and growth and the various channels that it might influence the economy.

## 2.4 Rentier States and the Political Economy

Within the literature attempting to show an explanation for a negative relationship between resources and prosperity there are also those which provide a more political narrative. These studies focus on the nature of the oil revenues as rent and emphasise the consequent effect that resource rents pose on the institutional anatomy of resource-rich states. Initially, Mahdavy (1970) coined the term ‘Rentier States’ in order to elucidate the oil-rich countries poor development records. He argues that due to the external windfall in revenues, governments gradually become less efficient in terms of investments and taxation.

A Rentier State is normally defined as one that a considerable share of its revenues consists of oil (resource) income. A necessary condition for classifying a resource based government to be a Rentier State is that it has to have access to these revenues directly. Within the literature attempts have been made to propose a quantitative definition of a full Rentier State. Luciani (1987) defines a Rentier State as a country which its state budget consists of more than 40 percent from oil rents. Nevertheless, it is argued that prior to the 1970s when the oil companies started to share the oil rents more fairly with the oil-rich countries, the sudden boost of revenues reshaped governments even before this threshold (Claes, 2001). The main explanation of the Rentier State theory is that by relying on the non-tax based revenue the state becomes almost financially independent of the domestic production taxes. Describing it as state-centred explanations, Ross (1999) indicates two major themes among the Rentier State literature that try to explain the negative effects of the external revenues. One reason is that the emergence of these rents fosters an elite group. Since the realisation of future rents are also not based on domestic economic production, this will cause the economy to move away from efficient maximising behaviour into inefficient, wasteful and corrupt economic behaviour. Consequently, the state will lose its extractive (taxing) capability when it needs it most (slowdown in oil rents) and only plays the distributive role (Mahdavy, 1970). The extractive power of the state is also a method of obtaining accurate information on the economy and since it no longer functions as such; it would mean the implementation of appropriate economic policy will be less likely (Chaudhry, 1989).

The second theme argues that these rents will bring about authoritarianism. The government will try any means of coercion, bribery or outright repression. For example, countries might pacify dissent by paying patronage and buying off votes and critics. This is the direct result of this inefficiency and emergence of the elite rent controlling group who see democratic political status as a direct threat to their interest (Beblawi and Luciani, 1987; Ross, 1999). In many instances, this non-tax revenue has ultimately resulted in repression of different social groups (Shambayati, 1994). Clearly, it is more likely that the reasons behind the growth of Rentier States is increasing rent rather than sound economic planning which is confirmed by the non-spectacular performance of these countries compared to non-Rentier States (Shambayati, 1994).

What is obvious from the conclusion of the Rentier State discourse is that the development process of an oil-rich country is more than anything a contextual question. Therefore, the recent Rentier State literature overwhelmingly focuses on context specificity and path dependence (e.g. Karshenas and Moshaver, 2012) rather than generalisations or multi-country comparisons. Nevertheless, observations against the Rentier State paradigm such as the positive effect of oil rents in Norway do exist. While being heavily dependent on oil exports the market and democratic structure has seemed to stop Norway from transforming into a Rentier economy. The crucial matter in this view seems to be the power structure of each country. In Chapter 3 it will be attempted to investigate the true power and decision making arrangements in the contemporary history of Iran. We will look at the pre and post revolution periods and how such problems have led to mismanagement in utilisation of oil revenues.

An emerging literature attempts to explain the impact of the uncertainty attributed to the oil revenues. These studies argue that it is the subsequent response of governments in the percolation of such revenues to different elements of the economy which can influence growth patterns. Obviously, this characteristic of oil economies further complicates all aspects of planning and management at the macro economy level all the way to firm-level decision making. The volatile nature of oil prices has always been a predicament that all countries with higher share of primary exports have to address.

The majority of these studies are inspired by the general literature concerned with the impact of revenues or terms of trade volatility and growth. Strong historical evidence suggests countries which specialise in a commodity with considerable price fluctuation have more volatility in their terms of trade and obtain lower foreign direct investment (FDI) and consequently lower growth rates (Blattman et al., 2007).

Aghion et al. (2006) find a robust negative relationship between real exchange rate volatility and growth performance highlighting the crucial role of sound financial development for sustainable growth. They explain that macroeconomic volatility can create financial constraints which could hamper firm innovation and therefore overall growth if there is inadequate financial development in the country. Furthermore, in their study of lower income countries, Koren and Tenreyro (2007) argue that poor countries suffer more from volatility due to a number of reasons. First, these economies tend to be less diversified, second they tend to specialise in more volatile sectors. Third, they have more macroeconomic policy-induced shocks. While a lot of oil exporting countries are not poor, nevertheless, they do suffer from a number of these problems which is normally because of the presence of a lopsided economy with a large resource enclave and weak institutional foundations.

On the other hand, Ramey and Ramey (1995), instead of terms of trade volatility, use the volatility of unanticipated output growth and document its negative effect on growth in a cross-country study while controlling for initial income, human capital, physical capital and population growth. In their cross-sectional analysis, Fatas and Mihov (2005) find a strong negative effect of fluctuations in government spending on growth. Moreover, van der Ploeg and Poelhekke (2009) suggest a negative relationship between growth and volatility while controlling for various factors including resource dependence. They argue that the direct positive effects of resources are often offset by the indirect volatility effects caused by that resource, providing an alternative explanation on the role of oil revenues on growth. Similarly, Cavalcanti et al. (2012) study the impact of commodity price volatility and growth for a number of countries with large reserves of different commodities and find a negative association. They also conclude that the true plausible argument for the Resource Curse hypothesis lies in the volatility rationale.

The most important tool at the disposal of these countries has been the resource-based wealth funds which are based on a number of fiscal policy rules in order to encourage economic stabilisation, maintain savings and manage absorptive constraints of these economies. These funds are intended to provide governments with means of enforcing countercyclical fiscal policies and buffer the economy against issues such as Dutch Disease by allowing the resource rents to be gradually converted to domestic currency over time (Davis et al., 2003). The experience of these funds in different countries have been mixed since often there is no guarantee that withdrawal rules or investment purposes of these funds are actually respected by the governments or are not changed throughout time. Furthermore, the transparency purpose of such initiatives can be rendered obsolete if, for example, governments use these funds as an alternative discretionary budget mechanism for fiscal spending (Petrie, 2009). Thus, the true onus is on the governments to adopt prudent fiscal policy by avoiding self-defeating actions such as running deficits in the boom periods. The Iranian experience with the oil stabilisation fund is explored in more detail in Chapter 4.

Among all the stylised rationales above what seems to be obvious is that the source of the volatility attribute of resources is not entirely an economic issue and more often it is overshadowed by political developments especially inside the country. This is suggestive of the fact that the real obstacle to growth might indeed be the volatility in government expenditures and lack of sound planning rather than other versions of volatility such as price volatility discussed in the literature. In this light, the unpredictable and unsustainable spending habits of states acts merely as a political economic indicator of that country which can be the main obstacle to growth.

### 2.5 Efficiency Analysis

It should not come as a surprise that looking at how efficiency can affect growth in resource-rich countries can be instrumental. As we have seen parts of the literature discussed so far such as learning by doing Dutch Disease models or some rent-seeking explanations either implicitly or explicitly employ productivity as a mechanism for explaining the effect of resource revenues on an economy. Thus, it seems interesting to see how the measures of productivity and more importantly efficiency of production can be influenced by the availability of resource rents.

This topic will be of great interest in the remainder of this research. In Chapter 4 and Chapter 5 we will discuss the key question in the context of the Iranian industrial sector and the underlying cause of its uncertain growth. The main feature of this sector which is the presence of seemingly profitable firms during oil booms which suddenly transform into bankrupt businesses in subsequent oil busts can be examined more warrants an adequate investigation and framework. This highlights a more long-term consequence of oil revenues that has not been appropriately explained in any of the aforementioned literature. To address these issues it seems imperative to look in more detail at the structure of these firms and their respective efficiency performance.

The literature on efficiency analysis can broadly be divided into two due to interest in two different components of economic efficiency, namely ‘allocative’ efficiency and ‘technical’ or ‘productive’ efficiency. The first group of studies focuses on the neo-classical based allocative efficiency measures. This literature elaborates the impact of the relative price ‘distortions’ on the efficiency of resource employment at different levels of aggregation. These studies have a longer history of analysis and consist of two main subsections. The first cohort emphasises the monopoly social welfare costs. The other group of allocative studies examine the benefits of trade and openness in outputs and growth. This is clearly one important avenue to assess if government spending sourced by natural resources might have a significantly different macroeconomic impact on indicators such as inflation which can ultimately determine the choice of production factors by firms and their respective allocative efficiency.

The second body of literature concentrates on explaining the sectors or firms performance by differences in their relative non-allocative efficiencies. Initially Farrell (1957) introduced the notion of ‘technical inefficiency’ by highlighting the importance of management and work incentives. Having a more empirical approach, he maintains that firms do not necessarily minimise their cost and there are considerable inefficiencies in management which results in efficiency disparities among firms. Based on similar considerations, in his pioneering paper, Leibenstein (1966) questions the relative importance of allocative efficiency. He argues that factors such as the intrinsic negative attributes of human organisation and their effect both within and outside the firm shapes the principles of the true measure of inefficiency. He goes on to call this type of inefficiency as X-inefficiency. One of the subtle differences between X-efficiency and technical efficiency is that the latter questions the conventional assumption of rational behaviour by the economic agents whereas Farrell focuses on the measurement issue and highlights the technical aspect of production and management staying within the neo-classical modelling frameworks.

On the empirical side, the technical efficiency literature has an overwhelming presence compared to the X-efficiency studies. Clearly, the biggest problem of X-efficiency measurement lies in construction of indexes of human attributes in a meaningful and consistent manner. The two main applied modes of analysis in empirically estimating technical inefficiencies are the Stochastic Frontier Analysis (SFA) and the Data Envelope Analysis (DEA) techniques. The most successful empirical studies for confirming non-allocative efficiency theory which have applied these techniques have been at the industry or firm level. Here the differences between firms or industries have predominantly been attributed to factors such as market structure, ownership and firm size. A more in depth discussion of the theoretical and empirical literature of production efficiency analysis is presented in Chapter 6.

The link between oil revenues and production efficiency can be both direct and indirect. The government can take prudent measures to support manufacturing firms to select better modes of production. For instance, it can facilitate the import of key capital goods and better international cooperation with foreign firms. Furthermore, the states can indirectly influence the production environment through both economic and political channels to help firms improve their technical production performance. For example, the introduction of better property laws and tighter regulatory supervision can induce production to be more economically competitive, or enforcing measures to reduce the privileges of elites and certain factions could lead to better business confidence and thus the employment of more productive processes.

## 2.6 Theoretical Framework Conclusion

Based on the above review of relevant works on resource abundance and growth it is clear that there is an ambiguous answer to the presence of the so called curse. It is most likely that a more comprehensive analysis of the causal relationship in question would depend not on a single rationale but rather a hybrid or a mixture of the above factors which would differ from one case study to another.

Furthermore, what seems to be lacking in the literature is a micro-level case-study analysis to assess the production performance of these resource-rich countries especially in the industry sector. More recently, the availability of detailed firm level censuses carried out by governments and statistical bodies paves the way to take a closer look on how the introduction of oil revenues into the economic system affects firms. Adjusted carefully, this can also be a useful re-examination technique to reassess the hypotheses and claims put forward by the above literature from a different vantage point.

In order to disaggregate oil from a macro-level variable to a micro-level phenomenon we would need a micro index that would capture the resultant direct or indirect influences of oil revenues for each specific firm's production performance. Clearly, this is an abstract notion and the closest equivalents to this are measures such as carbon footprint or value of fuel subsidies of the product are the closest equivalents. However, these measures only capture part of the oil effect. Therefore, the lack of a comprehensive disaggregated measure seems the main obstacle of a simple mechanical method of analysis.

Instead, we argue that the overall effect of the oil influence in a micro-level analysis can to a large extent be captured by its influence on technical efficiency of production. Assessing what factors are detrimental or beneficial to firm technical efficiency and how those factors are relevant to the oil revenues can shed light on the question at hand from a new perspective. Thus, the challenge here would be to identify the channels through which oil revenues shape the firm production decisions. For this purpose we can draw inspiration from the resource literature however, the result would be a highly context specific matter.

Thus, it is our attempt in the remainder of this research to incorporate different aspects of the literature discussed in this chapter to arrive at a more comprehensive model. In the case of Iran, the micro-level channel of efficiency performance and oil revenues can be built upon the political economic factors which can be considered as the skeleton of our theoretical contribution to acknowledge the contextual issues in the study of Iranian economy. Identifying, these key characteristics we can assess the role of oil in the economy's productivity and focus on manufacturing firms' performance due to their importance in Iran's development trajectory.

# Chapter 3 Political Economic Structure of Iran

## 3.1 Introduction

In this chapter we attempt to paint a clearer picture of the Iranian political structure and explore the contextual political economic challenges it has faced. Following the discussion on the political factors in explaining the role of oil in development of countries we try to investigate the validity of these explanations in the case of Iran. In order to better comprehend the nature of oil revenues' role in the Iranian economy it is crucial to take a closer look at the power structure in the Iranian context. This consideration seems even more necessary in the aftermath of the 1979 revolution and further complexities brought about to the political spectrum. We explore the role of oil in the arrangement of power and its importance from a political economic perspective. We explore the key characteristics of the Iranian political economy and the resulting key institutions which shaped investment and efficiency in production sectors. We address the important components of post-revolutionary paradigm of power and its economic consequences. This will help explain the main challenges facing the development and growth trajectory of the Iranian economy. This background will also provide context on our case study of manufacturing production in proceeding chapter and to address specific questions within the institutional context of Iranian political economy.

The layout of this chapter is as follows. First, we discuss the broad outlines of the Iranian political structure. A comparison between the Pahlavi monarchy and the Islamic Republic state structures and their key characteristics helps provide context to the evolution of the present system and emergence of various new institutions. We move on to study the role of three key economic institutions and their specific characteristics within the Iranian economy. First, we examine the importance of public sector production and key features of state owned enterprises (SOEs) vis-à-vis the private sector and evaluate how growth of the overall economy is affected by this presence. Second, the background to the unique semi-public organisations that became prominent in the post-revolutionary economy and the extent of their economic influence are discussed. Third, the importance of the old mercantile group in the contemporary history of Iran is briefly investigated. Finally, our findings are summarised in the final section.

## 3.2 The Iranian Political Economic Structure

During the pre-revolutionary period the Iranian power structure mainly revolved around the Shah. Centralised administration and planning was the main feature of this period. One of the biggest obsessions of the Shah after the 1953 coup and overthrow of Mosaddegh was the military. Abrahamian (2008) argues that one of the three pillars of Shah's power as the military. He argues that this is evident by the vast expenditures and investments in arms trade, military infrastructure and personnel upkeep receiving $7.7 billion equivalent to 35% share of the GDP by 1977. Only twenty years prior to that in 1954 the expenditure was around $60 million or 24% of GDP in 1954. Nevertheless, being wary of a potential coup, he instated people in charge of military on the basis of loyalty instead of measures of military abilities. In 1957 the Shah with the help of CIA and Israel's Mossad founded the intelligence service SAVAK. This agency alongside the intelligence units of different military forces were mandated to only be directly in contact with the Shah's office and provide updates on a regular basis.

The second pillar according to Abrahamian is the expansion of the bureaucracy and the state both in terms of number of ministries and also the far reaching influence of the state all the way to the smaller villages for the first time. He claims this was reflected in the fact that by the end of 1977 the state was directly employing one in every two full-time employees.

The third pillar, he argues, was the court patronage through the charity foundations such as Pahlavi Foundation (bonyad-e pahlavi in Persian) which were responsible for managing the royal funds, exerting economic control and rewarding the supporters of the regime. Regardless, all three components were maintained through the abundance of the oil revenues which accrued to the government and had become even more important with the fifty-fifty oil contracts introduced after the events of oil nationalisation upheaval prior to 1953. The oil revenues jumped from only $34 million in 1954 to $20 billion in 1975, respectively accounting for 15% and 72% of the country's foreign exchange receipts (Fesharaki, 1976).

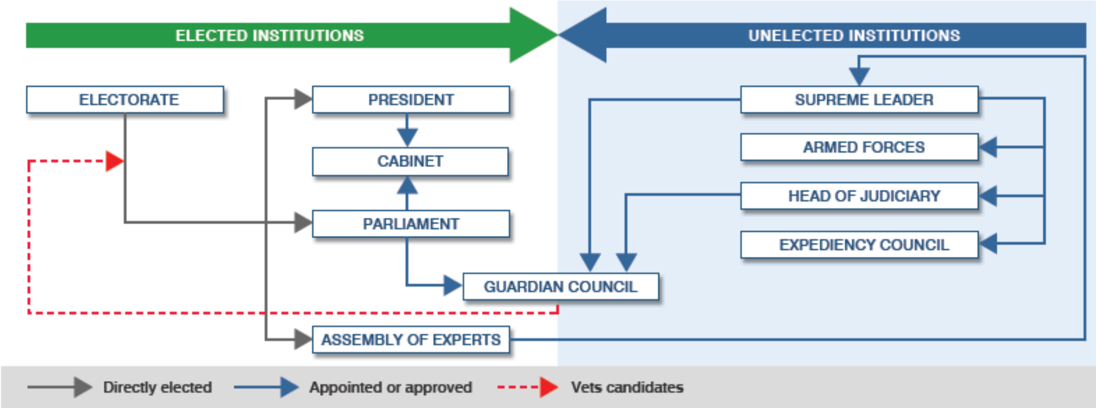
The authoritarian structure of power during this period meant that rent-seeking activities in the general economy and more specifically with regards to oil proceeds was conducted only through a single channel of direct connections with the Shah and his close associates. A series of reforms carried out by the Shah in the 1960s coupled with the oil boom in the early 1970s resulted in high growth rates. However, during the 1970s it also brought inflationary pressures to the average consumer as a result of over-ambitious policies pursued by the state. Furthermore, the Shah's economic, political and cultural reform programs caused the alienation of the clergy, the working class and 'bazaaris' (traditional merchants) while its three pillars of power, discussed above, all gradually crumbled in the wake of the revolution. These issues alongside the overheated economy paved the way for the Islamic revolution in 1979.

After the revolution, the political arena became more complex. Various institutions and supervisory councils were incorporated into the Constitution. Broadly speaking, the power structure in the post-revolutionary Iran can be divided into two parts. These are the elected body and an appointed core headed by clerical figures (see Figure 3–1). This categorisation does not mean that these two components of power are entirely independent but it does show that the rationale behind the introduction of the clerical core is supervision of the decisions and actions of the elected apparatus. In other words, these clerical institutions have the final authority and jurisdiction over the actions of the elected component of power.

The people directly elect the president, parliament representatives, provincial council members and members of 'Assembly of Experts'. However, the candidates of these elections are filtered through the vetting process carried out by the 'Guardian Council'. This council consists of six jurists, chosen by the head of the judiciary and approved by the parliament (Majles in Persian) and six theologians, chosen by the 'Supreme Leader'. This Council has veto powers over the laws passed in the parliament in order to guarantee that they conform to Islam and the Constitution (Article 96). However, if Majles disagrees with a veto on the legislation, the 'Expediency Council' is responsible for resolving the dispute and arriving at a final verdict. The Expediency Council is also a board of advisors to the Supreme Leader and consists of 42 members with political, military and religious backgrounds.

The Supreme Leader appoints the heads of the judiciary and armed forces. The only institution that theoretically has oversight on the Leader is the Assembly of Experts (Article 107). Based on the Constitution, the Assembly of Experts is responsible for choosing the Leader which possesses qualities such as scholarship, piety and political prudence (Article 109). Furthermore, the Assembly is responsible for overseeing the Leader's performance in order to make sure he maintains capability of fulfilling his responsibilities (Article 111). This power formation has meant that every institution is either directly or indirectly affected by the Supreme Leader which by explicit terminology of the Constitution is the highest authority in the country.

**Figure 3–1 Diagram of Iran's Political Structure (Post-Revolution).**




*Source*: BBC (2009).

The revamping of political arrangements and the introduction of new actors was necessary for embedding the religious elite in the main arteries of the state. It can be argued that this new power structure has been a strategy for maintaining a balance of power amongst different factions. Some have argued that the resulting duality of centres of power might not necessarily entail inefficiencies, due to the freedom and flexibility that the semi-official components enjoy which theoretically could be helpful in providing solutions that are not at the disposal of the official institutions (e.g. Esfahani, 2005). However, in practice the oversight of institutions on each other and the parallel structure of power have brought various clashes of ideas and ideological oppositions regarding various political, social and economic issues. As we will discuss below in a number of serious instances the confrontations amongst the existing factions were only resolved by the Leader's direct intervention. This is why other studies have emphasised the negative aspects of Iranian factionalism and labelled this process as 'destructive competition' (see Bjorvatn and Selvik, 2008).

More crucially, the clash and competition amongst different groups has presented itself in ideological issues as well. An important historical example is the debate at the onset of the revolution regarding the role of government and the economic strategy that was to be pursued after the revolution. Two main camps of thought were prominent at the time, a pro-state versus a liberal ideological group (Pesaran, 2011). The wider support of the revolution was gained on the basis of populist socioeconomic slogans of equality, wealth redistribution and defending the 'oppressed'.

On the face of it, statist measures taken by the regime such as nationalisation of industries, expropriation of properties of numerous major capitalists and establishing revolutionary parastatal organisations was meant to show their commitment to these promises. However, this was really a decision made out of exigency due to lack of entrepreneurs, revolutionary turmoil and the Iraq war (Harris, 2013). Amidst state interventions and marginalisation of the private sector, based on Article 44 of the Constitution, sanctity of private property was upheld from the very first days of the revolution and was echoed by Ayatollah Khomeini himself (Saeidi, 2004; Abrahamian, 2008). This was explicitly stated in support of the bazaaris who had played a major role throughout the revolutionary movement and had long enjoyed a special relationship with the clergy. This helped establishing this influential group's position firmly into Iran's post-revolutionary economic dynamic from the early days of the revolution which materialised especially after the war period.

Consequently, throughout the life of the Islamic Republic the statist arguments gradually lost ground to the liberal ideology not as a result of sound economic reasoning but rather as a product of political economic forces at play. In order to better appreciate the evolution and the extent of the political economic context in Iran here we will provide a brief chronology of political developments in the Islamic Republic period.

## 3.3 Historical Overview of Post-Revolutionary Power Formation

In the initial revolutionary phase (1979-80) Ayatollah Khomeini allowed more moderate figures to take control of the government. Straight after returning to Iran and following the fall of Bakhtiar's government in February 1979, Khomeini instated

Bazargan, a moderate technocrat figure as the prime minister of the interim government. The provisional government of Bazargan was dogged down by the gradual strengthening of conservative figures who were gaining influence through revolutionary bodies that were in the hand of members of the Islamic Republic Party (IRP). The members of the IRP entirely consisted of close associates of Khomeini. On numerous occasions, the prime minister voiced his discontent to the judicial proceedings of the revolutionary courts and local committees regarding the lack of democratic measures in the Constitution which was being drafted. The decisive event however, was the occupation of the US embassy in Tehran by a group of university students which received the full support of the Leader. The support of Ayatollah Khomeini for the occupation exposed the decreasing level of support that Bazargan was receiving from the Ayatollah. This led Bazargan to reluctantly resign from office in November 1980 in objection to his political alienation and the limited scope of power that was left at his disposal.

In February 1980 another liberal-minded figure, Banisadr, came into power as the first president of the Islamic Republic with 69% of votes (Axworthy, 2013). He was one of the figures that had criticised the seizure of the US embassy. The power struggle between him and the now strengthened IRP resulted in his eventual acceptance of the party's candidate Rajaie as the prime minister[1]. Nevertheless, the two continued a long disagreement on the choice of ministers which meant even by the end of Banisadr's presidency in 1981, a number of ministries did not have the posts filled.

Iraq invaded Iran on 22 September 1980 after announcing that it was no longer bounded by the Algiers Accord agreement regarding border disputes which had been negotiated in the Shah period. This was an additional burden on the already unstable political situation after the revolution. The war proved an important ingredient in the forging of the religious conservative factions' power by eliminating the non-aligned parties to that of IRP. After a series of street demonstrations and increasing pressure, the Mojahedin-e Khalgh Organisation's (MKO) took up armed resistance and carried out a number of assassinations and bombings of key IRP figures (including Rajaie) after the removal of Banisadr. Historically, the MKO was an important part of the

[1] Ultimately, Rajiae would go on to replace Banisadr as the president after he was removed from power.

revolutionary forces fighting against the Shah. They consisted of both Muslim and left wing fighters who had taken up arms against the Pahlavi monarch. After experiencing rifts and splinter groups during the revolutionary struggle, they sided with Ayatollah Khomeini in the beginning of the Islamic Republic. The MKO proved to be a determined (if not merciless) opponent to the Islamic hardliners but chiefly lacked the organisational infrastructure to succeed (Axworthy, 2013)[2].

Following the success of the conservatives' power grasp and the assassination of Rajaie, Khamenei the IRP's secretary at the time, ran and won the presidential elections. However, after the parliament rejected his initial proposed candidate for the prime minister post, even he had to settle with his second candidate, Mir-Hossein Mousavi. In this stage the next group targeted was the leftist Tudeh Party which again was a group that had collaborated with the religious groups in the struggle against the Shah. They were officially outlawed in 1983. This meant that the biggest organised groups which could be a threat to the conservatives' dominance were now officially forced out of the political sphere by their erstwhile Islamic counterparts.

Nevertheless, these events did not lead to a unified and homogenous residual group in power. On the contrary, it instigated the emergence of a left-right spectrum of political and economic ideology amongst the remaining supporters of Khomeini. The factional competition became so strong that it soon unsettled the IRP itself and in 1987 Ayatollah Khomeini dissolved the party altogether (Axworthy, 2013). The power struggle continued until after the ceasefire with Iraq in July 1988.

One of the crucial aspects of factionalism was the positions of different groups on the role of the state in the economy. On the left there were calls for maximum amount of nationalisation of trade and industries alongside land and labour reforms in favour of the working class. This seemed to be the inclination of Mousavi. On the other hand, the conservatives on the right had the support of the majority of the clergy and especially Khamenei. They supported the calls of the bazaaris for non-interventionist policies of the state. Ayatollah Khomeini who had tried to act as the moderator reiterated the sanctity of private property in Islam but assured that the state can impose rules and conditions on the activity of private sector. These events

[2] For a more detailed discussion on the history and complexities of MKO in the revolution process, see Abrahamian (1989).

highlighted the difference of opinion at the very top levels of power i.e. between the president and the prime minister. It is reasonable to conclude that it was only due to the mediation of the Leader that the Khamenei-Mousavi duo lasted for eight years until 1989.

However, with the end of the war other points of disagreement arose. The mistreatment and mass killings of MKO and other leftist prisoners brought the outcry of Ayatollah Montazeri, a close follower and the successor-in-waiting of Ayatollah Khomeini until that point. Montazeri had expressed sharp criticisms against him due to the purge of political freedom and the executions and mass killings in the jails which were carried out in the earlier periods. However, this time his stronger criticisms received an even stronger response from Ayatollah Khomeini himself. He dismissed him as politically incapable and dismissed him as his successor. Montazeri accepted and announced his resignation. In a matter of days Montazeri was completely alienated to the extent that even his name and speeches were almost entirely barred from all media outlets. Later on however, he continued to criticise the new leader after Khomeini. This led to him being dismissed as a simpleton, barred from carrying out his religious teachings and finally put under house arrest from 1997 to 2003.

It is worth mentioning that this was not the first fallout of a key religious figure with the state. The other important instance is the fate of Ayatollah Sharia'tmadari who prior to the revolution was largely an apolitical cleric. Nevertheless, he had openly voiced his opposition to the role of the 'Supreme Leader' or the concept of 'Velayat-e Faghih' (jurist prudence) in the Constitution in the early days of the revolution. However, after the trial of Ghotbzadeh, the former foreign minister, following plans to overthrow the government, in his confessions he mentioned that the Ayatollah had given his blessings to his plans. Subsequently, Sharia'tmadari was put under house arrest in 1982 where he remained until his death in 1986. These events highlight the non-uniform composition of various groups, in this case even within the clergy. With special reference to the clergy this phenomenon is partly related to the embedded idea of pluralism exercised in Shi'ism. The concept of 'ejtehad' or interpretation of religious laws allows each 'marja' or qualified religious jurist to provide his personal understanding of religious texts and laws to his followers. Nevertheless, Ayatollah

Khomeini's doctrine of 'absolute jurist prudence', which gave unique status to the country's Leader, even allowing him to waive or suspend fundamental religious laws if necessary, helped him curtail broader amount of the clerics' role.

After Ayatollah Khomeini's death in June 1989 and the dismissal of Montazeri, Khamenei (not an Ayatollah at the time) was chosen by the Assembly of Experts, with the strong support of Rafsanjani, as the new Supreme Leader. Rafsanjani, a cleric member of the IRP and another close associate of Ayatollah Khomeini had been the speaker of Majles since 1980. He quickly nominated himself for the presidential position and replaced Khamenei as the new president.

Soon after entering office, Rafsanjani proposed a broad reconstruction plan for the economy. This plan called for investments and restructuring of the economy which was in dire conditions due to the problems in the initial phase of the revolution and the crippling war with Iraq. Apart from repair and expansion of the infrastructure, the plan set out goals in liberalisation of the economy and promotion of the private sector. The initial progress such as reduction of unemployment and other reconstruction efforts was made possible due to the both the oil revenues directly and the foreign loans provided on the basis of these revenues. However, the over reliance of the government on high oil prices to finance these investments, which was crucially needed in the oil sector itself, caused a balance of payments crisis with the fall of oil prices in 1993. This placed great downward pressure on the value of Rial and subsequently the economy witnessed an inflation rate of 50%. His attempts of attracting foreign investment suffered a blow after the intensification of US's economic sanctions specifically aiming at companies not to invest in Iran. Furthermore, the privatisation efforts were also left incomplete as the parliament passed a law to give priority to war veterans and the dependants of the martyrs. After the growing dissatisfaction of the conservatives with the government policies, Khamenei wrote a letter to the president asking for greater efforts in alleviating the problems and improving the situation of the oppressed. This was the first sign of a possible rift between the two former close allies. Overall, during the reconstruction period due to the pragmatic stance of Rafsanjani the left-right power struggle had been relatively subdued and only publicised in a limited number of occasions involving the parliament and the guardian council. This would soon change in the proceeding periods.

In the 1997 presidential election, the strong favourite was the right-leaning speaker of Majles, Nategh-Nouri. The other serious contender was Khatami, who similar to the other candidate, was a cleric but with quite a different political, cultural and economic ideology. Khatami had been the minister of culture and Islamic guidance from 1982 (during Mousavi's term) until 1992 when he had to resign after the right wing dominated parliament and Nategh-Nouri as the speaker, strongly criticised his liberal tendencies. Khatami presented the option of change and liberalisation in social, political and economic fields. On the other hand, Nategh-Nouri was largely a symbol of the right-wing conservatives and the status-quo.

An important development prior to the election was the support of Khatami by the Kargozaran Front whose members were mainly Rafsanjani's relatives and associates. Ultimately, in a surprising landslide victory, Khatami won over 70% of the votes. From the early days into his presidency, Khatami emphasised the importance of foreign policy and amending ties with western countries. He restored full diplomatic ties with Britain and later on visited a number of European capitals, a first for any president since the revolution. Nevertheless, Khatami was gradually put under pressure from the conservative Majles with the impeachment of his interior minister who was forced to resign. Moreover, a series of murders of key liberal figures, including members of Bazargan's provisional government, carried out by ultra-hardliners, added pressure both domestically and internationally on him. Another scandal was the attack on the liberal students in the dormitory of Tehran University by plain-clothed elements (extremist pressure group members). Later on Khatami's minister of culture was forced to resign. This period was filled with controversies and other signs of unease from the conservative camp. Despite this, the reformists managed to take the majority of the seats in the 2000 parliament elections. This was another blow to the right wing factions but also to Rafsanjani who only managed to secure the last place out of the thirty seats appointed to Tehran province and subsequently withdrew his nomination. This further radicalised the political sphere and soon numerous reformist newspapers were closed. This was followed by an assassination attempt of a key reformist figure, Hajjarian, who was considered their main strategist. Throughout these events Khatami struggled to maintain the middle ground and manage these crises.

The reluctance of Khatami to directly confront the hardliners translated into some discouragement of the more liberal supporters but despite this he managed to secure an impressive 80% of the votes in 2001. This, however, was the beginning of the end for Khatami as a number of outside developments considerably undermined his ability to fulfil his political and economic goals. These events included the West's suspicion of Iran's nuclear programme, the rise of the Taliban in Afghanistan, the attack on the World Trade Centre in 2001 and the US invasion of Iraq in 2003. Again despite attempts by Khatami to reach out and even provide support against Taliban and assist in Iraq, Iran was labelled as part of the 'Axis of Evil'. These events further strengthened the hardliners in criticising Khatami's conciliatory stance toward the West and severely undermined the already limited power that was practically at his disposal.

The lack of progress and the backlash of the hardliners disrupted the social and economic reform plans of Khatami and caused the apathy of greater part of the public who had hoped for greater change and renewal in the direction of the country. This was reflected in the low turnout in the Majles elections of 2004.The dispiritedness of the general public and dismissal of a numerous reformist candidates paved the way for the right wing factions to win the majority of the seats in the seventh parliamentary elections. This was the prologue to the resurgence of the conservatives and their comprehensive power grab. These events and the unorganised campaign of reformists helped secure the hardliners victory in the 2005 presidential elections. Rafsanjani who had retreated to his role as the head of the expediency council (he had held the post since the inception of the council in 1989) was the favourite in the runoff. However, he suffered another defeat this time at the hands of the lesser-known Ahmadinejad, the former mayor of Tehran. Rafsanjani openly contested the results but eventually did not pursue this through official investigatory procedures.

In his campaign Ahmadinejad had strongly criticised Rafsanjani and his associates regarding allegations of corruption and decadence. He also managed to win support of part of the population due to his unknown credentials and populist slogans. After assuming power Ahmadinejad embarked on replacing key government positions such as provincial governors. He also drastically changed foreign policy and took a harder stance in the nuclear issue with the UN's atomic agency. This resulted in the implementation of economic sanctions by the UN Security Council for the first time. As Alizadeh (2014) notes, during Ahmadinejad term in office a return to populist policies were pursued which resulted in typical petro-populist stages of initial growth followed by inflationary pressure and stagnation which forced him to implement subsidy removals due to dire government financial situation and intensification of economic sanctions. On the domestic side the marginalisation of the reformists and the full support of the leadership meant that his term in office was largely unchallenged from political groups inside the country despite some of his populist-liberal comments on the role of women and praising Cyrus the Great the Shah of Iran in pre-Islamic times.

In the 2009 presidential election a coalition of the reformists and pragmatic figures (such as Rafsanjani and Mousavi), was determined to prevent Ahmadinejad hold onto power for the second term. Nevertheless, in another surprising outcome, Ahmadinejad was declared the winner of the race but the results were contested by the opponents and mass protest took place in Tehran. The turmoil after the elections finished after an ultimatum by the Leader in Friday prayers stating that his view were closer to that of Ahmadinejad and the leaders of the opposition had to stop the protests. After defying the leader Mousavi and Karroubi (two of the candidates who were key figures in the revolution) were put on house arrest and continue to be so to this day. These events which can be considered the biggest threat to the regime after the war initially were portrayed to further unite conservatives. The nuclear talks had stalled and US-EU sanctions reached an unprecedented level. This gave the part of the armed forces which were already participating in economic activities greater opportunity for more overt economic engagement. Later on Ahmadinejad, who had gained greater confidence, gradually fell out with the main body of the conservatives. Khamenei publicly intervened and prevented one appointment and one dismissal in Ahmadinejad's cabinet. In 2009 he appointed his close aide, a controversial figure, as vice president but was ordered by the leader to resign. The other intervention of Khamenei was the reversal of the removal of the intelligence minister. This was the beginning of a downward spiral for Ahmadinejad, who was strongly criticised by the majority of the members of Majles and conservative clerics. Prior to the 2013 presidential elections Ahmadinejad accused the brother of Larijani the speaker of Majles and the head of the judiciary of abusing his brothers' influence and illicitly benefiting from them. These and other incidents in the second term of Ahmadinejad sealed his fate and the candidacy of his close aide in the presidential elections. Ultimately, in 2013 Rohani, a more moderate figure that had the support of the reformists and Rafsanjani came to power. Rohani's main slogan was that of moderation and unity of different political groups. It is yet to be seen exactly how his term plays out but already signs of struggle between the president and the conservative camp can already be seen in speeches made by them.

This condensed narrative of the turbulent history of the Islamic Republic is a testament to the fact that the political economy of Iran is, if not entirely built around factionalism, at least riddled with ample examples of it. As pointed out earlier, this polycentric paradigm resonates with the Shi'a religious hierarchy of 'maraje taghlid' (see Walbridge, 2001). Consequently, groups and factions with similar interests have emerged in the political scene, not only within the elected and clerical structure, but also groups with members across the two components (Bjorvatn and Selvik, 2008). Nevertheless, this palette of different variants of political and economic ideology has allowed the regime to use this quasi-flexibility to weather the storms of different crises using different groups in different epochs.

The key issue here is that this complex and dynamic process of competition has had tangible implications for the choice of economic policy. As discussed above, after the war period, President Rafsanjani followed a series of policies, such as relaxing labour law and liberalising trade, in order to move towards a more rational mode of economic strategy. After that, Khatami took steps forward and implemented more measures of openness and accountability such as establishing the Oil Stabilisation Fund and foreign investment law. Acknowledging this multifaceted background of the political economic structure in Iran we argue that it has created new economic actors and influenced the performance of existing ones. Thus, the result of this dynamic will be informative in our analysis of economic production in the following chapters. We will briefly discuss the role and significance of three of the unique defining economic components of the Islamic Republic's economy below.

## 3.4 Public Sector Production

The overwhelming presence of the public sector is by all means not specific to Iran and is predominant in most oil producing countries. This is not to say that the intervention of the government can always be negative. In fact the presence of the government in early development stages of countries is mandatory to alleviate problems of information asymmetries, incomplete markets and other externalities that a developing country might experience in its growth paths. However, certain characteristics of large endowment of the government has had various repercussions for the structure of the economy and business environment. The public firms tend to be referred to as inefficient, overstaffed and unprofitable producers (e.g. Alizadeh, 2002)

After the revolution and in light of the ideological debates between proponents of pro-state and liberal economic strategies, the government expanded its control over the economy. In 1982 it increased the number of ministries from 20 (in 1979), employing 304,000 civil servants, to 26 which employed 850,000 people and further grew to above a million civil servants in 2004 (Abrahamian, 2008). This was in line with nationalisation of banks and businesses in the early periods of the revolution. For instance, the industries ministry took possession of factories belonging to 64 industrial notables under the accusation of being corrupt supporters of the Shah or the West. As a result, the government was left with more than 2000 loss-making factories (Abrahamian, 2008). In total, the government nationalised roughly 80 to 85 percent of the country's major production units (Ehteshami, 1995). The nationalisations were unconventional by modern standards as a major part of these industries were previously privately owned but were target of confiscation as many had fled the country due to the political turmoil. On the other hand, these appropriations were theoretically based on Islamic principles practiced even in the days of the prophet (see Behdad, 2006). Regardless, the ultimate result of this process was the growing presence of the government directly in production and the dependence of the country on its policies. In this process and throughout the turbulent economic history of Iran, especially after the revolution, due to economic mismanagement, oil revenues have not only failed to help the revival of the private sector but instead it has embedded public sector production as the main component of the economy. This is evident in the fact that the public firms alongside other quasi-public ones account for two thirds of the overall budget (Hertog, 2010).

Despite the high annual investment rate of the government in the first decade of the new millennium, around 33 percent of GDP (Crane et al., 2008), the dismal performance of these producers suggests that the efficiency of investment has been unsatisfactory. Rather than being productive, these expenditures have been mainly to subsidise costs of production and bailout poorly performing companies. This has meant that often these producers seek to keep these government transfers in place and prolong them as much as possible (Alizadeh, 2002).

The government's failure in implementing strict discipline and supervision on the SOEs has led to the majority of these firms remaining dependent on government transfers. In other words the soft budget constraint of these entities has not only entailed inefficiency of production and allocation of resources but also other negative macroeconomic implications for the economy such as inflating government budget and inflation (Alizadeh, 2002).

The increasing dependence of the economy on public sector production, even after the revolution, cannot be justified based on rationales of infant-industry protection. A number of industrial producers, such as automakers, that are protected by the government have been active for more than three decades and had even been profitable under private ownership prior to the revolution (Alizadeh, 2002). This is in contrast to the experience of countries such as South Korea (henceforth, Korea) that transformed firms to global competitors thanks to initial government supports and facilitations which were targeted and constrained by a time frame. Thus, what seems to be at the heart of the problem is the very ownership of the government in these firms which has barred openness and competition to increase the quality and sustainability of domestic production.

An explanation for the government failures or inability to remedy the problems of these firms is often political. For example, some firms are not directly overseen by the government such as the television and radio broadcasting organisation while other that are, might be given leeway since the CEO or the company itself is somehow linked to the interests of a certain political faction. Furthermore, the opacity of the accounts of these enterprises itself brings about less appropriate scrutiny (Alizadeh, 2002). Moreover, these units might have political or other alternative goals to fulfil alongside the economic ones, which might reduce their optimal performance. For instance, SOEs have to perform redistributive roles for the state rather than trying to solely increase production (Hertog, 2010).

While in general the hypothesis of inefficient production in the state owned companies seems plausible it does not mean that this is always the case as the issue could be a topical matter. Put differently, it might be other significant features of public sector (which might be shared by private companies) that could be the actual problem. For example, it might be the case that since on average these producers tend to be large compared to their private counterparts and the additional managerial know-how for large scale operations is the underlying source of weak performance. In other words, in the evaluation of their performance other factors need to be controlled for in a more systematic manner. Consequently, in the context of Iranian economy the hypothesis of negative impact of the public ownership on the performance of producers needs to be more rigorously investigated.

### 3.5 Bonyads and Parastatals

The Iranian political economic structure is further complicated with the creation of unregulated semi-governmental organisations such as ‘bonyads’ (Persian for foundations) after the revolution. The activities of these institutions are mainly beyond government supervision. The idea of foundations in the Islamic context stems from Islamic charitable funds (‘vaqf’ or ‘owqaaf’) which have been around in Iran at least since the Safavid Dynasty. The ‘vaqf’ funds were charity funds or endowments at the disposal of religious establishments. They acted as a source of untaxed endowment for the clergy, providing them economic independence from the state which was crucial to the operation of religious leaders (Maloney, 2000). For instance, when this independence was threatened by Reza Shah, taking control of their assets, it resulted in riots and stiff resistance from the clergy (Saeidi, 2004).

Beside such religious foundations in the mid-twentieth century, economic foundations such as the Pahlavi Foundation gained additional importance, especially due to the objective of gaining support and patronage through various investment and job creation channels (Thaler, et al., 2010). The Pahlavi Foundation was initially set up in the 1950s based on the assets of the Shah's father who was exiled. Later on, this foundation received possession of assets from the Shah and his family which was invested in shares of 207 domestic and a number of international companies operating in various businesses (Abrahamian, 2008).

In post-revolutionary Iran foundations with any connection to the previous regime were dismantled. Instead, provisions for a number of new foundations with greater autonomy and financial leverage were implemented. Their main objectives were defined as helping the deprived and assist the redistribution of wealth throughout Iran in order to improve the welfare of the 'Muslim community'. These organisations were assigned the responsibility of managing the factories or funds expropriated by the revolutionary government from the former royal family and the elite who had fled Iran after the overthrow of the Shah.

Similar to the details of their operations, their legal status is rather vague. They have been defined as public, non-governmental organisations with financial and administrative independence (Maloney, 2000). Interestingly, in different research on the Iranian economy, even by IMF, this confusion persists. For example, in an IMF report in 1995 they are treated as private entities (Maloney, 2000) whereas in IMF (2007) they are defined as nonfinancial public sector companies. This confusing terminology rather than being an obstacle potentially is a valuable asset for the foundations. It means that they can present themselves as private or public as it suits their interest which would allow them to take full advantage of a given policy or law.

As mentioned above, at the point of inception the stated objectives of these foundations were entirely humanitarian and charitable. While they are meant to spend their profits on the martyrs' families, war veterans and other activities to promote Islam and Islamic movements across the world, they only spend part of these profits as patronage tributes in order to secure votes and allegiance of a limited group (Roy, 1994). This function has managed to foster enough support for the state in times of political turmoil. It has also been a means of institutionalisation of the ideology of the new ruling class through increasing social mobility of the loyal revolutionaries (Saeidi, 2004).

However, over time some bonyads have evolved into capital accumulating conglomerates with rapid expansion paths. They have evolved into full-fledged profit-maximising conglomerates. They strengthened their foothold in the economy through direct transfers, preferential exchange rates and provision of interest-free credit. Moreover, being tax-exempt producers, detailed information on their operations is intentionally kept less transparent (Maloney, 2000).

The Iranian state relies heavily on these parastatals for job creation and maintaining domestic production levels and therefore these entities have significant influence on the economy as a whole. They have an influential place in the non-oil economy of Iran and are active in various sectors such as tourism, finance, agriculture and manufacturing. For example, the most prominent bonyad, Islamic Revolution Mostazafan Foundation (IRMF)[3], which was initially established from expropriation of funds belonging to the Pahlavi Foundation, is stated by Saami (2006) to account for around 10-20 percent of gross domestic product. At the onset of the revolution, its assets were almost twice as much as its predecessor's due to confiscation of possessions of 50 millionaires after the revolution (Abrahamian, 2008). The total assets of this organisation in the late 1980s is estimated around $20 billion through the ownership of 64 mines, 470 agribusinesses, 140 factories, 100 construction businesses, two hotels, two newspapers and 250 commercial corporations (Abrahamian, 2008). In the mid-90s, IRMF is said to have been contributing to a vast share of the production of textiles (20 percent), dairy products (30 percent), soft drinks (40 percent) and glass containers (70 percent) among other products (Behdad, 2000) while employing up to 700,000 people within at least 800 subsidiaries and additionally entering into sectors such as foreign trade and construction (Maloney, 2000). All this was in light of regular annual payments by the government to IRMF. For example, during 1981 to1990 the government provision of resources to it increased by 29.3% on an annual basis (Saeidi, 2004).

Other parastatals such as Alavi Foundation, Martyrs Foundation, Housing Foundation, War Refugees Foundation and Imam Khomeini's Publications Foundation jointly employed more than 400,000 people in the early 1990s (Amuzegar, 1993). Additionally, the increasing presence of the foundations is

[3] IRMF is referred to as 'Bonyad-e Mostazafan-e Enghelab-e Eslami' in Persian.

directly encouraged by oil resources allocated to these enterprises. It is worth noting that a number of bonyads only deal with cultural issues such as Farabi Foundation (cinema), Sazman-e Tablighat-e Eslami (Islamic missionary) and Resalat Foundation (newspaper) (Maloney, 2000).

It is important to note that a number of these bonyads such as Martyrs Foundation and Komiteh Emdad have an official allocation of resources from the government general annual budget. For example, Martyrs Foundation was allocated $120 million from the budget in 1997 which was equivalent to 21% of the entire government expenditures in health, treatment and nutrition (Messkoub, 2006).

Nevertheless, due to the limited and often incompatible data sources used in the literature to shed light on the relative size of IRMF (and similarly most other institutions) a great amount of caution has to be taken when using these data. Looking at the annual financial accounts recently published by IRMF (2014a) we can reassess these claims at least in the period covered (annual reports of 2010 to 2013). The website (see IRMF, 2014b) confirms the dominant market position of some of its leading companies. Behran Oil is said to have control of 53% of car lubricant oil's market and one third of total industrial oil market in 2011 and Iran Tire is said to have a 14.5% market share of car rubber industry. The Zam Zam Holding Company holds 35% of total beverages market and Sina Food Industries Development Company controls 63% of non-alcoholic beer and 18% of the fruit juice markets. Nevertheless, our calculations based on the 2010 annual review figures suggest that its total employees are just around 34 thousand people and IRMF's manufacturing and mining production accounts for 5% of Iran's total manufacturing and mining production in this year (see Appendix 1 for more details). This decreasing trend in the share of IRMF output simply might show the transfer of power of the bonyads who were dominant in the 1990s to the IRGC (discussed below) in the 2000s as described by Thaler et al. (2010).

Regardless of the exact current figure on the size of these conglomerates, the real problem has been the implications they have had on domestic production and competition in the productive sectors. These foundations have faced numerous allegations of corruption and calls for their greater transparency have been voiced from time to time. For instance, in a parliamentary investigation of IRMF in 1995-96 concluded that the foundation had used its influence to gain favourable terms and concessions (Maloney, 2000). Furthermore, in 1997 with the new reformist government of President Khatami coming into office pressure on the bonyads further increased. Only then was that the IRMF announced that it will be publishing details of the financial accounts and privatisation of 250 of its companies. In practice these statements proved to be hollow promises and were soon forgotten (Saeidi, 2004).

Apart from the financial power of these institutions they possess political influence due to various interpersonal and institutional relations with the government and other religious centres of power. They have acted as means of rivalry through the myriads of factions within the country and have often managed to redistribute power both between and within different social and political groups (Maloney, 2000). Interestingly, their relationship with the traditional merchants has been complicated and they are as much influenced by the bazaaris (and often cooperate) as they are economic rivals (Keshavarzian, 2007). Nevertheless, this power has allowed them to keep private sector investments away and secure their interests and has paved the way for their further expansion. They take measures to undermine potential threats through unfair trade conducts and monopolistic behaviour to their political agenda even if their economic interests are not at risk.

Apart from bonyads, the Islamic Revolutionary Guard Corps (IRGC), Sepah-e Pasdaran or Sepah in Persian, has increasingly become an influential economic actor since the end of the Iran-Iraq war. While the root of IRGC’s economic interests can be traced back to the post-war introduction of formal military ranks, it was the profit motive of creating independent revenue streams for governmental organisations, advocated by Rafsanjani (the president) in the early 1990s, that resulted in its notable economic operations (Wehrey et al., 2008). The IRGC has expanded its presence in the economic scene both directly and also through semi-private companies managed by its current or former members. Moreover, it has often collaborated with some bonyads in various projects. For example, the IRGC and IRMF cooperated in a $1.2 billion project of Tehran’s metro expansion (Bjorvaten and Selvik, 2008). This is not surprising due to the ‘Sepahi’ background of key foundation figures which itself partly stems from the close logistic support the bonyads provided to the Guards during the Iraq war. Furthermore, IRGC has proven its intolerance of foreign competition where they see their interests at risk. For example, in 2004, they unilaterally barred the operation of a Turkish company which was legally contracted to undertake construction and servicing of the Imam Khomeini Airport (Pesaran, 2011). Moreover, during Ahmadinejad's term they gradually obtained increasing presence in the oil sector, undertaking various projects such as production of pipelines and drilling activities (See Bjorvaten and Selvik, 2008). This trend culminated to the appointment of the head of a major economic wing of Sepah as the country's oil minister in 2011. However, he was replaced with the new cabinet of Rohani in 2013.

The Iranian political turmoil has resulted in the implementation of sanctions against Iran both through UN resolutions and also trade and financial embargos put in force by countries such as the US and the major European Union countries. These have placed the Iranian economy under immense pressure but have also meant an increase in the protection and aid provided to these parastatal organisations and their subsequent importance in the domestic economy.

In July 2006, after a number of failed attempts of privatisation, new amendments to article 44 of the Constitution (with the declaration of the Leader in mid-2005) envisaged a gradual privatisation procedure of 80 percent of public sector industries and companies, excluding upstream oil sector and other key infrastructure, through the stock market (see IMF, 2007; Atashbar, 2011). However, this move was largely hampered by the presence of these parastatals as they have been the ultimate winners of these policies (Harris, 2013). This is partly due to the financial strength of these institutions but more importantly these transfers were made possible through preferential price and tender conditions exclusive to these organisations (Saeidi, 2004). As a result, the foundations have entered the stock offering and ultimately ownership has been transferred from one group of public sector to another (Maloney, 2000). This has been referred to as 'pseudo-privatisation' instead of actual privatisation (Harris, 2013). Even though this process has resurrected the Tehran Stock Exchange back to life it is unlikely to benefit the economy and has emphasised the marginalisation of the private sector investment in the Iranian economy.

The sheer size and interrelatedness with the government, SOEs and other bonyads accompanied by the political agenda that they pursue, clearly demonstrate the potential for them to intensify the distortions in the Iranian economy which damage the country's economic dynamics. For example, their interests as monopolists coupled with tax exemptions, subsidised loans and preferential exchange rates, circumvent any type of competition from the private sector which entails additional costs for the economy as a whole. Similarly, they would fiercely oppose entry of any foreign competition to their markets leading to minimum transfer of technological knowhow from abroad.

The economic burden of the bonyads on the government itself has been quite crippling and in the past has made reaching the structural adjustment targets of IMF an arduous objective for the state. In the past when their economic interests clashes with those of the government, it has shown the powerlessness of the government to the extent that government figures have publicly voiced their frustration (Thaler et al., 2010). Crucially, despite the semi-public nature of these institutions their performance in comparison to the pubic production might be distinctively different. It might be argued that due to their autonomy they might end up being more efficient and competitive (Maloney, 2000) contrary to public sector production which as discussed earlier could be susceptible to various inefficiencies and mismanagement.

Consequently, in order to inspect the ultimate effect of the oil rents on the Iranian economy examining the presence of these economic giants and their impact on the economy is essential. To see how these parastatals have performed compared to private and other public firms in terms of efficiency can provide a valuable addition to the research on the Iranian economy. By closely examining the performance of these conglomerates in terms of efficiency in the manufacturing sector these claims can be verified. Furthermore, other potential positive roles in the development path of the economy, such as the intermediary between public and private sectors (Maloney, 2000), are yet to be fully investigated and tested. Based on these results reforms and remedies can be then put forward for the Iranian economy. Obviously, the biggest barrier to investigating such entities is the limited and often contradictory data available about these institutions. However, certain triangulation of data already available could help to shed some light on their activities. For example, in a given industry that the presence of the private sector is limited the mere size of a given firm could help identify these subsidiaries in datasets that are provided anonymously.

## 3.6 Bazaaris

The traditional merchants of the Tehran Bazaar, or ‘bazaaris’, have consistently played an important role throughout the economic history of Iran as early as 19th century (Abrahamian, 2008). Interestingly, they enjoy close affinity with the clergy, most visibly; the clerics supported them for being mistreated by the Qajar dynasty. This kinship was important to the extent that, alongside the crucial role of the intelligentsia, it is considered as a contributor to the success of the Constitutional Revolution in 1905 (Keshavarzian, 2007). Another important example of the clergy-bazaar alliance is the strikes undertaken by the merchants in support of clerics and Mosaddegh in the oil nationalisation upheavals in early 1950s (Bayandor, 2010). Once more at the onset of the 1979 revolution the bazaar played an important role in support of Ayatollah Khomeini (Abrahamian, 2008).

Nevertheless, the events after the revolution did not imply the increase of influence of the Bazaar after the revolution. As Keshavarzian (2007) argues, the ironic result of the revolution for the Bazaar as a whole was its marginalisation and loss of internal cohesion. He notes that despite the modernisation policies of Shah in the 1960s and 1970s and his hostility towards the bazaaris, the Bazaar remained autonomous and controlled two-thirds of wholesale trade and more than 30% of imports in this period. The bazaar prospered due to the growth-oriented policies of the Shah backed by the strong oil income. However, Keshavarzian (2007) maintains that after the revolution the situation changed as a result of the ideological categorisation of bazaaris by the Islamic Republic. This meant that the group that it considered in line with the revolution, the ‘committed bazaaris’, were allowed to benefit from access to state-controlled resources whereas the ‘non-committed bazaaris’ were left to fend for themselves. Furthermore, the dominance of the Bazaar was also undermined by the redistributive policies of the Islamic Republic (contrary to the Shah) and the state’s desire to control production and support low income strata through tentative and instable policies. This took place through the mushrooming of various state institutions and organisations after the 1980s.

On the other hand, a number of committed bazaaris went on further and directly entered the political sphere by taking part in parliamentary elections and starting the Islamic Coalition Society. Furthermore, one of the prominent figures of bazaar, Habibollah Asgaroladi, was straight away put in charge of the ministry of commerce in 1980. While the main economic function of bazaaris is mercantile operations, ruling them out simply as middleman would be an understatement. The participation in the revolution resulted in an even stronger sphere of influence for the 'committed bazaaris' in different offices which guaranteed their interests in the face of statist policies of trade nationalisation advocated by a separate faction at the onset of revolution. It guaranteed various profitable trade contracts and licenses for the (committed) ones in return for their allegiance and often charity spending for building mosques and other community projects (Abrahamian, 2008).

## 3.7 Conclusion

In this chapter we have provided a perusal of the key political economic factors in Iran's recent history. By exploring the power structure before and after the revolution we demonstrated the importance of political distribution of power which has been maintained with reliance on oil in both periods. Nevertheless, the nature of power structure in the two epochs is considerably different. During the Shah's reign power and decision making solely revolved around him. After the revolution, despite the supremacy of the Leader above all institutions there exists a considerable amount of heterogeneity among different groups active within the accepted circle of the regime. Looking at the Constitution we argued that this polycentric characteristic of post-revolutionary Iran was encouraged by the provision of duality in the obligations and oversight of institutions and councils. We briefly reviewed the turbulent three-decade political history of the Islamic Republic and identified the main influential factions and showed how throughout time their ideologies and vested interests constantly redrew the lines between allies and rivals.

To see the practical implications of this complex picture and the interests of these various groups we looked at the key features in the economy. We saw that the public sector production has dominated the economy and due to protective measures it has prevented the flourishing of a healthy private sector. We discussed a distinctive feature of the Iranian economy, the quasi-public or parastatal organisations that due to their financial capabilities act as monopolies and are barriers to competition and openness. The monopolistic interests of the elite bazaaris in international trade and both wholesale and retail domestic market is protected by this structure and itself cements ties between different components of power. These different entities have often been the centre stage of political arena and means of factional competition.

This unique economic layout of public and semi-public sectors after the revolution has had important ramifications for the performance of the productive sector. Having been assigned key goals of employment creation, provision of goods and services and improving income distribution, these sectors have been receiving preferential treatment compared to the private sector for a long time. The existence of these unique economic agents highlights the importance of firms' ownership in our study of production performance in the following chapters. Furthermore, other aspects of state influence such as relative large size and small incentives of exporting in Iranian components of the economy are important hypotheses to be tested in our investigation of the manufacturing sector vis-à-vis the oil income. We will explain the precedence and prominence of oil income in the next chapter and will formalise our framework in the chapters after that.

# Chapter 4 Oil and the Iranian Economy

## 4.1 Introduction

In the previous chapter we emphasised the key political developments and the influence of political economic factors in the Iranian economy. Confirming some of the political explanations (discussed in Chapter 2) of resource dependent economies for the case of Iran we argued that this structure has survived with reliance on the flow of oil revenues. In this chapter we investigate the extent of this dependence. We provide a historical narrative on the growth trend and key features of Iranian economy with special reference to the role of oil. By revisiting the historical performance of the economy we investigate the role of oil in economic policy and more crucially attempt to verify the validity of the economic frameworks discussed in Chapter 2 (Resource Curse and Dutch Disease). We try to provide an explanation on the channels through which the oil revenues have alternatively played their roles based on the political economic structure discussed in Chapter 3. To this end, the role of oil revenues on the competitiveness and efficiency of the productive sector is investigated.

## 4.2 Oil and Growth in Iran

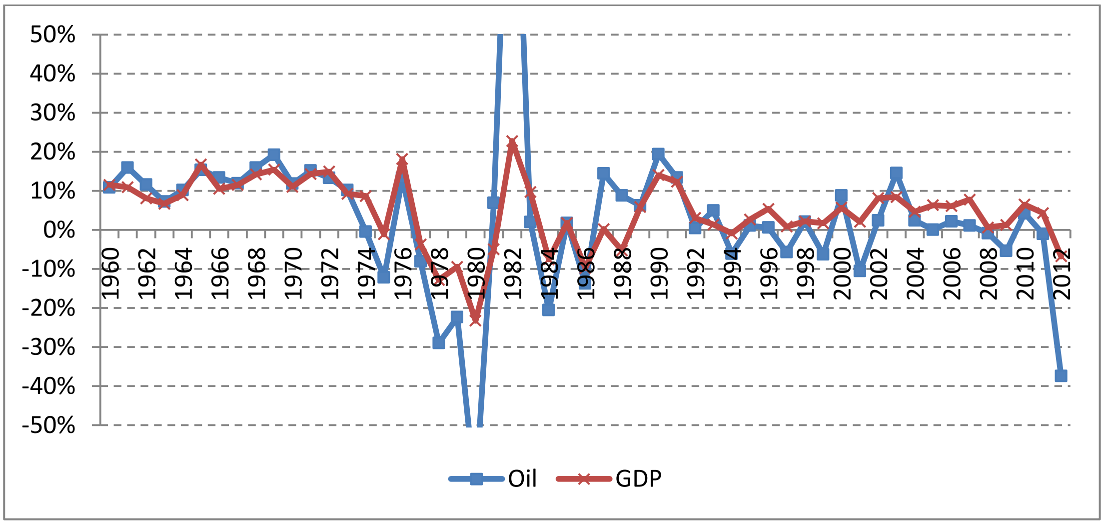
Whether a curse or a blessing, it is certain that the Iranian economy has for more than half a century been one that is heavily dependent on oil. It is clear that the oil sector has been the driving engine of Iran's economy. The government budgets and economic plans have long been closely intertwined with the oil revenues. Within the government budget there is explicit mention of the oil prices for the year and government finances are managed on the basis of this price.

As Karshenas and Hakimian (2005) demonstrate, there is a close relationship between oil export revenues and the real GDP figures for the majority of the last few decades in Iran especially after the revolution. This oil dependence can be clearly observed by looking at the differences between real GDP and oil annual[4] growth rates. Figure 4–1 highlights the close association between the output growth of the

[4] The data obtained from the Iranian sources such as CBI and SCI are reported according to the Iranian calendar. The Iranian calendar year starts on 20th March. As a close approximation, we convert the Iranian year to the Gregorian calendar year equivalent by adding 621 to the Iranian year.

oil sector and the growth rates of the Iranian economy. This graph clearly shows that contrary to the Resource Curse growth discourse, the relationship between oil and GDP growth rates are positive.

**Figure 4–1 Oil and GDP Annual Growth Rates, 1960-2011.**

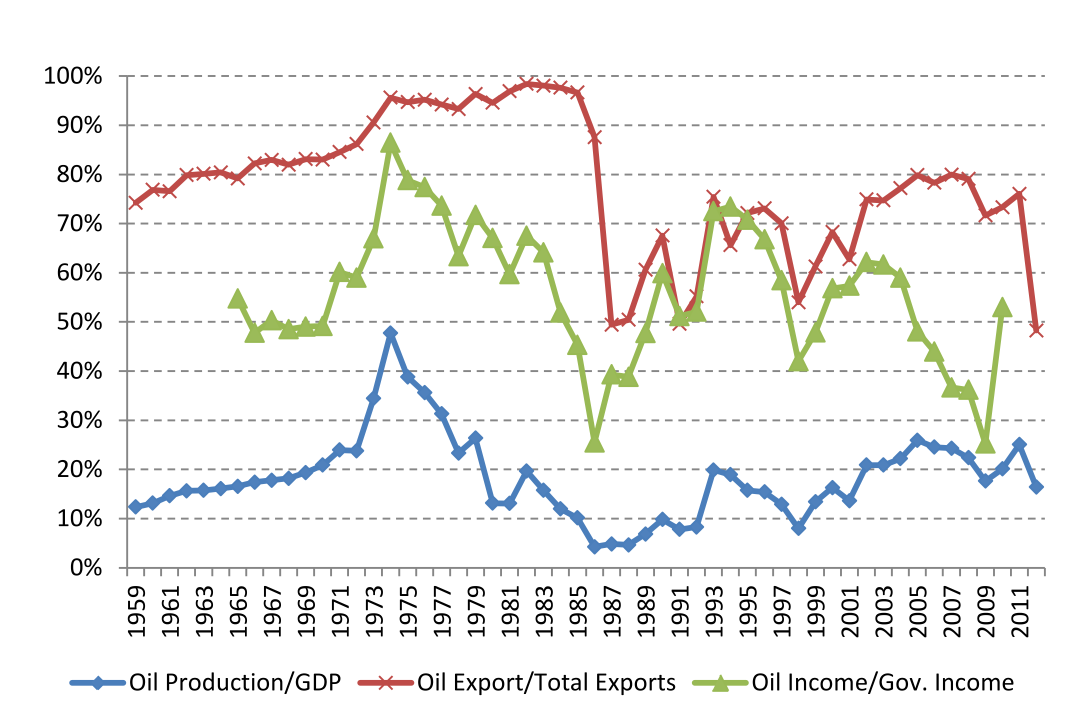



*Source*: Based on CBI (2014a).

*Notes*: * Real growth rates based on 2004 Rial prices.

We can also see in Figure 4–2 that, apart from the obvious decline in the revolution/war period, the share of oil in GDP has hovered around 20% and has not returned to its peak in mid-1970s of around 40%. Furthermore, the dependence of the economy on oil income as the biggest source of foreign currency is better understood by looking at its share in total exports (sum of merchandise and service exports). The figures are high in both pre and post revolution with averages of 85% and 74% respectively. This can be very problematic for the country and the government finances if this income becomes under threat such as in 2012 as a result of the sanctions a 37% decline in oil exports drops the oil export share to 48% for the first time in more than half a century. As expected the data also suggests that in the last four decades the biggest income source of the government has come from oil proceeds which on average have contributed to more than 50% of government annual income from 1965 to 2010. This constant share has been maintained in the post-revolutionary phase largely as a result of increase in the price of oil which has simultaneously countered the increase in consumption due to higher domestic consumption and a flat production trend after the war. This trend is in contrast to the pre-revolutionary one where the dominant engine of oil sector growth had been increase in production during the Shah era (see Appendix 2).

**Figure 4–2 Share of Oil in GDP Exports and Government Income, 1959-2011.**




*Source*: Based on CBI (2014a) and CBI (2014b).

The above observation is in line with a number of studies on the effect of oil income on the growth of oil exporting countries (e.g. Berument et al. 2010). Nevertheless, it has been argued that the relationship between oil income and output growth can be asymmetrically positive so that the extent of negative oil shocks might be more significant on average than positive shocks (Mehrara, 2008). These results are also confirmed in studies on the Iranian Economy which suggest a positive relationship between oil income and the overall growth of the Iranian economy (Farzanegan and Markwardt, 2009; Emami and Adibpour, 2012). In a recent study, Esfahani et al. (2013) study the effect of one standard deviation positive shock of oil revenues in the Iranian economy employing a General Impulse Response Function. They report that a shock equal to one standard deviation of oil revenues, despite putting upward pressure on prices and real exchange rate, can also lead to an increase of real GDP by 3.2%. These findings similar to our observation above provide empirical evidence contrary to the interpretation of oil abundance as a Resource Curse.

It is worth noting that most studies here focus on the growth aspect and largely avoid the development question. Thus, it is important to bear in mind the subtle difference between economic growth and economic development when interpreting these results for the case of Iran. Identifying the optimal course of action and utilising resource revenues (oil revenues in this case) is crucial to the developmental trajectory of the country. The strategy that a country undertakes in managing its resource revenues can have a great impact on macroeconomic indices such as the national savings ratios, unemployment figures and the long-term GDP trend.

### 4.3 Oil and Volatility

Having investigated the extent of the reliance of the economy and the government on the oil revenues it would be reasonable to argue that any source of volatility with regards to this source of income could pose serious challenges to the economy. This negative potential would materialise as a big problem only if the government expenditure was to be pegged to this oil income. In other words, while commodity prices 'naturally' tend to be volatile, it is the manner in which income from oil is incorporated in to the fiscal and monetary policies of the government that can either transform it to a curse or a blessing.

In their study, Mohaddes and Pesaran (2014) compare the extent of volatilities in the price, production and revenue of oil in the recent history of Iran. They report that in the period between 1960 and 2010, the highest volatility is for that of oil revenues followed by production and prices respectively. Their findings suggest that all three indices of volatility have increased through time. Prices have become more volatile due to the big oil multinationals gradually losing their hold on prices from 1950s, the collapse of the OPEC pricing mechanism in 1985 and a number of price shocks. They also suggest that the upward volatility in oil production is largely witnessed after the revolution due to the war with Iraq, the intentional halving of oil production as an agricultural production stimulus and more recently the lack of investment in oil projects due to sanctions imposed by the West. The compounding effect of these two components has led to an even more volatile oil revenue trend. While they demonstrate a positive association between oil export revenues and real growth (similar to Esfahani et al., 2013), they find a negative relationship between oil revenue volatility and real per capita GDP growth. Therefore, the volatility argument seems to be a more plausible proponent of the Resource Curse rather than the growth regressions of Sachs and Warner (1995) and others.

Consequently, as a first step, it seems necessary for countries such as Iran to improve the accountability and transparency of the government with regards to oil revenue through improvement in institutional quality and macroeconomic prudence. More crucially, they should also devise additional mechanisms to immunise the country to the negative effects of the tentative nature of oil income. The concept of sovereign wealth funds (SWFs) has been around for a long time. Examples of such funds include, Kuwait Investment Authority (founded in 1953), Abu Dhabi Investment Authority (founded in 1976) and Norway's State Petroleum Fund (founded in 1990). These funds act as a cushion to oil price and income volatility and their resources are often used to finance infrastructural and long-term investment projects. Due to the procedural and statuary requirements that have to be fulfilled in order to use the funds this mechanism acts as a screening tool of withdrawn amounts.

Despite the relatively long history of oil in Iran, the Iranian state has only recently followed suit and implemented SWFs in managing oil and gas revenues and the subsequent investment in the economy by inception of the country's oil fund for the first time in 1999. The fund has witnessed a number of amendments in its definition and regulations in its relative short life. Initially named the Oil Stabilisation Fund (OSF) it was introduced in the reform period of Khatami in 2000. The objective of this fund was merely to act as a reserve 'account'. It mainly served the purpose of using half of surplus revenues accruing from oil to cushion the volatility impact of these revenues on the government finances. The other half was earmarked for provision of loans to the private sector. In practice, the Treasury was allowed to withdraw funds if the oil revenues fell short of the projected budget values in order to meet its targets. This was due to the fact that the OSF was not integrated into the general budget of the country and, as such, has enjoyed relatively less regulatory scrutiny.

Under article 84 of the Fifth Five-Year Development Plan the OSF was almost entirely replaced by the National Development Fund (NDF) in 2011. The NDF has been established with broader objectives such as boosting private sector role, increasing overall productivity of the economy and maintaining the benefits of the oil wealth for future generations. The NDF obtains a minimum of 20% of the oil revenues based on budget predictions of the price of oil. Furthermore, each year this share is planned to increase by an additional 3%. However, if revenues were to exceed these predictions, 85.5% of this income is additionally transferred to the OSF from which half of the balance of this account is transferred to NDF (IMF, 2011). The other sources of income of the fund include interest from central bank and other interest returns from projects that have the fund reserves. The reserves of the fund can be used for production loans to private entrepreneurs and non-governmental public institutions, loans to customers of Iranian produced goods and investment in foreign markets, but it cannot be used to buy capital assets or to payback government debts.

The fund is not a subset of the ministry of Finance directly, but it is governed by a board of trustees who are senior members of the government including the president, ministers of oil, finance and labour. The board of executives conducts the management of the fund projects and its members are chosen by the president. There also exists a board of supervisors who are responsible on overseeing the fund activities and its progress towards the defined goals. In 2011, the fund revenues was valued at $24.4 billion (Heuty, 2012), $35billion in 2012 and estimated to be around $50 billion by early 2013 (George, 2012). Recently the head of the fund has confirmed the total inflow figure to the fund from its inception to mid-June 2014 to be around $64 billion (ISNA, 2014).

An additional factor regarding the establishment of the NDF is its role in the political infighting of various groups and factions within the state. For instance, the change of organisational structure of the OSF to NDF was ratified based on the recommendation of the Expediency Council (headed by Rafsanjani). This change was enforced in order to rein in the spending spree of the government and implement tighter controls on the flow of funds. On the political side, this was also testament to increasing frictions between the Ahmadinejad’s government and other factions especially in the final years of his presidency. Thus, in a number of instances rather than acting as a stabilising institution the fund has been changed and amended according to the power struggles inside the country. This highlights how the channels of oil revenues entering the economy can be heavily influenced by various groups in the political structure of the regime (as discussed in Chapter 3). It is clear that the presence of such political influences can determine, for example, the allocation of loans to firms that might not utilise these funds correctly or get them used to cheap credit and affect their production habits. These observations are important in reference to the framework we will employ for investigating the oil question and will be further explored in the following sections.

## 4.4 Oil and Trade Policy

As with all other aspects of economic policy in oil economies, their trade strategies are also largely determined, for good or worse, by the presence of proceeds from oil exports. The inherent characteristics of oil income, such as their denomination in dollars, can have implications for an oil exporter. One negative channel is the consequence of the Dutch Disease. It can be argued that the influx of foreign currency revenues leads to an appreciation of the national currency, leading to a contraction of other exports and can possibly increase the reliance on relatively cheaper imports (Amid and Hajikhani, 2005). Alternatively, the oil income could lead to the expansion of domestic demand and further pressuring the government to forgo policies of investment in manufacturing exports and rely on imports (Kavoussi, 1986). This contradicts objectives such as export promotion and strengthening of the state’s trade balances and extending backward linkages in the economy.

However, oil could potentially play a positive role in the sense that it can provide means of reducing the period of protection needed for domestic companies to become more competitive by expanding infrastructures and human capital. Other implications of the presence of resource funds for the government can have dubious effects. For instance, the availability of oil proceeds can prevent the need for foreign loans and the consequent large interest costs but at the same time it may be used as collateral for securing larger loans. Both instances can entail serious implications for the country’s national currency and consequently for volumes and directions of trade.

Moreover, while the presence of oil revenues allows the government to subsidise production and avoid the negative attributes of trade policies (such as tariffs and quotas) could ironically lead to production becoming over reliant on these transfers and further prolonging the need for government protection policies. This also means that with the increase in government's fiscal spending alongside the buoyant domestic market the result could well be that even though imports increase and industrial export is inhibited, the growth of the manufacturing sector might not be negatively affected in light of production subsidies (Kavoussi, 1986).

The oil income has strongly influenced the import and export behaviour of the Iranian economy. The government's trade policy changes have had a close association with variations in oil income receipts. Even though according to World Bank data the measure of trade openness in Iran is below that of the MENA average, at times instead of relying on oil money to import intermediary goods needed in production, it is spent on current expenditures such as imports of food. This is confirmed by the measured tariff restrictions index of trade for agricultural goods being half of that for non-agricultural goods (World Bank, 2009). This is not to say that the agriculture sector does not receive any protection from foreign competition since from time to time policies of self-sufficiency in produce such as wheat has been pursued due to populist intentions. However, these attempts similar to policies for the industrial sector have only had short run effects and significantly negative long run impact. For instance, the over-usage of groundwater and inefficient irrigation techniques has made water shortage as one of the biggest challenges to the country.

During the pre-revolutionary period there seems to be an overwhelming evidence of import-substitution policies with various forms of intervention including various tariffs and quotas. Additionally importers were obliged to pay commercial benefit tax, municipal tax and port tax (Amid and Hajikhani, 2005). The composition of imports was mainly geared towards the imports of intermediary and capital goods for the industrial sector. This partly inhibited greater forward and backward linkages due to the presence of cheap oil based credits and employment of heavily capital-intensive technologies that were dependent on such imports. These policies soon changed with the hike in oil revenues in the mid-1970s and a larger proportion of consumer goods took the place of capital goods in government import expenditures. On the other hand despite some tax exemptions for exporters the main non-oil exports even until 1978 remained to be agricultural and traditional exports such as carpets (Amid and Hajikhani, 2005).

After the revolution, the government initially followed strict protectionist policies based on political and ideological goals of self-sufficiency and achieving independence from foreign powers. These measures were further strengthened due to the problems in the first decade of the revolution and the Iraq war. However, in the 'reconstruction' period after the war the government exercised gradual liberalisation policies. These movements came to an abrupt end after the balance of payment crisis of the 1993–4 due to a slump in oil prices and the devaluated Rial (Esfahani and Pesaran, 2009). This pattern was repeated in subsequent years with the fluctuations of the oil income such as the sharp rise of oil prices in 2002.

The oil revenue has not been adequately utilised by the state in order to pursue a more export oriented industrialisation policy. Thus, the state has forgone the important goal of increasing the domestic production's competitiveness. Measures such as export diversification not only can reduce the dependence of the economy on oil but it also can foster other economic goals such as alleviating the problem of unemployment. However, the problem of large endowments of public and quasi-public sectors has been the main drawback of these objectives. In the quasi-public sector, the bonyads (especially IRMF) have been actively engaged in foreign trade (Maloney, 2000). Moreover, it is reported that in pursuit of obtaining an additional source of income, the IRGC engages in smuggling goods through unofficial ports (Wehrey et al., 2008). On a number of occasions these operations have even been contested by some of the country's notables, including Ahmadinejad in the latter part of his tenure after falling out with the traditional hardline factions. Thus, the vested interest of these entities in foreign trade while partially justifiable in the war period obviously undermines the planning and implementation of appropriate trade policies by the government.

More recently, the escalation of economic sanctions due to political pressure from the United States government over Iran's nuclear programme has severely disrupted imports and exports from various dimensions. In addition to putting pressure on the oil revenues, sanctions on the Central Bank of Iran has meant that the country has seen its connections to the world banking systems almost entirely severed. These restrictions and the resulting collapse of the exchange rate[5] have made receipt and

[5] See Habibi (2014) on a timeline of recent sanctions and exchange rate trend.

payment of revenues and expenses in dollars literally impossible for businesses. This has meant that on many occasions the government itself has pursued bartering transactions with countries such as China, India and Thailand.

There is no doubt that the inappropriate and inconsistent trade strategies alongside political impediments to trade in the Iranian context have caused short term costs to the economy. However, more crucially these factors have contributed to long lasting effects on production structure, especially in the industrial sectors, both in terms of machinery and production techniques. Subsequently, in this setting the emergence of a strong and competitive private sector that can replace the public sector production and compete with foreign imports is a remote possibility.

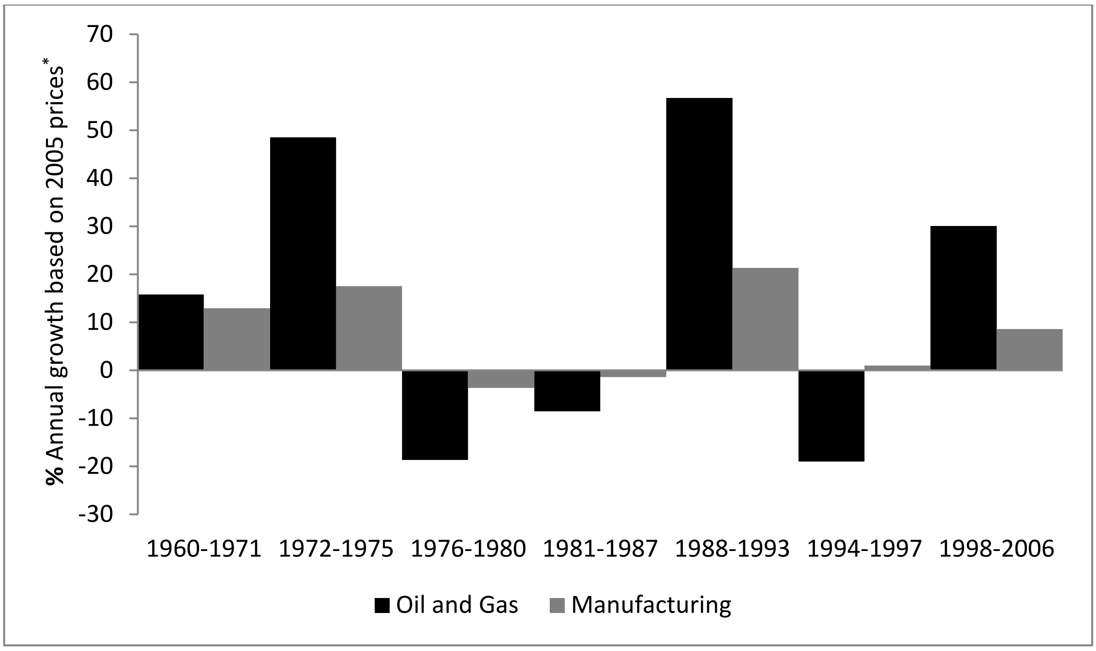
## 4.5 Dutch Disease in Iran?

To analyse the performance of the manufacturing sector in light of the oil revenues and the above factors we investigate the historic performance of the oil and manufacturing sector and assess whether or not the Dutch Disease framework which was discussed in Chapter 2 is even applicable in the case of Iran.

We argue that what the Iranian economy experienced has been the opposite of the Dutch Disease predicted outcomes. This is not to say that the Dutch Disease mechanism is negated but rather it is simply inapplicable in the case of Iran since the assumptions of the Dutch Disease model are not satisfied. As discussed in Chapter 2, a crucial assumption of Dutch Disease is assuming a small open economy. This assumption does not hold in the pre and post-revolutionary phase due to the various state implemented tariff and non-tariff protections of manufacturing sector which has transformed it to more of a non-tradable sector than a tradable one. Furthermore, government interventions by controlling wages and prices with the help of the oil revenues themselves violate other assumptions of the Dutch Disease framework.

The majority of the historic GDP trends by sector do not indicate a negative relationship between oil and gas revenues and manufacturing production. Taking a closer look at macro data in different sub-periods, we can shed light on the state of affairs of the manufacturing sector vis-à-vis the oil sector (Figure 4–3). A clear positive correlation between the growth figures of the two sectors is visible throughout the seven sub-periods covered. In the first sub-period which shows the years prior to the main oil boom, there is a steady growth in manufacturing with a slightly stronger increase in the oil and gas sector. The subsequent oil boom in the 1970s is accompanied by an increase in the manufacturing sector presence. However, as the boom finishes so does the growth in manufacturing until the revolution in 1979. The war period (1981-1987) continues with negative growth indicators for both sectors. However, again with the next oil boom the manufacturing sector rises into the green, thanks to the surge in oil revenues in late 1980s and early 1990s. The two periods of ‘construction’ (1994-1997) and ‘post-construction’ (1998-2006) similarly show the strong effect of the oil revenues on the manufacturing or ‘tradable sector’ in a positive way rather than what is put forward by the Resource Curse literature and the Dutch Disease in particular. Overall, the manufacturing sector expands with oil booms and production slows as the oil revenues decline.

**Figure 4–3 Oil and Manufacturing Sector Growth Patterns, 1960-2006.**




*Source*: Based on CBI Data (2011).

*Notes*: *Deflated by CPI index in 2005.

Apart from the above discussion, even if we hypothetically assume the conditions for Dutch Disease to be valid, the limited nature of this framework due to its short run scope deems it inapplicable to the case of Iran. The one-off influx of revenues, which is the mechanism that the model relies upon, applies for a country with limited oil reserves and thus does not provide a long run solution for the case of a major oil exporter such as Iran (Mohaddes and Pesaran, 2014).

The interaction between the industry and oil sector warrants a closer examination for the context of Iran. Below, we will explore the undercurrents of the manufacturing sector performance more closely by looking at the historical trend in labour productivity, wage and profitability of Iranian manufacturing. These indices will provide us with an alternative explanation since the Dutch Disease cannot be applied.

### 4.5.1 Labour Productivity, Wages and Manufacturing Markups

Under the Dutch Disease paradigm it is suggested that oil revenues cause deindustrialization in the manufacturing sector. The reason for this is the lack of competitiveness of manufacturing firms compared to their foreign counterparts due to wage increases induced by the oil income. In order to provide a framework regarding how the violation of the Dutch Disease model assumptions has meant that its prediction fails to materialise in the Iranian economy, we look at manufacturing production more closely. This way we can appreciate the adjustments of the economy's composition and study how price markups are influenced in the Iranian economy. To this end we can rely on the decomposition of manufacturing output value. Under a basic markup pricing setting we can formulate the relations between labour productivity, wages and outputs as below:

$$P.O = (1+\pi)(W.L + p_m.m) \tag{4–1}$$

Here $O$ is the quantity of output, $P$ is the price of manufactured output, which is set by global markets, $p_m$ and m are the price and quantity of raw material and intermediary goods, $W$ and $L$ are aggregate manufacturing money wage and employed labour and $\pi$ is the producer's markup. We divide both sides of Equation (4–1) by the output value we have:

$$1 = (1+\pi)\left(\frac{W.L}{P.O} + \frac{p_m.m}{P.O}\right) \tag{4–2}$$

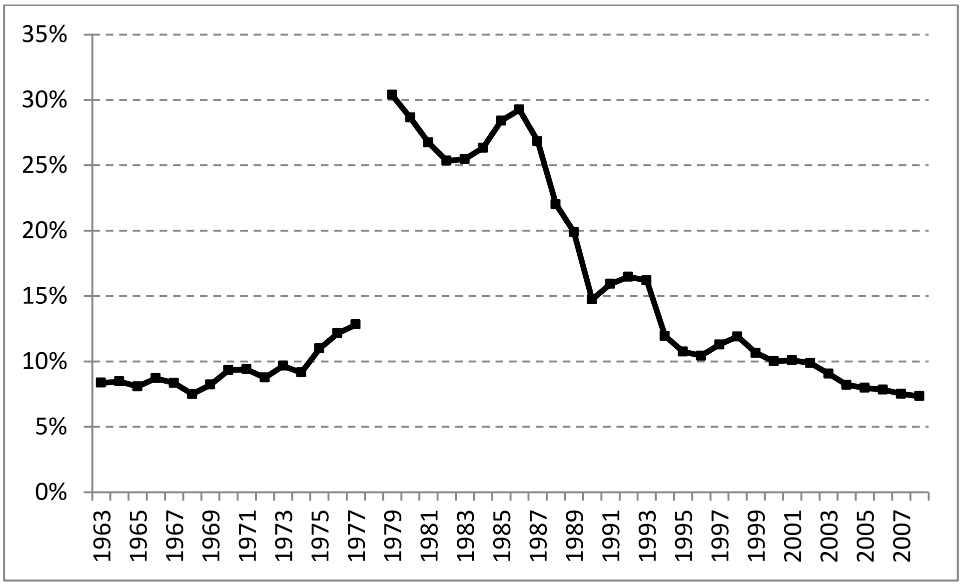
The LHS of the Equation (4–2) is a constant and thus we can analyse changes in the RHS more conveniently. In order to see labour productivity explicitly, we can divide both the numerator and denominator of $(W.L)/(P.O)$ by $P.L$. We would then have Equation (4–3) as below:

$$1 = (1+\pi)\left(\frac{\frac{W}{P}}{\frac{O}{L}} + \frac{p_m.m}{P.O}\right) \qquad \textbf{(4–3)}$$

We can see the results of a simple interpretation of Dutch Disease through this relationship. An oil-induced increase in money wages will lead to a drop in the profits ($\pi$), when all other factors are constant. The important issue here is that this is just one scenario out of many. This equation clearly shows other channels through which manufacturing profitability can be influenced. When other factors are not constant, the outcome of an oil boom for the economy might be different and an increase in money wage does not necessarily reflect a drop in profitability of the manufacturing sector. One possible scenario could be that if at the same time labour productivity increases, it can offset the downward pressure on producers' margins. As discussed in Chapter 2, labour productivity can increase due to employment of productivity enhancing machinery or the exit of less skilled labour from manufacturing into other sectors such as services. An alternative scenario could be that the share of intermediate goods in total output might be reducing due to improvements in technology or worldwide commodity price fluctuations.

The above relationship shows that not only the profitability of manufacturing necessarily needs to decrease but it may well be that it can more than offset the downward pressure of wages on profits and increase their margins with various protection measures provided by the government. Below, we will take a closer look to see what explanation seems to be more plausible by looking at the components of Equation (4–3) in the case of Iranian manufacturing.

**Figure 4–4 Wage Bill to Total Output ratio of Iranian Manufacturing, 1963-2008.**




*Source*: Based on UNIDO (2013).

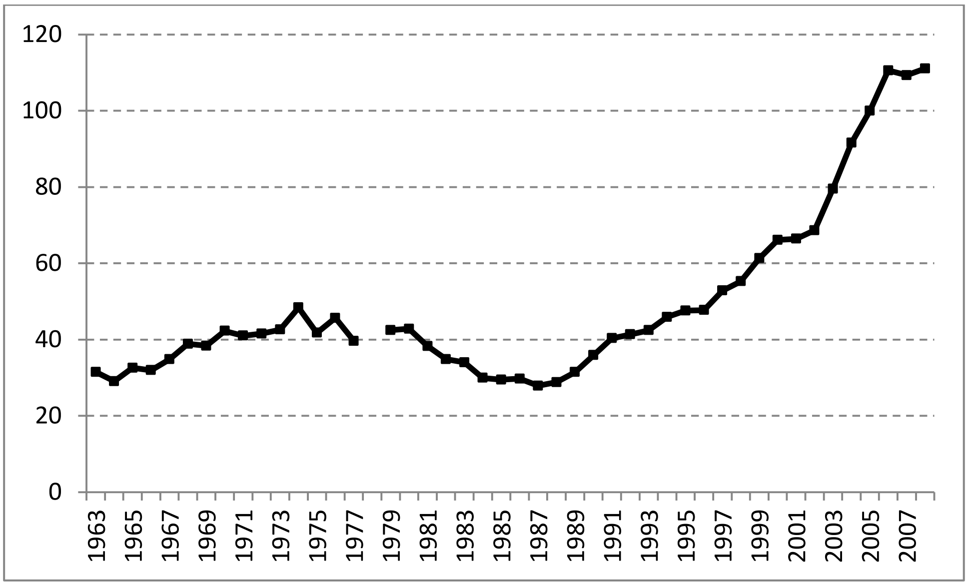
The empirical evidence in Figure 4–4[6] shows that despite short-lived upward trends, the share of wage bill in total output had a mild upward trend prior to the revolution but was predominantly on the decline in the Iranian manufacturing sector after the revolution. This graph also highlights the anomalies of price structure and the importance of wage bill in the period immediately after the revolution and during the war which was possible following the nationalisation of industries and control of production.

As we showed before, the wage bill share is equivalent to the ratio of product wage ($W/P$) to labour productivity ($O/L$). The above graph confirms that this ratio has mainly had a decreasing trend after a sharp jump right after the revolution. To further study this dynamic, we can compare the labour productivity trend vis-à-vis the product wage behaviour separately in Figure 4–5 and Figure 4–6. Looking at Figure 4–5 it can be observed that in the decade before the revolution (1968 to 1977) labour productivity had a mild increasing trend of 1.7% annually compared to the high growth rate of 6.6% on average in the years between 1995 and 2008. In other words, labour productivity growth in the 1970s was almost half the rate of growth in the post-war phase. However, according to Figure 4–6, the product wages growth trend is exactly the opposite when comparing the situation before and after the

[6] See Appendix 3 for more details on calculations for Figure 4–4, Figure 4–5, Figure 4–6, Figure 4–7 and Figure 4–8.

revolution. The product wage index witnessed average annual growth rate of 6.2% prior[7] to the revolution and 3.1% post-1995.

**Figure 4–5 Labour Productivity Index in Iranian Manufacturing, 1963-2008 (2005=100).**

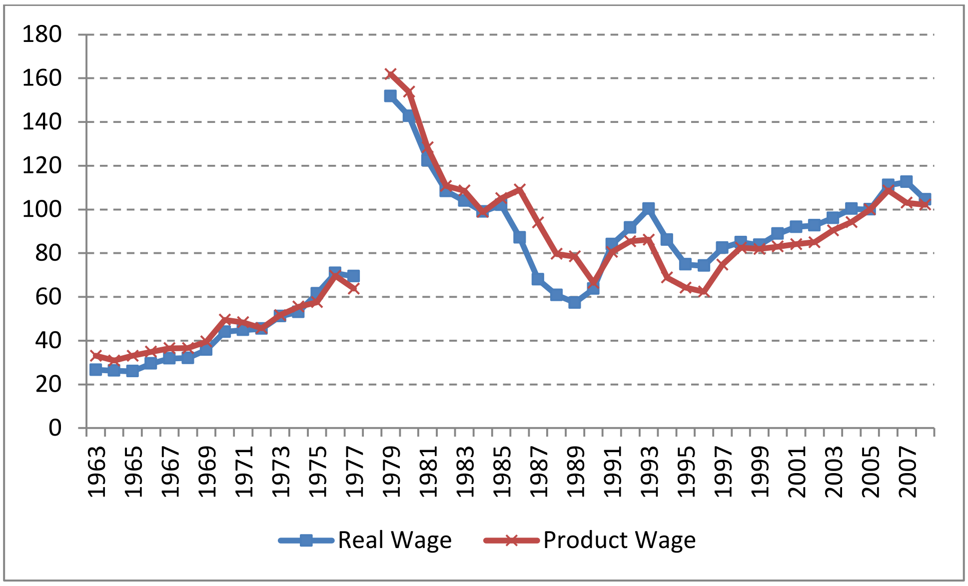



*Source*: Based on UNIDO (2013) and CBI (2013).

Thus, the data on the growth rates of product wage and output growth can explain how their ratio moved in these periods. Comparing the two indices of product wage and labour productivity we find that after the revolution, post-war product wages increased at a much more moderate pace compared to labour productivity. This has led to a drop in the ratio of product wage to labour productivity especially after the revolution. As a consequence, and as we saw earlier, the trend in Figure 4–4 is downward in this period. Based on the same analogy, the mild upward trend in the ratio illustrated in Figure 4–4 for the period prior to the revolution can be explained by the slower growth of labour productivity (the denominator) compared to product wage (the numerator).

[7] The underlying reason for the increasing trend in labour productivity especially after 1997 (Khatami's first term) can be summarised in three main explanations. First, thanks to increase in oil prices the government had managed to weather the balance of payment crisis of the earlier period during Rafsanjani's second presidential term, in the early 1990s. This resulted in easier availability of inputs and raw material for production. Second, the easing of the credit constraint problems also stimulated demand and allowed the utilisation of excess capacities in the economy. Third, we can see that during this period investment in the entire economy (gross capital formation) grew at an average rate of 6% annually.

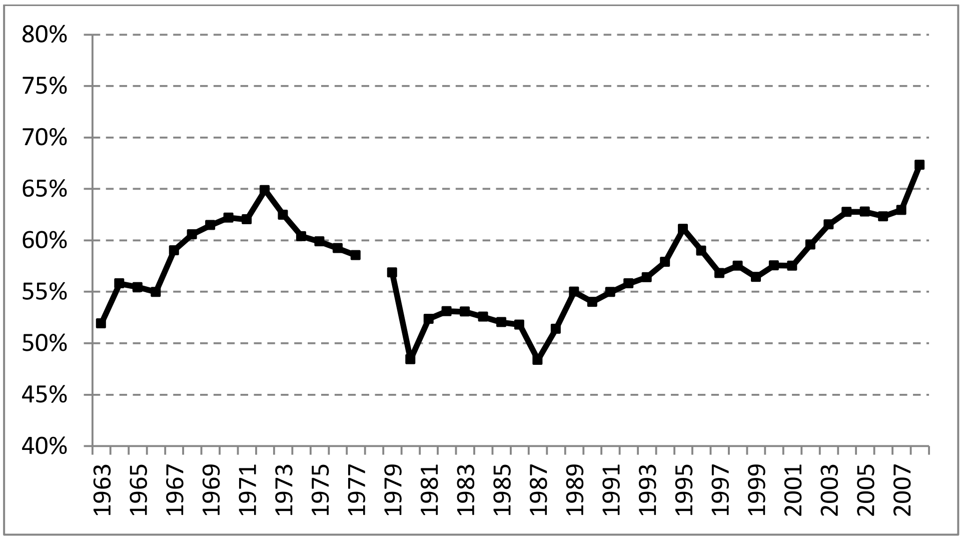
**Figure 4–6 Iran's Manufacturing Product Wage and overall Real Wage, 1963-2008 (2005=100).**




*Source*: Based on UNIDO (2013), World Bank (2013) and CBI (2011).

On the other hand, Figure 4–7 shows the trend in the other component of the markup relationship discussed in Equation (4–3). Here the share of intermediate goods in total output displays a relative flat trend (apart from a drop in the war period falling below 55%) and has been hovering around 60% up to 2007. Consequently, based on the markup relationship, the profit margin has been on the increase in the period after the war with Iraq. This can explain why despite increase in oil prices and the consequent high wage share immediately after the revolution, profit margins may have not necessarily shrunk.

**Figure 4–7 Share of Intermediate Goods in Output of Iranian Manufacturing, 1963-2008.**

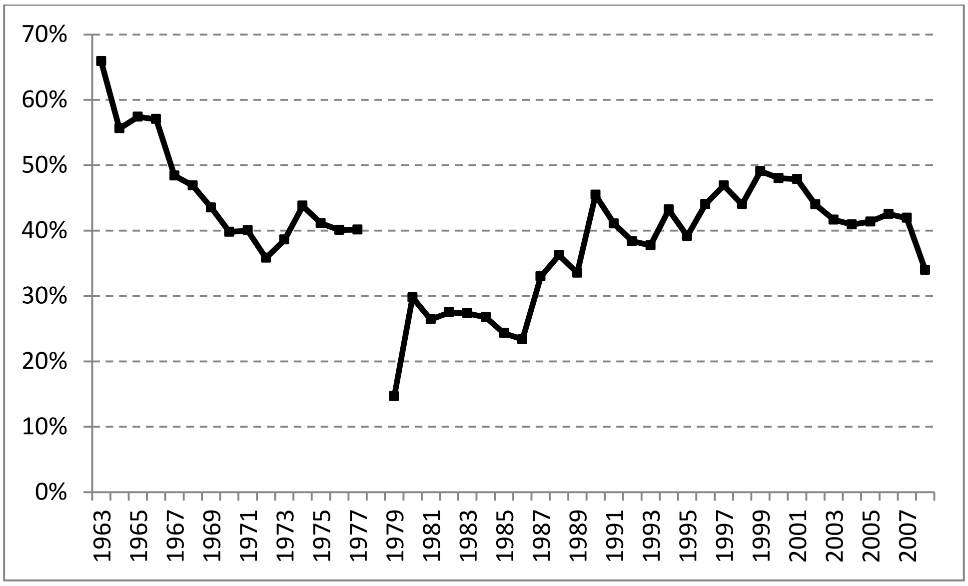



*Source*: Based on UNIDO (2013).

To see these developments more explicitly, the markups have been calculated from the identity relationship and illustrated in Figure 4–8. The aggregate markup of the manufacturing sector in the pre-revolutionary period shows a declining trend (except early 1970s) whereas in the post-revolutionary phase the trend up to early 2000s has been mainly an upward one. This highlights the effect that the increase in labour productivity has had on the profitability of the manufacturing sector.

Looking at the fall in labour productivity in the 1980s we can conclude that the product wage increase in this period was not economically viable for the producers. Despite these wage rigidities, the generous subsidies provided to these industries allows the profit markup to only fall to an average of 28% from 46% prior to the revolution. To see the extent of the help provided using Equation (4–3) we can calculate that the markup should have fallen to 17%, had the share of intermediate goods' bill not fallen. This was also welcomed by the workers as it translated to a real wage increase in their payroll.

**Figure 4–8 Aggregate Markup Trend in Iranian Manufacturing, 1963-2008.**




*Source*: Based on UNIDO (2013), World Bank (2013) and CBI (2011).

Furthermore, we see a much higher correlation coefficient (-0.73) between wage shares and the profit margin compared to intermediate goods bill and profits (0.06). This highlights the role that factors affecting productivity have on how oil income can determine the survival of manufacturing firms.

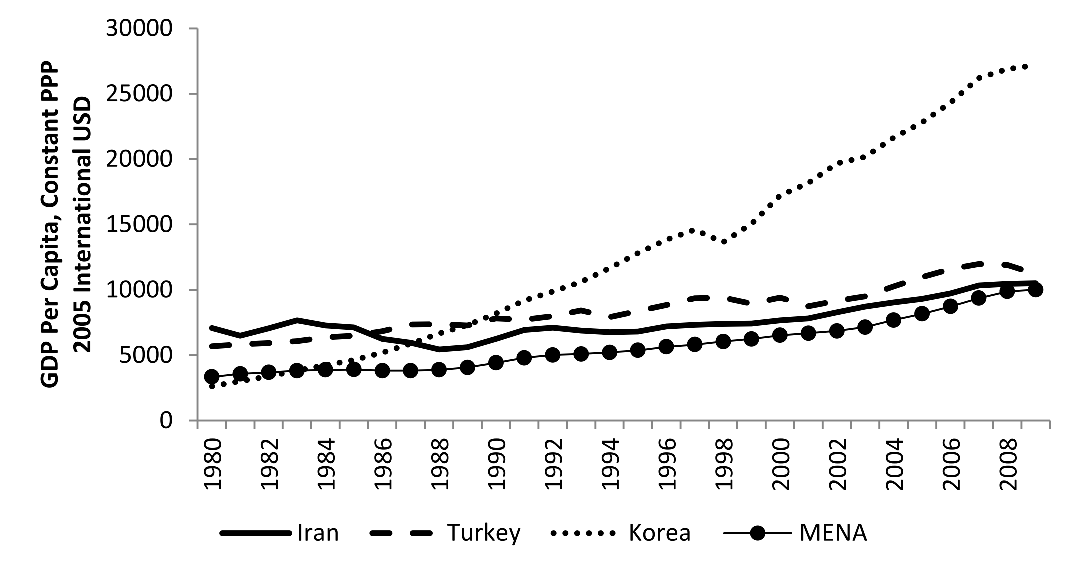
Our empirical findings show that the oil revenues through state interventions have distorted the wage price relationship. More importantly, this begs the question that what effect such provisions of cheap inputs may have had on altering the efficiency of industrial production itself and artificially preventing the markup from falling when oil income is available. Thus, the role of the state and the economic policies undertaken by it means that a number of Dutch Disease assumptions such as flexible prices and open economy assumption are violated which deems the standard Dutch Disease explanation seem irrelevant in this context.

We have explicitly only looked at one aspect of productivity, namely labour productivity. We will then investigate how efficiency and productivity of the manufacturing sector has been influenced by the oil income. This will provide the foundation for an alternative hypothesis with regards to the relationship between oil revenues and economic success of an oil economy such as Iran. Obviously, assessing the overall productivity of production and its determinants such as capital stock and human capital would provide a more comprehensive picture on the performance of industrial production. In order to investigate this issue further and evaluate other contributing factors to manufacturing productivity, in Chapter 5 we will look at a broader measure of productivity, namely total factor productivity.

### 4.6 Oil and Efficiency in Iran

As mentioned in Chapter 2, oil money can have both direct and indirect consequences for the productive performance of a country. In order to see the consequences of oil on the efficiency of the Iranian economy it would be useful to look at the relative position of Iran and countries such as Korea and Turkey. These two countries managed to overtake Iran thanks to increase in their performance levels despite being net energy importers (World Bank, 2013). Figure 4–9 shows the comparison between per capita GDP of the three countries and the MENA average. It clearly depicts the dismal growth performance of the economy relative to Korea in the past three decades despite its initial superior position. It also shows that Iran’s per capita growth never recovers after Turkey overtakes it in the mid-1980s and furthermore its gap with the MENA average shrinks.

**Figure 4–9 GDP per Capita of Iran, Turkey, Korea and MENA-Average, 1980-2009.**




*Source*: World Bank (2013)

As discussed earlier, the presence of oil income has affected the trade strategy of Iran and consequently the incentives of different sectors of the economy. As Hakimian and Karshenas (2000) observe, both Korea and Turkey followed similar import substitution policies as Iran until the mid-1960s when Korea started adopting the export promotion strategy thanks to its abundant skilled and well-educated labour force. In the late 1970s Turkey also initiated the adoption of its manufacturing exports promotion strategy. These measures resulted in higher productivity growth rates and manufacturing wages in Korea and Turkey in this period due to cumulative learning effects of manufacturing export orientation and increases in technological sophistication. The experience of these two countries is in line with the neoclassical trade literature regarding the positive effects of trade liberalisation on productivity and efficiency. Studies such as Corden (1974) and Krugman (1986) among others emphasise that through specialisation, market widening and division of labour that is brought about by international trade, the economy can improve the efficiency of resource allocation. Grossman and Helpman (1991) argue for swifter technical diffusion via foreign trade even for importing countries that import intermediate goods which either do not exist or are of lower quality in local market as it will ultimately enhance the productivity of their economies. Other studies such as Krugman (1987) and Lucas (1988) argue that the spillover effects from LBD of firms in the international markets such as the employment of new technologies and management techniques are also growth enhancing.

Despite attempts of trade liberalisation especially after the war and in the reform period the Iranian strategy remained far from satisfactory. Table 4–1displays a snapshot of average tariff rate in the three countries in 2007. It shows a much higher tariff rate in Iran for all three indices of manufactured, primary and total product rates. The manufactured products rate for Iran had been as high as 28.6% in as early as 2000 and has relapsed to 23.1% in 2011 (World Bank, 2013). The higher manufactured products tariff rate compared to primary products highlights a ‘protection trap’ that has damaged the flourishing of a strong manufacturing sector. It can be seen that this is the opposite for Korea and Turkey that have lower manufactured goods tariffs than primary goods. This has been possible due to establishing competitive production which was facilitated by initial limited protection. As a result, the domestic producers in these countries have managed to compete with foreign competition and reap the benefits of LBD and other spillover effects from trade openness.

**Table 4–1 Weighted Average Tariff Rate of Iran, Korea and Turkey, 2007 (%).**

| | Manufactured Products | Primary Products | Total |
|---|---|---|---|
| Iran | 18.47 | 15.36 | 17.55 |
| Korea | 4.8 | 11.47 | 8 |
| Turkey | 1.29 | 3.81 | 2.03 |

*Source*: World Bank (2013).

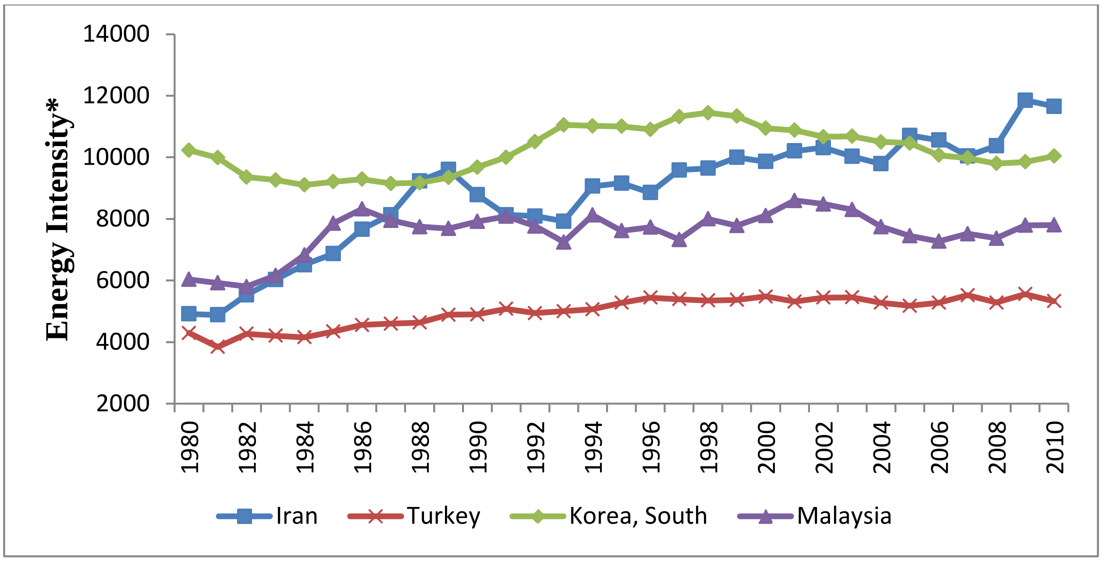
Looking at other measures of international business activity such as FDI (from UNCTAD, 2014) we can see that the Islamic Republic for the major part (1979 to 2000) has not had any meaningful inflows of investment. It was only after Khatami’s attempt of encouraging FDI that in 2002 it reached 2.6% of GDP. This was the highest share since 1973 but did not last long and dropped to 0.6% in 2013. For the major part, this can be attributed to political instability and the associated high risk which makes Iran unattractive for foreign investors. Obviously this has meant that the Islamic Republic has failed to engage in any outward FDI in return. As a result, additional benefits of this sort of international activity (compared to traditional trade) such as transfer of knowledge, employment and infrastructural investments have been forgone.

As discussed in Chapter 3, a key feature of the Iranian political economic structure has been the role of public and semi-public monopoly in production, distribution and trade activities of the economy. Employment, production and pricing decisions especially in the Islamic Republic seems to heavily depend on the state-owned enterprises and parastatals which, as discussed earlier, operate based on the political motives of the Iranian government. These enterprises at times have employed more than the optimum number they need and often pay wages higher than the market wages. Similarly, the pricing mechanisms are far from optimum and mainly attempt to satisfy the broader state objectives of securing loyalists to maintain support for the continuation of the ruling powers' ideology. The consequence of this type of economic behaviour has been the prevalence of inefficient public or semi-public institutions subsidised and supported by the oil revenues. In other words, it appears that the oil cushion not only misallocated the resources but more crucially shaped the industrial producers into technically inefficient producers.

The oil income has allowed the government to maintain this system and avoid dealing with the thorny issue of subsidies and transfers. Historically, the price subsidy is an issue going back to the pre-revolutionary period. However, since the early days of the Islamic Revolution these subsidies expanded and intensified due to populist promises of protecting the dispossessed and bringing the fruits of national oil wealth to people's dinner tables. For the majority of the post revolution period there has been wide scale subsidies for basic consumer goods, energy and utilities. This took the form of coupons for essential products in the war period and continued mainly through explicit price subsidies thereafter. Businesses were also entitled to various subsidies, cost exemptions and cheap credit by the state especially those with strong political ties in the government or other powerful factions. The consequence of such policies had been price-distortions, misallocation of resources and rent-seeking activities due to disincentives for more productive and efficient economic activity.

Production process has been far from optimal due to the protective subsidies that have been continuously injected into the Iranian economy. One example of these subsidies can be seen in the energy consumption behaviour in the Iranian economy. Figure 4–10 shows a more than twofold increase in energy intensity within the aggregate Iranian economy in the last three decades. This is in complete contrast to the global trend including in countries such as Korea, Turkey and Malaysia where the corresponding figures have been predominantly on the decline or stagnant due to the adoption of more energy efficient machinery and processes. This increase in intensity is despite the lower increase of per capita energy consumption in Iran (3.8%) compared to a country such as Korea (15.5%) in the same period (EIA, 2014). Furthermore, once compared with the trend of developed countries including United States and United Kingdom, which have witnessed a fall in their aggregate energy intensity (EIA, 2014), the Iranian energy usage seems to warrant drastic remedies.

**Figure 4–10 Energy Intensity Trend in Iran vs. Turkey, Korea and Malaysia, 1980-2010.**




*Source*: EIA (2014).

*Note*: * Energy intensity is measured as total energy consumption per GDP 2005 dollar using PPP.

With the growing domestic demand, the energy and other subsidies placed an enormous burden on government finances especially in years with lower oil income. The situation was further exacerbated due to the implementation of comprehensive and unprecedented economic sanctions by the United States and its European allies. This has recently compelled the government to reduce these subsidies. Thus, in hope of improving economic efficiency, a country-wide subsidy removal plan has been prepared and recently begun to be implemented. Under the 'Targeted Subsidy Reform' plan which was announced by Ahmadinejad in December 2010 and subsequently approved by Majles a large portion of price subsidies was planned to be removed gradually. On the consumer side, the plan is essentially a basic income scheme based on which the lower income deciles are reimbursed with direct cash payments. Based on the law, these payments should be financed through the revenues generated from the subsidies that previously accrued to the remaining deciles. However, the legislation does not stipulate the exact criteria of qualifying for these payments and only states that half of the revenue is to be paid back to households. The subsidy burden alleviated by the reform is reported to be $50-$60 billion. The reform plan intends to raise energy prices up to 90% of the Persian Gulf free-on-board prices in a period of five years (Guillaume et al., 2011).

The legacy of the reform is yet to be seen especially since the reform has not been completely implemented and a new president has already taken control. In an interview the new finance minister has indicated that the implementation of the second reform phase seems to be a rather remote possibility in the near future. Furthermore, soaring inflation and unemployment figures have often been attributed to this reform by other factions and economists. Despite all of these the idea of subsidy reform highlights the acknowledgement of the government that the oil dependence cannot continue for much longer and measures have to be taken to reduce the negative effects of oil revenues on the economy. We shall focus on establishing the significance of these drawbacks within this framework in the proceeding chapters.

### 4.7 Conclusion

In this chapter we examined the extent of oil dependence ramifications for the economic policy making and consequently the productive performance in the contemporary history of the Iranian economy. We provided stylised facts on the growth and the performance of the economy in different periods and drew upon the parallel political economic structure discussed in the previous chapter explaining these dynamics.

The observations provided attempted to ascertain the relevance of the theoretical frameworks discussed in Chapter 2 in the context of Iran. We showed that, contrary to the general Resource Curse discussion, the positive growths in oil revenue were mirrored by positive growths in the overall economy and vice versa. The high dependence on oil for as a source of foreign exchange and government revenues was also shown to continue even after the revolution. This in turn has influenced the trade policy and competition within the economy. Alternatively, we highlighted the role of volatility of oil revenues as a destabilising force in an economy highly dependent on this income.

Our analysis of the manufacturing sector's growth also confirmed a positive relationship between it and growth of oil income. Upon closer examination of Iranian manufacturing sector we looked at the role of labour productivity to explain why the Dutch Disease framework does not explain the Iranian predicament. The biggest components of the output value had consistently been the share of intermediate goods which was largely controlled by the government policies such as subsidies. Nevertheless, the profitability of the manufacturing sector was closely linked with the share of wages in total output value which had also been affected by government policies most notably in the war period.

We argued that labour productivity only explains part of the problem and as such we explored the negative aspect of productivity and efficiency of production in a broader manner. This channel of explanation has not been explored fully in this context. We argued that, similar to other oil economies, Iran has supported economic production mainly through public or semi-public production channels. While this satisfies a tighter grip over the entire economy for the state or serves as a means of power sharing between different interest groups, nevertheless, this could mean often non-economic goals might be given priority over the economic ones. In this setting the main policies such as trade policy of the country would be geared towards maintaining this control and presence of the public sector and further marginalisation of private production. The failure to liberalise the economy has also prohibited competitive production to flourish in the economy. Moreover, this can put rise to a great number of inefficiencies including in management, allocation of resources and other productive aspects of the economy.

Thus, it would be helpful to examine the dynamics of economic production throughout time and establish its relationship with the changes in oil revenues. This can be done by looking at the performance of the economy at the aggregate level. Once this has been achieved a more magnified picture would help connect the dots between the aggregate and disaggregate levels. The objective of the remaining chapters is to explore and empirically assess the situation in the context of Iranian economy.

# Chapter 5 Growth Trends and Industry Productivity of Iran

## 5.1 Introduction

In this chapter we examine the overall growth of the economy more closely. We review the literature regarding total factor productivity (TFP) measurement. Using the Solow method we attempt to dissect the overall growth of the economy into factor growth and TFP growth. Focusing on the estimated productivity measure, we try to explain the changes in the context of Iran's economic experience. We attempt to compare and contrast the results based on the key sub-periods stylised in the previous two chapters. In order to draw attention to the specific context of Iran we will repeat the exercise of TFP estimation for Korea and Turkey. Comparing the results we highlight the shortcomings in the Iranian development trajectory.

After that, we attempt to explore the importance of the industrial sector within the economic structure. More specifically, we assess the role of manufacturing sector in the economy. We investigate the structure of the manufacturing sector and review the performance of different subsectors in the past three decades. We try to explain whether the potential growth contributions of this sector have been realised in light of the presence of the public sector and government transfers.

## 5.2 Total Factor Productivity Measurement

In a nut shell, TFP can be explained as the other component contributing to output besides all other inputs. In other words, productivity change takes place when the change in the index of inputs is different than the change in the index of outputs (Kumbhakar and Lovell, 2000). The significance of productivity in the growth literature arises from the inability of achieving higher growth rates through solely increasing input usage. As a result, the focus has shifted towards the estimation of TFP and establishing its determinants in order to ultimately identify the sources of economic growth.

Thus, productivity enhancement has the potential to contribute positively to development and economic welfare. However, this does not necessarily mean that it always does so since the gains of productivity enhancement might not necessarily be allocated to other economically valuable activities such as leisure. Furthermore, from a more broad developmental point of view it can well be that economic or physical environment change (e.g. pollution) can counter the positive aspects of productivity (Griliches, 1998).

Various different methodologies have been used for the measurement of productivity, the earliest of which were only interested in creating an index reflecting productivity based on index number techniques. The key task in these researches is building an appropriate ratio of outputs to inputs. The benefit of such methods is that it avoids the estimation of a specific production function. Nevertheless, in order to obtain economically meaningful indices, a set of restrictive assumptions are needed. One index is the Tornqvist index which relies on the assumptions met in a Translog production function.

There are two other widely applied methods of productivity and productivity change estimation, namely regression based and growth accounting methods. The first method is based on the estimation of an aggregate production function via regression analysis. The idea here is that after obtaining a fitted model the difference between actual and fitted values would be an index of TFP. In other words, this way an explicit estimate of TFP levels (not TFP growth) is obtained. However, apart from the drawbacks of using an aggregate production function (discussed in the next section) the main problem here is that these estimates cannot be used to explain the source of TFP related output growth. Econometrically speaking, this would mean that the regression suffers from omitted variable bias, since if a determinant of output TFP must have been explicitly included as a variable. An equivalent version of such procedures is to regress output growth on factor growths such as the specification in Equation (5–2) discussed in the proceeding section. Here TFP growth would be reflected in the intercept of the fitted regression and the slopes would be the marginal products of inputs. Thus, the assumption of perfect competition can be relaxed. However, as Barro and Sala-i-Martin (2003) suggest, there are econometric problems such as endogeneity of input growth rates (both regressors) and inefficient slope estimates due to inherent measurement problems of capital stock and labour would defeat the purpose.

The second method or the growth accounting framework is based on the aggregate production function in Solow (1956) growth model (also referred to as Solow-Swan model) and was first introduced and empirically applied in Solow (1957). In this method productivity change is calculated from deducting the share of output growth due to change in inputs (normally, capital and labour) from total output growth. Hence, it is also referred to as the 'Solow residual'. We will discuss this in the following section and employ it in our analysis of Iranian TFP. As we will see later, this method relies heavily on a number of assumptions such as the presence of a well behaved differentiable aggregate production function. Furthermore, the competitive market assumption is required as a necessary and sufficient condition to make estimation possible (Jorgenson et al., 1987).

The measurement of TFP has widely been used to conduct cross-country and cross-industry comparisons of growth performance. However, as Abramovitz (1956) states the productivity index, the residual component of growth, is merely a 'measures of our ignorance'. Thus, refereeing to them simply as technological progress, does little help in understanding the fundamentals of productivity-led growth. Consequently, more recent non-parametric and parametric techniques attempt to not only measure total productivity values but also within the same framework explain the sources of variation across different countries or entities (Kumbhakar and Lovell, 2000). In these studies productivity growth is not entirely referred to as technological progress. Instead, technological progress is considered as one component of TFP alongside allocative, production and scale efficiencies. In other words all of these factors together explain a country's TFP. This necessitates the relaxation of a number of assumptions imposed on the methodology of estimating TFP (or TFP growth) such as perfect competition and constant return to scale. In this research we do not conduct the decomposition and thus will not explore the relaxation of these assumptions per se but we will look into only one of these factors role, namely production efficiency (technical efficiency).

## 5.3 Accounting for Aggregate Growth in Iran

In this section we attempt to construct estimates of TFP as a measure of overall productivity in the aggregate economy of Iran. Here the growth accounting framework based on a simple Solow growth model is employed. Once these values are obtained we will use these to verify the validity of the political economic factors by comparing the growth rates of TFP after and prior to the revolution. Furthermore, the context specificity of our argument will further be evaluated by comparison of these measures with those of two other countries, i.e. Korea and Turkey.

The growth accounting method of TFP measurement can be simply defined as the difference between output growth and input growth. Thus, we assume an aggregate production function Here we assume this function to be explained by three factors and expressed as below:

$$Y_t = F(K(t), L(t), A(t)) \tag{5–1}$$

In the above relationship, $Y$ is total output $K$ is the physical capital stock, $L$ is labour, $A$ is technology and $t$ is the time variable. Now if we take natural logarithms of both side and differentiate our model with regards to the time variable we have:

$$\frac{\dot{Y}}{Y} = \frac{F_K K}{Y}\frac{\dot{K}}{K} + \frac{F_L L}{Y}\frac{\dot{L}}{L} + \frac{F_A A}{Y}\frac{\dot{A}}{A} \tag{5–2}$$

Here a dot over the variable is the first derivative of that factor with regards to time and $F_K$ and $F_L$ are marginal products of capital and labour. We denote output growth rate $\dot{Y}/Y$ as $g_y$ and in a similar manner capital increment $\dot{K}/K$ as $g_k$ and labour growth $\dot{L}/L$ as $g_L$. This relationship suggests that the growth in output is a weighted average of the growth of the three components (Barro and Sala-i-Martin, 2003). Rearranging the above equation we have:

$$\frac{F_A A}{Y}\frac{\dot{A}}{A} = \frac{\dot{Y}}{Y} - \frac{F_K K}{Y}\frac{\dot{K}}{K} + \frac{F_L L}{Y}\frac{\dot{L}}{L} \tag{5–3}$$

Consequently, the LHS of the above equation is the contribution of ‘technology’ to growth or what is referred to as TFP growth. Furthermore, assuming factor markets as being competitive, the factors would be paid according to their marginal product or $F_K = r - \delta$ and $F_L = w$. Here $r$ is the return to capital and $w$ is the average wage and $\delta$ is a constant depreciation rate. This would follow that $F_L L/Y$ would be equal to $wL/Y$, the share of wages in total output. Hence we denote this ratio as $s_L$ or the share of $L$. Similarly, the ratio $F_K K/Y$ would be the same as $(r - \delta)K/Y$, which is the share of capital expenditure in output and can be denoted as $s_K$. Thus, Equation (5–3) can be rewritten as:

$$g_{TFP} = g_y - s_K g_K - s_L\, g_L \qquad \textbf{(5–4)}$$

This is referred to as the fundamental growth accounting relationship (Acemoglu, 2008). Assuming we have estimates of all elements in the RHS, the growth rate of TFP (LHS) can be calculated as a residual based on the above equation.

From a theoretical aspect, Robinson (1953) had earlier criticised the concept of an aggregate production function. She argued that due to the heterogeneous nature of capital, different equipment and machinery cannot be simply summed up (unlike labour) and result in an aggregate capital stock. This was later to be referred to as the 'Capital Controversy'. This criticism is more generally supported by Kaldor (1966) who argues that even though such theoretical abstractions allow the marginal productivity models to work; these a priori assumptions cannot lead to assertions about the real world. While these criticisms were accepted from a logical point of view, they were disregarded as empirically insignificant by proponents of marginal productivity theory such as Solow and Samuelson (Pressman, 2005).

Other major criticism of the accounting procedure relates to the assumptions needed to make the accounting procedure applicable. In other words, even accepting the derivation of Equation (5–4) , the associated measurement problems of the RHS variables was argued to bias estimates of TFP growth. If for example labour is measured in the strict sense and the quality of labour is not incorporated, then the role of inputs is underestimated and subsequently $g_{TFP}$ is overestimated. Therefore, factors such as human capital and the effective labour hours have to be taken into consideration.

Similarly, a big challenge lies with the measurement of capital stock. This problem arises due to data being expressed in value terms and thus incorporating an element of price. For instance, employing capital expenditure data on the value of assets can pose challenges. First, capital expenditures cover both equipment and structures. Thus, the change in the relative price of these assets throughout time can entail biased estimates. Furthermore, if through time, the same type of asset becomes considerably cheaper than the one before or has an improved quality than the previous years (e.g. computers and machinery), it can bias the estimation of the capital stock and hence the LHS of Equation (5–4).

One final issue is the fact that the above relationship has been obtained using derivatives assuming continuous time. However, factor shares in total output ($s_K$ and $s_L$) are available for a given point of time such as the beginning or end of a given time period in discrete form. Using either of these can lead to biases in the final results (Acemoglu, 2008). Hence, using the highest frequency data available and using averages of the beginning and end of period values can only help alleviate this drawback when the capital-labour ratio is relatively stable. Below we attempt to explain the measurement of these variables.

It has been attempted to minimise the associated problem based on the data that is available. Starting with capital, due to a lack of a reliable dataset on Iran's capital stock we will construct a new series of capital stock for the Iranian economy. There are various methods of measuring capital stock. We estimate capital stock based on the perpetual inventory method based on the below relationship:

$$K_t = (1 - \delta)K_{t-1} + I_t \qquad \textbf{(5–5)}$$

Here $I$ is the investment or gross capital formation (GCF), $K$ is the capital stock and as before $\delta$ is the rate of depreciation of capital. Even if data on $I$ is available for the entire period, there needs to be an initial capital stock ($K_0$) from which the accumulation of investment in each year can lead to capital stock in subsequent years. The earliest year for which data on capital formation is available corresponds to 1965. Investment prior to that is 'backcasted' based on the pre-revolution trend (1965-1976) and thus annual investment values until 1900 are calculated. This is similar to part of the approach in Wu (2008). Assuming that the capital stock in 1900 to be almost zero and depreciate at a rate of 4.9% (Jbili et al, 2008), a capital stock series is generated from Equation (5–5).

In order to adopt a better measure of labour and avoid problems of biased TFP growth values, we incorporate the schooling years into this variable. As such we will be constructing a proxy of human capital ($HK$) which will be used in our growth accounting framework. This variable has been calculated as a product of labour force size and average years of schooling. The years of schooling is based on the measurement done by Barro and Lee (2013) for total population of over 15year olds. The data is provided in five year intervals hence linear interpolation is used to obtain annual values. See Appendix 4 for more details on the constructed human capital and capital stock series.

Going back to the growth accounting model, under a Cobb-Douglas production specification, with constant returns to scale assumption ($Y_t = A_t {K_t}^{\alpha} {HK_t}^{1-\alpha}$), the fundamental growth accounting relationship will be equivalent to:

$$g_{TFP} = g_y - \alpha g_K - (1-\alpha) g_{HK} \tag{5–6}$$

Based on the above definitions and explanations all values on the right hand side can be calculated and hence estimate of total factor productivity growth can be obtained.

For calculation of contribution of capital to growth the depreciation and return to capital rates are assumed to be around 4.9% and 7% respectively, in line with Jbili, et al., (2007). We do not need wage data since we can use the Cobb-Douglas specification which imposes constant returns to scale criteria as can be seen in Equation (5–6). Thus, capital share would be one minus the human capital (labour) share ($s_K = \alpha = (r-\delta)K/Y$ and thus, $S_{HK} = 1 - \alpha = 1 - (r-\delta)K/Y$).

The assumption of perfect competition is a restrictive assumption in general and especially in the case of Iran. Imposing this assumption on our model could bias the estimates of productivity since with more monopolies in manufacturing sector this might mean producers are demanding higher prices. This higher price and ultimately higher output does not originate from higher productivity and is only a result of the market structure. This would mean an upward bias in our estimates if this assumption were to not hold. However, acknowledging the possibility of deriving better estimates with more appropriate assumption which would rely on more detailed data which is not available. Nevertheless, as the main objective of this section is not the measurement itself, these estimates can highlight the problem in the Iranian economy and serve the purpose of this research.

A brief summary of the growth accounting results is provided in Table 5–1 based on overall period of study and important sub-periods. The estimated TFP growth seems to explain the larger portion of changes in real output which as discussed in the previous chapter displayed a close relationship with growth in oil income. The estimates suggest that the contribution of residual factors affecting growth has been mainly a negative one. It has consistently been lower than the contribution of the traditional inputs and has even managed to offset them and reduce growth in the post-revolutionary period. The striking point in these results is the vast difference between TFP growth rates prior (2.41%) and after the revolution (-9.49% and -1.24%) periods. Even if we compare the performance of the economy with the post war phase there seems to be a considerable difference. This can further support our earlier hypothesis on how the prevalence of oil in the economy has been further visible in the post-revolutionary period which, as discussed earlier, is itself influenced by political economic structure of the country.

The results are quite similar even if we only calculate the TFP contribution to non-oil GDP growth. This fact highlights the embededness of the poor productivity performance in the economy. More crucially, it highlights the difference in type of growth in the two periods based on oil income. As oil production figures confirm that the majority of growth in oil income before the revolution was due to growth in the volume of production whereas the majority of oil income growth in GDP after the revolution is mainly due to higher oil prices.

**Table 5–1 Output Growth and Its Components, 1966-2007.**

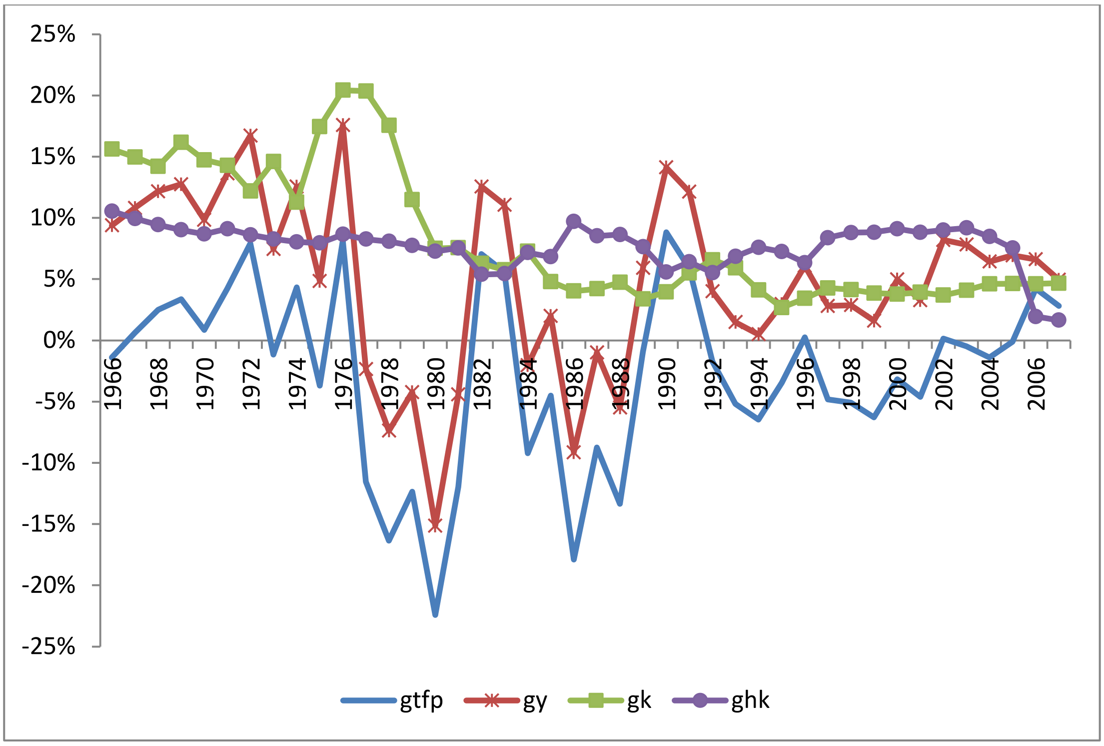
| Period | Real GDP Growth | Capital Contribution | Human Capital Contribution | TFP Contribution |
|---|---|---|---|---|
| **1966-76 (pre-revolution)** | 11.61% | 0.65% | 8.55% | 2.41% |
| **1977-88 (revolution/war)** | -2.13% | 0.56% | 6.79% | -9.49% |
| **1989-2007 (post-war)** | 5.45% | 0.30% | 6.39% | -1.24% |
| **1966-2007 (total)** | 4.90% | 0.50% | 7.25% | -2.64% |

*Source:* Based on CBI, (2011), Barro and Lee (2013), Feenstra, et al. (2013) (PWT 8.0), World Bank (2013).

The trend can be seen more closely in Figure 5–1. What is clear from the comparison of the growth rates is the relative importance of capital stock growth as an indicator of overall growth. We see a considerable change in the rate of investment prior and post revolution. The growth of the capital stock hovered around an impressive annual rate of 15% up to 1977, for obvious reasons during the early years of the revolution it more than halved to around 6.6%. However, even more interestingly, this growth rate further deteriorated to 3.2% after the war period despite the reconstruction phase after the war and high oil prices later on in the 2000s.

On the other hand, the growth trend in human capital stock has been relatively consistent despite the revolution. According to Barro and Lee (2013) calculations the annual average schooling years in Iran in 1960 for 15 year old and older people was just 0.92 years. This index reached 8.64 years in 2010 which is equivalent to an increase of 4.6% on an annual basis. The growth in employment in the same period has been slightly lower at just over 3%. This has led to a growth of around 7.7% for the human capital index (see Appendix 4 for the full trend).

**Figure 5–1 Growth Trend of TFP, Output, Capital and Human Capital, 1966-2007.**




*Source*: Based on CBI, (2011), Barro and Lee (2013), Feenstra, et al. (2013) (PWT 8.0), World Bank (2013).

If we re-estimate productivity without using human capital as the other input and instead use the number of employees directly, the trend of change stays the same but TFP values tend to be higher[8]. This can be explained by the fact that since changes in the quality of human capital (i.e. years of schooling) is disregarded it is transferred to the TFP residual hence higher estimates are obtained in this manner. As Jbili et al.

[8] See Appendix 5 for the corresponding results when using labour instead of human capital proxy.

(2007) suggests the actual productivity growths would probably lay somewhere in between these two since the actual relationship between human capital, years of schooling and size of labour force would also be something in between these two scenarios.

The graph clearly highlights the importance of the residual effect on overall growth rate of the economy. The two series ($g_y$ and $g_{TFP}$) move in almost identical directions. This verifies the importance of further decomposition and investigation of the components of total factor productivity in explaining the growth.

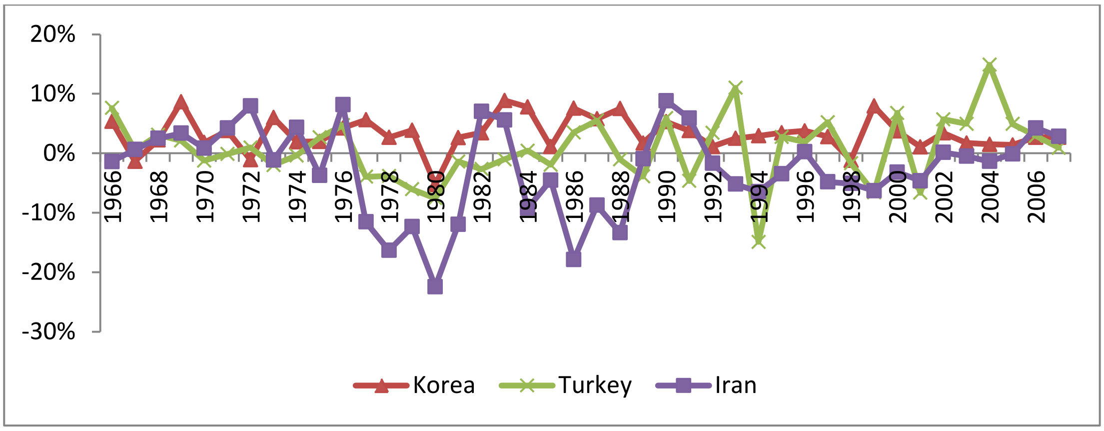
## 5.4 Cross-Country Productivity Comparison

Before looking more in detail at the manufacturing sector in Iran it will be useful to compare Iran's TFP performance compared to other countries. This comparison will be fruitful for our discussion as it can provide explanations on the sources of variation in productivity trends of Iran versus these countries. Furthermore, this exercise will help in establishing the relative position of Iran in the global context. Clearly, this comparison does not lead to an exhaustive list of explanations for the success of some countries compared to others. For instance, important historical and cultural issues clearly have a role in explaining cross-country difference which is not the objectives of the discussion here.

We will conduct the same growth accounting exercise with data for Korea and Turkey at the aggregate level of the economy. All assumptions are kept exactly the same as the one made for Iran, such as rate of return to capital, depreciation rate, etc. For more details on the data used for these two countries see Appendix 6.

Looking at the same three periods we can have a better understanding of the productivity performance of the three countries at the aggregate economy level. The results in Figure 5–2 and Table 5–2 show that in the first period Iran's average annual productivity is higher than Turkey and only slightly smaller than Korea. This reflects the high investments in modernization and the introduction of various heavy industries in Iran in this period. However, as expected the uncertainty and problems associated with production during the revolution and war periods meant that the productivity growth in this period witnessed a 9.64% reducing trend whereas Korea not only maintained its position but also managed to increase its TFP by 4.3% up from 3.05% in the previous period. Meanwhile Turkey also witnessed a negative productivity growth of 1.67%. Interestingly for Iran the deterioration in TFP continued even though less negative while its neighbour, Turkey, managed to increase its TFP by 1.72% annually and Korea on the other hand experienced a growth of 2.75%.

**Figure 5–2 TFP growth trends, Iran, Korea and Turkey, 1966-2007.**




*Source*: Based on Barro and Lee (2013), Feenstra, et al. (2013) (PWT 8.0).

Furthermore, Figure 5–2suggests that not only Korea has the highest productivity in all periods but it also has experienced the smallest volatility in the growth trend. The amount of growth instability is a bit higher in Turkey and much higher in Iran. This could partly be explained by the dependence of the economy directly on the price of oil but also lack of consistency in fiscal and monetary policy on the part of the government.

**Table 5–2 TFP Growth Comparison of Iran, Korea and Turkey, 1966-2007.**

| Average Annual TFP Growth | 1966-1976 | 1977-1988 | 1989-2007 | 1966-2007 |
|---|---|---|---|---|
| **Iran** | 2.34% | -9.64% | -1.14% | -2.66% |
| **Korea** | 3.05% | 4.30% | 2.75% | 3.27% |
| **Turkey** | 1.63% | -1.67% | 1.72% | 0.73% |

*Source*: Barro and Lee (2013) and Feenstra et al. (2013).

The dismal performance of the Iranian economy even after the war period and despite high oil prices in this period can be considered as a clear evidence for backward progress not only compared to its performance before the revolution but also compared to other countries with relatively similar initial positions, in per capita GDP terms, in the 1960s.

### 5.5 Industrial Sector Overview

In the proceeding chapters we will be focusing on the manufacturing sector as a sector that can be vital in the development trajectory of Iran. There are copious studies that argue for the importance of industrialisation in the economic growth literature. Most notably are the works of Kaldor from 1950s onwards. An important part of his contribution to the economic growth literature focuses on the role of manufacturing in his cross-sectoral analyses of growth.

In Kaldor (1967), he proposes three main hypotheses (also known as Kaldor's growth laws). First, he argues that higher manufacturing growth contribute to higher total growths. Hence, the sustainable engine of growth in the economy can be the manufacturing sector's performance. This does not mean that manufacturing growth should be at the expense of other sectors. He emphasises this point and notes that especially in the early stages of development, on the demand side the manufacturing sector growth itself depends on a strong agricultural sector. In later stages of industrialisation, part of the demand however is to be obtained through exports.

Second, he states that higher growth in the manufacturing sector, in return encourages higher manufacturing productivity growth due to static and dynamic increasing returns. This is mainly an argument on the supply side of manufacturing production. The static reason for increasing returns is due to the decreasing average costs as the manufacturing sector grows bigger. The dynamic productivity gains would arise as a result of greater amount of capital accumulation, specialisation and learning by doing as higher growth rates are obtained in the manufacturing sector.

Third, he suggests that productivity of non-manufacturing sectors are also improved by manufacturing growth. This is achieved through the absorption of surplus or less productive resources from other sectors. Furthermore, he argues that the higher overall rate of change of technology that is achieved through industrialisation would also, as a bi-product, increase the productivity of other sectors such as agriculture.

Thus, appraising the historical performance of the Iranian industrial sector in light of the dominant position of the economy seems to be an important factor in the economic development of Iran. In order to better propose prospective solutions for the manufacturing sector we need to comprehend its historical performance.

The major industrialisation attempt of the Iranian economy was carried out in the early 1960s when a big push on establishing different manufacturing industries was undertaken. This was later followed by large-scale industrial projects in early 1970s using government investments which were a result of the sudden boost in oil revenues due to rapid price increases. Although these projects were predominantly focused in petrochemical, basic metal and crude oil production a strong industrialisation policy was also pursued.

In mid 1970s with the fall of oil prices the situation changed for the worse and what followed was the economic downturn, the subsequent Islamic revolution and finally the Iraq war. The biggest economic result of these events in the post-revolutionary period was mass nationalisation of businesses and the emergence of public and semi-public sectors in almost all areas of economic activity. Consequently, the manufacturing sector was protected by a series of implicit and explicit subsidies in an unprecedented manner. Among the subsidies provided were large energy subsidies for the manufacturers which prompted them in employing more energy consuming processes. Furthermore, preferential exchange rates and overvalued Rial led to the industrial production itself to be highly import dependent. This also meant that the major part of the non-oil exports was dependent on the low exchange rates (Behdad, 2000). Nevertheless, these protective measures were feasible thanks to the oil revenues and thus the success of the manufacturing sector was tied to the oil sector.

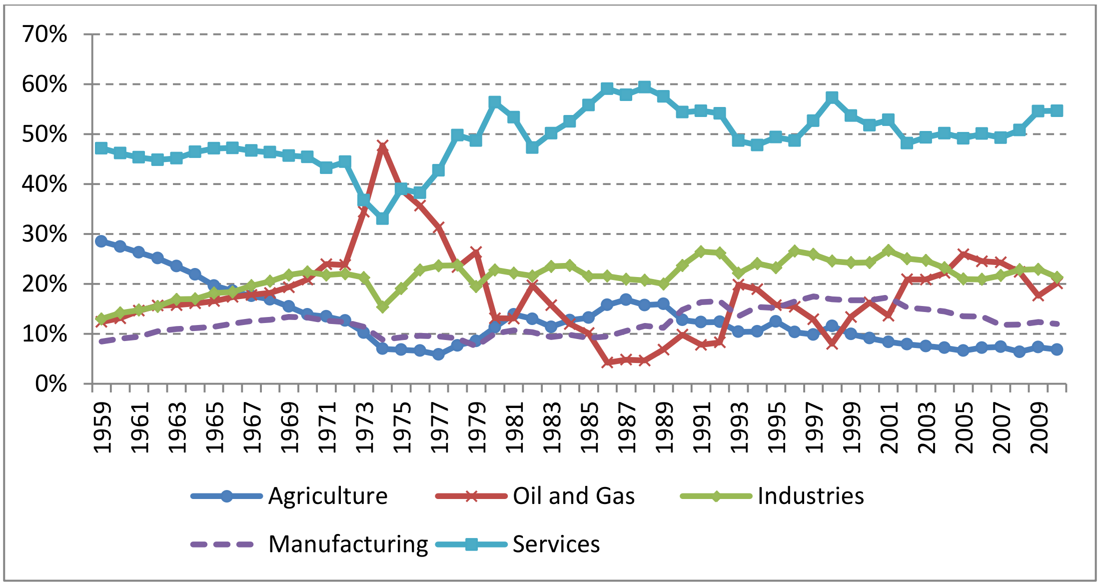
Although the government transfers helped shift up manufacturing share of GDP to above the 10% mark, these subsidies also gradually became embedded in the structure of production meaning that manufacturers did not have any incentive to upgrade their machinery and use more economical methods of production (see Figure 4–10). Thus, up to the current day the economy not only suffers from inefficiencies due to misallocation of resources but also from adverse effects of inefficient techniques used in production.

The relative importance of the manufacturing sector within the whole economy can be seen more broadly in Figure 5–3. The manufacturing share edges over the 10% mark in early 1960s but drops down in light of the oil shock of the early 1970s and the subsequent problems of the revolution. It recovers again in the late 1980s after the end of the war and peaks in 2001 accounting for 17% of the GDP.

It can be observed that the agricultural sector share has been on an overall downward trend which only saw an increase during the war period due to fall in the Oil and Gas sector. Finally, the Services sector has been the biggest sector on average accounting for 50% of the GDP since the early 1960s.

We focus on the manufacturing sector due to the major benefits of industrialisation to economic growth, as pointed out above, are best explained in this sector. As we can see in Figure 5–3 the majority of the industries group output throughout the last few decades can be attributed to the manufacturing output.

**Figure 5–3 GDP Shares by Group, 1959-2010.**




*Source*: Based on CBI data (2014a).

*Notes:* GDP at current factor cost.

**Table 5–3 Total Manufacturing Share in Province Employment, 2005-2008, (%).**

| Province | 2005 | 2006 | 2007 | 2008 |
|---|---|---|---|---|
| **Eastern Azarbaijan** | 37.9 | 42.0 | 42.9 | 41.5 |
| **Western Azarbaijan** | 19.7 | 21.0 | 22.7 | 23.9 |
| **Ardebil** | 19.9 | 21.2 | 21.2 | 22.5 |
| **Esfahan** | 44.1 | 44.6 | 42.3 | 41.8 |
| **Ilam** | 16.7 | 19.4 | 21.2 | 22.8 |
| **Bushehr** | 24.7 | 24.7 | 26.8 | 23.7 |
| **Tehran** | 32.6 | 33.9 | 34.6 | 34.1 |
| **Chaharmahal and Bakhtiari** | 39.6 | 42.5 | 43.1 | 43.8 |
| **Southern Khorasan** | 30.0 | 29.4 | 31.6 | 33.8 |
| **Razavi Khorasan** | 27.8 | 29.0 | 28.8 | 30.9 |
| **Northern Khorasan** | 28.2 | 27.9 | 26.4 | 29.5 |
| **Khuzestan** | 30.8 | 32.4 | 32.1 | 33.4 |
| **Zanjan** | 32.4 | 31.3 | 30.4 | 31.2 |
| **Semnan** | 30.9 | 31.5 | 34.5 | 34.3 |
| **Sistan and Baluchestan** | 33.7 | 43.6 | 37.9 | 32.5 |
| **Fars** | 26.7 | 28.5 | 29.3 | 28.3 |
| **Qazvin** | 31.4 | 31.1 | 32.9 | 35.2 |
| **Qom** | 44.4 | 42.6 | 43.1 | 43.0 |
| **Kordestan** | 23.6 | 23.4 | 24.3 | 22.7 |
| **Kerman** | 28.2 | 28.7 | 28.1 | 27.8 |
| **Kermanshah** | 21.0 | 20.2 | 21.9 | 25.0 |
| **Kohgiluyeh o Boyerahmad** | 26.0 | 27.0 | 32.0 | 33.5 |
| **Golestan** | 22.9 | 27.0 | 28.2 | 28.4 |
| **Gilan** | 21.6 | 21.5 | 24.1 | 24.3 |
| **Lorestan** | 25.8 | 26.8 | 28.9 | 31.2 |
| **Mazandaran** | 26.9 | 27.2 | 28.0 | 29.9 |
| **Markazi** | 34.3 | 33.7 | 38.4 | 37.7 |
| **Hormozgan** | 24.5 | 26.0 | 24.2 | 27.4 |
| **Hamedan** | 26.8 | 26.0 | 28.1 | 27.7 |
| **Yazd** | 42.7 | 43.8 | 44.3 | 42.9 |
| **Total** | 30.3 | 31.7 | 32.0 | 32.2 |

*Source*: SCI Labour force Statistical Yearbook 2005-2008.

Additionally, looking at manufacturing sector role as an important job creating sector not only highlights the importance of this sector in the economy, it can act as evidence in the political nature of economic decision making that was discussed in Chapter 3. According to the ‘labour force yearbook’, which is compiled separately by SCI, the share of total manufacturing (including firms with less than 10 employees) in total employment of the country in 2006 to 2008 was around 32%. These figures plus the relative importance of total manufacturing in job creation in different provinces is shown in Table 5–3. This table shows that in 2008, manufacturing alone provided around 40% or more of employment in four provinces. It can be seen that in this period the plans of equal distribution of manufacturing across provinces has been pursued. This is evident from the fact that provinces with the lower average shares (Ilam, Kohgiluyeh and Boyerahmad and Lorestan) have experienced the highest average annual growth rates. This might seem as a step in the promotion of economic equality. Nevertheless, if the appropriate strategies and true economic incentives of production are not the basis of such geographical restructuring, it will ultimately lead to additional burden on government to support in the future. This can be an indication of the populist policies of industrial job creation in more deprived regions of the country in this period.

## 5.6 Manufacturing Structure

We briefly discussed the growth, markups and labour productivity of Iran's manufacturing in Chapter 4. Here, we will focus on the subsectors to obtain a better understanding of the main challenges for growth. As mentioned earlier the manufacturing producers are not only directly dependent on oil prices but also heavily rely on various government transfers such as energy subsidies (discussed in the previous chapter), preferential exchange rates and various tax breaks.

In order to see the results of the policies and factors influencing the manufacturing sector we can look at its composition in the recent history. The proceeding four tables (Table 5–4 to Table 5–7) provide some stylised facts on the industrial composition of Iran and interpretations of key changes in the periods prior and after revolution using UNIDO data which covers firms with more than 10 employees. It provides a detailed account of the manufacturing structure by looking at the subsectors according to the two-digit ISIC classification (Revision 3.1).

Table 5–4 illustrates that the manufacturing sector was initially dominated by light industries with food and beverages (ISIC 15) having the highest share (27%) of manufacturing production, followed by textiles (ISIC 27) claiming a 22% share. However, in the years that followed a gradual restructuring of the manufacturing sector took place. The above sectors lost ground to more heavy manufacturing sectors such as, motor vehicles (ISIC 34), basic metals (ISIC 27) and coke and refined petroleum (ISIC 23) sectors. The latter group of industries together saw their share of manufacturing production increase from 12% in the 1960s to 40% by the period 1998-2006[9]. On the other hand, the two dominant sectors in the earlier periods (food and textiles) saw their joint share plummet to 18% in the early 2000s. This reshaping of the manufacturing sector is indicative of policies, such as preferential exchange rates and subsidies, undertaken by the state both prior to the revolution and after the war with Iraq to strengthen industrial production.

Table 5–5 illustrates the distribution of employment across manufacturing groups. In the latest period the biggest employers have been the food (ISIC 15), non-metallic minerals (ISIC 26) and textiles (ISIC 17) respectively. This table also can indicate the movement of labour across industries through the comparison of the first and latest periods covered. The data suggests that despite a change in production structure shown in Table 5–4, employment shares have not changed as drastically. For example, the food industries' share in employment dropped from 18% to 14.5%. In other words, even though the food industry production share shrank by 15% its employee share of manufacturing only fell by 5% in four decades. Moreover, three industries (non-metallic minerals, fabricated metals and electrical machinery) witnessed an increase in their share of employment despite their share of output falling. This means that while some sectors' output share importance has fallen they have remained important in the share of jobs they create.

To see the underlying driver of the change in manufacturing structure we can look at the growth of these sectors' output and employment. Looking at Table 5–6 it can be seen that overall manufacturing growth seems to be very significant in mid-1960s to mid-1970s with figures above 15%. However, as Table 5–7 shows, the major part of the post-revolutionary manufacturing growth occurred in the period after the end of war at a rate of 15.4% annually. This rate was primarily obtained due to the utilisation of unused capacities that were imposed in the previous uncertain climate and reconstruction. In the period between 1998 and 2005, this rate has fallen to 9.9%.

Looking at production and employment growth we can see that in some industries oil income has influenced their growth directly. In Table 5–6 and Table 5–7 we can see

[9] This change in structure is also evident even when we looked at value added data.

high growths in oil-based manufacturing sectors such as coke and petrochemical sector (ISIC 23). Throughout the four decades discussed this sector has consistently displayed one of the highest production and employment growth rates. Its production growth on a number of occasions has exceeded the 100% rate. In the 1970s the other industries which also enjoyed highest growth rates included machinery (ISIC 29) and fabricated metal (ISIC 28) industries. However, in the more recent period after the revolution there seems to be more emphasis on achieving growth from more sophisticated manufacturing production including the motor vehicle (ISIC 34) and other transport (ISIC 35) sectors. As the global cut-throat competition in pricing and quality of automotive products suggests, the important factor in the true success of such sectors theoretically should be their competitiveness. Nevertheless, these Iranian industries have managed to obtain these growth rates in the convenient environment of protected domestic market and subsidised inputs. Thus, the success of the recent focus on such industries more than ever depends on increasing incentives for improving their productive performance.

Consequently, the crucial factor here is the implementation process of this structural change. The strategy and the mechanism employed to obtain its goals can determine its long-run success. By looking at the production performance of producers we can investigate the growth has been obtained by competitiveness improvements in these sectors or their increasing dependence on government support and subsidies financed by oil income.

Furthermore, the above observation demonstrates that state policies addressed at increasing production do not necessarily tend to result in benefits with regards to job creation in a proportionate manner. Clearly, there has been a shift towards more capital intensive production. In other words, the subsidies received by producers seem to have enhanced the role of capital rather than labour. Thus, such restructuring of the manufacturing production has clear implications for the long-term prospects of growth and also other broad economic indices such as income distribution.

**Table 5–4 Iranian Manufacturing Structure by Output Share, 1964-2005.**

| | Share of Manufacturing Output (%) | | | | | |
|---|---|---|---|---|---|---|
| | Pre-Revolution | | | Post-Revolution | | |
| **ISIC Sector** | **1963-71** | **1972-75** | **1976-80** | **1981-87** | **1988-97** | **1998-2005** |
| **15 Food and Beverages** | 27.2 | 20.7 | 18.4 | 18.9 | 17.1 | 12.9 |
| **16 Tobacco Products** | 6.7 | 3.2 | 1.8 | 1.1 | 0.8 | 0.5 |
| **17 Textiles** | 22 | 15.9 | 14.5 | 17.7 | 13.1 | 5.5 |
| **18 Wearing Apparel, Fur** | 4.1 | 2.1 | 2.4 | 3.8 | 2.2 | 0.2 |
| **19 Leather, Leather products and footwear** | N/A | N/A | N/A | N/A | 1.3** | 0.5 |
| **20 Wood Products (excl. furniture)** | 0.9 | 0.7 | 0.9 | 1 | 0.9 | 0.4 |
| **21 Paper and Paper Products** | 0.9 | 2 | 2.0 | 2 | 1.9 | 1.3 |
| **22 Printing and Publishing** | 1.1 | 1.4 | 1.2 | 0.9 | 0.9 | 0.6 |
| **23 Coke, Ref. Petroleum, Nuclear Fuel** | 0.6 | 1 | 5.3 | 0.8 | 1.7 | 8.3 |
| **24 Chemicals and Chemical Products** | 5.3 | 8.4 | 6.2 | 6.9 | 9.6 | 11.8 |
| **25 Rubber and Plastic Products** | 2.1 | 2.8 | 3.8 | 4 | 3.9 | 3.1 |
| **26 Non-Metallic Mineral Products** | 7.3 | 7.7 | 9.7 | 10.5 | 8 | 7.1 |
| **27 Basic Metals** | 3.6 | 9.1 | 8.4 | 8 | 15.3 | 13.2 |
| **28 Fabricated Metal Products** | 4.4 | 5 | 5.4 | 4.2 | 4.1 | 3.6 |
| **29 Machinery and Equipment n.e.c.** | 1.2 | 2.8 | 3.1 | 5.7 | 5.9 | 5.3 |
| **30 Office, Accounting and Computing Machinery** | N/A | N/A | N/A | N/A | 0.2** | 0.2 |
| **31 Electrical Machinery and Apparatus** | 4.4 | 6.6 | 6.5 | 5.2 | 4.3 | 3.3 |
| **32 Radio, Television and Communication Equipment** | N/A | N/A | N/A | N/A | 1** | 1.3 |
| **33 Medical, Precision and Optical Instruments** | 0.2 | 0.2 | 0.2 | 0.3 | 0.5 | 0.5 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | 7.5 | 10.1 | 9.6 | 8.2 | 7.3 | 18.3 |
| **35 Other Transport Equipment** | N/A | N/A | N/A | N/A | 0.8** | 1.6 |
| **36 Furniture; Manufacturing n.e.c.** | 0.5 | 0.4 | 0.5 | 0.6 | 0.7 | 0.5 |
| **37 Recycling** | N/A | N/A | N/A | N/A | ~0** | ~0 |
| **Total Manufacturing** | **100** | **100** | **100** | **100** | **100** | **100** |

*Source*: Based on UNIDO (2010).

*Notes*: * 1978 data was approximated as the average of 1977 and 1979.

** 1994-1997 average due to absence of data prior to 1994.

**Table 5–5 Iranian Manufacturing Structure by Employee Share, 1963-2005.**

| | Share of Manufacturing Employees (%) | | | | | |
|---|---|---|---|---|---|---|
| | **Pre-Revolution** | | | **Post-Revolution** | | |
| **ISIC Sector** | **1963-71** | **1972-75** | **1976-80*** | **1981-87** | **1988-97** | **1998-2005** |
| **15 Food and Beverages** | 18.04 | 17.52 | 16.18 | 13.88 | 13.08 | 14.53 |
| **16 Tobacco Products** | 2.09 | 1.41 | 1.41 | 1.38 | 1.16 | 0.84 |
| **17 Textiles** | 41.45 | 30.21 | 22.70 | 21.72 | 20.27 | 13.35 |
| **18 Wearing Apparel, Fur** | 3.07 | 3.03 | 3.03 | 3.82 | 2.64 | 0.66 |
| **19 Leather, Leather Products and Footwear** | N/A | N/A | N/A | N/A | N/A | 1.22 |
| **20 Wood Products (Excl. Furniture)** | 1.37 | 1.08 | 1.54 | 1.79 | 1.40 | 0.91 |
| **21 Paper and Paper Products** | 0.80 | 1.17 | 1.46 | 1.68 | 1.72 | 1.68 |
| **22 Printing and Publishing** | 1.41 | 1.30 | 1.26 | 1.01 | 1.28 | 1.26 |
| **23 Coke, Refined Petroleum Products, Nuclear Fuel** | 0.34 | 0.38 | 2.32 | 0.57 | 1.22 | 1.73 |
| **24 Chemicals and Chemical Products** | 3.95 | 5.90 | 5.40 | 4.72 | 6.12 | 6.99 |
| **25 Rubber and Plastics Products** | 2.03 | 3.19 | 4.02 | 3.68 | 3.70 | 4.09 |
| **26 Non-Metallic Mineral Products** | 10.19 | 11.03 | 14.54 | 16.68 | 13.69 | 13.95 |
| **27 Basic Metals** | 1.74 | 5.85 | 5.82 | 6.19 | 8.61 | 7.42 |
| **28 Fabricated Metal Products** | 3.87 | 5.26 | 5.02 | 4.45 | 5.00 | 5.84 |
| **29 Machinery and Equipment n.e.c.** | 0.97 | 2.10 | 2.90 | 5.35 | 6.96 | 8.01 |
| **30 Office, Accounting and Computing Machinery** | N/A | N/A | N/A | N/A | N/A | 0.21 |
| **31 Electrical Machinery and Apparatus** | 3.79 | 5.90 | 5.87 | 5.22 | 4.42 | 4.04 |
| **32 Radio, Television and Communication Equipment** | N/A | N/A | N/A | N/A | N/A | 1.05 |
| **33 Medical, Precision and Optical Instruments** | 0.21 | 0.32 | 0.31 | 0.39 | 0.71 | 1.11 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | 3.93 | 3.70 | 5.65 | 6.64 | 4.63 | 7.89 |
| **35 Other Transport Equipment** | N/A | N/A | N/A | N/A | N/A | 1.83 |
| **36 Furniture; Manufacturing n.e.c.** | 0.76 | 0.64 | 0.56 | 0.83 | 1.01 | 1.37 |
| **37 Recycling** | N/A | N/A | N/A | N/A | N/A | 0.01 |
| **Total Manufacturing** | **100** | **100** | **100** | **100** | **100** | **100** |

*Source*: Based on UNIDO (2010).

*Notes*: *1978 data was approximated as the average of 1977 and 1979.

**Table 5–6 Iranian Manufacturing Structure by Output and Employment Growth, 1964-1980.**

| | **Production Growth (%)*** | | | **Employee Growth (%)** | | |
|---|---|---|---|---|---|---|
| **ISIC Sector**** | **1964-71** | **1972-75** | **1976-80***** | **1964-71** | **1972-75** | **1976-80***** |
| **15 Food and Beverages** | 15.2 | 9.2 | -1.6 | 8.9 | 10.4 | 5.5 |
| **16 Tobacco Products** | 5.4 | -1.3 | -6.6 | 2.2 | 5.6 | 8.6 |
| **17 Textiles** | 10.1 | 11.7 | 3.6 | 8.4 | 4.5 | 5.8 |
| **18 Wearing Apparel, Fur** | 8.3 | 4.6 | 7.9 | 9.9 | 11.6 | 12.8 |
| **20 Wood Products (excl. furniture)** | 7.3 | 19.2 | 5.1 | 4.4 | 13.9 | 12.9 |
| **21 Paper and Paper Products** | 50.2 | 14.6 | 2.8 | 21.8 | 16.6 | 0.8 |
| **22 Printing and Publishing** | 24.2 | 20.5 | -5.5 | 13.4 | 8.6 | 3.7 |
| **23 Coke, Ref. Petroleum, Nuclear Fuel** | 161.3 | 39.3 | 83.3 | 59.8 | 4.5 | 3.6 |
| **24 Chemicals and Chemical Products** | 22.8 | 17.2 | -5 | 14.2 | 19 | -3.8 |
| **25 Rubber and Plastic Products** | 21.6 | 19.8 | 11.4 | 15 | 19.3 | 6.2 |
| **26 Non-Metallic Mineral Products** | 10.9 | 20.5 | 1 | 8.3 | 17.2 | 9.7 |
| **27 Basic Metals** | 65.1 | 31.1 | -8.5 | 14.6 | 55.3 | -6.5 |
| **28 Fabricated Metal Products** | 13.5 | 33 | -1.7 | 16.8 | 11.9 | 1.9 |
| **29 Machinery and Equipment n.e.c.** | 29.9 | 41.1 | 1.8 | 13.5 | 32.5 | 15.8 |
| **31 Electrical Machinery and Apparatus** | 40.6 | 18.1 | -5 | 27.5 | 15.3 | 0 |
| **33 Medical, Precision and Optical Instruments** | 20.1 | 12.6 | 5.6 | 20.9 | 10 | 2.7 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | 22.6 | 20.9 | -6.4 | 9.9 | 14.4 | 12.1 |
| **36 Furniture; Manufacturing n.e.c.** | 8.6 | 17.5 | 3.9 | 6.1 | 11.5 | 6.2 |
| **Total Manufacturing** | **15.2** | **16.7** | **0.4** | **9.5** | **12.1** | **2.6** |

*Source*: Based on UNIDO (2010) and World Bank (2013).

*Notes*: * Growth rate of production was obtained from CPI-deflated output figures.

** Data for ISIC codes 19, 30, 32, 35 and 37 are only available from 1994 onwards.

*** 1978 data was approximated as the average of 1977 and 1979.

**Table 5–7 Iranian Manufacturing Structure by Output and Employment Growth, 1981-2005.**

| | **Production Growth (%)*** | | | **Employee Growth (%)** | | |
|---|---|---|---|---|---|---|
| **ISIC Sector**** | **1981-87** | **1988-97** | **1998-2005** | **1981-87** | **1988-97** | **1998-2005** |
| **15 Food and Beverages** | -1.9 | 11 | 7.1 | 5.5 | 2.6 | 4.4 |
| **16 Tobacco Products** | -10.3 | 17.2 | 4.2 | 8.6 | -2.9 | 1 |
| **17 Textiles** | -3.3 | 8.8 | -1.9 | 5.8 | 0.8 | -4.8 |
| **18 Wearing Apparel, Fur** | 5.1 | -12.3 | 5.8 | 12.8 | -11.3 | -0.6 |
| **19 Leather, Leather products and footwear** | N/A | -10.5 | -4.4 | N/A | N/A | -9 |
| **20 Wood Products (excl. furniture)** | 2.6 | 10.1 | -1.7 | 12.9 | 2 | -3.5 |
| **21 Paper and Paper Products** | -7.8 | 16.7 | 6 | 0.8 | 6.4 | 3.3 |
| **22 Printing and Publishing** | -0.8 | 14.8 | 13.6 | 3.7 | 7.3 | 3.3 |
| **23 Coke, Ref. Petroleum, Nuclear Fuel** | -5.8 | 90.8 | 13.9 | 3.6 | 40.7 | -1.4 |
| **24 Chemicals and Chemical Products** | 1.8 | 25 | 8.4 | 8.5 | 7.3 | 2.6 |
| **25 Rubber and Plastic Products** | -4.2 | 14 | 8.4 | 4 | 2.8 | 5 |
| **26 Non-Metallic Mineral Products** | 2.1 | 10.2 | 7.7 | 6.4 | 3.4 | 1.7 |
| **27 Basic Metals** | 0.4 | 29.9 | 10.6 | 13.4 | 3.5 | 1.7 |
| **28 Fabricated Metal Products** | -5.4 | 17.3 | 9.8 | 4.7 | 4.4 | 6 |
| **29 Machinery and Equipment n.e.c.** | 13.1 | 28.9 | 4.5 | 18.1 | 13.9 | 2.6 |
| **30 Office, Accounting and Computing Machinery** | N/A | 14.5 | 4.8 | N/A | N/A | 8.3 |
| **31 Electrical Machinery and Apparatus** | -10.7 | 33.3 | 11.4 | -1.7 | 15.7 | 5.2 |
| **32 Radio, Television and Communication equipment** | N/A | 24.1 | 1.3 | 7.7 | 14 | 5.9 |
| **33 Medical, Precision and Optical Instruments** | -3.2 | 29 | 4.8 | N/A | N/A | 0.7 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | -9.5 | 35.8 | 23.7 | 0.3 | 3.9 | 13.8 |
| **35 Other Transport Equipment** | N/A | 9.7 | 24.1 | N/A | N/A | 11.1 |
| **36 Furniture; Manufacturing n.e.c.** | 4.6 | 13.8 | 11.3 | 9.7 | 12.2 | 8.2 |
| **37 Recycling** | N/A | -10.3 | 100.8 | N/A | N/A | 80.8 |
| **Total Manufacturing** | **-4.1** | **15.4** | **9.9** | **5.5** | **3** | **2.6** |

*Source:* Based on UNIDO (2010) and World Bank (2013) (See notes * and ** in the previous table).

## 5.7 Conclusion

In this chapter we have attempted to evaluate the performance of the aggregate growth of the Iranian economy. We saw that factor accumulation especially in human capital has been substantial in both periods enjoying a growth rate of 7.7%. We constructed a new capital stock series for Iran. The estimates suggest that capital deepening enjoyed unprecedented scale prior to revolution at annual growth rate of almost 15%. However, after the revolution the rate fell to only 4.5%. However, an important part of the growth of Iran can be explained in the role of total factor productivity. Our estimates suggest a negative growth in the post-revolutionary phase. While the under-utilisation and reallocation of resources in the war period can explain the negative figure in this period, the trend continues well into 2007. This explains why the real GDP growth in Iran has never recovered back to the pre-revolutionary average of 11%.

To further assess the situation we compared the performance of Iran with Turkey, a neighbouring country, and Korea since both of these countries had lower per capita income than Iran up to the revolution. Despite both countries being net energy importers their growth rates have surpassed Iran's after the revolution. The results clearly suggest a much stronger TFP growth for these countries in this period. Both countries consistently enjoyed positive rates in the period after the revolution.

Subsequently, we looked at the industrial sector as the engine of growth in a developing country to obtain clues on the negative productivity performance of the economy. The benefits of the manufacturing sector and its linkages with other sectors led us to take a closer look at more disaggregated data of the manufacturing sector. Clearly, a gradual restructuring process of manufacturing was ushered in the course of last few decades. Most noticeably the share of heavy industries in manufacturing output drastically increased. This is evidence of the strong state policy in Iran since it was implemented through various implicit and explicit government subsidies both prior and after the revolution. As discussed in Chapter 3, this support strategy has been possible through the political economic structure of the Iran which has consistently relied on oil revenues (see Chapter 4).

The important conclusion to take away from the observations in this chapter is that various protective measures in the economy have not been conducive to long-run economic growth of the country. As a result of such disincentives the manufacturing sector, a potential growth engine for the economy, has witnessed misallocation of resources. More crucially, it seems that the structure of production and the efficiency of processes employed have also suffered in this sector. If such a hypothesis is to be proven, it would pose a long term challenge for the prospects of the growth in Iran as corrective measures for the latter problem are much more complex and time consuming than the static allocative issues.

In order to further dissect the sources of productivity and the ‘quality’ of growth, our discussion leads us to the topic of efficiency which we suggest can explain the dynamics of the impact of oil revenues on the industrial or manufacturing sector with a more detailed perspective. To this end, in the following chapters we will focus on evaluating the productive performance of Iranian manufacturing.

# Chapter 6 Efficiency Methodology

## 6.1 Introduction

The objective of this chapter is to introduce and formalise the quantitative method of this research by exploring the relevant literature's theory, methodology and empirical findings. We attempt to critically discuss the theoretical underpinnings of the concept of efficiency in microeconomics. We introduce the concept of production efficiency and discuss the significance of this factor with regards to the Iranian manufacturing sector.

We review the literature on the two main estimation methodologies of technical efficiency, namely SFA and DEA. We compare and contrast the two methods and opting for SFA method, explore the empirical literature with the view of constructing an appropriate model for the case of Iran in the following chapters.

## 6.2 Background and Theory

The idea of efficiency can be referred to as the biggest characteristic of any economic behaviour. It is clearly central to one of the widely used definitions of economics by Robbins (1935, p. 16), where he defines economics as 'the science which studies human behaviour as a relationship between ends and scarce means which have alternative uses'. Thus, economists have long attempted to obtain measures of performance for any economic activity in order to compare different agents, entities or countries. As a general definition, efficiency in economics is a value that measures the relative performance of an economic component to its potential value. Establishing this index, allows economists to question and hypothesise the underlying cause in difference among observations and ultimately examine possible improvements in these indices. The activity in question could be at different levels of aggregation, starting from firm-level all the way to the macroeconomic picture.

A widely addressed question in microeconomics is to assess the allocative efficiency of markets which is to examine the allocation of resources between activities in that market and to assess the possibility of arriving at a 'preferred state' through the reallocation of these inputs. However, often in macroeconomics and economics of development measures have been sought to explain why resources such as labour remain unused and what solutions might allow them to be utilised better. In contrast to allocative efficiency this is a slightly different notion of efficiency which is closer to the efficiency concept in other sciences of obtaining a certain goal with minimum possible effort, i.e. technical efficiency (Caves, 1992).

The interest domain of this chapter lies within microeconomics where, until recently, the production process and profit maximisation behaviour of firms was largely left unchallenged. This was due to assumptions within the neoclassical framework which assumed producers as successful optimisers. This assumption has come under question with theoretical research on market failures due to information asymmetries, agency problems and contract or bargaining costs. The result of questioning such assumptions paints a more realistic picture of producers but also infers limitations on the ability of firms and decision makers to achieve their optimal efficiency (Arrow 1977). This has led to a new definition of microeconomic efficiency named technical efficiency (also referred to as productive or production efficiency). In short, technical efficiency is concerned with the question of how well inputs are transformed into outputs within the production process. Once considered simultaneously, technical and allocative efficiencies jointly provide a measure of (total) economic efficiency.

### 6.2.1 Neoclassical Efficiency Critique

Interested in a more detailed picture of production processes, microeconomists began questioning efficiency disparities from a technical aspect. In other words, the quality of the transformation of inputs into outputs was finally questioned (technical efficiency) alongside the efficiency of allocating inputs considering their prices (allocative efficiency). This necessitated extending the understanding of production theory and re-examining the preceding assumptions on producer behaviour.

The idea that economic agents may not perform to the maximum of their ability is not a new proposition. The very concept of monopolies' market behaviour is based on such characteristics. This is indicated in works by people as early as Hicks (1935) who describes monopolies as economic agents not bothering to get close to maximum profits. This was followed by principle agent problems introduced by works including Williamson (1964) which claims that managers will maximise their utility function determined by staff and compensation apart from profits.

The ownership literature goes further and suggests private firms to be more efficient than public enterprises. The difference was attributed to the freedom of public managers to pursue their own criteria in running the business due to the dispersed and non-transferable quality of public ownership (e.g., Alchian, 1965).

*X-Efficiency*

Similarly, in a series of approaches focusing on agents within the production process, the foundation of neoclassic microeconomic theory of rationality and maximising behaviour was criticised. Here the ideas of bounded or selective rationality and 'satisficing' behaviour[10] of the economic agents were suggested. The notion of satisficing behaviour and bounded rationality, i.e. the behaviour of individuals according to what satisfies their needs which more often is not the optimal decision, was first suggested in the work of Simon (1956).

Subsequently, the X-efficiency concept was introduced in the pioneering work of Leibenstein (1966). In his study, he questions the relative importance of the allocative efficiency versus the intrinsic human organisation inefficiencies both within and outside the firm which he called X-inefficiency. In other words, he argues that production is bound to be inefficient due to motivation, supervising and agency problems.

Within the X-efficiency theory the basic unit is the individual unlike the firm or household in standard microeconomic theory. This individual is not assumed to maximise income compared to the household or firm in the neoclassical framework. The question here is the amount of effort which is exerted by the individual. In other words what influences the effort of the individual will ultimately determine the efficiency of that unit. These factors include the person's personality and the nature of relations within that firm.

Another assumption of the X-efficiency idea is the selective rationality argument. Here it is argued that different personalities react differently to supervision and work

[10] The term satisficing refers to the combination of the terms satisfy and suffice which was first used by Simon (1956) representing an opposing notion to the theory of optimised decision making.

pressure and ultimately will not choose maximising effort. Leibenstein (1978) models this behaviour of an individual based on its trade-off between the utility of leisure and the moral undertaking of obligations. Leibenstein refers to this reality as the amount of ‘constraint concerns’ that elements within the firm actually exhibit.

Furthermore, unlike conventional theory, X-efficiency assumes inertia in the basic unit behaviour as an important variable. This inertia behaviour depends on considerations such as the utility cost of decision making and habitual behaviour of doing things by that individual. Generally speaking, the inert area infers two cost components; the utility costs of moving away from a previous position and the cost of settling down in a new position.

As mentioned earlier, another factor impacting the effort barometer of the individual is the principal-agent effect which is not addressed in neoclassical theory. In addition to these factors, other sources of X-efficiency such as inter personal communication effects can have a role. Clearly, the extent of what and how much these factors impact output are case specific.

Even though there is no direct indication in the X-efficiency literature to Marx (1867) labour process theory, Leibenstein’s explanation of the causes of X-efficiency resonates with parts of Marx idea of the dynamics between the employers and employees within the production process. The underpinnings of the internal and external pressures on constraint concerns that Leibenstein (1978) introduces as the causes of X-inefficiency are partly explained by the conflict of interest between the employers and employees in Marx’s work. So the more internal pressure on constraint concerns is reduced due to a more powerful labour union the less efficient the production will be.

Nevertheless, referring to it as an incompletely specified model Stigler (1976) and others question the very existence of X-inefficiency by proposing the leisure argument. They argue that if the worker is not contributing to the firms’ production it is expending energy in producing leisure and thus the lazy worker is as efficient as the most hard-working one. Consequently, regardless of the emphasis of X-inefficiency firms are producing on the production possibility frontier.

What is essentially important here is that Leibenstein did assume that individuals can make avoidable errors in their income-leisure trade-off choice due to laziness and wrong habits (Frantz, 1992). Thus, if leisure is seen as such it means that competitive firms produce more commodity output and less leisure whereas monopolies create more leisure and produce fewer commodity output. So people are as likely to prefer the monopoly bundle of commodity and leisure over the competitive bundle. In this way, the monopolist can be considered as allocatively efficient as the competitive producer. Thus, if leisure is viewed as such, not only X-efficiency does not exist but also allocative efficiency should not exist. This is simply not the case. Frantz (1992) also discusses the other theoretical arguments against the existence of X-efficiency, and after presenting counter arguments concludes that X-efficiency is a determining element in growth and its criticism is mainly a cause of the critics' models and language use.

Since the 'micro-micro' model proposed by Leibenstein (1978), the quantification of the X-efficiency concept and the welfare analysis based on this notion has not progressed as fast as other literature in this field. Furthermore, a consistent methodology seems absent due to the main reason that establishing an appropriate counterfactual in order to compare to actual performance seems challenging (Button and Weyman-Jones, 1994). However, in a related field of research, the technical efficiency literature was making fast progress.

### 6.2.2 Technical Efficiency

*Concept*

The first paper formally defining technical efficiency was the work of Koopmans (1951) in which he defined a technically efficient producer as one that cannot produce more of one output without either reducing the production of another output or using additional input. Following this, Debreu (1951) and Shephard (1953) then complemented Koopmans work by incorporating the concept of distance functions in order to measure the radial distance of the producer from the frontier by output oriented and input oriented models respectively.

In the first empirical attempt to measure technical efficiency Farrell (1957) used a mathematical linear programming approach. He also defined the duality of cost efficiency and using this concept, he decomposed economic efficiency into technical and allocative elements.

Within the efficiency literature technical and X-efficiency are sometimes are used interchangeably which can be misleading. One of the major differences between X-efficiency and technical efficiency is that the former questions the conventional assumption of rational behaviour by the economic agents and looks at the causal relationship of efficiency, where as technical efficiency literature based on Farrell (1957) focus on the measurement issue and highlights the technical aspect of production and management staying within the neo-classical modelling frameworks. In this respect technical efficiency corresponds with the neoclassical framework but as mentioned above X-efficiency does not. This distinction is highlighted by Leibenstein (1977) himself. He explains that the cause of X-inefficiency is not solely a technical issue but one that is intrinsic to human organisation which can be both due to factors within (such as relationships between employees) and outside the firm (such as cultural background of workers). This is quite distinct from the notion of technical inefficiency that sees the problem only inside the firm and a lack of management which can be interpreted as a factor similar to normal inputs.

Nevertheless, due to the difference of the motive of the two literatures (measurement vs. examining motivation and managerial objectives), they could have a complementary relationship. Technical efficiency can be a baseline for measuring X-inefficiency. Even though the assumptions of X-inefficiency are not necessarily met in technical efficiency measurement, it does still provide an index of the extent to which costs have not been minimised (Button and Weyman-Jones, 1994).

*Determinants*

An additionally interesting research question is to examine the underlying causes and external factors that explain the variation in efficiency estimates amongst a given set of firms. These factors are external in the sense that they are neither inputs nor outputs but have an effect on the firm’s production and characterise the environment of where production takes place. These environmental factors can impact production by either influencing the technology structure of production or the efficiency of transforming inputs into outputs.

A lack of a widely accepted theoretical model of technical efficiency determinants has meant that different studies have introduced variables according to the specific observations of their interest. However, these determinants are predominantly related to examining the effects of competitive conditions, heterogeneity and the organisational characteristics of each group on their relative efficiencies (Caves and Barton, 1990).

Variables representing competitiveness or market conditions are considered to be the most important determinants. Carlsson (1972) and Caves and Barton (1990) claim that higher competition facilitates the circulation of information which can then translate to higher efficiency in production. The market conditions of the country and the industry is the background that the firm operates and partially defines the set of production strategies and techniques available to the firm to pursue. Various factors shape the market conditions, including but not limited to, property rights, labour market flexibility, existing market size or heterogeneity, trade openness and credit access. For example, in some studies, tests relating technical efficiency to product heterogeneity are carried out. The more heterogeneous the industry is the more their costs on research and development (R&D) would be. This could entail higher innovation rate and when complemented with higher advertising expenditure, it can be translated to higher efficiency (Alvarez and Crespi, 2003).

On the other hand, other variables are internal to the firms. These factors can mainly be described by organisational characteristics of firms which are the true source of variations between firms in a given business climate. Examples of such factors include the acquisition of new machinery and fuel intensity. These variables can proxy the occurrence of change and innovation in that firm, which in turn, can explain higher efficiency levels in firms that undertake these expenditures. Other firm characteristics have also proved significant results in the literature. These include the firm size, ownership, education of the employees and inter-firm relations.

### 6.2.3 Iranian Manufacturing

As discussed in the previous chapter, the introduction of modern manufacturing production was conducted by the state more than half a century ago and gradually became a significant component of the Iranian economy. Nevertheless, it has been strongly influenced, supported and mainly protected by various governments throughout its history. This has meant that even today, manufacturing in Iran is heavily dependent on oil money in various aspects such as project financing and imports of necessary machinery. In the existing literature explaining the effect of oil revenues on economic efficiency have mainly focused on the inefficiency of resource allocation due to the presence of the state. Thus, our objective here is to complement this literature by examining the technical efficiency side of the oil-efficiency hypothesis.

Thus, looking at these policies and their implications on the production behaviour of manufacturing sector can be helpful in explaining why some firms outperform others in terms of efficiency. Crucially, the oil income has considerably shaped the market structure and other determinants of technical efficiency.

One important factor in the more contemporary context is the effect that the 1978 revolution had on the ownership status of these companies (see Chapter 3). Due to the subsequent appropriation of factories and companies after the revolution ownership can give a great amount of explanation on the nature of the technical efficiency of the industry in Iran. The initial emergence of the foundations or bonyads was a result of these changes in ownership. Ironically, they have also increased their presence through the recent privatisation attempts. These factors emphasise the significance of firm ownership in our micro analysis of efficiency.

The post-revolution period not only affected the ownership of assets and production but also changed the openness of the economy. This was initially due to the political events after the revolution and the unilateral sanctions and asset freezes that were placed on Iran by the US and more recently by the EU due to Iran's nuclear programme. These events have led to the country's economic policy-making be (to a large extent) reluctantly pushed towards inward looking or self-sufficiency routes by means of various tariffs, quotas and subsidies. It should be noted that despite this, during the post revolution period distinctive attempts of liberalisation and greater integration with the world economy have been made. Most noticeably, these efforts started after the war with Iraq in the late 1980s in the presidency of Rafsanjani (See Chapter 3). The extent of dependence is even more acute in manufacturing production where a large amount of machinery and often material is imported due to lack of know-how inside the country.

The competitiveness of manufacturing firms is largely constrained by the amount of political connections and influence of the owners. A closer tie to the key political factions often translates to cheaper credit and other favourable cost rates. Competition is also restricted via the presence of the aforementioned semi-governmental foundations which many of them are much larger than the average private firm in terms of employees and scale of operations. Thus, cautiously interpreting the size-efficiency relationship we can verify these claims.

## 6.3 Methodology Theory

In this section we discuss the two most widely applied methodologies in the technical efficiency literature. Normally, models using efficiency are constructed based on two complementary components. The first component deals with establishing estimates and the second component consists of determining what exogenous factors have a meaningful explanatory power in explaining efficiency estimate variations between observations. As we will discuss, some studies take a two-stage approach. Others criticise this method and conduct both stages simultaneously. Below we will introduce and discuss these two parts of research from a theoretical perspective.

### 6.3.1 Efficiency Estimation

The most widely used methods of establishing technical inefficiency estimates are the stochastic frontier analysis (SFA) and the data envelopment analysis (DEA) techniques. Both of these methods have been applied to different cases at different levels of aggregation (Cook et al., 1990; Leibenstein and Maital, 1992; Majumdar, 1995). Nevertheless, the most successful empirical studies for confirming non-allocative efficiency theory which have applied these techniques have been at the industry or firm level.

Before moving on to the developments of these two approaches it is worth mentioning that building on the work of Farrell (1957), some studies have measured both allocative and technical efficiency using shadow profit or cost function procedure using a deterministic (Atkinson and Cornwell, 1994; Parker, 1995) or stochastic frontier (Fan, 2000) model. The shadow profit approach was first suggested by Lau and Yotopoulous (1971).

#### 6.3.1.1 Data Envelopment Analysis (DEA)

The linear programming method was first applied by Farrell (1957). Through the work of Charnes, et al. (1978) this evolved to the current form nonparametric linear programming method which is more often referred to as data envelopment analysis (DEA). In this approach efficiency estimates are obtained in a pure relative manner by comparing each unit to the best performing one. The best performing firm acts as a benchmark and roughly is the equivalent to a production frontier line. The estimation is achieved either through an output-oriented analysis where the maximum output for given levels of inputs is derived or by an input-oriented scope where minimum inputs needed for achieving a certain level of outputs are constructed. Consequently, the deviations of other decision-making units (DMUs)[11] from the optimum case defines their relative technical inefficiencies and allows for a measure of comparison not only for the firms' performance evolution along time but also its relative position to the others in the same cohort (Charnes, et al., 1994). The DEA approach is a non-parametric method so there is no need for assumptions on a production function and specification problems associated with it. It accommodates analyses on multiple outputs and inputs and can take returns to scale into consideration. Simply put, the DEA approach has minimum a priori assumptions on the production activities (Majumdar, 1995) and is reasoned to be more suitable in estimating technical efficiency.

We can formulise the general DEA as a model which establishes the frontier as a convex industry-wide hull of $n$ firm observations. Where, $\mathbf{X}$ and $\mathbf{Y}$ are the inputs and outputs of all observations within the industry in question. By defining vector $\mathbf{x}$ and scalar y as the set of inputs and output values of a specific firm, the solution to the below linear programming model is the efficiency index, θ, for a given firm:

[11] Due to a more diverse field of application of DEA in contexts such as schools, intra-firm departments, etc. the units of analysis are referred to as DMUs instead of firms.

Choose $\{\theta, \boldsymbol{\lambda}\}$ to: min $\theta$ such that:

$$\theta\mathbf{x} \geq \boldsymbol{\lambda}'\mathbf{X} \tag{6–1}$$

$$y \leq \boldsymbol{\lambda}'\mathbf{Y}$$

$$\lambda_i \geq 0, \qquad \sum \lambda_i = 1, \qquad i = 1, \ldots, n$$

Here, $\boldsymbol{\lambda}$ is an intensity vector which forms convex combinations of the input vectors and output vector in the sample at hand. The solution to the above model ($\theta^*$) is the fraction that a firm can multiply the inputs it uses and still manage to produce more (or equal) output. So $\theta^* = 1$ means that it is not possible for the DMU to obtain the same output with lower inputs, in other words, it is an efficient DMU. So the presence of technical inefficiency would mean that $\theta^*$ is smaller than 1. The variable return to scale assumption can be relaxed by relaxing the constraint on the weights to $\sum \lambda_i \leq 1$ resulting in a non-increasing return to scale model.

### *DEA Limitations and Remedies*

A number of shortcomings for the DEA method have been raised by critics of the procedure. First, it is claimed that this approach does not factor in the environmental differences among the DMUs. For example, in contrast to what the conventional DEA approach assumes, in practice, not all of the observations would have access to the same technology and also barriers hindering the implementation of the best available technology may exist. In other words, the choice of technology solely depends on the firms' own preferences. Various studies have linked the inefficiency question to the very same technology acquisition issue at different levels of aggregation. Stewart (1977) attributes the notion of inefficiency for LDCs to their inability in adopting 'appropriate technology' which is restricted by the technology that is at their disposal. Clearly, choosing the right technology is a factor of the known techniques and more crucially the available methods to that unit or country. Therefore, the fundamental criteria would be the selection process that results to an appropriate technology which would be an ideal fit for the characteristics of that firm or country. Thus, it would be more than likely that in the absence of competitive pressure, appropriate technology adoption will be far from optimum not only due to X-inefficiency attributes of the production process but also the technology access limitations due to factors such as principal-agent relations.

The other drawback of the traditional DEA is that it does not take into account the potential slacks in the inputs and outputs and thus the efficiency measures are argued to be imprecise. The third criticism of this model is that due to it being a deterministic approach, it does not consider statistical error or exogenous shocks. Finally, from an empirical point of view the estimates obtained by DEA appear to be sensitive to the aggregation of the inputs. Generally, the more disaggregated the inputs are defined the higher efficiency estimates tend to be (Gempesaw, 1992).

In order to remedy these limitations a number of studies have attempted to build upon the initial model and make it more accommodating. Banker and Morey (1986), propose a DEA model where the environmental effects are explained exogenously. They index the DMUs with reference to their operating environment. A three-stage DEA procedure was presented by Fried, et al. (2002) to decompose the distance from the optimum case into statistical error, environmental effect and managerial efficiency. In this hybrid procedure, after establishing the raw efficiency score in the first stage, stochastic frontier analysis is applied to the total slacks where the regressors are the environment factors. This decomposes the slacks into the above mentioned components. Finally, in the third stage the inputs or outputs data are adjusted according to the components and then DEA model is employed. In an empirical study, Lan and Lin (2004) conduct a four-stage DEA approach and argue that conventional DEA approaches can underestimate the measurements of efficiency.

#### 6.3.1.2 Stochastic Frontier Analysis (SFA)

Parallel to the above developments, the work of Farrell was also extended to a deterministic frontier approach with a positive error term of inefficiency (Aigner and Chu, 1968; Seitz, 1971; Afriat, 1972). Later, the stochastic frontier approach was proposed simultaneously in the studies of Aigner, et al. (1977) and Meeusen and van den Broeck (1977a).

The general stochastic frontier analysis is based on an assumption of a parametric frontier of either a production, cost or profit function. In the case of the stochastic production frontier (SPF), also referred to as output oriented approach, the maximum obtainable output by a vector of inputs $\boldsymbol{x}_i$ is assumed as a function such as $f(\boldsymbol{x}_i)$.

However, the production of the typical firm falls short of this amount by $\epsilon_i$, as below:

$$\ln y_i \;=\; \ln f\,(\boldsymbol{x}_i)\; + \epsilon_i \qquad\qquad \epsilon_i \leq 0 \tag{6–2}$$

Consequently, the dual relationships for the cost and profit frontiers can be expressed as below:

$$\boldsymbol{w}'\boldsymbol{x}_i \;=\; C\,(y_i\,,\boldsymbol{w}_i)\; + \epsilon_i \qquad\qquad \epsilon_i \geq 0 \tag{6–3}$$

$$p y_i - \;\boldsymbol{w}'\boldsymbol{x}_i = \;\pi(\boldsymbol{w}\,,p)\; + \;\epsilon_i \qquad\qquad \epsilon_i \leq 0 \tag{6–4}$$

Where $\boldsymbol{w}$ is the vector of input prices and $p$ is the output price. In this approach, the error term in the regression of the stochastic frontier is assumed to be composed of a normal distributed noise term $v$ and an element of technical inefficiency $u$ which is deemed to have a one-sided or asymmetric distribution. Due this assumption the SFS method is also called the composed error frontier. We can re-express (6–2) as:

$$\ln y_i = \;\ln f\,(\boldsymbol{x}_i)\; + \;v_i \;-\; u_i \qquad\qquad u_i \;\geq\; 0 \tag{6–5}$$

The noise term $v$ is a way of dealing with random shocks due to statistical noise such as measurement and aggregation errors. It also incorporates changing environmental factors such as weather conditions or physical conditions of the specific observation. Unlike normal regression analysis when estimating Equation (6–5) the main objective is not estimating parameters of the production function $\ln f(\boldsymbol{x}_i)$. Rather it is attempted to somehow obtain an index related to $u$ as a measure of technical inefficiency.

The difference between technical inefficiency $(u)$ and the second component $(v)$ is that the former is asymmetrical whereas the latter is symmetrical. For example, weather conditions can have both positive and negative effects on output and thus has a symmetrical distribution. This allows the identification of the two elements at the estimation stage.

It should be mentioned that the distribution that is assumed for $u$ in the analysis is mainly a choice of the researcher. The distribution is one of the half normal, truncated normal, exponential or gamma distributions. The choice of either of these will lead to different estimates but in reality there is no a priori reason or argument to prefer one distribution over another (Coelli, et al., 2005). This is why some studies consider all three cases and report the results for each case (Forsund et al., 1980).

*SFA Limitations and Remedies*

A number of weaknesses have been regularly associated with the stochastic production frontier analysis approach. First, there is no prior knowledge on the validity of the distribution assumptions made with regards to the composed error term. Thus, the choice of a half-normal versus an exponential distribution (or any other distribution) for the $u$s are made on an ad-hoc basis. Second, in the earlier days of research it was argued that it would not be possible to actually decompose the difference between the actual and potential outputs into $u$ and $v$ and have a firm specific measure of inefficiency. Therefore, only average measures of inefficiency for the industry were largely used. This criticism was short lived since Jondrow et al. (1982) showed that the mode or mean of the conditional distribution of $E[u_i|(v_i - u_i)]$ could be used as estimates of firm specific efficiency (This estimate is presented in Chapter 7). Third, in practice the measurement of technical inefficiency will include the input price inefficiency as well. This is not a problem of the model however. Subject to data availability on factor prices, it can be shown that a simultaneous input demand frontier can be constructed to deal with this problem (Yoo, 1992).

*Regression Estimation*

The estimation of Equation (6–5) is carried out using either maximum likelihood (ML) estimation or the Corrected Ordinary Least Squares (COLS) method proposed by Aigner et al. (1976). We provide a brief explanation on COLS procedure is given as it can help clarify the concept better.

Corrected OLS is a convenient approach of providing consistent estimators for the SFA regression. Denoting $\mu \equiv E(u) > 0$, we can rewrite Equation (6–5) in the following manner:

$$\ln y_{\mathrm{i}} = -\mu \;+\; \ln f(\boldsymbol{x}_i) \;+\; (v_i - u_i + \mu) \qquad u_i \geq 0 \qquad \textbf{(6–6)}$$

This equation satisfies all the assumptions to apply the usual OLS apart from the normal distribution of the error term due to the asymmetric distribution of $u$. By assuming linear parameters in $\ln f\ (\boldsymbol{x}_i)$, OLS will provide unbiased estimator for the parameters apart from the intercept which would be biased by $\mu$. So what is left now is to have a consistent estimator of $\mu$ based on the distributions of $v$ and $u$. Weinstein (1964) obtained the expression for $\mu$ from the probability density function of $\epsilon$ as below:

$$E(\epsilon_i) = E(v_i - u_i) = E(-u_i) = -\mu = -\sigma_u\sqrt{\frac{2}{\pi}} \quad \textbf{(6–7)}$$

Hence, if we obtain a consistent estimator of $\sigma_u$ which can be obtained from the second and third central moments of the residual $\epsilon$ ($m_2(\epsilon)$ and $m_3(\epsilon)$) we would have:

$$\sigma_u^2 = \left[\sqrt{\frac{\pi}{2}}\left(\frac{\pi}{\pi - 4}\right) m_3(\epsilon)\right]^{2/3} \quad \textbf{(6–8)}$$

$$\sigma_v^2 = m_2(\epsilon) - \left(\frac{\pi - 2}{\pi}\right)\sigma_u^2 \quad \textbf{(6–9)}$$

Consistent estimators for $\sigma_u^2$ and $\sigma_v^2$ are obtained by using the samples moments $\widehat{m}_2$ and $\widehat{m}_3$ (Yoo, 1992). Consequently a consistent estimator of $\mu$ will be obtainable using Equation (6–7).

What is crucial to bear in mind before estimating the above regression is that this procedure is almost entirely dependent on the correct skewness of the residuals. In other words if the assumptions are violated there is the possibility that the standard deviations of $v$ and $u$ cannot be calculated due to them equalling the square root of a negative number. Two main problems can arise here. The type I failure occurs if the skewness of the overall residual ($\epsilon$) is positive and the second type failure can arise if the variance of $u$ is greater than $\epsilon$ (Yoo, 1992). This drawback of the COLS urges careful interpretation of the estimates.

*Technical Efficiency Estimates*

Apart from the method of Jondrow et al. (1982) on obtaining firm-specific estimates, different average measures of technical efficiency have been proposed in various studies, as a sector or industry level measure. However, there is no a priori criterion to prefer one to the other. The most widely used measures are (Yoo, 1992):

$$EFF = 2\exp\left(\frac{\sigma_u^2}{2}\right)[1 - \Phi(\sigma_u)] \qquad \textbf{(6–10)}$$

The $EFF$ measure of technical efficiency was proposed by Lee and Tyler (1978) as the expected value of the ratio of the actual observation of output, $f(x) \cdot \exp(v - u)$ to the optimum output on the production frontier, $f(x) \cdot \exp(v)$. Here, $\Phi$ is the standard normal distribution function. So $EFF$ falls between 0 and 1 and the more efficient the observation the closer this measure is to 1.

$$ATI = \frac{\sigma_u\sqrt{2/\pi}}{\overline{\ln(y)} + \sigma_u\sqrt{2/\pi}} \qquad \textbf{(6–11)}$$

Average technical efficiency ($ATI$) measures the disparity of the production frontier and the average production function (the numerator), which is normalised by the mean of the production frontier measured on the y axis (the denominator). Similarly, $ATI$ is constrained within the (0, 1) interval and in the occurrence of a type I failure $ATI = 0$ and $EFF = 1$.

$$\lambda = \frac{\sigma_u}{\sigma_v} \qquad \textbf{(6–12)}$$

Here, $\lambda$ indicates the degree of asymmetry present in the distribution of $\epsilon = (v - u)$ since we have assumed a half normal distribution for $u$ and a normal distribution for $v$. In other words, $\lambda$ is a measure of technical inefficiency ($\sigma_u$) normalised by the degree of variation in the SPF function ($\sigma_v$). Thus, indirectly, it shows whether the gap between $y$ and $f(x)$ stems from $u$ or $v$.

$$S = \frac{m_3(\epsilon)}{[m_2(\epsilon)]^{3/2}} \qquad \textbf{(6–13)}$$

Another measure is the skewness of $\epsilon$, denoted as $S$, which is directly related to $\lambda$ under Equation (6–8) and Equation (6–9). Since higher levels of technical inefficiency cause a more negative skewness in the distribution of $\epsilon$, $S$ can be used as a measure of technical efficiency. In the case of type I and II failures $S$ exists but $\lambda$ is not defined. It is clear that unlike $ATI$ and $EFF$, here, $\lambda$ and $S$ comprise of both $\sigma_u$ and $\sigma_v$. Nevertheless, it can be seen that all four measures are independent of inputs.

*The Production Function*

The estimates obtained by the methods above explicitly depend on the specification of the production function $f(x)$ and also the distributions that have been assumed for the two components of $\epsilon$. Different functional forms of production can be used and tests can be carried out to compare the results to establish the best fit. The most widely used functional form in the literature is the transcendental logarithmic functions (Translog) model which can be appropriate due to fewer prior constraints as compared to the Cobb-Douglas or Constant Elasticity of Substitution (CES) specifications where, for example, output elasticity is assumed to be constant. This can be useful especially if there is considerable heterogeneity of observations within different industries regarding returns to scale (Harris, 1989).

#### 6.3.1.3 DEA - SFA Analysis

The main theoretical difference between the two methods discussed is that in parametric techniques such as SFA, the frontier (e.g. production) represents an assumption of maximising behaviour. This is intrinsic to the notion of the production function involved that is estimated through the use of each firm's input output data. Thus, contrary to nonparametric models such as DEA, X-inefficiency will not be incorporated in parametric models (Weyman-Jones and Button, 1992).

Empirically, different studies have compared these two methods and have shown that they can yield to different results with the same data. Furthermore, disparities between the assumptions made by researchers in implementing each method can not only exacerbate the divergence in the results for a given firm but it can also translate to contradicting ranking of firms or units studied (Button and Weyman-Jones, 1992). On the other hand, a number of studies have concluded that the two methods appear to be compatible and converge to similar results (Resti, 2000; Uri, 2001).

This obviously would make the comparison of the results between the two measures of efficiency problematic and thus a body of literature has focused on comparing the two measures. The main theoretical difference between the two methods is that in parametric techniques such as SFA, the frontier (e.g. production) represents an assumption of maximising behaviour. Thus, contrary to nonparametric models, X-inefficiency will not be incorporated in parametric models (Weyman-Jones and Button, 1992).

The SFA approach is predominantly applied in economics research whereas the DEA approach is used by operations and managerial researchers particularly in the public sector since it is often likely that output prices cannot be specified. For the majority of their existence they have been developing almost independently. Most studies on the comparison of DEA and SFA have tried to conclude a clear cut answer on the preference of one over another based on different scenarios such as level of noise in the data (Banker, et al., 1993; Yu, 1998). Basically, these studies suggest that DEA is more appropriate where the neoclassical behavioural assumptions are in question or where data accuracy does not pose a great threat. On the other hand SFA is more useful when simple production forms have a good explanatory power of the effect of technology on production levels or when statistical errors are important.

However, more recently, attempts of bridging the two almost separate fields of DEA and SFA have been made. The relationship between the two has been redefined as a complementary association and some studies have adopted a hybrid strategy of DEA and SFA (Ferrier and Lovell, 1990; Sengupta, 1998) and an increasing number of studies use both methods simultaneously in order to compare and show a more comprehensive attempt of efficiency estimation. Mortimer (2002) provides a list of 41 of these studies and the results of their comparisons.

### 6.3.2 Efficiency Determinants

The way the determinants or exogenous factors are incorporated in the model has also evolved and has been implemented in a number of different ways in various studies. Overall three main approaches have been suggested in the SFA literature.

The first method is a single stage approach mostly used in the earlier studies on efficiency. Here it is assumed that the exogenous variables influence the production process itself, for example, in transportation studies, network characteristics influences the production technology itself. Thus, $\boldsymbol{z} = (z_{1,} z_2, \dots, z_Q)$ or the vector of exogenous variables enters the SFA model directly alongside other inputs.

$$\ln y_i = \ln[f(\boldsymbol{x}_i, \boldsymbol{z}_i)] + v_i - u_i \qquad u_i \geq 0 \tag{6–14}$$

Equation (6–14) can be estimated similar to a normal SFA model. However, here an additional assumption arises and that being $\boldsymbol{z}$ is uncorrelated with $\boldsymbol{v}$ and $\boldsymbol{u}$ similar to $\boldsymbol{x}$. In this method the differences in efficiencies are not explained but only a more accurate possibility frontier is constructed.

The second approach is different since it attributes the estimated efficiency variations to differences of the environmental variables. In other words unlike the first approach here it is assumed that the $z$ variables influence efficiency itself and not the production structure. Thus, after estimating the efficiency scores from Equation (6–5) in the first stage, in the second step these efficiency scores are regressed on the exogenous variable vector according to Equation (6–15):

$$E(\boldsymbol{u}_i | \boldsymbol{v}_i - \boldsymbol{u}_i) = g(\boldsymbol{z}_i; \boldsymbol{\delta}) + \boldsymbol{\varepsilon}_i \tag{6–15}$$

Here $\boldsymbol{\varepsilon}$ is an independent identically distributed error term and $\boldsymbol{\delta}$ is a parameter vector that is estimated.

The second approach is argued to have serious econometric problems. One problem is that in the first stage COLS or ML estimation we need to assume that $\boldsymbol{z}$ and $\boldsymbol{x}$ are uncorrelated otherwise the estimates will be biased. However, if in the second stage we need to assume that $\boldsymbol{z}$ is correlated with $\boldsymbol{u}$, this means that we should have included $\boldsymbol{z}$ in the first model to avoid the problem of omitted variables and biased estimates. Furthermore, the two step method will still cause a bias in the $\boldsymbol{\delta}$ even if $\boldsymbol{z}$ and $\boldsymbol{x}$ are independent. The reason is that $\hat{u}_{\boldsymbol{i}}$'s are calculated via the shrinkage of $[\ln y_i - \ln f\ (\boldsymbol{x}_i)]$ and the amount of shrinkage depends on the relative variance of $v_i$s and $u_i$s but if the all $u_i$s are deflated by the same $\sigma_u^2$ then $\hat{\boldsymbol{u}}$ will be underdispersed and thus the influence of $\boldsymbol{z}$ on $\boldsymbol{u}$ will be underestimated (Schmidt, 2011). What follows is that simple tests on the significance of the relationship between $\boldsymbol{z}$ and $\boldsymbol{u}$ ($H_0$: $\boldsymbol{\delta} = \boldsymbol{0}$) will ultimately be invalid since the error in estimating $\hat{\boldsymbol{u}}$ affects the distribution of the test statistic. The other obvious contradiction is that in the first stage $\boldsymbol{u}$ is assumed to be identically distributed however in the second stage a functional relation between $\boldsymbol{u}$ and $\boldsymbol{z}$ is assumed (Kumbhakar, 2000).

The second stage is also carried out in the DEA approach to investigate the differences in efficiency figures obtained from the preceding mathematical programming technique. In the DEA approach, Equation (6–15) is estimated using a Tobit model since the dependent variables have to be censored to be between 1 and 0 and thus OLS is inappropriate. It is worth mentioning the two stage method for DEA models avoids these problems due to the underlying procedure in evaluating inefficiency (Schmidt, 2011) but still relies on heavily restricting assumptions that often are questionable (Simar and Wilson, 2011). An alternative method used in Barnum and Gleason (2008) is a two stage reverse application of the second approach where initially the relation of production values and the external variables is examined and then the estimation stage is implemented which allow the correction of the bias and imprecision.

Finally, the third popular approach in incorporating determinants is the simultaneous two stage approach introduced by Battese and Coelli (1995). This approach has been widely implemented in more recent empirical research. They express their procedure for panel data which will also mean that the vector $z$ can include time varying explanatory variables. Assuming $u$ to be $N(\mu_{it}, \sigma_u^2)$, they express the model of inefficiency effects as:

$$\mu_{it} = z_{it}\boldsymbol{\delta} + w_{it} \tag{6–16}$$

Here $w_{it}$ is a random variable defined by the truncation of the normal distribution with zero mean and variance $\sigma^2$, such that the point of truncation is $-z_{it}\boldsymbol{\delta}$. To estimate Equations (6–5) and Equation (6–16) simultaneously the method of maximum likelihood estimation has been used. The likelihood function is expressed in terms of the variance of the parameters $\sigma_S^2 \equiv \sigma_v^2 + \sigma^2$ and $\gamma \equiv \sigma^2/\sigma_S^2$.

Hence in a cross sectional representation of the model, technical efficiency for the $i$th firm is defined as:

$$te_{\mathrm{i}} = \exp(-u_i) = \exp(-z_i\boldsymbol{\delta} - w_i) \tag{6–17}$$

## 6.4 Empirical Survey

Empirical applications of stochastic frontier efficiency analysis have been carried out within a myriad of contexts in economics, management science and operational research literatures including fields as diverse as manufacturing and banking to policing and municipal services. An indicative (but certainly not exhaustive) list of these studies based on area of research is given in Fried, et al. (2008).

This wide spectrum of fields dealing with efficiency has adopted different components of different theoretical models in order to adapt their analysis according to the specific context of their research. As a result, efficiency analysis has been increasingly treated in a topical manner. A review of this literature would shed light on the benefits and disadvantages of each component for different research objectives. Consequently, the ranges of efficiency estimates themselves are quite varied. One of the earlier studies, Pitt and Lee (1981), looks at Indonesian weaving industry and based on different specifications, report efficiency estimates between 61.8 % and 76.6%. This is analogous to the 62.5% estimate of Lee and Tyler (1978) for overall Brazilian industry and Tyler and Lee (1979)'s 55.4% and 55.8% for Columbian apparel and footwear industry. However, these values were considerably lower than the 90.9% reported in Meeusen and van den Broeck (1977b) for the French Textile industry.

The lack of a well-founded theoretical framework is even more evident when it comes to establishing determinants of efficiency which demonstrates the difficulties involved (Lundvall, 1999). As Karamagi (2002) notes, the choice of variables to be included in the technical efficiency model is mainly based on little more than common reasoning.

Here we will investigate the differences between these studies with the aim of constructing an empirical model relevant to the case of Iran. In this respect the survey is not attempting to be exhaustive, but tries to review that part of the literature which can help develop our empirical model of Iranian industry.

### 6.4.1 Survey of determinants

As it has already been mentioned the list of empirical studies looking at technical efficiency using firm-level data is quite diverse, this is indeed the case for manufacturing firms. The problem of identifying which determinants directly contribute to economic growth in a more broad sense has also not been entirely resolved in the economic growth literature. Sala-i-Martin (1997) identifies around 60 variables from the growth literature which have at least in one instance been proven to be significant. Even though tests of robustness of these variables have been suggested initially by Levine and Renelt (1992) and a less extreme test by Sala-i-Martin (1997), the empirical models in the growth literature have predominantly chosen variables based on the availability of data or certain contextual parameters of their specific research question.

The efficiency literature has also mainly drawn inspiration from the productivity literature, and for the major part, it has had a similar experience. We begin with a look at empirical findings on the influence of different variables on efficiency. As noted above, it is important to remember that different firm-level studies of efficiency have adapted their research based on their research objective. It seems that some studies start off with a priori hypotheses to show a relationship between a few (normally one or two) main firm characteristics and efficiency. Often in these studies the title of the work even highlights their approach. Other works undertake a more exploratory approach. They generally include all relevant variables in the model to see which determinant has the most significant effect.

Finally, some studies pursue only estimation of efficiency with the aim of relating it to more macro measures such as country productivity and do not incorporate the determinants formally in the manner discussed so far. We will review all types of research based on their findings and relate them to each possible efficiency determinant.

#### 6.4.1.1 Size and Age

In most studies it is generally argued that larger firms should be more efficient. Some explain this because of their advantages in terms of organisation and technical knowledge. Also, older firms are expected to produce more efficiently due to LBD gains and their survival through a longer period.

Using the two-stage procedure, Pitt and Lee (1981) find three firm characteristics, size, age and ownership to have an important role in explaining technical efficiency. Interestingly, the effect of age was found to be negative and the size variable (proxied by number of workers) had a positive effect on efficiency estimates. The negative age effect is again confirmed in the Indonesian garment industry by Hill and Kalirajan (1993). This might be explained by the fact that a large number of the young firms were foreign firms with superior technical know-how (Pitt and Lee, 1981).

In a study of the effect of size on technical efficiency in Indian industries (shoes, printing, soap and machine tools), Page (1984) finds a maximum measure of 68.8% and a minimum of 42.4% respectively for the machine tools and shoe manufacturing based on a deterministic frontier in the first stage. In the next stage he shows that the machine tool sector is the only industry in which firm size displays a significant positive effect on the estimates. Furthermore, for at least one or more sectors, firm characteristics of employee experience, age, capacity utilisation and entrepreneur experience proved significant determinants.

Other works including Mengistae (1996) for Ethiopia, Brada et al. (1997) for Czechoslovakia and Hungary (using value added as a proxy for size) and Lundvall and Battese (2000) for Kenya, find a positive size-efficiency relationship. Soderbom and Teal (2004) find a significant quadratic relationship of firm size, meaning that a threshold in this relationship exists in a study of manufacturing in Ghana. Similarly, Chow and Fung (1997) and Alvarez and Crespi (2004) do not find a simple linear size-efficiency relationship. Both studies report a u-shaped picture with the biggest and smallest firms being more efficient than the firms in the middle of the size distribution.

Furthermore Alvarez and Crespi (2004) find evidence for a positive age-efficiency effect. This is in contradiction with related works such as Patibandla (1998) where an inverse u-shaped relationship describes the medium-sized firms as relatively more efficient than the other two groups.

#### 6.4.1.2 Ownership

*Foreign or domestic*

Domestic ownership can have a positive effect on firm efficiency since firms owned by foreigners might be less familiar with the local environment. Pitt and Lee (1981) find a significant negative effect of foreign ownership on firm efficiency in Indonesian weaving sector. At the same time, local owners might be less efficient due to less experience or lack of knowledge or culturally be less receptive of new but more efficient techniques (Chen and Tang, 1987).

*Private or public*

One of the key motives behind the pursuit of privatisation that has always been argued is the productivity and efficiency gains that are followed through more accountability and more competition of firms. Bottasso and Sembenelli (2004) show that in the context of large Italian manufacturing firms, the identity of the ultimate owner matters and privatisation brings efficiency improvements.

#### 6.4.1.3 Openness and competitiveness

Market openness in terms of exports has usually been explained on two grounds to enhance efficiency: (i) export is a learning by doing process itself which enhances firm productivity; (ii) the most efficient firms can survive the competitive markets; hence this is called the selection process.

It is also argued that export oriented growth strategy makes firms more efficient compared to import substituting policy. One reason is that under import substitution firms are protected by tariffs and subsidies and hence tend to be less efficient. In a study of foreign firms in Taiwan electronics industry, Chen and Tang (1987) estimate export oriented firms to have an average efficiency of 72% and the import substituting oriented firms 60.4%. After controlling for other characteristics they test the hypothesis of equal efficiency in the two groups but manage to reject it at 2.5% level and conclude that export oriented firms tend to be more efficient. Similarly, Hossain and Karunaratne (2004) reject the null hypothesis of no export orientation effect on levels of efficiency in a study of trade liberalisation in the Bangladeshi manufacturing sectors. Other empirical studies including Clerides, et al. (1998), Sun et al. (1999) and Bechetti and Sierra (2003) also provide evidence of this positive relationship.

Other channels of international exposure such as FDI and licensing have also been argued to affect production efficiency especially in country-level studies (Bhagwati, 1978). However, the FDI literature goes further to suggest a large magnitude of spill-over effects of increased efficiency in other industries in the host country due to the presence of foreign firms (Markusen and Venables, 1999).

#### 6.4.1.4 Subsidy

Martin and Page (1983) find an average technical efficiency of 72.4 and 84.4% for logging and sawmilling industries in Ghana. Via the two stage procedure, they attempt to look at managerial factors that could explain the difference of technical efficiency (or as they refer to it, X-efficiency). The only factor that displayed significant explanatory power for the efficiency estimates for both industries and different model specifications was the dichotomous subsidy (government loan) variable which showed a negative effect on technical efficiency. Focusing on Italian manufacturing, Sena (2006) also argues that with less access to external financial resources and grants, firms will be forced to become more technically efficient.

#### 6.4.1.5 Geography

The location advantage of firms has been shown to be a factor in their level of technical efficiency. Obvious reasons such as better infrastructure such as better roads or being closer to coasts or industry clusters or even other geographical differences such as crime levels can explain this relationship.

Bechetti and Sierra (2003) show that firms in the south of Italy are less efficient and thus at more risk of bankruptcy due to the probable higher crime rate and weaker infrastructure in the south.

#### 6.4.1.6 ICT

The impact of Information and Communication Technology (ICT) on economic growth has been increasingly the subject of studies in the last two decades. Several firm-level studies have showed the presence of a positive ICT-efficiency relationship

(Shao and Lin, 2001; Becchetti et al., 2003; Gholami et al., 2004; Castigione, 2012). Gholami et al. (2004) finds that in the Iranian case the effect of ICT is positively significant. However, some studies focusing on developing countries struggle to find the same relationship (Dewan and Kramer, 1998; Pohjola, 2001). This disparity has been attributed to the low levels of ICT investment to GDP and the lack of complements such as public infrastructure and knowledge base to increase the effective utilisation of ICT (Gholami, 2004).

#### 6.4.1.7 R&D

Another factor explaining the extent of efficient performance by producers is R&D. In a country-level study, Wang and Wong (2012) show that R&D transferred through both FDI and imports has a significant effect in explaining efficiency levels of the receiving country. They conclude that especially LDCs (Less-Developed Country) are shown to benefit from 6% increase in their average technical efficiency if they increase the foreign R&D they receive to levels that US receives.

### 6.4.2 Methodological Survey

In this section we conduct a methodological review of empirical models on the estimation of efficiency and its determinants is given. Various issues have been criticised and subsequently adjustments are proposed. Below, we will broadly discuss four main aspects of the current empirical models. While the issue of functional form is only a problem for the SFA models, the remaining three characteristics of models can equally apply to both SFA and DEA studies (albeit in slightly different sense).

#### 6.4.2.1 Functional form

The overwhelming majority of the empirical literature addresses the functional form issue by adopting either a Cobb-Douglas or trans-logarithmic model. Becchetti and Sierra (2003) assume a Cobb-Douglas function to test the relationship between the technical efficiency of manufacturing firms and their bankruptcy risk. Generally if there is no prior assumption regarding constant elasticity of inputs the Translog form is preferred due to fewer restrictions on the production function. Some studies provide a comparison of the two functions. Yang and Chen (2009) test the Translog model against a Cobb-Douglas specification using the generalised likelihood ratio statistic which rejects the Cobb-Douglas model. Similarly, Lundvall and Battese (2000), Hossain and Karunaratne (2004) and Faria, et al. (2005) empirically conclude on the preference of the Translog model. However, Uri (2001) considers both forms but does not conclude any significant difference between the two. We shall test the sensitivity of our results to functional form assumption in the following chapters.

The adoption of the most appropriate form for the estimated function (e.g. production function) is mainly treated as a tangential issue to the analysis. Nevertheless, it can entail the imposition of certain restrictions which can ultimately influence the estimated efficiency measures. A few studies have focused specifically on dealing with the functional form effect on efficiency estimates. Caves et al. (1980) used a Box-Cox functional form in an attempt to accommodate for zero values of some outputs within the data. Others such as Huang and Wang (2004) and Tsionas (2004) have suggested more generalized functional forms such as the Fourier flexible functions to reduce such restrictions on the inefficiency estimates.

#### 6.4.2.2 Choice and Measurement of Variables

The decisions on the type of variables that are used in different empirical works are likewise quite varied. We can look at this choice in different ways:

*Relevant Inputs and Outputs*

The usage of different dependent variables such as gross product versus value-added or ratios of output per employee are a few of the common variations in the literature. Also, sometimes the dependent variable is expressed in per capita terms, i.e. as the ratio of gross output or value-added to labour (Yoo, 1992).

Furthermore, the choice of what inputs to include is a topical matter but the simplest versions have included only labour and capital (Torii, 1992). Some studies include material cost as an input in the frontier alongside capital and labour this is because they have used gross output instead of value-added as the dependent variable (Page, 1984; Yoo, 1992).

*Value or Quantity*

The theoretical premise of the SFA model relies on the use of quantities. However, due to capital, labour and output heterogeneity in the applied sense such measurement is almost impossible. Hence, normally the deflated output values as opposed to nominal values are predominantly used in time series or panel data models. One important reason for this is that in studies involving more than one period the price change effect should be omitted in order to avoid misleading estimates. In other words, this way the inflationary effects of the prices of outputs are put aside and hence a more purified measure of the technical aspect of production efficiency is reflected in the results.

Labour is predominantly used as a quantity variable shown by the number of workers. Some studies use working hours. It is not uncommon that some leave the hours as unadjusted for the labour skill level. On the other hand, some studies use labour compensation as the input variable instead which implicitly recognises the quality of labour. Capital is also used in value terms which itself is obtained through a number of different methods such as the perpetual inventory method discussed in the previous chapter.

One advantage of the DEA approach is that unlike SFA models it can use a combination of values and quantities as inputs and outputs. This can be explained based on the fact that the objective of linear programming in these models is not estimation of a given predefined parameter. Here the closest notion to a frontier is the benchmark firm which can be compared to any given firm based on a relative input or output values assigned to that ideal firm. Thus, in some studies that focus on a specific industry, industry-specific outputs and inputs can be employed. For instance, in a study of US telecommunications industry, Majumdar (1995) uses inputs such as the number of telephony switches and total number of access lines. Moreover, these models allow the usage of rank data to arrive at estimates of technical efficiency. Nevertheless, in studies that use values rather than quantities, again, real values have to be used to avoid the price effects.

*Control Variables*

Some studies include variables directly in the frontier regression in order to control for possible differences in producers industry or context. These include variables such as capital intensity, ratio of production workers to overall workers, ratio of costs of electricity and fuel to material cost, index of specialisation and ratio of inventory to capital, only to name a few. In some panel-data studies such as Wang and Wong (2012) the time variable is included to control for the effect of different years on the efficiency of production. In a more aggregate level study, Nourzad (2008) employ the country stock of foreign direct investment as an input alongside labour and capital in the frontier regression.

#### 6.4.2.3 Cross-Sectional vs. Panel Data

From an econometric point of view the advantage of using panel data is that the strong distributional assumptions on the inefficiency term can be relaxed and thus these estimates would have better statistical properties (Kumbhakar and Lovell, 2000).

Schmidt and Sickles (1984) suggest that while the adoption of cross-sectional data would require the assumption of independence of inefficiency term from the inputs this assumption is not needed for panel data analysis. They also argue that in panel models distributional assumptions for the inefficiency component would be unnecessary since estimation of the frontier parameters can be done via the traditional fixed-effects and random-effects procedures.

Clearly, one of the practical advantages of panel data analysis over cross sectional analysis is that in the former the changes in efficiency throughout time and also technical change can additionally be measured. Two main types of panel models are used in the literature: time-invariant and time-varying models. The former which is generally used in shorter panels assumes that efficiency for each producer is constant through time. On the other hand, in the latter, efficiency is allowed to change across time. In other words, time-varying technical efficiency models are mainly extensions of the maximum likelihood cross-sectional models whereas the time-invariant models employ the conventional panel data procedures.

In panel data such as the empirical application of the Battese and Coelli (1995) the time variable is inserted directly in the determinants' equation. However, Sena (2006) incorporates the time variable in the first equation in level, squared and cross products with other inputs. The latter clearly assumes that the time factor influences the production process the same way as other inputs whereas the prior is assuming that time acts as determinant of technical efficiency among different observations.

#### 6.4.2.4 The Distribution of the $u$

The distributional assumption of the $u_i$s will have a clear effect on the sample mean efficiencies related to each distribution. This is confirmed by various studies assuming different specifications simultaneously. Corbo and de Melo (1986) show why the exponential distribution is expected to yield higher estimates than the half-normal assumption. Green (1990) suggests that even though the estimated inefficiency values will be different for each distributional assumption, the ranking of the firms seems mainly unaffected. Using empirical evidence, Ritter and Simar (1997) and Kumbhakar and Lovell (2000) support the use of the relatively simple half-normal and exponential distribution compared to the more flexible truncated-normal and especially gamma distributions. The argument is based on a lack of evidence for the advantages of the two parameter distributions and being impractical due to identification problems and in some circumstances due to non-existent log-likelihood functions. Furthermore, they even suggest that the choice between the half-normal and exponential distributions are largely immaterial.

## 6.5 Conclusion

This chapter has introduced the general concept of efficiency and focused on one of its components, namely technical efficiency. We introduced SFA and DEA methodologies of estimating technical efficiency.

Having looked at the benefits and drawbacks of each method, it seems that in line with the existing literature in the economics literature, SFA would be more useful for the purpose of this research. The main reason for the preference of SFA is the fact that it allows for the controlling of random shocks and thus it provides the conventional econometric method of analysis. Furthermore, it is in line with our methods and assumption in the previous chapter when we obtained Iran's TFP estimates. This method can allow us to have grounds on comparing and relating our estimates of efficiency with the overall productivity trend that has been estimated. Furthermore, we avoid the restrictiveness of the DEA estimates as we can use these data to compare with estimates of different studies using the similar models obtained here.

Furthermore, the review on other empirical challenges such as choice and measurement of variables also allows the amalgamation of the existing methodology with the key issues specific to Iran's economy discussed in the previous chapters. Consequently, our review in this chapter will ultimately assist us in derivation (and estimation) of a tailored model for the case of Iranian manufacturing performance in the proceeding chapters.

# Chapter 7 Model, Data and Initial Efficiency Estimates

## 7.1 Introduction

In this chapter we attempt to build upon our survey of methodological and empirical literature of efficiency analysis to obtain measures of efficiency using data from the Iranian manufacturing production. We will introduce the model and variables that we will use for the first task of efficiency analysis, namely efficiency measurement. We will discuss the firm-level dataset that will be used and summarise the key features of manufacturing sector with special focus on 2007, the most recent year the data is available for.

Finally, we attempt to build our initial estimates of manufacturing efficiency. It is an initial estimate in the sense that they are obtained without the incorporation of the determinants and thus are not the final results. Nevertheless, this exercise will allow us to have an initial snapshot of the performance of the manufacturing sector. We will attempt to identify the important points that may be relevant in the case of Iran that has been discussed so far. This will allow us to re-specify and arrive at the full model in the subsequent chapter.

## 7.2 Model and Variables

In accordance with the overwhelming majority of the literature the production process examined is expressed in two functional forms, namely the Cobb-Douglas (CD) and the transcendental logarithmic (Translog) functions. This will be the foundation of our exercise regarding technical efficiency estimation.

The log form of our CD production function can be expressed as:

$$Ln(VA_i) = \beta_0 + \beta_1 Ln(compL_i) + \beta_2 Ln(K_i) + v_i - u_i \qquad \textbf{(7–1)}$$

And the Translog specification:

$$\begin{aligned} Ln(VA_i) = \beta_0 \ &+ \beta_1\, Ln(compL_i\,) + \beta_2\, Ln(K_i\,) + \beta_3\, [Ln(compL_i\,)]^2/2 \\ &+ \beta_4\, [Ln(K_i\,)]^2/2 + \beta_5\, Ln(compL_i\,).Ln(K_i\,) + v_i - u_i \end{aligned} \qquad \textbf{(7–2)}$$

Here $VA_i$, $compL_i$ and $K_i$ are the value added, total compensation of employees and the capital stock of the $i$th firm respectively.

Output is represented as value-added rather than gross output. Using gross output would require the inclusion of raw material as an input. Salim and Kalirajan, (1999) argue that this could conceal the role of labour and capital. Additionally, they state that value-added is preferred in different studies since it accounts for the differences and changes in the quality of inputs. They argue that another advantage of value added is that it allows the estimation of efficiency for firms with multiple products. In a similar context of productivity growth estimation, Griliches and Ringstad (1971) state that using value-added allows the inclusion and comparison of firms that are heterogonous in the raw material inputs and hence it is more appropriate than gross output.

The value added definition used here is based on the definition provided by the Statistical Centre of Iran (SCI) which reflects the way the data are gathered. Broadly, value-added can be defined as below:

$$VA_i = Output_i - Input_i \qquad \textbf{(7–3)}$$

According to SCI, $Output_i$ is defined as the sum of the following components for each firm: total value of produced output, net changes in inventory of work in progress, difference between the purchase and sale value of sold unused goods or material, value of capital assets built by the firm, total value of water and electricity (produced or sold) and receipts from other industrial services undertaken. The other industrial services include contractual works, minor repairs to building, machinery, office equipment, transport vehicles and setting up or installation of the produced goods. Furthermore, $Input_i$ is the sum of five components: total value of raw material, nondurable tools and equipment used in production, value of purchased electricity and water, value of material or parts used in production of capital assets by the unit and payment for other industrial services. All of the above components are reported in current prices.

The labour input $compL_i$ is the sum of total compensation to production and non-production employees of each firm. The purpose of using compensation instead of employee numbers is to control for the quality of labour. Clearly, this assumes that high skilled labour are expected be compensated higher due to their skills.

Finally, since data on the value of capital services and replacement cost of fixed assets is not available capital stock has been calculated as below:

$$K = (Asset_a + Asset_b)/2 + (Inv_a + Inv_b)/2 \qquad \textbf{(7–4)}$$

Where $Asset_a$ and $Asset_b$ are the beginning and end of year value of total capital assets for each firm. These assets include machinery, durable goods and equipment, office equipment, transport vehicles, buildings and installations, land and computer software packages. In the dataset $Asset_a$ is given for each year but we calculate $Asset_b$ by subtracting the change of capital asset (purchase or selling of assets) throughout the year. Also, $Inve_a$ and $Inv_b$are the total inventory in the beginning and the end of the year. Total inventory is the sum of the inventory of finished goods, work in progress, untransformed goods and raw materials.

The estimation is carried out using Stata 12. The method of estimation is maximum likelihood (ML). Stata maximises the log-likelihood function of the model using the Newton-Raphson method. Equations (7–1) and (7–2) are estimated via ML under two assumptions on the technical efficiency component's ($u_i$) distribution. We build estimates first by assuming a half-normal and then an exponential distribution for the inefficiency component of the error term.

Restating the above models as below:

$$y_i = \boldsymbol{x_i \beta} + v_i - u_i \qquad \textbf{(7–5)}$$

Where $y_i$ is the value added of the $i$th firm, $\boldsymbol{x_i}$ is a $1 \times K$ vector of regressors for firm i, $\boldsymbol{\beta}$ is a $K \times 1$ vector of coefficients to be estimated. The log-likelihood functions for the models based on the two distributional assumptions for $v$ and $u$ are:

Normal $v$ / half-normal $u$

$$\ln L = \sum_{i=1}^{N} \left\{ \frac{1}{2} \ln \left( \frac{2}{\pi} \right) - \ln \sigma_S + \ln \Phi \left( -\frac{\epsilon_i \lambda}{\sigma_S} \right) + \frac{\epsilon_i^2}{2\sigma_S^2} \right\} \qquad \textbf{(7–6)}$$

and

Normal $v$ / exponential $u$

$$\ln L = \sum_{i=1}^{N} \left\{ -\ln\sigma_u + \frac{\sigma_v^2}{\sigma_u^2} + \ln\Phi\left( \frac{-\epsilon_i - \frac{\sigma_v^2}{\sigma_u^2}}{\sigma_v} \right) + \frac{\epsilon_i}{\sigma_u} \right\} \quad \textbf{(7–7)}$$

Where $\sigma_S = (\sigma_u^2 + \sigma_v^2)^{1/2}$ , $\lambda = \sigma_u / \sigma_v$ , $\gamma = \sigma_u^2 / \sigma_S^2$ , $\epsilon_i = y_i - \boldsymbol{x_i}\,\boldsymbol{\beta}$ and $\Phi(\,)$ is the cumulative probability density function of the standard normal distribution.

As discussed in the previous chapter, the seminal work of Jondrow et al. (1982) proved that firm specific efficiency estimates can be computed. Below the estimates of $u_i$ are obtained using the mean of the conditional distribution $f(u|\epsilon)$ in the following manner:

$$E(u_i|\epsilon_i) = \mu_{*_i} + \sigma_* \left\{ \frac{\phi(-\mu_{*i}/\sigma_*)}{\Phi(\mu_{*i}/\sigma_*)} \right\} \quad \textbf{(7–8)}$$

Here $\phi(\,)$ is the probability density function of the standard normal distribution.

Having decomposed the inefficiency components ($u_i$'s), actual firm-specific technical efficiency scores are constructed as below:

$$te_i = E\{\exp(-u_i)\,|\epsilon_i\} = \left\{ \frac{1 - \Phi(\sigma_* - \mu_{*i}/\sigma_*)}{1 - \Phi(-\mu_{*i}/\sigma_*)} \right\} \exp\left( -\mu_{*i} + \frac{1}{2}\sigma_*^2 \right) \quad \textbf{(7–9)}$$

Where $\mu_{*i}$ and $\sigma_*$ are defined as:

Normal\half-normal

$$\mu_{*i} = -\epsilon_i \sigma_u^2 / \sigma_S^2$$
$$\sigma_* = \sigma_u \sigma_v / \sigma_S \quad \textbf{(7–10)}$$

and

Normal\ exponential

$$\mu_{*i} = -\epsilon_i - \sigma_v^2 / \sigma_u$$
$$\sigma_* = \sigma_v \quad \textbf{(7–11)}$$

Ultimately, a likelihood ratio (LR) test can be constructed to examine which functional form (CD vs. Translog) is more appropriate for the data used. The LR test statistic has approximately a chi-squared distribution with degrees of freedom equal to the number of parameters of the restricted model (CD):

$$LR = 2\,[l(H_0) - l(H_1)] \quad \textbf{(7–12)}$$

Here $l(H_0)$ and $l(H_1)$ are the log-likelihood values of the restricted and unrestricted models respectively. However, in this context the test is carried out via a one-sided general LR test instead of a standard likelihood-ratio test since the test lies on the boundary of the space in which $\sigma_u^2$ is defined (Gutierrez, et al., 2001).

Furthermore, a comparison between efficiency estimates based on the two distributional assumptions can clarify the sensitivity (if any) of the analysis to these two hypotheses.

## 7.3 Data

In this section we introduce and explore the dataset that is used in the model discussed in this chapter and Chapter 8.

### 7.3.1 Dataset Description

The first industrial census in Iran was carried out in 1963. According to the website, SCI (2012), the SCI officially started census data gathering on ‘large firms’, i.e. firms with 10 or more workers, from 1972 to 1987 with the exception of 1977 and 1978 (the revolution years). The data gathering between the 1988 and 1991 period was conducted for industrial units of all size under a new ‘Comprehensive Industrial Survey Programme’, but then reverted back to the census gathering for large firms and survey data for firms having less than 10 employees. In, 2002 a survey of small firms (those with less than 10 employees) was also conducted. The structure and type of data gathered by the centre has changed throughout the years, but the most recent format of data for large firms has been relatively unchanged since 1994.

The annual raw dataset at our disposal of this research covers the years 1988 to 2007. There are no identifier variables for the firms. Thus, each year’s data has to be treated as a cross-section. This has been implemented in the spreadsheets provided by SCI to keep the identity of each firm and their production data confidential. The format of the dataset slightly varies across these years parallel to the changes in the procedures of SCI mentioned earlier. However, the questionnaires and hence the data follows a relatively cohesive structure since 1994.

The dataset is relatively rich and offers data regarding general characteristics of each firm and includes: whether or not the firm has been industrially active for at least 30 day; the type of ownership being cooperative or private or public; the legal status being either an unofficial company, a governmental company, a cooperative company, an official company or a public entity.

Firm employee data is provided in terms of numbers and compensation by gender, paid or unpaid and type of worker (production workers according to their skill level and non-production employees). Furthermore, employees' educational levels for each firm are tabulated which represent a measure of human capital for each firm.

Information on the firms' consumption of raw material, non-durable tools and instruments of production are provided in quantities and nominal values. Additionally, the quantity and value of inputs that are imported is available. These are followed by output measures such as production, sales and export values in both quantity and value.

After this, the dataset provides the inventory values of finished goods, work in progress and raw material at the beginning and end of year. This is followed by data on the consumption of energy and other utilities used by the units based on the type of energy source and utility is presented.

Data on firms' end of year value of capital assets are given alongside the changes in each year is available. The capital assets are classified into seven categories including: machinery, durable tools and instruments, office equipment, transport vehicles, building and infrastructure, land and software packages.

The dataset provides details on other expenditure and earnings of the units such as advertisements, building rent, minor building repairs and others. Furthermore, the amount of R&D expenditure (if any) is given together with the educational level of the researchers. Finally, numbers of unique outputs of each producer and a count on how many of the outputs have national or international certification is provided.

It is worth noting that in this dataset the data gathered for firms with 10 to 49 employees in 14 provinces are sample data and for other provinces covers all firms. However, for larger firms (i.e. those with 50 or more employees) the data are population data which cover all manufacturing establishments in all provinces (SCI, 2011). This means that there are minor disparities between the figures reported in some reports compared to analyses such as ours which rely only on raw data. For instance, the raw data in 2007 covers 13,239 firms, however in the summaries provided (e.g. SCI, 2013), which includes more 10-49 sized firms, the corresponding value is around 17,593.

### 7.3.2 Iranian Manufacturing in 2007

We have discussed the longer term picture of manufacturing structure in Chapter 5 for the period between 1963 and 2005. The data specifically used in this research is obtained from the above mentioned Statistical Centre of Iran's industrial census dataset for 2007 (year 1386 in the Iranian calendar) as the most recent available data. As mentioned earlier, the 2007 dataset includes data on 13,239 manufacturing firms with 10 or more employees. Furthermore, only for the 2007 data an additional data on the location of each firm is available which can allow identification of the province that the firm is located in. This will also be useful in creating location based variables explicitly in our models.

Considering the type of information available in the dataset, it will be useful to first examine the structure and other essential indicators in the manufacturing sector in 2007 and depict an overall picture of the industry. Finally, a selection of this data will be utilised in the context of efficiency analysis.

Table 7–1 illustrates the ownership composition of manufacturing firms. The data reveals that the overwhelming majority of the firms' (92.6%) are classified as privately or non-cooperatively owned. The data also shows that 3.9% are cooperative and 3.5% have a public ownership. These ownership types can be considered to be based on loose definitions. A private unit is one that the majority of its capital or assets are owned by individuals, whereas a cooperative firm is a unit that is registered as a cooperative company and more than 50% of its capital is owned by a cooperative board. Finally, a public unit is a unit that the majority of its capital is owned by ministries, governmental institutions, banks, revolutionary foundations, municipalities or other public sector entities.

The average size of cooperative, private and public firms is 34, 71 and 330. While this confirms the fact that public firms are on average bigger than the others, it is important to remember that this classification can be a bit misleading. For example, quasi-public firms such as the foundations might well be considered as private units in this data. This is clearly evident as the biggest private firm here employs 21,569 employees which is more than twice the amount employed by its biggest public sector counterpart. This firm is clearly too large to be a conventionally defined private firm in the Iranian context.

**Table 7–1 Manufacturing Firm Ownership Structure, 2007.**

| Ownership Type | Number of Firms | Percent of Total Firms | Average Number of Employees | Maximum Number of Employees |
|---|---|---|---|---|
| **Cooperative** | 517 | 3.91% | 34.46 | 488 |
| **Private** | 12,264 | 92.64% | 71.3 | 21,569 |
| **Public** | 458 | 3.46% | 330.06 | 8,843 |
| | **13,239** | **100%** | | |

*Source*: Based on SCI (2007).

The dataset covers a total of over one million (1,043,417) employees in the manufacturing industry for 2007. Around 90% of the workers are male accounting for 93% of total labour compensation. Table 7–2 suggests the annual cost of employing a male worker in 2007 was on average 20.5 million Rials more than that of a female employee. In other words, the average female worker earns 30% less than her male colleague. The disparity in labour compensation between males and females can partly be attributed to the type of jobs that females are engaged in that are deemed to be less productive. However, this might also provide evidence on gender-based wage discrimination and extraction of surplus output simply due to the less favourable conditions for the general female workforce.

**Table 7–2 Gender composition of Labour, 2007.**

| | Employees | Share of Workforce | Labour Compensation | Per Capita Compensation (Rials) |
|---|---|---|---|---|
| **Male** | 938,067 | 90% | 93% | 45,384,113 |
| **Female** | 105,350 | 10% | 7% | 65,848,961 |
| | **1,043,417** | **100%** | **100%** | |

*Source*: Based on SCI (2007).

Overall there are 11 establishments that employ only female workers, however, 4,412 have solely male employees. These observations clearly highlight the stark difference in not only compensation but also employability of male and female workers.

Additionally, the composition of the labour force can be looked at in terms of production and non-production labour. Non-production labour is defined as an employee that either has an office job, works in transportation (such as drivers) or one that offers any type of service which indirectly supports the production of the firm. The data suggests that at the aggregate level the ratio of production to non-production workers is close to 3.34. In other words, production workers account for 77% and non-production employees for 23% of the manufacturing workforce. This index can be a proxy of the level of bureaucracy or management in the structure of a given firm.

The geographical concentration of the manufacturing industry in Iran is mainly focused in a number of few important provinces. As Table 7–3 suggests, the biggest province is Tehran, where 21% of the firms are located. These firms jointly account for 28% of Iran's manufacturing sales in 2007. Tehran is followed by Esfahan accounting for 11% of firms and around 14.6% of total manufacturing sales. Interestingly, Khuzestan which hosts 3.2% of total firms represents a 14.1% share of total manufacturing sales in this year. This is probably due to the concentration of number of petrochemical and oil industry related firms in this oil-rich province. A possible confirmation of this is the relative large size of the average firm in Khuzestan. Concentration and linkages in these provinces show possible explanations of production differentials from a geographical dimension.

Table 7–4 illustrates the share and composition of different industrial subsectors. The top three manufacturing sectors in terms of total sales are the motor vehicle, basic metals and chemical sectors. However, the biggest number of firms operates in the food and beverages sector followed by the non-metallic mineral sector, which both have a smaller average number of employees per firm compared to the motor vehicle and basic metals industries. These are in line with our observation for the period 1998-2005 in Chapter 5.

**Table 7–3 General Firm Characteristics by Province, 2007.**

| Province | Average Firm Size | Share of Total Sales | Proportion of All Firms | Number of Firms |
|---|---|---|---|---|
| **Markazi** | 101 | 5.48% | 4.51% | 597 |
| **Gilan** | 66 | 1.27% | 3.27% | 433 |
| **Mazandaran** | 63 | 2.32% | 4.47% | 592 |
| **Eastern Azarbaijan** | 78 | 4.39% | 5.24% | 694 |
| **Western Azarbaijan** | 52 | 0.81% | 2.05% | 271 |
| **Kermanshah** | 46 | 0.74% | 1.88% | 249 |
| **Khuzestan** | 111 | 14.10% | 3.26% | 432 |
| **Fars** | 73 | 2.62% | 4% | 530 |
| **Kerman** | 119 | 2.88% | 1.1% | 145 |
| **Khorasan Razavi** | 82 | 4.68% | 6.99% | 926 |
| **Esfahan** | 76 | 14.62% | 11.81% | 1,564 |
| **Sistan and Baluchestan** | 44 | 0.13% | 0.68% | 90 |
| **Kordestan** | 31 | 0.26% | 1.27% | 168 |
| **Hamedan** | 39 | 0.62% | 2.34% | 310 |
| **Chaharmahal and Bakhtiari** | 52 | 0.30% | 0.99% | 131 |
| **Lorestan** | 83 | 0.56% | 0.74% | 98 |
| **Ilam** | 52 | 0.07% | 0.24% | 32 |
| **Kohgiluyeh and Boyerahmad** | 44 | 0.05% | 0.28% | 37 |
| **Bushehr** | | 1.78% | 0.42% | 55 |
| **Zanjan** | 121 | 1.50% | 1.29% | 171 |
| **Semnan** | 44 | 1.99% | 5.94% | 787 |
| **Yazd** | 92 | 2.64% | 2.97% | 393 |
| **Hormozgan** | 64 | 2.16% | 1.27% | 168 |
| **Tehran** | 107 | 28.33% | 21.01% | 2,782 |
| **Ardebil** | 38 | 0.36% | 1.61% | 213 |
| **Qom** | 40 | 0.97% | 3.99% | 528 |
| **Qazvin** | 93 | 3.26% | 3.89% | 515 |
| **Golestan** | 43 | 0.57% | 1.53% | 202 |
| **Northern Khorasan** | 63 | 0.30% | 0.52% | 69 |
| **Southern Khorasan** | 69 | 0.23% | 0.43% | 57 |
| | | **100%** | **100%** | **13,239** |

*Source*: Based on SCI (2007).

Based on Table 7–4, total manufacturing exports of this group of Iranian firms in 2007 was just over 10 billion US dollars. Around 1,179 firms (roughly 9%) officially engaged in export activity. As the table suggests the biggest exporting sector was the chemicals sector with over 55% of total manufacturing exports of all 13,239 firms. The next main exporting sector is the basic metals industry which accounts for around 18% share of manufacturing exports of our sample.

**Table 7–4 General Firm Characteristics by Sector, 2007.**

| Two-Digit ISIC Code/Sector (rev. 3.1) | Average Firm Size | Share of Total Sales | Proportion of Total Firms | Number of Firms | Exports* |
|---|---|---|---|---|---|
| **15 Food and Beverages** | 65.14 | 10.10% | 19.22% | 2,544 | 595 |
| **16 Tobacco Products** | 3,423.50 | 0.18% | 0.02% | 2 | 0 |
| **17 Textiles** | 83.56 | 2.92% | 7.92% | 1,048 | 119 |
| **18 Wearing Apparel, Fur** | 48.12 | 0.12% | 1% | 132 | 4.26 |
| **19 Leather, Leather Products and Footwear** | 39.68 | 0.30% | 1.49% | 197 | 81.2 |
| **20 Wood Products (Excl. Furniture)** | 54.03 | 0.40% | 1.03% | 137 | 2.49 |
| **21 Paper and Paper Products** | 60.39 | 0.94% | 2.27% | 301 | 12.7 |
| **22 Printing and Publishing** | 48.96 | 0.24% | 1.78% | 235 | 0.12 |
| **23 Coke, Refined Petroleum products, nuclear fuel** | 128.26 | 7.94% | 1.03% | 136 | 567 |
| **24 Chemicals and Chemical Products** | 85.44 | 16.60% | 6.93% | 918 | 5,580 |
| **25 Rubber and Plastics Products** | 57.58 | 2.67% | 6.16% | 816 | 72.6 |
| **26 Non-Metallic Mineral Products** | 58.20 | 5.52% | 17.33% | 2,294 | 254 |
| **27 Basic Metals** | 139.06 | 18.68% | 4.25% | 563 | 1,820 |
| **28 Fabricated Metal Products** | 63.22 | 3.74% | 8.04% | 1,065 | 70.1 |
| **29 Machinery and Equipment n.e.c.** | 81.33 | 4.60% | 7.43% | 984 | 124 |
| **30 Office, Accounting and Computing Machinery** | 83.69 | 0.09% | 0.24% | 32 | 0.14 |
| **31 Electrical Machinery and Apparatus** | 109.90 | 3.47% | 3.35% | 443 | 230 |
| **32 Radio, Television and Communication Equipment** | 111.66 | 0.48% | 0.55% | 73 | 4.13 |
| **33 Medical, Precision and Optical Instruments** | 79.81 | 0.37% | 1.13% | 149 | 2.64 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | 197.68 | 19.26% | 4.76% | 630 | 456 |
| **35 Other Transport Equipment** | 101.55 | 0.87% | 1.33% | 176 | 33.1 |
| **36 Furniture; Manufacturing n.e.c.** | 45.27 | 0.51% | 2.66% | 352 | 1.13 |
| **37 Recycling** | 23.00 | 0.01% | 0.09% | 12 | 0 |
| **Total Observations** | | **100%** | **100%** | **13,239** | **10,022** |

*Source*: Based on SCI (2007).

*Notes*: * Export values are in million USD.

*Data Correction*

As it has been already mentioned the data at hand consists of 13,239 firm observations. However, our sample reduces by 84 observations due to negative or zero value added data for these firms.

Furthermore, outliers are defined by firms having values more or less than 5 times the standard deviation of the two-digit ISIC industry average levels of inputs ($K$ and $L$) and output (VA). These observations are omitted since they can influence the frontier significantly and provide a less reliable picture. Based on these criteria 140 outliers were omitted from the estimation of the frontier.

Overall the dataset consists of 59 unique three-digit industry sectors and around 135 different four-digit sectors classified within these subsectors.

## 7.4 Initial Technical Efficiency Estimation Results

Our results suggest that for both functional forms and for either distributional assumption, the presence of technical inefficiency can be confirmed. The null hypothesis of no technical efficiency ($H_0$: $\sigma_u^2 = 0$ vs. $H_1$: $\sigma_u^2 > 0$) is strongly rejected with a p-value of close to zero.

Furthermore, the restrictions of the CD model ($H_0$: $\beta_3 = \beta_4 = \beta_5 = 0$) is rejected via the likelihood ratio test with a p-value of almost zero (a ${\chi^2}_{(3)}$ test statistic of 49.28 for the half-normal models).

Table 7–5 represents the estimation results for the models. There does not seem to be a great amount of disparity between the two Translog regressions. Also since there is no theoretical or empirical apriority to favour the half-normal over the exponential distribution, the prior is chosen to simplify the subsequent analyses in this chapter. This is in line with the majority of studies in the relevant literature. Thus, the analysis henceforth will rely on estimates obtained through the Translog specification with a half-normal distributed inefficiency term. The efficiency scores for this model will be called teho2[12].

**Table 7–5 – ML Estimation of Production Functions, 2007.**

| Parameter | Cobb-Douglas (CD) Half-Normal | Cobb-Douglas (CD) Exponential | Translog Half-Normal | Translog Exponential |
|---|---|---|---|---|
| ***Constant*** | -0.279**<br>(0.131) | -0.346*<br>(0.126) | 9.740*<br>(1.719) | 10.777*<br>(1.675) |
| $\boldsymbol{LcompL}$ | 0.842*<br>(0.008) | 0.837*<br>(0.008) | 0.819*<br>(0.133) | 0.778*<br>(0.13) |
| $\boldsymbol{LK}$ | 0.210*<br>(0.007) | 0.216*<br>(0.007) | -0.621*<br>(0.122) | -0.678*<br>(0.119) |
| $(\boldsymbol{LcompL})^{2}$ | | | $3.41e^{-24}$***<br>($1.87e^{-24}$) | $-3.33e^{-24}$***<br>($1.82e^{-24}$) |
| $(\boldsymbol{LK})^{2}$ | | | 0.018*<br>(0.004) | 0.0184*<br>(0.0041) |
| $\boldsymbol{LcompL \times LK}$ | | | 0.000455<br>(0.00056) | 0.002<br>(0.0055) |
| $\boldsymbol{\sigma_v}$ | 0.717 | 0.681 | 0.713 | 0.678 |
| $\boldsymbol{\sigma_u}$ | 0.489 | 0.348 | 0.499 | 0.35 |
| ***Log-Likelihood*** | -15154.864 | -15000.825 | -15129.163 | -14968.724 |

*Notes*: 1) Dependent variable is logarithm of firm value added in Rials.
2) *, ** and *** indicates significance at 1 %, 5% and 10% level respectively (standard error in parentheses).

Table 7–6 shows a brief summary of the estimated efficiency values. This show that a great amount of concentration is located around the mean efficiency estimated. The calculations show that around 242 firms have an efficiency of less than 50% whereas the number firms with higher than 85% efficiency is around 175.

**Table 7–6 Summary of Overall Efficiency Estimates in Iranian Manufacturing (teho2), 2007.**

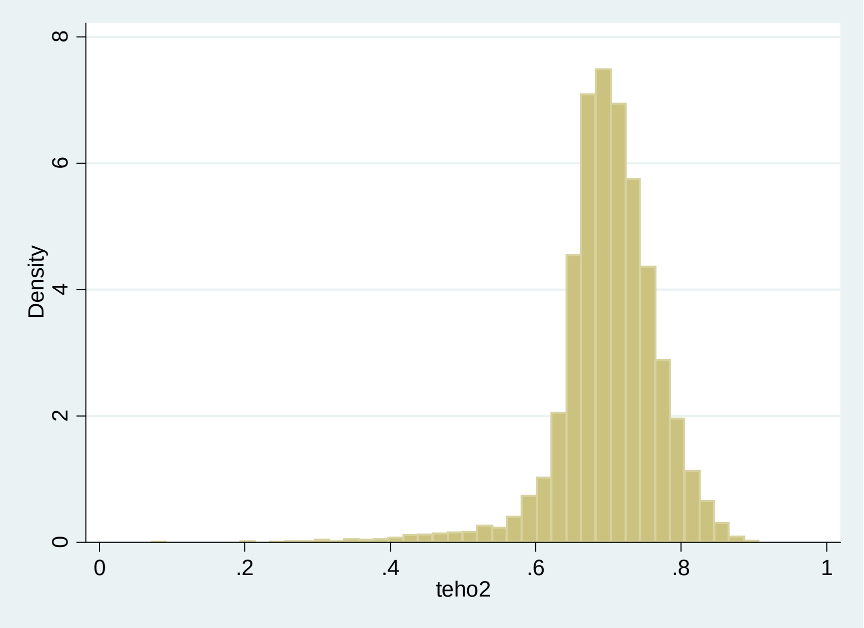
| Mean | Standard Deviation | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|
| 0.7004 | 0.0698 | 0.0715 | 0.9070 | 13,015 |

The histogram of the entire manufacturing firms' technical efficiency estimates obtained from the Translog model is presented in Figure 7–1. The figure clearly

[12] Here 'te' in 'teho2' stands for technical efficiency, 'h' reflects the assumption of half-normal distribution for the second component of the error term (u), 'o' shows that outliers have been omitted and '2' represents the Translog production function specification.

shows a wide potential for firms' improvement in the efficiency of their production with highest concentration of firms around 70% efficiency level. The relatively small size of the standard deviation mirrors the steep peak of the histogram.

**Figure 7–1 Histogram of Manufacturing Technical Efficiency Estimates (teho2), 2007.**




Furthermore, the output elasticities of each input in the Translog model can be defined as below:

$$\frac{\partial LVA}{\partial Ln(compL)} = \beta_1 + \beta_3 Ln(compL_i) + \beta_5 Ln(K_i) \quad \textbf{(7–13)}$$

$$\frac{\partial LVA}{\partial Ln(K)} = \beta_2 + \beta_4 Ln(K_i) + \beta_5 Ln(compL_i) \quad \textbf{(7–14)}$$

The results show that both elasticities are positive and overall the production processes show minor increasing returns to scale. However, this measure of returns to scale is not significant since the null hypothesis of constant returns to scale cannot be rejected at any meaningful level of significance.

In the proceeding section we will explore various categorisations of the firms and assess their corresponding relationship on the efficiency results. The results are presented in a way that can assist us in identifying determinants of the efficiency performance in the context of Iranian manufacturing.

**Table 7–7 Output Elasticities of the Translog Function.**

| Input | Mean Elasticity | Standard Deviation |
|---|---|---|
| **Labour** | 0.8313 | 0.0119 |
| **Capital** | 0.2079 | 0.0470 |

### *Exports and Efficiency*

The results in Table 7–8 show a significantly superior production performance for exporters compared to those firms that do not engage in any export activity. The average exporter firm is around 2% more efficient than a non-exporter. This result highlights the efficiency gains achieved by firms due to exposure to international markets. As discussed earlier, since exporter firms have to compete with highly competitive foreign firms they need to use the best production performance and strategy to survive. Additionally, the experience of engaging in new markets itself acts as a means of LBD which in turn can boost the performance of such firms.

Nevertheless, it is worth noting that some firms seem to export despite not being very efficient. For example, 15 exporters have an efficiency of less than 50%. Furthermore, a valid point to consider is the notion of reverse causality which has been addressed in the literature. In other words, it could be that firms export precisely because they are more efficient. A comprehensive explanation for such estimates and hypotheses requires controlling for more factors and adds additional dimensions to the analysis. As the objective of this section is identifying key efficiency determinants we will leave part of these issues to the next chapter and part of these would fall out of the main scope of this research.

**Table 7–8 Technical Efficiency (teho2) Summary Statistics by Exporter and Non-Exporter Firms, 2007.**

| Type of Firm | Mean | S.D. | Min. | Max. | Obs. |
|---|---|---|---|---|---|
| **Non-Exporter** | 0.6996 | 0.0693 | 0.0728 | 0.9071 | 11,915 |
| **Exporter** | 0.7183 | 0.0676 | 0.3389 | 0.8818 | 1,100 |

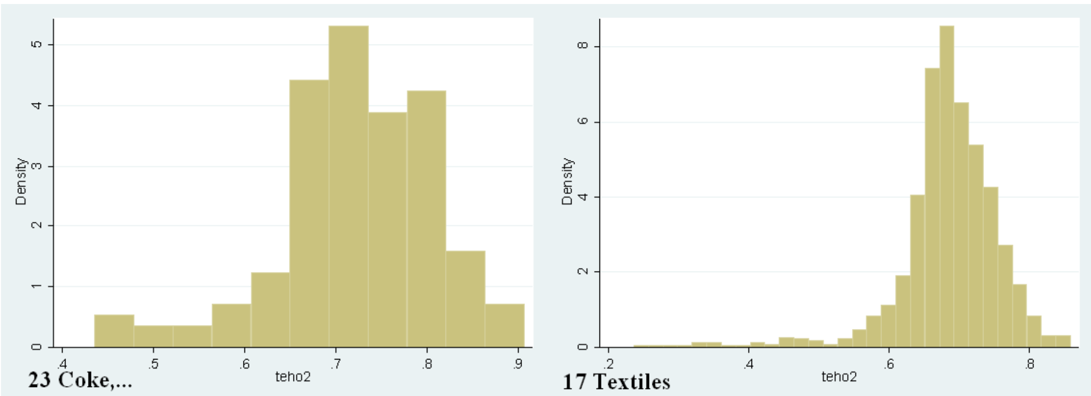
*Sectoral Efficiency*

In Table 7–9 the estimates are given by each ISIC sector. The data suggests that in terms of all estimates the efficiency of coke and refined petroleum sector is the highest (Actually, the tobacco products sector has the highest score but is ruled out due to only having two firms). However, the least efficient sector in is the textiles sector. Interestingly, the most efficient firm is also in the coke, refined petroleum and nuclear fuel sector (ISIC 23) with an efficiency of 90.7% but the least efficient firm is in the food and beverages industry with a measly value of 7.15%.

The mean estimates show that efficiency scores tend to be higher for less labour intensive (i.e. those with higher capital-labour ratio) production processes. It is clear that apart from the petroleum sector, the efficiency of chemicals and chemical products and other transport equipment sector show the higher bounds of efficient production. In contrast to this, sectors such as textiles or leather products which have a higher proportion of labour input seem to possess relatively lower levels of efficiency.

Figure 7–2 clearly illustrates the greater concentration of efficiency scores of between 50% and 80% for the textiles sector and a number of firms being less than 40% efficient. In contrast to this, in the coke and petroleum products sector in all firms operate above the 40% level and most are in the 60 to 90% levels of efficiency boundaries.

**Figure 7–2 Firm Technical Efficiency Histogram, Textiles vs. Coke and Refined Petroleum Sectors, 2007.**




We can look deeper into each ISIC sector to see if these trends hold at a less aggregated level. For instance, within the ISIC 23 sector, the refined petroleum subsector has a capital-labour ratio which is more than three times the ratio for coke oven subdivision. This is clearly reflected in that the average efficiency score of the first group of around 72.5% compared to 70% for the coke oven product sector. This wide difference between the two shows how the nature of production can influence the measures of efficiency even in the upper bounds of the performance spectrum.

**Table 7–9 Technical Efficiency (teho2) Summary Statistics by Sector, 2007.**

| Code ISIC Sector (rev. 3.1) | Mean | S.D. | Min. | Max. | Obs. |
|---|---|---|---|---|---|
| **15 Food and Beverages** | 0.6978 | 0.0748 | 0.0715 | 0.8943 | 2,467 |
| **16 Tobacco Products** | 0.7491 | 0.0371 | 0.7229 | 0.7754 | 2 |
| **17 Textiles** | 0.6843 | 0.0734 | 0.2364 | 0.8587 | 1,035 |
| **18 Wearing Apparel, Fur** | 0.6957 | 0.0513 | 0.4889 | 0.8371 | 128 |
| **19 Leather, Leather Products and Footwear** | 0.6909 | 0.0806 | 0.2008 | 0.8358 | 194 |
| **20 Wood Products (Excl. Furniture)** | 0.6933 | 0.0794 | 0.2124 | 0.8738 | 133 |
| **21 Paper and Paper Products** | 0.7059 | 0.0670 | 0.3066 | 0.8586 | 300 |
| **22 Printing and Publishing** | 0.6823 | 0.0628 | 0.2071 | 0.8072 | 227 |
| **23 Coke, Refined Petroleum Products, Nuclear Fuel** | 0.7238 | 0.0868 | 0.4359 | 0.9070 | 132 |
| **24 Chemicals and Chemical Products** | 0.7127 | 0.0743 | 0.2503 | 0.8985 | 904 |
| **25 Rubber and Plastics Products** | 0.7007 | 0.0662 | 0.2491 | 0.8823 | 804 |
| **26 Non-Metallic Mineral Products** | 0.7076 | 0.0688 | 0.2904 | 0.8890 | 2,260 |
| **27 Basic Metals** | 0.7093 | 0.0694 | 0.3017 | 0.8817 | 555 |
| **28 Fabricated Metal Products** | 0.7003 | 0.0657 | 0.2706 | 0.8629 | 1,053 |
| **29 Machinery and Equipment n.e.c.** | 0.6945 | 0.0574 | 0.3261 | 0.8808 | 978 |
| **30 Office, Accounting and computing Machinery** | 0.7034 | 0.0771 | 0.4045 | 0.8568 | 32 |
| **31 Electrical Machinery and Apparatus** | 0.7026 | 0.0650 | 0.2812 | 0.8933 | 437 |
| **32 Radio, Television and Communication Equipment** | 0.7048 | 0.0498 | 0.5900 | 0.8370 | 71 |
| **33 Medical, Precision and Optical Instruments** | 0.7021 | 0.0625 | 0.4784 | 0.8336 | 146 |
| **34 Motor Vehicles, Trailers, Semi-Trailers** | 0.6962 | 0.0658 | 0.2720 | 0.8554 | 626 |
| **35 Other Transport Equipment** | 0.7120 | 0.0716 | 0.3745 | 0.8485 | 173 |
| **36 Furniture; Manufacturing n.e.c.** | 0.6923 | 0.0645 | 0.2889 | 0.8702 | 346 |
| **37 Recycling** | 0.7118 | 0.0359 | 0.6767 | 0.8127 | 12 |
| **Total observations** | | | | | **13,015** |

### *Firm size*

Table 7–10 shows the average efficiency score for firms based on four groups in terms of firm size proxied by the number of employees of each firm. The estimates partially display a positive relationship between the estimates and size of the firm. The table also suggests that both the most efficient firm and the least efficient firm in the smallest firm size group employing between10 to 20 people.

**Table 7–10 Technical Efficiency (teho2) Summary Statistics by Firm Size, 2007.**

| Number of Employees (L) | Mean | S.D. | Min. | Max. | Obs. |
|---|---|---|---|---|---|
| $\mathbf{10 \leq L < 20}$ | 0.6984 | 0.0748 | 0.0715 | 0.9070 | 4,428 |
| $\mathbf{20 \leq L < 50}$ | 0.6998 | 0.0676 | 0.2706 | 0.8884 | 4,652 |
| $\mathbf{50 \leq L < 100}$ | 0.7029 | 0.0633 | 0.2008 | 0.8954 | 1,946 |
| $\mathbf{100 \leq L}$ | 0.7034 | 0.0688 | 0.0825 | 0.8641 | 1,989 |

### *Ownership*

Another important perspective on efficiency determinants is the ownership effect. Table 7–11 shows that based on the estimated measures of technical efficiency, the cooperative and private firms are on average more efficient than their public counterparts. Furthermore, the minimum and maximum efficiency scores belong to the private sector. This uniform result on this firm characteristic might imply the crucial role that ownership plays in our analysis.

**Table 7–11 Technical Efficiency (teho2) Summary Statistics by Ownership, 2007.**

| Ownership | Mean | S.D. | Min. | Max. | Obs. |
|---|---|---|---|---|---|
| **Cooperative** | 0.7028 | 0.0666 | 0.3883 | 0.8677 | 502 |
| **Private** | 0.7006 | 0.0685 | 0.0715 | 0.9070 | 12,101 |
| **Public** | 0.6926 | 0.1031 | 0.0825 | 0.8786 | 412 |

### *Geographical Location*

Table 7–12 illustrates the technical efficiency of firms by their geographical location i.e. the province that the firm is located in. The result suggests that on average Qom and Kohgiluyeh and Boyerahmad have the least efficient manufacturing firms and the most efficient firms operate in Western Azarbaijan, Kerman and Khuzestan.

**Table 7–12 Technical Efficiency (teho2) Summary Statistics by Province, 2007.**

| Province | Mean | S.D. | Min. | Max. | Obs. |
|---|---|---|---|---|---|
| **Markazi** | 0.7062 | 0.0789 | 0.2630 | 0.8817 | 591 |
| **Gilan** | 0.6845 | 0.0735 | 0.2812 | 0.8817 | 419 |
| **Mazandaran** | 0.7161 | 0.0659 | 0.2124 | 0.8436 | 579 |
| **Eastern Azarbaijan** | 0.7044 | 0.0653 | 0.3212 | 0.8762 | 685 |
| **Western Azarbaijan** | 0.7244 | 0.0708 | 0.3467 | 0.8890 | 270 |
| **Kermanshah** | 0.7035 | 0.0726 | 0.3119 | 0.8531 | 246 |
| **Khuzestan** | 0.7236 | 0.0721 | 0.0825 | 0.8705 | 417 |
| **Fars** | 0.6963 | 0.0958 | 0.2706 | 0.8750 | 514 |
| **Kerman** | 0.7251 | 0.0623 | 0.4600 | 0.8943 | 142 |
| **Khorasan Razavi** | 0.6947 | 0.0523 | 0.2071 | 0.8632 | 912 |
| **Esfahan** | 0.6968 | 0.0574 | 0.2364 | 0.8626 | 1,544 |
| **Sistan and Baluchestan** | 0.7144 | 0.0764 | 0.4591 | 0.8493 | 90 |
| **Kordestan** | 0.7084 | 0.0383 | 0.5834 | 0.8045 | 164 |
| **Hamedan** | 0.7190 | 0.0461 | 0.5337 | 0.8734 | 309 |
| **Chaharmahal and Bakhtiari** | 0.7181 | 0.0711 | 0.4778 | 0.8823 | 130 |
| **Lorestan** | 0.7002 | 0.0586 | 0.5361 | 0.8433 | 97 |
| **Ilam** | 0.7142 | 0.0638 | 0.5634 | 0.8335 | 31 |
| **Kohgiluyeh and Boyerahmad** | 0.6796 | 0.0945 | 0.4650 | 0.8485 | 37 |
| **Bushehr** | 0.7037 | 0.0661 | 0.5573 | 0.8334 | 50 |
| **Zanjan** | 0.7103 | 0.0581 | 0.2720 | 0.8501 | 166 |
| **Semnan** | 0.6993 | 0.1107 | 0.0715 | 0.9070 | 776 |
| **Yazd** | 0.6987 | 0.0786 | 0.2491 | 0.8590 | 386 |
| **Hormozgan** | 0.7031 | 0.1005 | 0.3368 | 0.8650 | 163 |
| **Tehran** | 0.6939 | 0.0495 | 0.2008 | 0.8626 | 2,740 |
| **Ardabil** | 0.6915 | 0.0627 | 0.3565 | 0.8269 | 206 |
| **Qom** | 0.6793 | 0.0941 | 0.2970 | 0.8985 | 525 |
| **Qazvin** | 0.7055 | 0.0648 | 0.4373 | 0.8618 | 503 |
| **Golestan** | 0.6966 | 0.0729 | 0.3456 | 0.8453 | 198 |
| **Northern Khorasan** | 0.7166 | 0.0460 | 0.5513 | 0.8090 | 69 |
| **Southern Khorasan** | 0.7023 | 0.0768 | 0.4353 | 0.8441 | 56 |

Nevertheless, big industrial provinces such as Tehran and Esfahan do not seem to have performed particularly more efficiently than other provinces. This can be interpreted in different ways. It might be an indication of a lack of adequate interconnectedness of production even in provinces with the highest concentration and better infrastructural access. On the other hand, it is reasonable to also argue that an aggregation of data in places such as Tehran which house a much more diverse range of industrial sectors can obscure any potential agglomeration effect.

## 7.5 Conclusion

In this chapter we proposed our initial model for the estimation of technical efficiency in Iranian manufacturing using firm-level data. Using an output-oriented SFA procedure, we obtained estimates for four scenarios depending on the functional form of the production function and the hypothesised distribution of the technical efficiency component of the residual. The test results confirmed the preference of the Translog function and the simple notion of a half-normal distribution led us to prefer the estimates of this scenario for our subsequent analysis and comparisons.

The results showed that in 2007 our sample of manufacturing firms operated at around an average rate of 70% of the production frontier. This suggests a great amount of potential for these industries to improve upon.

In line with the efficiency determinants literature discussed in the previous chapter we looked at tabulations of the estimates based on important variables discussed in the literature which could be relevant to Iran. Our initial findings suggest an important amount of disparity based on different classifications. We showed that exporter firms on average have higher efficiency estimates. Cross-industry variation of productive performance was one of the important factors differentiating firms. The most efficient firms tended to be those that have higher capital-labour ratios. Our findings also provide evidence for sizable cross-province disparities.

On the other hand, some variables do not seem to explain much of the efficiency disparities. The results suggest a relatively average productive performance for firms in the biggest industrial provinces (Tehran and Esfahan). This runs contrary to ideas of industrial concentration benefits. The ownership variable also does not show a meaningful difference between public or private firms in our initial estimates. This partly can be explained by the way this variable and others are defined.

As mentioned in this chapter's introduction, these findings are only initial estimates and warrant further clarification. Nevertheless, this exercise has provided a brief glimpse into the manufacturing sector performance. This will assist us in arriving at a more appropriate model in the following chapter which addresses the question of identifying the sources of efficiency variation more directly.

# Chapter 8 Efficiency Determinants

## 8.1 Introduction

As discussed in Chapter 6, the second aspect of assessing the technical efficiency of production in Iran's manufacturing production is to determine what factors can truly explain the difference in the efficiency estimates among different units or industries. These factors are sometimes referred to as environmental or exogenous factors affecting production efficiency.

In this chapter a more detailed comparison of these factors which was briefly discussed in the previous chapters will be presented. The key goal here will be to establish the relevance of the important variables in light of our initial estimation of Iranian manufacturing efficiency in Chapter 7. Based on the model specified in this particular context determinants of efficiency are empirically tested based on the two-staged and simultaneous estimation methods.

## 8.2 Efficiency Determinants – Concepts and Definitions

With different applications of efficiency analysis the choice of determinants has been predominantly treated as a context specific issue. Thus, different models vary considerably. For example, the determinants of efficiency in agricultural economics are considerably different form the crucial factors explaining the efficiency of education in a given country. Furthermore, within each of these fields there is no exhausting list of determinants applied in different studies. The reason for this is that there are additional sources of heterogeneity that are often unique to the country or sector that is being studied.

This might make comparisons between different models rather tedious. Regardless, it also provides the convenience of applying context specific and probably a more accurate evaluation in each study. It is worth mentioning that as with any other empirical study, data availability and limitations have also partially determined the variables included and ultimately the model itself.

In practice most studies attempt to explain an overview of the relevant studies and normally pick the most successful and widely used variables for their own analysis.

They sometimes add a few variables or employ new definitions or proxies to have a model that is more accommodating not only to their case study but also to the datasets that is available to them.

In a number of studies, these determinants have been used as control variables which enter the model directly in the stochastic function itself. This highlights the previously mentioned ad-hoc aspect of different empirical approaches additionally in the way they use these data in their models.

The question of the number of relevant determinants to be included is also treated differently. Some papers only focus on one or two specific factors which are the main research question in that study (e.g. Driffield and Munday, 2001) while others include as many variables as they see fit and then focus on those that have had significant role in explaining the efficiency estimates (e.g. Taymaz and Saatci, 1997).

Here it is attempted to have a closer look at the rationale behind the choice of determinants themselves but also the way these variables are constructed.

*Ownership*

The ownership category has been approached differently. As the examples provided in Chapter 5 suggest, the literature has mainly used ownership dichotomies such as private versus public or foreign versus domestic. Sometimes the legal status of the company corporate versus non-corporate or other categories is used as a proxy of ownership effect on technical efficiency.

In studies that the type of ownership is defined in terms of private or public criteria, the dominant rationale is that generally private companies might have better supervision and quality control compared to public firms which allocation of responsibilities and thus accountability are often vaguely defined. This is usually translated to public firms having less efficient production.

In the second categorisation of ownership, it is often argued that foreign owned firms might have additional knowledge or advantages due to be operating in an international context and thus might make a more efficient use of the inputs in production. Normally a dummy variable is used to show this difference.

Alternatively, ownership can be expressed as the unit's legal status. For example, creating three categories of corporate, non-corporate and other types of units can be differentiated.

The overwhelming majority of studies use a dummy approach for inclusion of these effects. The only difference amongst them is the way that each category is defined. A few resort to the majority ratio of shareholders as a description for each firm. Some studies use the predefined definitions of the data gathering body which is normally the statistical centre for each country.

In instances where there are additional data, other ownership related factors such as ownership concentration defined as the percentage of shares owned by the biggest shareholder is also introduced for which some studies suggest a U-shaped relationship between it and firm performance (e.g. Su and He, 2012).

*Operational Characteristics*

Various properties of the firms' operational attributes have been used to explain variations in efficiency index. These variables normally try to differentiate the firms organisational from various aspects. These include size, age, number of plants, research and development and other 'firm-infrastructure' expenditures.

Firm size has been incorporated in a number of studies. This variable has been defined in a varied number of ways including the number of employees, value of intermediate inputs and total sales. Taymaz and Saatci (1997) define size as the number of employees of a firm and find a significant positive relationship between the logarithm of firm size variable and efficiency in two sectors (cement and motor vehicle) but not in the textile sector. In their study of a panel of Turkish manufacturing firms they also demonstrate greater variation among efficiency estimate for small firms compared to their larger competitors. This confirms the fact that business failure and turnover for small firms tends to be higher.

Age has normally been hypothesised to entail a positive effect due to benefits of greater experience and establishing stronger industrial linkages. Some studies demonstrate a U-shaped relation especially for firms entering a new market where they initially tend to react to the change and gradually manage to favour better modes of production. Often the variable used is a simple count measure representing the number of operating time periods. However, in some instances a dummy approach of operation beyond a certain year has also been implemented to emphasise a certain structural age related notion (He and Su, 2012).

Other factors such as energy, advertising, R&D and communications spending are used to accommodate for firm or product characteristic and business strategy of the units. Usually, these variables are defined as intensities, i.e. the share of each of above components in total costs or sales of that firm.

If a reasonable number of firms being studied have more than one plant one can hypothesize a relationship between having multiple plants versus having one vertically integrated unit. Here it is expected for the multi-plant firms to be more technically efficient due to greater specialisation. Furthermore, provided that there are detailed plant-level data available, an intra-firm analysis of the above variables might be even more informative. For example the amount of investment or training expenditures based on different departments,

*Management Characteristics*

Studies focusing especially on small or medium enterprises sometimes suggest equivalent variables as those discussed above but with regards to the owners or manager characteristics of firms to explain firm efficiency results. Factors such as the age, experience, education level and foreign versus domestic origin of the managers are sometimes employed as determinants to examine the influence of such factors in productive performance of such units.

*Labour Union Power*

The greater the number of national or industry union members the greater the power of the unions on affecting industry's firms on their behaviour often in contrast to the decision of the management. The orthodox literature generally suggests a negative relationship between efficiency and employees union participation. Again sometimes simple dummies regarding the presence of unions are used. Where data is available some employ the number of employees being a union member for each firm to examine the validity of their hypotheses.

*Financial Characteristics*

Financial indicators are also sometimes used to explain the inefficiency of firms. These include the availability of cheap credit. This might be due to government intervention or the default risk of companies and various other aspects of a firm's financial properties which might influence the availability of credit to it. For example, cheap credit often provided by governments often might lead to firms not investing appropriately and thus increase an element of slack in their production behaviour. Alternatively, other studies argue that financial constraints of firms such as high default risks can provide incentives for firms to become more technically efficient. Again, these factors have been expressed in terms of both dummy and intensity variables.

*International Activity*

Whether or not a firm engages in cross-border activity in different modes of production have also received interest in efficiency analysis. These trade modes of engagement include exports, foreign direct investment, licensing or any other form of international collaboration. The rationale of greater efficiency that firms tend to have to be able to compete in the international markets is the basis of the inclusion of related variables. Some studies only employ a dummy approach to explore the differential effect of the different categories. Alternatively the extent of international exposure or activity of a firm Receipt or purchase of licensing agreement, international technology knowledge transfer or intensity measures of export or FDI have been incorporated in some models.

*Geographical Location*

The location factor is also introduced to establish locational advantages such as benefits of better access to trading routes such as ports. In some studies it is attempted to establish the effect of regional government regulation or the contrast in their enforcement which might ultimately influence the efficiency of producers differently. Most studies use dummy variables and normally define them based on the official provincial or federal divisions of a country while others divide the country in different segments based on a prior hypothesis such as regions' distances to sea ports.

*Agglomeration*

There exists a wide literature on the reasons for economic clusters and the effects of agglomeration on productive performance of businesses. From the perspective of a firm a cluster has potential benefits that are associated with closer interaction of firms around a geographical core. This concentration is argued to encourage the flow and accumulation of innovative ideas and entrepreneurial activities (e.g. Sorenson and Audia, 2000). Agglomeration also allows the firms to specialise in production of certain goods which can contribute to other firms' production and thus create a network of specialised firms. These linkages can encourage additional diffusion of knowledge and technology. Furthermore, the skilled labour is increasingly drawn to the cluster meaning that there is a positive effect on productivity and wages of these regions. On the other hand, there are also negative aspects (referred to as congestion effects) of agglomeration such as increase in pollution, social problems and land prices that can have negative effects on the region as a whole and the firms more specifically (Glaeser, 2010).

From a more macro point of view, while the roots of the clustering notion can be traced back to ideas of Marshall (1890) regarding specialisations of trade in districts, it has been addressed more closely in recent studies. Hirschman (1975) talks about 'growth poles' that countries start their development path from and maintains that through a subsequent trickling effect the rest of the economy would benefit from such poles. Furthermore, Romer (1986) incorporates increasing scale returns in his growth model by highlighting the role of knowledge as a capital good with non-diminishing marginal productivity. Based on this, Krugman (1991) uses increasing returns to scale and shows that firms choose places where manufacturing labour is initially concentrated. Nevertheless, Krugman and Venables (1995) highlight the role of low transportation costs that can foster a core geographical concentration only to a certain threshold. In other words they claim that after transport and transaction costs become sufficiently low the forward-backward linkages in the cluster becomes less attractive and firms would even move out of the concentrated core.

In empirical studies agglomeration effect is either captured through pure size variables or through a variable representing density of operations. For example, Handerson (1986) finds a positive relationship between industry size and industry productivity in a study of statistical metropolitan areas in US and Brazil. Furthermore, Meyer-Stamer (1998) compares evidence from three industry clusters in South of Brazil and argues that clusters can facilitate change from one development path to another, especially in the face of crises. On the other hand, Ciccone and Hall (1996) use the variable measuring employment per unit of physical space and argue that such density variables are more appropriate in capturing agglomeration effects.

Similarly, some empirical efficiency models use the latter type of variable definitions such as proportion of region output out of total country output to measures the effect of agglomeration.

*Inter-Firm Relations*

The inter firm relations in recent studies have been shown to influence the technical efficiency of firms in a positive manner. The positive effect is attributed to better transfer of knowledge and specialisation of production when subcontracting takes place. This networking is normally captured in subcontracting activities that firms engage in. This subcontracting can either take place in the use of inputs that a firm uses or the outputs.

Taymaz and Saatci (1997) find a positive effect of subcontracting inputs in all three manufacturing sectors they study. However, they do not conclude a significant efficiency enhancement for the subcontractor firm itself or for firms that subcontract outputs. Thus, they suggest that the inter-relatedness of firms seems to be beneficial in the above context.

*Market Structure and Government Regulation*

Clearly, the environment in which the firms operate in is also an important indicator of how productive the production performance of firms is. For instance, the extent of market power that a firm may possess and consequently the degree of monopoly in a given sector can have an important explanatory power of the efficiency that this firm displays. This can be captured by the firm’s share of total market sales.

Furthermore, the extent of government intervention can also have important explanatory power on firms’ efficiency scores. These include the different amount of direct and sometimes indirect subsidies that is provided to firms. Moreover, the extent of trade barriers such as import or export tariffs and quotas might impact the production behaviour. Where there is disparity of regulations that the government enforces due to different laws in different states or provinces the geographical characteristic of a firm can provide explanation on firm performance. For example, the extent to which pollution regulations are enforced (e.g. inspections or other monitoring means) might be different across states and thus this might influence the production behaviour of units differently.

It is clear from the above passage that there may be overlaps in the variables used in each category above and depending on the context and the way variables are defined a different efficiency explanation can be hypothesised.

## 8.3 Efficiency Determinants of Iran

We have discussed the recent trends in the Iranian economy and more specifically in the manufacturing sector in the previous chapters. On this basis, a number of potentially important determinants of efficiency are proposed for Iranian manufacturing production in the proceeding paragraphs. It is clear that due to the context many of these factors are either directly or indirectly related to the role that the state or government plays. Hence, we will group our determinants in terms of those that are determined to a great extent by the government and those that are not.

### 8.3.1 State Related Factors

One of the important factors in the case of Iranian industries is the type of ownership of firms. It is possible that this factor might explain disparities among firms. As discussed in the previous chapters, the ongoing protection and special treatment that public firms enjoy in various forms might contribute to them being less motivated in achieving improvements in the efficiency of their production processes. As discussed in Chapter 3, the influence of the state is even more important yet less transparent in the case of the bonyads or foundations. Often due to the large size of their operations they might influence other firms that operate in the same sector.

Subsidies can also possess an important role further showing the effect of government policies on the production of firms. It is important to see if, for example, subsidies levied on inputs and energy have incentivised firms to be dependent on these and thus be less technically efficient.

Trade barriers such as tariffs have always been imposed throughout the majority of the industrialisation history of Iran. It potentially has influenced the performance of firms in different aspects. First, import barriers undermine their competitiveness by protecting domestic firms from products of more efficient firms outside the country. Furthermore, any government policy that can restrict the import of intermediary goods (e.g. choice of exchange rate regime), which the manufacturing sectors heavily depend on, can strongly shape firms decisions. Additionally, the government in various instances has enforced export restrictions which again can equally reduce the incentives for firms to choose more efficient means of production needed to compete at global scale.

### 8.3.2 Other factors

Apart from the above state related factors there are some determinants that are primarily based on operational aspects of each firm. It is reasonable to assume that larger firms tend to be better organised and equipped in monitoring their performance and thus are expected to have higher levels of efficiency. These firms tend to have established wider economic ties to other firms and can utilise better production processes such as more advanced machinery and better quality control practices. This should be an important factor in the Iranian context.

The age-efficiency relationship might also be an indicator of how experience and the greater history of a firm in the business might explain better decisions in line with optimal production. Furthermore, location related factors discussed above both in terms of agglomeration or other geographic characteristics can help explain efficiency.

Finally, other strategic characteristics of firms such as interrelatedness with other firms, R&D intensity and export intensity can also be important factors.

Other factors such as the effect of labour unions in the technical efficiency of firms seem less plausible in the case of Iran. Rather than a technical aspect, this lack of relevance of these institutions has been mainly political. In the contemporary history of Iran (both pre and post revolution) trade unions have not been really allowed to operate freely and influence manufacturing policy due to political and security concerns.

### 8.3.3 Variable Definition and Availability

In the dataset ownership is defined broadly and does not include any information on the foundations. As we observed in the previous chapter there is indication that some bonyad firms are classified as private in the data and thus those labelled as public are those SOEs that their majority shares are owned by state institutions including the government. It will be attempted to use a dummy variable representing public firms to assess whether there is a considerable difference between public and non-public sector.

There is no direct data on the amount of subsidies in the data. However, one of the biggest sources of subsidies is in the form of subsidies on fuel. Thus, the inclusion of a fuel intensity variable defined as relative share of fuel expenditure to total input value can act as a good indicator of the effect of fuel subsidies on the performance of more fuel-intensive production.

In the absence of data on tariff payments by firms we look at export intensity of firms to capture the effect of additional international market exposure on the production efficiency of these firms. We define this variable as the ratio of exports (in Rials) to total sales of exporting firms.

Firm size will be measured in terms of the natural logarithm of the number of total employees. Additionally, the effect of monopoly power of a firm and thus the amount of competition it faces can increase incentives to achieve better efficiency. This effect in the model will be proxied by the relative share of each firm's sales in total two-digit ISIC sector sales that it operates in.

Furthermore, the importance of the composition of the labour force will be examined via a ratio of number of production labour to total employees. This can partly represent the effect of additional management and more complex production on performance of firms. Another aspect of type of production is the capital labour ratio.

We also use this variable to explain the relative importance of firms' efficiency scores according to the level of their capital intensiveness.

There is no data on firm age thus it is not included. Location dummies are suggested based on Iran's provinces we will compare the two main hubs of manufacturing, Tehran and Esfahan against all other provinces. This will capture any possible effects of agglomeration of industries. Finally R&D intensity will be defined as the ratio of R&D expenditure to total input value.

## 8.4 Estimation

In the first instance a simple two-staged estimation will be conducted. We conducted the first stage in the previous chapter and obtained firm-specific inefficiency estimates from the Translog specification with half-normal distribution. Here for the second stage, the inefficiency regression is estimated by regressing the estimates from stage one on the chosen efficiency determinants in order to identify the significant sources of technical efficiency.

As it has been discussed in the estimation theory chapter, the two-stage estimation suffers from econometric problems which might cause both regressions to have biased estimates. Nevertheless, it will be useful to see if these results are considerably different form the simultaneous estimation of the two regressions which will also be carried out. For the single-stage estimation, the model of Battese and Coelli (1995), discussed in Chapter 6, is implemented to simultaneously estimate the production frontier and also model the sources of firms' heterogeneity. Under this setting the technical inefficiency component is hypothesized to follow a truncated normal distribution. Thus, each firm will have a unique mean which its distribution can be explained by a set of the determinant variables as below:

$$\mu_i = z_i\boldsymbol{\delta} + w_i \qquad \textbf{(8–1)}$$

Here $\mu$ is the mean of the inefficiency terms ($u_i$), $z_i$ is a vector of determinants of inefficiency, $\boldsymbol{\delta}$ is a vector of $m$ parameters to be estimated and $w_i$ is the random disturbance term following a truncated normal distribution with the truncation point of $-z_i\boldsymbol{\delta}$ and a variance of $\sigma^2$.

## 8.5 Determinants Results

### 8.5.1 Two-Stage Estimation

The inefficiency regression below is estimated using OLS estimation.

$$\begin{aligned} u_i = \alpha_0 + \alpha_1 public + \alpha_2 FUELint + \alpha_3 INDshare + \alpha_4 Lproratio \\ + \alpha_5 TehEsf + \alpha_6 EXPORTint + \alpha_7 RDint + \alpha_8 LnL \\ + \alpha_9 KLratio + e_i \end{aligned} \qquad \textbf{(8–2)}$$

Here, $u_i$ is the inefficiency component of the error term that was estimated for each firm in Chapter 7, $public$ is a dummy variable taking the value 1 if the firm is a public firm and 0 if the firm is a private or cooperative firm, $FUELint$ is fuel intensity, $INDshare$ is the firm's industry share, $Lproratio$ is the share of production labour to total labour of the firm, $TehEsf$ is a dummy equalling to one if the firm is in either Tehran or Esfahan provinces, $EXPORTint$ is export intensity and $RDint$ is R&D intensity. Finally, $LnL$ and $KLratio$ are the size and capital labour ratio variables as described earlier.

Below the result of the estimation is given in Table 8–1. The results suggest that apart from $RDint$ and $LnL$ all other determinants seem to have a statistically significant role in explaining how far away firms are from the frontier[13].

Looking closer at the signs of the coefficients some variables have the expected signs. The estimation suggests evidence for positive effect of the public ownership dummy on inefficiency or in other words a negative relationship with efficiency. The greater the relative usage of subsidised fuel the less efficient the firms tend to be. Also, the more export oriented the firm the more efficient it seems to be. Finally, as the ratio of production workers to total employees of a firm rises, the firms' technical efficiency seems to fall.

However, the other three factors show relationships that were not expected in the first instance. Interestingly, the positive effect of agglomeration on efficiency some extent seems to be rejected. We discussed possible causes of this when we were analysing the initial estimates in the previous chapter. The negative sign of the

[13] Dropping both variables does not make any considerable change in the size or significance of other estimates.

$INDshare$ variable suggests that as firms are a bigger player in the industry they tend to be more technically efficient. Also, the higher the capital-labour ratio the less efficient the firm tends to be. This might be an indication of the low returns to capital investments, due to factors such as low capital utilisation, in Iran and more generally the inefficiency of investments in the economy. Nevertheless, as mentioned this procedure could be affecting the results seen here. Thus, we reserve the final interpretation of the determinants to the single-stage estimates presented below.

**Table 8–1 – Second Stage Regression of Inefficiency Determinants and Variable Summary Statistics.**

| | Inefficiency Model | | Variable Summary | | |
|---|---|---|---|---|---|
| **Variable** | **Parameter estimate ($\hat{\alpha}_m$)** | **Estimate Standard Error** | **Mean** | **Standard Deviation** | **Max.** |
| $\boldsymbol{constant}$ | 0.346* | 0.009 | | | |
| $\boldsymbol{public}$ | 0.028* | 0.007 | | | 1 |
| $\boldsymbol{FUELint}$ | 0.023*** | 0.013 | 0.035 | 0.089 | 0.980 |
| $\boldsymbol{INDshare}$ | -0.485* | 0.110 | 0.001 | 0.010 | 0.856 |
| $\boldsymbol{Lproratio}$ | 0.056* | 0.010 | 0.790 | 0.120 | 1 |
| $\boldsymbol{TehEsf}$ | 0.011* | 0.002 | | | 1 |
| $\boldsymbol{EXPORTint}$ | -0.042* | 0.008 | 0.030 | 0.141 | 1 |
| $\boldsymbol{RDint}$ | 0.001 | 0.014 | 0.005 | 0.085 | 5.486 |
| $\boldsymbol{LnL}$ | -0.00086 | 0.00119 | 3.544 | 0.990 | 8.811 |
| $\boldsymbol{KLratio}$ | 0.00021* | 0.00005 | 15.672 | 25.458 | 1017.853 |
| **$R^2$** | 0.0107 | | | | |
| **Obs.** | 12082 | | | | |

*Notes*: * and ***indicates significance at 1% and 10% levels of significance.

### 8.5.2 Single-Stage Estimation

In this estimation procedure we will incorporate the same determinant variables used in the two stage procedure. The results are based on the Translog production frontier with inefficiency model. This is because similar to the restrictions test in previous chapter the Cobb-Douglas production specification was also estimated but was rejected in favour of the Translog specification with a p-value of less than 0.001.

**Table 8–2 Final Model Estimation Results, Battese and Coelli (1995) Procedure.**

| Variable | Parameter | Estimate | Estimate Standard Error |
|---|---|---|---|
| **Frontier Model** | | | |
| $\boldsymbol{constant}$ | $\beta_0$ | 8.610* | 1.559 |
| $\boldsymbol{LcompL}$ | $\beta_1$ | 1.056* | 0.143 |
| $\boldsymbol{LK}$ | $\beta_2$ | -0.708* | 0.126 |
| $(\boldsymbol{LcompL})^2$ | $\beta_3$ | 0.002 | 0.012 |
| $(\boldsymbol{LK})^2$ | $\beta_4$ | 0.052* | 0.010 |
| $\boldsymbol{LcompL \times LK}$ | $\beta_5$ | -0.013 | 0.010 |
| **Inefficiency Model** | | | |
| $\boldsymbol{Constant}$ | $\delta_0$ | -0.503 | 0.335 |
| $\boldsymbol{public}$ | $\delta_1$ | 0.401* | 0.098 |
| $\boldsymbol{FUELint}$ | $\delta_2$ | 0.251 | 0.263 |
| $\boldsymbol{INDshare}$ | $\delta_3$ | -2.309 | 5.209 |
| $\boldsymbol{Lproratio}$ | $\delta_4$ | 0.985* | 0.241 |
| $\boldsymbol{TehEsf}$ | $\delta_5$ | 0.124** | 0.057 |
| $\boldsymbol{EXPORTint}$ | $\delta_6$ | -0.338** | 0.159 |
| $\boldsymbol{RDint}$ | $\delta_7$ | 0.266* | 0.097 |
| $\boldsymbol{LnL}$ | $\delta_8$ | -0.150* | 0.038 |
| $\boldsymbol{KLratio}$ | $\delta_9$ | 0.00254* | 0.00032 |
| **Other Parameters** | | | |
| $\boldsymbol{\sigma_s^2 = \sigma^2 + \sigma_v^2}$ | | 0.4343* | 0.022 |
| $\boldsymbol{\gamma = \sigma^2/(\sigma_u^2 + \sigma_v^2)}$ | | 0.8459* | 0.040 |
| **Log-Likelihood** | | -15,039.045 | |
| **LR-test for presence of inefficiency** | | 211.420 | |

*Notes*: *, ** indicates significance at 1% and 5% levels of significance (Model estimated using NLOGIT5 program).

Table 8–2 presents the results of the two components of the model. Clearly, the estimated coefficients of the frontier model are not identical to the results in the previous chapter (Table 7–5) however, they are fairly similar. Also, since the frontier estimated is slightly different the estimated efficiencies tend to be different from the previous chapter's model. As Table 8–3 suggests the overall mean efficiency is lower by approximately 5% compared to the half-normal model in Table 7–6 in the previous chapter. It is important to remember that part of this disparity is obviously due to the assumption of a truncated normal distribution for the inefficiency component in the frontier model and part of this is due to the simultaneous inclusion of the determinants.

The comparison of the average technical efficiency with a few other studies can highlight the relative weak performance of Iranian manufacturing. Taymaz and Saatci (1997) find an average technical efficiency of above 80% in four Turkish manufacturing sectors for the period 1988 to 1992. Hossain and Karunaratne (2004) find an average efficiency of around 70% in the case of Bangladesh manufacturing sector. Lundvall and Battese (2000) in a study of four Kenyan manufacturing sectors find the smallest mean of 68% for the wood industries versus 80% for the metal sector. Nevertheless, in a study a panel sample of Fortune 500 two-thirds of which were manufacturers, by Shao and Lin (2001) find an average technical efficiency estimate of around 84% for the pooled version of their model.

The results for the inefficiency part of the model are also slightly different to those obtained by the two-stage method. Most notably, the two coefficients for $RDint$ and $LnL$ that were previously insignificant have replaced two other coefficients for $FUELint$ and $INDshare$ that had been significant. The relationship between the size and industry share variables can partly explain at least half of the problem here. We can see this relationship even in two-stage procedure. If we drop the industry share variable and replace it with the firm size variable we see that the p-value of the significance of $LnL$ drastically improves to a lower value of 12.8% (down from 47.1%) in the model in Table 8–1.

**Table 8–3 Summary of Overall Efficiency Estimates in Iranian manufacturing (tebcsi2)[14].**

| Mean | Standard Deviation | Minimum | Maximum | Number of Observations |
|---|---|---|---|---|
| 0.657 | 0.099 | 0.065 | 0.930 | 13,015 |

[14] The letters in the 'tebcsi2' name stand for: 'te' for technical efficiency, 'bc' for Battese and Coelli estimation, 'si' for simultaneous estimation and 2 stands for the second model i.e. the Translog frontier.

A summary of the results can be expressed in the following descriptive statement for a hypothetical firm: a large private firm that has a lower share of its labour directly engaged in production, situated outside Tehran or Esfahan and exports a labour intensive product with minimum R&D expense is likely to be a very technically efficient firm in Iranian manufacturing in 2007.

The two determinants that have shown a significant negative effect on inefficiency and therefore a positive relationship with efficiency itself are the size and export intensity variables. These confirm the hypothesis that bigger firms tend to benefit from their size and produce in a more efficient manner. Furthermore, the experience of engaging in cross-border activity via exports seems to help firms become more efficient due to stronger competition and interaction with better and alternative production processes.

On the other hand, the estimates suggest that firms which are public tend to be less efficient. This provides additional evidence on the inefficient characteristic of SOEs' operations in Iranian manufacturing. As discussed in the previous chapter we can confirm that overstaffing or other structural problems in these firms have not only misallocated oil revenues but also have encouraged poor technical efficiency in production. Yet the negative coefficient for the firm size variable shows that larger firms have been able to use greater specialisation to their advantage.

That large but private firms tend to be more efficient is reminiscent of firms such as the bonyads. This can mean that the flexibility of such firms in imports, capitalisation and choice of more modern machinery compared to the average firm through bypassing various bureaucratic obstacles and red tapes has allowed these conglomerates in pursuit of better returns to opt for more technical efficient production processes. Such benefits for these firms come at the expense of and marginalisation of other smaller businesses and thus do not help improve the situation of the less-privileged private counterparts. These issues warrant further investigation which unfortunately due to limited data on these firms is a rather tedious task.

The negative effect of firms being situated in provinces such as Tehran or Esfahan is very important in terms of the Iranian context. Our finding is contrary to the discussion on the linkage and spillover benefits of agglomeration suggested in the literature (see Chapter 7) and thus warrants further research to clarify the underlying reasons for such a result. Nevertheless, this potentially highlights a fundamental problem in the industrial strategy of Iranian manufacturing. It can be translated as a mismanagement of oil revenues in that the vast amounts of investments in expanding the production base has not led to strong linkages and cross-firm cooperation. Thus, the potential benefits of a more organic manufacturing sector are yet to be realised.

Our evidence of positive effects of export activity shows that the exposure to international markets leaves little option for firms to attempt to reduce their distance from the efficient industry frontier. Moreover, this result can be generalised in the broader context of competitiveness. It highlights the positive benefits from the pursuit of gradual adjustment of policies towards increasing the competitiveness of domestic firms domestically and then at the international level.

The significant positive coefficients for production labour share and capital labour ratio variables suggest that the type of industry is an important determinant in technical efficiency performance. As discussed earlier the negative effect of capital intensive firms on their performance supports the hypothesis of low efficiency of investment in Iran. The importance of management and a more dynamic production structure can explain the negative effect of greater $Lproratio$ on efficiency.

The underlying reason for the negative effect of R&D expenditure by firms seems less clear. Some studies point to the 'disruptive' aspect of the adjustments necessary for new technologies as an explanation for negative R&D effect (Bower and Christensen, 1995). However, a more valid explanation for Iran might be the fact that firms engage in R&D due to other incentives such as access to loans or help provided by the government which has requirements on R&D expenditure by these firms. Regardless, this result suggests that the quality of firms R&D operations has not been satisfactory and thus has not been conducive to performance improvements.

## 8.6 Conclusion

In this chapter we have reviewed the main determinants of technical efficiency and explored the applied method of definition of such determinants. Based on this review we narrowed down these determinants to a number of important variables in the case of Iran. We identified ownership, subsidies and trade openness as important indicators which are directly related to the state presence in the economy. Other factors including firm size, agglomeration and LBD effects were indicated as important determinants. These actors while are mainly firm related matters can also be influenced by government policy.

Based on the data available to us we defined nine determinants to be incorporated in to our efficiency estimation procedures. We first implemented the two-stage estimation method. Having carried out the first stage in Chapter 7 we used those results and regressed our inefficiency terms on the list of determinants. Acting as an initial prototype model it presented us with significant results for a number of our hypothesised relationships.

Thus, in order to have a model which is more econometrically robust we implemented the single-stage estimation method of Battese and Coelli. (1995).Our new adjusted efficiency estimates for 2007 suggest that the manufacturing firms are on average performing at 66% of the hypothesised frontier. This shows a sizable inefficiency in the average manufacturing firm. Comparing the results with findings for other countries highlights the extent the production structure is behind even low income countries such as Bangladesh.

The results of the inefficiency model suggest that seven of the determinants have a statistically significant effect on firms' technical efficiency. We have shown that factors such as exports and size have a positive role in improving the productive performance of manufacturing firms. On the other hand public ownership and greater concentration of industries have had negative effects.

Our findings are micro-level evidence in support of our Chapter 5 estimates of low or negative overall productivity growth (TFP) trend and hence overall growth especially in the recent post-revolutionary phase of Iran's economy. As discussed in the previous section, inconsistent policy making and mismanagement of oil income has influenced the structure of production in a negative manner. This has even led to some determinants such as greater geographic concentration of production has ironically acted as a deterrent to productive efficiency.

# Chapter 9 Conclusions and Suggestions for Future Research

## 9.1 Introduction

In this chapter we provide a summary of the key findings of our research in the preceding chapters. We provide a final conclusion of our research. We will reflect on the significance of our approach and also discuss its limitations. After discussing these issues, we will identify the important directions for further research in this field.

## 9.2 Research Summary

The aim of this research has been to provide an alternative examination of the role of oil income in the development trajectory of Iran, by focusing on efficiency aspects of oil economies at the microeconomic level.

In Chapter 2 we reviewed the literature on natural resources and economic development. First, we discussed the Dutch Disease literature. We argued that such models mainly focus on the misallocation of resources at the sectoral level and rely on extremely restrictive assumptions. For instance, the assumptions of full employment and perfect factor markets implied in such models are far from the experience of oil exporters with large populations such as Iran. Furthermore, the resource effect is generally negligible for resources such as oil. We next reviewed the Resource Curse literature and concluded that this literature which is by and large based on empirical models with weak theoretical rationales and suffer from econometric problems such as omission of important variables and endogeneity bias. Furthermore, the models used in this research are rather ad-hoc and overgeneralise the results for a cross-section of non-homogenous countries. However, the biggest drawback of these models is the fact that they do not conform to the experience of oil-rich countries. The Rentier State literature provides a plausible argument in highlighting the context specific dynamics of the effect of natural resources in the political structure and ultimately the economic growth of the economy. Nonetheless, it falls short of an adequate paradigm that can measure and explain the experience of resource-abundant countries in an analytical manner. We concluded that an important limitation of the literature is that it does not explain the long-term effects of oil revenues in the productive sectors. The empirical evidence shows that it is not the lack of investment, but rather the low efficiency of investment which distinguishes the oil economies. We suggested that looking at the technical efficiency of production can help explain the deeper embedded adverse effects of overdependence on oil revenues.

In Chapter 3 we looked at the political structure of Iran and concluded that the duality in power distribution breeds factionalism and conflict of interest. Looking at the modern history of Iran we confirmed the numerous instances of power struggle throughout the history of the Islamic republic. The economic implications of the 1979 Revolution were discussed based on the three dominant economic institutions. We argued that wide scale nationalisations that happened after the revolution led to a bloated public sector and were dependent on various subsidies. Furthermore, we saw that the emergence of a semi-public sector which enjoys monopolistic profits due to various subsidies and privileges has further marginalised the private sector and hindered attempts of privatisation of SOEs. We showed that while the relative size of some of these bonyads in the recent years is not as big as some earlier estimates suggest, their direct and indirect use of oil revenues have had negative effects for their private counterparts. Furthermore, the traditional merchants have also used their influence especially in imports to maximise their own benefits. We concluded that these unique elements of the Iranian political economic structure all play an important role in explaining the productive performance of Iran in light of its oil revenues.

In Chapter 4 we looked at the experience of Iran’s economy and investigated the adequacy of the theoretical frameworks discussed in Chapter 2 in explaining the impact of oil on economic growth. We demonstrated a strong positive correlation between GDP growth and oil revenue growth. We also showed that manufacturing grows and contracts simultaneously as the oil revenues increase and decrease. We argued this was a result that Dutch Disease did not explain since the assumption of small open economy of the framework did not hold due to semi-non tradable nature of the protected manufacturing sector. To explain the reason for the positive relationship between oil and manufacturing growth we looked at the profitability of manufacturing sector and showed that the markup of manufacturing has not fallen even when labour productivity decreased and wage shares stayed relatively stagnant. We showed that this is only possible through the provision of subsidised intermediary goods by the state. We also looked at the broader consequence of such policies on the competitiveness of Iranian production and compared it with the export promotion success of Korea and Turkey. As an example we compared the energy efficiency of Iran with these countries and saw a deteriorating situation in Iran. We concluded this chapter with the need for an examination of overall productivity.

We started Chapter 5 by exploring the literature on productivity estimation. We then obtained the estimates of Iran's TFP growth for the period between 1966 and 2007. Our results showed that during this period TFP in Iran fell by an average of 2.7% annually. When we compare the pre and post revolution period we see that the productivity in the pre-revolutionary phase was increasing whereas even in the post war period in Islamic republic we see a 1.24% drop on an annual basis in this index. This shows that the production environment after the revolution has not been conducive to strong growth. Furthermore, we estimate the TFP of Korea and Turkey and see the strong contribution of TFP in these countries' strong economic growth trends. We clarify part of this by focusing on the industrial sector and show that both in terms of GDP share and employment share this sector is crucial to the growth of the economy. Analysing the manufacturing sector, we demonstrate a structural shift towards heavy industries. But, we show that this shift is based on support of the government confirming our findings in Chapter 4 when we looked at manufacturing collectively. We concluded at the end of this chapter that in line with our theoretical framework in Chapter 2 we can use technical efficiency analysis to explain the dismal productivity trend as a result of mismanagement of oil revenue.

Chapter 6 dealt with the main methodologies of estimating technical efficiency. We concluded that due to better statistical properties of the SFA method and the conformity with the estimation of TFP in the previous chapter it was more appropriate in our analysis than the linear programming models. We used this approach in Chapter 7 and obtained initial estimates of Iran's manufacturing efficiency in 2007 which was around 70% for the entire sample. We concluded that this highlights the big distance between the average firm's position and the frontier.

We categorised the firms and found considerable variation in their efficiency based on their industry, location, ownership, firm size and their export activity. We concluded that these factors are potential determinants of technical efficiency.

In Chapter 8 we introduced our final model using a list of potentially relevant determinants of technical efficiency which can be created based on our dataset. Our final efficiency estimates showed that when we simultaneously control for the effect of these determinants, the average technical efficiency of the sample decreases to 66%. All determinants, apart from industry share and fuel intensity, are shown to have a significant effect on the technical efficiency of producers. We found evidence that public ownership, greater ratio of production labour to total employees, agglomeration, research intensity and capital-labour ratio have a negative impact on technical efficiency. On the other hand, export intensity and size have a positive effect on the firms' production performance. The most important variables for the purpose of our research are ownership, agglomeration and exports. The ownership variable confirms the discussion in Chapter 3 that public firms tend to be less efficient producers. This explains why such firms are truly less profitable and rely heavily on oil income to survive. The implication of our conclusion that manufacturing firms inside Tehran and Esfahan provinces, despite housing 32% of all firms in our sample, highlights the mismanagement of economic policies to the extent that a potentially enhancing factor has had the opposite effect. Finally, the positive contribution of exports shows that the oil income's true potential contribution to manufacturing should be towards measures of boosting their competitiveness.

## 9.3 Contributions

This research is based on a synthesis of two major economic literatures. By bridging the gap between the economic growth and natural resource literature it has provided an alternative approach to explain the deeper effects of inappropriate use of oil revenues.

The framework of our analysis is consistent across different levels of aggregation as we have covered different levels of the Iranian economy. In this light, it can be interpreted as microeconometric approach that can answer the bigger macro questions in the economy in a consistent manner. Similarly, it allows for an explanation of the micro consequences of macro policy making.

Part of our work can be considered as a contribution to the growth and productivity literature in Iran on its own. We constructed a new TFP growth series for Iran and conducted a cross-country comparison within a consistent framework with two other countries. For this purpose we have constructed a new capital stock series for the Iranian economy at macro level.

Furthermore, to our knowledge, the technical efficiency estimates obtained here are the most comprehensive attempt, both methodologically and in terms of using the most recent data in the context of the Iranian economy.

## 9.4 Policy Implications

As mentioned above, the absence of a close assessment of productive efficiency in the Iranian economy had been long overdue partly due to lack of appropriate data. Thus, there are important policy implications from the findings of this study. This research is also a timely analysis of the Iranian economy especially in the view of the current economic and political developments in Iran. The new administration of President Rohani has promised to embrace more rational economic policies. There are early signs of such actions in the government's attempts to follow a more disciplined annual budget plans and there are already signs of significant reductions in the inflation rates down to around 21% in the middle of 2014 (CBI, 2014c). On the other hand, the ongoing global economic crisis and the downward spiral of oil prices in the final months of 2014 will undoubtedly have important results for oil dependent countries such as Iran. Our research finding of average technical efficiency of around 66% highlights the necessity of undertaking policies that can address these embedded inefficiencies especially in the face of challenges such as falling oil prices and the ongoing US-EU sanctions implemented against the Iranian economy.

Our analysis provided an explanation of how political economic structure of Iran has facilitated poor productive performance in its manufacturing production. Most noticeably the negative effect of public ownership on efficiency scores presents a very clear direction for economic and industrial policy. Though, this does not imply the abolishment of all public production, it highlights the need for a better and more transparent privatisation implementation strategy. As discussed due to the strong influence of public and semi-public institutions this would require bold decisions to resist the pressure of such entities.

Our findings also highlight the need for a more comprehensive export promotion strategy in the manufacturing sector. The main objective of such policies should ultimately be the improvement of the domestic producers' competitiveness in line with the experience of East Asian growth strategy. An important step in this direction is to improve economic infrastructures such as adequate transportation, energy and communications. Such policies can then be complemented through a gradual process of increased openness and entry of more competitive foreign firms. Encouraging exports can additionally improve the dependence of the country on oil as the major source of foreign exchange.

The result of better productive performance in larger firms also provides evidence for implication of strategies that encourage utilisation of scale economies. The benefits of larger firms also arise from acquisition of better machinery and quality control practices.

Our framework also provides a benchmark for the implementation of economic diversification. Our estimates either based on type of industry or the province can provide an eye-opening assessment on the inter-industry and inter-regional disparities. For example, as we discussed above the negative effect of firms being located in the two biggest provinces emphasises the need for addressing in previous industry policies and guide the way for future decision-making. Therefore, arriving at a more diversified economy allows a quicker transition to a more robust economy as a whole to external shocks such as sanctions.

## 9.5 Limitations and Suggestions for Future Research

From a theoretical point of view this research has addressed the growth of Iran which contributes to explaining part of the wider development question. While the incorporation of the political economic factors partly proxies social, cultural and historical aspects of the country it does not capture their full effects and thus does not intend to do so. For instance, an important question that was not assessed in this research is the presence of any meaningful welfare effect arising from better and more efficient production. It is important to assess the relative extent that the current productive performance of sectors such as manufacturing might entail for the inequality index of the economy. A potential causal relationship between technical efficiency in a given sector or industry and the livelihood of the lower income deciles could be an important piece of evidence that can have even greater policy implications.

A number of limitations of this research are due to the absence of appropriate data in the micro dataset. The lack of an identifying variable that would allow us to identify each firm uniquely rules out any possibility of analysing technical efficiency over time. This also means that we cannot undertake a dissection of productivity change to its components that involve time, such as technological progress, in a systematic manner. Furthermore, despite presenting possible evidence on channels through which the impact of bonyads can be explained, we highlight the need for identifiers of these institutions in a more focused analysis. This would help clarify the true performance of these foundations as producers and their impact on the privately owned firms that compete with them.

In this research we have focused on the role of manufacturing sector. It seems necessary to conduct efficiency analyses in other sectors such as services and agriculture. Such studies can complement our findings in providing a more holistic picture but also address the specific characteristics and challenges of each sector.

From a methodological point of view, future work can use alternative efficiency estimation methodologies such as DEA to conduct the same research and compare the results to our findings. Clearly, our parametric restrictions influence the estimates to a great extent. Moreover, in our research we have only looked at technical efficiency. Prospective research can extend our approach and simultaneously incorporate technical and allocative efficiency in their framework and assess the significance of their different methodology.

Another fruitful exercise would be to apply our framework to a number of other oil economies and compare the results between these cases to see whether a more general pattern can be observed despite path dependencies of each country.

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## Appendix 1. IRMF Annual Accounts

In Table A and Table B (Below) we have used data from the four annual reports available on the website of IRMF (IRMF, 2014a). The Product Price Index column is calculated from the data on growth in IRMF's products' prices. Initially the index was calculated with a base year of 2005 but later the base year has been changed to 2008 in order to conform to the base year used in the reports. The Manufacturing and Mining Output column represents IRMF's total output in these sectors and is calculated by using the shares originally reported in the report multiplied by the Total Output column. Finally, the IRMF Share in Total Manufacturing and Mining column is the bonyad's manufacturing and mining output value divided by the sum of manufacturing and mining output of the entire economy, reported in CBI (2014a).

**Table A. IRMF Performance Indicators.**

| Year | Output (2008 prices) | Product Price Index | Total Output | Manufacturing & Mining Output | IRMF Share in Total Country Manufacturing and Mining |
|---|---|---|---|---|---|
| **2006** | 35 | 70.9 | 49.4 | 22.21 | 6.52% |
| **2007** | 41 | 84.0 | 48.8 | 19.39 | 4.93% |
| **2008** | 48 | 100.0 | 48 | 16.56 | 3.50% |
| **2009** | 56 | 107.1 | 52.3 | 15.74 | 3.10% |
| **2010** | 71 | 111.8 | 63.5 | 18.29 | 3.01% |

*Source*: Based on CBI (2014a) and IRMF (2014a)

*Notes*: All output values are in thousands of billion Rials.

Here we can see a gradual decreasing share of IRMF in the manufacturing and mining sectors of the economy. The additional cost and profit details of IRMF can be seen in Table B.

**Table B. IRMF Cost and Profit Structure.**

| Year | Sales | Wage Bill to Sales | Total Employees | Finished Price to Sales | Operating Profit | Total Investment |
|---|---|---|---|---|---|---|
| 2003 | 18 | | | | | |
| 2004 | 20 | | | | | |
| 2005 | 24 | | | | | |
| 2006 | 28 | 13.5% | 34,912 | 79% | 18% | |
| 2007 | 40 | 10.8% | 34,652 | 80% | 15% | 10 |
| 2008 | 51 | 9% | 33,806 | 75% | 14% | 18 |
| 2009 | 60 | 8% | 32,254 | 71% | 21% | 19 |
| 2010 | 81 | 7.2% | 34,471 | 70% | 24% | 20 |
| 2011 | 105 | 6.5% | 34,825 | 71% | 21% | 23 |
| 2012 | 147 | 5.9% | 36,231 | 70.8% | 23% | 27 |
| 2013 | 204 | 5.2% | 36,343 | 70.4% | 24% | 36 |

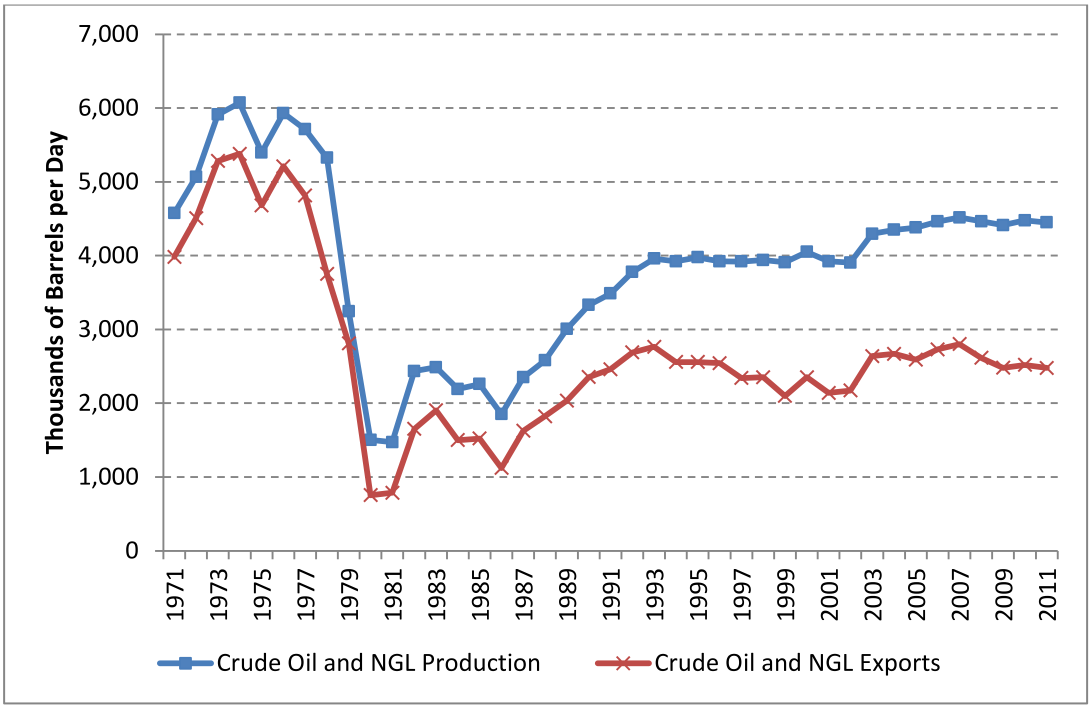
*Source*: IRMF (2014a).

*Notes*: Sales and investment values are in thousand billion Rials and employment in persons.

The results suggest an impressive profit margin. The foundation's reports attribute this increasing trend in investment and acquisitions of successful companies such as Irancell Telecommunication Company and Pak Diary Company and Glocozan Company in 2010 website itself. Nevertheless, in light of the removal of subsidies and the increase in the cost of production inputs for the average producer seems contradictory to this trend. The real explanation for this might be the preferential treatment that these organisations continue to receive from banks, cheap exchange rates and tax exemptions on top of the weakening of other competitors due to subsidy reform.

## Appendix 2. Production, Exports and Price of Iranian Oil

**Figure A. Oil Production and Exports Annual Average Daily Quantities, 1971-2011.**




*Source:* IEA (2013).

The increasing gap between production and export quantities highlights the growing domestic consumption of oil due to increasing population, increase general energy intensive usages and petrochemical production.

Figure A also highlights the fact the production volume has never returned to the peak of six million barrels per day in the 1970s. This highlights the problems the country has faced in investments in oil projects due to US sanctions preventing foreign firms entering the Iranian projects. Furthermore the conditions of the buyback contracts have not been enough of an incentive for companies to think about bypassing these limitations.

**Table A. Iranian Light and Heavy Crude Oil Prices post-1980 (USD per barrel).**

| Year | Iran Light | Iran Heavy | Year | Iran Light | Iran Heavy |
|---|---|---|---|---|---|
| 1980 | 34.68 | 32.99 | 2009 | 60.19 | 60.46 |
| 1981 | 38.61 | 38.13 | 2010 | 78.1 | 77.36 |
| 1982 | 32.91 | 31.24 | 2011 | 109.66 | 106.88 |
| 1983 | 30.21 | 29.2 | | | |
| 1984 | 29.11 | 28.64 | | | |
| 1985 | 27.8 | 27.24 | | | |
| 1986 | 14.99 | 15.05 | | | |
| 1987 | 18.32 | 17.98 | | | |
| 1988 | 14.79 | 14.34 | | | |
| 1989 | 17.14 | 16.77 | | | |
| 1990 | 22.8 | 20.48 | | | |
| 1991 | 19.58 | 17.87 | | | |
| 1992 | 18.56 | 17.51 | | | |
| 1993 | 16.18 | 15.2 | | | |
| 1994 | 15.59 | 14.92 | | | |
| 1995 | 16.91 | 16.63 | | | |
| 1996 | 19.89 | 19.55 | | | |
| 1997 | 19.02 | 18.26 | | | |
| 1998 | 12.12 | 11.64 | | | |
| 1999 | 16.25 | 16.01 | | | |
| 2000 | 27.19 | 26.95 | | | |
| 2001 | 23.83 | 23.37 | | | |
| 2002 | 23.94 | 23.7 | | | |
| 2003 | 27.82 | 27.2 | | | |
| 2004 | 35.12 | 33.74 | | | |
| 2005 | 49.41 | 47.3 | | | |
| 2006 | 62.07 | 60.04 | | | |
| 2007 | 67.33 | 67.08 | | | |
| 2008 | 95.46 | 96.63 | | | |

*Source:* IEA (2012).

## Appendix 3. Calculations of Manufacturing Real Wages, Product Wages and Labour Productivity

The data for Figure 4–4, Figure 4–5, Figure 4–6, Figure 4–7 and Figure 4–8 are extracted from UNIDO (2013), World Bank (2013) and CBI (2013). In this appendix we provide a brief summary on how these were calculated. The UNIDO Indstat2 database provides data on aggregate manufacturing sector of firms with more than 10 employees. It provides data on output, employees, wages, etc. CBI (2013) is the national accounts dataset and World Bank (2013) is the bank's World development indicators database.

Figure 4–4: Wage bill ($W.L$) in Rials, output value, ($O.L$) in Rials and consequently their ratio is calculated based on data from the UNIDO database. The database does not cover the year 1978, the year of the revolution, thus it has been left as a missing data point in the graphs using UNIDO data.

Figure 4–5: Manufacturing labour productivity is measured as constant output per employee. Nominal output and employee are obtained from UNIDO. The price index for deflating the nominal manufacturing output from data provided in CBI (2013) implicitly via dividing nominal output to constant 2004 output. The base year for the price series is subsequently changed to 2005 to conform to the next table.

We calculated labour productivity in value-added per employee terms with relatively similar outcome (see below) and thus in order for our graph to conform to the equation we kept the output per worker definition.

**Figure A. Value-Added per Employee in Iran's Manufacturing Sector (2005=100).**

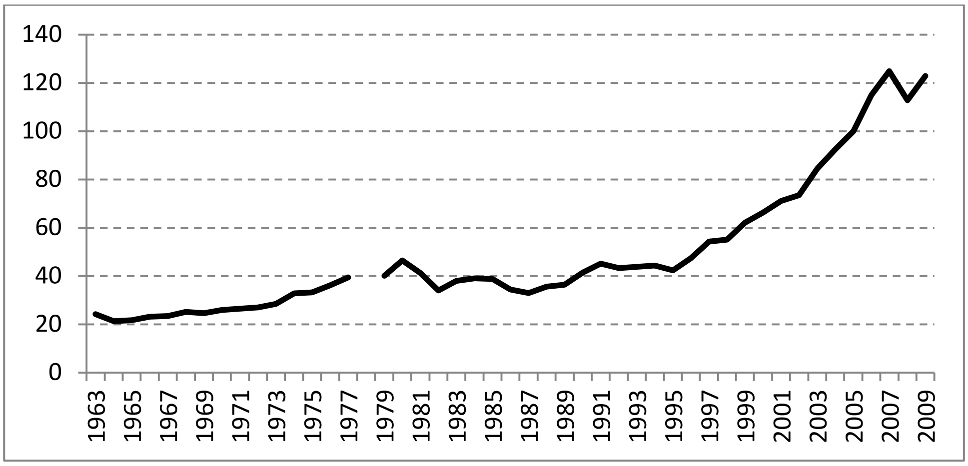


Figure 4–6: Product wage is obtained by deflating average annual money wages with manufacturing price index. Average money wage is calculated by dividing wage-bill ($W.L$) by total employees ($L$) which are both obtained from UNIDO (2013). For creating the real wage series, average money wages are deflated by Consumer Price Index obtained from World Bank (2013).

Figure 4–7: Intermediate input value is obtained by subtracting output value from value-added given in Indstat2. Next, the share is calculated by dividing intermediate input value to total output value.

Figure 4–8: The profit markup is simply calculated as a residual after rearranging Equation (4–3) in the below manner:

$$\pi = \frac{1}{\left(\frac{\frac{W}{P}}{\frac{O}{L}} + \frac{p_m.m}{P.O}\right)} - 1 \tag{1}$$

## Appendix 4. Variable Definition and Tables - Iran's TFP Estimation

*Capital Stock:*

As discussed the capital stock series is calculated based on the conventional perpetual inventory method shown in Equation (5–5). The calculation of the series relies on the gross capital formation (GCF) data obtained from World Bank (2013), according to which:

> Gross capital formation (formerly gross domestic investment) consists of outlays on additions to the fixed assets of the economy plus net changes in the level of inventories. Fixed assets include land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. Inventories are stocks of goods held by firms to meet temporary or unexpected fluctuations in production or sales, and "work in progress." According to the 1993 SNA, net acquisitions of valuables are also considered capital formation. Data are in constant local currency.

The series is in constant Rials based on 1997 prices and covers 1965 to 2007. However, to have capital stock in 1965 we need to have the GCF data for prior to this. We artificially create this by backcasting the data using a nonlinear extrapolation of data from 1965-1967 (our method is partially influenced by Wu, 2008). The relationship we use is as below:

$$y = 2 \times 10^{13} e^{0.1541x} \tag{2}$$

Here $y$ is the backcasted GCF and $x$ is the difference of the backcasted year and year 1965. For instance, GCF in year 1975 is calculated by inputting -10 into the above equation as $x$. Following this relationship we obtain values for GCF all the way back to 1900.

Next, we assume that in 1900 the capital stock to be zero. Therefore, by adding $(1-\delta)$GCF in 1900 we build capital stock for the year 1901. Subsequently, by adding the depreciated capital stock for each year to the previous year value we build our capital stock series. As noted in Chapter 5 we use a depreciation rate of 4.9% in line with the IMF study of Jbili et al. (2007) and their suggestion of 7% which is the long run international return to capital estimated in Siegel (1998).

There are other methods of obtaining capital stock. One such method is using the capital output increments ratio and generating data for prior to 1965 accordingly. After estimating capital stock in this method it was concluded that the choice of this method does not substantially change our findings in TFP growth estimates. The series in provided in Table A, at the end of this appendix.

*Human Capital:*

As discussed the proxy for human capital has been calculated based on two variables. The employment data was obtained from the new Penn World Tables Version 8 (Feenstra, et. al., 2013), or PWT8, measured in number of employed persons. The years of schooling is obtained from the Barro and Lee (2013) dataset which provide average years of schooling for a country under different age specifications. We use the variable for the above 15 year old population. The only problem here is that the data are provided in 5 year intervals. In order to obtain an annualised version, we use linear interpolation and calculate four points between each successive pairs of 5 year averages. By multiplying the two variables we obtain a series of human capital index from which we can obtain annual growth rates. The calculated series are reported below in Table B. See Figure A for a comparison of the historical trend of human capital index and its components.

*Output:*

The output data employed is GDP in Rials, at constant basic prices of 1997 which was obtained from CBI (2011).

**Table A. Actual and Constructed Gross Capital Formation and Capital Stock, Iran, 1900-2007.**

| Year | GCF | Capital Stock | Year | GCF | Capital Stock |
|---|---|---|---|---|---|
| **1900** | 1041943326 | 0 | **1935** | 2.29198E+11 | 1.23917E+12 |
| **1901** | 1215538943 | 1215538943 | **1936** | 2.67384E+11 | 1.44584E+12 |
| **1902** | 1418056898 | 2574034432 | **1937** | 3.11933E+11 | 1.68692E+12 |
| **1903** | 1654315871 | 4102222616 | **1938** | 3.63903E+11 | 1.96817E+12 |
| **1904** | 1929937372 | 5831151080 | **1939** | 4.24532E+11 | 2.29626E+12 |
| **1905** | 2251479493 | 7796904170 | **1940** | 4.95262E+11 | 2.67901E+12 |
| **1906** | 2626592956 | 10041448822 | **1941** | 5.77777E+11 | 3.12551E+12 |
| **1907** | 3064203152 | 12613620981 | **1942** | 6.74039E+11 | 3.6464E+12 |
| **1908** | 3574722506 | 15570276060 | **1943** | 7.86339E+11 | 4.25406E+12 |
| **1909** | 4170298235 | 18977630768 | **1944** | 9.17349E+11 | 4.96296E+12 |
| **1910** | 4865101373 | 22912828233 | **1945** | 1.07019E+12 | 5.78996E+12 |
| **1911** | 5675663952 | 27465763602 | **1946** | 1.24849E+12 | 6.75474E+12 |
| **1912** | 6621272371 | 32741213557 | **1947** | 1.45649E+12 | 7.88026E+12 |
| **1913** | 7724426284 | 38861320376 | **1948** | 1.69916E+12 | 9.19328E+12 |
| **1914** | 9011373958 | 45968489635 | **1949** | 1.98225E+12 | 1.07251E+13 |
| **1915** | 10512736820 | 54228770463 | **1950** | 2.31251E+12 | 1.2512E+13 |
| **1916** | 12264238058 | 63835798769 | **1951** | 2.69779E+12 | 1.45967E+13 |
| **1917** | 14307552612 | 75015397242 | **1952** | 3.14726E+12 | 1.70288E+13 |
| **1918** | 16691298781 | 88030941557 | **1953** | 3.67162E+12 | 1.9866E+13 |
| **1919** | 19472195038 | 1.0319E+11 | **1954** | 4.28334E+12 | 2.31759E+13 |
| **1920** | 22716409585 | 1.2085E+11 | **1955** | 4.99697E+12 | 2.70372E+13 |
| **1921** | 26501134742 | 1.41429E+11 | **1956** | 5.82951E+12 | 3.15419E+13 |
| **1922** | 30916423654 | 1.65416E+11 | **1957** | 6.80075E+12 | 3.67971E+13 |
| **1923** | 36067332997 | 1.93378E+11 | **1958** | 7.9338E+12 | 4.29278E+13 |
| **1924** | 42076422683 | 2.25979E+11 | **1959** | 9.25563E+12 | 5.008E+13 |
| **1925** | 49086672030 | 2.63992E+11 | **1960** | 1.07977E+13 | 5.84238E+13 |
| **1926** | 57264881787 | 3.08322E+11 | **1961** | 1.25967E+13 | 6.81577E+13 |
| **1927** | 66805642968 | 3.60019E+11 | **1962** | 1.46954E+13 | 7.95133E+13 |
| **1928** | 77935966914 | 4.20314E+11 | **1963** | 1.71437E+13 | 9.27609E+13 |
| **1929** | 90920686772 | 4.9064E+11 | **1964** | 2E+13 | 1.08216E+14 |
| **1930** | 1.06069E+11 | 5.72667E+11 | **1965** | 2.1864E+13 | 1.24777E+14 |
| **1931** | 1.23741E+11 | 6.68347E+11 | **1966** | 2.42286E+13 | 1.42892E+14 |
| **1932** | 1.44357E+11 | 7.79955E+11 | **1967** | 2.64502E+13 | 1.6234E+14 |
| **1933** | 1.68408E+11 | 9.10145E+11 | **1968** | 3.43832E+13 | 1.88769E+14 |
| **1934** | 1.96466E+11 | 1.06201E+12 | **1969** | 3.63916E+13 | 2.15911E+14 |

(Continued on next page)

**Table A. (Continued)**

| Year | GCF | Capital Stock | Year | GCF | Capital Stock |
|---|---|---|---|---|---|
| **1970** | 4.04735E+13 | 2.45805E+14 | **2005** | 1.60361E+14 | 1.79733E+15 |
| **1971** | 3.94647E+13 | 2.73225E+14 | **2006** | 1.70008E+14 | 1.87927E+15 |
| **1972** | 5.30042E+13 | 3.12841E+14 | **2007** | 1.87523E+14 | 1.97471E+15 |
| **1973** | 4.6958E+13 | 3.4447E+14 | | | |
| **1974** | 8.07589E+13 | 4.0835E+14 | | | |
| **1975** | 1.11075E+14 | 4.99416E+14 | | | |
| **1976** | 1.33339E+14 | 6.08284E+14 | | | |
| **1977** | 1.38388E+14 | 7.16866E+14 | | | |
| **1978** | 1.06311E+14 | 7.8805E+14 | | | |
| **1979** | 7.75577E+13 | 8.26994E+14 | | | |
| **1980** | 8.40881E+13 | 8.70559E+14 | | | |
| **1981** | 7.50402E+13 | 9.02942E+14 | | | |
| **1982** | 7.30655E+13 | 9.31763E+14 | | | |
| **1983** | 9.74951E+13 | 9.83602E+14 | | | |
| **1984** | 6.90371E+13 | 1.00444E+15 | | | |
| **1985** | 6.07938E+13 | 1.01602E+15 | | | |
| **1986** | 6.59714E+13 | 1.03221E+15 | | | |
| **1987** | 7.74126E+13 | 1.05904E+15 | | | |
| **1988** | 5.79739E+13 | 1.06512E+15 | | | |
| **1989** | 6.99678E+13 | 1.0829E+15 | | | |
| **1990** | 1.01029E+14 | 1.13086E+15 | | | |
| **1991** | 1.27568E+14 | 1.20302E+15 | | | |
| **1992** | 1.22146E+14 | 1.26622E+15 | | | |
| **1993** | 9.01753E+13 | 1.29435E+15 | | | |
| **1994** | 6.10132E+13 | 1.29194E+15 | | | |
| **1995** | 8.01713E+13 | 1.3088E+15 | | | |
| **1996** | 1.03388E+14 | 1.34806E+15 | | | |
| **1997** | 1.04619E+14 | 1.38663E+15 | | | |
| **1998** | 1.01392E+14 | 1.42007E+15 | | | |
| **1999** | 1.03228E+14 | 1.45372E+15 | | | |
| **2000** | 1.11083E+14 | 1.49357E+15 | | | |
| **2001** | 1.08525E+14 | 1.52891E+15 | | | |
| **2002** | 1.24787E+14 | 1.57878E+15 | | | |
| **2003** | 1.46865E+14 | 1.64828E+15 | | | |
| **2004** | 1.538E+14 | 1.72132E+15 | | | |

*Source*: Based on World Bank (2013).

*Notes*: The shaded cells are our estimated data.

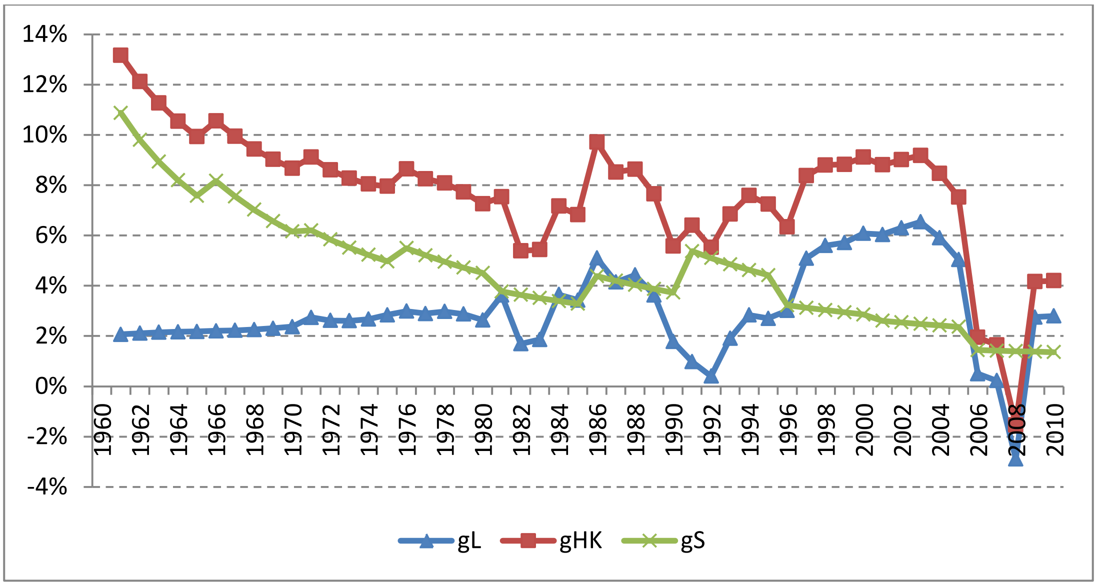
**Table B. Employment, Average Schooling and Human Capital Series, 1965-2007.**

| Year | Employment | Schooling | Human Capital | Year | Employment | Schooling | Human Capital |
|---|---|---|---|---|---|---|---|
| **1965** | 6.313222885 | 1.42 | 8.964776497 | **2000** | 18.03823661 | 7.13 | 128.6126 |
| **1966** | 6.452240467 | 1.536 | 9.910641357 | **2001** | 19.12710571 | 7.316 | 139.9339 |
| **1967** | 6.595560074 | 1.652 | 10.89586524 | **2002** | 20.3331337 | 7.502 | 152.5392 |
| **1968** | 6.74423933 | 1.768 | 11.92381514 | **2003** | 21.66264343 | 7.688 | 166.5424 |
| **1969** | 6.89978838 | 1.884 | 12.99920131 | **2004** | 22.94202995 | 7.874 | 180.6455 |
| **1970** | 7.063215256 | 2 | 14.12643051 | **2005** | 24.09935379 | 8.06 | 194.2408 |
| **1971** | 7.256586075 | 2.124 | 15.41298882 | **2006** | 24.21943855 | 8.176 | 198.0181 |
| **1972** | 7.446401596 | 2.248 | 16.73951079 | **2007** | 24.2737484 | 8.292 | 201.2779 |
| **1973** | 7.640528202 | 2.372 | 18.1233329 | | | | |
| **1974** | 7.844747066 | 2.496 | 19.58048868 | | | | |
| **1975** | 8.067655563 | 2.62 | 21.13725758 | | | | |
| **1976** | 8.308641434 | 2.764 | 22.96508492 | | | | |
| **1977** | 8.548978806 | 2.908 | 24.86043037 | | | | |
| **1978** | 8.803553581 | 3.052 | 26.86844553 | | | | |
| **1979** | 9.056785583 | 3.196 | 28.94548672 | | | | |
| **1980** | 9.29546833 | 3.34 | 31.04686422 | | | | |
| **1981** | 9.632472038 | 3.466 | 33.38614808 | | | | |
| **1982** | 9.795509338 | 3.592 | 35.18546954 | | | | |
| **1983** | 9.977619171 | 3.718 | 37.09678808 | | | | |
| **1984** | 10.34186745 | 3.844 | 39.75413847 | | | | |
| **1985** | 10.69631004 | 3.97 | 42.46435087 | | | | |
| **1986** | 11.70791149 | 4.318 | 46.58581497 | | | | |
| **1987** | 12.22628021 | 4.492 | 50.55476182 | | | | |
| **1988** | 12.67041874 | 4.666 | 54.92045071 | | | | |
| **1989** | 12.89583588 | 4.84 | 59.12017384 | | | | |
| **1990** | 13.02176476 | 5.1 | 62.41584564 | | | | |
| **1991** | 13.07407379 | 5.36 | 66.41100025 | | | | |
| **1992** | 13.32289982 | 5.62 | 70.07703552 | | | | |
| **1993** | 13.70032024 | 5.88 | 74.87469698 | | | | |
| **1994** | 14.07029438 | 6.14 | 80.55788303 | | | | |
| **1995** | 14.49456501 | 6.338 | 86.39160749 | | | | |
| **1996** | 15.23224068 | 6.536 | 91.86655303 | | | | |
| **1997** | 16.08504677 | 6.734 | 99.55792506 | | | | |
| **1998** | 17.00391769 | 6.932 | 108.3167049 | | | | |
| **1999** | 18.03823662 | 7.13 | 117.8711575 | | | | |

*Source*: Based on Barro and Lee (2013) and Feenstra, et al. (2013).

*Notes*: The shaded cells are our estimated data.

**Figure A. Growth in Total Employment (L), Average Schooling (S) and Human Capital (HK), Iran, 1961-2010.**




*Source*: Barro and Lee (2013) and Feenstra, et al. (2013).

## Appendix 5. TFP Results Using Labour

The table below reports the results of TFP growth when using labour directly instead of the human capital proxy.

**Table A. Iran Output Growth and Its Components, based on labour only (Period's Annual Average).**

| **Period** | **Real GDP Growth** | **Capital Contribution** | **Labour Contribution** | **TFP Contribution** |
|---|---|---|---|---|
| **1966-76 (pre-revolution)** | 11.61% | 0.65% | 2.42% | 8.54% |
| **1977-88 (revolution/war)** | -2.13% | 0.56% | 2.94% | -5.64% |
| **1989-2007 (post-war)** | 5.45% | 0.30% | 3.34% | 1.82% |
| **1966-2007 (Total)** | 4.90% | 0.50% | 2.99% | 1.45% |

*Source:* CBI, (2011), Barro and Lee (2013), Feenstra, et al. (2013) (PWT 8.0), World Bank (2013).

The results are relatively different once we use labour instead of capital. The issue here is that this way the effect of schooling and quality of labour is being transferred to the TFP component of growth. This can be observed in the smaller growth contribution of labour compared to the human capital growth contribution discussed in Chapter 5. This has led to the inflated estimates for the contribution of TFP in total growth for this scenario.

## Appendix 6. Variables and Tables, Korea and Turkey TFP Estimation

Here due to maintaining more cohesion between estimates obtained for Korea and Turkey we have relied more on a single database, the PWT8.

*Capital:*

Capital stock is not built as for Iran. We employ the capital stock data from the PWT8 of Feenstra, et al. (2013). The variable used is called 'rkna' in the dataset which measures the capital stock at 2005 prices in USD.

*Human Capital:*

Human Capital has been constructed in the same manner as Iran discussed in Appendix 4.

*Output:*

We employ output growth obtained from the output variable of the PWT8 dataset called 'rgdpna'. It measures real GDP at constant 2005 national prices expressed in USD.

We have also kept the assumption of a similar depreciation rate and return to capital rate of 4.9% and 7% respectively. Furthermore, the assumptions of perfect competition and increasing return to scale have also been maintained through our estimations for these two countries.

Below in Table A we have provided TFP, output and input contributions for Korea and Turkey in the same periods for our study on Iran.

**Table A. Output Growth and Its Components, Period's Annual Average.**

| Period | Real GDP Growth | Capital Contribution | Human Capital Contribution | TFP Contribution |
|---|---|---|---|---|
| ***Korea*** | | | | |
| **1966-76** | 10.21% | 0.35% | 6.80% | 3.05% |
| **1977-88** | 9.17% | 0.46% | 4.41% | 4.30% |
| **1989-2007** | 6.06% | 0.54% | 9.14% | 2.75% |
| **1966-2007** | 8.03% | 0.47% | 4.29% | 3.27% |
| ***Turkey*** | | | | |
| **1966-76** | 6.61% | 0.18% | 4.79% | 1.63% |
| **1977-88** | 3.73% | 0.12% | 5.28% | -1.67% |
| **1989-2007** | 4.33% | 0.20% | 5.81% | 1.72% |
| **1966-2007** | 4.76% | 0.17% | 3.85% | 0.73% |

*Source*: Barro and Lee (2013), Feenstra, et al. (2013) (PWT 8.0).