Do Firms With Higher Energy Efficiency Have Better Access to Finance?

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Abstract

Improving energy efficiency quickly is key to mitigating climate change and a large part of such improvements has to be implemented in firms. But since most energy efficiency improvements require upfront investments, good access to external finance is important. Theory suggests that information asymmetries may prevent lenders from including energy efficiency into their lending assessment, even though higher energy efficiency makes a firm more cost-competitive and its collateral worth more, especially if stringent climate change mitigation plans are implemented. Empirically, little is known about the impact of energy efficiency on access to external finance. Here we examine for the first time empirically the effect of a firm's higher energy efficiency on their ability to obtain loans in European Union countries. We exploit a unique firm-level dataset that links a survey from the European Investment Bank on energy efficiency of firms' building stock and on access to external finance with the ORBIS firm database for European firms. We find that energy efficiency has no effect on the ability of a firm to obtain external financing compared to other indicators on the financial or operational health of the firm. The results reveal an unexploited potential for energy efficiency policy to signal when firms are energy efficient.

Keywords: Energy efficiency, access to external finance, information asymmetry, EU firms, building energy consumption

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1. Introduction

Greater energy efficiency is a key projected contribution to mitigating climate change. In particular, it is seen as essential for performing the near-term reversal in the trend of greenhouse gas emissions and their rapid decline. The International Energy Agency (henceforth IEA) projects that more than 40% of global mitigation efforts until 2040 could be met by higher energy efficiency that reduces the need for fossil fuelled energy supply [28]. The most recent IPCC report shows that in order to limit average temperature increases to 1.5 degrees increase in the temperature above pre-industrial average, there will need to be an absolute decoupling of economic growth from both primary and final energy demand between 2020 and 2030 that would require large additional investments into energy efficiency [52].

Complementary to these scenarios, national governments and international organisations have set ambitious targets for energy intensity reductions[1]. For instance, the UK's clean growth strategy aims to reduce industrial energy intensity by 20% in the period 2018-2030 relative to baseline [5], and the United Nations Sustainable Development Goals call for a doubling in the rate of decline of energy intensity relative to historical averages. More recently, Europe's Green Deal put forward by the EU Commission aims for a carbon-neutral continent by 2050 [15].

While targets are important, a large part of the actual efficiency investments must ultimately be implemented in firms. In the European Union, only 26% of final energy is consumed by households, and even excluding transport (33%), at least part of which must be attributed to firms, 41% of final energy is directly consumed in industry (25%), services (13%) and agriculture (3%) [20]. Globally, an even greater 38% of the final energy is used directly in industry [29]. It is therefore important to understand how aggregate targets and scenarios can be translated into company action at the micro-level. Incentives are a key mechanism to do so.

[1] Although energy intensity, the ratio of aggregate or sectoral energy inputs to value aggregate output is one measure of energy efficiency (another one is the conversion efficiency from one energy form to another), we will use it as the proxy for efficiency here, in line with the IEA and other institutions.

One area that has achieved insufficient attention in the energy efficiency debate is access to external finance to pay for these investments. As we review below, only 10 out of 28 European countries have policies in place that explicitly target improving the access to finance for efficiency investments, even though it is well known that such access is limited, especially for small and medium-sized enterprises [46]. Therefore, ensuring good access to finance should be an important component of energy efficiency policies. Moreover, access to finance is also an important determinant of firm growth [4, 37]. As such, easy access to finance for energy efficient firms or those that want to become more efficient would be a natural way of helping increase the market share of energy efficient firms. Clearly, the relatively better is access to finance for firms that implement energy efficiency, the more likely it is that the economy as a whole improves its energy efficiency. One step that has been made in that direction is the increasing Environmental, Social and Governance (henceforth ESG) performance reports and ratings provided by major agencies to inform financial institutions and other stakeholders. However, as we review below, ESG is so far insufficient in terms of depth and coverage to fill the gap.

In theory, more energy efficient firms should be more competitive and have better collateral, so their access to finance should be better. The advantage of high energy efficiency for collateral value is especially salient given the stringent climate change mitigation plans just reviewed. Former Bank of England governor Mark Carney recently translated this to clear terms: "Companies that don't adapt – including companies in the financial system – will go bankrupt without question" [11]. However, market failure theory advances good reasons why such improved access may not be forthcoming. Information asymmetries may prevent lenders from including energy efficiency into their lending assessment, even if it makes a firm more cost-competitive and its collateral worth more. This ultimately implies rationing loans for these less risky borrowers [53]. Appropriate signals could help resolve this problem, if it exists. Yet, we found no empirical evidence that could corroborate or challenge the salience of these theoretical propositions for real world markets.

This paper is a first attempt to elucidate the relationship between a firm's energy efficiency and its access to credit using quantitative methods for a large firm sample. Making use of a unique dataset from the European Investment Bank, we examine whether firms that are more energy efficient

have better access to external finance. To carry out the analysis, this paper uses a comprehensive dataset that matches ORBIS financial and ownership data with the European Investment Bank's Investment Survey (henceforth EIBIS). The data covers three years (2016, 2017 and 2018), the only ones during which this survey has been conducted. Each year includes some 12,500 firms from all EU countries, of all sizes, and from the sectors of manufacturing, construction, infrastructure and services. The dataset contains two types of barriers to access to finance, which we use to examine the borrowing conditions for energy efficient firms, and a firm's share of building stock that satisfies high or the highest energy efficiency standards, which we use as an indicator of a firm's energy efficiency. We also use a rich set of financial, operational and ownership variables, as well as information on the firms' characteristics (i.e. size, sector, age) as controls.

To the best of our knowledge, this paper is the first to examine systematically whether lenders consider the energy efficiency of companies in their lending criteria. The findings are particularly important due to the salience of the question for current climate change mitigation, and we spell out policy implications. We rely on a unique proxy to measure energy efficiency that is available for all EU countries. Although this measure has limitations, it is good enough and complemented by a rich dataset that allows for robustness checks for a credible first analysis of this problem.

The next section briefly reviews energy efficiency policy in the EU and the literature on energy efficiency and access to finance. We then present our method of analysis and data, the latter with some detail about the summary statistics of the matched EIBIS-ORBIS database. The penultimate part presents our results. In our conclusion, we highlight policy implications.

2. Literature Review

2.1. EU efforts directed at energy efficiency

The EU has set ambitious targets for energy efficiency. In 2012, Directive 2012/27/EU mandated 20% energy savings relative to a baseline without additional efficiency measures in 2020, and 32.5% savings in 2030. However, in 2019, just a year away from the first benchmark, most countries were far removed from reaching their energy efficiency targets for 2020, as Figure 1

below shows[2]. In all areas, whether residential, industrial or tertiary, EU countries are lagging behind their 2020 energy efficiency targets in 2019[3] . The only countries where at least one quarter of the targets have been met are Denmark, Spain and Germany. By contrast, most other countries reach a lower score, with Belgium and Sweden showing no improvement over the baseline of their energy efficiency potential. This lack of progress demonstrates the need for further measures.

[2]The figure can be reproduced from the output-based scoring energy efficiency policy scoreboard available on the ODYSSEE-MURE online website.

[3]The energy efficiency target is either the flat 20% increase in energy efficiency, or the Energy Efficiency Directive target provided by each Member State individually.

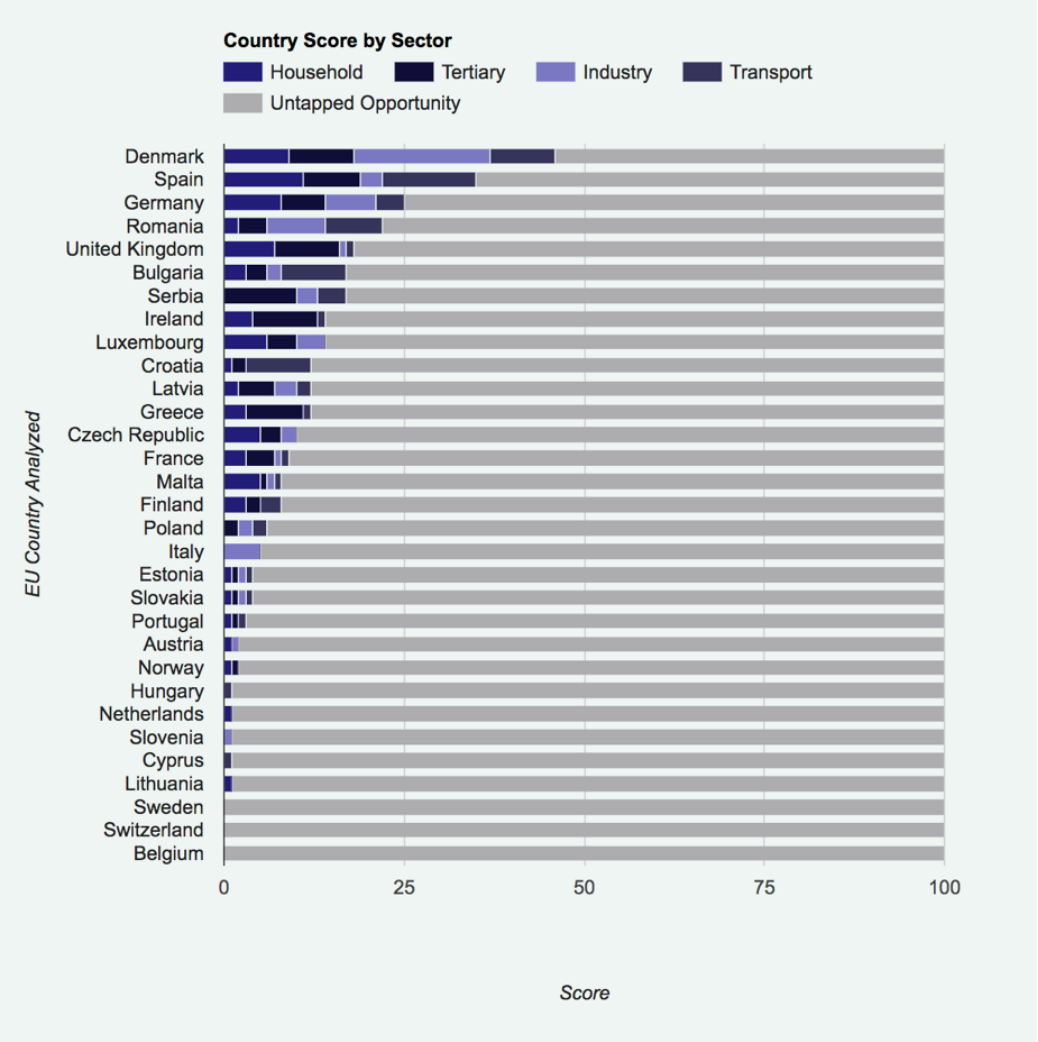

Figure 1: Output-based scoring relative to the 2020 energy efficiency targets for all EU countries for 2013-2019, including Norway, Serbia and Switzerland, for all sectors, based on the Policy Scoreboard using MURE data

Amongst existing policies supporting efficiency, the problem of financing has received limited attention. Ten countries have implemented financial measures incentivising firms to make energy efficiency investments. Table 1 below is based on data from ODYSSEE-MURE and shows details of these

measures for EU countries[4]. Financial measures here mean either grants and subsidies, or soft loans for energy efficiency, renewables and Combined Heat and Power (CHP). Each EU country is indicated on the left hand column. The column on the very right hand-side gives the code of the specific policy as is used in the ODYSSEE-MURE database. For instance, in 2010 , France introduced an eco-energy loan aimed at financing equipment eligible for the white certificate schemes (i.e. documents proving that the targeted level of energy consumption has been reached following energy efficiency measures) and their installation costs in the industrial and tertiary sectors at a preferential rate, without a guarantee, and repayable over 5 years, with one year deferred. The loan can vary between 10k euros and 100k euros. By the end of 2016, over 267 of these loans had been granted to very small firms. While there is thus some support for energy efficiency financing, the fact that financial measures targeting energy efficiency in industry concern only about a third of the EU countries (i.e. 10 out of 28 Member States) reflects that these measures are far from mainstream.

Interestingly, a new measure possibly relevant for credit access has been introduced at the level of the European Union [14]. Since 2012, under Article 8 of the Energy Efficiency Directive, energy audits are compulsory for large EU firms. In 2012, large firms were subject to a compulsory energy audit by December 2015 and at least every four years thereafter. We return to this policy in our following discussion of how financing and energy efficiency at the firm level hang together.

[4]Information from the table can be found in the Mure II Database query section on energy efficiency policy on the ODYSSEE-MURE online website.

Country	Title	Status	Starting Year	Code
Bulgaria	Energy Efficiency and Renewable Energy Credit Line (BEERECL)	Completed	2004	IND-BG3
Bulgaria	Implementation of energy efficient measures with significant energy saving and ecological effect	Ongoing	2010	IND-BG17
Czech Republic	ENERG Programme (part industry)	Ongoing	2017	IND-CZ14
France	Loans for small and medium sized enterprises / "prêt vert" & "prêt éco-énergie"	Ongoing	2010	IND-FRA15
Germany	ERP Environmental Protection and Energy Efficiency Programme (ERP-Umwelt- und Energieeffizienzprogramm)	Ongoing	1995	IND-GER22
Germany	Market Incentive Programme for Renewable Energies in Heat Market (Marktanreizprogramm für erneuerbare Energien im Wärmemarkt– MAP)	Ongoing	1999	IND-GER5
Germany	KfW Energy Efficiency/Environmental Programme (KfW-Energieeffizienz/Umweltprogramm)	Ongoing	2003	IND-GER28
Germany	KfW Renewable Energies Programme (Standard / Premium)	Ongoing	2009	IND-GER52
Germany	Funding for energy performance contracting (including default guarantees)	Ongoing	2014	IND-GER56
Malta	EU-related: Energy End-Use Efficiency and Energy Services ESD (Directive 2006/32/EC) - EU related: Energy performance of buildings (Directive 2002/91/EC) - Malta Enterprise soft loans	Ongoing	2012	IND-MAL13
Malta	GRTU Soft Loans - Schemes open for small businesses	Completed	2013	IND-MAL14
Poland	Priority Programme "Smart Grids"	Completed	2012	IND-PL13
Poland	Improvement of Energy Efficiency. Part 3 – Energy Efficiency Investments in SMEs	Ongoing	2014	IND-PL14
Poland	Infrastructure and Environment Operation Programme 2014-2020 (Investment Activity 1.2) – Support for Energy Efficiency and Renewable Deployment in industrial enterprises	Ongoing	2015	IND-PL15
Romania	Improvement of energy efficiency in industrial operators through the implementation of investment projects co-financed by community funds	Ongoing	2007	IND-RO5
Slovakia	Programme Supporting Economic Activities Leading to the Fuel, Energy and Imported Raw Material Conservation	Completed	1992	IND-SK2
Slovakia	Operational Programme "Competitiveness and Economic Growth" priority line Energy, Measure 1.1 - Innovations and technology transfers in industry; Measure 2.1 Improvement of energy efficiency of industrial production; High efficient cogeneration	Ongoing	2008	IND-SK9
Slovakia	Promotion of energy efficiency in industry - SLOVSEFF II	Completed	2010	IND-SK13
Slovakia	Promotion of energy efficiency in industry - SLOVSEFF III	Ongoing	2016	IND-SK19
Slovenia	Financial incentives for efficient electricity consumption	Ongoing	2008	IND-SLO5
Slovenia	Financial incentives to increase energy efficiency in industry and the services sector and significantly increase the scope of environmentally friendly electricity generation from RES and CHP systems	Ongoing	2008	IND-SLO7
Spain	Third Party Financing (Financiación por Terceros)	Ongoing	1985	IND-SPA12

Table 1: Financial measures for the industry sector of EU countries based on ODYSSEE-MURE data

2.2. Energy efficiency, competitiveness and creditworthiness

The literature presents evidence that more energy efficient firms are also more competitive, as their energy costs are lower. This is particularly the case for EU firms in 'resource intensive' sectors such as food and drinks, chemicals, steel, automotive etc. [48] and for French exporting firms [10]. This finding is relevant in a context of rising energy prices, where the real end use energy price index for industry in Europe has increased by 7.6% in only two years through the second quarter of 2019 [30]. Indeed, implementing energy efficiency measures can lead to considerable savings. For instance, a study on Germany estimates a potential to reduce the country's energy consumption by 20% by 2020, if firms and households adopt energy efficiency measures, which would save an annual EUR 53 billion [20]. More specifically, German firms could save up to 9 billion euros in energy costs in transportation if they optimised shipping volumes and distances. Another estimation from the same study shows that simply redesigning the production process and products can help German firms reduce their energy costs by 4%. Energy efficient firms also have better collateral as they are more protected against 'asset stranding'. One example is their buildings that are more likely to comply with increasingly stringent efficiency regulations [45].

In theory, if more energy efficient firms are more cost-competitive, they should – *ceteris paribus* – be more creditworthy. Access to cheap credit should in turn reinforce the cost advantage of energy efficient firms and lead to a virtuous cycle of more energy efficient firms capturing larger market shares and thereby naturally contributing to the achievement of energy efficiency goals. However, we know that this circle is not happening automatically. Productivity studies show that even less productive firms, under certain market conditions, can survive for long times [49, 12]. In addition, firms adopt energy efficiency measures only sluggishly, mainly because of market failures [1, 25, 31].

One question is therefore whether access to finance plays a role in holding back highly energy efficient firms. Absent perfect information about the project, banks use certain firm characteristics that can be cheaply obtained, such as information on a firm's balance sheet [8]. More recently, rating agencies have also started to report about the ESG of firms. The environmental criteria look at air pollution, waste management and compliance with legis-

lation, amongst others. There is also a dimension on energy efficiency, but it is limited to total direct energy use or total renewable energy use [27]. One fundamental issue with the ESG assessment is that reports and ratings are neither distributed evenly across firms nor consistent across rating agencies [36].

Traditionally, energy efficiency is not reported by firms.In this context, the energy audits mentioned above could be an important piece of information. The two hypotheses we wish to investigate are whether **(I) more energy efficient firms have better access to finance than less energy efficient ones**; and whether **(II) the compulsory energy audit helps large energy efficient firms access finance by acting as a signal**. Before describing our analysis, we briefly review existing literature on access to finance for standard results and any reference to energy efficiency.

2.3. Determinants of access to finance

According to the extensive literature on the determinants of access to external finance, firm characteristics matter. This is particularly true for firm age and size.Larger and older firms are found to have better access to finance, compared to smaller and younger firms (see Bougheas et al. (2006) for a study on UK firms [8]; and Dong and Men (2014) for a study on emerging markets [18]). Dong and Men (2014) also find that firms in non-manufacturing sectors tend to be more financially constrained. Other studies find that the ownership type, productivity, and export orientation of the firm [47], its business relations to banks [55], access to government grants [44], or a firm's innovative activity [17], play a determining role as to why some firms are more financially constrained than others.

Perception also seems to be a factor. In a paper on perceived versus actual financial constraints, Ferrando and Mulier (2013) find that profitability, working capital and lower leverage ratios can improve actual access to finance amongst EU firms [22]. In terms of perceived financial constraints, firms feel more financially constrained when they are more indebted with shorter-term maturity.

The business literature approaches the topic from a different angle. The typical answer is the '5 Cs': Character, Capacity, Collateral, Conditions,

Capital [3, 9, 21]. By **character** is meant whether the borrower is honest and reliable. One way to assess whether the borrow can be trusted is to check her or his credit history. Others would argue that experience, knowledge, financial competency and future plans also lead to a good assessment [21].

Capacity implies that the firm will be able to pay the loan back. In order to be able to service the debt, the firm needs to have enough liquidity, or at least be able to generate it. Here again the credit history becomes essential, in addition to the track record of repayments. The firm can only pay back its debt if it is financially healthy. This implies looking at the current ratio and return on assets and financial leverage, amongst other variables.

Conditions relate to the economic conditions and environment, and whether these are favourable to this type of loan. Conditions can be national, industrial, or local. National conditions can simply mean the business environment in which the firm operates, while industrial or local can be about how the firm situates itself in that market, relative to its competitors. We capture the latter by using competitiveness indicators. Competitiveness indicators include, productivity, investments and whether the firm is operating at its full capacity.

In terms of national conditions, Dong and Men (2014) and Knack and Xu (2017) find that the institutional environment matters for firms' access to external financing [18, 35]. Whereas measuring the institutional environment of each EU country is beyond the scope of this paper, we acknowledge that country-specific issues matter, which is why we always include country-fixed effects in our regression analysis. Papers on EU firms also found that regions across Europe [6] and countries within the euro area more specifically [7], were affected differently by the financial crisis. We seek to capture the potential effect of being in a particular region of the European Union or in the euro area in our empirical analysis by comparing results from the three regions of Europe (i.e. Northern and Western, Southern and CESEE countries[5]), and by including a binary variable for the euro area.

[5]Central, Eastern and Southeastern European

Capital matters. A firm needs to show that it has invested enough in its own business, making a financial commitment, thereby also exposing itself to risk. This can be measured by looking at financial leverage (i.e. debt-to-equity ratio), as it reflects how much debt is required relative to how much the firm has invested.

Finally, a valuable **collateral** is required, as it acts as a security against the failure of the firm to pay its debt back on time. It usually comes in the form of assets. While the value of the collateral is fixed, the type of collateral can be worth more or less. If the collateral comes in the form of commercial building stock that meets high or higher energy efficiency standards, it is worth more than the same stock that has low energy efficiency standards, *ceteris paribus*. This is because high-energy efficiency standards imply less energy consumption, and hence less risk in the long term. It is preferable for banks to request collaterals that are "cleaner" and not at the risk of becoming "stranded assets" that are likely to lose values in the coming years [13]. This is especially relevant now with the recent EU Green Deal and the 2050 EU target of a net zero carbon emissions.

The present paper contributes to the existing literature, as to the best of our knowledge, no existing study assesses the importance of energy efficiency as a criterion for bank's lending policy, mainly due to a lack of data on firm-level energy efficiency. In the present study, we proxy energy efficiency by looking at the percentage of commercial building stock of the firm that meets high or the highest energy efficiency standards. We can then include a series of control variables drawn from the existing literature on selection criteria by banks when it comes to lending, thanks to our unique matched EIBIS-ORBIS dataset. Another contribution to our analysis is the inclusion of both *actual* access to finance, and a firms' *perceived* access to finance, as we replicate our analysis using one definition after another. The second definition consists of whether firms perceive that the availability of finance is an obstacle to investment. After repeating our analysis with this alternative definition and including a control for indebtedness, we find that our results do not change significantly. We cover these in detail in our section on data.

3. Methodology

We construct a logistic model, where our dependent variable is represented by a binary choice variable, such that it takes the value 1 when the firm i has access to finance at time t $(y_{it} = 1)$ and 0 when it does not $(y_{it} = 0)$. The probability that the firm i has access to finance at the time t is written as p_{it}

$$y_{it} = \begin{cases} 0 \text{ with probability } p_{it} \\ 1 \text{ with probability 1- } p_{it} \end{cases}$$

p_{it} is represented through the following function that follows a logistics cumulative distribution

$$p_{it} = Pr[y_{it} = 1] = E(y_{it}|x_{it}) = F(x'_{it}\beta) \tag{1}$$

where $F(x'_{it}\beta)$ is included between zero and 1, x is a regressor vector and β a parameter vector with the dimensions Kx1. The last equality holds as long as the density function describing F is symmetric around zero.

The logit model can be written more generally as

$$p = Pr[y = 1|x] = \frac{e^{x\prime\beta}}{1 + e^{x\prime\beta}} \tag{2}$$

And the marginal effects of the j^{th} regressor is defined as

$$\frac{\delta p}{\delta x j} = F(x'\beta)[1 - F(x'\beta)]\beta_j \tag{3}$$

Our regressors x'_{it} for firm i at time t are the percentage of commercial building stock that meets high or highest energy efficiency standards (a proxy for energy efficiency), and different sets of control variables that measure the operational and financial health of the firm, and identify a set of firm characteristics.

We expand on our choice of energy efficiency measure in the data section. Besides the controls for competitiveness, innovation and capital mentioned in the previous section, we also control for the country where the firm is headquartered, its age, size, sector and ownership type. The inclusion of these variables is based on findings from the existing literature on banks' credit assessment of firms reviewed in the previous section. We also include an interaction term between energy efficiency and a binary variable capturing whether the firm is large. This is because lending institutions carry out due diligence before they lend to firms, in order to assess the ability of the lender to pay the loan back at some point in the future. Whereas for smaller firms this due diligence is most likely to be based on a few key financial metrics, for larger firms many more criteria are included, as the loan is also usually of a greater amount, and as more information is available on the larger firm and more time devoted to carry out the due diligence. Finally, large firms tend to be more exposed to public scrutiny.

We also include an interaction term between having carried out an energy audit in the previous three years and being more energy efficient. Following evidence revealing that energy audits can enhance investments in energy efficiency improvements [33, 32, 51, 2], having carried out an energy audit might have made the firm more energy efficient.

From our control variables, we expect that the older and the larger the firm, the better the access to finance. We also expect that firms with high labour productivity, more state-of-the-art machinery and that operate at full capacity will be granted better access to finance. However, based on the existing literature on innovative firms, we do not expect more innovative firms to have better access. On the contrary, the uncertainty about the outcomes of innovation and informational asymmetries makes it harder for banks to finance innovation [26, 34, 38]. In terms of financial health indicators, the current ratio and return on assets, positive signs are also expected, except for financial leverage. With respect to ownership, we expect foreign-owned firms to have a better access to finance, as operating in foreign countries reduces frictions in international debt for the mother company [47]. It is worth noting that in our dataset, most foreign-owned subsidiaries are owned by either German or Austrian parents, and that firms in these countries tend to hav better access to finance than those in the countries their subsidiaries operate in, as will be demonstrated below.

We have added a squared term for the variable on energy efficiency to test for non-linearity in our model. The argument behind the inclusion of this squared term is that the effect on access to finance of having a share of commercial building stock that meets high or highest energy efficiency standards, our proxy for energy efficiency, might be much stronger if this share is very high, rather than moderate. In other words, high levels of energy efficiency of commercial building stock would be outweighing moderate levels of energy efficiency. . In other words, high levels of energy efficiency of commercial building stock would be outweighing low levels of energy efficiency. We can think of two reasons why this might be the case. On the one hand, there is growing concern for having more energy efficient buildings and this was already the case before the years of the survey, so firms might have already started targeting energy efficiency for their commercial building before 2016. On the other hand and in line with the first point, commercial buildings are facing new construction standards and minimum energy consumption requirements, meaning that it is also likely that some of the commercial building stock of firm is already energy efficient. Under this hypothesis, firms would only be making a real difference in influencing their access to finance if they proved to be cutting edge in terms of energy efficiency, and not just fulfilling basic energy efficiency requirements or buying buildings that meet these already. Even though a squared term is included in our regression analyses, it is usually omitted due to multicollinearity because of the binary nature of the squared variable (i.e. energy efficiency). The only exceptions can be found in Tables 2 and 3 of Appendix 2, where we test our model by replacing the binary variable for energy efficiency with its continuous alternative. In these cases, the squared term is included.

We complement our main empirical analysis by including a dummy variable on whether the firm is located in a country that is part of the eurozone, as we expect access to finance to differ between eurozone and non-eurozone countries, based on the literature above. We also compare our results between the three main EU regions. We now present the data.

4. Data

One of the contributions of this research is the exclusive use of the matched EIBIS-ORBIS data. The data we use covers the waves 2016, 2017

and 2018, which report data for the years 2015, 2016 and 2017, respectively. Firms come from all 28 EU countries, are of all sizes (i.e. micro, small, medium and large) and from all economic sectors (i.e. manufacturing, construction, services and infrastructure). Table 2 shows the coverage of firms across countries. The EIBIS is representative of the EU and all 28 Member States, and so the larger the economy, the larger the share of firms in the database that are from that economy.

	Unweighted		Weighted	
Country	**N° observations**	**Sample coverage (%)**	**N° observations**	**Sample coverage (%)**
Austria	978	3.8	640	2.5
Belgium	809	3.1	702	2.7
Bulgaria	1,226	4.7	112	0.4
Croatia	1,165	4.5	99	0.4
Cyprus	396	1.5	41	0.2
Czech Republic	895	3.5	356	1.4
Denmark	985	3.8	527	2.1
Estonia	728	2.8	35	0.1
Finland	1,101	4.3	450	1.8
France	1,133	4.4	3151	12.2
Germany	1,241	4.8	5840	22.7
Greece	970	3.7	205	0.8
Hungary	1,254	4.8	279	1.1
Ireland	985	3.8	585	2.3
Italy	1,507	5.8	3819	14.8
Latvia	861	3.3	43	0.2
Lithuania	565	2.2	47	0.2
Luxembourg	353	1.4	84	0.3
Malta	348	1.3	13	0.1
Netherlands	1,025	4.0	1239	4.8
Poland	1,018	3.9	774	3.0
Portugal	1,113	4.3	343	1.3
Romania	1,179	4.6	244	1.0
Slovakia	726	2.8	120	0.5
Slovenia	791	3.1	79	0.3
Spain	1,088	4.2	2099	8.2
Sweden	723	2.8	724	2.8
United Kingdom	740	2.9	3090	12.0

Table 2: Number of observations and share of firms belonging to each EU countries with and without pooled value added weights (%)

Tables 3 and 4 show the share of firms belonging to the four broad eco-

nomic sectors and four size class groupings used in the dataset, respectively. The survey is designed in such a way that it is representative[6].

	Unweighted		Weighted	
Sector	N° observations	Sample coverage (%)	N° observations	Sample coverage (%)
Manufacturing	7,757	30.0	9,941	38.6
Construction	5,774	22.3	2,241	8.7
Services	6,235	24.1	6,538	25.4
Infrastructure	6,117	23.6	7,019	27.3

Table 3: Number of observations and share of firms in each sector with and without pooled value added weights (%)

	Unweighted		Weighted	
Size	N° observations	Sample coverage (%)	N° observations	Sample coverage (%)
Micro	4,976	19.2	1,851	7.2
Small	8,465	32.7	5,218	20.3
Medium	8,324	32.1	5,924	23.0
Large	4,136	16.0	12,746	49.5

Table 4: Number of observations and share of firms in each size bracket with and without pooled value added weights (%)

The originality of the dataset lies in the fact that it includes enough information on firms, so that we can capture their access to finance, the percentage of their commercial building stock that meets high or the highest energy efficiency standards, their operational and financial health, and information on their characteristics. This allows us to carry out empirical analysis on the determinants of firms' access to finance, and to verify whether banks' credit assessment includes an assessment of energy efficiency.

To measure energy efficiency, we use a continuous variable from the EIBIS database that gives a firm's self-reported share of their commercial building stock that satisfies high or the highest energy efficiency standards. To the best of our knowledge, this information in our database is unique, as very little data across countries is comparable to it. It is a good proxy for the firm's level of energy efficiency, as it is specific and asks a question directly

[6]More information about EIBIS can be found at https://www.eib.org/en/about/economic-research/surveys-data/investment-survey.htm.

related to high or highest energy efficiency standards. It also has weaknesses. First, it is based on an estimation by firms. Nonetheless, we believe that it is the best proxy available, especially in a sample that encompasses as many countries as ours, and is good enough to carry out a first analysis. As far as we know, no other indicator at the EU-level looks at the energy efficiency of building stock. Other studies look at energy consumption measured by GHG emissions [19] , which is available for all EU countries through the European Trading Scheme [42, 40]. Whereas this indicator could have potentially been used as an indicator of energy efficiency, the data available does not match the rich firm-level EIBIS dataset that contains all the complementary firm information necessary for the realisation of our study. Other indicators of energy efficiency typically include energy consumption, energy costs or energy efficiency measures from a more qualitative perspective, meaning that these measures are not necessarily quantifiable, which in our opinion are worse proxies than our choice to capture the level of energy efficiency of firms.

Second, it only considers the energy efficiency levels of the commercial building stock. However, since in most European countries this accounts for upward of 15% of total final consumption [16], it covers more than one third of total non-transport energy consumption of commercial users (which is 41% of final energy consumption). Therefore, whether a firm has an energy efficient building stock greatly matters for its total energy consumption. A third potential additional drawback is that the importance of this indicator may vary considerably by sector. For instance, in the service sector a large share of total energy may be used by buildings, whereas in industry a much larger share may be used by machinery. In order to tackle this last issue, we add sector-fixed effects.

In our survey, 37% of firms replied that none of their commercial building stock met these standards. The maximum share is 100%. The average percentage of commercial building stock that meets high or highest energy efficiency standards in our survey is 35%.

In most of our analysis, we do not take the continuous variable on the percent share of commercial building stock that satisfies high or highest energy efficiency standards at face value. Rather, we create a binary variable from it that takes the value 1 if the firm has a percent share of commercial building stock that satisfies high or highest energy efficiency standards that

is higher than the national median of the country in which it is located, and 0 if it is lower or equal to the national median. We use this binary version of the continuous variable in our estimation because the latter varies considerably across EU countries. It makes then more sense to look at how this value for each firm compares to its national median, rather than to all other EU firms. For instance, the mean of the percent share of commercial building stock that satisfies high or highest energy efficiency standards for all Austrian firms is more than 50%, whereas in Lithuania it stands at 17%. In our results' tables, we indicate the binary variable by adding "high or low", and the continuous variable by adding "%". As we show below, we carried out most of our regression analysis using the binary version of the share of commercial building stock that satisfies high or highest energy efficiency standards, and then repeat the exercise using the continuous version of it to find that our results remain unchanged (see Appendix B).

As a robustness check of our indicator, we correlated our indicator with two variables from our database, as Table 5 shows. The first variable (left-hand side) checks whether the firm has carried out an energy audit in the past three years. Clearly, firms with an energy audit tend to report higher building efficiency. The second variable (right-hand side) asks about the percentage of total investment for measures to improve energy efficiency. We adjusted it to look at the percentage of firms that invest more or less than their national median, from which we also created two categories of firms, independently from the first categorisation. This variable is different from the one we use about the percentage share of commercial building stock that meets high or highest energy efficiency standards. This variable asks the firm about the share of its total investment that goes to energy efficiency measures.

We look at the average percentage share of commercial building stock that meets high or highest energy efficiency standards according to the different two sets of categories just described. Results show that this percentage share is higher for firms that carried out an energy audit over the past three years (i.e. 46% versus 29%) and that invest more in energy efficiency measures (i.e. 36% versus 30%).

Energy Efficiency measure	% of highly energy efficient buildings	
	If measure applies	If measure does not apply
Energy Audit	46	29
Above median investments	36	30

Table 5: Average share in percent of commercial building stock that satisfies high or highest energy efficiency standards for different categories of firms (%)

For our dependent variable, access to finance, the EIBIS data supplies two main indicators that capture whether the firm is financially constrained. The first is called 'financially constrained' and takes the value 1 when the firm is constrained, and 0 when it is not. The variable takes the value 1 under four different case scenarios. These are whether the firm was satisfied with the amount of external finance received (i.e. quantity constrained), whether it decided not to seek any external financing due to high cost (i.e. price constrained) or due to the concern of being rejected (i.e. discouraged), and whether its request of external financing had been rejected (i.e. rejected)[7]. Table 6 shows the average share of commercial building stock that satisfies high or highest energy efficiency standards for firms that report these different types of financial constraint. Regardless of the type of financial constraint, the average share of the firm's commercial building stock that satisfies high or the highest energy efficiency standards (i.e. our proxy for energy efficiency) is always higher when the firm said that it was not financially constrained.

We use 'financially constrained', as the main dependent variable in our analysis[8]. An alternative indicator asks firms whether the availability of finance was perceived as an obstacle to investment. On average, for the three years of observation, 54% of firms said that finance was available, and hence

[7]More information on how these variables were created based on data available in the EIBIS-ORBIS dataset can be shared upon request.

[8]For a technical comparison of the EIBIS definition of financial constraints with that of the European Central Bank's SAFE survey, refer to Box 6, page 45 of the EIBIS 2016/2017 report on 'Surveying Corporate Investment Activities, Needs and Financing in the EU'.

that it was not an obstacle to investment. We reproduce our empirical analysis using this alternative definition of access to finance and present the results in Appendix B. They do not change significantly, except when we use the continuous variable of energy efficiency instead of the binary one, which we report below. This additional analysis complements the main one, as the 'financially constrained' variable would be more representative of the actual financial constraint, while the alternative definition related to whether the availability of finance is seen as an obstacle would capture the firm's perceived financial constraint [22].

Type of financial constraint	% of highly energy efficient buildings	
	If constraint applies	If constraint does not apply
Quantity constrained	34	35
Price constrained	33	35
Rejected	33	35
Discouraged	31	35

Table 6: Average share of commercial building stock that satisfies high or highest energy efficiency standards under different financial constraints (%)

Based on the existing literature, we add a series of control variables that matter for firms' access to finance. These have been grouped under firms' characteristics, and operational and financial health indicators. Firms' characteristics include the size of the firm (i.e. large or not), the sector of the economy in which it operates, the country in which it operates, its age and if the firm is foreign-owned. Firms have been classified into the following economic sectors: manufacturing, construction, services and infrastructure. Age varies from one to 313 years old. An interesting point is the variation across EU countries (Figure 2). In half of the countries, financially unconstrained firms have at least 5 percentage points more energy efficient building stocks. But in five countries, the relationship is the opposite. There is no obvious regional pattern to this heterogeneity. Our country fixed-effects seem appropriate and capture a possible different regulatory environment across

countries. Further correlations on sector variations are in Appendix A.

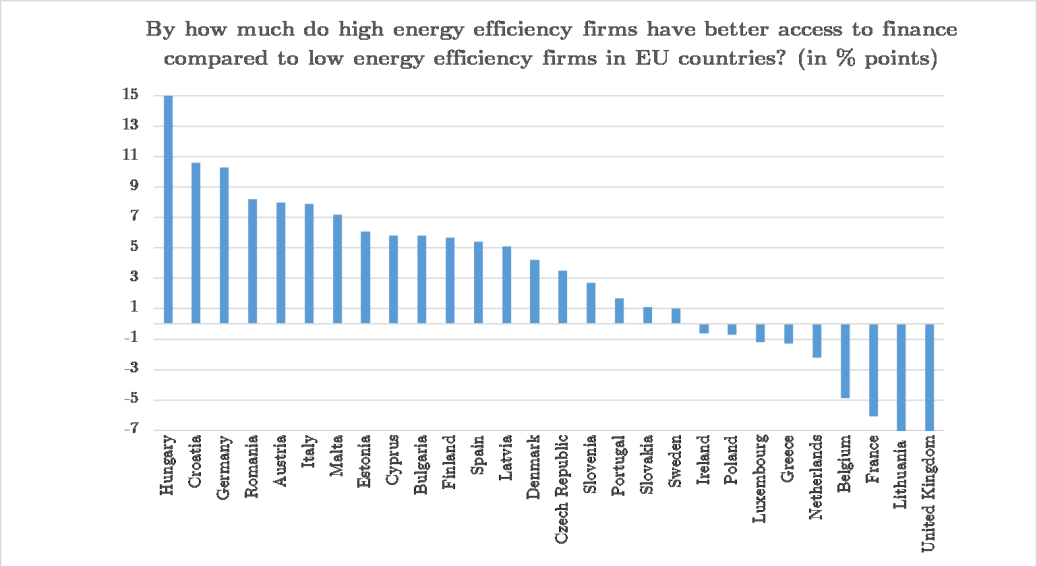

Figure 2: Difference in access to finance between high and low energy efficiency firms in the EU (%)

Operational health indicators are whether the firm has invested in an innovative product over the past year, what percentage of its equipment is state-of-the-art machinery, labour productivity[9], what percentage of its investment goes to research and development (RD) and whether it is operating at full capacity. We use three financial health indicators. The first one is the current ratio, which is the firm's total assets over its total liabilities. The second indicator is the return on assets[10] , which is net income over the average assets. The final indicators is the firm's financial leverage, which is its debt-to-equity ratio.

A firm is foreign-owned, if a foreign-based firm owns more than 50% of the company (defined as the global ultimate owner in the ORBIS database). Ta-

[9]Labour productivity is measured as GDP-deflated value added divided by the number of employees.

[10]We winsorised the data to discard outliers and kept 99% of the distribution, as extreme values can be due to data entry or reporting errors with the denominator [50].

ble 7 presents descriptive statistics for all our variables over the three years of observations: 2016, 2017 and 2018. The independent variables selected from our dataset fall within the scope of the existing literature on banks' credit assessment of firms presented above.

Variable	Variable type	Obs	Weight	Mean	Std. Dev.	Min	Max
Access to finance	Binary	24575	3784082	0.94	0.24	0	1
Finance available	Binary	25739	4027518	0.54	0.50	0	1
Energy efficient building stock (%)	Continuous	25739	4027518	0.39	0.35	0	1
Innovation	Binary	25107	3929075	0.38	0.49	0	1
SOA machinery (%)	Continuous	25335	3952090	0.45	0.32	0	1
Labour productivity	Continuous	11634	1898297	10.88	0.79	2.17	15.50
Operating at full capacity	Binary	25495	3969725	0.52	0.50	0	1
Investment in R&D (%)	Continuous	21728	3365168	0.08	0.19	0	1
Current ratio	Continuous	16348	2419557	2.03	2.54	0.00	49.39
Return on assets	Continuous	15043	2191960	0.11	0.11	-0.99	0.83
Financial leverage	Continuous	13949	2268877	0.21	0.22	0.00	1.47
Foreign-owned	Binary	25739	4027518	0.18	0.39	0	1
Large	Binary	25739	4027518	0.50	0.50	0	1
Age	Continuous	17691	2765406	33.12	25.82	1	313

Table 7: Descriptive statistics using pooled value added weights (%)

5. Results

Before we start analysing our results, it is necessary to recall the main purpose of this research, which is to assess whether firms' energy efficiency matters for access to finance. We measure firms' energy efficiency using a binary variable that looks at whether the firm's percent share of commercial building stock that meets high or higher energy efficiency standards is above or below the national median. Access to finance is also measured using a binary variable that considers whether firms are financially constrained.

In the first part of this results section, we test different model specifications using alternative definitions of firms' energy efficiency and access to finance. For firm's energy efficiency, we use the continuous energy efficiency variable from which our binary variable was created. For the alternative variable on access to finance, we use a binary variable that captures firms' perceived access to finance by asking whether they think finance is available

for investments in energy efficiency. Findings are discussed in the text and results reported in Appendix B.

In the second part of this section, we include past energy audits as a complementary variable and interact it with our energy efficiency variable, in order to test whether having carried out a past energy audit when being energy efficient matters for access to finance. We conclude this section by carrying out complementary analysis that includes adding a variable for eurozone countries, and comparing results for different groups, such as services vs non-services firms, and different EU regions.

5.1. Testing different model specifications

We regress energy efficiency on access to finance several times in altogether six model specifications, as we add variables to the model. Marginal effects are presented in Table 8. Our main result is that energy efficiency is not a good predictor of access to finance. Model (1) shows that access to finance improves conditional on energy efficiency. However, for any specification with co-variates, the statistical significance disappears. In models (2)-(6), the coefficient is hardly ever more than one standard deviation removed from zero. Clearly, access to finance varies systematically with other firm characteristics and energy efficiency is not picked up as an important factor. Banks look at other factors in their credit assessment, such as competitiveness and financial health. In our data, their assessment of energy efficiency has no significant effect on lending decisions.

In more detail, model (2) shows that size, industry and age are sufficient to explain the variation in access to finance that model (1) attributes to energy efficiency. Larger and older firms have better access to finance, as the literature predicts. However, as soon as operational and financial health indicators are included in the analysis, the size of the firm and its age become insignificant. All operational and financial health indicators are significant (models 3-4), except return on assets, which also has an unexpected sign.

VARIABLES	(1) Energy Efficiency	(2) Age and Size	(3) Operational health	(4) Financial health	(5) Foreign-owned	(6) Energy efficiency & large
Energy efficiency*Large						0.0137
						(0.0148)
Energy efficiency (high or low)	0.00753**	0.00377	0.00678	0.00632	0.00695	0.00451
	(0.00347)	(0.00415)	(0.00566)	(0.00600)	(0.00592)	(0.00647)
Innovation			-0.00480	-0.0144**	-0.0136**	-0.0136**
			(0.00591)	(0.00618)	(0.00611)	(0.00610)
SOA machinery			0.0224**	0.0281***	0.0280***	0.0281***
			(0.00941)	(0.0101)	(0.00996)	(0.00996)
Labour productivity			0.0253***	0.0261***	0.0232***	0.0233***
			(0.00388)	(0.00475)	(0.00475)	(0.00475)
Operating at full capacity			0.0235***	0.0222***	0.0220***	0.0220***
			(0.00549)	(0.00589)	(0.00581)	(0.00581)
Investment in R&D			-0.0715***	-0.0670***	-0.0658***	-0.0658***
			(0.0151)	(0.0159)	(0.0157)	(0.0157)
Current ratio				0.00199	0.00201*	0.00202*
				(0.00123)	(0.00122)	(0.00122)
Return on assets				-0.0331	-0.0252	-0.0257
				(0.0251)	(0.0249)	(0.0249)
Financial leverage				-0.0374**	-0.0294*	-0.0289*
				(0.0154)	(0.0154)	(0.0154)
Large		0.0132**	0.00389	0.00618	0.000992	-0.00565
		(0.00642)	(0.00780)	(0.00802)	(0.00802)	(0.0106)
Age		0.000387***	0.000263	0.000116	0.000122	0.000123
		(0.000138)	(0.000184)	(0.000187)	(0.000185)	(0.000185)
Foreign-owned					0.0444***	0.0444***
					(0.0118)	(0.0118)
Observations	24,715	16,939	9,351	7,841	7,841	7,841
Pseudo r-squared	0.0291	0.0327	0.0565	0.0607	0.0639	0.0640
AIC	0.601	0.601	0.606	0.594	0.593	0.593
BIC	-234848	-234848	-79533	-65338	-65344	-65336

Table 8: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraints) on different sets of variables

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector- and country-fixed effects are included but not reported.

As expected, more innovative firms and those that invest more in R&D have worse access to finance. By contrast, firms that have a higher share of state-of-the-art machinery, higher labour productivity levels and these that operate above their full capacity have better access to finance. A higher current ratio also leads to better access, though the coefficients are only significant at the 10% significance level, while an increase in financial leverage jeopardises the firm's access to finance. A firm that is foreign-owned will have better access to finance as model (5) shows. To recall our argument above as to why foreign-owned firms would have better access to finance, operating in foreign countries reduces frictions in international debt for the parent company [47] . The interaction term between energy efficiency and whether the firm is large is positive but statistically insignificant.

As a robustness check, we reproduced the same empirical analysis by trying different combinations of variables and changing the order of the sets of variables. In all the combinations we have tried, the results remain robust[11]. Additionally, we also tried using an alternative definition of access to finance, the one where firms are asked whether the availability of finance is an obstacle to investment, which is a measure of the perceived access to finance. Results are presented in Table 1 of Appendix B.

Our findings do not change significantly, except that energy efficiency (i.e. measured by the binary variable based on whether the percentage of commercial building stock that satisfies high or the highest energy efficiency standards is below or above the national median) is still significant in model (2), when the characteristics of the firm (i.e. size and age) are included. The return on assets also becomes significant with the expected sign at the 1%

[11]These results can be shared upon request.

significance level. The interaction between being energy efficient and large remains insignificant. The main conclusion that banks do not take into consideration energy efficiency in their lending assessment holds.

To push our empirical analysis further, we also replaced our binary variable on energy efficiency standards by its continuous version, that is the percentage of commercial building stock of the firm that meets high or the highest energy efficiency standards, and carried out the same regression analysis. First we repeat the exercise using the binary variable on access to finance, and then with the availability of finance- these are two measurements of whether firms have access to finance. Results can be found in Tables 2 and 3 of Appendix B. The major difference with the binary result is that large firm-energy efficiency interaction term becomes significant (Table 2 in the Appendix B). This confirms the hypothesis that energy efficiency assessments, which large firms are more likely to go under considering the due diligence carried out by banks, can act as a signal to banks for their lending assessment, and is an important message for policy aimed at supporting energy efficient firms. The squared term for energy efficiency is insignificant.

The picture looks somewhat different when the availability of finance (i.e. the perceived access to finance) is regressed on the continuous variable of energy efficiency. Whereas all control variables are consistent with previous findings, the coefficient and squared term of energy efficiency are now significant, the former with a positive, the latter with a negative sign. This would mean that firms at the cutting edge of efficiency see gains in financial access, whereas firms with moderately good levels of efficiency might actually be penalised. These results are at variance with the ones we found previously. While this result might seem intriguing at first sight, it is to be taken with a pinch of salt for two reasons. First, this definition of access to finance is based on perception rather than reality. Second, about 37% of the firms said to have zero of their commercial building stock that satisfies high or the highest energy efficiency standards. Including these observations in our analysis biases our results, which is why we had created this binary variable for energy efficiency in the first place. In fact, if excluding the firms that replied zero to the question and carrying out the same regression analysis again with the continuous version of the energy efficiency variable, results change and become consistent with all our findings so far in terms of sign and significance of independent variables. Overall, our analysis indicates that the

first hypothesis, that more energy efficient firms have better access to finance than less energy efficient ones, is not supported in our data.

To test for the differences between the models specifications in Table 8, running from (1) to (6), and justify our choice for model (5) in the last column on the right, we looked at different measure of fit, which are the pseudo r-squared and information measures, namely the Akaike information criterion (AIC) and the Bayesian information criterion (BIC). In the case of the pseudo r-squared, the higher it is, the more the variability of the outcome can be explained. For the AIC, the smaller the better fit, whereas for the BIC it is the opposite, where the bigger the absolute value, the better fit. More precisely, the AIC and the BIC cannot be interpreted on their own. They need to be compared between two different model specifications that contain the same number of observations for the interpretation to be accurate (see Long and Freese (2014) pages 86-7 for more details [39]). Under these conditions, only the statistics for model specifications (4) to (6) are really comparable.

The pseudo r-squared is the highest for specification (6) that includes the interaction. This is not surprising, as by definition the r-squared increases as more variables are added to the model. The AIC for (5) and (6) is lower than for (4), but equal between the two. Regarding the BIC, the most negative value is for model specification (5). Based on these three statistics to measure the goodness-of-fit, it is not exactly clear which model is the preferred one between (5) and (6). In subsequent analysis, we keep all our model specifications because the key message of this paper is to show that without additional lending criteria accompanying the share of commercial building stock that satisfies high or highest energy efficiency standards, access to finance is higher. However, as soon as new criteria are added, the coefficient for the energy efficiency variable loses significance, revealing that lending institutions give factors such as operational and financial health, or ownership, more weight in their lending assessment.

5.2. Audits as a signal

Finally, we reproduced the same regression analysis with all model specifications by including an interaction term between a variable asking whether

the firm has carried out an energy audit in the past three years and our energy efficiency variable, to see whether an energy audit has been used as a signal to overcome information asymmetry by informing the bank on the energy efficiency situation of the firm. Our results in Table 9 show that both energy audits by themselves and audits in conjunction with higher energy efficiency have no impact on access to finance. This highlights the lack of use of energy audits in current bank lending, and suggests an unexploited usability of these audits (or a modification of them or a similar assessment that could convey information about energy efficiency) as a signal. This result also shows that our second hypothesis, that the compulsory energy audit helps large energy efficient firms access finance by acting as a signal, cannot be confirmed in our data.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Energy Efficiency	Age and Size	Operational health	Financial health	Foreign-owned
Energy efficiency*audit	0.00440	0.0143	0.0119	0.0140	0.0145
	(0.00914)	(0.0120)	(0.0148)	(0.0155)	(0.0153)
Energy efficiency (high or low)	0.0100*	0.00492	0.0114	0.0118	0.0119
	(0.00523)	(0.00689)	(0.00902)	(0.00970)	(0.00962)
Past energy audit	-5.28e-05	-0.0138	-0.0115	-0.0137	-0.0143
	(0.00661)	(0.00911)	(0.0110)	(0.0115)	(0.0114)
Observations	16,326	9,313	5,257	4,398	4,398
Pseudo R2	0.0319	0.0351	0.0527	0.0624	0.0642
AIC	0.590	0.590	0.582	0.574	0.573
BIC	-148464	-148464	-41701	-34082	-34079

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraints) on different sets of variables including an interaction with past energy audits

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency standards is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector- and country-fixed effects are included but not reported.

5.3. Complementary analysis

As was argued above, the different regions of the EU and the eurozone vs non-eurozone EU countries reacted differently to the financial crisis, and hence might also face different financing constraints.

Table 10 reports our regressions analysis outputs including a dummy for euro area countries but excluding country fixed-effects, to avoid capturing twice the same effects. The results show that the interaction term is still insignificant, that our variable on energy efficiency is still only significant and positive in the first model specification with no other control, and that being part of the eurozone is also positive and significant but only in model specification (1), meaning that ignoring all other indicators, a firm located in a eurozone country is more likely to obtain access to finance, but that once other indicators are included, such as characteristics of the firm, or financial and operational health, the country location becomes irrelevant.

VARIABLES	(1) Energy Efficiency	(2) Age and Size	(3) Operational health	(4) Financial health	(5) Foreign-owned	(6) Energy efficiency & large
Energy efficiency*Large						0.0193
						(0.0153)
Energy efficiency (high or low)	0.00909**	0.00380	0.00775	0.00798	0.00843	0.00489
	(0.00370)	(0.00442)	(0.00588)	(0.00625)	(0.00614)	(0.00674)
Large		0.0207***	0.00807	0.00972	0.00379	-0.00564
		(0.00675)	(0.00801)	(0.00820)	(0.00816)	(0.0109)
Eurozone	0.00892**	0.00220	-0.0122*	-0.0109	-0.01000	-0.0101
	(0.00380)	(0.00453)	(0.00626)	(0.00684)	(0.00673)	(0.00673)
Observations	24,715	16,939	9,429	7,926	7,926	7,926
Pseudo R2	0.00196	0.00653	0.0378	0.0414	0.0456	0.0459
AIC	0.616	0.614	0.608	0.595	0.593	0.593
BIC	-234707	-154463	-80446	-66318	-66329	-66322

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraints) on different sets of variables including a control for euro area countries

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency standards is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector-fixed effects are included but not reported. Full results are available from the authors upon request.

Tables 11 and 12 look at the results of our first and then our full model specification for the three EU regions. We exclude country-fixed effects. These are the Northern and Western together (i.e. Austria, Belgium, Denmark, Ireland, Germany, Finland, France, Luxembourg, Netherlands, Sweden and the UK), Southern (i.e. Cyprus, Greece, Italy, Malta, Spain and Portugal) and the CESEE (i.e. Bulgaria, Croatia, Czech Republic, Esto-

nia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia) regions.

	(1)	(2)	(3)
VARIABLES	Northern and Western	Southern	CESEE
Energy efficiency (high or low)	-0.00421	0.0133	0.0168***
	(0.00484)	(0.00861)	(0.00650)
Observations	9,513	5,235	9,967
Pseudo R2	0.000486	0.00280	0.00275

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraints) on energy efficiency for the different EU regions

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency standards is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector-fixed effects are included but not reported. Full results are available from the authors upon request.

In Table 11, we look at model specification (1) as presented above with access to finance regressed on energy efficiency for the three different EU regions. In previous estimations, when energy efficiency was on its own as an independent variable, it came out as positive and significant. Here this is only the case for the CESEE region. This confirms the hypothesis that the environment or conditions matter for access to finance, and hence that countries will respond differently to the financial crisis and show different results. Here the country grouping is based on geography and common structural economic characteristics.

Table 12 looks at model specification (6) and shows that when all other control variables are included, energy efficiency becomes irrelevant for all three regions. The interaction is not significant either. All other control variables are significant and of the expected sign for at least one region (except the binary on whether the firm is large). The variable that captures whether the firm is foreign-owned is significant at the 1% significance level for the CESEE region, which is the region where the German and Austrian firms mentioned above are mostly concentrated [43].

VARIABLES	(1) Northern and Western	(2) Southern	(3) CESEE
Energy efficiency*Large	-0.00468	0.0180	0.0405
	(0.0164)	(0.0299)	(0.0341)
Energy efficiency (high or low)	0.000225	0.0242	-0.00113
	(0.00903)	(0.0154)	(0.0114)
Innovation	-0.0162**	-0.0199	-0.0135
	(0.00791)	(0.0134)	(0.0114)
SOA machinery	0.0144	0.0154	0.0306*
	(0.0124)	(0.0219)	(0.0177)
Labour productivity	0.0121*	0.0351***	0.0275***
	(0.00708)	(0.00999)	(0.00654)
Operating at full capacity	0.00745	0.0103	0.0380***
	(0.00777)	(0.0133)	(0.0105)
Investment in R&D	-0.0382**	-0.0844***	-0.0507
	(0.0158)	(0.0307)	(0.0389)
Current ratio	0.00234	0.00988*	0.00255
	(0.00275)	(0.00519)	(0.00174)
Return on assets	0.00876	0.253***	-0.0836**
	(0.0357)	(0.0909)	(0.0375)
Financial leverage	-0.0581***	0.00776	-0.0320
	(0.0178)	(0.0349)	(0.0288)
Large	-0.00739	-0.0240	0.0293
	(0.0124)	(0.0202)	(0.0237)
Age	0.000347*	-0.000368	-1.75e-05
	(0.000187)	(0.000384)	(0.000430)
Foreign-owned	0.0124	0.102**	0.0730***
	(0.0106)	(0.0407)	(0.0242)
Observations	2,671	1,802	3,453
Pseudo R2	0.0462	0.0585	0.0346

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraints) on different sets of variables for the different EU regions

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency standards is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable

that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector-fixed effects are included but not reported.

We also undertook a comparative analysis of services versus non services firms to test whether energy efficiency and the link to access to finance varied across those firms. For instance, in the case where firms in the services sector would not necessarily invest in energy efficiency, as this would be costly to them, and where non-services firms, such as those in manufacturing would inevitably use more energy through their machinery. Evidence from the literature also suggests that energy efficiency has a more positive financial effect for firms in the manufacturing sector than in the service sector [41]. However, neither specification yields a significant regressor. The only difference in the results is that for service sector-firms hardly any variable is significant except labour productivity and operation at full capacity, an interesting result in its own right that is beyond the scope of this paper.

We also looked at firms' access to finance by including a variable on the type of finance that firms would be using for their investment activities, namely whether it is a bank loan excluding subsidised bank loans, overdrafts and other credit lines, or the latter including newly issued bonds, equity, leasing etc. The coefficient for the binary bank loan variable remained insignificant and results for other variables were unchanged, meaning that the type of financing sought by the firm did not alter its access to finance. Overall, our complementary analysis does not change our assessment about the first hypothesis [12].

6. Conclusion and Policy Implications

This paper provides first evidence about an inefficiency in the allocation of financial resources that has been receiving insufficient attention in the energy efficiency literature. More energy efficient firms do not have better access to finance, even though they are more competitive and have better collateral, especially as climate change mitigation puts more stringent CO2-emissions

[12]These results can be shared upon request.

limitations on firms, and the risk of asset stranding increases. One theoretical explanation of this problem involves information asymmetries that could lead to lenders' rationing of credit for energy efficient firms, thereby slowing the adoption of energy efficiency technology, which require upfront investments. In our sample of European firms, we found that the energy efficiency of the firm's commercial building stock in EU firms conveys no advantage in access to finance. This suggests that a signal might help resolve any information asymmetry at work. We also do not find that having had an energy audit conveys better access to finance, suggesting that current regulation could better be harnessed as information for lending assessments.

Our research points to a potential blind spot in energy efficiency policies. If energy efficiency does not lead to better access to finance, or if firms that want to implement such measures cannot finance them cheaply, this can slow down overall progress on energy efficiency. Scope therefore exists for policies focusing on facilitating energy efficiency financing, which are currently implemented only by 10 out of 28 countries in the EU. But our results also point to a more indirect way in which this lack of better access could slow adoption of energy efficient technologies across the economy. Since overall access to finance (not just for making an energy efficiency investment) is an important determinant of firm growth, better access to finance for energy efficient firms would help grow their market share and incentivise inefficient firms to make efficiency investments. Asymmetric information theory can explain why this does not happen automatically even though more efficient firms do have better collateral and are more competitive. However, it also suggests that signals to potential lenders can overcome some of this asymmetry. For instance, Meuleman and De Maeseneire (2012) show that government grants facilitate better subsequent access to external finance to small and medium enterprises, where the grant (and the previous assessment of the firm's performance by the government) helps signal to the bank the credit worthiness of the company [44].

It turns out that a similar signal is already potentially available with energy efficiency: energy efficiency assessment as part of the lending process. Large firms' energy efficiency is more likely to be under scrutiny when banks lend to them, as they go under due diligence. Although our results on this point are only suggestive, as large firms tend to have better access to finance anyway, one way of improving information about efficiency would be to har-

ness energy audits (and possibly a follow up, as these audits often lead to subsequent efficiency improvements) as a transmission channel for information on a firm's energy efficiency for lenders. Our results show that currently, these audits seem to have no such signalling effect. If this were implemented, it would also require extending the need for audits or similar energy efficiency assessment to more (i.e. smaller) firms in a first step. Since energy audits are costly, however, this could hamper smaller firms' competitiveness as a whole. Therefore, a complementary policy that would deal with the financial burden these assessments or energy audits would bring for smaller firms could be the use of fiscal policies. An alternative policy that could also contribute to overcoming the problem of asymmetric information is the introduction of a standard framework for measuring and reporting energy efficiency by firms.

Policy makers are starting to consider the links between financing investments and climate change mitigation. The EU Commission is considering lower risk rates for bank credits that fall in the clean energy taxonomy [54]. One of the Commission's new Executive Vice President, Valdis Dombrovskis, speaks about having different capital requirements for green versus non-green loans [23] and the European Investment Bank has committed to becoming the first "Climate Bank" [23]. However, our research shows that to date there is an unused potential of using access to finance as a mechanism for accelerating energy efficiency investments. As with all climate change-related market failures [24], removing this one and improving access to finance to energy efficient EU firms could lead to a "triple win situation": for the banks, firms, and the effort at mitigating climate change.

References

[1] Hunt Allcott and Michael Greenstone. Is There an Energy Efficiency Gap? *Journal of Economic Perspectives*, 26(1):3–28, 2012. 10

[2] Soren T. Anderson and Richard G. Newell. Information Programs for Technology Adoption: the Case of Energy-Efficiency Audits. *Resource and Energy Economics*, 26, 2004. 15

[3] John E. Baiden. The 5 C's of Credit in the Lending Industry. *SSRN Journal*, 2011. 12

[4] Thorsten Beck and Asli Demirguc-Kunt. Small and medium-size enterprises: Access to finance as a growth constraint. *Journal of Banking & Finance*, 30(11):2931–2943, November 2006. 4

[5] BEIS. The Clean Growth Strategy: Leading the way to a low carbon future. *UK Gov*, pages 165–165, 2017. 3

[6] Ansgar Belke, Ulrich Haskamp, and Ralph Setzer. Regional bank efficiency and its effect on regional growth in "normal" and "bad" times. *Economic Modelling*, 58:413–426, November 2016. 12

[7] Ansgar Belke and Florian Verheyen. The European Central Bank and the Financing Conditions of Small and Medium-Sized Enterprises in Europe. *Rivisita di Politica Economica*, 103(2), 2014. 12

[8] Spiros Bougheas, Paul Mizen, and Cihan Yalcin. Access to external finance: Theory and evidence on the impact of monetary policy and firm-specific characteristics. *Journal of Banking and Finance*, 30(1):199–227, 2006. 10, 11

[9] Richard G. Brody and Kimberley E. Frank. Don't Throw Good Money After Bad. *Commercial Lending Review*, 14, 1999. 12

[10] Dominique Bureau, Lionel Fontagné, and Philippe Martin. Energy and Competitiveness. *Conseil d'Analyse Economique*, (6), June 2013. 10

[11] Mattha Busby. Capitalism is part of solution to climate crisis, says Mark Carney. *The Guardia,*, July 2019. 4

[12] Uwe Cantner, Jean-Luc Gaffard, and Lionel Nesta. Introduction. In Uwe Cantner, Jean-Luc Gaffard, and Lionel Nesta, editors, *Schumpeterian Perspectives on Innovation, Competition and Growth*. Springer Berlin Heidelberg, Berlin, Heidelberg, 2009. 10

[13] Pilita Clark. Mark Carney warns investors face 'huge' climate change losses. *The Financial Times*, September 2015. 13

[14] European Commission. A Study on Energy Efficiency in Enterprises: Energy Audits and Energy Management Systems. Technical report, European Union, 2016. 8

[15] European Commission. The European Green Deal. Technical Report 640 final, 2019. 3

[16] Delia D'Agostino, Barbara Cuniberti, and Paolo Bertoldi. Energy consumption and efficiency technology measures in European non-residential buildings. *Energy and Buildings*, 153:72–86, October 2017. 19

[17] Pelin Demirel and Stuart Parris. Access to finance for innovators in the UK's environmental sector. *Technology Analysis & Strategic Management*, 27(7):782–808, August 2015. 11

[18] Yan Dong and Chao Men. SME Financing in Emerging Markets: Firm Characteristics, Banking Structure and Institutions. *Emerging Markets Finance and Trade*, 50(1):120–149, January 2014. 11, 12

[19] Damien Dussaux. The joint effects of energy prices and carbon taxes on environmental and economic performance: Evidence from the French manufacturing sector. *OECD Environment Working Papers No. 154*, January 2020. 19

[20] EEA. Energy: A key to competitive advantage- New sources of growth and productivity. Technical report, McKinsey&Company, April 2009. 3, 10

[21] Seda Erdogan. Bank Lending Criteria and Relationship Lending. *Journal of Advanced Management Science*, 2(3), September 2014. 12

[22] Annalisa Ferrando and Klaas Mulier. Firms' Financing Constraints: Do Perceptions Match the Actual Situation? *ECB Working Paper Series*, (1577), August 2013. 11, 22

[23] Sam Fleming and Jim Brunsden. Brussels eyes easing bank rules to spur green lending. *The Financial Times*, November 2019. 38

[24] Duncan K. Foley, Armon Rezai, and Lance Taylor. The social cost of carbon emissions: Seven propositions. *Economics Letters*, 121(1):90–97, October 2013. 38

[25] Todd D. Gerarden, Richard G. Newell, and Robert N. Stavins. Assessing the Energy-Efficiency Gap. *NBER Working Paper Series n20904*, January 2015. 10

[26] B. H. Hall and J. Lerner. The Financing of R&D and Innovation. In *Handbook of The Economics of Innovation*, volume 1, pages 609–39. North Holland, 2010. 15

[27] Jiří Hřebíček, Jana Soukopová, Michael Štencl, and Oldřich Trenz. Integration of economic, environmental, social and corporate governance performance and reporting in enterprises. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, 59(7):157–166, 2011. 11

[28] IEA. Market Report Series energy efficiency 2018. Technical report, 2018. 3

[29] IEA. *Word Energy Balances 2018*. International Energy Agency, Paris, 2018. 3

[30] IEA. Energy Prices and Taxes for OECD Countries. Technical report, Paris, 2019. 10

[31] Adam B Jaffe and Robert N Stavins. The energy paradox and the diffusion of conservation technology. *Resource and Energy Economics*, 16(2):91–122, 1994. 10

[32] Fotios Kalantzis, Philipp-Bastian Brutscher, and Pauline Ravillard. Investment in Climate Change Mitigation. In *Investment Report 2018-9: Retooling Europe's Economy*. European Investment Bank, Luxembourg, 2018. 15

[33] Fotios Kalantzis and Debora Revoltella. How energy audits promote SMES' energy efficiency investment. *EIB Working Paper*, February 2019. 15

[34] W. R. Kerr and R. Nanda. Financing Innovation. *Annual Review of Financial Economics*, 7(1):445–462, 2015. 15

[35] Steve Knack and Lixin Colin Xu. Unbundling institutions for external finance: Worldwide firm-level evidence. *Journal of Corporate Finance*, 44:215–232, June 2017. 12

[36] Sakis Kotsantonis and George Serafeim. Four Things No One Will Tell You About ESG Data. *Journal of Applied Corporate Finance*, 31(2):50–58, June 2019. 11

[37] Mihye Lee. Does a firm's access to external finance matter for its performance? *Applied Economics Letters*, pages 1–4, July 2019. 4

[38] Neil Lee, Hiba Sameen, and Marc Crowling. Access to finance for innovative SMEs since the financial crisis. *Research Policy*, 44(2):370–380, 2015. 15

[39] J. Scott Long and Jeremy Freese. *Regression models for categorical dependent variables using Stata*. StataCorp LP, College Station, Tex, 2nd ed edition, 2006. OCLC: ocm62464715. 29

[40] Andreas Löschel, Benjamin Johannes Lutz, and Shunsuke Managi. The impacts of the EU ETS on efficiency and economic performance – An empirical analyses for German manufacturing firms. *Resource and Energy Economics*, 56:71–95, May 2019. 19

[41] Georgia Makridou, Michalis Doumpos, and Emilios Galariotis. The financial performance of firms participating in the EU emissions trading scheme. *Energy Policy*, 129:250–259, June 2019. 36

[42] Giovanni Marin, Marianna Marino, and Claudia Pellegrin. The Impact of the European Emission Trading Scheme on Multiple Measures of Economic Performance. *Environmental and Resource Economics*, 71(2):551–582, October 2018. 19

[43] Laurent Maurin, Frank Betz, Philipp-Bastian Brutscher, Marcin Wolski, Helmut Kraemer-Eis, Frank Lang, Wouter Torfs, Salome Gvetadze, Giorgio Barba Navaretti, and Alberto Franco Pozzoli. Credit Conditions and Corporate Investment. In *Investment Report 2018/2019: Retooling Europe's Economy,*. European Investment Bank, Luxembourg, 2019. 34

[44] Miguel Meuleman and Wouter De Maeseneire. Do R&D subsidies affect SMEs' access to external financing? *Research Policy*, 41(3):580–591, April 2012. 11, 37

[45] Kevin Muldoon-Smith and Paul Greenhalgh. Suspect foundations: Developing an understanding of climate-related stranded assets in the global real estate sector. *Energy Research & Social Science*, 54:60–67, August 2019. 10

[46] Allen N. Berger and Gregory F. Udell. The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle. *Journal of Banking & Finance*, 22(6-8):613–673, August 1998. 4

[47] Nina Ponikvar, Katja Zajc Kejžar, and Barbara Mörec. Determinants of Financial Constraints: Th Effect of Financial Crisis and Heterogeneity Across Industries. page 18, 2013. 11, 15, 27

[48] Koen Rademaekers, Sahar Samir Zaki Assad, and Johannes Berg. Study on the Competitiveness of the European Companies and Resource Efficiency. Technical report, ECORYS, Rotterdam, July 2011. 10

[49] Ray C. Rist, editor. *Development Evaluation in Times of Turbulence: Dealing with Crises That Endanger Our Future*. The World Bank, April 2013. 10

[50] E. Scharfenaker and Gregor Semieniuk. A Statistical Equilibrium Approach to the Distribution of Profit Rates. *Metroeconomica*, 68(3):465–99, 2017. 23

[51] Joachim Schleich, Tobias Fleiter, Simon Hirzel, Barbara Schlomann, Michael Mai, and Edelgard Gruber. Effect of Energy Audits on the Adoption of Energy-Efficiency Measures by Small Companies. Toulon, June 2015. 15

[52] Gregor Semieniuk, D. K. Foley, L. Taylor, and A. Rezai. Do the IPCC 1.5C scenarios stand up to historical scrutiny? *Forthcoming SOAS Econ Working Paper Series*, 2020. 3

[53] Joseph E Stiglitz and Andrew Weiss. Credit Rationing in Markets with Imperfect Information. *American Economic Review*, 71(3):393–410, 1981. 4

[54] Jakob Thomä and Kyra Gibhardt. Quantifying the potential impact of a green supporting factor or brown penalty on European banks and lending. *Journal of Financial Regulation and Compliance*, 27(3):380–394, July 2019. 38

[55] P Winker. Causes and Effects of Financing Constraints at the Firm Level. *Small Business Economics*, 12(2):169–181, 1999. 11

Appendix A: Additional correlations

Looking at firms' characteristics, Table A1 shows that high energy efficiency firms that are medium or large have a better access to finance than their counterparts. Having high energy efficiency grants a better access to finance, except for micro firms, where high energy efficiency seems less important. We add controls for firms' sizes.

Table A2 shows the same but across the different economic sectors. The only sector where being highly energy efficient does not seem to matter for access to finance is construction. High energy efficiency infrastructure firms have a better access to finance.

Access to finance	**Low energy efficiency**	**High energy efficiency**	**All**
Micro firms			
No	8.5	8.6	8.6
Yes	91.5	91.4	91.4
Small firms			
No	9.2	7.6	8.5
Yes	90.8	92.4	91.5
Medium firms			
No	5.2	4.9	5.1
Yes	94.8	95.1	94.9
Large firms			
No	5.7	5.2	5.4
Yes	94.3	94.8	94.6

Table A1: Percentage share of firms with access to finance by level of energy efficiency and firm size (%)

Access to finance	**Low energy efficiency**	**High energy efficiency**	**All**
Manufacturing			
No	6.3	5.6	5.9
Yes	93.7	94.4	94.1
Construction			
No	7.0	7.8	7.4
Yes	93.0	92.2	92.6
Services			
No	6.6	6.0	6.3
Yes	93.4	94.0	93.7
Infrastructure			
No	7.0	5.2	6.1
Yes	93.0	94.8	93.9

Table A2: Percentage share of firms with access to finance by level of energy efficiency and firm sector (%)

Appendix B: Additional regression results

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Energy Efficiency	Age and Size	Operational health	Financial health	Foreign-owned	Energy efficiency & large
Energy efficiency*Large						0.0319
						(0.0289)
Energy efficiency (high or low)	0.0268***	0.0237***	-0.0120	-0.00376	-0.00128	-0.00821
	(0.00650)	(0.00785)	(0.0112)	(0.0124)	(0.0125)	(0.0140)
Large		0.0501***	0.0230	0.0333**	0.0197	0.00286
		(0.0111)	(0.0143)	(0.0154)	(0.0157)	(0.0219)
Observations	25,883	17,756	9,611	8,081	8,081	8,081
Pseudo R2	0.0546	0.0540	0.0639	0.0825	0.0849	0.0850
AIC	1.313	1.315	1.305	1.283	1.279	1.279
BIC	-228730	-150089	-75296	-62028	-62046	-62038

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B1: Marginal effects from logistics regression analyses of the perceived access to finance (i.e. finance availability) on different sets of variables

Note: Energy efficiency is measured using the binary variable that takes the value 1 (0) if the percentage of commercial building stock that satisfies high or highest energy efficiency standards is equal or above (below) the country's median. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm sees the availability of finance as an obstacle to investment,, and 0 if it does not. A squared term for the energy efficiency variable has been included on the right hand-side but was omitted in the estimation due to multicollinearity. Sector- and country-fixed effects are included but not reported. Full results are available from the authors upon request.

VARIABLES	(1) Energy Efficiency	(2) Age and Size	(3) Operational health	(4) Financial health	(5) Foreign-owned	(6) Energy efficiency & large
Energy efficiency*Large						0.0319
						(0.0289)
Energy efficiency (high or low)	0.0268***	0.0237***	-0.0120	-0.00376	-0.00128	-0.00821
	(0.00650)	(0.00785)	(0.0112)	(0.0124)	(0.0125)	(0.0140)
Large		0.0501***	0.0230	0.0333**	0.0197	0.00286
		(0.0111)	(0.0143)	(0.0154)	(0.0157)	(0.0219)
Observations	25,883	17,756	9,611	8,081	8,081	8,081
Pseudo R2	0.0546	0.0540	0.0639	0.0825	0.0849	0.0850
AIC	1.313	1.315	1.305	1.283	1.279	1.279
BIC	-228730	-150089	-75296	-62028	-62046	-62038

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B2: Marginal effects from logistics regression analyses of access to finance (i.e. financial constraint) on different sets of variables

Note: Energy efficiency is measured using the continuous variable that reports the percentage of commercial building stock that satisfies high or highest energy efficiency. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm is financially constrained, and 0 if it is not. A squared term for the energy efficiency variable is included and reported. Sector- and country-fixed effects are included but not reported. Full results are available from the authors upon request.

VARIABLES	(1) Northern and Western	(2) Southern	(3) CESEE
Energy efficiency*Large	-0.00468	0.0180	0.0405
	(0.0164)	(0.0299)	(0.0341)
Energy efficiency (high or low)	0.000225	0.0242	-0.00113
	(0.00903)	(0.0154)	(0.0114)
Innovation	-0.0162**	-0.0199	-0.0135
	(0.00791)	(0.0134)	(0.0114)
SOA machinery	0.0144	0.0154	0.0306*
	(0.0124)	(0.0219)	(0.0177)
Labour productivity	0.0121*	0.0351***	0.0275***
	(0.00708)	(0.00999)	(0.00654)
Operating at full capacity	0.00745	0.0103	0.0380***
	(0.00777)	(0.0133)	(0.0105)
Investment in R&D	-0.0382**	-0.0844***	-0.0507
	(0.0158)	(0.0307)	(0.0389)
Current ratio	0.00234	0.00988*	0.00255
	(0.00275)	(0.00519)	(0.00174)
Return on assets	0.00876	0.253***	-0.0836**
	(0.0357)	(0.0909)	(0.0375)
Financial leverage	-0.0581***	0.00776	-0.0320
	(0.0178)	(0.0349)	(0.0288)
Large	-0.00739	-0.0240	0.0293
	(0.0124)	(0.0202)	(0.0237)
Age	0.000347*	-0.000368	-1.75e-05
	(0.000187)	(0.000384)	(0.000430)
Foreign-owned	0.0124	0.102**	0.0730***
	(0.0106)	(0.0407)	(0.0242)
Observations	2,671	1,802	3,453
Pseudo R2	0.0462	0.0585	0.0346

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table B3: Marginal effects from logistics regression analyses of the perceived access to finance (i.e. finance availability) on different sets of variables

Note: Energy efficiency is measured using the continuous variable that reports the percentage of commercial building stock that satisfies high or highest energy efficiency standards. The dependent variable on access to finance is the binary variable that takes the value 1 if the firm sees the availability of finance

as an obstacle to investment„ and 0 if it does not. A squared term for the energy efficiency variable is included. Sector- and country-fixed effects are included but not reported. Full results are available from the authors upon request.