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IS IT ABOUT SIZE?

What Lies Behind the Low Productivity of Portuguese Firms

Evidence from Firm-Level Data on the Portuguese Manufacturing Sector

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Dissertation written under the supervision of Professor Diana Bonfim

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Abstract

Productivity is a fundamental driver of sustainable, long-term economic growth, yet Portugal's persistent productivity gap remains one of its most pressing economic challenges. This study investigates whether the small size of Portuguese firms may help explain their lower productivity outcomes, using firm-level data from manufacturing companies for the period 2008-2023. The analysis confirms a positive and statistically significant relationship between firm size and productivity: larger firms are consistently more productive than smaller ones. However, despite being an important determinant, size alone does not fully explain productivity differences. Other firm-level characteristics also play a crucial role. While capital structure and financing decisions appear to constrain productivity in smaller companies, the proportion of intangible assets emerges as a relevant determinant in larger, more productive firms, exhibiting a solid, significant positive association with their higher productivity levels. This study provides new evidence on the possible microeconomic roots of Portugal's productivity gap and highlights the need to foster firm growth.

Key-words: Productivity gap; Total factor productivity; Productivity determinants; Firm size; Firm growth; Firm-level data; Empirical analysis; Manufacturing sector; Portugal.



É UMA QUESTÃO DE DIMENSÃO?

O Que Explica a Baixa Produtividade das Empresas Portuguesas:

Evidência Baseada em Dados ao Nível da Firma no Sector Transformador

Catarina Abreu Castro

Dissertação realizada sob a orientação da Professora Diana Bonfim

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Dezembro de 2025

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Resumo

A produtividade constitui um dos principais motores do crescimento económico sustentável a longo-prazo, sendo o persistente défice de produtividade da economia portuguesa um dos seus desafios mais prementes. O presente estudo procura investigar se a menor dimensão das empresas portuguesas poderá contribuir para explicar os seus reduzidos níveis de produtividade, utilizando dados das empresas do setor transformador referentes ao período de 2008-2023. A análise confirma a existência de uma relação positiva e estatisticamente significativa entre a dimensão das empresas e a produtividade: as empresas de maior dimensão revelam-se sistematicamente mais produtivas do que as de menor dimensão. Contudo, e apesar da sua relevância, a dimensão, por si só, não é suficiente para explicar integralmente as diferenças de produtividade. Outras características empresariais assumem, também, um papel fundamental. Enquanto a estrutura de capital e decisões de financiamento parecem condicionar a produtividade nas empresas de menor dimensão, a proporção de ativos intangíveis destaca-se como fator relevante entre as empresas maiores, mais produtivas, exibindo uma associação significativa, consistente e positiva, com os seus níveis de produtividade, mais elevados. Este estudo apresenta novas evidências sobre os eventuais determinantes microeconómicos do défice de produtividade em Portugal e reforça a importância da promoção do crescimento das empresas.

Palavras-chave: Déficit de produtividade; Produtividade total dos fatores; Determinantes da produtividade; Dimensão das empresas; Crescimento das empresas; Dados ao nível da firma; Análise empírica; Setor transformador; Portugal.

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1. Introduction

Productivity and output are closely related. Productivity is a driver of sustainable, long-term growth, and becomes even more important in contexts of uncertainty such as the one we are currently experiencing. If Europe is facing a serious productivity challenge (Draghi, 2024), what can be said about Portugal, which has been diverging from Europe over the last decades?

The low productivity of the Portuguese economy is a condition we are all long-time familiar with; some of us have not heard any different in our lives. It has motivated several authors in their studies. In the period between the 1950s and 1995, there was a documented improvement in productivity, following the transition from an agricultural-based economy to manufacturing and services, together with the transition to democracy and the adherence to the European Economic Community (EEC) (Duarte and Restuccia, 2007; Alves, 2017). However, after 1995, Portugal entered a path of low or close-to-zero productivity growth, with a persistent and widening productivity gap towards Europe (Blanchard, 2007; Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Gopinath *et al.*, 2017; Lourenço *et al.*, 2022), despite additional efforts and capital inflows resulting from the process of Euro adhesion. Convergence – and not divergence – between Portugal and Europe was the expected outcome during this period.

This persistent low productivity of Portugal is cause for serious concern. Addressing it and understanding it should be central to the agenda of those with the power to change whatever is needed. Portugal needs to enter a path of sustainable growth and should become an attractive country for younger and future generations to live, work and invest. Improving the productivity of Portuguese companies, making them more competitive, is one of the keys to achieving that goal. As aggregate productivity depends on both firm-level productivity and the efficiency of resource allocation across firms, this study addresses only part of the equation of the productivity problem in Portugal: the firm-level component; nonetheless, it aims to raise additional awareness and provide new insights on this topic.

One of the variables that appears in multiple studies related to lower productivity is company size (Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Bento and Restuccia, 2017; Gopinath *et al.*, 2017), usually showing a positive relation – larger companies are more productive than smaller ones. Firm size also influences other productivity-related variables, such as the ability of companies to finance their growth.

In Portugal 99.9% of the non-financial companies are micro, small or medium-sized companies (MSMEs)¹. They generate 67% of all value-added and are responsible for 76% of employment². Portugal is among the European countries with the highest number of SMEs per capita and lowest SME value-added per employer³, indicating lower productivity of Portuguese companies relative to their European peers. Portuguese MSMEs are only 66% as productive as larger companies; narrowing this gap – by improving MSMEs productivity to top-quartile levels of larger companies – could be equivalent to 4.4% of Portuguese GDP (not even considering all sectors)². This would be major in terms of growth and should not be disregarded.

These facts motivated this study, which explores the relationship between productivity and firm size in Portuguese companies, particularly in MSMEs, in comparison with larger firms. Can the smaller size of Portuguese companies be one of the main determinants of its lower productivity outputs? The purpose of this paper is to assess the differences in labour productivity between companies of different sizes, understand the impact of size as a determinant of those differences, and analyse how other known productivity determinants – mainly resulting from corporate-finance decisions – influence productivity across firm size-categories. Finally, the paper also briefly compares Portuguese firms with their European peers, particularly Spain.

While the Portuguese productivity slowdown has been extensively examined at the macro level – highlighting structural stagnation since the mid-1990s, capital and labour misallocation, and the persistence of a widening productivity gap towards Europe (Blanchard, 2007; Duarte and Restuccia, 2007; Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Gopinath *et al.*, 2017; Lourenço *et al.*, 2022) – firm-level evidence on the specific drivers of productivity differences within Portugal remains comparatively scarce. Although several papers document the relation between firm size and productivity in Portugal (Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Gopinath *et al.*, 2017) few specifically analyse the influence of size while controlling for other variables and approach the issue through different perspectives and methodologies. This thesis contributes to that literature by providing a systematic, firm-level assessment of productivity determinants across firm size-categories, documenting how size and corporate-finance-related factors shape productivity outcomes differently for micro, small, medium and large firms. By integrating these determinants into both within-Portugal and cross-country

¹ Source: INE, 2023.

² Source: McKinsey Global Institute, 2024. *A microscope on small businesses*.

This paper is based on data from 2016 to 2019 and excludes some sectors such as farming, financial services, real estate, education, human health and social work activities, arts and entertainment, public administration and defense, and activities of households and extraterritorial organizations.

³ Source: European Commission, 2024. *Annual report on European SMEs 2023/2024*.

(Portugal–Spain) comparisons, the study adds new empirical granularity to the analysis of Portugal’s productivity gap, complementing and extending prior knowledge. Also, it further complements existing firm-level data analysis on Portuguese SMEs linking firm size to performance (like the one by Serrasqueiro and Nunes, 2008) by focusing on productivity instead, enriching the knowledge on how size conditions firms.

The findings of this analysis document a positive relation between firm size and productivity in Portugal during the period 2008-2023, and reinforce that size is an important productivity determinant; however, they also indicate that size is not the only factor that matters when analysing productivity differences at firm-size level. Other determinants, such as the proportion of intangible assets, shareholders’ funds and leverage levels, also play an important role, assuming different degrees of relevance across different firm-size groups.

This paper proceeds as follows: Section 2 presents the literature review, Section 3 describes the methodology, Section 4 discusses the empirical results, and Section 5 concludes.

2. Literature review

This chapter reviews the literature on the determinants of productivity considered in the analysis. It provides the conceptual basis for formulating the hypotheses regarding the relationship between each determinant and productivity. In addition to firm size, variables related to companies’ asset structure, capital structure and financing decisions, as well as foreign ownership, are also included in the analysis, as these have been identified in the literature as relevant productivity determinants.

2.1 Size

Company size is frequently found to be related to productivity – and productivity differences – in the work of several authors (Hsieh and Klenow, 2009; Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Bento and Restuccia, 2017; Gopinath *et al.*, 2017; Ayerst *et al.*, 2024). Regardless of the underlying causes – whether because larger companies benefit from economies of scale, have better access to funds and resources (such as innovative technologies), or for other reasons – the documented relationship between size and productivity is most often positive: larger companies are more productive than smaller companies.

This positive relation is also reflected in aggregate productivity and in productivity differences across countries – there is evidence of a higher proportion of smaller companies in less developed, less productive, economies. Recent research shows a strong positive relation between average establishment size and GDP per capita, using firm-level data from 134 countries (Bento and Restuccia, 2017). The authors link the presence of distortions that penalize more productive companies to the prevalence of smaller size firms, amplifying resource misallocation and hampering aggregate productivity.

Evidence from recent studies that document the productivity gap between larger and smaller companies also supports a positive relation (Katsinis *et al.*, 2024; McKinsey Global Institute, 2024). On average, MSMEs are only about half as productive as large companies²; in Europe this figure rises to 60%³, although it has been deteriorating in recent years. These studies also highlight that, even among MSMEs, productivity levels are different between micro, small and medium-sized companies – and so is the gap towards larger companies. This finding is particularly relevant in a country like Portugal, where most of the companies are microenterprises. In 2023, 99.9% of non-financial companies in Portugal were MSMEs – 96% micro, 3.3% small and 0.6% medium-sized¹.

Several authors document the positive relation between company size and productivity in Portugal (Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; McKinsey Global Institute, 2024). Particularly relevant to the purpose of this study is the finding of a distinctive firm-size-related characteristic of the Portuguese economy, not observed in other advanced economies – a leftward-shifting drift of the firm-size distribution over recent decades – which the authors relate with lower productivity (Braguinsky *et al.*, 2011). They suggest that the high level of employment protection and existing benefits for smaller companies in terms of taxes, rules and social policies, increase market distortions and resource misallocation, encouraging firms to remain below their optimal size and constraining aggregate productivity and performance.

Although the positive association between firm size and productivity is well established internationally, firm-level evidence for Portugal remains comparatively limited, with most productivity analyses adopting a macro perspective. This study contributes to the existing literature and complements it, by examining the size–productivity relationship using firm-level data over a recent period, and by comparing productivity patterns across micro, small, medium, and large firms, providing a more detailed, micro-level analysis, and shedding new light on how size shapes productivity outcomes in the Portuguese economy.

2.2 Asset structure

The literature on the role of tangible and intangible assets in productivity growth is abundant, and it mostly reports a positive relation between each asset type and productivity.

Tangible assets are directly linked to productivity via capital stock – the inventory of tangible assets available for use in production processes (machinery, equipment, infrastructure, technologies and others) – a component of the capital inputs. The relationship between investment in capital stock and productivity is expected to be positive (Gopinath *et. al*, 2017). In Europe, a positive relation between capital intensity – defined as capital stock per worker – and labour productivity is historically observed (Banco de Portugal, 2025).

The tangible fixed assets may also have an indirect effect on productivity, through access to credit. Tangible fixed assets are usually valued by banks as collateral, improving their willingness to lend and reducing the associated risk (Hall *et al.*, 2004). This is particularly relevant for MSMEs – typically perceived as riskier, more exposed to information asymmetry – that face greater difficulties in accessing finance.

On the other hand, intangible assets – such as investment in R&D, patents, technology, databases or human capital – are known to be fundamental drivers of firm productivity, primarily by contributing to total factor productivity (TFP) (Demmou and Franco, 2021). More innovative, more productive firms, usually have a higher proportion of intangible assets. Technology-related firms – which typically possess a high level of intangible assets – provide a good illustration, as in recent years they have been among those with higher growth rates, contributing to higher aggregate productivity and generating spillover effects that enhance productivity in other firms.

Capturing how efficiently capital and labour inputs are used, TFP is a productivity measure that reflects technology creation and adoption (among other factors). While some authors argue that differences in output are mostly due to differences in capital (physical and human), the prevailing literature consensus points to a higher relevance of differences in TFP growth in explaining output variations (Klenow and Rodríguez-Clare, 1997; Caselli, 2005). Certain types of intangible assets – like R&D, branding and human capital – appear to have a stronger association with firm productivity (Crass and Peters, 2014).

In Europe, there is evidence of a positive relation between investment in intangible assets and improved labour productivity in Western European countries. However, among Eastern

European countries the relation appears to be negative, possibly suggesting an inability to translate such assets into higher efficiency (Castelli *et al.*, 2024).

There is also evidence supporting a scale-related effect on access to intangible assets, with younger and smaller firms showing increased difficulties in accessing and financing them; this further widens the productivity gap between MSMEs and larger companies (Demmou and Franco, 2021; McKinsey Global Institute, 2024).

Given the above, two asset structure determinants are considered: one measuring the proportion of fixed assets – both tangible and intangible – within the company's asset structure, and the other capturing the level of intangible assets alone, serving as a proxy for measuring innovation.

2.3 Capital structure and financing decisions

It is expected that access to funds – whether equity or debt – when efficiently allocated, allows productive companies to finance their operations and to invest in capital and technology that enhance productivity and support future growth. There are relatively few studies that directly examine the relationship between firm-level productivity and debt or shareholders' funds, although this paper aims to analyse both in the case of Portuguese firms.

At firm-level, the relation between productivity and both shareholder's funds and debt has been described as positive by some authors (Levine and Warusawitharana, 2014; Gomis and Khatiwada, 2017) and investment in projects that increase firm productivity appears to be dependent on access to external financing (Levine and Warusawitharana, 2014). One paper adds an interesting contribution to this discussion by identifying a leverage level above which additional leverage may lead to lower productivity growth, suggesting a non-linear relationship (Coricelli *et al.*, 2012).

Ideally, to match the maturity of assets and liabilities, long-term debt should be used to finance investments in fixed assets while short-term debt should fund working capital needs. Firm-level evidence from a European country suggests a positive relationship of long-term debt with productivity for larger companies, and a positive association with short-term debt for SMEs; because SMEs are more constrained in accessing long-term debt, they appear to rely more on short-term borrowing to invest in intangible assets, such as technology and software, that quickly boost productivity (Nakatani, 2023).

Access to finance and leverage is more relevant for SMEs than larger companies in enabling them to improve their TFP (Gomis and Khatiwada, 2017). SMEs are, indeed, a distinct case

with regard to capital structure and financing decisions, as they do not benefit from the same ease of access to funding sources – from capital markets (national and international) to bank loans – as larger companies do. Access to finance for European SMEs, particularly to bank lending, is more constrained than for larger firms. This applies to loan availability, interest rates, pricing and collateral requirements. Across all firm sizes, the primary use of both external and internal finance is fixed investment, followed by inventories and working capital, while the most frequent reason given by firms for not applying for bank loans is the existence of sufficient internal funds to finance their business plan (European Central Bank, 2025).

A final note concerns a paper that studies the determinants of SME capital structure in European countries: according to the authors, there is evidence of a significant negative relationship between company profitability and long-term debt in Portugal, supporting the idea that Portuguese SMEs depend considerably on own funds to finance themselves (Hall *et al.*, 2004).

Despite limited availability of firm-level data-based literature on this topic, three determinants of productivity related to capital structure and financing decisions are considered: the proportion of shareholder's funds, and separate ratios for long-term and short-term debt.

2.4 Foreign ownership

One can theorise that companies with foreign ownership may benefit from better access to knowledge, technology or even financial resources, all of which can positively impact their productivity. This would be the case, for instance, of multinational foreign affiliates compared with domestic companies.

On this topic, the empirical evidence is mixed. Some authors find no significant productivity differences between foreign- and domestic-owned companies; however, this relationship becomes positive and significant when controlling for nationality, suggesting that a positive association may exist where the productivity gap between origin and host countries is sufficiently wide (Benfratello and Sembenelli, 2006).

A strong and positive relationship between foreign ownership and higher productivity is reported across several studies. Both selection and innovation decisions appear to contribute to the higher productivity of foreign subsidiaries – most of foreign investment comes from acquisition and typically the more productive firms are the ones acquired; also, foreign subsidiaries are more prone to invest in innovation, benefit from access to larger markets, and face lower labour and implementation costs, as well as fewer financial constraints (Guadalupe *et al.*, 2012; Xu *et al.*, 2022). The positive association of foreign ownership with productivity

appears to be stronger for large and medium-sized companies than for smaller ones (Xu *et al.*, 2022).

In Table 1, we list the testable hypotheses based on the existing literature. We expect size, asset structure, asset intangibility, shareholders' funds, and foreign ownership to be positively related with productivity. Debt maturity is expected to have a non-linear relationship associated with size, with longer-maturities being associated with more productivity only for the larger firms.

Table 1 | Hypotheses identification

Determinant	Hypotheses
Size	H1: positive relation between size and productivity
Asset structure	H2: positive relation between fixed assets and productivity
Asset intangibility	H3: positive relation between intangible assets and productivity
Shareholders' funds	H4: positive relation between shareholders' funds and productivity
Long-term debt	H5a: negative relation between long-term debt and productivity for MSMEs H5b: positive relation between long-term debt and productivity for larger companies
Short-term debt	H6a: positive relation between short-term debt and productivity for MSMEs H6b: negative relation between short-term debt and productivity for larger companies
Foreign ownership	H7: positive relation between foreign ownership and productivity

3. Methodology

This section describes the dataset, variables, and methodology employed in the study.

3.1 Dataset and variables

In this study, a firm-level dataset provided by Banco de Portugal Microdata Research Laboratory (BPLIM, 2025) and Banco de España (BELab, 2025) was used, comprising the Spanish and Portuguese Companies Microdata. It contains “economic and financial granular information on non-financial Spanish and Portuguese corporations from iBACH”. The dataset is derived from BACH, a harmonized database of companies' annual accounts compiled according to national accounting standards.

The dataset covers the population of Portuguese non-financial companies and a representative sample of Spanish non-financial companies. The May 2025 extraction was used, containing a total of 19,220,754 observations from 2,845,243 firms, covering the period 2008-2023; the Portuguese data comprises 6,894,200 observations from 889,453 firms.

The use of this dataset, providing firm-level data from balance sheets and income statements, is particularly well suited for an accurate analysis of the relation between a firm's output, company size and corporate-finance decisions; it contains all the relevant data needed to categorize companies by size and to compute the necessary variables and ratios (see Table A1.1).

Although the main purpose of this study is to examine the relation between firm productivity and size for Portuguese MSMEs, the analysis includes additional variables – previously identified in the literature as productivity determinants – related to asset structure, capital structure, financing decisions and foreign ownership, in order to provide an integrated perspective on productivity, firm size and corporate-finance decisions (see Table 2). The analysis also incorporates a comparison with Portugal's Iberian peer, to explore whether systematic differences exist between Portuguese and Spanish firms that could help to clarify Portugal's lower productivity levels.

Table 2 | Dependent and control variables

Variable	Definition and measurement
Dependent variable	
TFP	Natural logarithm of estimated TFP ⁴ : $GVA_{i,t}(\text{real}) / (\text{Capital input}_{i,t}(\text{real})^{\beta_K} \times \text{Labour input}_{i,t}^{\beta_L})$
Control variables	
Size	Natural logarithm of number of employees _{i,t} ⁴
Asset structure	Proportion of fixed over total assets ⁵ : $BV \text{ of fixed assets}_{i,t} / BV \text{ of total assets}_{i,t}$
Asset intangibility	Proportion of intangible fixed over fixed assets ⁵ : $BV \text{ of intangible fixed assets}_{i,t} / BV \text{ of total assets}_{i,t}$
Shareholders' funds ratio	Proportion of shareholders' funds: $\text{Shareholders' funds}_{i,t} / BV \text{ of total assets}_{i,t}$
Long-term debt ratio	Proportion of debt due in more than 12 months: $BV \text{ of non-current liabilities}_{i,t} / BV \text{ of total assets}_{i,t}$
Short-term debt ratio	Proportion of debt due within the next 12 months: $BV \text{ of current liabilities}_{i,t} / BV \text{ of total assets}_{i,t}$
Foreign ownership	Dummy variable that identifies firms with foreign control ⁶ : assumes 1 for foreign control and 0 otherwise

⁴ For the purpose of comparability and regression analysis, both TFP and size are in logarithmic scale.

⁵ There are several possibilities for these measures; I chose the ones more prevalent in the literature.

⁶ Foreign ownership was identified based on the legal form of companies – for Portugal it includes foreign branch companies (code 202), for Spain it includes foreign entities and permanent establishments of non-resident entities (codes 107 and 110).

3.2 Data screening and sample representativeness

As in several studies on productivity, this analysis focuses exclusively on the manufacturing sector⁷ (Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Hsieh and Klenow, 2009; Wooldridge, 2009; Akerberg *et al.*, 2015; Gopinath *et al.*, 2017; Bento and Restuccia, 2017; Ayerst *et al.*, 2024). Despite the growing importance of services' sector in today's economy, manufacturing has historically been a key driver of productivity growth and has remained at the core of productivity research due to data availability and greater reliability of production functions' estimations; it is also a highly competitive sector and particularly suitable for international comparisons, given its production of tradable goods.

Following the methodology of two recent papers using firm-level data (Gopinath *et al.*, 2017; Ayerst *et al.*, 2024), data-cleaning procedures were applied to ensure consistency and reliability, dropping firm-year observations with missing, zero or negative values on relevant variables, with dates of incorporation that would imply a non-positive age, with inactive or unknown firm status, with atypical legal forms⁸ and, finally, duplicate firm-year observations. After cleaning the data, and to control for the presence of outliers that could distort the analysis, ratio variables were winsorised – specifically asset structure, asset intangibility, shareholders' funds ratio, long-term and short-term debt ratios – at the 2nd and 98th percentiles.

The resulting dataset comprises 1,123,360 observations from 173,800 companies; of these, 398,850 observations and 52,435 firms correspond to Portugal. To validate sample representativeness, the dataset was compared with data from Eurostat's Structural Business Statistics (SBS), which are based on census information and representative of the firm universe. Even after applying the data-screening procedures, the final sample remains broadly representative of the manufacturing sector in both countries – more so for Portugal than for Spain, due to the composition of the dataset itself – both in terms of the number of firms, employment and turnover (see Table A1.2) and in terms of company-size distribution (see Table A1.3).

The summary statistics of the final sample, together with the correlation matrices on control variables (see Tables 3 and 4), provide reassurance regarding the representativeness and suitability of the sample for the proposed analysis. Correlations are generally low to moderate

⁷ Data from the manufacturing sector was identified by the four digit NACE Rev. 2 code.

⁸ The following legal forms were excluded from the analysis: in Portugal – complementary grouping of companies and european economic interest grouping, non-profit organizations, others and professional societies (codes 201, 205, 206 and 208); in Spain – cooperative companies, associations, public organizations and others (codes 105, 106, 108 and 109).

with the highest values observed between the short-term and long-term debt ratios and the shareholders' funds ratio; while most correlations are statistically significant, their magnitudes remain sufficiently modest to suggest that multicollinearity among the explanatory variables should not be a major concern.

Table 3 | Sample summary statistics on control variables

	Portugal sample N = 398,850			Spain sample N = 724,510			Total sample N = 1,123,360		
Variable	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Size	2.15	2.08	1.28	1.93	1.79	1.24	2.01	1.95	1.26
Asset structure	0.29	0.23	0.22	0.30	0.26	0.23	0.30	0.25	0.23
Asset intangibility	0.00	0.00	0.01	0.01	0.00	0.02	0.00	0.00	0.02
Shareholders' funds ratio	0.41	0.38	0.25	0.45	0.43	0.26	0.43	0.41	0.26
Long-term debt ratio	0.18	0.11	0.20	0.15	0.08	0.18	0.16	0.09	0.19
Short-term debt ratio	0.40	0.36	0.24	0.39	0.36	0.24	0.40	0.36	0.24
Foreign ownership	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.02

Size is in logarithmic scale, foreign ownership is a dummy variable, the remaining variables are ratios.

Table 4 | Correlation matrices on control variables

	Size	Asset structure	Asset intangibility	Shareholders' funds ratio	Long-term debt ratio	Short-term debt ratio	FO
Portugal sample							
Size	1						
Asset structure	0.0977***	1					
Asset intangibility	0.1424***	0.1672***	1				
Shareholders' funds ratio	-0.0119***	-0.1188***	-0.0284***	1			
Long-term debt ratio	-0.0398***	0.2853***	0.0390***	-0.4274***	1		
Short-term debt ratio	0.0362***	-0.1162***	-0.0111***	-0.6569***	-0.3781***	1	
Foreign ownership (FO)	-0.0006	-0.0227***	-0.0001	-0.0037**	-0.0202***	0.0194***	1
Spain sample							
Size	1						
Asset structure	0.0028**	1					
Asset intangibility	0.1394***	0.1161***	1				
Shareholders' funds ratio	0.0736***	-0.1238***	-0.0402***	1			
Long-term debt ratio	-0.0284***	0.4046***	0.0815***	-0.4919***	1		
Short-term debt ratio	-0.0748***	-0.1822***	-0.0250***	-0.7207***	-0.2347***	1	
Foreign ownership (FO)	-0.0004	-0.0051***	0.0004	-0.0007	-0.0024**	0.0028**	1
Total sample							
Size	1						
Asset structure	0.0335***	1					
Asset intangibility	0.1319***	0.1311***	1				
Shareholders' funds ratio	0.0379***	-0.1194***	-0.0320***	1			
Long-term debt ratio	-0.0264***	0.3569***	0.0619***	-0.4704***	1		
Short-term debt ratio	-0.0331***	-0.1590***	-0.0209***	-0.6973***	-0.2870***	1	
Foreign ownership (FO)	0.0015	-0.0147***	-0.0019**	-0.0037***	-0.0110***	0.0121***	1

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

3.3 TFP estimation and regressions

The chosen methodology for analysing the relationship between productivity and firm size in Portuguese companies involves a series of regressions between a productivity measure and several productivity determinants (including size).

The first step of this methodology is the estimation of the chosen productivity measure. Consistently with several firm-level productivity studies (Hsieh and Klenow, 2009; Bento and Restuccia, 2017; Gopinath *et al.*, 2017; Ayerst *et al.*, 2024), labour productivity is proxied by estimated TFP.

The adopted TFP estimation methodology follows more closely one of those papers (Gopinath *et al.*, 2017), in the sense that production functions are estimated by industry j within the manufacturing sector (totalling 24 industries, identified by the first two digits of the NACE Rev. 2 code). In this paper, they are estimated as Cobb-Douglas-type (log-linear) production functions, without imposing constant returns to scale:

$$\ln(y_{i,t}) = \beta_{j,t}^k \ln(k_{i,t}) + \beta_{j,t}^l \ln(l_{i,t}) + \ln(TFP_{i,t}) + \theta_{j \times t} + \varepsilon_{i,t} \quad (1)$$

where $y_{i,t}$ is the output measure (gross value-added deflated by the industry gross value-added price index), $k_{i,t}$ is the capital input (book value of fixed assets deflated by the industry gross fixed capital formation price index), $l_{i,t}$ is the labour input (number of employees) and $\theta_{j \times t}$ is an industry-year fixed-effect. $\beta_{j,t}^k$ and $\beta_{j,t}^l$ represent the output elasticities with respect to capital and labour inputs, respectively, which are estimated at industry-level and thus, allowed to vary across industries but not across firms within the same industry (Hsieh and Klenow, 2009; Gopinath *et al.*, 2017). Summary statistics for estimated elasticities by country are presented in Table A2.1. Using these elasticities, it was then possible to estimate firm-level TFP as a residual:

$$\ln(\widehat{TFP}_{i,t}) = \ln(y_{i,t}) - \hat{\beta}_{j,t}^k \ln(k_{i,t}) - \hat{\beta}_{j,t}^l \ln(l_{i,t}) \quad (2)$$

The results for the estimated firm-level TFP in this sample, together with the respective summary statistics, align with expectations – in Portugal, average TFP increases consistently with firm size-category, and the overall mean appears to be influenced by the prevalence of microenterprises, as it falls between the mean TFP of micro and small firms (see Table 5; results for Spain and total sample are reported in Table A2.2 and analysed in section 4.2). Over the period of analysis, a positive evolution of the estimated TFP is observed across all firm size-

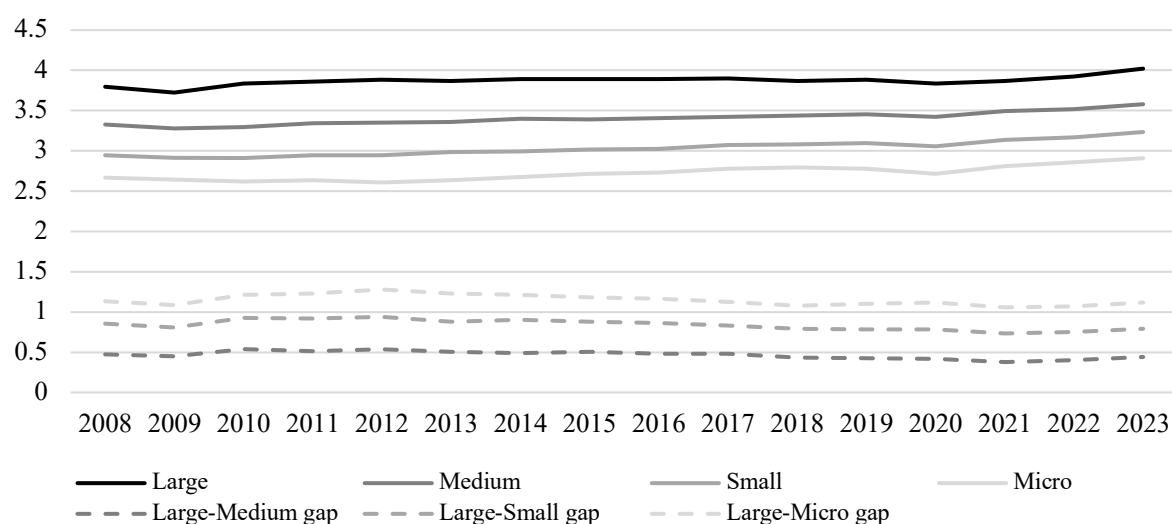
categories, accompanied by a persistent productivity gap between larger firms and MSMEs (see Figure 1; results for Spain and total sample are shown in Figures A2.3 and A2.4 and analysed in section 4.2).

Table 5 | Estimated TFP statistics by firm size-category for Portugal

	All	Micro	Small	Medium	Large
Mean	2.90	2.72	3.03	3.41	3.88
Median	2.89	2.75	3.00	3.37	3.80
SD	0.70	0.71	0.58	0.62	0.75
Observations	398,850	225,565	136,036	32,895	4,354

Values for estimated TFP and statistics are presented in logarithmic scale (ln TFP).

Figure 1 | Evolution of estimated TFP by firm size-category and TFP gap for Portugal



Values represent the yearly mean of estimated TFP (ln TFP) by firm size-category for Portugal.

These results for the estimated TFP are analysed in the following chapter, together with the outcomes of the regressions performed to examine the relationship between firm-level TFP, size and other productivity determinants arising from corporate-finance decisions. The correlation between the estimated TFP and controls provide preliminary descriptive evidence on these relationships (see Table 6). TFP does not exhibit excessively strong correlations with any of the control variables, alleviating possible concerns regarding strong endogeneity.

Table 6 | Correlation matrices on TFP and control variables

	Size	Asset structure	Asset intangibility	Shareholders' funds ratio	Long-term debt ratio	Short-term debt ratio	FO
Portugal sample							
TFP	0.3483***	-0.0945***	0.0522***	0.1768***	-0.1028***	-0.1022***	0.0454***
Spain sample							
TFP	0.5158***	-0.1749***	0.0667***	0.1955***	-0.1168***	-0.1350***	0.0057***
Total sample							
TFP	0.3812***	-0.1335***	0.0685***	0.1951***	-0.1295***	-0.1141***	0.0193***

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

The results of four regression analyses are presented and discussed. The first one is a pooled base-case regression, which identifies how size – along with the other determinants – relate to TFP. To complement this analysis, a second regression is presented, to clarify the differences in TFP arising solely from variation across size-categories, holding all other determinants constant. To assess whether the determinants of productivity differ across firm size-categories, two additional regressions are estimated: split regressions by firm size-category (micro, small, medium, and large) are constructed to disclose the heterogeneity in the relationships between firm-level productivity and its determinants; a pooled regression including interaction terms between size-categories and the explanatory variables is estimated, to formally test for size-dependent differentials within a unified framework. While some authors opt for just one of these approaches, the use of this combined methodology – split regressions and pooled regression with interactions – has been employed in prior research (Beck *et al.*, 2005).

Serving the purpose of this paper, these regressions are designed to capture pooled variation in TFP levels, reflecting between-firm and within-firm variation. Their specifications include industry-year fixed-effects to control for industry shocks that might impact productivity, while allowing for firm-level heterogeneity; standard errors are clustered at firm-level to control for serial correlation and heteroskedasticity within firms over time. Although not core to this work, an additional regression with firm fixed-effects will be briefly discussed, to provide complementary insight on within-firm variation.

This empirical strategy allows for a comprehensive assessment of the research question of whether the smaller size of Portuguese firms constitutes one of the main determinants of their lower productivity outcomes, by examining the differences in productivity across firm size-categories in Portugal and evaluating both, the specific role of firm size on productivity, and the behaviour of size and other productivity determinants within each size group. Finally, by comparing the regressions' results for Portugal and Spain, the analysis aims to determine

whether the underlying productivity determinants exhibit similar patterns or distinct dynamics between Portugal and its Iberian peer.

4. Data analysis and results

This section presents the results obtained in the series of regressions designed to examine the relation between TFP levels and their determinants; the analysis is presented first for Portugal, followed by the cross-country comparison.

4.1 Portuguese data

Examining the relationship between firm size and productivity in Portugal is the central focus of this study. The departing point of the data analysis involves estimating a pooled base-case regression, relating TFP to size and the selected productivity determinants:

$$\begin{aligned} \ln(\widehat{TFP}_{i,t}) = & \beta_0 + \beta_1 Size_{i,t} + \beta_2 Asset_structure_{i,t} + \beta_3 Asset_intangibility_{i,t} \\ & + \beta_4 Shareholders_funds_{i,t} + \beta_5 LT_debt_{i,t} + \beta_6 ST_debt_{i,t} \\ & + \beta_7 Foreign_ownership_{i,t} + \theta_{j \times t} + \varepsilon_{i,t} \end{aligned} \quad (3)$$

The results of this regression (see Table 7) show statistically significant relationships between estimated TFP and all the determinants considered. The regression results reveal the following patterns:

- Size has a positive relationship with TFP, consistent with H1. This positive relation is well documented in the literature (Hsieh and Klenow, 2009; Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Bento and Restuccia, 2017; Gopinath *et al.*, 2017; Ayerst *et al.*, 2024; Katsinis *et al.*, 2024; McKinsey Global Institute, 2024);
- Asset structure shows a negative relation with productivity, contrary to H2 and to the revised literature on this productivity determinant (Gopinath *et al.*, 2017; Banco de Portugal, 2025);
- Asset intangibility has a positive relationship with TFP, supporting H3 and in agreement with previous literature (Demmou and Franco, 2021; Castelli *et al.*, 2024);
- Shareholders' funds display a positive relationship with TFP, in accordance with H4, and as described by some of the studied authors (Levine and Warusawitharana, 2014; Gomis and Khatiwada, 2017);

- Long-term and short-term debt ratios both display a negative relationship with firm productivity (since the hypotheses formulated for these variables differ between smaller and larger firms, they can only be evaluated in the split regressions by firm size-category);
- Foreign ownership positively relates to TFP, in accordance with H7. Some authors present findings pointing in this direction (Guadalupe *et al.*, 2012; Xu *et al.*, 2022), although the literature on this determinant is, sometimes, contradictory.

Table 7 | Pooled base-case regression for Portugal

Dependent variable	TFP	
Control variables	Size	0.2139*** (0.0021)
	Asset structure	-0.4054*** (0.0108)
	Asset intangibility	0.3907* (0.2145)
	Shareholders' funds ratio	0.1898*** (0.0416)
	Long-term debt ratio	-0.1955*** (0.0426)
	Short-term debt ratio	-0.2016*** (0.0418)
	Foreign ownership	0.8474*** (0.1496)
	Constant	2.5898*** (0.0415)
Observations		398,850
Adjusted R-squared		0.258

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Deepening the analysis on this regression, a partial variance decomposition was computed⁹ to evaluate the relative importance of productivity determinants (see Table A3.1). In this model, firm size accounts for the largest share of explained productivity variation. In addition, to assess the relative magnitude of productivity determinants, the regression was re-estimated using standardised variables¹⁰ (see Table A3.2), allowing for a comparison of coefficients in relative terms. In this model, size is also the variable with the largest standardised coefficient, followed

⁹ The partial variance decomposition is based on partial R-squared measures computed using the within R-squared, which refers to variation within the fixed-effect dimension (industry-year).

¹⁰ All continuous variables were standardised to have zero mean and unit variance. Dummy variables, as foreign ownership, were not standardised, not allowing for direct comparison with the standardised variables.

by asset structure. These results highlight the importance of firm size in explaining productivity differences.

To further explore the TFP differences across size-categories, a pooled size-category regression was performed:

$$\ln(\widehat{TFP}_{i,t}) = \beta_0 + \beta_s \text{Small}_{i,t} + \beta_m \text{Medium}_{i,t} + \beta_l \text{Large}_{i,t} + X'_{i,t} \beta + \theta_{j \times t} + \epsilon_{i,t} \quad (4)$$

where firm size was replaced by size-category dummies – micro, small, medium, large – being micro the baseline category (and thus, omitted) and $X'_{i,t}$ a vector with the control variables. This regression allows the analysis of systematic differences in estimated TFP across firm size-categories, holding other factors constant; the size-category coefficients represent the difference (in log points) between the mean TFP of each group and that of micro companies.

Table 8 | Pooled size-category regression for Portugal

Dependent variable	TFP	
Size-category coefficients (vs. Micro)	Micro (baseline)	–
	Small	0.3629*** (0.0045)
	Medium	0.7252*** (0.0087)
	Large	1.0953*** (0.0314)
Control variables	Asset structure	-0.4017*** (0.0111)
	Asset intangibility	0.7205*** (0.2187)
	Shareholders' funds ratio	0.2033*** (0.0429)
	Long-term debt ratio	-0.1729*** (0.0439)
	Short-term debt ratio	-0.1798*** (0.0431)
	Foreign ownership	0.8732*** (0.1495)
	Constant	2.8342*** (0.0426)
Observations	398,850	
Adjusted R-squared	0.238	

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category (omitted).

This regression results (see Table 8) show that small, medium and larger firms have significantly higher levels of estimated TFP than micro companies; medium companies present a higher difference relative to micro than small companies, and large companies display an even wider difference. These findings are consistent with the estimated TFP statistics (see Table 5), which show the mean TFP increasing across all size-categories, and with the pairwise t-tests (see Table A2.5), which confirm statistically significant mean differences in TFP across all size-categories. As for the remaining determinants, the relationships and results are consistent with those from the base-case regression, as expected.

The next step in the analysis involves estimating split regressions by firm size-category. This approach replicates the base-case specification separately for each size group (micro, small, medium, and large firms), allowing the estimated relationships between productivity, size, and the remaining determinants to differ across firm-size groups:

$$\begin{aligned} \ln(\widehat{TFP}_{i,t}) = & \beta_0^{(s)} + \beta_1^{(s)} Size_{i,t} + \beta_2^{(s)} Asset_structure_{i,t} + \beta_3^{(s)} Asset_intangibility_{i,t} \\ & + \beta_4^{(s)} Shareholders_funds_{i,t} + \beta_5^{(s)} LT_debt_{i,t} + \beta_6^{(s)} ST_debt_{i,t} \\ & + \beta_7^{(s)} Foreign_ownership_{i,t} + \theta_{j \times t} + \varepsilon_{i,t} \end{aligned} \quad (5)$$

This step is important to disclose differences across groups, since the pooled regressions are influenced by the firm-size distribution, thus leaning towards the most prevalent category (micro firms). Analysing these differences could help explain why larger companies are generally more productive.

The results of the split regressions are diverse (see Table 9) and lead to the acceptance of most of the defined hypotheses (see Table 1):

- Size exhibits a statistically significant and positive relationship with estimated TFP across all size-categories, as expected and consistent with H1 and with the findings from several authors (Hsieh and Klenow, 2009; Braguinsky *et al.*, 2011; Reis, 2013; Alves, 2017; Bento and Restuccia, 2017; Gopinath *et al.*, 2017; Ayerst *et al.*, 2024; Katsinis *et al.*, 2024; McKinsey Global Institute, 2024);
- Asset structure displays a negative and statistically significant association with TFP for micro, small, and medium-sized firms. For large firms, the relationship remains negative but is not statistically significant. This finding does not support the relationship proposed in H2, nor is it supported by the revised literature and recent evidence (Gopinath *et al.*, 2017; Banco de Portugal, 2025), as also seen in the base-case regression;

- Asset intangibility exhibits a positive and statistically significant relationship with productivity in medium and large firms, supporting H3 for these size groups. For micro and small firms, however, the relationship is negative and not statistically significant. While the literature often reports a positive association between intangible assets and productivity (Demmou and Franco, 2021; Castelli *et al.*, 2024), there is also evidence that such assets may fail to improve productivity when firms lack the capabilities to translate them into performance gains (Castelli *et al.*, 2024). In addition, recent evidence highlights that smaller firms face greater obstacles in accessing and financing intangible assets effectively (Demmou and Franco, 2021; McKinsey Global Institute, 2024). The combination of these factors may explain the inconclusive results observed for micro and small companies;
- Shareholders' funds ratio is positively and significantly associated with estimated TFP among micro firms, as predicted by H4. For small, medium, and large firms, the relationship is not statistically significant, not allowing for conclusions;
- Long-term debt ratio exhibits a negative and statistically significant relationship with TFP for small and medium companies, corroborating H5a for these groups. There is no statistical significance in the relation for micro or large firms;
- Short-term debt ratio also yields statistically significant results only for small and medium companies, showing a negative relationship with productivity, contrary to the prediction in H6a and also contradicting recent evidence that points to a positive association of short-term debt with productivity for SMEs (Nakatani, 2023);
- Foreign ownership displays a positive and statistically significant relationship with TFP among micro, small and medium-sized firms, confirming H7. For larger companies the result is omitted due to collinearity.

From the results on this regression it can be observed that, while some determinants have a more consistent behaviour between firm-size groups – namely size, asset structure and foreign ownership – others present differing dynamics, which is the case of asset intangibility.

Assessing the relative magnitude of productivity determinants within each size-category, by re-estimating the regressions with standardised variables¹¹ (see Table A3.3), adds further insights into the pattern analysis. Each size group exhibits a different pattern:

¹¹ In the pooled base-case and in the split regressions by size-category, the standardised coefficients – resulting from re-estimating regressions with standardised variables – are expressed in standard-deviation units, capturing relative magnitudes.

- For micro firms, shareholders' funds ratio and firm size exhibit the two largest standardised coefficients, with very similar magnitude (and positive signs);
- Among small firms, size displays the largest relative coefficient (positive), followed by the short-term debt ratio (with a negative sign);
- For medium-sized firms, short-term debt ratio emerges as the most relevant determinant, followed by asset structure (both with negative signs);
- In large firms, size, again, stands out as the determinant with the largest standardised coefficient, followed by asset intangibility (both with a positive coefficient).

It is also noteworthy that the adjusted R-squared increases with firm size, indicating a stronger model fit for larger companies.

Table 9 | Split regressions by firm size-category for Portugal

	All	Micro	Small	Medium	Large
Dependent variable	TFP				
Control variables					
Size	0.2139*** (0.0021)	0.1479*** (0.0044)	0.2552*** (0.0063)	0.1827*** (0.0155)	0.1404** (0.0581)
Asset structure	-0.4054*** (0.0108)	-0.4247*** (0.0136)	-0.3458*** (0.0163)	-0.5960*** (0.0380)	-0.2145 (0.1338)
Asset intangibility	0.3907* (0.2145)	-0.0507 (0.3047)	-0.3820 (0.2852)	1.6649*** (0.4377)	3.3088** (1.3501)
Shareholders' funds ratio	0.1898*** (0.0416)	0.3870*** (0.0548)	0.0122 (0.0613)	-0.1316 (0.1187)	0.5968 (0.4177)
Long-term debt ratio	-0.1955*** (0.0426)	0.0728 (0.0564)	-0.4095*** (0.0621)	-0.7228*** (0.1234)	-0.1745 (0.4173)
Short-term debt ratio	-0.2016*** (0.0418)	0.0619 (0.0551)	-0.4452*** (0.0617)	-0.7485*** (0.1194)	0.0068 (0.4127)
Foreign ownership	0.8474*** (0.1496)	1.0064*** (0.1501)	0.6232** (0.2664)	0.7775** (0.3775)	—
Constant	2.5898*** (0.0415)	2.4536*** (0.0549)	2.6390*** (0.0630)	3.2405*** (0.1336)	2.7853*** (0.5546)
Observations	398,850	225,564	136,033	32,888	4,319
Adjusted R-squared	0.258	0.121	0.279	0.426	0.504

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership for large companies was omitted due to collinearity.

The last regression is a pooled regression with size-category interaction terms. It extends the pooled base-case regression by introducing interaction terms between firm size-categories and all explanatory variables. This allows the estimated coefficients on productivity determinants to vary across size groups (as in the split regressions) while maintaining a unified regression framework:

$$\ln(\widehat{TFP}_{i,t}) = \beta_0^{(s)} + X'_{i,t}\beta + \sum_{s=\{small,medium,large\}} (\delta_s + X'_{i,t}\gamma^{(s)})D_{s,i,t} + \theta_{j \times t} + \varepsilon_{i,t} \quad (6)$$

where $X'_{i,t}$ is a vector of control variables, β is the vector of slope coefficients for micro companies (the baseline category), δ_s is the size-category dummy coefficients, $\gamma^{(s)}$ denotes the coefficient differentials for each size-category and $D_{s,i,t}$ is the dummy for size-category.

This regression directly reports coefficient differentials by size-category, relative to micro firms (see Table 10):

- Asset structure interaction terms are positive and statistically significant for small, medium and large companies, indicating that for companies other than micro, asset structure relates less negatively with estimated TFP;
- Asset intangibility interaction terms are positive for all other firm sizes, and incremental – the larger the firm, the higher the coefficient differentials of asset intangibility. While the coefficient differential for small firms is not statistically significant, for medium and large firms this result reinforces what was already seen on the split regressions – for medium and large companies, more productive than micro and small companies, the differentials for asset intangibility are positive and statistically significant, being even more relevant for larger companies, the most productive, than for medium-sized ones;
- Shareholders' funds ratio differentials are all negative relative to micro companies and statistically significant. For micro companies the coefficient of this determinant is positive;
- Long-term debt ratio, as well as short-term debt ratio interactions, are all negative, incremental and statistically significant for small, medium and large companies compared with microenterprises. These results indicate that debt ratios have a positive association with productivity only for micro firms, while their relationship becomes increasingly negative as firm size grows;
- Foreign ownership differences vs. micro-sized firms don't have statistical significance, preventing any conclusions regarding this determinant except for micro companies.

Table 10 | Pooled regression with size-category interaction terms for Portugal

	Micro (baseline)	x Small	x Medium	x Large
Dependent variable	TFP			
Control variables				
Asset structure	-0.4714*** (0.0140)	0.2090*** (0.0206)	0.0752* (0.0437)	0.6015*** (0.1704)
Asset intangibility	-0.1461 (0.3145)	0.6459 (0.4198)	2.7960*** (0.6074)	4.8217*** (1.6056)
Shareholders' funds ratio	0.4394*** (0.0562)	-0.5532*** (0.0866)	-0.4988*** (0.1474)	-1.0423* (0.6288)
Long-term debt ratio	0.1503*** (0.0577)	-0.7425*** (0.0881)	-0.9093*** (0.1539)	-1.6541*** (0.6270)
Short-term debt ratio	0.1412** (0.0564)	-0.7499*** (0.0870)	-0.8686*** (0.1482)	-1.2470** (0.6261)
Foreign ownership	1.0333*** (0.1458)	-0.3692 (0.3041)	-0.2821 (0.4015)	—
Constant	2.5721*** (0.0559)			
Size-category coefficients (vs. Micro)				
Small	0.9599*** (0.0857)			
Medium	1.3954*** (0.1450)			
Large	2.0332*** (0.6159)			
Observations	398,850			
Adjusted R-squared	0.242			

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category.

Foreign ownership for large companies was omitted due to collinearity.

The findings on the size-category coefficients once again reinforce that larger firms exhibit progressively higher TFP levels relative to micro firms. The results of this regression, particularly on those determinants that present a pattern increasing with firm size, offer additional insights to the previous analysis. To complement its interpretation, the size-category marginal coefficients¹² were computed (see Table A3.4). Overall, the marginal coefficients corroborate the patterns identified by the interaction terms (for large companies, the coefficients could not be computed). In the case of foreign ownership, the marginal coefficients add to the interactions' analysis, as they reveal a statistically significant positive association with

¹² In the pooled regression with size-category interaction terms, size-specific marginal coefficients are in levels, measured in the original units of each regressor, representing economic marginal effects rather than relative magnitudes.

productivity within size groups (consistent with the split regressions), even though the interaction terms indicate no statistically significant differences across firm sizes.

As a robustness exercise, all the regressions were re-estimated using labour productivity, defined as output per worker¹³, instead of estimated TFP. The overall results remain largely unchanged (see Tables A3.5, A3.6, A3.7 and A3.8), confirming the consistency of the main relationships.

4.2 Cross-country comparison with Spain

The same set of regressions was estimated using Spanish firm-level data, allowing for a direct comparison between Portugal and Spain to evaluate whether the relationships follow similar patterns in both countries or reveal structural differences in how TFP relates to firm size and other firm characteristics. Spain is recognized as one of Portugal's closest peers in Europe in terms of productivity performance and structural economic characteristics. Both countries share geographic, cultural, and institutional similarities, and their economic development paths have been strongly interconnected over the past decades. Portugal and Spain both joined the European Economic Community (EEC) in 1986, initiating parallel processes of economic integration, structural transformation, and convergence towards European standards. Comparing these two Iberian economies, with a shared regional and institutional context, could, therefore, provide an insightful benchmark for understanding the specific factors behind Portugal's lower productivity levels.

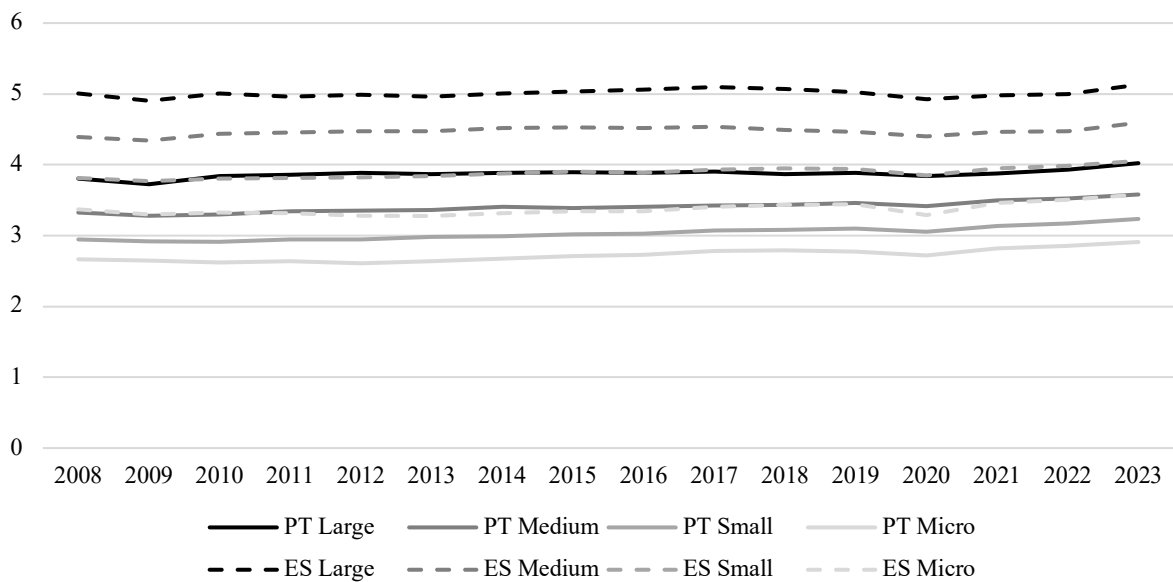
As in Portugal, TFP in Spain rises with firm size, with statistically significant differences between size groups, as confirmed by the pairwise t-tests (see Tables 11 and A2.5). However, when comparing firms within the same size-category, Spanish companies consistently display higher TFP levels than their Portuguese counterparts; these differences are confirmed by cross-country pairwise t-tests (see Table A2.6). Spanish micro firms reach productivity levels similar to those of Portuguese medium-size firms, while Spanish small firms perform on par with Portuguese large firms. Spanish medium and large firms exhibit even higher TFP levels (see Figure 2).

¹³ Labour productivity is measured as gross value-added (GVA) deflated by the gross value-added price index (GVA_{pi}) of each industry, divided by number of employees; as the TFP, it is in logarithmic scale.

Table 11 | Estimated TFP statistics by firm size-category for Portugal and Spain

Portugal sample				Spain sample		
N Total = 398,850				N Total = 724,510		
N Micro = 225,565				N Micro = 463,286		
N Small = 136,036				N Small = 219,159		
N Medium = 32,895				N Medium = 33,842		
N Large = 4,354				N Large = 8,223		
Size category	Mean	Median	SD	Mean	Median	SD
Total	2.90	2.89	0.70	3.60	3.62	0.72
Micro	2.72	2.75	0.71	3.37	3.42	0.70
Small	3.03	3.00	0.58	3.89	3.88	0.51
Medium	3.41	3.37	0.62	4.47	4.46	0.55
Large	3.88	3.80	0.75	5.01	4.95	0.67

Values for estimated TFP and statistics are presented in logarithmic scale (ln TFP).

Figure 2 | Evolution of estimated TFP by firm size-category for Portugal and Spain

Values represent the yearly mean of estimated TFP (ln TFP) by firm size-category for Portugal and Spain.

If firms of comparable size (from the same size-category) systematically show higher productivity in Spain than in Portugal, firm size alone does not fully account for the observed productivity gap between Portuguese and Spanish companies. To explore what may lie beyond firm size, comparing the regressions estimated for Portuguese and Spanish firms can allow to identify patterns that shed some light on which determinants – alongside firm size – contribute to explaining these cross-country differences in firm productivity.

Looking at the pooled base-case regression (see Table 12), the overall pattern of results is similar across countries: all coefficients display the same signs, despite some variations in magnitude and statistical significance.

Table 12 | Pooled base-case regression for Portugal and Spain

		Portugal sample	Spain sample
Dependent variable	TFP		
Control variables	Size	0.2139*** (0.0021)	0.2885*** (0.0014)
	Asset structure	-0.4054*** (0.0108)	-0.4709*** (0.0071)
	Asset intangibility	0.3907* (0.2145)	0.3216*** (0.0654)
	Shareholders' funds ratio	0.1898*** (0.0416)	0.0714** (0.0360)
	Long-term debt ratio	-0.1955*** (0.0426)	-0.1592*** (0.0370)
	Short-term debt ratio	-0.2016*** (0.0418)	-0.3283*** (0.0360)
	Foreign ownership	0.8474*** (0.1496)	0.6804*** (0.1896)
	Constant	2.5898*** (0.0415)	3.3028*** (0.0361)
Observations		398,850	724,510
Adjusted R-squared		0.258	0.406

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

As observed for the Portuguese data, firm size has a statistically significant positive relationship with productivity that is stronger for Spanish firms when comparing with Portuguese ones. Larger coefficients can also be observed for asset structure and short-term debt ratio, both displaying a negative relation with TFP, as in Portugal; as for the remaining determinants – asset intangibility, shareholders' funds ratio, long-term debt ratio and foreign ownership – their association with productivity is weaker when comparing with data from Portuguese firms. It is also noteworthy that the explanatory power of this regression is higher for Spanish firms.

As in Portugal, the partial R-squared measures indicate that firm size is the variable explaining the largest share of within industry-year productivity variation in Spain (see Table A4.1). As for the relative magnitudes resulting from replicating the regression with standardised variables (see Table A4.2), they display a pattern quite similar to the one observed in Portugal, with size

standing out as the determinant with the strongest (positive) relative association to productivity, followed by asset structure (with a negative coefficient).

The pooled size-category regression (see Table 13) for the individual country samples does not provide substantial additional insights into understanding cross-country productivity differences, as its conclusions just reinforce those obtained in the pooled base-case regression.

Table 13 | Pooled size-category regression for Portugal and Spain

		Portugal sample	Spain sample
Dependent variable	TFP		
Size-category coefficients (vs. Micro)	Micro (baseline)	–	–
	Small	0.3629*** (0.0045)	0.4847*** (0.0030)
	Medium	0.7252*** (0.0087)	1.0499*** (0.0070)
	Large	1.0953*** (0.0314)	1.5818*** (0.0182)
Control variables	Asset structure	-0.4017*** (0.0111)	-0.4878*** (0.0075)
	Asset intangibility	0.7205*** (0.2187)	0.5542*** (0.0690)
	Shareholders' funds ratio	0.2033*** (0.0429)	0.1619*** (0.0392)
	Long-term debt ratio	-0.1729*** (0.0439)	-0.0625 (0.0402)
	Short-term debt ratio	-0.1798*** (0.0431)	-0.2606*** (0.0393)
	Foreign ownership	0.8732*** (0.1495)	0.7281*** (0.1610)
	Constant	2.8342*** (0.0426)	3.5671*** (0.0391)
Observations		398,850	724,510
Adjusted R-squared		0.238	0.366

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category (omitted).

So, as a robustness check, this regression was also estimated over a unified dataset, to verify whether the observed patterns in the individual country estimations would remain consistent under a common specification. In fact, most of them do (see Table 14)¹⁴; exception is made for

¹⁴ Although the unified dataset includes the same observations for each country, the coefficients obtained for Portugal and Spain differ slightly from those estimated on each country's standalone sample. This results from

the asset intangibility that, in this regression, assumes a stronger association to productivity in Spain than in Portugal.

Table 14 | Pooled size-category regression over unified sample

		Total sample	Portugal sample	Spain sample
Dependent variable	TFP			
Size-category coefficients (vs. Micro)	Micro	–	–	–
	Small	0.4008*** (0.0029)	0.4584*** (0.0046)	0.4070*** (0.0030)
	Medium	0.7878*** (0.0065)	0.8935*** (0.0089)	0.8688*** (0.0074)
	Large	1.2407*** (0.0199)	1.2805*** (0.0310)	1.2754*** (0.0209)
Control variables	Asset structure	-0.3849*** (0.0069)	-0.3727*** (0.0112)	-0.4885*** (0.0075)
	Asset intangibility	1.3180*** (0.0796)	0.3363** (0.1676)	0.5369*** (0.0765)
	Shareholders' funds ratio	0.3481*** (0.0322)	0.1809*** (0.0435)	0.1478*** (0.0408)
	Long-term debt ratio	-0.0667** (0.0331)	-0.1869*** (0.0447)	-0.0817* (0.0417)
	Short-term debt ratio	-0.0732** (0.0322)	-0.1988*** (0.0437)	-0.2742*** (0.0408)
	Foreign ownership	0.5988*** (0.1391)	0.8997*** (0.1471)	0.7359*** (0.1606)
	Constant	3.1409*** (0.0320)	2.9210*** (0.0432)	3.5236*** (0.0406)
Observations		1,123,360	398,850	724,510
Adjusted R-squared		0.262	0.280	0.311

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category (omitted).

The split regressions by firm size-category (see Table 15) provide more detailed and valuable insights for the cross-country analysis:

- Size exhibits a statistically significant positive relationship with TFP in all size groups both in Portugal and in Spain, with a consistently stronger association with productivity in Spain across all firm size-categories;

differences in how the regression model defines the global variance–covariance structure and minimises the residuals when both countries are estimated jointly.

- Asset intangibility shows a positive relation with productivity for all size categories in Spain, whereas in Portugal it is negative (though not significant) for micro and small companies. Among the groups in which the relationship is statistically significant – medium and large companies for Portugal, and small, medium and large companies in Spain – the coefficient of asset intangibility increases with firm size in both countries; however when comparing between the same groups across countries, the coefficient of asset intangibility is greater for Portuguese medium and large firms than for their Spanish counterparts;
- Long-term and short-term debt ratios contribute more to explaining TFP levels in Spain than in Portugal, particularly among small and medium firms, where both ratios display a negative relationship with productivity;
- Foreign ownership is positively and significantly associated with TFP in both countries for all size groups for which results are available (coefficients are omitted due to collinearity for large firms in Portugal and for medium and large firms in Spain). While in Portugal it is more relevant for micro companies, in Spain this determinant is more important for the productivity of small companies.

For the split regressions, the cross-country comparison based on re-estimated regressions with standardised variables adds limited additional insight to the preceding analysis, as only subtle differences emerge between the relative magnitudes' patterns. In Spain (see Table A4.3), where firms are more productive, patterns are more consistent across size groups than in Portugal, allowing to highlight two main determinants: in Spanish companies, firm size systematically stands out as one of the most relevant variables relating to productivity (positively) in all size-categories – in Portugal, that is not the case in medium-sized companies; alongside with size, in Spanish companies the short-term debt ratio is also consistently among the most relevant determinants of productivity (with a negative coefficient) – for small, medium and large companies. In Portugal, as previously seen, patterns are more heterogeneous across size groups. As in Portugal, the explanatory power of this regression in Spain is greater for larger companies, and overall – with the exception of medium-sized companies – it is higher for Spain than Portugal.

Table 15 | Split regressions by firm size-category for Portugal and Spain

	All	Micro	Small	Medium	Large
Portugal sample					
Dependent variable	TFP				
Control variables					
Size	0.2139*** (0.0021)	0.1479*** (0.0044)	0.2552*** (0.0063)	0.1827*** (0.0155)	0.1404** (0.0581)
Asset structure	-0.4054*** (0.0108)	-0.4247*** (0.0136)	-0.3458*** (0.0163)	-0.5960*** (0.0380)	-0.2145 (0.1338)
Asset intangibility	0.3907* (0.2145)	-0.0507 (0.3047)	-0.3820 (0.2852)	1.6649*** (0.4377)	3.3088** (1.3501)
Shareholders' funds ratio	0.1898*** (0.0416)	0.3870*** (0.0548)	0.0122 (0.0613)	-0.1316 (0.1187)	0.5968 (0.4177)
Long-term debt ratio	-0.1955*** (0.0426)	0.0728 (0.0564)	-0.4095*** (0.0621)	-0.7228*** (0.1234)	-0.1745 (0.4173)
Short-term debt ratio	-0.2016*** (0.0418)	0.0619 (0.0551)	-0.4452*** (0.0617)	-0.7485*** (0.1194)	0.0068 (0.4127)
Foreign ownership	0.8474*** (0.1496)	1.0064*** (0.1501)	0.6232** (0.2664)	0.7775** (0.3775)	—
Constant	2.5898*** (0.0415)	2.4536*** (0.0549)	2.6390*** (0.0630)	3.2405*** (0.1336)	2.7853*** (0.5546)
Observations	398,850	225,564	136,033	32,888	4,319
Adjusted R-squared	0.258	0.121	0.279	0.426	0.504
Spain sample					
Dependent variable	TFP				
Control variables					
Size	0.2885*** (0.0014)	0.2292*** (0.0028)	0.3070*** (0.0042)	0.3037*** (0.0119)	0.2658*** (0.0171)
Asset structure	-0.4709*** (0.0071)	-0.5003*** (0.0088)	-0.4215*** (0.0106)	-0.4107*** (0.0359)	-0.4534*** (0.0812)
Asset intangibility	0.3216*** (0.0654)	0.0138 (0.0943)	0.4288*** (0.0893)	0.6221*** (0.1864)	1.1878*** (0.3202)
Shareholders' funds ratio	0.0714** (0.0360)	0.5073*** (0.0470)	-0.4906*** (0.0706)	-0.4649*** (0.0907)	-0.3902*** (0.1392)
Long-term debt ratio	-0.1592*** (0.0370)	0.3424*** (0.0484)	-0.8081*** (0.0715)	-0.9317*** (0.0995)	-0.8380*** (0.1420)
Short-term debt ratio	-0.3283*** (0.0360)	0.1089** (0.0470)	-0.8774*** (0.0703)	-0.9153*** (0.0918)	-0.7952*** (0.1400)
Foreign ownership	0.6804*** (0.1896)	0.6266*** (0.2160)	0.8114** (0.3156)	—	—
Constant	3.3028*** (0.0361)	2.9335*** (0.0468)	3.7918*** (0.0714)	3.8912*** (0.1097)	4.0250*** (0.1822)
Observations	724,510	463,284	219,151	33,825	8,217
Adjusted R-squared	0.406	0.219	0.350	0.325	0.519

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership for large companies (and medium in Spain) was omitted due to collinearity.

Regarding the results of the pooled regression with size-category interaction terms (see Table 16) the major differences between Portugal and Spain rely on the behaviour of the interaction terms for asset intangibility and for long- and short-term debt ratios; the results on the shareholders' funds ratio are also noteworthy:

- Asset intangibility interaction terms in Spanish companies do not present a regular, increasing pattern, as they do for Portuguese companies: while in Portugal these differentials are incremental with firm size and become particularly relevant for medium and large firms, in Spain the differential coefficients for small, medium and large firms (relative to micro firms) decline in magnitude with firm size and even lose statistical significance for larger firms;
- Long-term and short-term debt ratios display negative interaction terms for all firm size-categories in relation to micro companies in both countries, but while in Portugal the differentials become increasingly negative with firm size, for Spanish companies they weaken, being stronger for small companies than for medium and large companies;
- Shareholders' funds ratio exhibit a pattern that is similar to the one described above for the debt ratios, by having a statistically significant relationship with TFP that is positive for micro companies, with negative interaction terms for all other group sizes. This behaviour is observed in both countries for these three determinants related with capital structure and financing decisions.

The larger size-category coefficients estimated for Spain in comparison with Portugal indicate that productivity differentials between firm size-categories are more pronounced in Spain, suggesting that firm size plays a stronger role in explaining productivity variation in Spanish firms than in Portuguese ones, reinforcing the evidence from the previous regressions regarding the role of firm size.

The size-category marginal coefficients from this regression were also computed for Spain (see Table A4.4). Although these estimates add limited additional insight – given that marginal coefficients could not be separately identified for medium-sized and large firms – it is worth noting that, for most variables, particularly those discussed above, the marginal coefficients for micro and small firms are larger in Spain than in Portugal. This indicates stronger marginal associations between these determinants and productivity for Spanish micro and small firms, which are, on average, more productive than their Portuguese counterparts.

Table 16 | Pooled regression with size-category interaction terms for Portugal and Spain

		Micro (baseline)	x Small	x Medium	x Large
Portugal sample					
Dependent variable	TFP				
Control variables	Asset structure	-0.4714*** (0.0140)	0.2090*** (0.0206)	0.0752* (0.0437)	0.6015*** (0.1704)
	Asset intangibility	-0.1461 (0.3145)	0.6459 (0.4198)	2.7960*** (0.6074)	4.8217*** (1.6056)
	Shareholders' funds ratio	0.4394*** (0.0562)	-0.5532*** (0.0866)	-0.4988*** (0.1474)	-1.0423* (0.6288)
	Long-term debt ratio	0.1503*** (0.0577)	-0.7425*** (0.0881)	-0.9093*** (0.1539)	-1.6541*** (0.6270)
	Short-term debt ratio	0.1412** (0.0564)	-0.7499*** (0.0870)	-0.8686*** (0.1482)	-1.2470** (0.6261)
	Foreign ownership	1.0333*** (0.1458)	-0.3692 (0.3041)	-0.2821 (0.4015)	—
	Constant	2.5721*** (0.0559)			
Size-category coefficients (vs. Micro)	Small	0.9599*** (0.0857)			
	Medium	1.3954*** (0.1450)			
	Large	2.0332*** (0.6159)			
Observations		398,850			
Adjusted R-squared		0.242			
Spain sample					
Dependent variable	TFP				
Control variables	Asset structure	-0.5365*** (0.0093)	0.1513*** (0.0141)	0.3281*** (0.0386)	0.3262*** (0.1017)
	Asset intangibility	0.2548** (0.1004)	0.6385*** (0.1361)	0.3958* (0.2210)	0.3563 (0.4523)
	Shareholders' funds ratio	0.6579*** (0.0505)	-1.4245*** (0.0940)	-1.1536*** (0.1053)	-0.8807*** (0.1580)
	Long-term debt ratio	0.5009*** (0.0521)	-1.6186*** (0.0957)	-1.5198*** (0.1137)	-1.1180*** (0.1687)
	Short-term debt ratio	0.2443*** (0.0506)	-1.4381*** (0.0938)	-1.2165*** (0.1065)	-0.8918*** (0.1545)
	Foreign ownership	0.6971*** (0.1873)	0.0940 (0.3631)	—	—
	Constant	3.0776*** (0.0504)			
Size-category coefficients (vs. Micro)	Small	1.8801*** (0.0934)			
	Medium	2.1518*** (0.1023)			
	Large	2.3719*** (0.1388)			
Observations		724,510			
Adjusted R-squared		0.368			

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category.

Foreign ownership for large companies (and medium in Spain) was omitted due to collinearity.

4.3 Within-firm productivity variation

The regressions previously presented for Portugal and Spain were specified with industry-year fixed-effects, in order to control for common shocks affecting firms operating in the same industry in a given year, while preserving cross-firm heterogeneity in productivity levels. These specifications were adopted to allow an analysis of pooled variation in productivity levels – combining cross-sectional and within-firm variation – across firms and size groups, rather than purely isolating within-firm dynamics. Given that the main focus of this work is the relation between firm size and productivity, and that size effects are predominantly cross-sectional, analysing pooled variation is appropriate. Moreover, TFP differences across firms are largely structural and persistent; therefore, within-firm variation alone is not sufficient to explain why productivity differs systematically across firms or across countries.

Nonetheless, a brief analysis of within-firm variation provides additional insight by offering a complementary perspective on the extent to which productivity variation originates from changes within firms over time. This is achieved by replicating the pooled base-case specification while replacing the industry-year fixed-effects with firm and year fixed-effects (see Table 17). In contrast to the previous regressions, which capture long-run cross-firm differences, the firm fixed-effects specification highlights short-run within-firm dynamics, leading to the following observations, common to both countries:

- Size coefficient becomes substantially smaller, indicating that the size–productivity relationship is primarily driven by persistent cross-firm differences rather than short-run within-firm size adjustments;
- Asset intangibility coefficient becomes negative, suggesting that, while long-run cross-firm differences in intangible assets are associated with higher productivity, short-run within-firm intangible investment may involve adjustment costs that temporarily depress productivity;
- Long- and short-term debt ratios become positive, indicating that, although structural differences in leverage across firms may be negatively associated with productivity – due to misallocation of financial resources or financial frictions – increases in leverage within firms is associated with higher productivity, consistent with debt financing supporting investment in productive activities;
- Foreign ownership becomes omitted, as it exhibits little to no within-firm variation over time and its effect is fully absorbed by firm fixed-effects.

As expected, these regressions present a higher adjusted R-squared, reflecting the importance of persistent firm-specific productivity components that are absorbed by firm fixed-effects, which capture each firm's average productivity level.

Overall, the firm fixed-effects results confirm that the main productivity relationships identified in the baseline regressions are largely driven by persistent cross-firm differences, while within-firm variation over time plays a more limited role. This reinforces the relevance of the baseline industry-year fixed-effects specification for analysing productivity gaps across firms and countries.

Table 17 | Pooled base-case regression with firm fixed-effects for Portugal and Spain

		Portugal sample	Spain sample
Dependent variable	TFP		
Control variables	Size	0.0114** (0.0047)	0.0113*** (0.0029)
	Asset structure	-0.4731*** (0.0101)	-0.4891*** (0.0084)
	Asset intangibility	-0.4909*** (0.1757)	-0.2762*** (0.0694)
	Shareholders' funds ratio	0.4609*** (0.0305)	0.4307*** (0.0330)
	Long-term debt ratio	0.0772** (0.0306)	0.1754*** (0.0333)
	Short-term debt ratio	0.0391 (0.0302)	0.0997*** (0.0327)
	Foreign ownership	—	—
	Constant	2.7998*** (0.0314)	3.4757*** (0.0328)
Observations		391,918	700,942
Adjusted R-squared		0.630	0.730

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

5. Conclusion and discussion

Firm size is frequently identified as one of the main determinants of productivity. Many authors have analysed and documented a positive relationship between size and productivity (Hsieh and Klenow, 2009; Bento and Restuccia, 2017; Gopinath *et al.*, 2017, Ayerst *et al.*, 2024); this relationship is also well established for Portugal (Braguinsky *et al.*, 2011; Reis, 2013; Alves,

2017; Lourenço *et al.*, 2022). Bigger size is related with more productive firms. The data used in this work also reflects that relationship. It is evident that average TFP in Portugal is influenced by the firm-size distribution and the prevalence of micro companies, those with lowest TFP levels. Despite size exhibiting, in these models and among the studied determinants, an important role in explaining productivity variation, one of the key conclusions of this analysis is that size alone does not fully explain productivity differences.

This conclusion becomes evident by the comparison of TFP levels between Portuguese and Spanish firms of similar size: if firms of the same size-category consistently exhibit substantially higher TFP levels in Spain, factors beyond firm size must be contributing to these productivity differences. Interestingly, size plays a more prominent role in explaining productivity variation across all firm size-categories in Spain than it does in Portugal. Thus, while firm size remains an important determinant, it is not sufficient on its own to account for the Portuguese productivity gap.

The purpose of the cross-country comparison was to identify patterns in Spanish firms – regarding productivity determinants – that would differ from those of Portuguese companies and thus help explain their relatively higher productivity. The pooled regressions were not particularly revealing, as they displayed broadly similar relationships for both countries. To shed further light on this issue, it was therefore important to examine the results of the split regressions by firm size-category and of the regressions with size-category interaction terms, in order to better understand how the determinants of productivity differ across firm sizes within each country and across countries. This is particularly relevant because, as already noted, pooled results are conditioned by the firm-size distribution, with micro firms prevailing in both countries. Rather than revealing marked contrasts, the patterns observed for Spanish firms were broadly similar to those of Portuguese firms within the same size-categories, though with subtle differences that allowed to emphasize the role of specific determinants in explaining productivity differences.

Starting with the results for micro firms, one of the conclusions emerging from the cross-country analysis highlights the relevance of capital structure and financing decisions in this group, since all the variables related to it – shareholders' funds, long-term and short-term debt ratios – exhibited a positive association with productivity only among micro firms. The positive association with productivity in micro companies is observable in both economies, although it is more pronounced for Spanish companies – more productive – than for Portuguese companies. These results are relatable to the evidence found in previous literature emphasizing a higher

relevance of access to finance and leverage for SMEs (than larger companies) in enabling them to improve their TFP (Gomis and Khatiwada, 2017). On the other hand, evidence also indicates that access to finance – particularly to bank lending – is more constrained for European SMEs than for larger companies (European Central Bank, 2025), and that tightening financial conditions further amplifies the productivity gap between MSMEs and larger companies (McKinsey Global Institute, 2024); this may be conditioning the productivity of micro companies as a group, not allowing them to be more productive.

It was possible to draw further insights regarding capital structure and financing decisions: in Portugal, for small and medium firms, debt (both short and long-term) has a significant negative relationship with TFP levels; the relation is more negative for medium than small firms (for large firms it was not possible to reach a definite conclusion on these determinants). In Spain, where productivity is higher, a similar behaviour is observed, but it is even more pronounced. This evidence is not consistent with the positive relation between external finance and productivity documented by some authors (Levine and Warusawitharana, 2014; Gomis and Khatiwada, 2017). This result can be partly associated with the documented misallocation of capital inflows towards less productive firms that both countries experienced in the period following their adhesion to the European Economic Community (Reis, 2013; Gopinath *et al.*, 2017). It is also consistent with firm-level evidence for Portugal showing a negative relationship between debt and performance among SMEs (Serrasqueiro and Nunes, 2008), suggesting that debt overhang and repayment pressure reduce profitability and, likely, the capacity to invest in growth and technology. Interestingly, the within-firm variation analysis added to this discussion by showing that, in the short-term, an increase in a firm's leverage was associated with an increase in productivity.

An intriguing finding of this study is that the proportion of total fixed assets shows a negative relationship with productivity, whereas when isolating intangible fixed assets, the relation becomes positive. This finding concerning intangible assets aligns with the studies that put in evidence the relevance of intangible assets, many times linked with innovation, for productivity growth (Demmou and Franco, 2021, Castelli *et al.*, 2024). In both Portugal and Spain, the larger the firm, the larger the coefficient on asset intangibility, becoming particularly relevant for medium and large companies. Although the above-mentioned productivity determinants also display interesting – sometimes subtle – variations across size categories and between countries, for the pattern it exhibits across size-categories, asset intangibility is the determinant that shows the most consistent and robust association with productivity in the most productive size groups

in both countries, fostering it. This suggests that, among the factors examined, beyond size, asset intangibility may be one of the most relevant determinants in explaining productivity differences. Bearing that in mind, if we consider that MSMEs face increased difficulties in accessing and financing intangible assets, as documented by some authors (Demmou and Franco, 2021; McKinsey Global Institute, 2024), this may be, indeed, one interesting conclusion to follow up upon. A more detailed analysis on the role of intangible assets in firms' productivity could, therefore, represent a promising field for future research.

Another interesting observation concerns the fact that these models have a better fit for larger than for smaller companies, both in Portugal and in Spain, indicating that the explanatory variables account for a greater share of productivity differences among larger firms, whereas for smaller firms, other factors not being captured, may play a more relevant role. This opens the door for future research on additional determinants, namely for the smaller, less productive companies, that could better explain their lower TFP levels. Valuable additional contributions to this work could be obtained by extending the cross-country comparison to countries beyond Spain, especially to European economies with diverse structural characteristics, in an attempt to find patterns on those countries that are more distinct to those of Portugal and Spain (that ended up being broadly similar).

Although relevant conclusions were reached, in several dimensions this analysis is a simplification and involved making assumptions; as such, one should bear in mind that it has limitations. TFP, computed as a residual, includes all components of output not explained by labour and capital inputs; as such, it can capture both technology as well as potential measurement errors (Solow, 1957; Griliches and Mairesse, 1995). In estimating production functions, firms choose their input levels based on expected productivity or profitability, implying an optimization behaviour that creates simultaneity and endogeneity problems. Because of this simultaneity, OLS yields biased productivity estimates. In addition, firm-level productivity estimation may suffer from selection bias, as less productive firms are more likely to exit the market (Griliches and Mairesse, 1995; Olley and Pakes, 1996; Levinsohn and Petrin, 2003; Akerberg *et al.*, 2015). One additional methodological limitation concerns the use of stock variables as proxies for input flows; capital stocks, for instance, may not accurately reflect the true flow of capital services used in production, introducing potential measurement errors in estimated productivity (Griliches and Mairesse, 1995; Akerberg *et al.*, 2015). Finally, focusing the analysis on the manufacturing sector has its advantages (already highlighted), but can also be seen as limiting, given the crescent importance of services in economy.

Despite these limitations, the analysis conducted in this study provides valuable insights into the relationship between firm size and productivity in Portugal. By combining firm-level data with a comprehensive empirical framework, the results were able to cast additional light on how size, and other firm characteristics resulting from corporate-finance decisions, shape productivity outcomes across firms of different sizes. The presented evidence underscores the relevance of this topic for understanding the persistent productivity gap in Portugal, offering deeper insights into why the country continues to lag behind its European peers and highlighting the need for policies and measures that can foster innovation and growth among Portuguese firms. These policies should aim to raise TFP levels across all firm size-categories and to promote firm growth, thereby reducing the prevalence of smaller – and generally less productive – companies within the Portuguese economy.

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Appendixes

Appendix A1: Relevant variables and sample representativeness

Table A1.1 | Relevant variables

Variable	Definition and measurement
Company size-categories	Based on number of employees ¹⁵ : micro < 10, small < 50, medium < 250, large ≥ 250
Output measure (nominal)	Gross value-added ¹⁶ (GVA): Net turnover + Variation in stocks of finished goods and work in progress + Capitalised production + Other income – Cost of goods sold, materials and consumables – External supplies and services – Operating taxes and other operating charges
Output measure (real)	GVA deflated by the gross value-added price index ¹⁷ (GVApi): $GVA_{i,t} / (GVApi_{j,t} / 100)$
Capital input (nominal)	Book value (BV) of fixed assets ¹⁸
Capital input (real)	BV of fixed assets deflated by gross fixed capital formation price index (GFCFpi) ¹⁹ : $BV \text{ of fixed assets}_{i,t} / (GFCFpi_{j,t} / 100)$
Labour input	Number of employees ²⁰
Total assets	BV of assets
Fixed assets	BV of intangible fixed assets + BV of tangible fixed assets
Total liabilities	BV of liabilities
Shareholders' funds	BV of assets – BV of liabilities

¹⁵ The European Commission company size categorization just based on number of employees (instead of also including turnover and total balance sheet) was the chosen criterion, to be more relatable with the company size variable, defined as natural log of number of employees, and also with Eurostat data regarding company-size distribution.

¹⁶ The gross value-added (GVA) has the same definition that is considered in the iBACH dataset (derived variables).

¹⁷ The GVA of each company is deflated by the gross value-added price index (GVApi) (2010 = 100) of each industry, with industry level defined as the first two digits of the NACE Rev. 2 industry code. Source: Eurostat, GDP and main components – Gross value-added and income by industry (NACE Rev. 2) (dataset nama_10_a64_custom_17581491, custom extraction, 24 July 2025).

¹⁸ Following some authors (Gopinath *et al.*, 2017; Ayerst *et al.*, 2024), book value of fixed assets was chosen as capital input proxy.

¹⁹ In order to have all the variables of the production function in real terms, gross fixed capital formation price index (GFCFpi) (2010 = 100) of each industry was used to deflate the book value of fixed assets; for Spanish data, since detailed industry level data was unavailable, the index used is for the whole manufacturing sector. Source: Eurostat, GDP and main components - Capital formation by industry (NACE Rev. 2): GFCF price index (dataset nama_10_a64_p5_custom_17581463, custom extraction, 24 July 2025)

²⁰ Following some authors that use number of employees as labour input (Hsieh and Klenow, 2009; Ayerst *et al.*, 2024).

Table A1.2 | Sample representativeness

Portugal sample				Spain sample			Total sample		
Year	Companies	Employees	Turnover	Companies	Employees	Turnover	Companies	Employees	Turnover
2008	33%	80%	94%	19%	38%	49%	23%	48%	55%
2009	33%	79%	91%	24%	46%	55%	27%	55%	60%
2010	36%	82%	93%	24%	48%	59%	27%	56%	64%
2011	35%	82%	94%	25%	51%	64%	27%	59%	68%
2012	35%	81%	92%	25%	53%	67%	28%	61%	71%
2013	35%	82%	93%	26%	55%	67%	29%	62%	71%
2014	35%	83%	93%	28%	58%	66%	30%	65%	70%
2015	36%	83%	94%	28%	59%	71%	31%	66%	74%
2016	36%	85%	94%	29%	57%	69%	31%	64%	73%
2017	37%	85%	95%	28%	55%	68%	30%	63%	72%
2018	37%	86%	96%	28%	57%	68%	31%	65%	72%
2019	38%	86%	96%	29%	57%	67%	31%	65%	72%
2020	38%	86%	90%	28%	55%	64%	31%	63%	68%
2021	38%	86%	96%	26%	54%	63%	29%	63%	68%
2022	37%	86%	97%	27%	57%	64%	30%	65%	69%
2023	37%	86%	95%	21%	(n/a)	53%	26%	(n/a)	60%

Comparison between sample data and Eurostat data. Source: Eurostat, Business Structural Statistics – Annual enterprise statistics by size class (NACE Rev. 2, 2005–2020) (dataset sbs_sc_sca_r2_custom_17532800, custom extraction, 18 July 2025); Business Structural Statistics – Enterprise statistics by size class (NACE Rev. 2, from 2021 onwards) (dataset sbs_sc_ovw_custom_17532834, custom extraction, 18 July 2025).

Table A1.3 | Company-size distribution

	Observations	Companies	Micro	Small	Medium	Large
Portugal sample	398,850	52,435	65.8%	28.0%	5.6%	0.6%
Eurostat			81.9%	14.5%	3.2%	0.4%
Spain sample	724,510	121,365	68.8%	26.2%	4.2%	0.8%
Eurostat			82.5%	14.3%	2.6%	0.5%
Total sample	1,123,360	173,800	68.0%	26.6%	4.6%	0.7%
Eurostat			82.4%	14.4%	2.8%	0.5%

Comparison between sample data and Eurostat data. Source: Eurostat, Business Structural Statistics – Annual enterprise statistics by size class (NACE Rev. 2, 2005–2020) (dataset sbs_sc_sca_r2_custom_17532800, custom extraction, 18 July 2025); Business Structural Statistics – Enterprise statistics by size class (NACE Rev. 2, from 2021 onwards) (dataset sbs_sc_ovw_custom_17532834, custom extraction, 18 July 2025).

Appendix A2: TFP estimation and statistics

Table A2.1 | Summary statistics on production function estimated elasticities

	Portugal sample N = 398,850			Spain sample N = 724,510			Total sample N = 1,123,360		
Variable	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Sum of betas	0.89	0.90	0.06	0.80	0.81	0.04	0.84	0.82	0.07

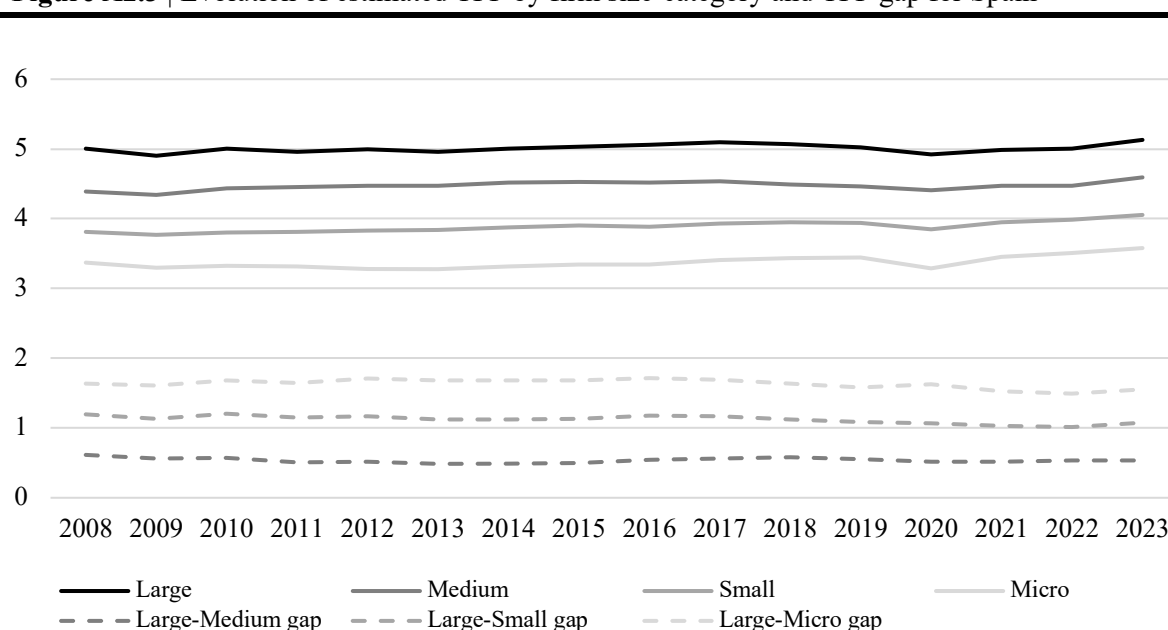
Sum of betas is computed as the sum of the estimated industry elasticities for capital and labour.

Table A2.2 | Estimated TFP statistics by firm size-category

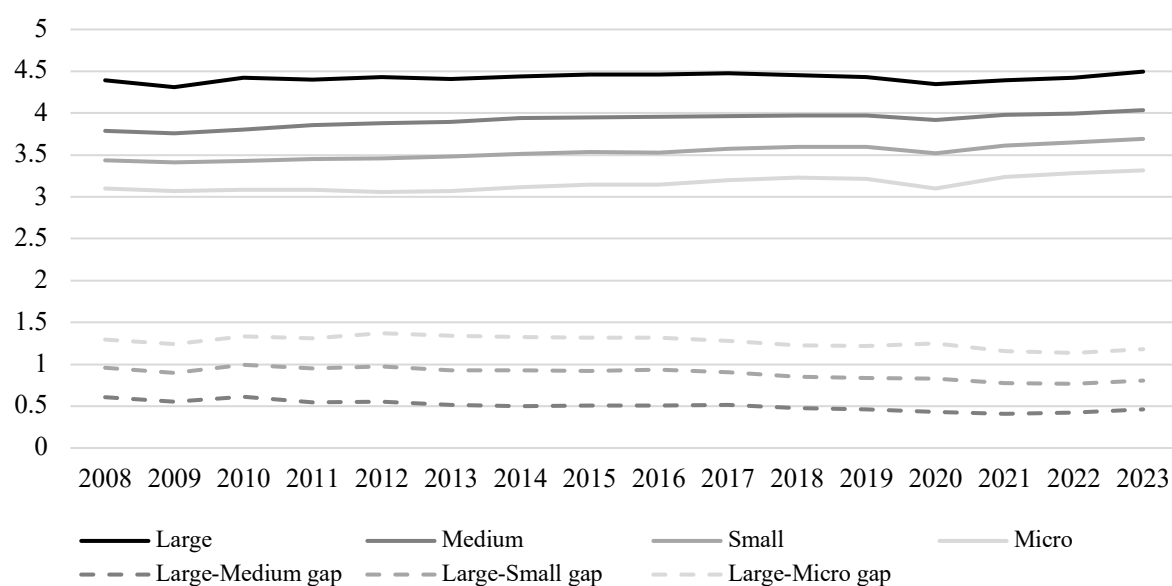
	Portugal sample N Total = 398,850 N Micro = 225,565 N Small = 136,036 N Medium = 32,895 N Large = 4,354			Spain sample N Total = 724,510 N Micro = 463,286 N Small = 219,159 N Medium = 33,842 N Large = 8,223			Total sample N Total = 1,123,360 N Micro = 688,851 N Small = 355,195 N Medium = 66,737 N Large = 12,577		
Size category	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Total	2.90	2.89	0.70	3.60	3.62	0.72	3.33	3.36	0.75
Micro	2.72	2.75	0.71	3.37	3.42	0.70	3.15	3.19	0.74
Small	3.03	3.00	0.58	3.89	3.88	0.51	3.53	3.54	0.61
Medium	3.41	3.37	0.62	4.47	4.46	0.55	3.92	3.93	0.68
Large	3.88	3.80	0.75	5.01	4.95	0.67	4.42	4.43	0.76

Values for estimated TFP and statistics are presented in logarithmic scale (ln TFP).

Figure A2.3 | Evolution of estimated TFP by firm size-category and TFP gap for Spain



Values represent the yearly mean of estimated TFP (ln TFP) by firm size-category for Spain.

Figure A2.4 | Evolution of estimated TFP by firm size-category and TFP gap for Total sample

Values represent the yearly mean of estimated TFP (ln TFP) by firm size-category for Total sample.

Table A2.5 | Pairwise t-test results

	Portugal sample			Spain sample			Total sample		
Groups (1 vs 2)	Mean 1	Mean 2	tstat	Mean 1	Mean 2	tstat	Mean 1	Mean 2	tstat
Micro vs Small	2.72	3.03	-134.52***	3.37	3.89	-308.18***	3.15	3.53	-260.71***
Micro vs Medium	2.72	3.41	-164.99***	3.37	4.47	-284.57***	3.15	3.92	-258.10***
Micro vs Large	2.72	3.88	-105.23***	3.37	5.01	-211.33***	3.15	4.42	-189.94***
Small vs Medium	3.03	3.41	-104.48***	3.89	4.47	-194.42***	3.53	3.92	-149.70***
Small vs Large	3.03	3.88	-93.71***	3.89	5.01	-192.67***	3.53	4.42	-159.03***
Medium vs Large	3.41	3.88	-45.09***	4.47	5.01	-75.41***	3.92	4.42	-74.41***

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Table A2.6 | Cross-country pairwise t-test results

Cross-country comparison	Mean Portugal	Mean Spain	tstat
Micro Portugal vs Micro Spain	2.80	3.33	-289.97***
Small Portugal vs Small Spain	3.18	3.78	-306.80***
Medium Portugal vs Medium Spain	3.60	4.27	-139.65***
Large Portugal vs Large Spain	4.11	4.74	-47.38***

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Appendix A3: Regressions on Portuguese data

Table A3.1 | Pooled base-case regression for Portugal with partial R-squared

Dependent variable	TFP	
Control variables	Size	0.2139*** (0.0021)
	Asset structure	-0.4054*** (0.0108)
	Asset intangibility	0.3907* (0.2145)
	Shareholders' funds ratio	0.1898*** (0.0416)
	Long-term debt ratio	-0.1955*** (0.0426)
	Short-term debt ratio	-0.2016*** (0.0418)
	Foreign ownership	0.8474*** (0.1496)
	Constant	2.5898*** (0.0415)
Observations		398,850
Adjusted R-squared		0.258
<u>Additional diagnostics:</u>		
Within R-squared		0.1873
Partial R-squared	Size	0.1554
	Asset structure	0.0182
	Asset intangibility	0.0001
	Shareholders' funds ratio	0.0002
	Long-term debt ratio	0.0002
	Short-term debt ratio	0.0002
	Foreign ownership	0.0018

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Partial R-squared is based on Within R-squared.

Table A3.2 | Pooled base-case regression for Portugal with standardised variables

Dependent variable	TFP	
Control variables	Size	0.3885*** (0.0038)
	Asset structure	-0.1288*** (0.0034)
	Asset intangibility	0.0061* (0.0033)
	Shareholders' funds ratio	0.0663*** (0.0145)
	Long-term debt ratio	-0.0543*** (0.0118)
	Short-term debt ratio	-0.0687*** (0.0143)
	Foreign ownership	1.2027*** (0.2123)
	Constant	-0.0011 (0.0031)
Observations	398,850	
Adjusted R-squared	0.258	

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership was not standardised, since it is a dummy variable (discrete).

Table A3.3 | Split regressions by firm size-category for Portugal with standardised variables

	All	Micro	Small	Medium	Large
Dependent variable	TFP				
Control variables					
Size	0.3885*** (0.0038)	0.1400*** (0.0042)	0.2025*** (0.0050)	0.1264*** (0.0107)	0.0953** (0.0394)
Asset structure	-0.1288*** (0.0034)	-0.1383*** (0.0044)	-0.1274*** (0.0060)	-0.1864*** (0.0119)	-0.0516 (0.0322)
Asset intangibility	0.0061* (0.0033)	-0.0007 (0.0040)	-0.0077 (0.0057)	0.0397*** (0.0104)	0.0875** (0.0357)
Shareholders' funds ratio	0.0663*** (0.0145)	0.1407*** (0.0199)	0.0048 (0.0243)	-0.0458 (0.0413)	0.1673 (0.1171)
Long-term debt ratio	-0.0543*** (0.0118)	0.0215 (0.0167)	-0.1257*** (0.0191)	-0.1756*** (0.0300)	-0.0357 (0.0854)
Short-term debt ratio	-0.0687*** (0.0143)	0.0223 (0.0198)	-0.1701*** (0.0236)	-0.2317*** (0.0370)	0.0017 (0.1015)
Foreign ownership	1.2027*** (0.2123)	1.4088*** (0.2100)	1.0773** (0.4605)	1.2443** (0.6042)	—
Constant	-0.0011 (0.0031)	-0.0013 (0.0040)	-0.0011 (0.0054)	-0.0001 (0.0108)	-0.0199 (0.0298)
Observations	398,850	225,564	136,033	32,888	4,319
Adjusted R-squared	0.258	0.121	0.279	0.426	0.504

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership for large companies was omitted due to collinearity.

Foreign ownership was not standardised, since it is a dummy variable (discrete).

Table A3.4 | Pooled reg. with size-category interaction terms for Portugal: marginal coefficients

	Micro (baseline)	x Small	x Medium	x Large
Dependent variable	TFP			
Control variables				
Asset structure	-0.4714*** (0.0140)	0.2090*** (0.0206)	0.0752* (0.0437)	0.6015*** (0.1704)
Asset intangibility	-0.1461 (0.3145)	0.6459 (0.4198)	2.7960*** (0.6074)	4.8217*** (1.6056)
Shareholders' funds ratio	0.4394*** (0.0562)	-0.5532*** (0.0866)	-0.4988*** (0.1474)	-1.0423* (0.6288)
Long-term debt ratio	0.1503*** (0.0577)	-0.7425*** (0.0881)	-0.9093*** (0.1539)	-1.6541*** (0.6270)
Short-term debt ratio	0.1412** (0.0564)	-0.7499*** (0.0870)	-0.8686*** (0.1482)	-1.2470** (0.6261)
Foreign ownership	1.0333*** (0.1458)	-0.3692 (0.3041)	-0.2821 (0.4015)	—
Constant	2.5721*** (0.0559)			
Size-category coefficients (vs. Micro)				
Small	0.9599*** (0.0857)			
Medium	1.3954*** (0.1450)			
Large	2.0332*** (0.6159)			
Observations	398,850			
Adjusted R-squared	0.242			
Marginal coefficients				
Asset structure	-0.4714*** (0.0140)	-0.2624*** (0.0163)	-0.3962*** (0.0416)	—
Asset intangibility	-0.1461 (0.3145)	0.4998* (0.2980)	2.6499*** (0.5266)	—
Shareholders' funds ratio	0.4394*** (0.0562)	-0.1138* (0.0665)	-0.0594 (0.1362)	—
Long-term debt ratio	0.1503*** (0.0577)	-0.5922*** (0.0672)	-0.7591*** (0.1426)	—
Short-term debt ratio	0.1412** (0.0564)	-0.6088*** (0.0668)	-0.7275*** (0.1369)	—
Foreign ownership	1.0333*** (0.1458)	0.6641** (0.2764)	0.7512** (0.3743)	—

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category.

Foreign ownership interaction-term for large companies was omitted due to collinearity.

Marginal coefficients for large firms could not be separately identified due to limited within-industry-year variation.

Table A3.5 | Pooled base-case regression for TFP and labour productivity for Portugal

Dependent variable		TFP	Labour productivity
Control variables	Size	0.2139*** (0.0021)	0.1211*** (0.0022)
	Asset structure	-0.4054*** (0.0108)	0.0043 (0.0115)
	Asset intangibility	0.3907* (0.2145)	0.9307*** (0.2281)
	Shareholders' funds ratio	0.1898*** (0.0416)	0.1277*** (0.0441)
	Long-term debt ratio	-0.1955*** (0.0426)	-0.2774*** (0.0451)
	Short-term debt ratio	-0.2016*** (0.0418)	-0.3034*** (0.0443)
	Foreign ownership	0.8474*** (0.1496)	0.8217*** (0.1527)
	Constant	2.5898*** (0.0415)	2.7167*** (0.0440)
Observations		398,850	398,850
Adjusted R-squared		0.258	0.187

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Table A3.6 | Pooled size-category regression for TFP and labour productivity for Portugal

Dependent variable		TFP	Labour productivity
Size-category coefficients (vs. Micro)	Micro (baseline)	–	–
	Small	0.3629*** (0.0045)	0.2090*** (0.0048)
	Medium	0.7252*** (0.0087)	0.4566*** (0.0089)
	Large	1.0953*** (0.0314)	0.6812*** (0.0283)
Control variables	Asset structure	-0.4017*** (0.0111)	0.0022 (0.0116)
	Asset intangibility	0.7205*** (0.2187)	0.9816*** (0.2268)
	Shareholders' funds ratio	0.2033*** (0.0429)	0.1485*** (0.0444)
	Long-term debt ratio	-0.1729*** (0.0439)	-0.2467*** (0.0454)
	Short-term debt ratio	-0.1798*** (0.0431)	-0.2772*** (0.0446)
	Foreign ownership	0.8732*** (0.1495)	0.8380*** (0.1525)
	Constant	2.8342*** (0.0426)	2.8368*** (0.0440)
Observations		398,850	398,850
Adjusted R-squared		0.238	0.186

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category (omitted).

Table A3.7 | Split regressions by firm size-category for TFP and labour productivity for Portugal

	All	Micro	Small	Medium	Large
Dependent variable	TFP				
Control variables					
Size	0.2139*** (0.0021)	0.1479*** (0.0044)	0.2552*** (0.0063)	0.1827*** (0.0155)	0.1404** (0.0581)
Asset structure	-0.4054*** (0.0108)	-0.4247*** (0.0136)	-0.3458*** (0.0163)	-0.5960*** (0.0380)	-0.2145 (0.1338)
Asset intangibility	0.3907* (0.2145)	-0.0507 (0.3047)	-0.3820 (0.2852)	1.6649*** (0.4377)	3.3088** (1.3501)
Shareholders' funds ratio	0.1898*** (0.0416)	0.3870*** (0.0548)	0.0122 (0.0613)	-0.1316 (0.1187)	0.5968 (0.4177)
Long-term debt ratio	-0.1955*** (0.0426)	0.0728 (0.0564)	-0.4095*** (0.0621)	-0.7228*** (0.1234)	-0.1745 (0.4173)
Short-term debt ratio	-0.2016*** (0.0418)	0.0619 (0.0551)	-0.4452*** (0.0617)	-0.7485*** (0.1194)	0.0068 (0.4127)
Foreign ownership	0.8474*** (0.1496)	1.0064*** (0.1501)	0.6232** (0.2664)	0.7775** (0.3775)	—
Constant	2.5898*** (0.0415)	2.4536*** (0.0549)	2.6390*** (0.0630)	3.2405*** (0.1336)	2.7853*** (0.5546)
Observations	398,850	225,564	136,033	32,888	4,319
Adjusted R-squared	0.258	0.121	0.279	0.426	0.504

Dependent variable	Labour productivity				
Control variables					
Size	0.1211*** (0.0022)	0.0273*** (0.0047)	0.1822*** (0.0069)	0.0980*** (0.0170)	0.0393 (0.0629)
Asset structure	0.0043 (0.0115)	-0.0055 (0.0146)	0.0294* (0.0178)	-0.3203*** (0.0423)	0.0427 (0.1497)
Asset intangibility	0.9307*** (0.2281)	0.4594 (0.3348)	0.0182 (0.3087)	2.1928*** (0.4756)	3.9705*** (1.5030)
Shareholders' funds ratio	0.1277*** (0.0441)	0.3598*** (0.0585)	-0.0241 (0.0649)	-0.2137* (0.1286)	0.6343 (0.4440)
Long-term debt ratio	-0.2774*** (0.0451)	0.0461 (0.0602)	-0.4696*** (0.0658)	-0.7968*** (0.1336)	-0.1131 (0.4445)
Short-term debt ratio	-0.3034*** (0.0443)	0.0202 (0.0588)	-0.5315*** (0.0654)	-0.9109*** (0.1293)	-0.0206 (0.4413)
Foreign ownership	0.8217*** (0.1527)	1.0179*** (0.1513)	0.5866** (0.2703)	0.7024** (0.3472)	—
Constant	2.7167*** (0.0440)	2.5664*** (0.0586)	2.6892*** (0.0668)	3.4278*** (0.1455)	2.9717*** (0.6058)
Observations	398,850	225,564	136,033	32,888	4,319
Adjusted R-squared	0.187	0.094	0.286	0.373	0.386

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership for large companies was omitted due to collinearity.

Table A3.8 | Pooled reg. with size-category interaction terms for TFP and labour prod. for Portugal

		Micro (baseline)	x Small	x Medium	x Large
Dependent variable	TFP				
Control variables	Asset structure	-0.4714*** (0.0140)	0.2090*** (0.0206)	0.0752* (0.0437)	0.6015*** (0.1704)
	Asset intangibility	-0.1461 (0.3145)	0.6459 (0.4198)	2.7960*** (0.6074)	4.8217*** (1.6056)
	Shareholders' funds ratio	0.4394*** (0.0562)	-0.5532*** (0.0866)	-0.4988*** (0.1474)	-1.0423* (0.6288)
	Long-term debt ratio	0.1503*** (0.0577)	-0.7425*** (0.0881)	-0.9093*** (0.1539)	-1.6541*** (0.6270)
	Short-term debt ratio	0.1412** (0.0564)	-0.7499*** (0.0870)	-0.8686*** (0.1482)	-1.2470** (0.6261)
	Foreign ownership	1.0333*** (0.1458)	-0.3692 (0.3041)	-0.2821 (0.4015)	—
	Constant	2.5721*** (0.0559)			
Size-category coefficients (vs. Micro)	Small	0.9599*** (0.0857)			
	Medium	1.3954*** (0.1450)			
	Large	2.0332*** (0.6159)			
Observations		398,850			
Adjusted R-squared		0.242			
Dependent variable	Labour productivity				
Control variables	Asset structure	-0.0245* (0.0145)	0.1107*** (0.0217)	-0.1248*** (0.0444)	0.2805* (0.1598)
	Asset intangibility	0.3507 (0.3361)	0.2387 (0.4456)	2.5763*** (0.5976)	4.9245*** (1.6081)
	Shareholders' funds ratio	0.3642*** (0.0587)	-0.4964*** (0.0898)	-0.5801*** (0.1474)	-0.2525 (0.4971)
	Long-term debt ratio	0.0531 (0.0604)	-0.6801*** (0.0915)	-0.9226*** (0.1533)	-0.8076 (0.4945)
	Short-term debt ratio	0.0315 (0.0590)	-0.7075*** (0.0904)	-1.0132*** (0.1478)	-0.6230 (0.4906)
	Foreign ownership	1.0126*** (0.1508)	-0.3919 (0.3043)	-0.4146 (0.3927)	—
	Constant	2.5802*** (0.0585)			
Size-category coefficients (vs. Micro)	Small	0.7844*** (0.0889)			
	Medium	1.2842*** (0.1447)			
	Large	1.0093** (0.4842)			
Observations		398,850			
Adjusted R-squared		0.190			

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category.

Appendix A4: Regressions on Spanish data

Table A4.1 | Pooled base-case regression for Spain with partial R-squared

Dependent variable	TFP	
Control variables	Size	0.2885*** (0.0014)
	Asset structure	-0.4709*** (0.0071)
	Asset intangibility	0.3216*** (0.0654)
	Shareholders' funds ratio	0.0714** (0.0360)
	Long-term debt ratio	-0.1592*** (0.0370)
	Short-term debt ratio	-0.3283*** (0.0360)
	Foreign ownership	0.6804*** (0.1896)
	Constant	3.3028*** (0.0361)
Observations		724,510
Adjusted R-squared		0.406
<u>Additional diagnostics:</u>		
Within R-squared		0.3185
Partial R-squared	Size	0.2735
	Asset structure	0.0280
	Asset intangibility	0.0001
	Shareholders' funds ratio	0.0000
	Long-term debt ratio	0.0001
	Short-term debt ratio	0.0004
	Foreign ownership	0.0000

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Partial R-squared is based on Within R-squared.

Table A4.2 | Pooled base-case regression for Spain with standardised variables

Dependent variable	TFP	
Control variables	Size	0.4952*** (0.0024)
	Asset structure	-0.1479*** (0.0022)
	Asset intangibility	0.0089*** (0.0018)
	Shareholders' funds ratio	0.0259** (0.0130)
	Long-term debt ratio	-0.0398*** (0.0093)
	Short-term debt ratio	-0.1067*** (0.0117)
	Foreign ownership	0.9386*** (0.2616)
	Constant	0.0000 (0.0020)
Observations	724,510	
Adjusted R-squared	0.406	

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership was not standardised, since it is a dummy variable (discrete).

Table A4.3 | Split regressions by firm size-category for Spain with standardised variables

	All	Micro	Small	Medium	Large
Dependent variable	TFP				
Control variables					
Size	0.4952*** (0.0024)	0.2259*** (0.0028)	0.2694*** (0.0037)	0.2468*** (0.0097)	0.2897*** (0.0186)
Asset structure	-0.1479*** (0.0022)	-0.1706*** (0.0030)	-0.1748*** (0.0044)	-0.1420*** (0.0124)	-0.1237*** (0.0222)
Asset intangibility	0.0089*** (0.0018)	0.0004 (0.0024)	0.0178*** (0.0037)	0.0319*** (0.0096)	0.0625*** (0.0169)
Shareholders' funds ratio	0.0259** (0.0130)	0.1974*** (0.0183)	-0.2367*** (0.0341)	-0.1928*** (0.0376)	-0.1263*** (0.0451)
Long-term debt ratio	-0.0398*** (0.0093)	0.0947*** (0.0134)	-0.2556*** (0.0226)	-0.2395*** (0.0256)	-0.1897*** (0.0321)
Short-term debt ratio	-0.1067*** (0.0117)	0.0391** (0.0169)	-0.3562*** (0.0285)	-0.3105*** (0.0311)	-0.2183*** (0.0384)
Foreign ownership	0.9386*** (0.2616)	0.8993*** (0.3100)	1.5830** (0.6157)	—	—
Constant	0.0000 (0.0020)	-0.0000 (0.0027)	-0.0001 (0.0039)	-0.0019 (0.0103)	0.0004 (0.0193)
Observations	724,510	463,284	219,151	33,825	8,217
Adjusted R-squared	0.406	0.219	0.350	0.325	0.519

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Foreign ownership for large and medium companies was omitted due to collinearity.

Foreign ownership was not standardised, since it is a dummy variable (discrete).

Table A4.4 | Pooled reg. with size-category interaction terms for Spain: marginal coefficients

	Micro (baseline)	x Small	x Medium	x Large
Dependent variable	TFP			
Control variables				
Asset structure	-0.5365*** (0.0093)	0.1513*** (0.0141)	0.3281*** (0.0386)	0.3262*** (0.1017)
Asset intangibility	0.2548** (0.1004)	0.6385*** (0.1361)	0.3958* (0.2210)	0.3563 (0.4523)
Shareholders' funds ratio	0.6579*** (0.0505)	-1.4245*** (0.0940)	-1.1536*** (0.1053)	-0.8807*** (0.1580)
Long-term debt ratio	0.5009*** (0.0521)	-1.6186*** (0.0957)	-1.5198*** (0.1137)	-1.1180*** (0.1687)
Short-term debt ratio	0.2443*** (0.0506)	-1.4381*** (0.0938)	-1.2165*** (0.1065)	-0.8918*** (0.1545)
Foreign ownership	0.6971*** (0.1873)	0.0940 (0.3631)	—	—
Constant	3.0776*** (0.0504)			
Size-category coefficients (vs. Micro)				
Small	1.8801*** (0.0934)			
Medium	2.1518*** (0.1023)			
Large	2.3719*** (0.1388)			
Observations	724,510			
Adjusted R-squared	0.368			
Marginal coefficients				
Asset structure	-0.5365*** (0.0093)	-0.3853*** (0.0111)	—	—
Asset intangibility	0.2548** (0.1004)	0.8933*** (0.0957)	—	—
Shareholders' funds ratio	0.6579*** (0.0505)	-0.7665*** (0.0793)	—	—
Long-term debt ratio	0.5009*** (0.0521)	-1.1177*** (0.0803)	—	—
Short-term debt ratio	0.2443*** (0.0506)	-1.1939*** (0.0790)	—	—
Foreign ownership	0.6971*** (0.1873)	0.7911** (0.3111)	—	—

*** indicates significance at 1% level, ** significance at 5% level and * significance at 10% level.

Standard errors, reported in between brackets, are clustered at the firm level, making them robust to heteroskedasticity and serial correlation within firms over time.

Micro firms are the baseline category.

Foreign ownership interaction-term for large and medium companies was omitted due to collinearity.

Marginal coefficients for large and medium-sized firms could not be separately identified due to limited within-industry-year variation.