



Article

Labour Productivity in European Non-Financial Corporations: The Roles of Country, Sector, and Size

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Abstract

This study aims to investigate the determinants of labour productivity across European non-financial entities using aggregated data from the Bank for the Accounts of Companies Harmonized (BACH) database. Focusing on six European Union countries (Belgium, France, Italy, Portugal, Poland, and Spain). Annual information from 2010 to 2023 is used (the last available year), including three size classes (small, medium-sized and larger entities) per division (two-digit code) by year and by country, totalling 14,188 observations. The combination of sectors and class sizes varies from 191 to 208 by country. It uses gross value added per employee as a proxy for labour productivity. Using a fixed-effects estimator and panel data regression techniques, the analysis reveals that labour productivity explanatory factors, particularly firm size, profitability, financialisation, leverage, and tangibility, have heterogeneous and sometimes contradictory effects across countries, sectors, and size classes. Larger firms generally tend to have higher levels of labour productivity, although this feature is not consistent among countries. Size and profitability more consistently exert a strong positive influence, whereas financialisation and leverage typically show negative or nonlinear effects. The results highlight the structural diversity of the European corporate landscape and challenge the adequacy of one-size-fits-all policy measures, contributing to the literature on productivity and offering further insights to policymakers by integrating cross-sectional, sectoral, and size-specific perspectives on labour efficiency within the EU context.

Keywords: aggregate data; European countries; labour productivity; size effects; sectoral effects



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1. Introduction

Although still a relatively unexplored research area, it has been documented that inefficient labour investment affects firms' productivity, future profitability, and overall performance (Habib et al., 2024). For example, in their assessment of manufacturing firms across 27 European countries, Stundziene and Baliute (2022) show that personnel costs have a positive impact on apparent labour productivity. Their evidence suggests that, contrary to common belief, increases in employee expenses do not necessarily lead to a reduction in profitability. Similarly, Taussig (2017) finds that labour-related expenditures influence firms' operating inflexibility, which in turn affects stock returns.

Literature also provides evidence that firms' fixed cost structures stemming from long-term asset investments are relevant for inventory valuation and future performance, and that investors incorporate these cost structures into earnings forecasts (e.g., [Gupta et al., 2010](#)). Previous evidence indicates that efficient labour investment enhances productivity ([Pelinescu, 2015](#)). Furthermore, labour productivity has been studied in several ways, including labour intensity, labour investment, or income distribution (e.g., [Jung et al., 2014](#); [Towo et al., 2019](#); [Habib et al., 2024](#)), since it is a core factor of production and contributes materially to economic value added ([Habib et al., 2024](#)).

Distinguishing labour effects from capital effects in total factor productivity (TFP) continues to be of central relevance. Advanced European economies, which experienced substantial gains in productivity during the second half of the 20th century, now lag behind the United States (USA) by more than 20 per cent in per capita income. This gap persists despite significant labour, capital, and product market reforms in Europe during the 1990s and 2000s ([Adilbish et al., 2025](#)). Less-developed European countries face even larger disparities. According to [Adilbish et al. \(2025\)](#), the transatlantic gap is primarily attributable to lower hourly labour productivity rather than lower capital intensity, implying that Europe's weaker TFP reflects deeper labour-related inefficiencies, only partly associated with fewer hours worked.

Against this backdrop, understanding the drivers of labour productivity and competitiveness in Europe remains particularly salient. The Draghi Report on EU competitiveness highlights that the EU's productivity gap relative to the USA is mainly due to differences in industry composition, sectoral innovation capacity, and the diffusion of advanced technologies. Whereas the EU retains a strong position in mid-tech industries, it lacks a significant presence in high-growth fields such as Information and Communication Technology (ICT) and large-scale digital services—sectors that have fuelled much of the USA's recent productivity growth ([European Union, 2025](#)). As modern competitiveness depends increasingly on the knowledge and skills embedded in the workforce ([European Union, 2025](#)), investing in human capital has become essential for meeting labour market demands and stimulating productivity growth ([European Commission, 2025](#)). Enhancing human capital may therefore support the revival of productivity dynamics in Europe ([Adilbish et al., 2025](#)).

Although sectoral and country-level heterogeneity in productivity is widely recognised within the European Union, the relationship between firm size and labour productivity also matters significantly, as firm size tends to capture both industry and geographical effects ([Turégano, 2020](#)). Additional contextual factors—such as the educational attainment of employees, research and development intensity, capital-to-labour ratios, and technological progress—likewise play a critical role. [Stundziene and Baliute \(2022\)](#) show that differences in productivity levels can be linked to variations in turnover per employee, which are themselves influenced by industry size. Larger firms can achieve economies of scale, reduce administrative costs, invest more heavily in technology, and allocate resources to personnel who work more efficiently. Similarly, differences in economic development provide a plausible explanation for cross-country productivity disparities.

Given the relevance of labour productivity for Europe's competitiveness ([European Commission, 2025](#); [European Union, 2025](#)), this research investigates whether the determinants of labour productivity vary across countries, sectors, and firm size classes. By focusing on those dimensions and using aggregated data for European non-financial corporations, this study aims to identify the economic and financial characteristics that are individually or jointly associated with labour productivity across sectors of economic activity.

To achieve this, the study uses data from the Bank for the Accounts of Companies Harmonized (BACH) database, which provides harmonised aggregate information for non-

financial firms across industry divisions (two-digit level) according to the Nomenclature Statistique des Activités Économiques (NACE) classification. Three size classes (small, medium-sized, and large enterprises) are analysed in addition to total aggregates by country. Six European countries were selected based on data availability and sample coverage: Belgium (BE), France (FR), Italy (IT), Portugal (PT), Poland (PL), and Spain (ES). Including countries at different stages of economic development enables the comparison of potential divergences and convergences in the determinants of labour productivity.

Understanding the structural drivers of labour productivity has become increasingly urgent as Europe faces demographic pressures, uneven digitalisation, and heterogeneous post-crisis recovery patterns. Therefore, this study provides timely evidence for policymakers as the EU continues to grapple with widening productivity gaps, both internally and relative to global competitors.

This study positions itself at the intersection of productivity analysis, financial structure research, and EU competitiveness debates by offering a comprehensive assessment of labour productivity drivers. By focusing on non-financial corporations, this study addresses a key segment of the European economy whose productivity performance directly influences growth, employment, and investment. The findings show how diverse factors shape productivity across Member States. Therefore, policymakers should adopt targeted strategies that reflect country, sector, and firm-size differences rather than relying solely on broad macroeconomic variables. In this context, it also contributes to the literature by offering new insights into a relatively unexplored role of the determinants of labour productivity since, to the authors' knowledge, this is the first study to examine this measure across Europe using aggregated data with cross-classifications by country, sector, and firm size. Therefore, it advances the literature by moving beyond firm-level datasets and employing a rare cross-classified structure, simultaneously capturing national, sectoral, and size-class heterogeneity.

Apart from this introduction, the paper is organised into four additional sections. Section 2 presents the theoretical background and hypotheses development. Section 3 outlines the materials and methods. Section 4 reports empirical findings. Section 5 discusses the results and summarises the key conclusions.

2. Literature Review

This section is divided into two subsections, with the first providing the theoretical background while the second presents the hypotheses developed.

2.1. Theoretical Background

Productivity has been extensively examined in the literature, both in relation to specific dimensions—such as labour productivity (e.g., [Avarmaa et al., 2013](#); [Towo et al., 2019](#); [Xing et al., 2025](#))—and in more aggregate forms, including green TFP (e.g., [Chen et al., 2025](#); [Li et al., 2025](#)) and TFP (e.g., [Ding et al., 2025](#); [Nakatani, 2024](#); [Tang, 2025](#); [Xiong et al., 2025](#)). Despite the diversity of productivity measures used across studies, the underlying approach commonly involves calculating a ratio between an output indicator and a relevant input used in generating that output.

When evaluating TFP or labour productivity, researchers adopt several proxies. Labour productivity, in particular, is often defined as an entity's performance indicator divided by the number of employees (e.g., [Avarmaa et al., 2013](#); [Xing et al., 2025](#)), by total hours worked (e.g., [OECD, 2024](#); [Turégano, 2020](#)), or by total employees' expenses (e.g., [Athanasoglou et al., 2009](#); [Das & Hoque, 2023](#); [Nakatani, 2024](#); [Towo et al., 2019](#)).

Turning to theoretical foundations, labour productivity research is grounded in agency theory, as established in the seminal work of [Jensen and Meckling \(1976\)](#), further developed

by Fama and Jensen (1983) and Jensen (1986). As noted by Habib et al. (2024), these contributions remain highly relevant, particularly because labour-related decisions are susceptible to agency conflicts. Information asymmetries can generate moral hazard and adverse selection problems (Shleifer & Vishny, 1997), leading managers either to overinvest or underinvest in labour activities. Such inefficiencies may reduce firm profitability, while insufficient monitoring by investors may exacerbate suboptimal labour-related decisions (Jung et al., 2014).

The broader productivity literature is rich and increasingly focused on identifying the determinants of firms' productivity levels, though not always specifically examining labour productivity. Habib et al.'s (2024) extensive review of labour investment determinants reveals that most research in this area has emerged within the past three years. Geographically, the literature is concentrated largely in the United States (38 studies) and China (36 studies). The studies reviewed are grouped into four broad themes: fundamental firm characteristics (including financial reporting quality), corporate governance (internal and external), corporate social responsibility or environmental regulation, and macroeconomic determinants. Analyses based on fundamental firm characteristics typically follow econometric frameworks such as those proposed by Pinnuck and Lillis (2007) and Jung et al. (2014). These models incorporate profitability, sales, size, market value, liquidity, and leverage to examine issues such as aggressive tax planning, stock price reactions, cash flow volatility, accounting comparability, accounting conservatism, and reporting quality.

Existing work has also tended to focus on specific industries or geographical contexts. This is evident in the construction-sector studies reviewed by Hamza et al. (2022), in manufacturing-based research across Europe (Stundziene & Baliute, 2022), and in the extensive analyses of Chinese manufacturing firms (e.g., Chen et al., 2025; Ding et al., 2025; Li et al., 2025; Tang, 2025; Xing et al., 2025; Xiong et al., 2025). China is particularly prominent in empirical productivity studies, especially those relying on listed firms, a trend confirmed in the broader literature review by Habib et al. (2024).

2.2. Hypotheses Development

Studies examining the determinants of entities' productivity typically propose one main explanatory variable as the focal point of analysis, such as the level of intangibility (Nakatani, 2024) or leverage (e.g., Avarmaa et al., 2013; Towo et al., 2019) and complement it with a set of related control variables.

In this context, prior research frequently incorporates a set of firm-level control variables, including age, assets' intangibility or digitalisation, audit characteristics, market concentration, corporate governance mechanisms, efficiency indicators, financialisation, growth, investment levels or asset tangibility, investor-related characteristics, leverage, liquidity, management expenses weight, market value, profitability, firm size, and tax-related effects (e.g., Avarmaa et al., 2013; Towo et al., 2019; Nakatani, 2024; Chen et al., 2025; Ding et al., 2025; Li et al., 2025; Tang, 2025; Xing et al., 2025; Xiong et al., 2025).

For example, in examining the drivers of productivity with a focus on intangible assets, Nakatani (2024) analysed food manufacturing firms across China, France, Germany, Italy, Japan, South Korea, Spain, Thailand, Turkey, and the UK. The study identified a nonlinear and heterogeneous relationship, showing that economies with fewer product market regulations derive higher productivity gains from intangible assets.

Recent research has increasingly explored the effects of digital transformation on firms' productivity, particularly within Chinese listed companies (Chen et al., 2025; Ding et al., 2025; Xiong et al., 2025). Ding et al. (2025) report that digital transformation enhances TFP both directly and indirectly by strengthening corporate social responsibility, particularly employee- and public-related responsibilities. This highlights the importance of

employee-oriented CSR in improving productivity during digitalisation processes. Other studies also confirm the positive impact of the digital economy on total and green TFP (Chen et al., 2025; Xiong et al., 2025), with results robust to endogeneity controls and alternative specifications.

Focusing specifically on labour productivity, Xing et al. (2025) find that digital economy development significantly enhances it. This effect is reinforced by firms' exploitative and exploratory innovation capabilities, which serve as moderating variables. The impact also varies across industry factor intensities, with technology-intensive sectors better positioned to exploit digital advances.

In the European context, Adarov et al. (2020) show substantial cross-country and cross-industry differences in labour productivity. Intangible ICT capital emerges as a particularly strong driver of productivity, stronger than tangible ICT capital, at both the industry and economy-wide levels.

For instance, the relationship between leverage and productivity is also well documented. Towo et al. (2019) and Xing et al. (2025) find a negative association between financial leverage and labour productivity. However, other studies identify nonlinear effects. Avarmaa et al. (2013) report that in the Baltic region, leverage initially enhances labour productivity at low levels but becomes detrimental beyond a threshold. Similarly, Nunes et al. (2007) find that leverage negatively affects less productive Portuguese firms but positively influences highly productive ones.

The mechanism is intuitive: leverage can reduce financing costs and improve resource allocation, but excessive debt increases financial risk, interest burdens, and thus undermines operational efficiency (Tang, 2025). Lower financing costs facilitate investment in fixed assets and reduce incentives for financialisation, enhancing productivity (Duan et al., 2023). Conversely, Dvouletý and Blažková (2021) show that excessive debt or negative equity is associated with lower TFP.

Financialisation also plays a notable role in explaining productivity variations. Li et al. (2025), focusing on green TFP, find that deviations from the optimal level of financialisation are negatively associated with firms' green productivity. The relationship is nonlinear and becomes stronger for highly polluting industries. Tang (2025) similarly finds that financialisation reduces TFP, especially in regions with severe financing constraints and underdeveloped markets.

Other studies link productivity to tangibility, generally negatively (Avarmaa et al., 2013), and to financial indicators such as long-term capital liability ratios and return on equity, both of which may positively influence productivity (Xing et al., 2025).

At the European level, Ferrando and Ruggieri (2018) analyse eight euro-area countries and report substantial cross-country heterogeneity in productivity. Labour productivity is highest in the Netherlands, Belgium, and Germany, and lowest in Italy, Spain, and Portugal. The authors highlight that improved access to external financing enhances productivity and supports growth, whereas high financing costs disproportionately harm smaller firms.

Turégano (2020) also documents persistent labour productivity heterogeneity across EU27 member states between 1995 and 2019, driven by country- and sector-specific factors. Higher productivity is associated with greater educational attainment, R&D expenditure, capital-labour ratios, ICT use, and firm size. The distribution of firm sizes also matters: economies dominated by small firms (e.g., Portugal, Italy, Spain) tend to exhibit lower productivity, while those with more large firms (e.g., Germany, France) benefit from scale-driven productivity gains.

Firm size itself shows a positive relationship with both TFP (Dvouletý & Blažková, 2021) and labour productivity (Avarmaa et al., 2013; Towo et al., 2019). Larger firms typically benefit from economies of scale, better access to financing, and greater capacity to

adopt new technologies. At a macro level, European firm concentration is also positively associated with productivity changes (Bighelli et al., 2022).

Moreover, OECD (2024) reports that large firms are generally more productive, although the advantage is smaller in knowledge-intensive services. In these sectors, young and innovative firms often outperform incumbents due to their agility and human capital. Consistent with this, Chen et al. (2025) find that firm size moderates the effect of digitalisation on green TFP, with larger firms benefiting more. By contrast, Xiong et al. (2025) report a stronger positive effect of digital transformation on TFP for smaller firms, likely due to their superior flexibility.

Sectoral differences are also relevant. Xing et al. (2025) show that the impact of financial indicators on productivity varies across sectors: for example, return on equity is more strongly associated with productivity in asset-intensive industries. The effect of digitalisation also differs, being positive in non-labour-intensive sectors but negative in labour-intensive ones, likely due to the challenges associated with digitalising human-centred processes.

Drawing on the above literature—particularly the evidence of heterogeneity across countries, sectors, and firm sizes—this study focuses on identifying whether the determinants of labour productivity differ along these dimensions. Accordingly, the following hypotheses are proposed:

H1. *Labour productivity in Europe has distinctive determinants by country.*

H2. *Labour productivity in Europe has distinctive determinants by firm size.*

H3. *Labour productivity in Europe has distinctive determinants by sector.*

The next section outlines the materials and methods used in the empirical analysis.

3. Materials and Methods

This research uses labour productivity as the dependent variable, which is defined as the total value added divided by the number of employees in a given sector. Then, a set of independent variables to assess its determinants with a cross-breakdown by country was selected based on the previous literature review.

Data was obtained from the BACH database, which comprises yearly aggregate data of non-financial corporations for several (twelve) European countries by country, economic activity sector, size and two different samples (sliding and variable sample). Data start in 1999 till the last available year, depending on the country. However, differences in coverage and some breaks in the time series over this period must be considered by users.

Within this database, the following countries are included, with the information being provided by their national central banks or national statistics: Austria, Belgium, Croatia, France, Germany, Hungary, Italy, Luxembourg, Poland, Portugal, Slovakia, and Spain. Matters such as data delivery, data harmonisation, anonymization criteria, data quality controls and other technical aspects are defined by the BACH working group, which works under the aegis of the European Committee of Central Balance Sheet Data Offices (ECCBSO).

Size classification in the BACH database is based on the companies' net turnover, being provided for the following categories:

- “0”—All sizes, which comprises all companies, regardless of their net turnover; totals provided for some indicators in this category are equal to the sum for the sizes “1” and “2” by country, sector and sample;

- “1”—Small and Medium-sized companies, including companies with a net turnover up to 50 million euros; totals provided for some indicators are equal to the sum for the sizes “1a” and “1b” by country, sector and sample;
 - “1a”—Small companies, for those with a net turnover lower than 10 million Euros;
 - “1b”—Medium-sized companies, for those with net turnover between 10 million Euros and lower than 50 million Euros;
- “2”—Larger companies, which include companies with a net turnover equal or higher than 50 million euros.

The BACH economic activity sector classification is based on the NACE classification, providing information by sector divisions (two-digit), sector sections (one-digit) and two types of total companies (one that includes M701—Activities of head offices, but excludes K642—Activities of holding companies, and another one that excludes both). This research also provides a cross-breakdown by sector with the same details provided above for the total non-financial corporations (by country and by size). For this purpose, the dataset is divided into two subgroups, as follows: manufacturing and non-manufacturing sectors. The first comprises the divisions inserted into NACE C (Manufacturing), with the latter including the divisions other than those. The latter includes the remaining divisions.

The BACH database is publicly available through the following website, hosted by the Banque de France. Documents such as the BACH Userguide, methodology and warnings, national samples, and release calendars of publications, which provide comprehensive information on the BACH dataset and data characteristics, can also be downloaded via the following link: <https://www.bach.banque-france.fr/#/login> (accessed on 7 November 2025).

As previously mentioned, the analysis provides data with a breakdown by country and size. Annual information from 2010 to 2023 is used (the last available year), including three size classes (small, medium-sized and larger entities) per division (two digits of NACE code) by year and by country (six countries were selected), in a total of 14,188 observations. The combination of sectors and class sizes (small, medium and large) varies from 191 to 208 by country.

As coverage level can be distinct among countries and, within each country, by sector, six countries were selected for this research based on the higher level of data availability by sector and data coverage, as follows: Belgium (BE), France (FR), Spain (ES), Italy (IT), Poland (PL), and Portugal (PT). IT and PT provide information to all their national company. The overall level of coverage, based on the total companies, for the remaining countries ranges between 40% (for BE) to 90% (for FR), depending on the measure used as reference (total employees or net turnover). In all cases, however, some of the aggregate data (by size, sector, and sample) are not disclosed by countries, regardless of data availability, to ensure data confidentiality criteria.

Researchers have used the BACH database to perform several European cross-country analyses, such as the entities’ financial structures and the performances by small, medium-sized and larger entities, particularly from 2000 onwards (e.g., Bobillo et al., 2002; Caprio & Rigamonti, 2014; Cinca et al., 2005; Cruz, 2016; Izquierdo & Carrascal, 2010; Rivaud-Danset et al., 2001; Schmidt-Faber, 2004).

The independent variables are based on those gathered from the literature on the determinants of entities’ productivity, as summarised in Table 1.

Table 1. Independent or control variables used as proxies for explanatory factors found in research on the determinants of entities' productivity.

Explanatory Factors	Variables as Proxies
Age *	Years since the starting date (Avarmaa et al., 2013; Ding et al., 2025; Nakatani, 2024; Towo et al., 2019; Xiong et al., 2025)
Assets' Intangibility / Digitalisation	Assets' intangibility: Intangible assets divided by total assets (Nakatani, 2024) Digitalisation: The frequency of terms in annual reports is commonly used. The variables include the entities' investment in emerging technologies such as blockchain, cloud computing, big data, and artificial intelligence (Ding et al., 2025; Xiong et al., 2025); digital infrastructure, the extent of digital economy penetration, network information resources, and digital economy's commercial scope (Chen et al., 2025); digital internet development, and digital financial inclusion (Xing et al., 2025)
Audit *	Assuming "1" If the company is audited, and "0" otherwise (Ding et al., 2025), Assuming "1" If a Big-4 audits the company, and "0" otherwise (Chen et al., 2025)
Debt	Share of a firm liabilities on its assets (Dvouletý & Blažková, 2021)
Concentration or Equity Balance *	NA (Chen et al., 2025; Ding et al., 2025)
Corporate Governance Elements *	Two positions in one/CEO duality, or not, assuming "1" if the general manager also holds the position of chairman, and "0" otherwise (Ding et al., 2025; Tang, 2025; Xiong et al., 2025), proportion of independent directors (Chen et al., 2025; Xiong et al., 2025), number of directors on the board (Li et al., 2025), major shareholder fund occupation, calculated as other receivables divided by total assets (Xing et al., 2025)
Assets Efficiency	Turnover of total capital (Ding et al., 2025)
Financialisation	Ratio of financial assets to total assets (Li et al., 2025); Financialisation level, calculated as follows: (trading financial assets + derivative financial assets + loans and advances granted + net amount of available-for-sale financial assets + net amount of held-to-maturity investments + long-term equity investments + net amount of investment property) / total assets (Tang, 2025)
Growth *	Total assets growth rate (Chen et al., 2025), operating income growth rate (Ding et al., 2025; Tang, 2025), revenue growth rate (Li et al., 2025; Xing et al., 2025)
Investment Level or Tangibility	NA (Ding et al., 2025); net fixed assets to total assets (Tang, 2025); fixed tangible assets to total assets (Avarmaa et al., 2013)
Investors' Features *	Management ownership percentage (Xiong et al., 2025), share ratio of institutional investors (Chen et al., 2025; Ding et al., 2025; Tang, 2025), proportion of shares held by the top five or ten shareholders (Chen et al., 2025; Xiong et al., 2025; Li et al., 2025), state-owned or not (Li et al., 2025)
Debt (Leverage)	NA (Ding et al., 2025); asset-liability ratio / total debts to total assets / total liabilities divided by total assets (Li et al., 2025; Nakatani, 2024; Tang, 2025; Xing et al., 2025; Xiong et al., 2025); long-term debt divided by total assets (Xing et al., 2025); Long-term debt divided by (Total assets - Current liabilities + Short-term debt) and (Short-term debt + Long-term liabilities) / (Total assets - Current liabilities + Short-term debt) (Avarmaa et al., 2013); total loans from other financial institutions divided by total assets (Towo et al., 2019)
Liquidity	Quick ratio (Chen et al., 2025), cash-flow ratio / operating cash-flow ratio (Li et al., 2025; Xing et al., 2025; Xiong et al., 2025); deposit-to-asset ratio (Towo et al., 2019)
Management Expense Weight *	NA (Ding et al., 2025; Xiong et al., 2025), management expenses divided by operating revenue (Xing et al., 2025)
Market Value *	Tobin's Q ratio, i.e., ratio of stock market value to asset replacement cost (Li et al., 2025; Xing et al., 2025)

Table 1. Cont.

Explanatory Factors	Variables as Proxies
Profitability	Return on equity (Ding et al., 2025; Xing et al., 2025), return on net assets/total profit to total assets (Li et al., 2025; Tang, 2025; Xiong et al., 2025)
Size	NA (Ding et al., 2025; Xiong et al., 2025), total assets (Avarmaa et al., 2013; Chen et al., 2025; Tang, 2025; Li et al., 2025), total employee (Xing et al., 2025)
Tax Effects (Interest Burden)	Income tax expenses divided by total profit (Tang, 2025)

Notes: * Explanatory factors not included in the following model.

Notwithstanding, considering the characteristics of the data used (at an aggregate level) and the variables available in the BACH database, some of the explanatory factors are not included, namely the AGE, AUDIT, CORPORATE GOVERNANCE ELEMENTS, CONCENTRATION OR EQUITY BALANCE, GROWTH, INVESTORS' FEATURES, MANAGEMENT EXPENSE WEIGHT, and MARKET VALUE. In addition, other variables used as proxies for the explanatory factors also required a certain level of adaptation based either on their similar economic interpretation or their high level of availability in that dataset.

Finally, two further variables were included to assess the possible impact of the average level of interest expenses (interest burden) and the operating working capital by industry and size on the dependent variable under assessment. The first may be seen as a complementary analysis of the leverage through the cost of debt, while the second relates to the entities' efficiency and liquidity from their operating cycle perspective.

Therefore, Table 2 summarises the variables used as explanatory factors assessed in this research and their definition, as well as BACH database codes for a better understanding and reconciliation.

Table 2. Variable names and definition.

Explanatory Factors	Variable Name	Variable Definition (Proxy)	BACH Codes
Size	SIZE	$\ln(\text{average assets by sector} = \text{total assets over number of companies})$	Absolute values
Assets' Intangibility/Digitalisation	INTAN	$\frac{\text{Intangible fixed assets}}{\text{Total assets}}$	A11
Investment Level or Tangibility	TANG	$\frac{\text{Tangible fixed assets}}{\text{Total assets}}$	A12
Financialisation	FINANCE	$\frac{(\text{Financial assets} + \text{Cash and bank assets} + \text{Other current financial assets})}{\text{Total assets}}$	A13 + A6 + A7
Debt (Leverage)	DEBT	$\frac{\text{Total debt}}{\text{Total Assets}}$	L11 + L12 + L21 + L22 + L311 + L312 + L321 + L322
Liquidity	LIQUID	$\frac{\text{Other current financial assets} + \text{Cash and bank assets}}{\text{Total assets}}$	R14
Tax Effects (Interest Burden)	INTEREST	$\frac{\text{EBIT} - \text{Income tax}}{\text{EBIT}}$	$\frac{(R35 - I11)}{R35}$
Profitability	PROFIT	$\frac{\text{Net operating profit}}{\text{Net turnover}}$	R34
Tax Effect	TAX	$\left[1 - \frac{\text{Net profit}}{\text{Net profit before tax}}\right]$	$\left[1 - \frac{R38}{R310}\right]$

Table 2. Cont.

Explanatory Factors	Variable Name	Variable Definition (Proxy)	BACH Codes
Assets Efficiency	EFFIC	$\frac{\text{Net turnover}}{\text{Total assets}}$	R41
Working Capital Management	WORK_CAP	$\frac{\text{Inventories} + \text{Trade receivable} - \text{Trade payables} - \text{Payments received on account of orders}}{\text{Net turnover}}$	R54

To deal with inflation, monetary variables other than ratios were adjusted, for which the numerator and denominator refer to the same period, based on country indices of consumer prices (ICP), available on the European Central Bank website. This includes the variables size and productivity. For those, we have calculated a year 2010 base index for each country, based on inflation during the period of the study. Furthermore, regression models include dummies for the COVID period (for the years 2020 and 2021) to control for pandemic effects. Additionally, a quadratic term for leverage was added.

To empirically investigate the relationship between the variables under study, a pooled Ordinary Least Squares (OLS) regression was first employed. The Breusch-Pagan test indicated that OLS was not appropriate. After calculating the Hausman test between random effects and fixed effects, we have concluded that each industry has fixed effects not observed as expected, considering differences in business structures and commercial margins. By using the fixed-effects (FE) model, which controls for time-invariant unobserved heterogeneity by allowing for individual-specific intercepts (α_i), expressed as shown in Equation (1).

$$Y_{it} = \alpha_i + \beta_1 X_{1it} + \dots + \beta_k X_{kit} + u_{it} \quad (1)$$

where

- Y_{it} represents the dependent variable for individual i at time t .
- $i = 1, \dots, N$ indexes cross-sectional units;
- $t = 1, \dots, T$ denotes periods;
- α_i : The individual-specific intercept, capturing unobserved time-invariant characteristics of individual i
- $\beta_1, \dots, \beta_k$: Coefficients for the independent variables as proposed in Table 2, assumed to be constant across individuals and time.
- $X_{1it}, \dots, X_{kit}$: The values of the k independent variables for individual i at time t .
- u_{it} : Idiosyncratic error term, capturing pure randomness, time-varying unobserved heterogeneity and other unobserved factors (measurement error).

This model assumes that individual-specific effects are correlated with the regressors and absorbs them into the estimation via entity-demeaned transformations.

These tests intend to provide a robust framework for model selection, ensuring that the estimation approach is consistent with the data structure and econometric assumptions.

Furthermore, the Variance Inflation Factor (VIF) is used to assess possible multicollinearity issues among independent variables, with values below 2.0, indicating an absence of multicollinearity concerns.

The dynamic panel estimators using the Arellano-Bond (AB) procedure were explored. The AB model results showed that neither the AR(1) nor AR(2) serial correlation tests were statistically significant, and the coefficient of the first lag of the dependent variable was also insignificant, suggesting that the dependent variable does not exhibit meaningful temporal dependence in this context.

To further assess serial correlation, the Wooldridge test for autocorrelation in panel data was also performed, which indicated that correction was necessary. Consequently, a fixed-effects model with AR(1) disturbances using the *xtregar* command was estimated in Stata (version 18 BE). This estimator accounts for first-order autocorrelation in the error term while preserving the within transformation.

Finally, a quadratic term for leverage to capture potential nonlinear effects was incorporated.

The next section presents the findings.

4. Results

This section starts with a previous overview of labour productivity across the European countries included in this research. Then, using the BACH sector Zc (total companies excluding K642—Activities of holding companies and M701—Activities of head offices sectors), to better capture the non-financial corporations' institutional sector, Figure 1 shows the average labour productivity values (gross value added over total employees in thousand euros) by country and size from 2010 to 2023. Despite the different levels of labour productivity across countries, the figures indicate a similar pattern by size for all countries, except for Belgium, with labour productivity increasing more evidently from small to larger companies. By size, only Belgium has the highest average values for labour productivity, conversely to Poland and Portugal, with both showing the lowest values.

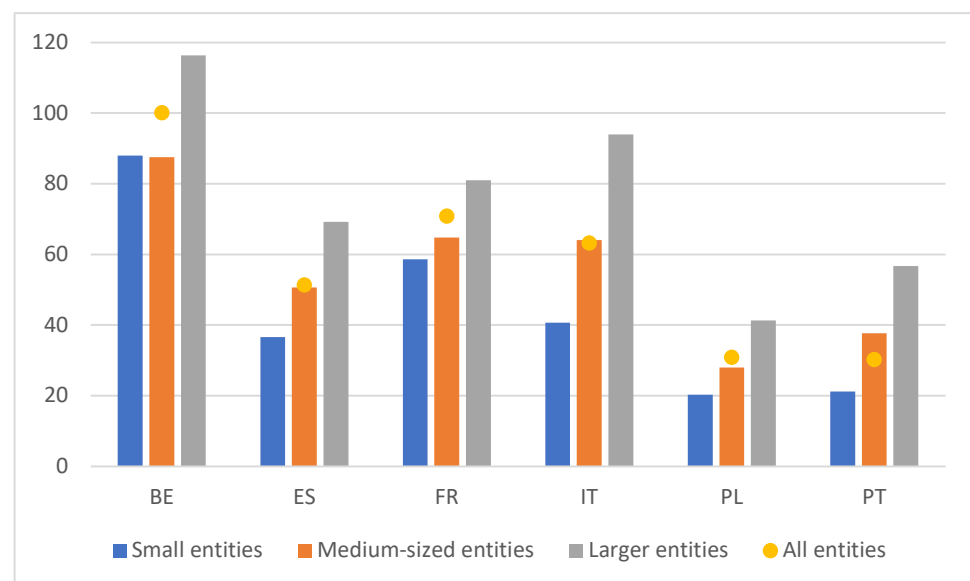


Figure 1. Labour productivity by country and size.

Furthermore, Portugal is the only case for which, all entities considered, its average labour productivity is below the value found for the same variable for medium-sized entities, with both being close for Spain and Italy, and France and Poland slightly above. In all cases, larger entities present higher average values for labour productivity than all entities.

Table 3 presents some descriptive statistics by size for all relevant variables (dependent and independent variables) proposed for this research. The dataset presents descriptive statistics for several financial and performance indicators across all sectors and disaggregated by firm size (small, medium-sized, and large entities). Data were compiled for the six European countries and the period under assessment (from 2010 to 2023). All divisions were considered as observations to compute those statistics.

Table 3. Descriptive statistics by size.

All Sectors, Regardless of Size Classes	N. Obs.	Mean	Std. Deviation	Minimum	Maximum
LABOUR PRODUCTIVITY	6555	68.02	81.46	−194.39	2575.44
SIZE	7327	8.75	1.75	4.46	16.03
INTAN	7266	5.13	7.45	0.00	84.25
TANG	7318	27.00	17.95	0.08	96.99
FINANCE	7219	28.66	16.68	−0.21	99.04
DEBT	7270	39.04	13.35	0.00	115.86
LIQUID	7334	12.32	7.72	−1.75	92.44
INTEREST	7262	0.81	1.95	−58.00	86.20
PROFIT	7275	4.77	8.79	−436.56	46.46
TAX	7308	0.34	6.20	−49.40	383.00
EFFIC	7278	96.85	68.70	0.16	1617.50
WORK_CAP	7275	15.40	24.03	−389.10	420.93
Small entities	N. Obs.	Mean	Std. Deviation	Minimum	Maximum
LABOUR PRODUCTIVITY	6068	48.37	82.46	−1846.80	1773.54
SIZE	6814	7.27	0.89	4.38	12.46
INTAN	6766	3.86	5.20	0.00	65.85
TANG	6809	30.46	16.35	0.03	96.99
FINANCE	6735	25.10	12.74	0.23	98.00
DEBT	6763	42.11	45.59	0.34	2629.76
LIQUID	6818	15.81	7.59	0.21	92.87
INTEREST	6800	0.73	4.50	−233.00	118.00
PROFIT	6814	2.73	27.05	−982.10	144.23
TAX	6742	0.17	11.96	−862.00	229.50
EFFIC	6818	91.65	53.03	0.83	527.34
WORK_CAP	6814	18.01	59.79	−4035.60	694.45
Medium-sized entities	N. Obs.	Mean	Std. Deviation	Minimum	Maximum
LABOUR PRODUCTIVITY	5423	65.49	77.03	−452.39	1335.65
SIZE	6159	9.89	0.61	6.64	12.54
INTAN	6067	4.99	6.82	0.00	75.74
TANG	6114	26.01	17.01	0.01	92.95
FINANCE	6019	23.48	12.54	0.27	92.69
DEBT	6052	37.29	14.02	5.41	401.28
LIQUID	6142	12.41	6.91	−2.22	80.47
INTEREST	6128	0.74	2.42	−126.00	67.00
PROFIT	6142	5.22	6.48	−178.28	53.30
TAX	6102	0.21	3.65	−196.00	61.80
EFFIC	6142	112.02	81.03	7.25	2038.38
WORK_CAP	6142	17.08	22.66	−112.49	865.20

Table 3. Cont.

All Sectors, Regardless of Size Classes	N. Obs.	Mean	Std. Deviation	Minimum	Maximum
Larger entities	N. Obs.	Mean	Std. Deviation	Minimum	Maximum
LABOUR PRODUCTIVITY	4563	98.03	188.56	−62.90	6097.97
SIZE	5279	12.15	0.99	9.54	16.73
INTAN	5181	6.64	9.70	0.00	81.86
TANG	5260	22.71	18.48	0.00	92.87
FINANCE	5126	28.17	16.59	−3.22	90.02
DEBT	5155	36.64	15.26	3.52	144.92
LIQUID	5286	10.14	8.14	−6.54	72.61
INTEREST	5269	0.82	1.14	−43.00	31.35
PROFIT	5286	5.08	7.93	−246.15	85.26
TAX	5249	0.22	3.00	−120.50	96.60
EFFIC	5286	114.46	82.14	4.87	1647.92
WORK_CAP	5286	12.84	25.93	−171.70	608.30

Overall, the variables display substantial heterogeneity, reflecting differences in operational scale, financial structure, and performance profiles across size classes.

Across all sectors, labour productivity shows wide dispersion, with a relatively modest mean (68.02) but a large standard deviation (81.46) and extreme values, indicating considerable variability in efficiency among sectors. When split by size, productivity rises consistently with firm scale: small firms show the lowest average productivity (48.37), medium-sized firms perform better (65.49), and large firms stand out with substantially higher productivity (98.03). The high maximum values, especially for large firms, suggest that a small number of highly productive entities exert a strong upward influence on distribution.

Firm size (measured by logarithmic or similar scale) naturally increases across the categories. Small firms have an average size of around 7.27, medium firms with 9.89, and large firms with 12.15, confirming appropriate distinction across size classes.

In terms of asset structure, intangibility remains generally low across categories but tends to increase with firm size. Tangibility, on the other hand, is proportionally more significant in small firms (mean 30.46) compared to medium (26.01) and large firms (22.71), hinting at less diversified asset bases among smaller entities.

Financial indicators also reveal meaningful differences. Small firms tend to have the lowest levels of financialization (with a mean of 25.10), while medium firms show slightly lower values than large ones. Debt levels are highest on average for small firms (42.11), and although the standard deviation is relatively high, suggesting some sectors as outliers, the pattern still indicates greater leverage pressure at the lower end of the size class distribution. Liquidity is also higher for small firms (15.81), decreasing for medium (12.41) and large firms (10.14), possibly reflecting more conservative working capital policies among smaller entities.

Profitability exhibits large variability and extreme outliers in all groups, though medium and large firms show higher mean profitability compared to small firms. Tax effects remain very low across all sizes, with high variation but small absolute means, reflecting either low effective tax burdens or the presence of entities with tax losses.

Efficiency increases notably with firm size—large firms are the most efficient on average (114.46), followed by medium ones (112.02), while small firms lag (91.65). The

dispersion is significant in all groups, again pointing to heterogeneous operational environments.

Finally, working capital shows high variability across all size classes, with small firms presenting the widest spread and most extreme values, possibly due to greater volatility in short-term financing and operational cash flow management.

Overall, the descriptive statistics reveal a consistent pattern: larger firms tend to exhibit higher productivity, better efficiency, and more stable financial structures, while small firms show greater variability, higher leverage, and more extreme outliers across many indicators. This distribution reflects the expected scaling effects in operational, financial, and structural characteristics across entity size classes.

The following regressions provide the results based on a fixed-effects specification that corrects for first-order autocorrelation.

Table 4 starts the analysis by providing the results for regressions performed to identify the explanatory factors for labour productivity by sectors, with a breakdown by country.

Table 4. Explanatory factors for productivity by sectors: Breakdown by country.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
SIZE	12.261 *** (1.884)	23.057 ** (9.350)	6.676 *** (2.056)	25.707 *** (4.520)	32.500 *** (4.042)	4.740 *** (0.496)	17.297 *** (3.076)
INTAN	−0.186 (0.245)	0.113 (1.586)	0.093 (0.218)	−0.268 (0.534)	−0.976 *** (0.316)	0.08 (0.076)	0.175 (0.372)
TANG	−0.125 (0.165)	−0.315 (0.669)	0.462 ** (0.199)	−0.017 (0.282)	−1.870 *** (0.269)	−0.017 (0.046)	0.937 *** (0.300)
FINANCE	−0.439 *** (0.146)	−1.546 *** (0.553)	−0.072 (0.167)	−0.483 ** (0.246)	−1.387 *** (0.241)	0.098 * (0.053)	−0.284 (0.280)
DEBT	−0.673 ** (0.338)	−1.736 (1.440)	−1.500 *** (0.398)	−0.227 (0.727)	0.202 (0.696)	−0.108 (0.096)	−1.021 (0.645)
DEBT ²	0.006 (0.004)	0.008 (0.017)	0.018 *** (0.004)	−0.004 (0.007)	0.008 (0.009)	0 (0.001)	0.007 (0.006)
LIQUID	0.278 (0.196)	0.677 (0.857)	0.031 (0.151)	2.126 *** (0.344)	0.303 (0.408)	0.171 ** (0.068)	−0.439 (0.409)
INTEREST	0.012 (0.150)	−0.765 (2.777)	0.027 (0.200)	0.017 (0.265)	0.005 (0.104)	0.001 (0.048)	−0.032 (0.308)
PROFIT	0.890 *** (0.044)	8.856 *** (0.703)	0.734 *** (0.121)	4.045 *** (0.196)	1.073 *** (0.036)	0.181 *** (0.015)	1.917 *** (0.208)
TAX	0.005 (0.058)	−0.039 (0.819)	0.141 (0.459)	−0.296 (0.587)	0.007 (0.029)	−0.046 (0.099)	0.017 (0.207)
EFFIC	0.017 (0.038)	−0.121 (0.191)	0.003 (0.039)	0.138 (0.093)	0.107 (0.078)	0.008 (0.008)	−0.058 (0.072)
WORK_CAP	−0.001 (0.013)	−0.326 ** (0.152)	−0.198 *** (0.043)	0.016 * (0.009)	−2.041 *** (0.104)	0.035 ** (0.014)	0.249 *** (0.093)
MAN × SIZE	−5.393 (3.934)	−9.728 (16.442)	−0.095 (3.918)	0.835 (13.858)	−3.316 (13.837)	0.149 (1.389)	−12.746 * (6.952)
MAN × INTAN	0.047 (0.673)	−0.94 (3.091)	−0.019 (0.689)	−0.129 (1.515)	1.308 (0.802)	−0.318 (0.225)	−0.004 (1.289)
MAN × TANG	0.329 (0.328)	1.249 (1.189)	−0.476 (0.391)	−0.491 (0.756)	1.881 ** (0.754)	−0.221 * (0.134)	−0.84 (0.565)
MAN × FINANCE	0.483 (0.296)	1.639* (0.936)	0.03 (0.367)	−0.188 (0.525)	1.304 * (0.715)	−0.362 ** (0.143)	0.207 (0.609)
MAN × DEBT	0.309 (0.253)	1.201 (0.915)	0.199 (0.301)	0.628 (0.490)	−0.936 ** (0.437)	−0.027 (0.092)	0.493 (0.439)

Table 4. Cont.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
MAN × LIQUID	−0.615 (0.429)	−1.052 (1.556)	−0.061 (0.414)	−1.798 ** (0.731)	−0.67 (1.050)	−0.186 (0.158)	0.138 (0.835)
MAN × INTEREST	−0.002 (0.311)	0.741 (3.161)	−0.007 (0.274)	0.036 (0.781)	−0.032 (0.261)	0.036 (0.283)	0.029 (0.894)
MAN × PROFIT	1.881 *** (0.310)	−5.792 *** (1.072)	0.643 (0.464)	0.131 (0.956)	2.499 *** (0.582)	0.871 *** (0.154)	0.074 (0.710)
MAN × TAX	−0.008 (0.189)	0.025 (0.933)	−0.167 (0.534)	0.185 (1.164)	0.001 (0.325)	−0.025 (0.144)	−0.029 (0.463)
MAN × EFFIC	0.047 (0.088)	0.126 (0.407)	0.031 (0.101)	0.065 (0.153)	0.294 (0.203)	−0.040 ** (0.026)	0.115 (0.175)
MAN × WORK_CAP	−0.052 (0.160)	0.271 (0.422)	0.175 (0.246)	−0.114 (0.691)	1.807 *** (0.334)	−0.149 (0.143)	−0.271 (0.511)
FY2020	7.887 (7.342)	2.031 (9.312)	22.167 (25.716)	3.772 (9.970)	1.769 (5.583)	8.885 *** (2.187)	−1.956 (17.522)
FY2021	2.134 (3.443)	−11.151 (9.101)	5.112 (6.815)	0.759 (4.758)	0.522 (3.220)	4.272 *** (1.031)	−0.819 (7.355)
_cons	−18.344 ** (7.229)	−21.809 (33.660)	16.026 (11.533)	−204.826 (24.311)	−197.150 (12.709)	−11.600 *** (1.735)	−60.028 *** (11.710)
R2—Within	0.0405	0.0772	0.0617	0.2011	0.3188	0.1791	0.0849
Nb Observations	14188	2422	2441	2604	2584	2153	1984
Nb Groups	1220	205	206	206	204	208	191
COVID dummies	Yes	yes	yes	yes	yes	yes	yes

Note: The regressions use a within estimator for fixed-effects when the disturbance term is first-order autoregressive. The variables are defined in Table 2. MAN means manufacturing industries, defined in NACE as section C. Significance levels are expressed as follows: * at 10% level; ** at 5% level; *** at 1% level.

The results reveal several consistent patterns across the full sample (all countries), while also highlighting substantial cross-country differences. In the overall specification, firm size emerges as a strong and statistically significant determinant of labour productivity, indicating that larger firms tend to be more productive. Profitability is likewise a powerful predictor, showing a robust positive association with productivity. By contrast, financialisation displays a negative and significant effect, suggesting that greater reliance on financial assets is generally detrimental to productive performance. Leverage also exerts a negative influence, although the quadratic term is not significant, pointing to a predominantly linear relationship. Most other variables are not significant in the aggregate, except for the manufacturing interaction with profitability, which indicates that profitability contributes even more strongly to productivity within manufacturing firms.

The country-level estimates show that these relationships are not consistent.

In Belgium, the effect of size is large but estimated imprecisely, while financialisation is strongly negative, in line with the full sample. Interestingly, the interaction between manufacturing and profitability is significantly negative, suggesting that profitability plays a different role in the productivity dynamics of Belgian manufacturing firms.

Spain exhibits a clearer structure, where size, tangibility, profitability, and leverage all display significant relationships with productivity. The positive coefficient on tangible assets suggests that physical capital intensity plays an important role in Spanish firms' productive capacity.

France shows one of the strongest effects of size, while liquidity presents a substantial positive coefficient, indicating that short-term financial buffers may support productivity. A few other variables reach significance, implying a more stable or less sensitive productivity structure relative to other countries.

Italy, by contrast, displays extensive significance across many variables. Size, tangible assets, financialisation, and working capital all contribute meaningfully to productivity, while intangible assets exhibit a negative association, suggesting that intangible investment may not translate efficiently into productivity gains in the Italian context. Several interaction terms are significant, indicating that manufacturing firms in Italy respond differently to financing and capital structure variables.

In Poland, the pattern differs again. Size retains a positive effect, but financialisation is associated with higher productivity, a result that contrasts with the broader sample and suggests that financial asset holdings may support productive activity in this context. Liquidity is also positively associated with productivity, and some manufacturing interactions are negative, indicating sector-specific sensitivities.

Portugal displays strong significance for size, tangibility, profitability, and working capital, while the interaction between manufacturing and size is negative, implying that scale effects are weaker in manufacturing than in the rest of the economy.

Taken together, these results demonstrate that while some determinants of labour productivity exert more consistent effects across countries, particularly being the case for firm size and profitability, others vary considerably depending on national structures and sectoral characteristics. Manufacturing firms in particular exhibit heterogeneous responses, with several coefficients indicating sector-specific dynamics that differ meaningfully across the seven countries. The within- R^2 values, ranging from 0.04 to 0.32, are consistent with firm-level fixed-effects models and reflect the varying explanatory power of the determinants across different institutional and economic environments.

Then, Table 5 shows the results for regressions performed to identify the explanatory factors for labour productivity with smaller firms in interaction with other size classes and a breakdown by country.

Table 5. Explanatory factors for productivity with smaller firms in interaction with other size classes: Breakdown by country.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
SIZE	13.371 *** (1.881)	21.166 ** (8.441)	8.478 *** (1.880)	29.238 *** (5.159)	39.114 *** (3.897)	5.253 *** (0.468)	13.02 *** (2.970)
INTAN	0.004 (0.260)	0.06 (1.604)	−0.092 (0.236)	−0.298 (0.589)	0.741 ** (0.300)	−0.005 (0.074)	0.404 (0.389)
TANG	−0.001 (0.180)	1.277 * (0.694)	0.262 (0.200)	−0.119 (0.360)	−0.856 *** (0.284)	−0.154 *** (0.054)	0.939 *** (0.272)
FINANCE	−0.581 *** (0.154)	−0.676 (0.565)	−0.28 (0.167)	−0.848 *** (0.261)	−0.602 ** (0.243)	−0.264 *** (0.057)	−0.041 (0.269)
DEBT	−0.742 ** (0.317)	−2.157 (1.482)	−1.552 *** (0.347)	0.185 (0.624)	−1.84 *** (0.637)	−0.103 (0.084)	−0.538 (0.584)
DEBT ²	0.006 * (0.004)	0.009 (0.018)	0.019 *** (0.004)	−0.009 (0.007)	0.021 *** (0.008)	0.001 (0.001)	0.003 (0.006)
LIQUID	−0.008 (0.208)	0.105 (0.894)	−0.035 (0.159)	2.22 *** (0.389)	1.013 ** (0.408)	0.322 *** (0.072)	−0.679 * (0.378)
INTEREST	0.028 (0.261)	0.825 (4.370)	0.059 (0.180)	−0.03 (0.286)	0.159 (0.368)	0.022 (0.083)	0.015 (2.465)
PROFIT	4.486 *** (0.176)	12.098 *** (0.825)	0.768 *** (0.162)	6.011 *** (0.297)	2.314 *** (0.241)	1.367 *** (0.054)	3.321 *** (0.280)
TAX	0.007 (0.150)	−0.083 (0.459)	0.053 (0.259)	−0.424 (0.539)	0.078 (0.128)	−0.051 (0.072)	0.017 (0.305)
EFFIC	−0.043 (0.039)	−0.125 (0.185)	−0.015 (0.040)	0.08 (0.081)	0.395 *** (0.075)	−0.026 *** (0.008)	0.009 (0.066)
WORK_CAP	0.061 (0.059)	0.455 (0.288)	−0.238 *** (0.047)	0.03 (0.059)	0.002 (0.149)	−0.190 *** (0.035)	0.965 *** (0.194)
SMALL × SIZE	−11.439 *** (4.037)	−11.875 *** (22.252)	−7.884 (5.414)	−25.734 ** (11.420)	−42.304 *** (8.849)	−2.603 *** (0.906)	−9.159 (6.622)
SMALL × INTAN	−0.548 (0.528)	−0.78 (2.951)	0.296 (0.458)	0.274 (1.087)	−7.782 *** (0.683)	0.093 (0.144)	−0.25 (0.877)

Table 5. Cont.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
SMALL × TANG	0.053 (0.295)	−0.923 (1.171)	0.272 (0.370)	0.698 (0.546)	−2.706 *** (0.478)	0.186 ** (0.078)	−0.713 (0.589)
SMALL × FINANCE	0.8 *** (0.275)	0.905 *** (0.922)	0.711 (0.398)	0.891 * (0.472)	−1.451 *** (0.475)	0.506 *** (0.088)	0.025 (0.578)
SMALL × DEBT	0.582 *** (0.206)	2.429 *** (0.907)	−0.115 (0.232)	0.53 (0.342)	0.949 *** (0.355)	0.013 (0.058)	0.181 (0.380)
SMALL × LIQUID	−0.15 (0.366)	−0.091 (1.467)	−0.051 (0.401)	−2.161 *** (0.630)	−3.341 *** (0.749)	−0.592 *** (0.111)	0.874 (0.973)
SMALL × INTEREST	−0.034 (0.300)	−0.822 (4.581)	−0.134 (0.282)	−0.056 (0.538)	−0.169 (0.379)	−0.021 (0.096)	−0.004 (2.481)
SMALL × PROFIT	−3.785 *** (0.182)	−9.737 *** (1.072)	−0.093 (0.241)	−3.317 *** (0.387)	−1.032 *** (0.244)	−1.250 *** (0.056)	−2.908 *** (0.398)
SMALL × TAX	−0.005 (0.160)	0.061 (0.858)	−0.088 (0.586)	1.447 (1.445)	−0.066 (0.131)	0.066 (0.149)	−0.007 (0.381)
SMALL × EFFIC	0.08 (0.079)	0.099 (0.481)	0.093 (0.095)	−0.044 (0.183)	−1.364 *** (0.153)	0.084 *** (0.015)	0.076 (0.219)
SMALL × WORK_CAP	−0.059 (0.060)	−0.506 (0.330)	0.297 ** (0.140)	−0.022 (0.059)	−3.124 *** (0.192)	0.234 *** (0.038)	−0.962 *** (0.219)
FY2010	2.634	13.838	24.344	5.97	5.627	7.971	−8.586
FY2011	7.105	34.877	25.26	9.811	5.18	1.949	17.587
	−0.067	0.314	5.516	1.837	3.136	3.232	−2.841
	3.359	16.763	6.734	4.663	2.978	0.909	7.326
_cons	−22.576 *** (7.052)	−58.698 *** (39.672)	22.513 (14.178)	−169.262 (22.295)	−64.844 *** (8.771)	−11.282 *** (1.549)	−74.989 *** (10.389)
R2—Within	0.0705	0.0998	0.0639	0.2293	0.4255	0.3667	0.1193
Nb Observations	14,188	2422	2441	2604	2584	2153	1984
Nb Groups	1220	205	206	206	204	208	191
COVID dummies	yes	yes	yes	yes	yes	yes	yes

Notes: The regressions use a within estimator for fixed-effects when the disturbance term is first-order autoregressive. The variables are defined in Table 2. SMALL means small firms, following BACH definition, with a net turnover lower than 10 million euros. Significance levels are expressed as follows: * at 10% level; ** at 5% level; *** at 1% level.

The results of this model confirm some of the patterns seen previously while revealing pronounced differences between small and large firms through the interaction terms. Across the full sample, firm size again shows a strong, positive, and highly significant association with labour productivity, indicating that larger firms benefit from scale-related advantages that translate into higher productive performance. Profitability also exhibits a large and robust positive effect, reinforcing the idea that more profitable firms are typically more efficient or better able to invest in productivity-enhancing resources. Financialisation retains a negative and significant coefficient, while leverage continues to show a detrimental effect, although the quadratic term is only marginally significant. Other variables, such as tangibility and intangibility, remain largely insignificant at the aggregate level.

Once the interaction terms with the “small firm” indicator are introduced, clear differences emerge. For size, the interaction is strongly negative in the pooled sample, meaning that the positive effect of firm scale on productivity is substantially weaker among small firms. A similar pattern appears for profitability, where the interaction term is strongly negative, suggesting that the productivity benefits associated with profitability accrue more to larger firms. Conversely, some interaction terms, notably those involving financialisation and leverage, are positive and significant, implying that small firms may experience less harmful, or even comparatively favourable, effects from these financial variables relative to larger firms.

The country-level regressions again demonstrate significant heterogeneity.

In Belgium, size remains strongly positive, but smaller firms show substantially lower productivity gains from scale, as evidenced by the large and negative size interaction term. Profitability displays a very strong positive effect, but the negative interaction term suggests that these gains are far less pronounced for small firms.

Spain shows a more balanced structure: size and profitability are positive and significant, but the negative interaction terms indicate that small firms benefit less from these drivers. Tangibility and working capital behave differently across firm sizes, again highlighting structural differences in how small firms operate.

France presents particularly strong scale effects, with size showing one of the largest coefficients in the sample. Liquidity also plays a substantial positive role. However, the size interaction term is sharply negative, indicating that smaller firms benefit far less from size-related productivity advantages.

Italy demonstrates one of the most complex structures, with many variables, such as tangibility, financialisation, leverage, liquidity, efficiency, and working capital, displaying significant effects. Several interaction terms for small firms, particularly those involving intangibles, tangibility, financialisation, leverage, efficiency, and working capital, are significantly negative, implying that small firms in Italy face disadvantages across multiple productivity channels.

In Poland, the results differ notably from those of other countries. Size and profitability remain positive and significant, but the interactions suggest that the productivity disadvantage for small firms is more modest. Liquidity and working capital also play a stronger role than in other countries, while financialisation and efficiency have negative effects.

Portugal shows strong positive effects for size, tangibility, profitability, and working capital, but the interaction terms again indicate that small firms capture only a portion of these advantages, with particularly strong negative interactions for profitability and working capital.

Overall, the results reveal that while larger firms tend to be more productive across all countries, the mechanisms underpinning productivity vary substantially depending on the national context and firm size. Small firms consistently appear to face structural disadvantages, particularly with respect to returns to scale, profitability, and capital structure. The within R^2 values, which vary between 0.06 and 0.43, indicate that the explanatory power of the models differs meaningfully across countries, with Italy and Poland showing the highest fit.

These findings emphasise the importance of accounting for firm-size heterogeneity when analysing productivity determinants and highlight the considerable cross-country variation in the economic and financial conditions that shape firm performance.

Finally, Table 6 presents the results for regressions performed to identify the explanatory factors for labour productivity with larger firms in interaction with other size classes and a breakdown by country.

Table 6. Explanatory factors for productivity with larger firms in interaction with other size classes: Breakdown by country.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
SIZE	6.143 *** (2.154)	17.809 * (10.129)	6.95 *** (2.463)	7.774 (5.256)	12.304 ** (5.544)	2.603 *** (0.516)	5.830 * (3.337)
INTAN	−0.085 (0.276)	−0.304 (1.405)	0.18 (0.260)	−0.101 (0.575)	−1.489 *** (0.341)	0.018 (0.078)	0.089 (0.439)
TANG	−0.03 (0.158)	0.346 (0.549)	0.348* (0.207)	0.378 (0.266)	−2.334 *** (0.274)	0 (0.042)	−0.009 (0.284)
FINANCE	0.01 (0.148)	−0.062 (0.462)	0.183 (0.189)	−0.108 (0.248)	−1.293 *** (0.283)	0.094 * (0.048)	−0.258 (0.277)
DEBT	−0.303 (0.316)	−0.122 (1.272)	−1.782 *** (0.350)	0.575 (0.629)	−0.517 (0.678)	−0.133 (0.090)	−0.087 (0.613)
DEBT ²	0.006 * (0.003)	0.008 (0.016)	0.021 *** (0.004)	−0.008 (0.006)	0.019 ** (0.008)	0 (0.001)	0.002 (0.006)
LIQUID	0.084 (0.202)	0.465 (0.731)	−0.085 (0.179)	0.025 (0.333)	−0.252 (0.448)	0.233 *** (0.064)	0.359 (0.446)

Table 6. Cont.

Productivity Labour (Dependent Variable)	All Countries	Belgium	Spain	France	Italy	Poland	Portugal
INTEREST	0 (0.130)	−0.022 (1.184)	−0.017 (0.136)	−0.059 (0.240)	0.004 (0.095)	−0.001 (0.043)	−0.01 (0.281)
PROFIT	0.737 *** (0.043)	2.287 *** (0.500)	1.105 *** (0.133)	2.347 *** (0.195)	1.095 *** (0.035)	0.140 *** (0.014)	0.933 *** (0.223)
TAX	0.003 (0.055)	−0.003 (0.389)	0.008 (0.301)	0.069 (0.506)	0.005 (0.029)	−0.044 (0.067)	0.013 (0.198)
EFFIC	0.022 (0.043)	0.026 (0.219)	0.005 (0.046)	0.033 (0.097)	−0.264 *** (0.091)	−0.004 (0.008)	−0.008 (0.104)
WORK_CAP	0.002 (0.012)	−0.016 (0.136)	0.024 (0.063)	0.01 (0.008)	−2.156 *** (0.102)	0.058 *** (0.013)	0.059 (0.093)
LARGE × SIZE	9.376 *** (3.253)	−19.42 (14.48)	1.511 (3.420)	26.321 *** (8.000)	35.84 *** (7.469)	4.768 *** (0.879)	15.698 *** (5.335)
LARGE × INTAN	−0.386 (0.467)	0.602 (2.833)	−0.197 (0.398)	−0.776 (0.950)	2.115 *** (0.616)	−0.235 (0.149)	0.576 (0.698)
LARGE × TANG	−0.201 (0.335)	1.348 (1.286)	0.151 (0.346)	−1.259 ** (0.591)	0.907 (0.566)	−0.372 *** (0.115)	2.199 *** (0.498)
LARGE × FINANCE	−1.172 *** (0.274)	−1.172 (0.945)	−0.757 *** (0.290)	−1.421 *** (0.407)	0.274 (0.466)	−0.65 *** (0.115)	0.712 (0.531)
LARGE × DEBT	−0.568 *** (0.214)	−2.46 *** (0.858)	0.225 (0.196)	−0.415 (0.343)	−1.295 *** (0.385)	0.272 *** (0.075)	−0.648 * (0.351)
LARGE × LIQUID	−0.228 (0.368)	−3.026 (1.510)	0.074 (0.282)	4.618 *** (0.632)	2.159 *** (0.776)	−0.141 (0.131)	−2.195 *** (0.733)
LARGE × INTEREST	0.281 (0.711)	3.076 (7.606)	0.228 (0.855)	0.641 (0.789)	0.172 (0.490)	−0.526 (0.534)	7.998 (7.715)
LARGE × PROFIT	7.013 *** (0.262)	36.353 *** (1.503)	−1.653 *** (0.269)	8.246 *** (0.435)	2.205 *** (0.393)	1.322 *** (0.072)	3.513 *** (0.454)
LARGE × TAX	0.029 (0.252)	−0.305 (0.841)	0.031 (0.464)	−0.814 (1.311)	0.132 (0.207)	−0.433 (0.288)	−0.017 (0.474)
LARGE × EFFIC	−0.103 (0.069)	0.037 (0.307)	0.034 (0.073)	−0.012 (0.135)	0.784 *** (0.143)	−0.02 (0.018)	−0.019 (0.127)
LARGE × WORK_CAP	0.113 (0.096)	0.738 ** (0.342)	−0.555 *** (0.087)	−0.147 (0.294)	2.243 *** (0.302)	−0.509 *** (0.061)	1.410 *** (0.282)
FY2010	3.256 6.99	2.11 28.522	23.864 25.128	1.89 8.39	3.948 5.46	8.762 *** 2.032	−9.549 17.806
FY2011	0.481 3.311	−0.034 14.319	5.584 6.675	0.316 4.14	2.02 3.147	4.098 *** 0.945	−3.668 7.304
_cons	−14.724 ** (6.763)	−24.284 (30.775)	13.693 (11.705)	−122.157 *** (18.383)	−76.229 *** (9.450)	−6.108 *** (1.548)	−85.031 *** (10.566)
R2—Within	0.0912	0.267	0.0905	0.3328	0.3527	0.3212	0.1486
Nb Observations	14,188	2422	2441	2604	2584	2153	1984
Nb Groups	1220	205	206	206	204	208	191
COVID dummies	yes	yes	yes	yes	yes	yes	yes

Notes: The regressions use a within estimator for fixed-effects when the disturbance term is first-order autoregressive. The variables are defined in Table 2. LARGE means large firms, following the BACH definition, with a net turnover higher than 50 million euros. Significance levels are expressed as follows: * at 10% level; ** at 5% level; *** at 1% level.

The final set of estimates reveals substantial cross-country heterogeneity in the determinants of labour productivity and in the extent to which larger and smaller firms benefit from these determinants. At the aggregate level, firm size remains a strong and positive driver of productivity, echoing classical scale-related advantages. Profitability also exhibits a consistently large and highly significant coefficient, confirming its role as one of the most powerful predictors of labour productivity across European firms. By contrast, intangible assets, tangible assets, and liquidity do not display systematic effects in the pooled model, while the negative coefficients on financialisation and leverage align with the notion that financially burdened firms face productivity constraints. The quadratic term for leverage is small but statistically significant, indicating a mild nonlinearity in the relationship between capital structure and productivity.

Introducing interactions with the large-firm indicator deepens these insights and highlights structural asymmetries between firm sizes. In the pooled sample, large firms benefit disproportionately from size and profitability, as reflected in the strongly positive and highly significant interaction terms. Conversely, large firms appear more adversely

affected by financialisation and leverage, which may signal that larger firms face more complex financial structures. Several other interactions are significant but vary considerably in sign and magnitude across specifications, underscoring that the advantages associated with firm size are neither uniform nor universal.

The country-level results reveal even more pronounced divergences.

In Belgium, size exerts a strong positive effect, although the interaction term suggests that this scale benefit does not extend to large firms. Profitability dominates as a determinant of productivity, whereas most other variables are statistically insignificant.

Spain shows a pattern similar to the pooled model: size and profitability are key drivers, while leverage exhibits a strong negative coefficient partially counteracted by the positive quadratic term. The interactions generally indicate that the productivity gains from these variables differ across firm sizes, but without a clear directional pattern.

In France, firm size plays an even more prominent role, accompanied by a significant contribution from liquidity. The interaction terms suggest that large firms capture exceptional scale advantages, with size and profitability interactions being particularly strong.

Italy presents one of the most complex productivity structures, with many regressors—intangibles, tangibles, financialisation, debt, profitability, and working capital, showing significant coefficients. Notably, the signs often indicate that large firms experience stronger effects, either positively or negatively, suggesting that size amplifies the sensitivity of Italian firms to multiple balance sheet and financial variables.

Poland exhibits a distinctive configuration: profitability remains a robust determinant, and liquidity and working capital emerge as especially relevant. The interactions confirm the strong roles of size and profitability for large firms, but with narrower productivity gaps between firm sizes than in other countries.

Portugal, in turn, displays significant contributions from size, tangibility, profitability, and working capital, though the interaction terms generally indicate that these benefits are attenuated among large firms.

Taken together, the results demonstrate that while size and profitability consistently underpin labour productivity, the underlying mechanisms vary markedly across countries and firm sizes. Large firms often, but not always, enjoy stronger productivity returns from key operational and financial indicators. The within- R^2 values, which range from 0.09 in Spain to 0.35 in Italy and 0.32 in Poland, confirm that the explanatory power of the models differs considerably across national contexts.

Therefore, these findings corroborate the previous by stressing the need to account for firm-size heterogeneity and institutional differences when analysing productivity dynamics in European companies.

The next section presents the discussion of the findings as well as the main conclusion from this research.

5. Discussion and Conclusions

This research, which used data from 2010 to 2023, identified cross-country, sector and size-class heterogeneity in labour productivity across six European countries, as follows: Belgium, France, Italy, Portugal, Poland and Spain. Aggregate data from the BACH database are used for this purpose. Therefore, unlike previous studies that focus on individual industries or single-country settings, the proposed approach uncovers multi-dimensional divergence patterns that may not be observable in narrower datasets.

These findings are consistent with earlier evidence using data from European countries (Ferrando & Ruggieri, 2018; Turégano, 2020). Notwithstanding, it must be stressed that the average values do not necessarily illustrate the same pattern observed in the literature

regarding the countries' ranking. This could be explained by the different proxies used to measure labour productivity, a factor that must be considered when comparing these findings over time and between countries, sectors or size classes. For instance, the number of workers employed may not replace the worked hours whenever there are marked changes in average hours worked (Dixon & Shepherd, 2008).

The results consistently show that larger firms tend to have higher labour productivity than smaller ones, in line with the broader literature (Avarmaa et al., 2013; Dvouletý & Blažková, 2021; OECD, 2024; Towo et al., 2019). However, the magnitude and direction of the determinants influencing productivity vary substantially across countries and firm sizes. Contrary to the expectation that all determinants exert a stable influence, the evidence reveals that only a subset, particularly size, profitability, leverage, and certain working-capital indicators, show consistent effects. Other determinants, such as tangibility, intangibility, liquidity, and tax, exhibit weak, sporadic, or country-dependent significance, which underscores the heterogeneous institutional and structural conditions shaping productivity across Europe.

This heterogeneity highlights an important methodological and policy concern: the European corporate landscape cannot be treated as homogeneous. Even within the borders of a single country, productivity drivers diverge markedly, suggesting that regional differences, sectoral composition, and local economic structures condition firm performance. As such, aggregate assessments risk obscuring meaningful variations in productivity dynamics.

Regarding country-level determinants (H1), the findings show that size maintains a positive and significant influence in the largest economies of the sample, namely in Spain, France, and Italy, while its effect is more modest in Poland and weaker in Portugal. Importantly, the interaction terms reveal that large firms in Spain, France, Italy, Poland, and Portugal benefit disproportionately from size-related productivity advantages, although this amplification does not hold in Belgium. Profitability is a consistently strong and positive determinant in every country examined, with large firms again enjoying an even stronger association in most cases. Tangibility and intangibility, however, do not display uniform patterns: tangibility is strongly negative in Italy and mostly insignificant elsewhere, while intangibility tends to have limited explanatory power, except in Italy, where it exerts a negative effect. Financialisation and leverage also show country-specific behaviour, being negative and substantial in Italy, but weaker or occasionally positive in Poland, confirming that financial structure influences productivity in ways that depend on national institutional contexts.

Turning to size classes (H2), the results highlight clear asymmetries. Large firms obtain stronger productivity returns from size and profitability across nearly all countries. In contrast, small firms appear less sensitive to these traditional drivers, and in some cases, are even less affected by the negative impact of financialisation and leverage. The effects of tangibility, intangibility, liquidity, and tax vary virtually entirely by size class, with no coherent pattern across countries, suggesting that structural characteristics of firms—such as capital intensity, customer-base stability, or governance form—may condition the direction of these relationships more than size alone.

The sector-based results (H3) add a further layer of nuance. Size remains an important determinant in both manufacturing and non-manufacturing sectors, although its role is stronger among the first, consistent with scale-related advantages typical of manufacturing and capital-intensive activities. Intangibility tends to depress productivity more in manufacturing settings, reflecting the lower strategic value of intangible assets in traditional manufacturing, whereas tangibility displays more positive effects in non-manufacturing sectors. Financialisation exerts stronger adverse effects in industrial sectors, a pattern

consistent with the literature showing that capital-intensive industries are more vulnerable to the distortions created by excessive financial activity.

Taken together, the findings confirm all three hypotheses: labour productivity in Europe is shaped by a complex set of country-specific, sector-specific, and size-specific determinants, and these determinants also interact when analysed jointly. This aligns with the broader literature on structural heterogeneity in Europe. [Ferrando and Ruggieri \(2018\)](#) and [Turégano \(2020\)](#) show that productivity differences across European countries stem from institutional structures, access to finance, education, and sectoral specialisation. The inconsistency of effects across countries and firm sizes reinforces the idea that the EU cannot be treated as a single, integrated productivity space.

The divergent effects of tangibility and intangibility across countries echo [Nakatani \(2024\)](#), who shows that the benefits of intangible assets depend heavily on national regulatory environments. Likewise, the general dominance of profitability and the size-related productivity advantages observed here are consistent with the evidence that large firms benefit from economies of scale, better access to skilled labour, and superior capital allocation ([Dvouletý & Blažková, 2021](#); [Avarmaa et al., 2013](#); [OECD, 2024](#)). The unusual negative marginal size effect found for large Portuguese firms contrasts with this pattern and may reflect country-specific structural obstacles such as bureaucratic constraints or weak innovation capabilities.

The findings also align with research showing that digitalisation, innovation intensity, and financial structure interact differently with firm size and sector ([Xiong et al., 2025](#); [Chen et al., 2025](#); [Xing et al., 2025](#); [Tang, 2025](#)). These studies emphasise that determinants of productivity must be interpreted in the context of national institutional conditions and sectoral strategic orientation.

Overall, the results highlight that labour productivity in Europe is influenced by a multifaceted and context-dependent set of factors, with non-uniform and sometimes contradictory effects of common explanatory variables such as size, tangibility, leverage, and financialisation. This underscores the need for differentiated policy strategies that recognise the structural diversity of European firms across countries, sectors, and size classes, instead of relying on EU-wide uniform productivity-enhancing measures.

Finally, the study faces several limitations. Although the database provides harmonised financial information, coverage varies across countries, which may limit the generalisability of the findings. The use of aggregate-level data rather than firm-level micro-data may mask heterogeneity in financial behaviour and sectoral composition. Differences in national accounting practices, confidentiality thresholds, and statistical conventions further complicate cross-country comparisons. Moreover, key institutional variables—such as regulatory quality, creditor protection, innovation capacity, and education levels—are absent from the dataset, potentially leading to oversimplified interpretations of cross-country patterns. These limitations suggest that future research should integrate richer institutional variables and micro-level evidence to more fully capture the structural drivers of productivity differences in Europe.

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