The Rise and Fall of Misallocation: From Firms to Aggregate Productivity in Spain, 2003–2023*

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Abstract

This paper analyzes the evolution of total factor productivity (TFP) and allocative efficiency in Spain over 2003–2023 using firm-level balance-sheet data. We estimate firm-level TFP and construct within-industry measures of the marginal revenue products of capital and labor to track misallocation. We uncover a clear two-phase pattern. Between 2003 and 2013, aggregate TFP fell sharply while the dispersion of the marginal revenue products increased markedly, implying a substantial rise in TFP losses from misallocation. After 2013, TFP recovered, dispersion declined, and these losses were partly reversed, consistent with improved allocative efficiency. Cross-country evidence further indicates that other Southern European economies share a similar two-phase pattern, characterized by a pronounced deterioration in allocative efficiency prior to 2013, followed by a partial reversal and subsequent improvement, in contrast to the experience of Northern European countries. In the case of Spain, we further show that the post-crisis improvement was associated with a declining share of small firms, better alignment of credit growth with firm productivity and capital scarcity, and stronger selection through employment and investment growth.

Keywords: Total Factor Productivity, Misallocation, Firm Dynamics

JEL Codes: D24, E23, O47, O52

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1. Introduction

A central question in the study of economic growth is why income levels differ so dramatically across countries. The standard development accounting framework decomposes output into contributions from physical capital, human capital, and a residual commonly referred to as Total Factor Productivity (TFP). In the canonical formulation, aggregate output Y is expressed as:

$$Y = AK^{\alpha}(hL)^{1-\alpha}, \tag{1}$$

where K is the physical capital stock, L is labor, h is human capital per worker, A represents aggregate TFP, and α is the capital share. The literature has shown that measured inputs—capital and labor adjusted for quality—explain only a fraction of cross-country income variation, leaving a substantial role for TFP (Klenow and Rodriguez-Clare, 1997; Prescott, 1998; Caselli, 2005; Jones, 2016; Lagakos and Schoellman, 2026). This has motivated a large literature on the sources of productivity differences across countries. Starting with contributions by Banerjee and Duflo (2005), Guner et al. (2008), Restuccia and Rogerson (2008), and Hsieh and Klenow (2009), a growing body of work has focused on how distortions that misallocate resources across production units can have large effects on aggregate productivity.[1] Understanding these mechanisms is particularly important from a policy perspective because weak TFP growth directly undermines living standards, wage growth, and the economy's capacity to absorb technological change.

This paper studies the evolution of TFP and allocative efficiency in Spain over the last two decades. Spain is a particularly informative case. Within this period, it experienced large capital inflows, a major housing and construction boom, a deep financial crisis, and a prolonged adjustment process.[2] These developments make it a natural setting for studying how aggregate productivity evolves as the allocation of capital and labor across firms first deteriorates and later improves. More broadly, the Spanish experience speaks to a central question in macroeconomics and development: to what extent are weak productivity outcomes driven not only by low average firm-level efficiency, but also by the misallocation of resources across heterogeneous producers? In this sense, improving allocative efficiency—getting capital and labor to more productive firms—is central to reviving sustained productivity growth.

[1] See Hopenhayn (2014) and Bergquist et al. (2026) for recent reviews. The focus here is on the negative effects of distortions on TFP. Petit et al. (2026) show that distortions correlated with firm productivity can increase TFP by stimulating entry.

[2] Jimeno and Santos (2014) provide an excellent account of the crisis in Spain during the Great Recession.

Our empirical analysis combines detailed firm-level data with a simple sufficient-statistics view of misallocation. We use the *Central de Balances* of the Banco de España to construct a long panel of Spanish firms from 2000 to 2023, with annual information on value added, employment, wages, and capital stocks. These data allow us to estimate firm-level TFP from Cobb-Douglas value-added production functions at the two-digit industry level, using the control-function approach of Olley and Pakes (1996), Levinsohn and Petrin (2003), and Wooldridge (2009). We then aggregate firm-level productivity to obtain sectoral and economy-wide TFP indices. To measure allocative efficiency, we follow the Hsieh–Klenow approach and construct firm-level measures of the marginal revenue product of capital (MRPK), the marginal revenue product of labor (MRPL), and revenue productivity (TFPR). Our key misallocation indicators are the within-industry dispersions of MRPK and MRPL: in a frictionless economy, these marginal products would be equalized across firms, so greater dispersion signals stronger distortions in the allocation of inputs. To place Spain in comparative perspective, we also replicate part of the analysis using the Orbis Historical dataset for a set of Southern and Northern European economies.[3]

Our results reveal a striking two-phase pattern. Between 2003 and 2013, aggregate TFP in Spain declined sharply, first during the boom and then during the crisis. Over the same period, the dispersion of MRPK and MRPL rose markedly, indicating a deterioration in allocative efficiency. The Spanish economy was accumulating capital and expanding employment, yet productivity was falling, and resources were increasingly allocated inefficiently across firms. After roughly 2013, this pattern reverses. Aggregate TFP recovers, while the dispersion of marginal revenue products declines, pointing to a substantial improvement in the allocation of capital and labor. In cross-country comparisons, Spain and other Southern European economies also exhibit higher and more volatile MRPK dispersion than Northern European countries, consistent with more severe misallocation during the pre-crisis years.

Finally, we investigate the sources of this post-crisis improvement. We document three complementary mechanisms. First, the firm-size distribution shifts away from very small firms, consistent with a cleanup and reallocation process in which marginal producers contract or exit. Second, credit growth becomes more strongly aligned with firm productivity and capital scarcity, suggesting that the financial system allocates resources more effectively after the crisis. Third, employment and investment growth become more closely

[3] In particular, Spain, Italy, and Portugal represent Southern Europe, while Germany, France, and Belgium represent Northern Europe.

linked to firm productivity, indicating improved selection and reallocation toward better-performing firms. Taken together, these patterns suggest that the post-crisis recovery in Spain involved not only higher average productivity but also a more efficient distribution of resources across firms.

1.1 Related Literature

Several recent papers also examine Spanish productivity from a firm-level perspective. Arregui and Shi (2023) study labor productivity using Spanish firm-level data and emphasize the role of financial constraints, firm heterogeneity by size and age, and differences in capital- and labor-market constraints across firms. de Guevara Radoselovics and Bosque (2025) document large and persistent within-sector productivity differences across Spanish firms, showing that allocative efficiency and firm dynamics are central to understanding aggregate productivity performance. Finally, Villegas-Sanchez (2025) highlights the role of business dynamism and firm life cycles, arguing that Spain's productivity slowdown is linked not only to misallocation but also to weak growth among mature firms and barriers that hinder firm expansion over time. Relatedly, Riveiro (2025) argues that Spain's weak firm life-cycle growth partly reflects the fact that borrowing constraints disproportionately restrain firms with high expected productivity growth.

A growing literature links Spain's weak productivity performance before the Global Financial Crisis to the interaction of abundant capital inflows, distorted credit allocation, and weak institutional discipline. A central theme in this work is that the problem was not a shortage of capital. Rather, the key issue was that cheap external finance was directed toward firms, sectors, and locations that were not the most productive.

Gopinath et al. (2017) provide an account of this mechanism for Southern Europe. They show that euro-area interest rate convergence, combined with size-dependent financial frictions, channeled cheap credit toward high-net-worth firms rather than high-productivity firms. In their framework, firms with more collateral—not necessarily better technologies—could borrow more cheaply and expand, while productive but asset-poor firms remained constrained. The result was a widening dispersion of MRPK across firms and a decline in aggregate TFP despite strong capital accumulation.

Complementing this view, García-Santana et al. (2020) emphasize the role of political connections and cronyism in Spain. They argue that worsening allocative efficiency in Spain was especially severe in sectors where success depended more on connections with public officials, consistent with a rise in cronyism and institutional deterioration. This

interpretation is reinforced by Challe et al. (2019), who argue that large and persistent capital inflows into Southern Europe were accompanied by a deterioration in institutional quality, and by Fernández-Villaverde et al. (2013), who stress how easy external borrowing in the euro area weakened political discipline and contributed to distorted credit dynamics. Finally, Basco et al. (2025) show that local housing booms relaxed collateral constraints for firms with more real-estate collateral, increased their borrowing and investment, and thereby generated within-industry capital misallocation and sizable TFP losses.

Our emphasis on pre- and post-crisis periods is shared by Fu and Moral-Benito (2018), who also document a sharp contrast between the crisis years and the subsequent recovery: the initial TFP decline is associated with a generalized rise in firms' capital-to-labor ratios, whereas the later TFP revival is driven primarily by improved allocative efficiency across firms. On the recovery of TFP, Albrizio et al. (2026) identify the causal effect of high-frequency monetary policy shocks and show that monetary easing reduces MRPK dispersion in Spain, mainly through incumbent firms' investment responses rather than through entry and exit.

Relative to this literature, our contribution is to document both the deterioration and the subsequent recovery of allocative efficiency in Spain over 2003–2023 within a unified framework, and to connect those aggregate patterns to firm dynamics, credit allocation, and cross-country evidence.

The remainder of this paper is organized as follows. Section 2 describes our data sources for Spain and the European cross-country analysis. Section 3 documents the evolution of aggregate TFP in Spain, combining evidence from macroeconomic data with aggregate measures constructed from firm-level microdata. Section 4 analyzes the dynamics of MRPK and MRPL dispersion and presents cross-country comparisons. Section 5 investigates the sources of the post-crisis improvement in allocative efficiency. Section 6 concludes.

2. Data

2.1 Spanish Firm-Level Data

Our primary data source for Spain is the *Central de Balances* of the Banco de España, which provides annual firm-level balance-sheet information for the non-financial market economy from 2000 to 2023. The dataset contains detailed information on value added, em-

ployment, wages, and capital stocks for a very large number of firms, and is therefore well suited to studying productivity, misallocation, and firm dynamics over a period that spans the pre-crisis expansion, the Global Financial Crisis and subsequent recession, and the post-crisis recovery.

The sample has broad coverage and closely tracks the aggregate evolution of the Spanish economy. In the sample, coverage is high for the number of firms and the wage bill, and more moderate, but still substantial, for employment and value added. Moreover, aggregates constructed from the microdata closely follow the dynamics of national accounts for value added and the wage bill. As shown in Appendix A.1, the correlations between the microdata aggregates and the corresponding national accounts series exceed 80–85 percent (see Figure A.2), while Figure A.1 documents the evolution of firms and wage-bill coverage over time.

The dataset also provides an accurate representation of the firm-size and sectoral composition of the Spanish market economy. Small firms with fewer than 10 employees account for roughly 86 percent of firms in the sample, while large firms with more than 200 employees represent about 0.4 percent, figures that are very close to those in the population. Likewise, the sectoral distribution in the sample closely mirrors that of the economy as a whole, with trade, professional and scientific activities, construction, hospitality, and transport among the most important sectors. These patterns are documented in Figure A.3 in Appendix A.1.

Overall, these features make the *Central de Balances* a particularly useful source for our purposes. It combines a long time dimension, broad coverage, and a high degree of representativeness across the key margins relevant to this paper. Additional evidence on coverage, aggregate consistency, and the distribution of firms by size and sector is provided in Appendix A.1.

2.2 European Cross-Country Data

For the cross-country analysis, we use Orbis Historical, an extensive firm-level database compiled by Moody's Bureau van Dijk (BvD) that covers millions of companies worldwide. Orbis provides variables comparable to those available in the *Central de Balances*—including value added, employment, wages, and capital stocks—over the period 2000 to 2023. BvD constructs this database by aggregating information from various national sources, such as business registries, and harmonizes it into a globally comparable format.

Following Kalemli-Özcan et al. (2024), we focus on a sample of European countries

with the best coverage in Orbis: Spain, Italy, and Portugal (representing Southern Europe) and Germany, France, and Belgium (representing Northern Europe). The microdata closely track aggregate macroeconomic dynamics for value added and the wage bill as reported by the OECD across all six countries. As documented in Appendix A.2, Figure A.4 compares the annual growth rates of value added and the wage bill in Orbis with the corresponding aggregate series, while Figure A.5 shows that the sectoral distributions of value added and the wage bill in the Orbis data also replicate well the patterns observed in the macro data across the pooled sample of countries.

3. The Evolution of Aggregate TFP in Spain: Macro and Firm-Level Evidence

This section analyzes the evolution of aggregate total factor productivity (TFP) in Spain over the period 2003–2023 using firm-level microdata. Our approach follows a bottom-up methodology. We first estimate TFP at the firm level by recovering productivity as the residual from an estimated value-added production function. These firm-level TFP estimates are then aggregated using value-added weights to construct an economy-wide measure of TFP. This microdata-based aggregation allows aggregate productivity dynamics to reflect not only within-firm productivity changes over time, but also shifts in economic activity across firms with heterogeneous productivity levels. As a result, movements in aggregate TFP can be directly linked to firm-level adjustment and patterns of resource reallocation.[4]

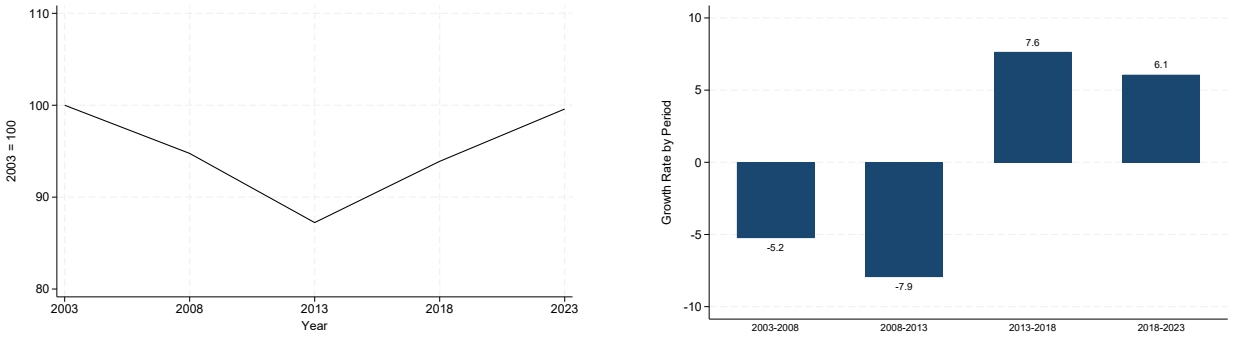
Our estimates reveal a clear two-phase pattern in Spanish aggregate TFP over the 2003–2023 period. During the first decade, from 2003 to 2013, TFP declined markedly. In the pre-crisis boom period (2003-2008), aggregate TFP fell by 5.2 percent, and during the financial crisis (2008-2013), it fell by a further 7.9 percent, bringing the cumulative decline to approximately 13 percent relative to 2003 levels. The TFP index, normalized to 100 in 2003, reached its trough at around 87 in 2013. Figure 1 summarizes both the level and the period-by-period growth rates of our microdata-based TFP measure.

This decline during the boom period is particularly noteworthy because it occurred alongside rapid capital accumulation and employment growth. The Spanish economy was expanding strongly in terms of measured inputs, yet productivity was deteriorating.

[4]Technical details on the estimation of firm-level TFP and the production-function methodology are provided in Appendix C.1.

Figure 1: TFP in Spain: Levels and Growth Rates

(a) **TFP levels (2003 = 100)** (b) **TFP growth**



NOTES: Panel A reports the evolution of aggregate TFP in Spain, normalized to 100 in 2003, based on firm-level microdata, following Wooldridge (2009). Panel B reports cumulative TFP growth rates for the subperiods 2003–2008, 2008–2013, 2013–2018, and 2018–2023.

This apparent paradox is consistent with the misallocation narrative: abundant credit flowed disproportionately to low-productivity firms and sectors—notably construction and real estate—while productive firms in tradable sectors remained credit-constrained. The result was a growing volume of resources deployed inefficiently.

The second phase begins around 2013, when TFP starts to recover. Between 2013 and 2018, aggregate TFP grew by 7.6 percent, and between 2018 and 2023 by a further 6.1 percent. By 2023, TFP had approximately returned to its 2003 level, though not yet surpassed it. This recovery coincides with the unwinding of the construction boom, the restructuring of the financial sector, and various labor market reforms.[5]

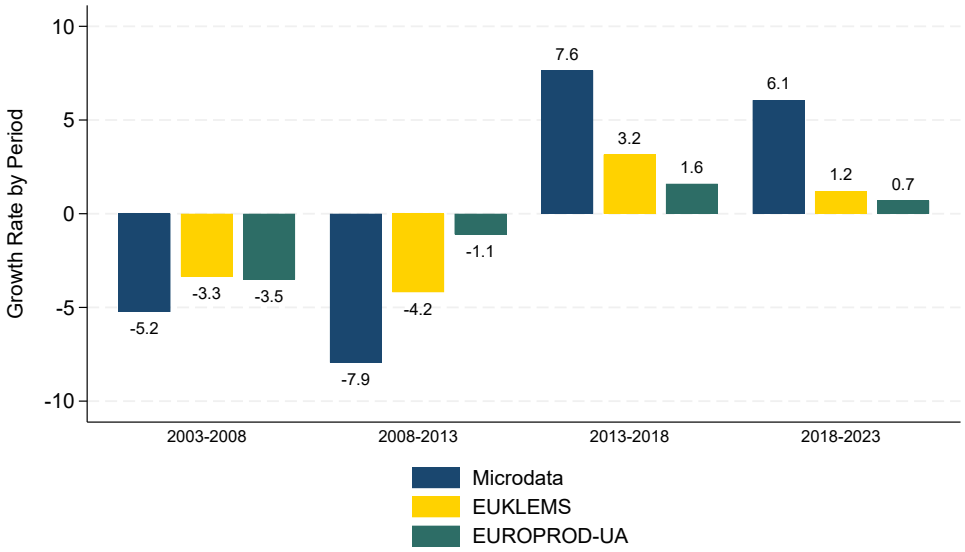
We validate these findings by comparing our microdata-based estimates with external sources. EUKLEMS and EUROPROD-UA data, which are based on national accounts rather than firm-level microdata, show qualitatively identical patterns: negative TFP growth during 2003–2013 and positive growth thereafter.[6] The magnitudes differ somewhat, with the microdata estimates showing larger swings. For instance, during 2003–

[5]The labor market reforms enacted in 2010, 2012, and 2021 —whose effects have been largely complementary— have contributed to facilitating internal adjustment mechanisms, reducing labor market duality, and promoting both greater employment stability and a more efficient reallocation of labor toward more productive firms and uses. Consistent with these developments, OECD indicators of labor market flexibility point to a significant improvement in Spain since 2013.

[6]The EUKLEMS database provides measures of economic growth, productivity, employment creation, capital formation, and technological change at the industry level for all European Union member states from 1970 onwards. It can be accessed at https://euklems-intanprod-llee.luiss.it/. The EUROPROD-UA database contains annual and quarterly series for Total Factor Productivity (TFP) growth for five Euro Area countries, adjusted for changes in factor utilization and for non-zero profits. Details can be found in Comin et al. (2025).

2008, our estimates show a decline of 5.2 percent compared with 3.3 percent (EUKLEMS) and 3.5 percent (EUROPROD-UA). In the recovery period of 2013–2018, our estimate of 7.6 percent compares with 3.2 percent and 1.6 percent, respectively. These differences likely reflect variations across datasets and the different methodologies used for TFP estimation, but the qualitative agreement across sources strengthens confidence in the overall pattern. Figure 2 reports this comparison across data sources.

Figure 2: TFP Growth in Spain: Microdata and External Sources



NOTES: The figure compares cumulative TFP growth rates across four subperiods, 2003-2008, 2008-2013, 2013-2018, and 2018-2023, using our microdata-based estimates as reported in Figure 1, EUKLEMS, and EUROPROD-UA. EUKLEMS and EUROPROD-UA are based on aggregate national accounts data rather than firm-level microdata. EUROPROD-UA excludes agriculture, real estate, public administration, education, and health and social work. EUKLEMS further excludes mining, coke and refined petroleum products, household services, and extraterritorial organizations. The firm-level sample additionally excludes finance, other services, and utilities.

4. Misallocation and Aggregate Productivity

To understand whether the dynamics of aggregate TFP reflects changes in resource allocation across firms, we next turn to measures of within-industry misallocation. The connection between resource misallocation and aggregate productivity can be illustrated through a simple framework. Consider a firm operating with Cobb–Douglas technology:

$$Y_{et} = A_{et} K_{et}^{\alpha} L_{et}^{1-\alpha}, \tag{2}$$

where Y_{et} is output of firm e at time t, A_{et} is firm-level productivity, K_{et} denotes capital, L_{et} denotes labor, and α is the capital share. The firm's manager chooses capital and labor to maximize profits:

$$\pi_{et} = P_{et}Y_{et} - r_t K_{et} - w_t L_{et}, \tag{3}$$

where P_{et} is the output price, r_t is the rental rate of capital, and w_t is the wage. In a competitive equilibrium without frictions, the first-order conditions for profit maximization imply that the marginal revenue product of capital (MRPK) equals the rental rate and the marginal revenue product of labor (MRPL) equals the wage across all firms and are given by

$$\text{MRPK}_{et} \equiv P_{et}\frac{\partial Y_{et}}{\partial K_{et}} = \alpha P_{et}A_{et}K_{et}^{\alpha-1}L_{et}^{1-\alpha} = r_t, \quad \text{and} \tag{4}$$

$$\text{MRPL}_{et} \equiv P_{et}\frac{\partial Y_{et}}{\partial L_{et}} = (1-\alpha)P_{et}A_{et}K_{et}^{\alpha}L_{et}^{-\alpha} = w_t. \tag{5}$$

These conditions also imply that the capital-labor ratio is equalized across firms within a sector and is equal to

$$\frac{K_{et}}{L_{et}} = \frac{\alpha}{1-\alpha}\frac{w_t}{r_t}. \tag{6}$$

Hence, in a frictionless economy, MRPK, MRPL, and the capital-labor ratio are identical across all firms in the same industry.

When some firms face higher effective capital costs—due to credit constraints, regulatory burdens, or other distortions—they will have higher MRPK in equilibrium because they are unable to expand to the point where their marginal product equals the common rental rate. Conversely, subsidized or politically favored firms will have lower MRPK because they have been able to accumulate more capital than warranted by their productivity. The same logic applies to labor: firms facing hiring frictions or regulatory costs will exhibit higher MRPL. Consequently, the dispersion of MRPK and MRPL across firms within narrowly defined industries constitutes direct evidence of misallocation. This is the central insight of Hsieh and Klenow (2009): the within-industry dispersion of marginal revenue products is a sufficient statistic for the TFP loss attributable to firm-level distortions and misallocation.

4.1 Measuring MRPK, MRPL, and Dispersion

Following Hsieh and Klenow (2009), we construct firm-level measures of marginal revenue product of capital (MRPK), marginal revenue product of labor (MRPL), and revenue

TFP (TFPR), as

$$\text{MRPK}_{et} \propto \frac{VA_{et}}{K_{et}}, \tag{7}$$

$$\text{MRPL}_{et} \propto \frac{VA_{et}}{L_{et}}, \quad \text{and} \tag{8}$$

$$\text{TFPR}_{et} \propto \frac{VA_{et}}{K_{et}^{\alpha}\, L_{et}^{1-\alpha}}, \tag{9}$$

where VA_{et}, K_{et}, and L_{et} are the value added, capital stock, and labor input of firm e in year t, and the parameter α represents the capital share. MRPK and MRPL measure value added per unit of capital and labor inputs, respectively, whereas TFPR measures value added per unit of a Cobb-Douglas aggregate of inputs. Following Gopinath et al. (2017), we set $\alpha = 0.35$.[7]

As measures of misallocation, we use the within-industry dispersion of MRPK, MRPL and TFPR. In a frictionless economy, MRPK and MRPL would be equalized across firms within an industry—see equations (4) and (5) above. As a result, any dispersion would reflect distortions in the efficient allocation of resources. As we show in Appendix B, equation (19), TFPR is also affected by distortions, and its dispersion is informative about the degree of misallocation. We compute the standard deviation of log MRPK, log MRPL, and log TFPR within narrowly defined industries for each year, and then aggregate across industries using value-added weights to obtain economy-wide dispersion indices.

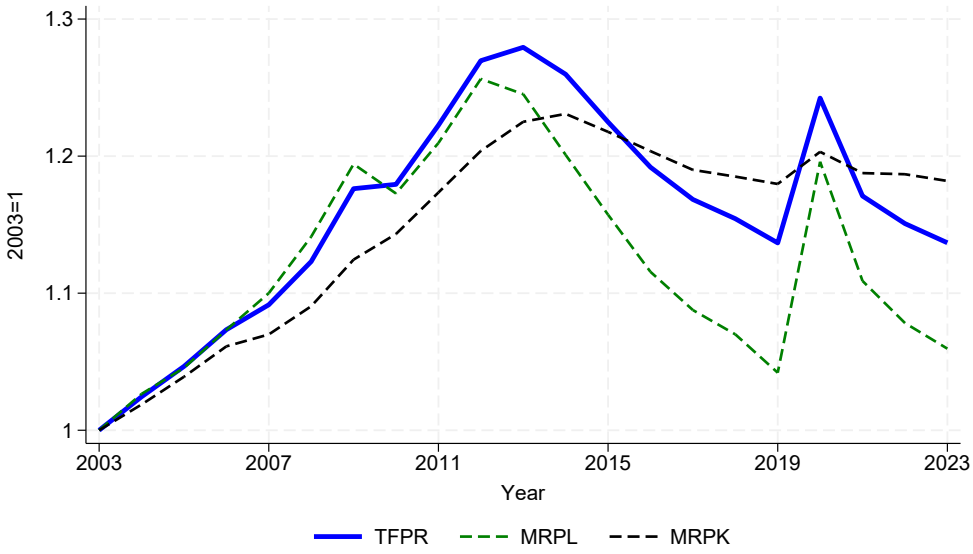
4.2 Spain

The dispersion of TFPR, MRPK and MRPL across firms within industries tracks the evolution of aggregate TFP remarkably closely, but with an inverted sign: periods of falling TFP correspond to rising dispersion, and vice versa. We index all dispersion measures to 1 in 2003 to facilitate comparison of trends.

Between 2003 and 2013, the dispersion of all three measures, TFPR, MRPK, MRPL, increases substantially. TFPR dispersion shows the sharpest increase, rising by approximately 30 percent relative to 2003 by its peak around 2011–2013. MRPL and MRPK follow a broadly similar trajectory, with peak increases of around 25 percent and 23 percent, respectively. These overall dynamics are summarized in Figure 3 and Table 1. The table is useful for quantifying the magnitude of changes from the beginning of the sample,

[7] The number corresponds to the average capital share across sectors in the US, a relatively undistorted economy.

Figure 3: Evolution of Misallocation in Spain



NOTES: The figure reports the evolution of within-industry dispersion measures for TFPR, MRPL, and MRPK normalized to 1 in 2003. Higher dispersion indicates greater within-industry misallocation.

through the dip in aggregate TFP around 2013, to the end of the sample. It is clear that all three dispersion measures rise sharply during 2003–2013, while the subsequent decline is only partial, especially for MRPK.

After 2013, dispersion declines across all three measures. The reduction is particularly pronounced for MRPL, which, by 2023, had nearly returned to its 2003 level. TFPR dispersion also declines substantially, though it remains somewhat elevated relative to 2003. MRPK dispersion shows a more moderate decline and remains the most elevated of the three measures by 2023. In this sense, the post-crisis improvement in allocative efficiency is broad-based, but incomplete. The ranking across measures is also informative: distortions associated with capital allocation appear more persistent than those associated with labor allocation, a pattern that will reappear below in the cross-country evidence.

The results are consistent across broad sectors. Examining the goods, construction, and services sectors separately, we find qualitatively similar dynamics across all sectors: rising dispersion during 2003–2013 and declining dispersion thereafter. The goods and, to a greater extent, the construction sector exhibit somewhat larger fluctuations in MRPL dispersion, which may reflect the greater exposure of manufacturing and construction to the credit and housing boom. The services sector exhibits persistent elevation in MRPK dispersion, suggesting that capital misallocation in services has been slower to unwind.

Table 1: Evolution of Misallocation in Spain

	sd[MRPL] (1)	sd[MRPK] (2)	sd[TFPR] (3)
2003	0.52	1.48	0.63
2013	0.65	1.81	0.81
2023	0.55	1.75	0.72
2003-2013 (%)	24.52	22.51	27.94
2013-2023 (%)	-14.91	-3.52	-11.15

NOTES: The table reports within-industry dispersion of MRPL, MRPK, and TFPR. Dispersion measures are shown for 2003, 2013, and 2023, along with percentage changes over the periods 2003-2013 and 2013–2023. Higher dispersion reflects greater within-industry misallocation.

These sectoral patterns are reported in Appendix C.2, Figure C.6.

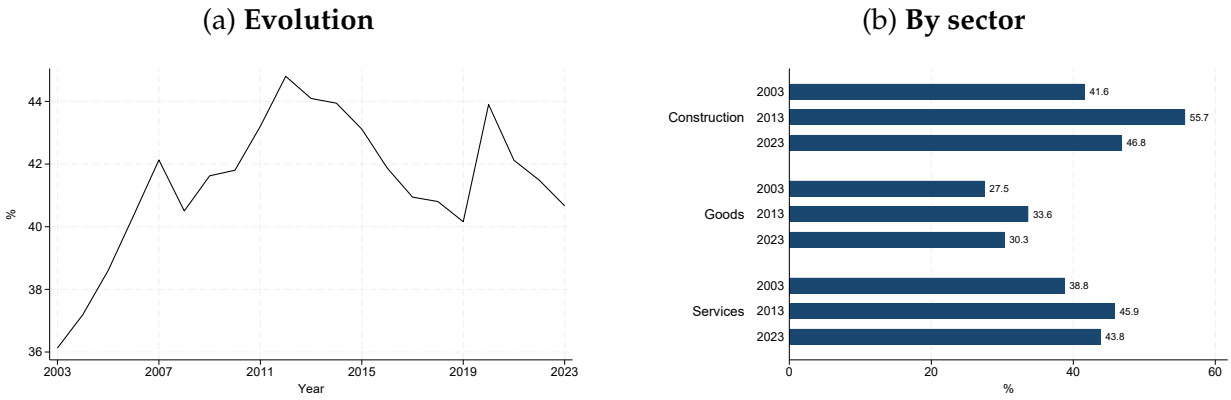
These patterns are also robust to corrections for measurement error. Following Bils et al. (2021), who propose a methodology to distinguish true dispersion in marginal products from measurement error in firm-level data, we find that the temporal patterns are preserved: the rise through 2013 and decline thereafter are evident in the corrected series. In addition, the level of MRPK dispersion remains notably elevated even after the correction, highlighting the role of structural distortions rather than mere data noise in driving the observed patterns; see Appendix C.3, Figure C.7.

Lastly, Figure 4 illustrates TFP losses relative to a benchmark of no misallocation after correcting for measurement error. This figure complements Figure 3 and Table 1 by translating dispersion into implied aggregate efficiency losses.[8] Panel A shows that allocative efficiency losses increased between 2003 and 2013 and then partially reversed by 2023. Specifically, misallocation accounts for a loss of about 36 percent of TFP in 2003, rising to 44 percent in 2013, and declining to 41 percent by 2023. Thus, while the post-crisis reallocation substantially reduced the losses associated with misallocation, the Spanish economy in 2023 still remained well below the benchmark of frictionless within-industry allocation.

There is also considerable heterogeneity in TFP losses across sectors. Panel B shows that the construction and services sectors exhibit larger allocative efficiency losses than goods-producing industries. Consistent with the aggregate patterns, these sectors experience a marked deterioration in allocative efficiency between 2003 and 2013, followed by a partial recovery through 2023. These sectoral differences are consistent with evidence

[8]See Appendix B.2 for details on the construction and interpretation of the allocative efficiency measure.

Figure 4: TFP Loss from Misallocation



NOTES: The figure reports total factor productivity losses relative to a benchmark of no misallocation after correcting for measurement error. Panel A shows the evolution of allocative efficiency losses over the period 2003-2023. Panel B reports the corresponding losses for the goods, construction, and services sectors.

from García-Santana et al. (2020), who document that during the pre-financial-crisis period, misallocation was larger in construction, services, and trade.[9] Taken together, the results in this subsection point to a common conclusion: the pre-crisis period was characterized by a broad worsening in allocative efficiency, while the post-2013 recovery involved a meaningful but incomplete unwinding of these distortions.

4.3 Cross-Country Comparison

Placing Spain in a comparative European context, we compute MRPK and MRPL dispersion indices for six countries using Orbis data and normalize all series to 1 in 2005. Panel A of Figure 5 shows the evolution of MRPK dispersion across these economies, while Panel B reports the corresponding patterns for MRPL. The addition of MRPL in Panel B shows that the Southern European pattern is not confined to capital allocation alone, although the cross-country differences are sharper and more systematic for MRPK than for MRPL.

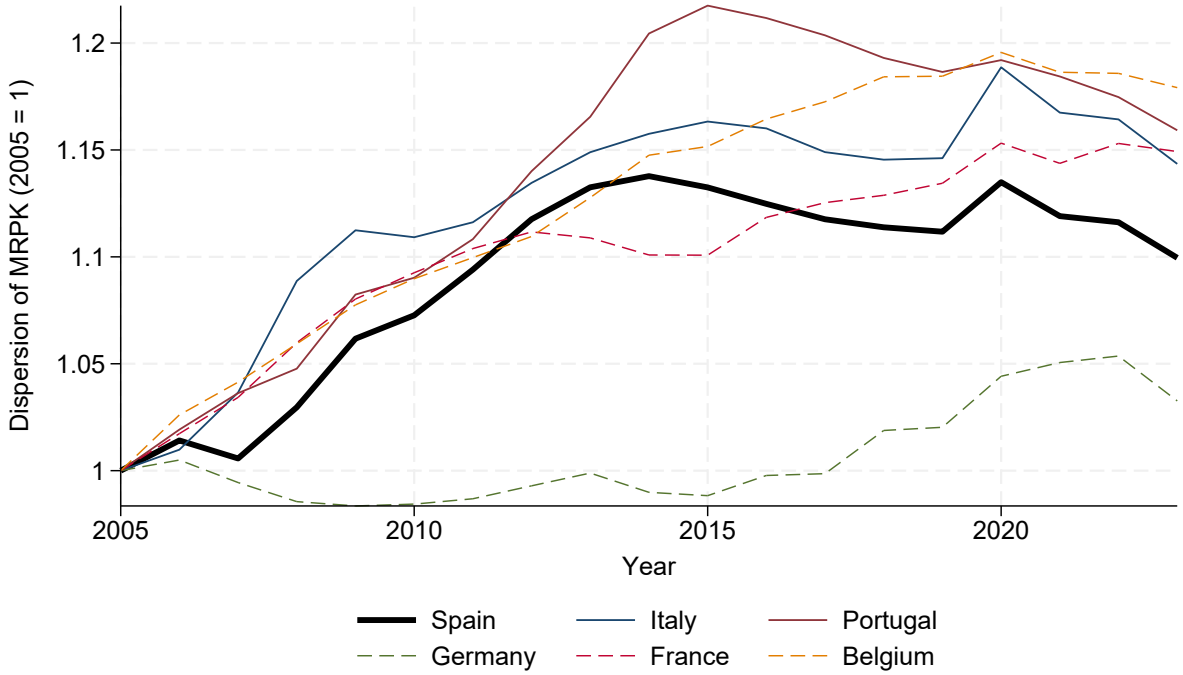
Spain exhibits higher and more volatile MRPK dispersion than the Northern European economies. The Spanish MRPK dispersion index rises rapidly from 2005, reaching approximately 1.13 by 2013, a 13 percent increase, before declining to around 1.10 by the early 2020s. Among the Southern European countries, Portugal shows the sharpest increase, with MRPK dispersion rising to over 1.20 by 2015, while Italy follows a path broadly similar to Spain's.

Germany presents a stark contrast, with MRPK dispersion remaining essentially flat

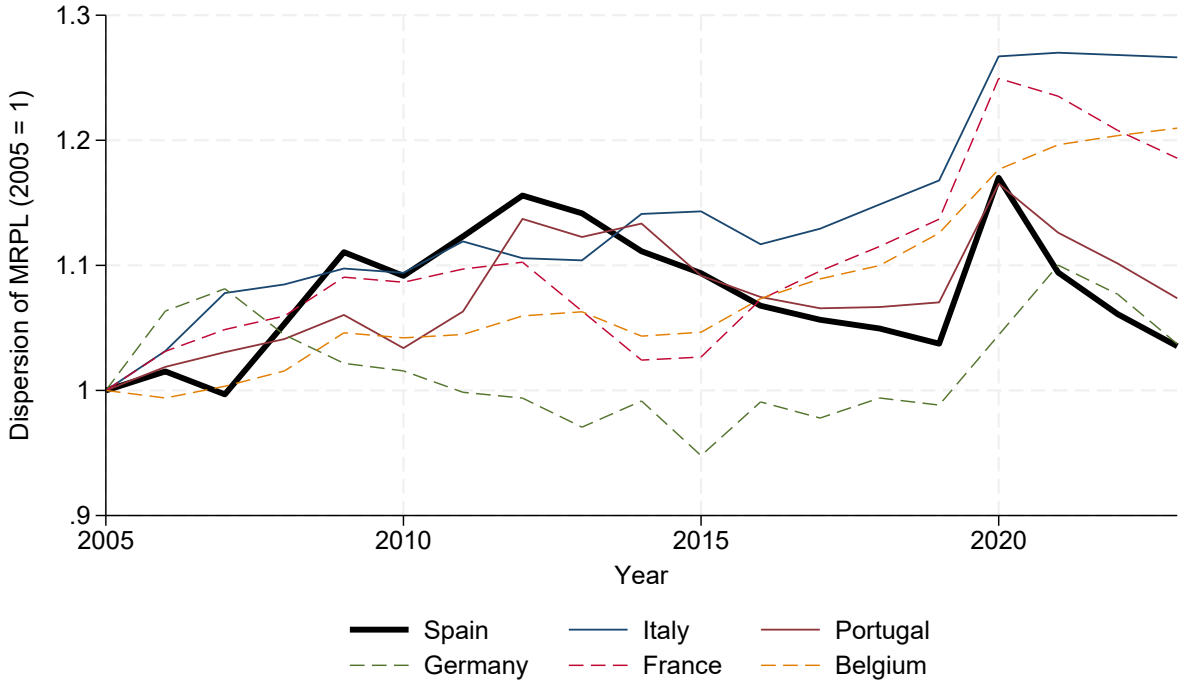
[9] Dias et al. (2016) provide similar evidence for Portugal.

Figure 5: Misallocation across Europe

(a) **MRPK dispersion**



(b) **MRPL dispersion**



NOTES: The figure reports the evolution of within-industry MRPK and MRPL dispersion for Germany, France, Belgium, Spain, Italy, and Portugal, normalized to 1 in 2005. Higher dispersion indicates greater misallocation of capital or labor across firms within industries. Southern European countries are shown together with Northern European economies for comparison.

until around 2015 and then rising only modestly to about 1.03 by 2023. France and Belgium occupy intermediate positions, with dispersion increasing gradually, accelerating somewhat after 2010. By the end of the sample period, all six countries show higher MRPK dispersion than in 2005, but the Southern European countries have experienced markedly larger increases, consistent with more severe misallocation during the pre-crisis boom and a subsequent partial correction.

Panel B shows that the cross-country patterns for MRPL are somewhat noisier, but still informative. Southern European economies also tend to exhibit higher and more volatile labor misallocation than the Northern countries, especially during the crisis and the immediate post-crisis years. Spain, Italy, and Portugal exhibit a more pronounced rise in MRPL dispersion up to the early 2010s, followed by some decline or stabilization thereafter, whereas Germany, France, and Belgium show flatter profiles overall. The contrast is less sharp than for MRPK, which suggests that the North-South divide is more closely tied to the allocation of capital than to the allocation of labor.

Taken together, the two panels reinforce the interpretation of the previous subsection. Relative to the Northern European economies, Southern Europe experienced a stronger increase in the dispersion of marginal revenue products during the years surrounding the boom and crisis, with the difference particularly pronounced for capital. This pattern is consistent with the view that cheap external finance and housing-related distortions played a central role in the deterioration of allocative efficiency in Southern Europe, while the subsequent adjustment involved only a partial correction of those distortions.

5. Sources of Allocative Efficiency Gains

Since about 2013, aggregate TFP has been increasing while the dispersion of MRPK and MRPL has been declining. This section investigates the mechanisms behind that improvement in allocative efficiency. The central question is whether the post-crisis recovery in Spain simply reflects higher average firm-level productivity, or also reflects a broader cleanup and reallocation process through which resources were redirected toward more productive or more capital-scarce firms. To address this question, we study three complementary channels: changes in the firm-size distribution, improved credit allocation, and improved firm selection through employment and investment growth.

Our empirical strategy is deliberately simple and closely connected to the sufficient-statistics view of misallocation. Rather than attempting to identify every underlying dis-

tortion structurally, we examine whether, in the post-2013 period, observable margins of adjustment become more strongly aligned with firm-level productivity measures. In particular, we ask whether credit, employment, and investment growth become more responsive to lagged productivity and, where relevant, to capital scarcity after the crisis. Following the logic emphasized by Bau and Matray (2023), reforms or shocks that reduce misallocation should lead firms with high marginal returns to expand relatively more, thereby compressing the dispersion of marginal revenue products and raising aggregate productivity.[10] In this sense, the regressions in this section provide reduced-form evidence on whether post-crisis reallocation in Spain moved resources toward the firms where they were socially more valuable.

We begin by documenting a shift in the firm-size distribution away from very small firms, together with stronger post-crisis growth among surviving young firms. We then turn to credit allocation, estimating whether the relationship between firm productivity and credit growth strengthened after 2013. Finally, we examine whether employment and investment growth became more tightly linked to lagged productivity, first within Spain and then in a comparative European perspective. Together, these exercises trace the main margins through which Spain's post-crisis productivity recovery was associated with improved allocative efficiency.

5.1 Changing Firm-Size Distribution and Firm Growth

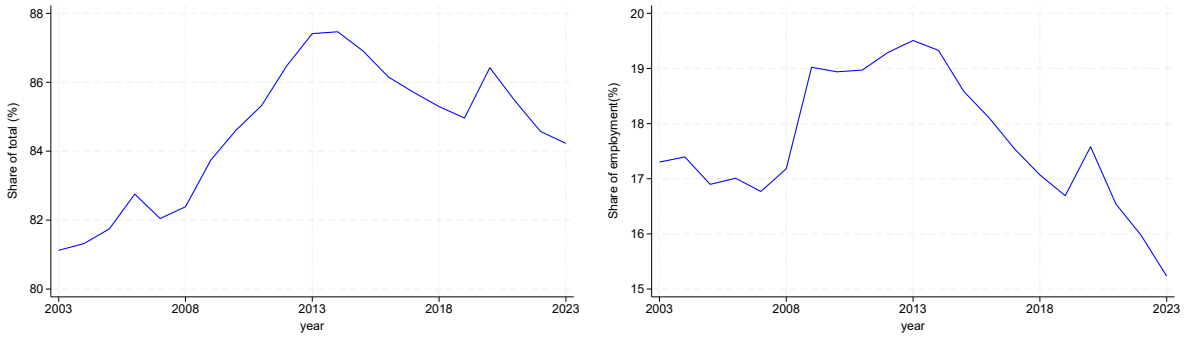
A well-established finding in the productivity literature is that small firms tend to have lower average productivity than larger firms, reflecting economies of scale, selection effects, and the tendency for the least productive firms to remain small. Changes in the size distribution and life-cycle growth can therefore affect aggregate productivity through a composition channel. These margins provide insight into whether the post-crisis recovery was accompanied by a more efficient process of firm selection and expansion.

We begin by documenting changes in the aggregate firm-size distribution. The share of small firms (those with fewer than 10 employees) in the total number of firms rose during the boom years, peaking at approximately 87 percent around 2013, and has since declined to about 84 percent by 2023. The employment share of these small firms has followed a similar trajectory, rising from around 17 percent in 2003 to a peak of approx-

[10] This interpretation is closely related to the broader sufficient-statistics approach developed by Sraer and Thesmar (2018), who show how firm-level treatment effects can be aggregated using moments of the wedge distribution, and to the general-equilibrium aggregation results in Baqaee and Farhi (2020), which clarify how changes in allocative efficiency map into aggregate TFP.

Figure 6: Firm Size Distribution

(a) **Firms,** <10 **employees** (b) **Employment,** <10 **employees**



NOTES: Panel A reports the share of firms with fewer than 10 employees in the total number of firms over the period 2003-2023. Panel B reports the share of total employment accounted for by firms with fewer than 10 employees over the same period.

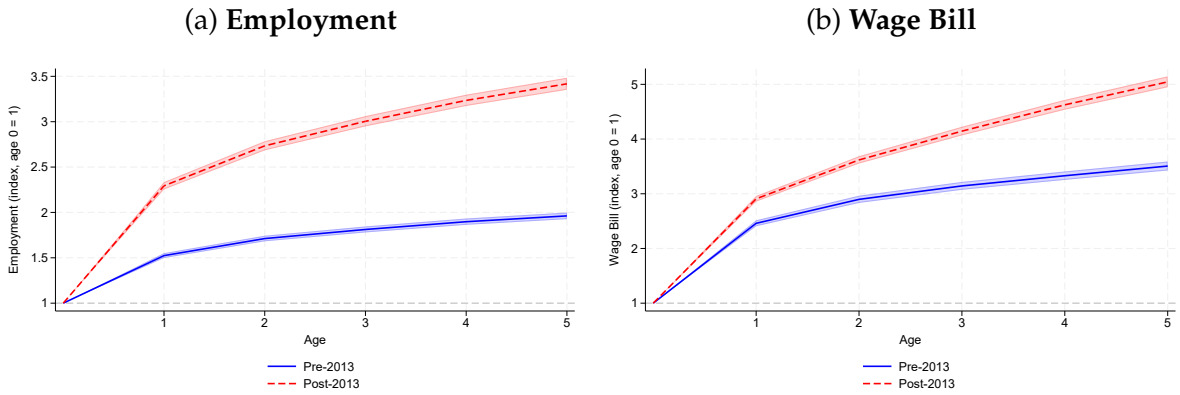
imately 20 percent around 2013, and then declining back to roughly 15 percent by 2023. These changes are summarized in Figure 6.

This compositional shift—a declining share of the smallest and typically least productive firms—is consistent with a post-crisis cleanup in which marginal firms exited or were absorbed, while more productive firms survived and expanded. The tightening of credit conditions after 2012, the resolution of non-performing loans, and the restructuring of the banking sector all contributed to imposing harder budget constraints on firms, forcing the exit of those unable to survive without cheap credit. Figure 6, therefore, captures an extensive-margin dimension of improved allocative efficiency: the post-crisis period is characterized by a smaller weight of very small firms in both the firm distribution and total employment.

We next examine whether the post-crisis period also exhibits stronger growth dynamics among surviving young firms. Figure 7 compares life-cycle trajectories of employment (panel A) and wage-bill (panel B) for firms that began operating in 2000–2001 with those of firms that entered in 2013–2014. Firms born after 2013 grow substantially faster along both margins. By age 5, post-2013 entrants have more than tripled their initial employment, compared with approximately a doubling for pre-2013 entrants. The contrast is also sharp for the wage bill: post-2013 cohorts reach nearly five times their initial wage bill by age 5, whereas pre-2013 cohorts reach only about three and a half times.

These life-cycle patterns point to an intensive-margin dimension of the cleanup and reallocation process. In a distorted environment, young, productive firms may remain too small for too long because credit constraints, weak selection, or congestion from low-

Figure 7: Life-cycle dynamics



NOTES: This figure reports the life-cycle dynamics of firm-level employment (panel A) and wage bill (panel B) for firms that started operating in 2000-2001 (blue line) or in 2013-2014 (red line). Employment and wage bill profiles are obtained from regressions with firm fixed effects and age dummies, normalized to 1 at age 0. Shaded areas represent 95% confidence intervals based on heteroskedasticity-robust standard errors clustered at the firm level.

productivity incumbents prevent them from scaling up. The stronger post-2013 growth of surviving entrants is therefore consistent with an environment in which expansion became easier for better-performing firms. Taken together, Figures 6 and 7 suggest that the post-crisis improvement in allocative efficiency operated through both margins: a decline in the weight of very small firms in the aggregate distribution and faster subsequent growth among cohorts entering after the crisis.

5.2 Allocation of Credit

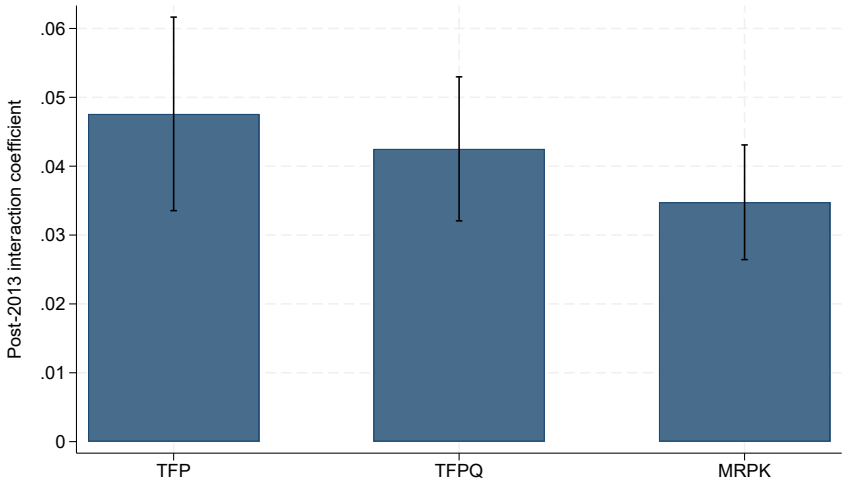
A key mechanism by which misallocation operates is the financial sector's allocation of credit: if banks allocate credit based on collateral, political connections, or relationship lending rather than on productivity, the resulting capital allocation will be inefficient. In the context of the post-crisis recovery, the relevant question is whether credit began to flow more systematically toward firms with higher marginal returns. We assess this idea by asking whether the relationship between firm-level productivity and credit growth strengthened after 2013. Specifically, we estimate the following specification:

$$\Delta \log \text{Credit}_{et} = \beta_1 A_{et-1} + \beta_2 (A_{et-1} \times \text{Post2013}_t) + \gamma' X_{et-1} + \alpha_{i(e)t} + \omega_{s(et)} + \varepsilon_{et}, \quad (10)$$

where $\Delta \log \text{Credit}_{et}$ is firm-level credit growth, A_{et-1} is the lagged firm-level log TFP estimated in Section 3, Post2013_t is a dummy equal to 1 for 2014-2023, X_{et-1} is a vector of firm-level controls (including credit exposure, multi-bank relations and default status),

$\alpha_{i(e)t}$ are sector-year fixed effects, $\omega_{s(et)}$ are firm-size dummies (0-49,50-250, and >250 employees), and ε_{et} are random errors. A positive and large value of the coefficient attached to TFP in the post-2013 period, β_2, would indicate that credit growth has become more strongly and positively related to firm productivity.

Figure 8: Allocation of Credit



NOTES: This figure reports the estimated post-2013 interaction coefficient β_2 in equation (10) for three alternative specifications: i) TFP estimated by the Wooldridge (2009) method; ii) TFP is proxied using TFPQ; iii) MRPK. The dependent variable is firm-level credit growth. The specifications include firm-level controls for default status (overdue loans), multiple-bank relationships, and credit exposure, as well as sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014-2023) relationship between firm productivity and credit growth relative to 2004-2013.

Figure 8 reports the OLS estimate of the post-2013 interaction coefficient β_2, and it compares it with estimates from alternative versions of equation (10) where TFP is replaced by either a measure of a model-based physical productivity (TFPQ), or by the MRPK, constructed as in Section 4.[11]

Our results confirm this prediction. When productivity is measured by TFP, the interaction coefficient implies a statistically significant increase of 0.05 in the post-crisis period. This result suggests that, after the crisis, banks became more likely to expand lending to

[11]See Appendix B, equations (18) and (19), for the model-based definition of physical productivity, TFPQ. As a baseline for TFPQ calculations, we use $\alpha = 0.35$ and $\sigma = 3$. In Appendix C, we replicate all the results for Spain in this section, with $\alpha = 0.12$ and $\sigma = 3$ and with $\alpha = 0.35$ and $\sigma = 6$, where $\alpha = 0.12$ corresponds to the average estimated capital share from the production-function estimation in Appendix C.1. The results, reported in Figure C.9 in Appendix C, are consistent with the baseline results in this section.

firms with higher underlying efficiency, consistent with a better alignment between financial flows and productive opportunities. When productivity is measured with the TFPQ, the post-crisis coefficient is 0.04. The pattern for MRPK is also particularly informative. The coefficient is positive (0.035), suggesting that as the housing bubble deflated and the banking sector underwent restructuring, credit allocation became more efficient after 2013, channeling resources toward capital-scarce (and hence capital-productive) firms.[12]

5.3 Better Selection: Wage Bill and Investment Growth

Beyond the allocation of credit, we examine whether the broader process of resource reallocation—as captured by employment and investment dynamics—has become more closely aligned with productivity. If allocative efficiency improved after the crisis, one would expect not only better credit allocation but also stronger expansion of more productive firms along real margins. We estimate specifications of the form:

$$\Delta \log y_{et} = \beta_1 A_{et-1} + \beta_2 (A_{et-1} \times \text{Post2013}_t) + \alpha_{i(e)t} + \omega_{s(et)} + \varepsilon_{et}, \tag{11}$$

where y_{et} is either wage bill or investment of firm e at time t.

Our specification is in the spirit of Foster et al. (2016), who study whether recessions are cleansing episodes in which employment and exit become more strongly linked to productivity. We find that the relationship between wage bill growth and TFP strengthens considerably after 2013: the post-crisis interaction coefficient is 0.048.[13] This magnitude indicates that high-productivity firms expanded their workforce more rapidly than low-productivity firms in the post-crisis period. This is consistent with improved selection: labor is increasingly reallocated toward higher-productivity firms rather than remaining trapped in less efficient ones. The results are robust when productivity is measured using TFPQ.

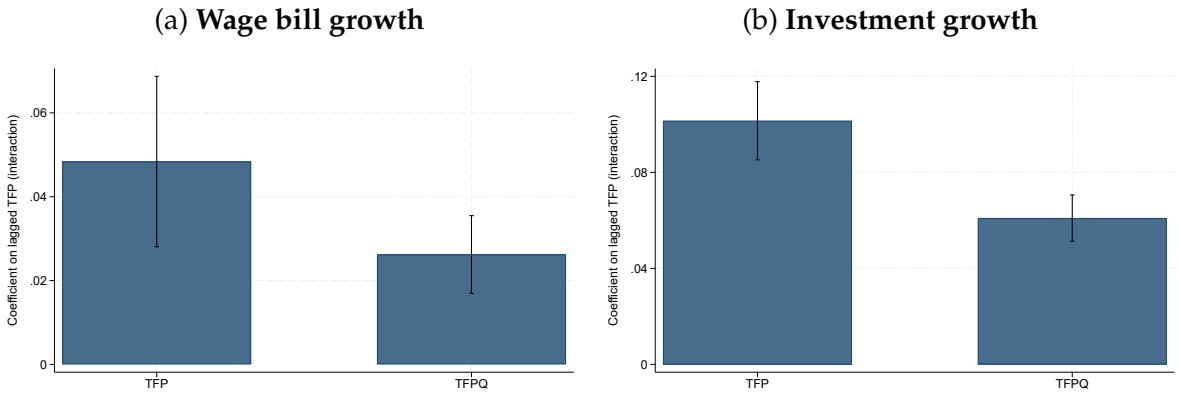
The investment growth results are more dramatic. The post-crisis interaction coefficient is about 0.10, suggesting that productive firms receive disproportionately more investment in the post-crisis period. The strengthening is also confirmed when using TFPQ. These results are summarized in Figure 9.

Comparing the two panels, the strengthening is evident for both wage bill and invest-

[12] This interpretation is also consistent with Albrizio et al. (2026), who find that monetary easing improves capital allocation in Spain primarily by relaxing financial constraints on high-MRPK firms, which then expand borrowing and investment more than low-MRPK firms.

[13] Results are consistent with replacing wage bill growth with employment growth. See Figure C.8 in Appendix C.4.

Figure 9: Selection: Wage Bill and Investment Growth



NOTES: This figure reports the estimated post-2013 interaction coefficients β_2 in equation (11) when TFP is estimated with the Wooldridge (2009) method, or it is measured using TFPQ. Panel A shows wage bill growth. Panel B refers to investment growth. All specifications include sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014-2023) relationship between firm productivity and firm growth relative to 2001-2013.

ment, but it is larger for investment. This pattern suggests that the post-crisis reallocation process may have operated especially strongly through capital deepening and investment adjustment, which is consistent with the broader evidence in the paper that capital misallocation played a central role in Spain's pre-crisis productivity deterioration.

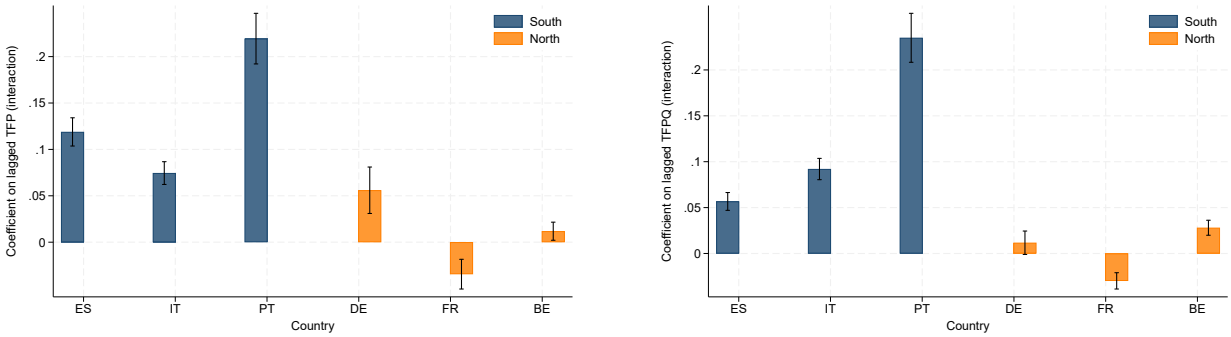
5.4 Cross-Country Evidence on Post-Crisis Adjustment

To assess whether the improved alignment between productivity and resource allocation is specific to Spain or reflects a broader Southern European pattern, we replicate the wage bill and investment growth regressions for all six countries in our sample using Orbis data—see equation (11).

The results reveal a clear North–South divide. For investment growth, the post-crisis interaction coefficient is large and statistically significant for all three Southern European countries: approximately 0.12 for Spain, 0.07 for Italy, and 0.22 for Portugal. In contrast, the corresponding coefficients for the Northern European countries are substantially smaller: approximately 0.06 for Germany, near zero for France, and approximately 0.01 for Belgium. The same pattern emerges when productivity is measured using TFPQ. These results are summarized in Figure 10. The pattern closely mirrors the earlier evidence on dispersion in Section 4: the countries that experienced the strongest rise in misallocation before and during the crisis are also the ones that display the strongest post-crisis improvement in the responsiveness of firm growth to productivity.

Figure 10: Selection – Investment Growth, Europe

(a) **TFP** (b) **TFPQ**



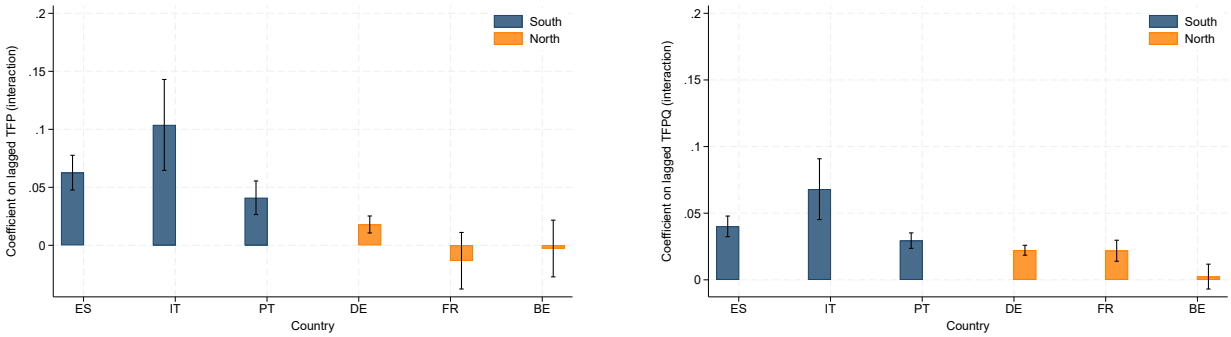
NOTES: The figure reports the estimated post-2013 interaction coefficient β_2 from equation (11) for each country in the sample. Panel A measures productivity using firm-level TFP estimated with the Wooldridge (2009) method, while Panel B uses TFPQ. The dependent variable is investment growth. All specifications include sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014-2023) relationship between firm productivity and investment growth relative to 2001-2013. Spain (ES), Italy (IT), and Portugal (PT) are Southern European economies; Germany (DE), France (FR), and Belgium (BE) are Northern European economies.

The pattern for employment growth, proxied by wage bill growth, is qualitatively similar. Spain, Italy, and Portugal all show positive and significant post-crisis interaction coefficients (approximately 0.06, 0.10, and 0.04, respectively), while Germany shows a small positive coefficient (around 0.018), and France and Belgium show coefficients that are indistinguishable from zero. The pattern is robust when productivity is measured using TFPQ. These results are shown in Figure 11. Thus, the stronger post-crisis reallocation toward high-productivity firms in Southern Europe is visible not only in investment but also in employment dynamics.

These cross-country results are consistent with the interpretation that the Southern European economies, which experienced the most severe misallocation during the pre-crisis boom, have undergone sharper post-crisis adjustments. The Northern European economies, where pre-crisis misallocation was less pronounced, show correspondingly smaller improvements in the productivity–investment and productivity–employment relationships. This pattern suggests that the post-crisis reallocation was driven in significant part by the correction of boom-era distortions rather than by common secular trends affecting all European economies. More broadly, Section 5.4 provides the cross-country counterpart to the within-Spain evidence in Sections 5.2 and 5.3: the same economies that saw the largest deterioration in allocative efficiency before 2013 are also the ones in which post-crisis firm growth became most strongly aligned with productivity.

Figure 11: Selection – Wage bill Growth, Europe

(a) **TFP** (b) **TFPQ**



NOTES: The figure reports the estimated post-2013 interaction coefficient β_2 from the employment-growth specification for each country in the sample. Panel A measures productivity using firm-level TFP estimated with the Wooldridge (2009) method, while Panel B uses TFPQ. The dependent variable is wage bill growth. All specifications include sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014-2023) relationship between firm productivity and wage-bill growth relative to 2001-2013. Spain (ES), Italy (IT), and Portugal (PT) are Southern European economies. Germany (DE), France (FR), and Belgium (BE) are Northern European economies.

6. Conclusions

In this paper, we study the evolution of total factor productivity (TFP) and allocative efficiency in Spain over the period 2003–2023 using firm-level data from the *Central de Balances* of the Banco de España. The evidence points to a clear two-phase pattern. Between 2003 and 2013, aggregate TFP declined markedly, while the within-industry dispersion of the marginal revenue products of capital and labor increased, indicating a substantial deterioration in allocative efficiency. After 2013, this pattern reversed: TFP recovered and dispersion measures declined, indicating a significant improvement in the allocation of resources across firms.

These results help clarify the nature of Spain's productivity problem. Weak productivity performance before the Global Financial Crisis did not simply reflect low average firm-level efficiency. It also reflected a worsening allocation of capital and labor across heterogeneous firms. Spain accumulated capital and expanded employment during the boom years, but these resources were not directed toward the most productive firms. In this sense, the decline in TFP before the crisis is closely linked to the growing severity of misallocation.

The paper also provides evidence on the sources of the post-crisis improvement. The shift in the firm-size distribution away from very small firms is consistent with a cleanup

process in which marginal producers exited or contracted. At the same time, credit growth became more closely aligned with firm productivity and capital scarcity, suggesting that the financial system improved its resource allocation after the crisis. Finally, employment and investment growth became more responsive to lagged productivity, indicating stronger selection and reallocation toward better-performing firms. Cross-country evidence reinforces this interpretation: Southern European economies, which experienced the largest boom-era distortions, also display the sharpest post-crisis improvements in the relationship between productivity and firm growth.

Taken together, the findings suggest that understanding Spain's productivity performance requires going beyond aggregate indicators and examining how resources are allocated across firms. The evidence in this paper points to misallocation as a central dimension of Spain's pre-crisis productivity weakness and to post-crisis cleanup and reallocation as key elements of the subsequent recovery. More broadly, the Spanish experience illustrates how prolonged periods of abundant credit and distorted incentives can generate sizable productivity losses, and how reversing these distortions can become an important source of aggregate productivity growth.

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A. Data Appendix

A.1 Spanish Firm-Level Database

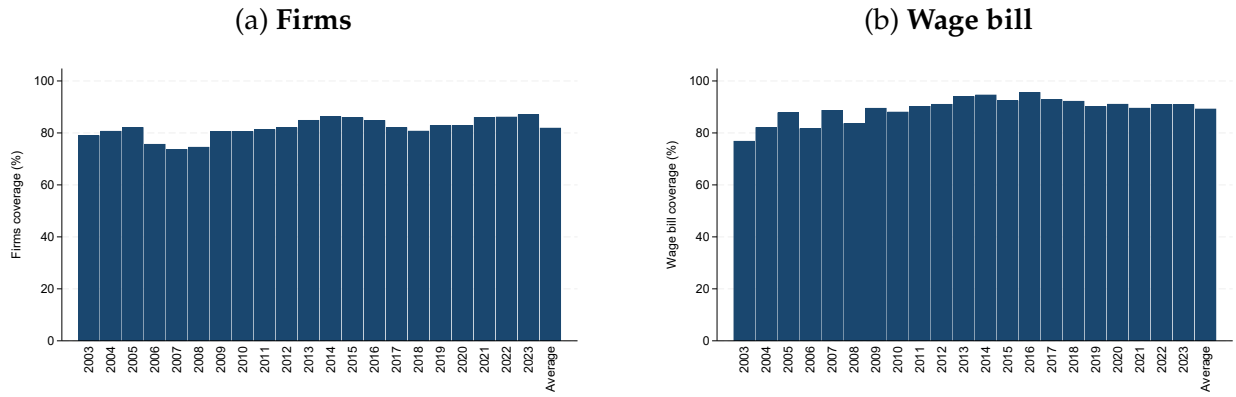
The firm-level dataset used in this paper is drawn from the *Central de Balances* of the Banco de España. The dataset has a panel structure covering the period 2000–2023 and contains more than 23 million firm-year observations for approximately 2.8 million firms. Although the full dataset spans this period, most of the analysis focuses on observations from 2003 onwards, when coverage and reporting quality improve.

We focus on the private non-financial market economy. Firms whose main activity belongs to financial and insurance activities, utilities, or real estate are excluded. We also exclude firms operating in public administration and defense, education, and human health and social work activities, as well as household services and other public or quasi-public activities, including membership and associative organizations.

A cleaning procedure is applied to ensure internal consistency and to mitigate the influence of reporting errors and extreme outliers. Duplicate records are removed, missing sector codes are imputed using historical information for the same firm, and delayed filings are corrected by recovering missing firm-year observations when they become available in subsequent submissions. Observations with clearly inconsistent values are excluded, including negative employment or sales figures and values exceeding those of the largest firm in the sample. To address implausible productivity levels likely driven by measurement error, extreme observations are replaced by missing values based on labor productivity ratios: output is set to missing for firms with fewer than 50 employees whose output-per-worker exceeds the 99.5th percentile of the sample, while employment is set to missing for firms with more than 50 employees whose output-per-worker falls below the 0.5th percentile. In addition, range-based filters are applied to key variables (employment, value added, production, labor costs, total assets, material inputs, and fixed assets), setting all observations for a given firm-variable pair to missing if the firm reports both a value exceeding one million euros and a value below one euro at any point in time. Average wages above one million euros are also excluded. All nominal variables are deflated using industry-level deflators.

This cleaning strategy substantially improves data quality while preserving a high degree of representativeness. In this Appendix, we report evidence on the representativeness of the firm-level dataset used in the paper We focus on three dimensions. First, we document the coverage of the raw sample relative to the universe of Spanish firms

Figure A.1: Firms and Wage Bill Coverage 2003–2023



NOTES: Panel A reports the number of firms in the raw *Central de Balances* sample as a share of the total number of operating firms in Spain. Panel B reports the aggregate wage bill in the raw sample as a share of the aggregate wage bill in the economy. The reference population is constructed using official statistics from the Spanish National Statistics Institute. Official data on wage bill come from Annual National Accounts by branch of activity and the number of firms data come from DIRCE Census on Business.

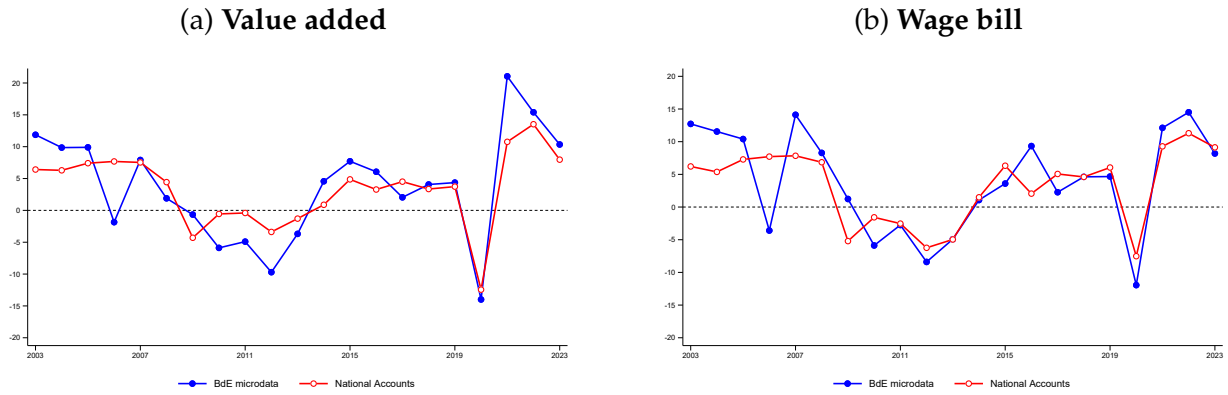
and to aggregate wage-bill totals. Second, we show that aggregates constructed from the microdata closely track the evolution of value added and the wage bill in the national accounts. Third, we compare the firm size and sectoral distributions in the sample with their corresponding population distributions. Taken together, these results indicate that the *Central de Balances* provides a reliable basis for studying firm-level productivity, misallocation, and reallocation in Spain over the 2003–2023 period.

Figure A.1 reports the evolution of sample coverage. Panel A shows the share of firms in the raw sample relative to the total number of operating firms in Spain, while Panel B reports the corresponding coverage of the aggregate wage bill. Coverage is high throughout the sample period and remains relatively stable over time, supporting the use of the dataset for long-run analysis.

Figure A.2 assesses the ability of the microdata to reproduce aggregate macroeconomic dynamics. Panel A compares the annual growth rate of value added in the microdata with the corresponding national accounts series, and Panel B does the same for the wage bill. The two sets of series move very closely together over time, with correlations above 85 percent for value added and above 80 percent for the wage bill.

Figure A.3 compares the cross-sectional composition of the sample and the population in 2023. Panel A shows the distribution of firms by size class, and Panel B shows the sectoral distribution. The sample reproduces both margins closely. In particular, small firms with fewer than 10 employees account for 86.4 percent of firms in the sample, compared with 88.5 percent in the population, while firms with more than 200 employees represent

Figure A.2: Macroeconomic Dynamics



NOTES: Panel A compares the annual growth rate of aggregate value added in the firm-level dataset with the corresponding growth rate in Spanish national accounts. Panel B compares the annual growth rate of the aggregate wage bill in the firm-level dataset with the corresponding national accounts series. Official data is taken from the Annual National Accounts reported by the Spanish National Statistics Institute.

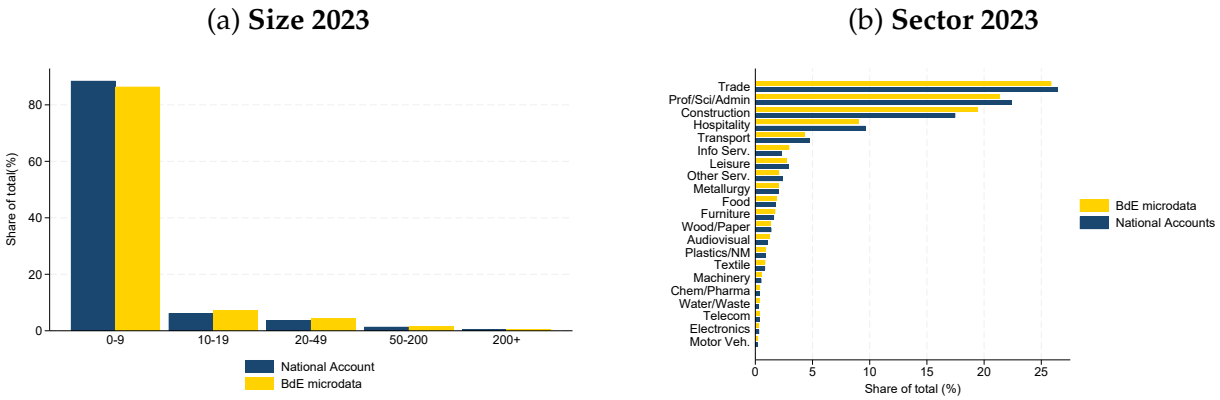
around 0.4 percent in both the sample and the population. Sectoral shares are also very similar, with trade, professional activities, construction, hospitality, and transport among the largest sectors in both the sample and the population.

A.2 Orbis Data

The firm-level data used for the cross-country analysis are drawn from Orbis Historical. The dataset provides harmonized balance-sheet and income-statement information for firms operating in a broad set of European countries over the period 2000–2023, including Spain, Belgium, France, Germany, Italy, and Portugal. While the full sample spans this period, most of the analysis focuses on observations from 2005 onwards, when coverage and reporting quality improve substantially across countries. Sectoral coverage is the same as in the Spanish firm-level dataset.

The raw Orbis data are subjected to a cleaning procedure designed to ensure internal consistency and cross-country comparability. First, we correct for changes in reporting units over time (for example, switches between thousands and millions) to ensure consistency in firm-level magnitudes. Second, we remove duplicates and exclude firms reporting negative equity, total assets, employment, or sales. Third, to mitigate the influence of outliers, we drop firms exhibiting implausible year-over-year changes in total assets (contractions by a factor greater than 100 or expansions by a factor greater than 200), firms reporting implausibly large employment levels (exceeding two million employees in any year), and firms with extreme balance-sheet intensity ratios (employment-

Figure A.3: Firm Distribution by Size and Sector



NOTES: Panel A reports the distribution of firms by employment size class in the sample and in the population in 2023. The size bins are 0–9, 10–19, 20–49, 50–200, and more than 200 employees. Panel B reports the distribution of firms across sectors in the sample and in the population in 2023. Official data on the number of firms comes from the DIRCE Census on Business (Spanish National Statistics Institute).

to-assets, employment-to-sales, and sales-to-assets) above the 99.9th percentile of the respective distributions. Finally, all nominal variables are converted to real terms using country-specific CPI deflators. These filters reduce the influence of reporting errors and extreme observations while preserving a high coverage.

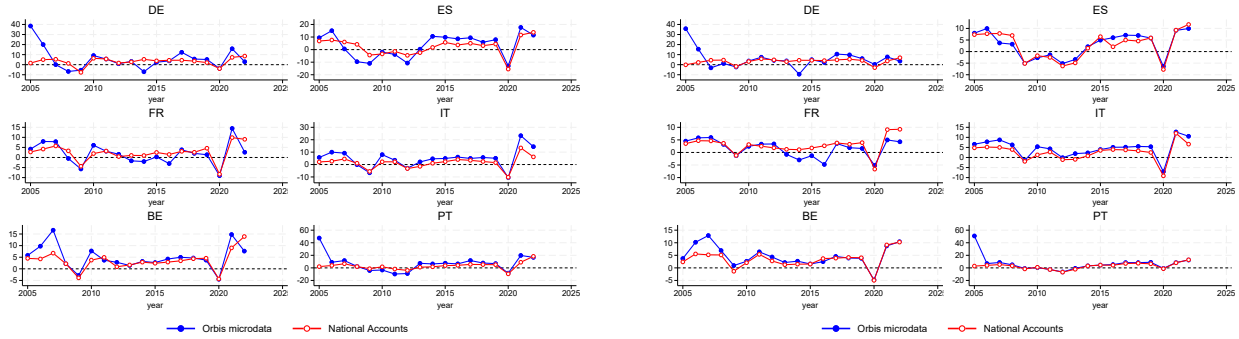
In this Appendix, we provide evidence on the quality of the Orbis data used in the cross-country analysis. We focus on two dimensions. First, we compare the aggregate dynamics of value added and the wage bill in Orbis with the corresponding macroeconomic series for the six countries in our sample: Germany, Spain, France, Italy, Belgium, and Portugal. Second, we compare the sectoral composition of Orbis with that in the macro data. Overall, the figures show that Orbis reproduces the main aggregate and sectoral patterns in the data reasonably well for the set of countries we analyze.

Figure A.4 compares annual growth rates of aggregate value added and the wage bill in Orbis with the corresponding series from the macro data. Panel A reports value added growth and Panel B wage-bill growth. For each country, the two series move closely together over time, indicating that the Orbis sample captures the main aggregate fluctuations in economic activity and labor compensation.

Figure A.5 compares the sectoral composition of Orbis and the macro data in the pooled sample of countries. Panel A reports sectoral shares of total value added and Panel B reports sectoral shares of the total wage bill. The sectoral distributions line up closely, indicating that Orbis provides a broadly representative picture of the composition of economic activity across the countries in our sample.

Figure A.4: Macroeconomic Dynamics in Orbis

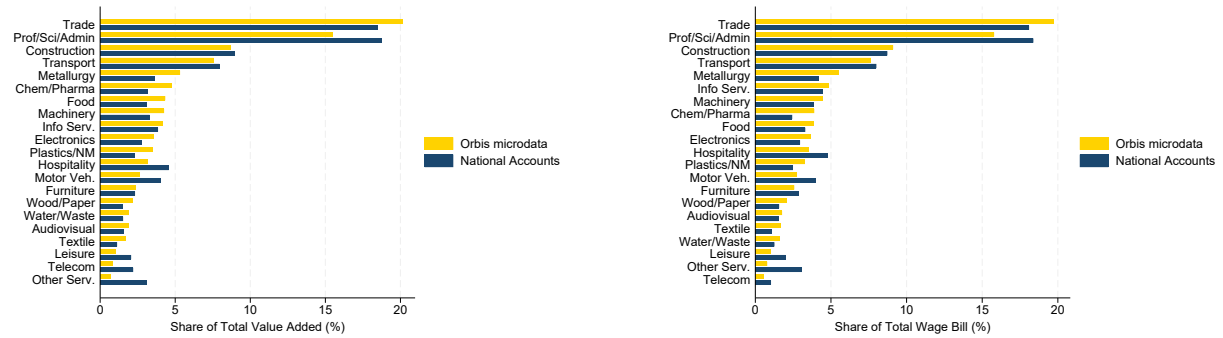
(a) **Value added** (b) **Wage bill**



NOTES: Panel A compares the annual growth rate of aggregate value added in Orbis with the corresponding aggregate series from the macro data for Germany (DE), Spain (ES), France (FR), Italy (IT), Belgium (BE), and Portugal (PT). Panel B reports the analogous comparison for the aggregate wage bill. In each subpanel, the blue line corresponds to Orbis microdata and the red line to the macro data. Official macroeconomic data on value added and the wage bill are taken from the OECD Structural Analysis Database (STAN), which is based primarily on annual national accounts.

Figure A.5: Sectoral Composition in Orbis and Macro Data

(a) **Value added by sector** (b) **Wage bill by sector**



NOTES: Panel A reports the distribution of total value added across sectors in Orbis and in the macro data, pooling Germany, Spain, France, Italy, Belgium, and Portugal over the sample period. Panel B reports the analogous comparison for the wage bill. Sectoral shares are expressed as percentages of the total. The blue bars correspond to the macro data, and the red bars to Orbis. Official macroeconomic data on value added and the wage bill are taken from the OECD Structural Analysis Database (STAN), which is based primarily on annual national accounts.

B. Model Appendix

This appendix provides a theoretical framework for our empirical analysis in Sections 4 and 5. We first derive firm-level input demands and marginal revenue products, then define revenue and physical productivity, and finally show how dispersion in TFPR maps into industry-level allocative efficiency.

B.1 Basic Hsieh and Klenow (2009) Framework

We consider an economy where a representative final-good producer aggregates industry output Y_t by combining the output Y_{it} of I industries using a Cobb-Douglas aggregator, given by,

$$Y_t = \prod_{i=1}^{I} Y_{it}^{\theta_i}, \quad \sum_{i=1}^{I} \theta_i = 1. \tag{12}$$

where t denotes time. Aggregate industry output Y_{it} is assumed to be a CES aggregate of the output of firms in that industry, given by,

$$Y_{it} = \left(\sum_{e=1}^{M_i} Y_{iet}^{\frac{\sigma-1}{\sigma}} \right)^{\frac{\sigma}{\sigma-1}}, \tag{13}$$

where M_{it} is the measure of firms, indexed by e, in industry i, at time t, each producing a differentiated variety and operating under monopolistic competition, and $\sigma > 1$ is the elasticity of substitution across varieties within industries.

Each variety is produced using capital K_{iet} and labor L_{iet} with a Cobb-Douglas production function,

$$Y_{iet} = A_{iet} K_{iet}^{\alpha_i} L_{iet}^{1-\alpha_i}, \tag{14}$$

where A_{iet} denotes firm-e physical productivity (TFPQ) at time t, while α_i denotes the capital share.

Given competitive factor prices for labor, w_t, and capital, r_t, firms choose prices and capital and labor inputs to maximize profits. However, firms are subject to idiosyncratic capital and output distortions (wedges), τ_{Kiet}, and τ_{Yiet}. These distortions are meant to capture inefficiencies discussed in Section 4. Firms' problem is given by

$$\pi_{iet} = \max_{P_{iet}, K_{iet}, L_{iet}} P_{iet} Y_{iet}(1 - \tau_{Yiet}) - w_t L_{iet} - (1 + \tau_{Kiet}) r_t K_{iet},$$

subject to

$$Y_{iet} = A_{iet} K_{iet}^{\alpha_i} L_{iet}^{1-\alpha_i} \quad \text{: technology}$$
$$Y_{iet} = \left(\frac{P_{iet}}{P_{it}}\right)^{-\sigma} Y_{it} \quad \text{: demand}$$

Under CES demand, marginal revenue is $\frac{\sigma-1}{\sigma} P_{iet}$, which yields the first-order conditions below:

$$(1-\tau_{Yiet})\frac{\sigma-1}{\sigma} P_{iet} \alpha_i \frac{Y_{iet}}{K_{iet}} = (1+\tau_{Kiet}) r_t, \tag{15}$$

and

$$(1-\tau_{Yiet})\frac{\sigma-1}{\sigma} P_{iet} (1-\alpha_i) \frac{Y_{iet}}{L_{iet}} = w_t. \tag{16}$$

Then, a solution to this problem is a demand function for capital,

$$K_{iet} = \alpha_i \frac{\sigma-1}{\sigma} \frac{(1-\tau_{Yiet})}{(1+\tau_{Kiet})} \frac{P_{iet} Y_{iet}}{r_t},$$

a demand function for labor,

$$L_{iet} = (1-\alpha_i) \frac{\sigma-1}{\sigma} (1-\tau_{Yiet}) \frac{P_{iet} Y_{iet}}{w_t},$$

and a price function,

$$P_{iet} = \frac{\sigma}{\sigma-1} \left(\frac{r_t}{\alpha_i}\right)^{\alpha_i} \left(\frac{w_t}{(1-\alpha_i)}\right)^{1-\alpha_i} \frac{(1+\tau_{Kiet})^{\alpha_i}}{A_{iet}(1-\tau_{Yiet})}.$$

Given the firm-level first-order condition, the capital-labor ratio is equal to:

$$\frac{K_{iet}}{L_{iet}} = \frac{\alpha_i}{1-\alpha_i} \frac{w_t}{r_t} \frac{1}{(1+\tau_{Kiet})}$$

and the marginal revenue products read as

$$MRPK_{eit} = \frac{(1+\tau_{Kiet})}{(1-\tau_{Yiet})} r_t,$$

and

$$MRPL_{eit} = \frac{1}{(1-\tau_{Yiet})} w_t.$$

In contrast to equations 4 and 5 in Section 4, where all firms have the same MRPK and MRPL, idiosyncratic distortions, τ_{Kiet} and τ_{Yiet}, imply dispersion of MRPK and MRPL across firms.

B.2 Inferring Allocative Efficiency

To obtain the TFP per sector (industry), we aggregate the firm-level demands for the two factor inputs. Then, we combine the aggregate demand for the factor inputs in each sector with the allocation of total expenditure across sectors, and express aggregate production as

$$Y_t = \prod_{i=1}^{I} (TFP_{it} K_{it}^{\alpha_i} L_{it}^{1-\alpha_i})^{\theta_i}. \tag{17}$$

where $K_{it} = \sum_{e=1}^{M_{it}} K_{iet}$, $L_{it} = \sum_{e=1}^{M_{it}} L_{iet}$ and TFP_i is the sector-i aggregate TFP.

Notice that, when industry deflators are used, differences in plant-specific prices show up in measures of firm-level TFP (Foster et al., 2008). Hence, we can distinguish between physical productivity (TFPQ) and revenue productivity (TFPR), given by,

$$TFPQ_{iet} = A_{iet} = \frac{Y_{iet}}{K_{iet}^{\alpha} L_{iet}^{1-\alpha}} \propto \frac{(P_{iet} Y_{iet})^{\frac{\sigma}{\sigma-1}}}{K_{iet}^{\alpha} L_{iet}^{1-\alpha}}, \tag{18}$$

and

$$TFPR_{iet} = P_{iet} A_{iet} = \frac{P_{iet} Y_{iet}}{K_{iet}^{\alpha} L_{iet}^{1-\alpha}} \propto \frac{(1+\tau_{Kiet})^{\alpha_i}}{(1-\tau_{Yiet})}. \tag{19}$$

Firm-level TFPR is correlated with distortions and their dispersion, as the dispersion of MRPK and MRPL is informative about the extent of misallocation. Substituting firm-level equilibrium demands into the CES aggregator yields the following expression for TFP_i as

$$TFP_{it} = \left(\sum_{e=1}^{M_i} \left[TFPQ_{iet} \frac{TFPR_{it}}{TFPR_{iet}} \right]^{\sigma-1} \right)^{\frac{1}{\sigma-1}}, \tag{20}$$

where $TFPR_{it}$ denotes the value added weighted harmonic mean of firm-level TFPR within industry i at time t. Notice that, if $\tau_{Yiet} = \tau_{Kiet} = 0, \forall e$, i.e., if marginal products

were equalized across firms, TFP_{it} would collapse to

$$TFP_{it}^{*} = \left(\sum_{e=1}^{M_{it}} TFPQ_{iet}^{\sigma-1} \right)^{\frac{1}{\sigma-1}},$$

which is the value of TFP in a benchmark undistorted economy. Therefore, a measure of allocative efficiency for industry i can be written as:

$$AE_{it} \equiv \frac{TFP_{it}}{TFP_{it}^{*}} = \left[\sum_{e=1}^{M_{it}} \frac{\left(TFPQ_{iet}^{\sigma-1} \cdot \frac{TFPR_{it}}{TFPR_{eit}} \right)}{\sum_{e=1}^{M_{it}} TFPQ_{iet}^{\sigma-1}} \right]^{\frac{1}{\sigma-1}}. \tag{21}$$

The index $AE_{it} \in (0, 1]$ measures the fraction of potential industry-level TFP that is realized given the observed allocation of resources across firms in a given time t. Lower values of AE_{it} indicate greater within-industry misallocation, and $100 \cdot (1 - AE_{it})$ captures the share of industry-level TFP lost due to misallocation. In Section 4, we compute AE_{it} for Spain across industry over time.

C. Additional details and results

C.1 Measurement of Firm-Level TFP

This appendix describes the methodology used to estimate firm-level total factor productivity (TFP).

We measure firm-level TFP from a Cobb–Douglas value-added production function estimated separately at the two-digit industry level, following the European Union classification of economic activities (NACE):

$$\log VA_{et} = \alpha_L \log L_{et} + \alpha_K \log K_{et} + A_{et}, \tag{22}$$

where VA_{et} denotes value added for firm e in year t (measured as total sales minus intermediate expenditures), L_{et} and K_{et} denote labor (measured by the wage bill) and capital (fixed assets), respectively, and A_{et} is log TFP, capturing productivity differences not explained by measured inputs.[14]

Estimating production functions at the firm level raises endogeneity concerns, as firms observe their productivity when choosing input levels. As a result, input choices may be correlated with unobserved productivity, leading to biased estimates under ordinary least squares. To address this simultaneity problem, we follow the control-function approach pioneered by Olley and Pakes (1996), extended by Levinsohn and Petrin (2003), and refined by Wooldridge (2009). This approach uses intermediate input expenditures as a proxy for unobserved productivity, thereby instrumenting for endogenous input choices. Specifically, we implement the GMM estimator proposed by Wooldridge (2009), which formulates the proxy-variable approach within a single-equation GMM framework.

Firm-level TFP is obtained as the residual from the estimated value-added production function.

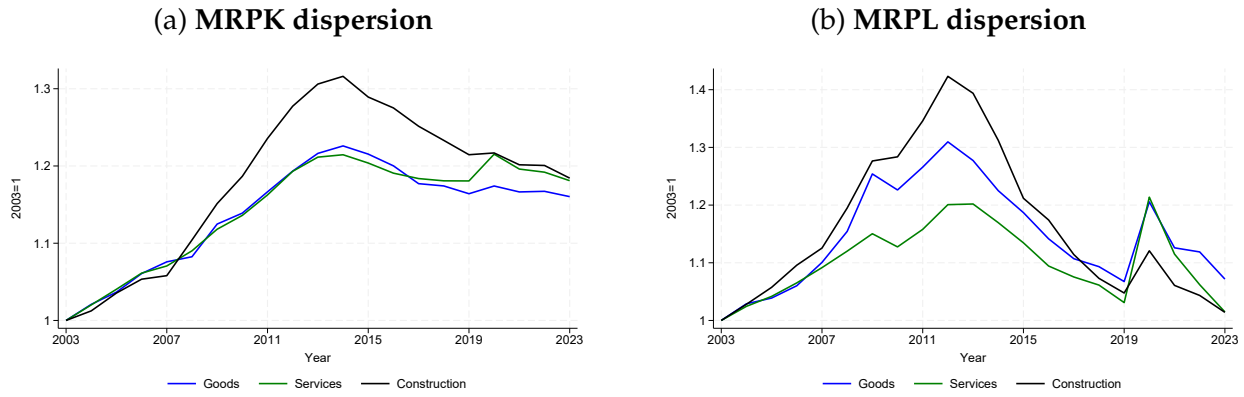
C.2 Misallocation, by Sectors

Figure C.6 reports the evolution of within-industry dispersion in MRPK and MRPL separately for goods, construction, and services, using the uncorrected firm-level measures. The broad pattern is similar in both cases: dispersion rises between 2003 and 2013 and

[14] Because firm-product-level output and input prices are not observed, measured TFP may reflect not only technical efficiency but also firm-product-specific price variation and other distortions. This limitation is well understood in the literature.

declines afterwards. At the same time, there are some sectoral differences. The goods sector displays somewhat larger fluctuations, particularly in MRPL, while the services sector shows a more persistent elevation in MRPK, consistent with slower unwinding of capital misallocation in services.

Figure C.6: Dispersion of Marginal Products, By Sectors



NOTES: The figure reports within-industry dispersion of MRPK (Panel A) and MRPL (Panel B) for the goods, construction, and services sectors, normalized to 1 in 2003. Higher dispersion indicates greater misallocation within sectors.

C.3 Measurement Error Correction

In this appendix, we present additional evidence on misallocation. Specifically, we show that the main time-series pattern in the dispersion of marginal revenue products is robust to correcting for measurement error following Bils et al. (2021), and reports the same dispersion measures separately for goods, construction, and services.

Bils et al. (2021) propose a methodology to estimate the dispersion across firms, removing the spurious component induced by measurement errors. The idea is that if a firm's revenue or inputs are consistently overestimated due to measurement errors, then they will appear less responsive to changes in productivity. To be more concrete, following International Monetary Fund (2024), we implement this correction by estimating the parameter λ_i from the following regression, separately by sector group (goods and services) and by period (2003–2012 versus 2013–2023):

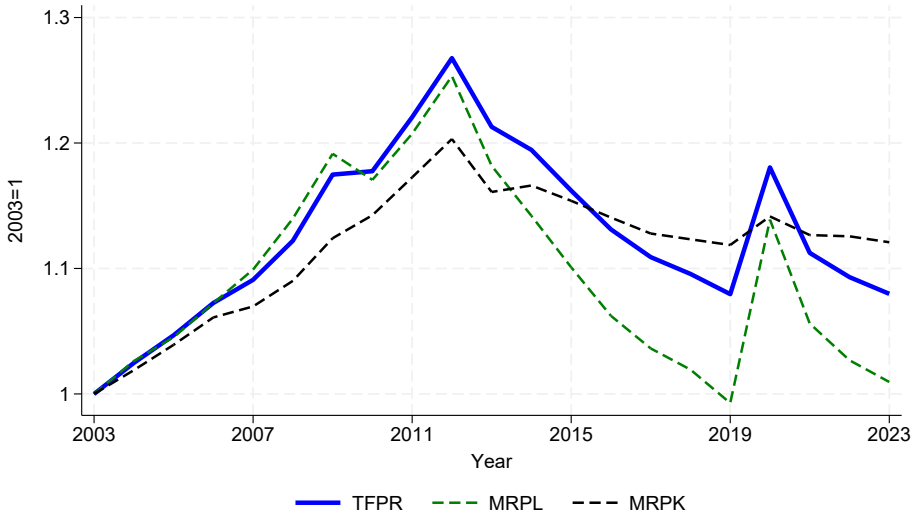
$$\begin{aligned}\Delta \ln VA_{eit} = \Phi \Delta \ln TFPR_{eit} + \Psi \Delta \ln K_{eit}^{\alpha_i} L_{eit}^{1-\alpha_i} \\ - \Psi(1-\lambda) \ln TFPR_{eit} \cdot \Delta \ln K_{eit}^{\alpha_i} L_{eit}^{1-\alpha_i} + D_{it} + \xi_{eit},\end{aligned} \tag{23}$$

where D_{it} denotes four-digit sector–year fixed effects and ξ_{eit} is a mean-zero error term. Estimates of $\hat{\lambda}$ by sector and period can therefore be used to recover the error-free counterparts of MRPK, MRPL, TFPR, and TFPQ, as

$$\begin{aligned} \ln \text{MRPK}_{et} &= \mathbb{E}\left[\hat{\lambda}\, \ln \widehat{\text{MRPK}}_{et}\right], \qquad \ln \text{MRPL}_{et} = \mathbb{E}\left[\hat{\lambda}\, \ln \widehat{\text{MRPL}}_{et}\right], \\ \ln \text{TFPR}_{et} &= \mathbb{E}\left[\hat{\lambda}\, \ln \widehat{\text{TFPR}}_{et}\right], \qquad \ln \text{TFPQ}_{et} = \mathbb{E}\left[\hat{\lambda}\, \ln \widehat{\text{TFPQ}}_{et}\right]. \end{aligned} \tag{24}$$

Figure C.7 presents the corrected series. The main message is unchanged: dispersion rises strongly up to around 2013 and then declines thereafter. In particular, MRPK remains persistently elevated even after the correction, which suggests that the observed movements reflect genuine distortions in the allocation of resources rather than pure measurement error.

Figure C.7: Misallocation – Correction for Measurement Error

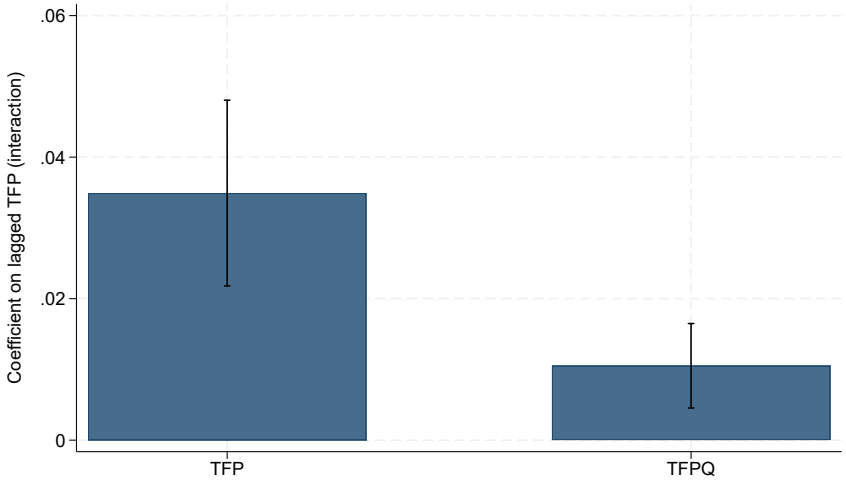


NOTES: The figure reports corrected within-industry dispersion measures for TFPR, MRPL, and MRPK normalized to 1 in 2003. The correction follows International Monetary Fund (2024) and is intended to separate true dispersion in marginal revenue products from dispersion generated by measurement error.

C.4 Productivity and Employment Growth

In Figure C.8 we report the estimates of β_2 in equation (11) when employment-growth is used as a dependent variable.

Figure C.8: Selection: Employment Growth

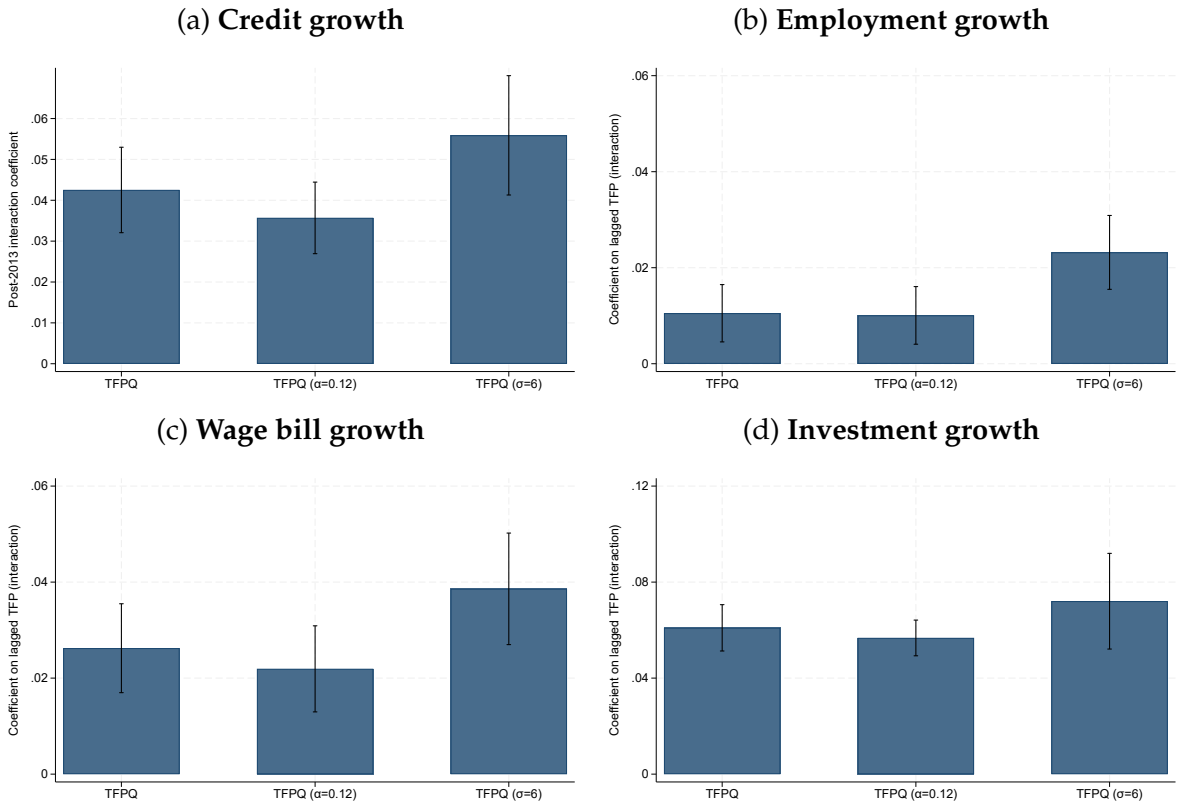


NOTES: This figure reports the estimated post-2013 interaction coefficients β_2 in equation (11) for the case of employment growth. All specifications include sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014–2023) relationship between firm productivity and firm growth relative to 2001–2013.

C.5 Alternative TFPQ Measures

Figure C.9 reports the estimates of β_2 in equations (10) and (11) when TFPQ is constructed using alternative parameterizations.

Figure C.9: Selection: Credit, Employment, and Investment Growth. Alternative TFPQ measures



NOTES: Panel A reports the estimated post-2013 interaction coefficient for the case of credit growth, using TFPQ under three parametrizations: the baseline specification ($\alpha = 0.35$, $\sigma = 3$), an alternative with $\alpha = 0.12$ and $\sigma = 3$, and an alternative with $\alpha = 0.35$ and $\sigma = 6$. $\alpha = 0.12$ corresponds to the average estimated capital share from the production-function estimation. Panel B shows the estimated coefficient for employment growth, Panel C reports the estimated coefficient for wage bill growth, and Panel D reports the estimated coefficient for investment growth. All specifications include sector-year fixed effects and firm-size dummies. Standard errors are two-way clustered at the firm and sector-year level. Higher values indicate a stronger post-crisis (2014–2023) relationship between firm productivity and growth relative to 2001–2013 (2004–2013 in the case of credit).