Productivity-Wage Nexus: distributional approach on firms in Portugal

Alexandre Mergulhão
José Azevedo Pereira*

Abstract

There is a growing international concern about a slowdown in productivity growth. However, labour productivity enhancements are important if they translate into higher generalized living standards. Using administrative data of firms in Portugal, between 2010 and 2016, we analyse the relationships between productivity and wages. At odds with neoclassical theory of marginal product of labour, we find that two thirds of firms insufficiently raised wages given the growths in productivity. Employing unconditional quantile regressions, we investigate some quantifiable determinants of the productivity-wage gap, at different parts of the distributions. Most of the documented dynamics contributed not only to the divergence of productivity and wages but also to the decoupling between the two. We argue that labour market flexibilization intensified segmentation, providing incentives for non-standard contracts. Both dimensions, as well as higher board compensations, trade and training weakened the link between productivity and wages.

Key words: productivity-wage links, labour market reforms, sectorial dispersion dynamics, distributional microeconometrics, public policy.

"Although boosting productivity growth is an important long-run goal, this will not lead to broad-based wage gains unless we pursue policies that reconnect productivity growth and the pay of the vast majority". Josh Bivens, 2015

Gabinete de Planeamento, Estratégia, Avaliação e Relações Internacionais
Ministério das Finanças
Rua da Alfândega n.º 5A
1100 – 016 Lisboa
www.gpeari.min-financas.pt

* GPEARI / Ministry of Finance
The opinions expressed are those of the author and not necessarily of the institution. The author would like to thank Mónica Simões (GPEARI) and Ana Martins (GEE) for the experienced insights on the IES database and for the TFP estimations. I would like to thank DPFP/GPEARI for giving me the time to embrace this project. A special thanks to Ana Filipa Fernandes and Frederico Silva Leal for the constant motivation and suggestions. Any mistakes or omissions are the author's responsibility.

1. Introduction

Starting amid the 1990s and the 2000s, advanced economies have been witnessing a slowdown in aggregate productivity growth, which intensified in the post-crisis period. Based on the seminal Cobb-Douglas production function, economic growth can be decomposed into improvements in: labour utilisation, capital used in production and overall efficiency – measured by Total Factor Productivity (TFP). This equates to enhancements in labour productivity (i.e. output per unit of work) and/or in labour utilisation (e.g. total hours worked), for the former results from: higher capital deepening and/or TFP.

Being a backbone of output evolution, economists and policymakers have become particularly concerned about finding ways to boost labour productivity growth. Namely, the OECD created the Global Forum on Productivity, fostering international research cooperation to assess public policies and best practices. In 2016, the Council of E.U. issued a recommendation for the establishment of National Productivity Boards to promote a public discussion, based on statistical and economic analysis, on productivity issues. Furthermore, other international institutions have been addressing productivity-enhancing measures, particularly through structural reforms (e.g. WB, 2018; IMF, 2017).

Figure 1 – Aggregate annual average of GVA per worker and total number of workers per year. Author's calculations.

This common concern arises from an economic premise which regards productivity as the anchor for generalized rising living standards. However, this assertion is conditional on productivity gains translating into higher wages, for that is the most widespread income source of workers and families. Indeed, around 70% of household income, in Portugal, derives from labour in the form of wages (ILO, 2018).

Furthermore, the link between productivity and wages is not only important for raising the well-being of the median worker. There is a recent and vivid debate on the sources of the "wage puzzle" (Bivens, 2018) – i.e.

insignificant wage growth in a period of historically low levels of unemployment/labour market slack. This wage stagnation has implications on the ability of monetary policy to achieve inflation targets. Recently in the ECB Forum of Central Banking, held in Sintra, Mario Draghi stated that the structural reforms which reinforced wage bargaining at the firm level might have increased downward wage flexibility but not in the opposite direction. ECB president further added that wage bargaining has changed and one of the reasons for lower wage growth is the decline of unions. Indeed, at the macro-level, the decoupling of labour compensation from labour productivity is unambiguous (Figure 2).

Thus, it is paramount to dig into the theoretical and empirical contributions for the classical political economy problem: what is the relationship between labour pay (e.g. wages) and labour productivity? Using administrative firm-level data for Portugal, during the period 2010-2016, we present some evidence for this relationship and investigate the influence of some quantifiable determinants on the link between labour productivity and average wages. We also aim to shed some light into the heterogeneous effects of both avenues along the distributions of wages and productivity. Lastly, we focus on top TFP firms.

The remainder of paper is organized in the following manner. Section 2 briefly summarizes the theoretical and empirical literature review. In section 3 we present the final dataset used. The different methodologies used are discussed before presenting the results, in section 4. Lastly, in section 5 we conclude, discuss possible implications and refer some limitations.

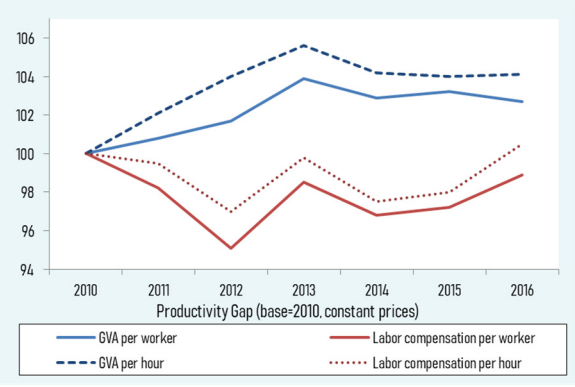


Figure 2 – Decoupling of labour compensation (total gross earnings, social security contributions, pension plans, life insurance and benefit plans) from labour productivity (per worker and per hour). Labour compensation decrease in 2012 reflects the MoU wage cuts, in the public sector, as well as the freezing of bonuses and extra hours, in the private sector. 2013 is also partially influenced by the reversal of the wage cuts (declared unconstitutional) and historically high unemployment (16.2%). OECD-Productivity stats.

2. Literature Review

i) Theory

How does the wage-setting process take place and how tight is the link between wages and productivity? According to the neoclassical school of thought, profit-maximizing firms will hire labour until the marginal product of labour equals the real wage (John Bates Clark, 1899). Also known as the Walrasian theory of labour market equilibrium, the thesis predicts that firms will increase wages at the same rate of productivity improvements. However, it relies on unrealistic assumptions such as perfect competition, constant returns to scale, absence of any market frictions (e.g. involuntary unemployment), symmetric information, and homogeneous agents. Knowing that workers differ in many dimensions, Mincer (1974) developed a seminal model for wages where, on top of the mentioned market clearing wage, wage premium are estimated for various worker characteristics – e.g. sex, education, experience, on-the-job training etc. Yet, even with homogeneous workers, in the absence of asymmetric information and under perfectly predictable productivity, agents incur in search costs and unemployment benefits are temporary: it won't be optimal for firms to hire at the full marginal productivity (Van Biesebroeck, 2014).

On the other hand, (post-) institutional economics, which incorporates neoclassical developments, models wage-setting as a Nash-bargaining *game* between workers and firms (Pissarides, 1985). In these models, how the surplus is split is determined by the relative bargaining power of labour, and by the payoffs of outside options. These, in turn, depend on labour market conditions (Oreopoulos et al., 2012), such as unemployment benefits, job vacancies, monopsony power etc. Indeed, Manning's (2011) literature review points out that, often, firms pay less than the marginal revenue product of labour and workers receive more than their disutility of work. What is more, the Mortensen-Pissarides framework predicts that productivity-wage gaps will widen as the bargaining power of labour (e.g. unions) diminishes.[1]

Opposing to the Conventional theory, the Efficiency-wage theory advocates that higher wages incentivize workers to boost productivity. The authors of this theory (Shapiro and Stiglitz, 1984) reject the premise that wages are aligned with marginal productivity even

[1] Using Panel-VAR estimations for 31 OECD countries during 1960-2009, Elgin and Kuzubas (2013) confirms the robust positive relationship between unemployment and wage-productivity gap, and a negative response from unionization.

under perfect competition. Instead, they argue that, even in the short-run, it is rational for a firm to pay above-market-average wages, under the presence of labour market institutions (e.g. unemployment benefits or firing costs). If a worker is paid a wage higher than it would receive in expectation through a new employer, this is sufficient incentive to induce greater effort – leading to productivity upsurges (Meager, 2011).

ii) Empirical

Campbell (1993) developed an efficiency-wage model, with wage and quit equations, finding results that are generally favourable to this theory. Millea (2002) exploits feedback techniques to separate the relationship between productivity and wages into bidirectional mechanisms: productivity to wages (Conventional) and wages to productivity (Efficiency-wage). The author concludes that the dominating effect depends on institutional differences: unionization increases the convectional mechanism while countries with lower replacement rates and less Active Labour Market Policies (ALMP) exhibit stronger efficiency wage evidences. These findings are broadly consistent with efficiency-wage models to the extent that greater and longer unemployment benefits increase the outside options' payoffs. Similarly, Strauss and Wohar (2004) perform bidirectional Granger causality tests on more than 450 U.S. manufacturing plants, over the period 1956-1996, finding a less than unity increase in real wages from productivity improvements and concluding that labour shares of these industries experienced a permanent decline.

There is a growing literature addressing the decoupling of wages from productivity (OECD, 2018; Sharpe et al., 2017; Bivens and Mishel, 2015; Pessoa and Van Reenen, 2012). Most of the literature puts forward several sources for the decoupling, many of which overlapping with those of wage stagnation literature: technological changes biased towards capital substitution of labour (Schwellnus et al., 2018), larger profit mark-ups and product market rents from weaker competition (Autor et al., 2017, Barkai 2017), diminished labour bargaining power and dual labour markets (Guschanski and Onaran, 2017; Peters, 2008 Levy and Temin, 2007), structural changes such as globalisation – global value chains and labour offshoring – (Autor et al., 2013) and financialisation (Cournède et al., 2015; Stockhammer, 2013), capital accumulation (Piketty 2014, Piketty and Zucman 2014) and income inequality (Atkinson et al. 2011).

Analysing rising wage inequality together with real wage stagnation, Machin (2016) shows how both have gone hand-in-hand due to productivity-wage decoupling, and that median wage stagnation is linked to the declining influence of trade unions. Summers and Stansbury (2017) document the rise in U.S. productivity coupled with the stagnation of real median wages, starting in 1973. The authors highlight two main mechanisms for the disconnection: rising gap between mean and median compensation (individual inequality), and falling labour shares (functional inequality). They argue that productivity growth is not enough to raise living standards, technological changes are not the main cause and emphasize institutional and structural explanations. Pessoa et al. (2012) decomposed decoupling into wage inequality (faster average growth than median wage growth), the gap between wages and compensation (which also includes employer-provided benefits) and deflator differences. Similarly, Sharpe et al. (2016) decompose the productivity-wage gap into: inequality, data sources, deflators and changes in labour shares. Investigating 11 OECD economies over the 1986-2013 years, they conclude that, while there is no common cause for decoupling, most countries experienced inequality upturns and falling labour shares.

In a very recent EC discussion paper, Pasimeni (2018) shows that the decoupling is also significant in Europe. Using 34 advanced economies over the past half century, the author demonstrates that the deceleration of labour compensation is not merely a result of productivity slowdown or cyclical fluctuations but a product of structural conditions in labour markets such as reduced bargaining power. Neoclassical theory regularly points to technological changes as the main determinant of income and functional distributions, whilst wage stagnation is a product of the productivity slowdown. On the other hand, heterodox economists typically regard these dynamics as the result of multiple institutional changes (e.g. Onaran et al., 2013). Accordingly, in a panel analysis of 71 countries from 1970 to 2007, Stockhammer (2013) finds evidence that, while technological change and globalization (in production and trade) had some negative effects, financialisation had stronger negative impacts on the wage share, in both developed and developing countries. Furthermore, welfare state retrenchment and the decline in unionization were also important determinants of falling wage shares in advanced economies.

It is also well stablished that declining labour shares – a global phenomenon since 1980 (Karabarbounis and Neiman, 2014) – are a reflection of the decoupling of wages from productivity. Looking at 15 advanced

economies, between 1963 and 1996, Carter (2014) also argues against the Bowley's Law (i.e. constant wage share neoclassical assumption) by presenting evidence of a structural break (1979) in functional distribution, when real wages exhibit productivity inelasticity and wage shares initiate a generalized downward path. IMF (2017) find that increased participation in global value chains reduced labour shares for low-income countries but the effect is not significant for high-income ones. On the other hand, IMF (2018) find significant, large and robust negative effects of job protection deregulation on the labour share of 26 advanced economies, over the period 1970-2015.

In addition, Autor et al. (2017) shows that labour shares declined particularly in U.S. industries with higher market concentration. In turn, the increase of anti-competitive product market regulations – e.g. lower anti-trust enforcement or non-compete clauses – rises rents (Furman and Orszag, 2015) and shrinks labour shares (Schwellnus et al., 2018). However, rents may have the opposite effect if they are shared with the workforce through wages. Blanchard and Giavazzi (2003) argue that labour market institutions, like collective bargaining and minimum wages, have a direct effect on how these rents are distributed between workers and capital-owners. The authors also stress that labour market reforms without product market reforms redistribute these rents from labour to capital, without lowering their total size. Without higher product market competition, labour market flexibility "does not enhance investment or productivity, but hurts workers" (OECD, 2018), widens income distributions (Dabla-Norris et al., 2015; Lemieux, 2008) and decreases labour shares (Stockhammer, 2013, Calderon and Chong, 2009).

Aiming at understanding the global slowdown in productivity growth, the OECD and others have presented several studies, in the last years. The literature points to: weak aggregate demand and historically low investment in physical capital (Remes et al., 2017; OECD, 2018), measurement issues – arising from the tertiarization and digitalisation of economies – (Murray, 2017; Byrne et al., 2016), international profit shifting[2], slowdown in technological progress[3], global productivity frontier firms largely outpacing laggards, break of the diffusion mechanisms, declining business dynamism (Gouveia and Osterhold, 2018)[4] and lower product market competition. Chad Syverson (2010) summarizes a myriad of papers on the determinants of productivity into two groups: those over which producers can have control (managerial practice, quality of labour and capital inputs, ICT and R&D, learning-by-doing, product innovation and firm structure) and factors that are external (competition, deregulation or proper regulation, flexible input markets and productivity spill overs).

Using cross-country firm level data for 24 OECD economies during 2001-2013, Andrews, Criscuolo and Gal (2016) argue that aggregated productivity slowdown results from two micro-level mechanisms: wider gap between performance of frontier firms and laggards, and a deteriorated process of creative destruction (fewer exits of weak firms and less entries). Focusing on TFP, the authors still find significantly higher growth at the frontier after controlling for mark-ups and capital deepening. They explain these phenomenon with substantial market concentration at the frontier, winner-takes-it-all dynamics from digitalisation, increase of tacit knowledge importance and lack of product market reforms.

Using Portugal's firm data for a period of substantial structural reforms (2006-2014), Gouveia et al. (2017) find that, in general, reforms provide productivity improvements, despite initial costs in the short-term. While there are areas delivering productivity enhancements in both the short- and long-run (e.g. goods market, financial market, insolvencies), labour market reforms are found to have negative impacts for all firms but the 8% lowest TFP firms (who benefit only in the long-run). Exploring the same dataset, for the years 2010-2016, Branco, Domingues and Martins (2018) find positive significant correlations between TFP and financial health, wage premium, innovation and exporter status, while non-linear effects are found for firm's age, capital intensity and training. Using matched employer-employee data for Portugal, Queiró (2016) demonstrates the crucial importance of manager's education: firm's life cycle growth increases, those with college educated managers employ 12 times more than the average entrant, more educated managers use incentive pay schemes and incorporate more new technologies. Even more sticking, the author estimates

[2] Zucman, Torslov and Wier (2018) show that, between 1985 and 2018, the global average statutory corporate tax halved due to profit shifting. Close to 40% of multinational's profits migrated to tax havens in 2015.

[3] Robert Gordon (2016) argues that the ICT-driven productivity boom, occurred in the beginning of the century, was a deviation from normal state of affairs. In the author's rather pessimistic view, the period where the effects of the second industrial revolution (electricity, combustion engine, telephone etc.) were felt (1920-1970) is unlikely to be seen again.

[4] The authors estimate that circa 8% of firms in Portugal are non-viable/*zombie* firms (i.e. interest expenses greater than EBIT for 3 consecutive years) preventing efficient reallocation of about 20% of total capital and 10% of total labour. Using a less stringent definition, Alexandre et al. (2018) estimates that 26% of firms in Portugal are *zombies*.

that if Portugal had the distribution of manager's education of the U.S. it would experience a 33% rise in aggregate productivity, accounting for half of the GDP per capita gap between both countries.

3. Data

The dataset used in our analysis comprises a myriad of firm-level characteristics, income statements, balance sheets, wages and some information on worker's contracts, of companies in Portugal. Our version of *Informação Empresarial Simplificada* (IES) was compiled by the Banco de Portugal (BdP) and subject to some quality checks, covering the period of 2010-2016. We chose this period to avoid issues arising from the change in accounting standards occurred in 2009-2010, and because it covers the recession and the following recovery years. The classification used for economic activities was NACE Revision 3, where we consider sectors as the one letter sections and industries as the two-digit divisions, englobing total economy.

The initial dataset contained 2,783,238 firm-year pairs. To insure robustness and exclude misreported values, several data cleaning adjustments were done which substantially decreased the number of observations. We begin to delete firms with negative or nil values for: turnover, gross value added (GVA), total fixed and intangible assets as well as liabilities, workers and paid workers, labour costs and wages.[5] Finally, after examination of the labour productivity (both per hour and per worker) by sectors, one could see major outliers in the data, and, thus, the 0.5% and 99.5% tails of both distributions were removed. The final dataset is an unbalanced panel containing 1,144,661 observations.

Following most of the literature, our main indicator for labour productivity is GVA per worker. We followed Banco de Portugal (2014) definition of GVA as the sum of turnover and operating subsidies (output) minus utilities and external services, and the cost of inputs (intermediate consumption). Total Factor Productivity (TFP) was estimated through Levinsohn and Petrin (2003) semiparametric methodology, which uses intermediate inputs as proxy for unobservable productivity shocks.[6] The output variable is the firm's turnover, the proxy is external services and utilities, while labour costs (labour) and the sum of fixed and intangible assets (capital) form the production function. For robustness, following Berlingieri et al. (2017), we also include a non-parametric measure of TFP similar to Solow residual, which relies on important assumptions. Finally, the wage variable is the total annual firm's remuneration divided by the number of workers.

Turning to the determinants of productivity, taking the Eurostat definition, Size is a categorical variable ranging from 1 (micro) to 4 (large) according to the number of workers.[7] Training is expenses of on-the-job formation over total labour costs, while Age is the rounded number of years since the firm's date of birth. To analyse the effects of what recent literature is referring as labour market slack, Irregular Contracts variable is the sum of workers with temporary, service providers/independent workers or part-time contracts relative to the workforce. Following Martins et al. (2018), we consider the Banco de Portugal definition for Exporter Status, where this dummy variable takes the value of one if at least one condition is verified: firm exports 50% of its turnover or 10% of its turnover is exported with that value being greater than €150,000.[8] Likewise, a rough proxy for Innovation Status is assigned if the firm's intangible assets exceed the respective annual industry's median or if it has more personnel in R&D than its industry's annual median. It is important to consider the level of Capital Intensity computed by total fixed assets value over labour costs and the corresponding square to account for possible non-linear relations.

To assess the importance of high electricity prices (see annex, p. 24), the weight of Electricity Costs for the firm is expressed relative to EBITA. Portugal's net external debt went from less than 30% of GDP to almost 95% of GDP, between 2000 and 2016. To capture companies' financial difficulties we take the ratio of total liabilities to total equity (Leverage), the same for Non-Performing Loans (NPL) and Net Interest received over EBITA. Executives of stock market companies in Portugal receive, on average, 23 times more remuneration than their average worker, reaching a ratio of more than 150 in some cases.[9] Given the solidification of the global shareholder economy, where stock value is the primary goal and administrator's remuneration increases with

[5] Additionally, observations with negative values for ICT per worker and interest paid were also dropped.

[6] See Ana Martins, et al. (2018) for a comprehensive review and explanation of the literature on TFP estimation issues and strategies.

[7] Micro (1) = less than 10 workers; Small (2) = 10 to 49; Medium (3) = 50 to 249; Large (4) = more than 250 workers.

[8] Exports over GDP grew 10pp points, from 30% to more than 40%, surpassing imports over GDP, between 2010 and 2016. More openness should have effects on the relationship between productivity and wages.

9 See https://eco.sapo.pt/2018/09/30/ceo-portugueses-ganham-23-vezes-mais-que-trabalhadores-e-la-fora/. Between 2010 and 2017, CEO remuneration of stock market Portuguese companies increased by almost 50% while average wages of their workers decreased by more than 6%. https://expresso.pt/economia/2018-09-30-CEO-saem-da-crise-com-50-de-aumentos#gs.01tzcp

stock options (Lazonick, 2011; Stockhammer, 2010; Fligstein and Shin, 2007), we take the board/administrator's remuneration relative to the total wage bill (Board compensation).

Finally, we consider two policy indicators: the annual Minimum Wage from OECD-LFS database and Labour Market deregulation index. The latter is retrieved from Fraser Institute (Gwartney et al, 2012) because the most common indicator (OECD Employment Protection Legislation) is not available from 2013 onwards. Nevertheless, the correlation between the two is higher than 0.99, in absolute value, and the chosen index closely follows the inverse of the EPL trend (see end of annex).

4. Methodology and Results

4.1 Great Divergences

We begin our investigation by replicating parts of a recent paper by Berlingieri, Blanchenay and Criscuolo (2017), since Portugal was not included. We apply the same methodology to assess: (a) the evolution of the sectoral dispersion of both productivity and wage measures; (b) and investigate the relationship between these dimensions. The former is achieved by plotting the coefficients of the year dummies from equation (1):

$$(log\, Y_{P\,high} - log\, Y_{P\,low})_{st} = \alpha + \boldsymbol{\beta_t year_t} + \delta_s + \varepsilon_{st}$$

Where the left-hand side is a measure of sectoral dispersion of the variable of interest (e.g. log 90th/10th percentiles of wages or of productivity), β_t capture the average dispersion in each year controlling for unobservable time-invariant variables with a δ_S vector of dummies for each sector (fixed effects).

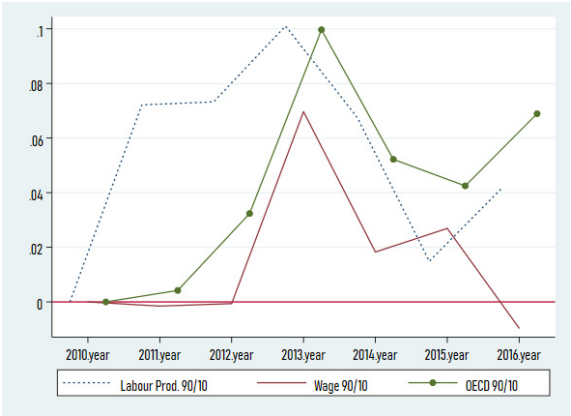


Figure 3 – Evolution of logged (90th/10th) of labour productivity (dash line), wage dispersion (solid), plus overall earnings inequality for Portugal based on OECD-IDD database. Graph plots the betas of equation (1) for each of the above.

In line with the average of OECD countries, Portugal has experienced upsurges in dispersions, particularly until 2013, both in productivity and wages – with the latter fairly following the trend of overall earnings inequality. This shows that there is significant heterogeneity in productivity and wages, also among firms within the same sector. According to Figure 3, by 2013, within-sector labour productivity dispersion was 10% higher than in 2010, whereas wage dispersion was 7% above. By 2016, overall wage dispersion practically returned to 2010 levels, while that of productivity remained 4% above. Thus, dispersions display a considerable pro-cyclical behaviour, with peaks in 2013, the year with record high unemployment rates.

Performing equation (1) for the top (90th/50th) and bottom (50th/10th) halves of the distributions, we confirm that the increase in overall sectoral dispersion of wages is driven by the bottom, while in the case of productivity both halves contributed to the *Great Divergence*. Considering the three wage curves (Figure 4), there is evidence that workers in low-paying firms were much more penalized during the crisis, but recovered in the last year, outpacing high-paying and median firms. On the other hand, looking at the three curves of labour productivity, one can see that the top firms performed better than median and bottom firms throughout the whole period. Low productivity firms only outpaced the median in 2015, whereas median firms kept up with top performing firms since 2014, enhancing their relative productivity in the last year. Thus, although there's evidence that productivity in high-performing firms has significantly diverged from the remaining companies the same cannot be said for wages. The absence of upper-half wage dispersion increase contrasts with documented widening of wage inequality, from 1984 to 2009, at the individual level (Centeno and Novo, 2014).

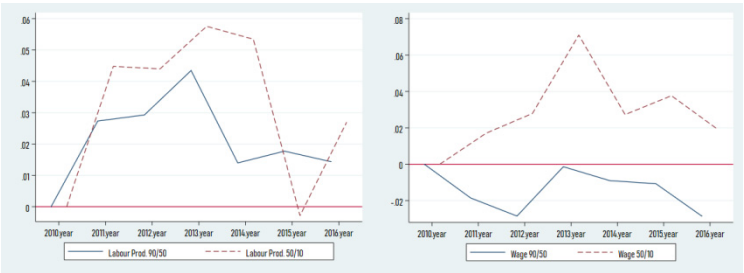


Figure 4 – Labour productivity (LHS) and wage dispersion (RHS) divided in to top (solid; 90th /50th) and bottom (dashed; 50th/10th) halves. Each line plots the coefficients from the four estimations of equation 2. These graphs are bigger in the annex.

A similar specification is employed for (b), only now we are interested in identifying the relationship between productivity and wage dispersions over time, controlling for overall time shocks, as those from the crisis, and sector-specific fixed-effects. Thus, we run the following equation (2):

$$log(Ydispersion)_{jt} = \alpha + \boldsymbol{\beta}\, log(Xdisp)_{jt} + year_t + \delta_s + \varepsilon_{st}$$

In line with the paper, results from Table 1 demonstrate a positive and significant link between labour productivity and wage dispersions. More specifically, on average, an increase of one standard deviation in logged dispersion of productivity per worker is correlated with a 10.7% increase in logged wage dispersion, among companies in the same sector.[10] Likewise, in column (2) an increase of one standard deviation in TFP is associated with an 8.1% increase in wage dispersion, significant at 5% level. Nevertheless, the explanatory power is much lower than those found in the paper.

Table 1 - Great Divergences(s) - log Wage (p90/p10)

	(1)	(2)	(3)
log LP (p90/p10)	0.153***		
	(0.0441)		
log TFP (p90/p10)		0.0571**	
		(0.0241)	
log TFP_ols (p90/p10)			0.109***
			(0.0199)
Observations	134	126	135
Number of sectors	20	18	20
Sector and Year fixed effects	YES	YES	YES
R^2 adjusted	0.245	0.161	0.146

By conducting the same regressions for the top ($90^{th}/50^{th}$ percentile ratio) and bottom ($50^{th}/10^{th}$) of the distributions, one can explore if the link is homogeneous. Output 1 (annex) shows no evidence of a positive relationship between any productivity top-half polarisation and wage top-half divergence. This may be an indication that top-performing companies are not sharing rents and profits with their workforce, channelling productivity gains to shareholders and/or to the board's compensation. In fact, only labour productivity's top dispersion is significant but negative. This suggest that: (i) productivity improvements at the top – relative to the median – do not translate into appropriately higher wages for the former; and/or that (ii) sectors with median performing firms – deteriorating relative to top firms – do not decrease wages accordingly, due to reasonable downward wage stickiness. On the other hand, results for the ($50^{th}/10^{th}$) are positive, significant and very similar to the ($90^{th}/10^{th}$) ones. Suggesting that a relative change of productivity for median firms is associated with a change of wages. Thus, (i) might be a better explanation for the above mentioned and results from the previous table seem to be driven by dynamics at the bottom half of the distributions.

[10] To in interpret as in Berlingieri (2017). For example, standard deviation of log LP ($90^{th}/10^{th}$) is roughly 0.7, multiplying by the estimated coefficient 0.153 equals 0.107.

4.2 Productivity and Wage Relationships

Having investigated the connections between productivity and wage in terms of their sectoral dispersions, it is useful to dive into the firm-level relationships between the two. One important caveat of the database is that it does not contain any information about the wage structure or the skills of workers. Moreover, regression analysis only allows for causal inference given a randomized experiment, a quasi-experimental research design or matching techniques for observational data, providing the possibility to construct a convincing counterfactual (A. Nichols, 2008).

Notwithstanding, regression coefficients have an implicit direction assumption and we can test the correlations between productivity and average wage at the firm level (Pasimeni, 2018). We should have in mind, univariate regressions with these variables might suffer from omitted variable bias – a source of endogeneity. To mitigate this issue we always include some kind of fixed effects (firm, sector or year). We employ linear regressions of productivity on contemporaneous and lagged wage growths, and wage on productivity growths, diminishing the risk of simultaneity – another source of endogeneity. Regressions in levels are presented in the annex, for completeness (Output 3).

Table 2	(1) Avg. Wage	(2) Avg. Wage	(3) Lab. Prod.	(4) Lab. Prod.
L.P. growth(t)	1.054***			
	(0.0451)			
L.P. growth(t-1)		0.00160		
		(0.0218)		
Wage growth(t)			36.61***	
			(0.516)	
Wage growth(t-1)				2.464***
				(0.440)
Observations	852934	626337	852934	626337
Number of firms	226597	181901	226597	181901
Year and Sector F.E.	YES	YES	YES	YES
R^2	0.0176	0.0112	0.0337	0.0104

Robust standard errors are clustered at the firm level: * p < 10%, ** p < 5%, *** p < 1%.

Results presented in Table 2 confirm the positive correlation between productivity and wage in levels and growth forms. What is more, there's evidence of a stronger association between firms paying higher wages having productivity enhancements than the relationship between productivity improvements translating into wage increases. A productivity growth acceleration of one percentage point is associated to a 1.05 euros average wage increase in the same year. Interestingly, equal productivity growth acceleration in the previous year does not seem to have a significant effect on today's average level of wages. On the other hand, if the company saw their wages growing faster in the previous year it might, on average, produce more output per worker this year. Past wage growths may have a

motivation upshot on workers which materializes into higher present productivity levels. In contrast, profit maximizing employers/firms might believe they have no incentive to further increase labour costs, after productivity upsurges, particularly in the fear of downturns. The contemporaneous effect of wage growth is larger than the two prior ones: one percentage point acceleration is associated with an increase of 36 euros in GVA per worker.

The relationship between productivity and wage growths can be visualized in Figure 3 where we display sectoral density functions of the ratio (L.P. growth over wage growth), for every firm-year pair. We take the natural logarithm of the ratio for presentation purposes, knowing that the transformation normalizes distributions. Moreover, if a firm raises wages at the exact pace of productivity improvements – as neoclassical theory predicts –, the logged ratio will equal zero. We present the distribution of such ratio for the total economy as well as for some illustrative sectors. Namely, we chose the largest sectors in terms of employment (G and C), the fastest employment share growth sector (I), and the two sectors related to natural resources and with the highest ratios (B and the aggregation of D and E). In line with previous findings, all distributions are shifted to the right of the vertical red line, with modes larger than zero. This suggests that 67% of firms in each year did not raise average wages in line with labour productivity.[11]

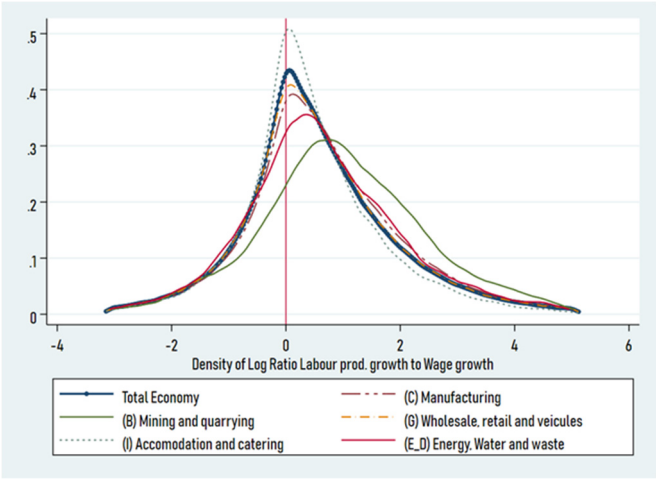


Figure 5 – Density functions of the (logged) ratio of productivity growth to wage growth for every firm-year pair. Red line represents the situation where wage growth matches that of GVA per worker. As an example of interpretation, a mode of 0.1 indicates that most firms should have raised wages by 10.5% more, if the aim was to match growths.

It is also interesting to explore the presence of heterogeneous correlations along the distribution. Increasing wages in a top performing firm may have different effects on productivity compared to the effects of having the same wage increase in a low-productivity company. Conversely, productivity growth in a low-paying firm can increase wages by more or less than in a high-paying one. To shed some light on this question, we resort to quantile regressions (Koenker and Basset, 1978) which allow us to assess the relationship between the variables of interest along different points of the conditional distribution, instead of just at the mean as OLS. Quantile regressions relax some of the OLS assumptions and, thus, are more robust to non-normal errors or outliers (Baum, 2013), by minimizing a different loss function, which gives more weight to observations around a quantile τ, through a check function ρ:

$$Q_\tau(\mathrm{Y}_i|\mathrm{X}_i) = \arg\min_{q(X)} \; E\left[\rho_\tau(\mathrm{Y}_i - q(\mathrm{X}_i))\right]$$

We run two hundred univariate quantile regressions, one for each 0.05 quantile increment until the last percentile, first for productivity and then for wages. These coefficients are plotted in Figure 6 along with the two simple OLS estimates. Firstly, one can see that there is substantial heterogeneity across both distributions, which is invisible through OLS. Both display a pronounced upslope monotonic relation along each distribution. The wage increase, from productivity enhancements, in a median-paying firm is larger than for a company paying average wages. Whereas, the wage increase effect on productivity is greater for firms with average, than with median, productivity.

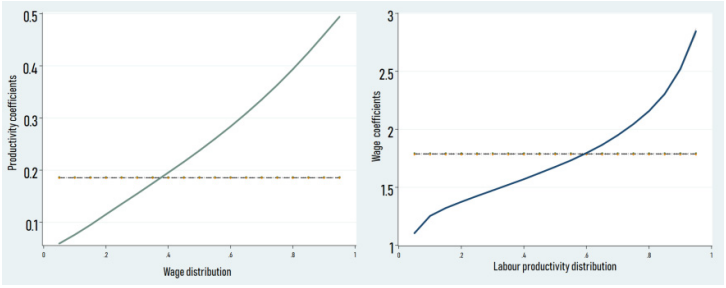


Figure 6 – Coefficients of quantile regressions of GVA per worker on average wages (left) and of wages on productivity (right). The horizontal line represents the respective OLS estimates.

Another way to test these hypotheses econometrically is to use the growth of wages and productivity, as well as dummy variables for different parts of each distribution. Therefore, we construct dummies for both firms belonging to their industry-year top and bottom 10% in terms of wages and labour productivity. As before, we define the growth rate variables as the firm's consecutive change divided by the product of the original level and duration, to account for annual gaps in our unbalanced panel set. Consequently, 291,727 observations are lost and the mean growth of firm's productivity is 10pp higher than that of wages with a much higher standard deviation. Finally, we generate

[11] After losing more than 290,000 observations in the calculation of the growth variables and removing 1% top and bottom tail's outliers, we end up with 401,703 logged ratio observations, 268,688 of which are greater than zero.

interaction terms between these variables and run fixed effects estimations (Table 3).

We confirm the previous finding that wage changes have more impact on productivity than the opposite. On average, a wage growth acceleration of one percentage point is associated to a similar productivity growth. On the other hand, a one percentage point increase in productivity growth is correlated with an increase in the firm's wage growth of only 0.05pp.[12]

Table 3 - Relationship between Productivity (1-3) and Wage (4-6) growths

	(1)	(2)	(3)	(4)	(5)	(6)
Wage growth	1.026***	1.039***	0.957***			
Wage gr. * Bot. 10% LP		-0.928***				
Bottom 10% LP		-1.515***				
Wage gr. * Top 10% LP			0.103			
Top 10% LP			0.977***			
LP growth				0.0527***	0.0527***	0.0469***
LP gr. * Bot. 10% Wages					-0.0281***	
Bottom 10% Wages					-0.473***	
LP gr. * Top 10% Wages						0.0277***
Top 10% Wages						0.374***
constant	0.000298	0.226***	0.0345***	0.0759***	0.117***	0.0465***
Observations	852934	852934	852934	852934	852934	852934
Number of firms	226597	226597	226597	226597	226597	226597
Firm and Year fixed effects	YES	YES	YES	YES	YES	YES
District Fixed Effects	YES	NO	NO	YES	NO	NO
R^2	0.0553	0.0955	0.0703	0.0562	0.120	0.0923
R^2 overall	0.0562	0.0556	0.0618	0.0516	0.0683	0.0511
R^2 between	0.0686	0.0445	0.0724	0.0545	0.0475	0.0407

Robust standard errors are clustered at the firm level: * p < 10%, ** p < 5%, *** p < 1%.

Furthermore, the fixed effects results for growth (i.e. within each firm) are consistent with the pooled quantile regression's graphs in levels, in the sense that the correlations are larger for firms higher in the distributions. According to these estimations, the bidirectional links between productivity and wages are weaker once we account for unobservable time-invariant firm and district characteristics, as well as widespread annual shocks. In column (2), one can see that the productivity growth associated to wage acceleration is smaller for low-performing companies, although positive and significant at 1% level (1.039 – 0.928), and these firms have lower productivity growth.

Contrariwise, top-performing companies have, on average, almost one percentage point higher productivity growth. Although it seems that these firms do not have productivity improvements, from wage growth, significantly above others – column (3) –, the joint wage growth elasticity is still significant at 1% and above one. Note that all joint interaction effects are significant at 1% level and positive, consistent with previous findings. Looking at the last columns, there's evidence that productivity improvements for companies at the lower tail of wages have a smaller effect on wage growth, and these seem to have lower productivity growth overall. If a top-paying firm improves its productivity, on average, it would experience a higher wage increase compared to all others.

4.3 Decoupling of Wages from Productivity

All the results above contribute for two dynamics: the increase in dispersions of productivity and wages – *Great Divergences* (Berlingieri et al., 2017) –, and the decoupling of wages from productivity (Schwellnus et al., 2018), presented in the graph below.

Industry's mean labour productivity exhibits an expected pro-cyclical behaviour, closely following macro-level real GDP growth. Compared to 2010, productivity decreased almost 2% in the first year of recession (compared to annual -1.8% real GDP growth) and plumped 4% in the worst period (roughly the same as annual real output downturn in 2012), but rapidly recovers to 6% higher values than in 2010. Distinctly, wages display significantly less volatility due to wage-stickiness (Keynes, 1936) but also downward nominal wage rigidity, which is high by international standards (Dickens et al., 2006). In fact, according to the Portuguese labour code, employers are prohibited to pursue nominal wage cuts, with very few exceptions related to collective bargaining (Article 129th, d).

Figure 7 – Each series is derived by estimating the industry mean GVA per worker, average wage and the industry's median value for the latter, per year. Next indexes, based on 2010, are calculated within each industry and then annually averaged.

This might put some pressure on the firm's labour costs during downturns, complicating the adjustment to avoid bankruptcy. The closure of these less productive firms is likely to be an explanation for the 2011's increase in wages depicted in the graph, since the total number of firms decreased by around 20,000 (Graph 3, annex). Furthermore, one should keep in mind the importance of these rigidities, particularly in recessions, for they act as a buffer for domestic demand, moderate output volatility and risks of deflation, and speed up recovery (European Commission, 2018). Interestingly, as real output growth

[12] Please note that from this point forward, standards errors are omitted for presentation purposes but available upon request.

returns to positive values (2014) a productivity-wage gap appears, even with nominal wage upturns. In line with the lower firm-level wage inequality presented in Figure 11, median wages at the industry-level consistently grow faster than mean industry wages. Lastly, we should bear in mind that not only the decoupling is more pronounced at the macro-level (Figure 2) but also that it would be larger for a greater timespan. Indeed, from all EMU countries, Portugal recorded the largest cumulative decrease in Unit Labour Costs (ULC) and was the only economy experiencing a decline in real compensation per employee, from 2000 to 2016 (EC, 2018).[13]

Following Zhang and Liu (2013), in order to capture this phenomenon in one indicator, we take the ratio of labour productivity to average wage for each firm-year pair. In Figure 8 we display the evolution of the ratio for each macro-sector of the economy. By doing so, the sectoral heterogeneity in terms of decoupling becomes evident. The gap has widened in all sectors, expect in Non-Market Services (O_U) and Construction (F), while in Energy, Water and Waste (D_E) it stabilized in 2016. Additionally, in the annex we present some representative examples of sector groups, showing the mixed dynamics between productivity and wages separately.

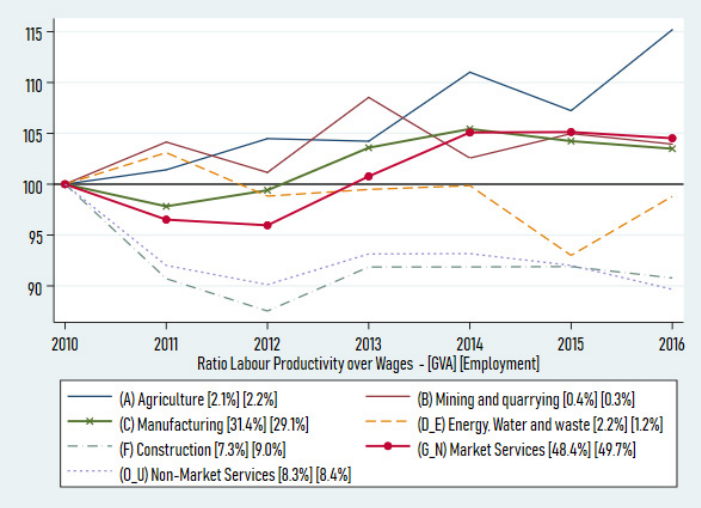


Figure 8 – Depicts the evolution of the ratio of GVA per worker over firm's average wage for each group of sectors, indexed at 2010. It also shows the GVA and employment shares of those sectors.

Even though the largest gap increase is found in Agriculture (A), Market Services (G_N) and Manufacturing (C) are the main sources for overall productivity-wage gap, representing circa 50% and 30% of total GVA and employment, respectively. What is more, although these sectors show slight decreases until 2012, we can see that the Construction sector's severe decline of 15% (20% in GVA, according to Statistics Portugal) largely explains the above mentioned productivity downturn (Figure 7).

Before diving into some of the determinants of the decoupling, it is important to clarify its consequences and relation to the ULC. As emphasized by Felipe (2005 and 2011), in practice, ULC can be interpreted as the labour share multiplied by a price deflator:

$$ULC = \frac{Wn}{(GVAn/P)/L} = \frac{Wn * L}{GVAn} * P$$

$$= \frac{Total\ Labour\ Comp.}{GVAn} = Labour\ Share * P$$

Where Wn is the average nominal wage/compensation rate, L the number of workers and P the price deflator. Furthermore, our measure for the decoupling can be rearranged as such:

$$Ratio = \frac{GVAn/L}{Total\ Wages/L} = \frac{1}{T.\ Wages/GVAn} = \frac{1}{Wage\ Share}$$

Thus, taking other forms of labour compensation (e.g. employer-provided benefits) and the deflator as constant, to promote ULC reduction is equivalent to decrease the labour share. In turn, lowering labour shares is equal to widening the gap between labour productivity and wages – i.e. increase our ratio. Despite the fact that, historically, there is no clear relationship between ULC and output growth (*Kaldor's Paradox*), the IMF and the EC constantly advocate for its reduction, in the name of competitiveness (i.e. *internal devaluation*).[14] What is more, on top of the direct increase in functional inequality, reduced labour shares can have recessive effects on wage-led economies. Onaran and Obst (2016) demonstrate that an isolated decline in the wage share leads to lower growth in eleven EU-15 countries, including Portugal. Yet, if the fall in wage shares is simultaneous then there is an overall decline in EU-15 GDP. The authors, thus, conclude that Portugal, as well as the EU-15 as a whole, are wage-led economies.

To investigate some of the quantifiable drivers of the decoupling of wages from productivity, at the firm level, – i.e. changes in ratio of productivity to wages – we run within firm estimations through equation (3):

$$log\ LP/\ Wage_{it} = \alpha + \boldsymbol{X'\beta_{it}} + year_t + \delta_i + \varepsilon_{it}$$

Where $\boldsymbol{X}$ is the vector of covariates used in each regression; $year_t$ is a vector of time dummies to account for annual across the board shocks (e.g. external demand downturns); δ_i captures firm fixed effects (e.g. manager's

[13] In the EC note for the Eurogroup, the largest ULC decrease is attributed to Ireland but only because of revisions in calculation methods for the Irish real GDP (component of the ULC denominator) resulting in a 25% growth in 2015.

[14] See, for example, Paul Krugman in: https://krugman.blogs.nytimes.com/2010/05/17/et-tu-wolfgang/ (Felipe, 2011).

ability) and ε_{it} is the error term. While column (5) is the main model, including standard firm characteristics that affect productivity and wages (e.g. Martins et al., 2018), we also run reduced forms of the latter for robustness. Coefficients can be interpreted as semi-elasticities to the ratio as it is in logs while regressors are in levels.

Table 4 - Fixed effects models - log (LP/wage) ratio

	(1)	(2)	(3)	(4)	(5)
Training	1.160***			1.040***	1.018***
Export status	0.0725***			0.0601***	0.0614***
Irregular contracts	0.0495***			0.0691***	0.0671***
Innovation status		-0.00543**		-0.00795*	-0.00620
Electricity costs		-0.734***		-0.710***	-0.722***
Net Interest		0.0274***		0.0155**	0.0189**
L.M. deregulation			0.00645***	0.0224***	0.0184***
Minimum wage			-0.00000471	-0.0000176**	-0.0000191**
Board compensation			0.316***	0.159***	0.125***
Size					-0.0272***
Leveradge					-0.00000818*
Capital intensity					0.0139***
Capital intensity^2					-0.0000135***
NPL / Equity					0.00000160***
Observations	152796	479444	714261	108176	99684
Number of firms	64546	150497	213504	44722	41134
Firm and Year fixed effects	YES	YES	YES	YES	YES
R^2 within	0.0116	0.0814	0.0229	0.0775	0.0933
R^2 overall	0.0134	0.0776	0.0345	0.0854	0.148
R^2 between	0.0183	0.0798	0.0364	0.0887	0.152

Robust standard errors are clustered at the firm level: * p < 10%, ** p < 5%, *** p < 1%.

Results indicate that companies which invest more in on-the-job training relative to labour costs, surprisingly, tend to have a weaker link between productivity and wages. Yet, this is consistent with the findings of Konings et al. (2015) to the extent that they find substantially larger productivity premium than wage premium from work-related training. The same is true for companies with exporter status because price competitiveness partially depends on the firm's ULC relative to trading competitors. Although not significant in the main model, there is some evidence suggesting that, being an innovative firm is associated with lower ratios. Furthermore, on average, having a higher share of irregular contracts tends to decouple wages from productivity. Biesebroeck (2014) points out that the unwinding of labour regulations encourage a dual labour market where firms have the incentive to hire workers, many times younger and carrying higher human capital (more productive), through theses atypical contacts to perform the same work as incumbents for a lower cost.

Berlingieri et al. (2017) found no significant effects from changes in EPL on the link between wage and productivity sectoral dispersions, once they accounted for country-sector year fixed effects. At the firm level, we find evidence that the extensive labour market flexibility reforms, pushed throughout the adjustment programme (2011-2014), contributed to the weakening of the link between productivity and wages, significant at 1% level. In column (4) we regress the latter together with Irregular contracts to ensure that lower labour protection does not increase the gap only due to a lower share of permanent contracts in the firm's workforce.

Despite the fact that minimum wages were frozen during the adjustment programme, there is some evidence that the updates in the two following years contributed to a stronger correlation between wages and productivity improvements. This finding is consistent with those of Berlingieri et al. (2017), concluding the same in terms of sectorial dispersions for OECD countries. As in their paper, this result has an opposite sign if we do not account for year and industry fixed effects. Looking at our robustness checks (Output 4 in annex), we conclude that the sign is only positive once we neglect the impacts originated from across the board shocks from the crisis (time fixed effects).

Moreover, we find evidence that companies with higher board's compensation relative to total wage bill are associated with wider decoupling of wages from productivity, significant at 1% level. On average, a percentage point increase in relative remuneration of executives is associated to an increase in decoupling of around 15%. Note that this remuneration does not include other income sources which usually compose executive pay (e.g. interests and capital gains). That is, upsurges of this indicator should translate into higher within-firm wage inequality, since the workforce receives a smaller share of total wage bill. Surprisingly, electricity costs over EBITA appear to be associated with lower productivity-wage gaps. Indeed, in almost all sectors with the lowest ratios these costs represent at least 20% of EBITA (overall average 15.5%), with the lowest ratio sector – Accommodation and catering (I) – having the highest rate of 35% (annex, p. 24). On the other hand, companies with higher net interests received and which are less leveraged tend to have higher productivity relative to wages. Finally, capital intensity has a non-linear influence: it increases the ratio until a turning point where more capital per worker tends to decrease it. These findings are also robust to the exclusion of conventionally dropped sectors, where productivity estimation is less reliable – column (6) of Output 4 (annex).

4.4 Determinants of Productivity and Wages along the distributions

Naturally, changes in the ratio can arrive from changes in the numerator and/or denominator. In order to understand, not only how each determinant affects decoupling but also, how those effects vary for firms at different parts of the distributions, unconditional quantile regressions with fixed effects are performed at three quantiles: 10th, median (50th) and 90th. Firpo, Fortin, and Lemieux (2009) developed Unconditional Quantile Regressions (UQR) which allow estimating

effects on quantiles defined pre-regression – i.e. not influenced by the chosen covariates (Killewald and Bearak 2014). In UQR one can adjust for selection bias including fixed effects without redefining the quantiles, through a methodology and STATA command developed by Borgen (2016). We run UQR on average wage and productivity, with year and industry fixed effects, and standard errors clustered by industry, using the same set of covariates as before.

Results (Outputs 5 and 6, annex) show evidence of heterogeneous effects with generally higher absolute impacts on higher quantiles, for almost all determinants, driving the *Great divergences*. The finding that increases in the firm's average wage have a larger effect on productivity, than the opposite (Efficiency-wage theory), is confirmed for every quantile, regardless of the controls used.

As expected, training increases productivity per worker (Dearden et al., 2006), particularly in top-performing companies where the coefficient is about threefold that of median firms. A striking result is that companies with higher investments in on-the-job formation for their workers are associated with lower average wages. This might indicate that, not only wage updates from specialization take time to materialize but also that, executives substitute wages for training expenses. This explains the decoupling impact of training, which is much more pronounced in top-performing and high-paying enterprises. Having an exporter status does not significantly influence productivity or wages in bottom tail companies (10^{th} percentiles). Yet there's evidence that exporting companies have higher productivity (Greenaway et al., 2004) and wages (Wagner, 2002), with the effect on the first being larger – i.e. increasing the ratio.

Though not significant for median-productivity firms, irregular contracts significantly decrease productivity for low-performing companies and increase it for those at the higher tail – cubic relationship of irregular contracts on productivity. In an extensive report, ILO (2006) points to an inverse U-shaped relationship between temporary contracts and productivity. If the share of these contracts is not too high, and if they are voluntary, productivity increases. On the other hand, if firms abuse of temporary contracts and these are involuntary, there is a significant negative productivity effect. Thus, our results suggest that top-performing firms may have a culture of hiring stable labour, with a high degree of conversion of temporary into permanent contacts and the former are signed voluntarily. Whereas, in low-productivity firms temporary contracts might be renewed several times with the goal of reducing labour costs and appear to be involuntary. *The Green Book of Labour Relations – Portugal* (2016) highlights Eurostat data showing that, in 2015, 68% of temporary workers between 15 and 24 years of age (the most qualified generation ever) are involuntary, while the EU-28 average is less than half (37,3%).[15] Moreover, the share of temporary contracts among young employees increased by almost 10pp, in just six years (Figure 9). While the OECD average remained stable around 25%, in 2016 pratically two thirds of workers in Portugal, aged between 15 and 24, had temporary working relations.

Our measure of irregular contracts also includes part-time workers. In Figure 9 one can see that more than a third of part-time contracts were involuntary in 2016 – more than the double of OECD average. These also increased substantially, since 2010, until they represented 4.5% of total employment. Unstable working relations can have nefarious productivity effects. Using tenure as a proxy for stability in EU-13, Auer et al. (2005) show a positive and robust relationship with productivity growth, until a turning point of 13.6 years – although no EU country surpassed it. The authors argue that stable working relations promote worker's commitment, more coordinated tasks with permanent workers and managers, as well as on-the-job training leading to productivity enhancements.

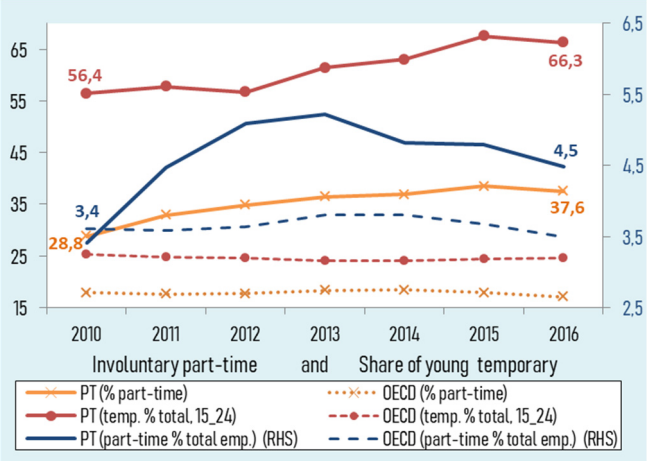


Figure 9 – Involuntary part-time as a percentage of total part-time and as a share of total employment (Right Hand Side); Incidence of temporary contracts in total employment between 15 and 24 years old; OECD - Labour Force Statistics.

Returning to our results, non-standard contracts tend to significantly decrease average wages for all companies – except for high-paying ones where the effect is not significant. This might be an indication that the mentioned voluntary nature at top-performing companies arises from the absence of significantly lower wages for these irregular contracts in these companies. Additionally the negative effect on wages is more pronounced for companies already in the lowest tail of

[15] The percentage of involuntary contracts in temporary employment is even higher for workers aged between 24 and 65 years (87%), also above EU-28 average (72%).

overall wage distribution. The combinations of all these effects also contribute to the decoupling of wages from productivity, in all parts of both distributions.

Likewise, higher board compensation displays a cubic relationship with productivity, being significantly positive for top-performing companies but negative for low-productivity firms and insignificant at the median – i.e. contributes for productivity dispersion. Interestingly, the productivity improvements for top-productivity firms are not found to translate into higher average wages for workers in high-paying companies – indeed they seem to significantly decrease wages in column (3) of Output 6. Across all firms, average wages tend to significantly decrease after upsurges in relative executive pay– except in column (6). Therefore, higher board compensation relative to total wage costs might be one of the explanations for the non-significant link between top-half productivity divergence and top-half wage dispersion ($90^{th}/50^{th}$).

Closely related to the high share of irregular contracts is the unwinding of labour regulations (Figure 10). Turning to the decomposed effects of labour market flexibilization, one can see that while it does not significantly increase productivity it decreases wages, mainly for companies at the tails of the distribution. OECD (2013) comprehensive literature review points to a trade-off between productivity enhancing impacts from lower EPL – e.g. lower burden implied by firing costs increasing worker flows and, desirably, efficient allocation (Hopenhayn and Rogerson, 1993) – and equally beneficial effects arising from higher employer and employee investment in firm-specific human capital due to greater job protection (Belot et al., 2007; Fella, 2005). Accordingly, analysing 20 OECD countries for the period 1984-2004, Storm and Naastepad (2009) found that more regulated and coordinated ("rigid") labour markets promote long-run productivity growth. Using a more extended period (1960-2004), Vergeer et al. (2010) show that wage-cost saving flexibilization of labour markets has a negative impact on labour productivity growth, and find a causal link between wage growth and productivity growth.

What is more, while there's evidence that dualized labour markets hinder productivity growth (OECD, 2004, 2007a, 2010), it's not clear that reducing EPL will tackle segmentation per se. In fact, Graph 1 (annex) shows that segmentation, in Portugal, actually increased after reforms vis-à-vis 1995. These reforms intensified the decline of the labour share (largest fall in EU-28 between 1995 and 2016), because the protection of temporary contracts was further reduced. The combination of these effects sheds light on how labour deregulation hampers the link between productivity and wages.

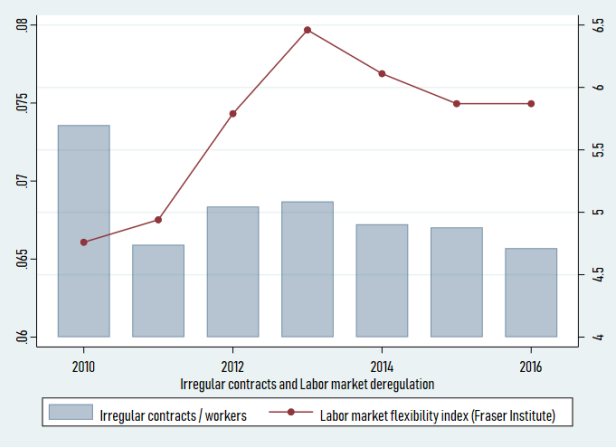


Figure 10 – Memorandum of Understanding (2011-2014) significantly increased labour market flexibility/deregulation, facilitating the presence of non-standard contracts (i.e. service providers, temporary and part-time). The 2011's decrease of around 1pp in the latter might be explained by the exiting of low-performing firms, reflected in Graph 3 (annex).

Annual minimum wage advancements show a significant positive effect both on productivity and wages, for companies at the lower tails and at the median of the distributions. Contrary to most determinants, minimum wage appears to have greater impacts on companies at the unconditional 10^{th} percentile of the distributions, most likely because they have a higher share of workers receiving it. These conclusions align with Croucher et al. (2012) who found causal productivity improvements in all low-paying sectors, using a difference-in-difference analysis, after the introduction of national minimum wage in the UK. Therefore increasing minimum wages tackles wage inequality (e.g. Carl Lin et al., 2016) and productivity divergence thought its positive effect on firms at the bottom halves of both distributions.

Regarding financial dimensions, we find evidence that median-paying firms see their average wage decrease about the same as their productivity after leveraging, yet no significant effect for other firms. Moreover, firms at the bottom-half of the overall productivity distribution with a better net interest situation tend to have greater performance but not better wages. Whereas there's some sign that higher net interest for high-paying companies is associated with lower average wages. This may suggest that interest returns are absorbed by the firm's board compensation and shareholders. Accordingly, both findings contribute to the decoupling of wages from productivity.

As expected electricity costs over EBITA have a negative significant impact on labour productivity across all of its distribution. Absolute electricity costs are a component of the firm's GVA which is higher for firms at the 90^{th} quantile than those at the 10^{th} percentile. Concerning its effects on wages, one can see that it is only significant for companies at the bottom of the distribution.

Therefore, electricity costs reduce the ratio only because they reduce labour productivity's numerator. The positive non-linear association of capital intensity on productivity is symmetric in the case of wages. Lastly, while it's evident that larger firms pay higher wages, there's only significant evidence that larger firms tend to have lower productivity at the top.

4.5 Frontier firms vs Laggards

Following the most recent literature, we now focus on the frontier firms, i.e. the top-performing companies here defined by TFP levels. As in the case of labour productivity, TFP presented major outliers, with the top 1% detaining more than 45% of total TFP. Therefore, we delete the observations above the 99% and below the 1% percentiles. In Figure 11 we display the cross-sectional shares for different groups of the distributions of average wages, labour productivity and TFP. The latter is still notoriously more unequally distributed than the others, with a Gini coefficient above 86.

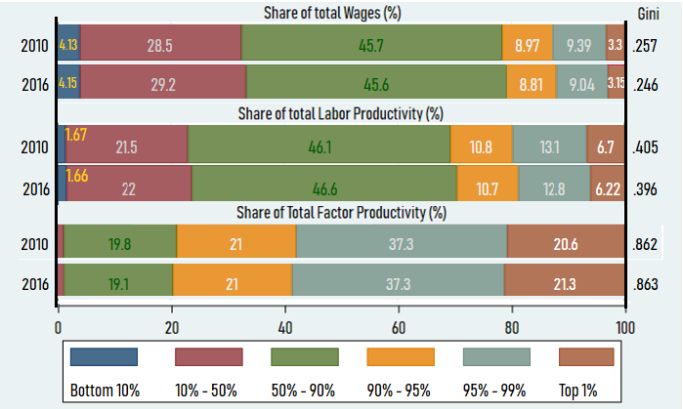


Figure 11 – Shows the share of each variable detained by different groups in the distributions, for the first and the last year in our sample. While the top 10% firms had around 30% of total annual labour productivity the top 10% in terms of TFP held practically 80% of the latter.

In line with Andrews et al. (2016) results for the OECD average, we find that the TFP frontier firms in Portugal (i.e. top 5% and 10% of each industry) experienced substantial growth in overall efficiency – 10% above the levels of 2010. On the other hand, laggards where affected by the crisis, slowly recovering to 2010 TFP levels, in 2016.

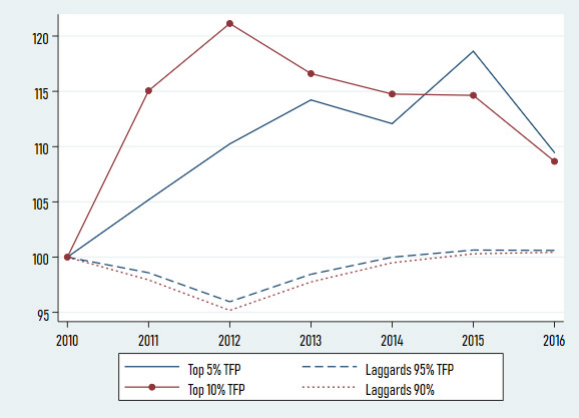


Figure 12 – Frontiers vs Laggards. As an example, the connected red line shows the evolution of the average TFP of the top 5% firms within each 2-digit industries. Indexes were computed within those industries and then annually averaged.

Given that the top 1% is responsible for more than 20% of TFP, we take the average of firms in this group as the main frontier. Note that for a given capital intensity level labour productivity follows the firm's TFP. To investigate the hypothesis that the drivers of the first influence the second, we use a subset of covariates as regressors in the logit model. Contrasting with the previous econometric identifications, we perform logistic regressions on a dummy variable which takes the value of one if the firm belongs to the overall top 1% of total TFP, and zero otherwise. Thus, positive (negative) coefficients can be interpreted as increasing (decreasing) the likelihood of belonging to the TFP frontier. These results can also be viewed as robustness checks for the previous findings but cannot be interpreted as marginal effects.

Once again, we find evidence that paying higher wages is positively associated with having higher productivity, in this case overall efficiency (TFP). If the firm increases its average wage level there's a greater probability that it belongs to the top 1% and to the top 10% TFP firms (Output 7, annex). Moreover, a higher share of non-standard contracts significantly decreases the likelihood of being at the 1% frontier.[16] However, this negative influence is not significant on the likelihood of belonging to the broadest frontier (top 10%). Surprisingly, solely using these two covariates delivers the highest percentage of correctly classified observations, for both frontiers.

[16] Results for the top 5% are very similar to those of the top 1% and are available upon request.

Table 5	Logit model - Top 1% TFP dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
Average wage	0.0000799***				0.0000563***	0.0000589***
Irregular cont. (%)	-0.151**				-0.515***	-0.558***
Board comp.		-0.620***		-0.620***	-0.574***	-0.576***
Training		-0.273		-0.392	-0.219	-0.210
Size		0.582***		0.621***	0.410***	0.485***
Age		0.00261*		0.00338**	0.00294*	0.00339**
Export status			0.193***	-0.492***		-0.574***
Innovation status			0.388***	0.0826*		-0.00148
log(Herfindahl)			0.152***	0.123***		0.0747***
Observations	808461	191921	1113268	191921	165654	165654
Pseudo-R^2	0.0223	0.0309	0.00461	0.0342	0.0386	0.0418
Correctly classified cutoff = 0.01	72.62%	55.99%	60.82%	54.33%	59.55%	59.94%

Standard errors are available upon request: * p<10%, ** p<5%, *** p<1%.

Increasing the relative compensation of the firm's board is found to robustly decrease the likelihood of being at the frontiers, significant at 1% level. This is an unexpected result specially controlling for size and age given that larger and older firms are more likely to be at the top 1% of TFP. On the other hand, there's evidence of a significant number of young firms belonging to the top 10%, whereas the effect of size is not consistent (Output 7, anmex). Likewise, larger investments in on-the-job training appear to have no impact on the likelihood of belonging to the top 1%, while a robust positive effect is found for the top 10%.

Furthermore, there's some evidence that having an innovation status (i.e. higher intangible assets or research personnel than the annual industry's median) increases the prospects of belonging to the top 1%. Yet, the influence is not robust to the inclusion of more controls and seems to be negative for the probability of belonging to the top 10%. Similarly, an exporter company is less likely to be at the frontiers once we account for some firm's characteristics. Lastly, higher Herfindahl indices[17] tend to increase the likelihood of being at the frontiers. We interpret these results in the following manner: the more concentrated the firm's industry is the easier it is for top companies to retain their dominant positions in terms of overall efficiency. In other words, in industries where there is less competition, and relatively high turnover concentration, there are more incumbent firms belonging to the total economy TFP frontiers.

In order to further increase the robustness of our results we conduct the same methodology using alternative definitions for most of the regressors. Namely, we disentangle the three numerators of irregular contracts variable and add the manager's bonuses to the board compensation covariate. To better test the Efficiency-wage hypothesis we define wage premium as a dummy equalling one if the firm pays an average wage above its industry's median. Training costs are expressed relative to the workforce instead of labour costs, and total exports are divided by (positive) total turnover. Innovation status is attributed if the firm has development projects' value higher than the industry's median (instead of total intangible assets) or more personal devoted to research then the industry's median. Generally, the results are the same.

There's evidence for the Efficiency-wage theory since wage premium increases the probability of belonging to both TFP frontiers, significant at 1% level. Looking at the first column of both alternative specifications (top 1% and 10%) it seems that the absolute value of non-standard contracts does not have an influence on the likelihood of being at the frontiers. Yet, once we account for other firm's features the negative effect of temporary and part-time contracts become significant. So, having a larger number of these contracts seems to decrease the probability of being at the overall efficiency frontiers. As stressed before, many of these contracts are involuntary and materialize the highly dualized Portuguese labour market. Workers with temporary contracts, which in some cases are illegally assigned to permanent tasks and are many times renewed, are less able, and maybe less committed, to contribute to the firm's overall efficiency.[18]

Table 6	Alternative Logit model - Top 1% TFP dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
Wage Premium	0.940***				0.881***	0.896***
Temp. Cont.	-0.000000691				-0.0470***	-0.0373***
Part-time Cont.	-0.000225				-0.0248**	-0.0316**
Indep. Workers	0.0000231				0.00238*	0.00232*
Board (Man. Bonus)		-0.771***		-0.761***	-0.420***	-0.419***
Training per worker		0.0000114		0.0000131	-0.0000443	-0.0000407
Size		0.583***		0.694***	0.672***	0.778***
Age		0.00266*		0.00363***	0.00106	0.00142
Exports / Turnover			-0.177***	-0.940***		-1.015***
Innov. (R&D)			-0.0657	-0.856***		-0.640***
log(Herfindahl)			0.164***	0.140***		0.141***
Observations	457302	191757	1113268	191757	122804	122804
Pseudo-R^2	0.0175	0.0309	0.00215	0.0388	0.0468	0.0528
Correctly classified cutoff = 0.01	50.20%	56.00%	57.55%	56.28%	57.99%	61.07%

Standard errors are available upon request: * p<10%, ** p<5%, *** p<1%.

Weak evidence is found for higher numbers of independent workers increasing the probability of being at the frontiers – only significant at 10% level. Frontier

[17] Herfindahl index measures the degree of competition in a market. It is defined as the sum of squared turnover/market shares in a given industry. Higher values correspond to less competition.

[18] ILO (2018) point out that Portugal has one of the least regulated temporary contracts in EU. While fixed-term temporary contracts can be successively renewed three times, uncertain term temporary contracts had no such regulation. The law only limited their duration up to six years. According to OECD (2014), by 2012 around 75% of all new hires were fixed-term temporary contracts.

firms may outsource labour, hiring freelancers who can provide specialized skills for certain temporary tasks (Burke, 2011).[19] The amount of part-time contracts has similar effects to temporary contracts, but is significant even in the first column, for the top 10% frontier (Output 8). Contrasting with OECD data, according to the Portuguese Labour Force Survey (*Inquérito ao Emprego),* more than 50% of part-time workers in our dataset's timespan wanted to work full-time (almost 70% in 2011 decreasing to circa 58% in 2016). This form of underemployment is likely to have negative impacts on the worker's capacity to participate in teamwork and to acquire firm-specific human capital.

Including the manager's bonuses into the board compensation variable still delivers robust negative influence on the likelihood of belonging to the TFP frontiers. Counterintuitively, the alternative proxy for innovation status seems to decrease the probability of the firms being at the frontiers. In an extensive literature survey, Hall (2011) demonstrates the importance of distinguishing process innovation from product innovation. Most of the literature finds substantial positive effects from product innovation, while the effects of process innovation are ambiguous, and some times negative. Unfortunately, our dataset does not allow for this distinction. These results might suggest that most innovations are aimed at the process of production or that TFP fruits from the latter take more years to materialize. All remaining results are the same as in the main specifications. Finally, note that most of the findings are consistent with those of the summary statistic's (annex, p. 25). The table also shows that top 10% TFP firms are, significantly, more profitable, less leveraged (with 34pp less NPL over Equity), have a lower correlation between wages and labour productivity and a higher ratio, and surprisingly have lower capital intensity despite having much more Assets.

5. Conclusion and Policy Implications

In the last decades, advanced economies have been experiencing a slowdown in productivity growth. On the other hand, there's an ongoing debate on the causes of wage stagnation, particularly in a period of such reduced unemployment (*wage puzzle*). While productivity is a crucial ingredient for output growth, it is only a motor of rising living standards if the gains translate into higher wages. Thus, it is utmost to understand how the wage-setting process takes place and what drives the productivity-wage gap.

Using administrative data of firms in Portugal between 2010 and 2016, we investigate the relationships between productivity and wages. We find positive and robust associations between productivity and average wages in levels and growths, though with noteworthy heterogeneity along the distributions. The link is also significant in terms of overall sectoral dispersions. However, top-half productivity dispersion was not followed by top-half wage dispersion, suggesting that productivity gains of top-performing companies are not being shared with the workforce.

In line with Efficiency-wage theory, while past wage growth significantly increases present productivity levels, firms do not upgrade today's wages after past productivity improvements. Moreover, at odds with the neoclassical theory of marginal product of labour, we find that two thirds of firms do not raise wages in line with labour productivity. These results contribute to two well documented dynamics: amplified productivity and wage dispersions (*Great Divergences*) and the decoupling of wages from productivity (*Productivity-wage gap).*

Focusing on the productivity-wage gap we find that the ratio of productivity to wages has widened in all major sectors, with the exceptions of Construction and Non-Market Services, which were notoriously affected by the crisis. We also show how the pressure for lower ULC translates into lower labour shares and larger decoupling.

Furthermore, we assess the influence of some quantifiable determinants of the decoupling and decompose them into numerator and denominator mechanisms, for different parts of each distribution. We argue that labour market flexibilization intensified dualization by further reducing the protection of non-standard employment, providing incentives for companies to hire through these contracts. Indeed, between 2008 and 2017, Portugal recorded the highest EU increase in 3 months temporary contracts, after Croatia. The percentage of these very short-term irregular contracts more than doubled relative to total employees (from 1.1% to 2.9%).

The pressure for deregulating labour markets is usually justified by its positive effects on tackling unemployment and boosting productivity. However, the literature is, at best, inconclusive regarding both (Betcherman, 2012). The conditions of the EMU limit the capacity of economies to undertake counter-cyclical policies, leaving the channel of *internal devaluation* as

[19] Burke (2011) analyses the effects of freelancers (independent workers) on firms in the UK. The reality in Portugal is much different, where a number of workers performing permanent tasks are illegally hired as independent workers (*falsos recibos verdes).*

one of the main adjustment mechanisms to correct external imbalances. Current account imbalances are "now widely agreed to haven been a major contributor to the persistent economic crisis in the EMU" (Horn and Watt, 2017). In this EC discussion paper, the authors show that *wage policy* alone is not sufficient to correct the "huge German surplus", arguing for nominal wage coordination linked to productivity plus the ECB target inflation, while managing aggregate demand.

In our results, flexibilization significantly decreases wages and has no apparent effect on productivity. In turn, irregular contracts are found to also significantly contribute for the decoupling of wages from productivity. Conversely, minimum wages are positively correlated with both productivity and wages for firms at the median and below, and reinforce the link between the two. Moreover, higher board compensation and exporter companies are associated with a weaker link between productivity and wages. Surprisingly, so do firms which invest more in on-the-job training because, on top of substantial productivity enhancement effects, they discount these costs on wages. In general, these results are robust when estimating their influence on the likelihood of belonging to TFP frontiers, even when using alternative measures for the indicators.

On top of the mentioned methodological issues, this article would significantly benefit from a wider timespan, namely since the implementation of the euro, and data on individuals. Moreover, we should always have present that this measure of labour productivity does not, primarily, concern worker's effort or ability. Going forward, the use of *Quadros de Pessoal* would allow for the investigation of productivity-wage nexus on matched employee-employer data, unveiling more detailed effects from different types of contracts, as well as the role of within firm wage inequality and educational levels.

It is important to find ways to boost productivity, including through well designed and monitored structural reforms: sound combination of labour and product markets (tackling segmentation[20] and market concentration), in financial markets (namely in adequate credit concessions and regulations) and education (promoting university access and ICT skills).[21] Yet, it is imperative to take into account both efficiency and equity considerations, while acknowledging that a trade-off between the two is not always in place. This is particularly crucial when dealing with labour markets, for the panacea of constantly lowering labour costs, in the name of competitiveness, can hamper productivity and will likely break the link between productivity and rising living standards.

> *"A productivity strategy that just focuses on businesses and innovations, or that relies on a race to the bottom - via low wages, dismantled social protection, or unacceptable working conditions – to increase the competitive advantage of firms and regions, whilst assuming that eventually everyone will benefit, will ultimately be less effective than a strategy that also addresses the disadvantages that hold people back from contributing to a dynamic economy."*
>
> *Productivity-Inclusiveness Nexus - OECD (2018)*

[20] Portugal's second Country Specific Recommendation, for 2018 and 2019 states: "Promote an environment conducive to hiring on open-ended contracts, including by reviewing the legal framework in consultation with social partners. Increase the skills level of the adult population, including digital literacy, by strengthening and broadening the coverage of the training component in adult qualification programmes. Improve higher education uptake, namely in science and technology fields."

[21] According to OECD Survey of Adult Skills (PIACC), only 25% of workers use office software and about 40% of them do not have sufficient ICT skills to use them effectively.

Bibliography

Acemoglu D., and D. Autor (2010), "Skills, Tasks and Technologies: Implications for Employment and Earnings", NBER Working Paper, No. 16082, National Bureau of Economic Research.

Adler, G. et al. (2017). "Gone with the Headwinds: Global Productivity". IMF Staff Discussion Note, April 2017 SDN/17/04

Andrews, D., Criscuolo C., and Gal P. N., "The Best versus the Rest: The Global Productivity Slowdown, Divergence across Firms and the Role of Public Policy", OECD Productivity Working Papers, 2016-05, OECD Publishing, Paris.

Atkinson, A., Piketty, T., and Saez, E. (2011). Top incomes in the long run of history. Journal of Economic Literature, 49(1): 3–71.

Auer, P., Berg, J., & Coulibaly, I. (2005). Is a stable workforce good for productivity. Int'l Lab. Rev., 144, 319.

Autor, David, David Dorn, Lawrence F. Katz, Christina Patterson, and John Van Reenen. 2017. "Concentrating on the Fall of the Labor Share." American Economic Review, 107 (5): 180-85.

Azmat, Ghazala, Alan Manning, and John Van Reenen (2011). "Privatization and the Decline of Labour's Share: International Evidence from Network Industries," Economica 79(315): 470-492

Barkai, S. (2017). "Declining labor and capital shares". University of Chicago.

Baum, C. F. (2013, May). Implementing new econometric tools in Stata. In Mexican Stata Users' Group Meetings (Vol. 9).

Belot, M., Boone, J., & Van Ours, J. (2007). Welfare-improving employment protection. Economica, 74(295), 381-396.

Berlingieri, G., Blanchenay, P., & Criscuolo, C. (2017). Great Divergences: The growing dispersion of wages and productivity in OECD countries.

Betcherman, G. (2012). Labor market institutions: A review of the literature. The World Bank.

Bivens, J., & Mishel, L. (2015). "Understanding the historic divergence between productivity and a typical worker's pay: why it matters and why it's real". Washington DC: Economic Policy Institute.

Bivens, Josh (2018). The "wage puzzle" is real – but low inflation and low productivity are also puzzles that need to be solved. Working Economic Blog. https://www.epi.org/blog/the-wage-puzzle-is-real-but-low-inflation-and-low-productivity-are-also-puzzles-that-need-to-be-solved/

Blanchard, O., & Giavazzi, F. (2003). Macroeconomic effects of regulation and deregulation in goods and labor markets. The Quarterly Journal of Economics, 118(3), 879-907.

Borgen, N. T. (2016). Fixed effects in unconditional quantile regression. The Stata Journal, 16(2), 403-415.

Branco, Domingues and Martins (2018), The Determinants of TFP Growth in the Portuguese Service Sector. GEE Working Papers 114.

Burke, A. (2011). The entrepreneurship enabling role of freelancers: Theory with evidence from the construction industry. International Review of Entrepreneurship, 9(3), 131-158.

Calderón, C., & Chong, A. (2009). Labor market institutions and income inequality: An empirical exploration. Public Choice, 138(1-2), 65-81.

Campbell III, C. M. (1993). "Do firms pay efficiency wages? Evidence with data at the firm level". Journal of labor Economics, 11(3), 442-470.

Carter, S. (2007). Real wage productivity elasticity across advanced economies, 1963-1996. Journal of Post Keynesian Economics, 29(4), 573-600.

Centeno, M., & Novo, Á. A. (2014). When supply meets demand: Wage inequality in Portugal. IZA Journal of European Labor Studies, 3(1), 23.

Ciminelli, G., Duval, M. R. A., & Furceri, D. (IMF, 2018). Employment Protection Deregulation and Labor Shares in Advanced Economies. International Monetary Fund.

Clark, J. B. (1899). 1.2 "The Distribution of Wealth: A Theory of Wages, Interest and Profits".

Cournède, B., & Denk, O. (2015). Finance and economic growth in OECD and G20 countries. Available at SSRN 2649935.

Croucher, R., & Rizov, M. (2012). The impact of the national minimum wage on labour productivity in Britain. E-Journal of International and Comparative Labour Studies, 1(3-4), 263-289.

Cusolito, Ana Paula; Maloney, William F.. (WB, 2018). "Productivity Revisited: Shifting Paradigms in Analysis and Policy". Washington, DC: World Bank. © World Bank. https://openknowledge.worldbank.org/handle/10986/30588 License: CC BY 3.0 IGO.

Dabla-Norris, M. E., Kochhar, M. K., Suphaphiphat, M. N., Ricka, M. F., & Tsounta, E. (2015). Causes and consequences of income inequality: A global perspective. International Monetary Fund.

Dearden, L., Reed, H., & Van Reenen, J. (2006). The impact of training on productivity and wages: Evidence from British panel data. Oxford bulletin of economics and statistics, 68(4), 397-421.

Dickens, William T. "How Wages Change: Micro Evidence From The International Wage Flexibility Project." Journal Of Economic Perspectives, 21(2): 195-214.

Elgin, C., & Kuzubas, T. U. (2013). "Wage-productivity gap in OECD economies". Economics: The Open-

Access, Open-Assessment E-Journal, 7(2013-21), 1-21.

European Commission (2018), "Wage Dynamics in te EMU". Thematic Discussions on Growth and Jobs. Note for the Eurogroup.

Felipe, J. (2005). A Note On Competitiveness, Unit Labor Costs And Growth: Is" Kaldor'S Paradox" A Figment Of Interpretation? (No. 2005-06). Centre for Applied Macroeconomic Analysis, Crawford School of Public Policy, The Australian National University.

Felipe, J., & Kumar, U. (2011). Unit labor costs in the Eurozone: the competitiveness debate again. Levy Economics Institute of Bard College Working Paper, (651).

Fella, G. (2005). Termination restrictions and investment in general training. European Economic Review, 49(6), 1479-1499.

Firpo, S., Fortin, N. M., & Lemieux, T. (2009). Unconditional quantile regressions. Econometrica, 77(3), 953-973.

Fligstein, N., & Shin, T. (2007, December). Shareholder Value and the Transformation of the US Economy, 1984–2000 1. In Sociological forum (Vol. 22, No. 4, pp. 399-424). Oxford, UK: Blackwell Publishing Ltd.

Furman J. and P. Orszag (2015), "A Firm-Level Perspective on the Role of Rents in the Rise in Inequality", Presentation at "A Just Society" Centennial Event in Honor of Joseph Stiglitz, Columbia University.

GEP-MSESS (2016), Livro Verde sobre as Relações Laborais 2016. "*The Green Book of Labour Relations – Portugal"*

Gordon, R. J. (2015). Secular stagnation: A supply-side view. American Economic Review, 105(5), 54-59.

Gouveia, A. F. e Osterhold (2018), Fear the walking dead: zombie firms, spillovers and exit barriers, OECD Productivity Working Paper 13

Gouveia, A. F., Santos, S. e Gonçalves, I. (2017), The impact of structural reforms on productivity: the role of the distance to the technological frontier, OECD Productivity Working Papers, 2017-08, OECD Publishing, Paris, May 2017.

Greenaway, D., & Kneller, R. (2004). Exporting and productivity in the United Kingdom. Oxford Review of Economic Policy, 20(3), 358-371.

Guschanski, A., & Onaran, Ö. (2017). Why is the wage share falling in emerging economies? Industry level evidence. Working Paper University of Greenwich.

Hall, B. H. (2011). Using productivity growth as an innovation indicator. Report for the High Level Panel on Measuring Innovation, DG Research, European Commission, 2010-2014.

Hopenhayn, H., & Rogerson, R. (1993). Job turnover and policy evaluation: A general equilibrium analysis. Journal of political Economy, 101(5), 915-938.

Horn, G. A., & Watt, A. (2017). Wages and Nominal and Real Unit Labour Cost Differentials in EMU (No. 059). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

IMF (2017), "Chapter 3 : Understanding the Downward Trend in Labor Income Shares", in World Economic Outlook, April 2017: Gaining Momentum?

International Labour Office (ILO). (2006). Non-standard employment around the world: Understanding challenges, shaping prospects.

International Labour Organization (ILO, 2018). "Decent work in Portugal 2008–18: From crisis to recovery". International Labour Office – Geneva: ILO, 2018

Karabarbounis, L., & Neiman, B. (2014). Capital depreciation and labor shares around the world: measurement and implications (No. w20606). National Bureau of Economic Research.

Keynes, J. M. (1973). 1936. The general theory of employment, interest and money, 7.

Killewald, A., & Bearak, J. (2014). Is the motherhood penalty larger for low-wage women? A comment on quantile regression. American Sociological Review, 79(2), 350-357.

Koenker, R., & Basset, G. (1978). Asymptotic theory of least absolute error regression. Journal of the American Statistical Association, 73(363), 618-22.

Konings, J., & Vanormelingen, S. (2015). The impact of training on productivity and wages: firm-level evidence. Review of Economics and Statistics, 97(2), 485-497.

Lazonick, W. (2011). From innovation to financialization: how shareholder value ideology is destroying the US Economy. The handbook of the political economy of financial crises, 491-511.

Lemieux, T. (2008). The changing nature of wage inequality. Journal of population Economics, 21(1), 21-48.

Levinsohn, J., & Petrin, A. (2003). Estimating production functions using inputs to control for unobservables. The review of economic studies, 70(2), 317-341.

Levy, F., & Temin, P. (2007). "Inequality and institutions in 20th century America". NBER Working Paper No. 13106.

Lin, C., & Yun, M. S. (2016). The effects of the minimum wage on earnings inequality: Evidence from China. In Income Inequality Around the World (pp. 179-212). Emerald Group Publishing Limited.

Manyika, J., J. Remes, J. Mischke, M. Krishnan (2018) "The Productivity Puzzle, A Closer Look at the United States," McKinsey Global Institute, Discussion Paper

Meager, N., & Speckesser, S. (2011). "Wages, productivity and employment: A review of theory and

international data". EEO Thematic Report, European Employment Observatory, 73.

Millea M (2002), 'Disentangling the Wage-Productivity Relationship: Evidence from Select OECD Member Countries', International Advances in Economic Research, 8, 314-23

Mincer, J. (1974). "Schooling, Experience, and Earnings. Human Behavior & Social Institutions" No. 2.

Murray, A. (2017). What Explains the Post-2004 US Productivity Slowdown? (No. 2017-05). Centre for the Study of Living Standards.

Nichols, A. (2008). Causal inference with observational data. The Stata Journal, 7(4), 507-541.

OECD (2018), The Productivity-Inclusiveness Nexus, OECD Publishing, Paris, https://doi.org/10.1787/9789264292932-en

OECD (2014), Employment Outlook, Paris.

Onaran, O., & Obst, T. (2016). Wage-led growth in the EU15 member-states: the effects of income distribution on growth, investment, trade balance and inflation. Cambridge Journal of Economics, 40(6), 1517-1551.

Oreopoulos, Philip, Till von Wachter, and Andrew Heisz. 2012. "The Short- and Long-Term Career Effects of Graduating in a Recession." American Economic Journal: Applied Economics, 4 (1): 1-29.

Organisation for Economic Co-operation and Development (OECD). (2013). Protecting jobs, enhancing flexibility: a new look at employment protection legislation. OECD Employment Outlook, 2013.

Pasimeni, P. (2018). The Relation between Productivity and Compensation in Europe (No. 079). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Pessoa, J. P., & Van Reenen, J. (2012). Decoupling of Wage Growth and Productivity Growth?: Myth and Reality. Resolution Foundation.

Peters, J. (2008). Labour market deregulation and the decline of labour power in North America and Western Europe. Policy and Society, 27(1), 83-98.

Piketty, T. (2014). Capital in the twenty-first century. Cambridge Massachusetts: The Belknap Press of Harvard University Press.

Piketty, T., & Zucman, G. (2014). Capital is back: Wealth-income ratios in rich countries 1700–2010. The Quarterly Journal of Economics, 129(3), 1255-1310.

Pissarides, Christopher A. (1985). "Short-run Equilibrium Dynamics of Unemployment Vacancies, and Real Wages," American Economic Review 75(4): 676-690.

Queiró, F. (2016). The effect of manager education on firm growth. QJ Econ, 118(4), 1169-1208.

Schwellnus, C. and P. Pionnier (2018) "Decoupling of wages from productivity: Micro-level mechanisms" 22-23 March 2018, OECD Conference Centre ECO/CPE/WP1(2018)3

Schwellnus, C., A. Kappeler and P. Pionnier (2017), "Decoupling of wages from productivity: Macro-level facts", OECD Economics Department Working Papers, No. 1373, OECD Publishing, Paris,

Shapiro, Carl and Joseph E. Stiglitz (1984). "Equilibrium Unemployment as a Worker Discipline Device," American Economic Review 74(3): 433-444.

Sharpe and Uguccioni (2017) "Decomposing the Productivity-Wage Nexus in Selected OECD Countries, 1986-2013," International Productivity Monitor, Vol. 32, Spring.

Stansbury, A. M., & Summers, L. H. (2017). Productivity and Pay: Is the link broken? (No. w24165). National Bureau of Economic Research.

Stephen Machin , (2016), Rising Wage Inequality, Real Wage Stagnation and Unions, in (ed.) Inequality: Causes and Consequences (Research in Labor Economics, Volume 43) Emerald Group Publishing Limited, pp.329 - 354

Stockhammer, E. (2010). Financialization and the global economy. Political Economy Research Institute Working Paper, 242, 40.

Stockhammer, E. (2013). Why have wage shares fallen. ILO, Conditions of Work and Employment Series, 35(61), 1-61.

Stockhammer, E., & Onaran, O. (2013). Wage-led growth: theory, evidence, policy. Review of Keynesian Economics, 1(1), 61-78.

Storm, S., & Naastepad, C. W. M. (2009). Labor market regulation and productivity growth: evidence for twenty OECD countries (1984–2004). Industrial Relations: A Journal of Economy and Society, 48(4), 629-654.

Strauss, J., & Wohar, M. E. (2004). "The linkage between prices, wages, and labor productivity: a panel study of manufacturing industries". Southern Economic Journal, 920-941.

Syverson, C. (2011). What determines productivity?. Journal of Economic literature, 49(2), 326-65.

Tørsløv, T. R., Wier, L. S., & Zucman, G. (2018). The missing profits of nations (No. w24701). National Bureau of Economic Research.

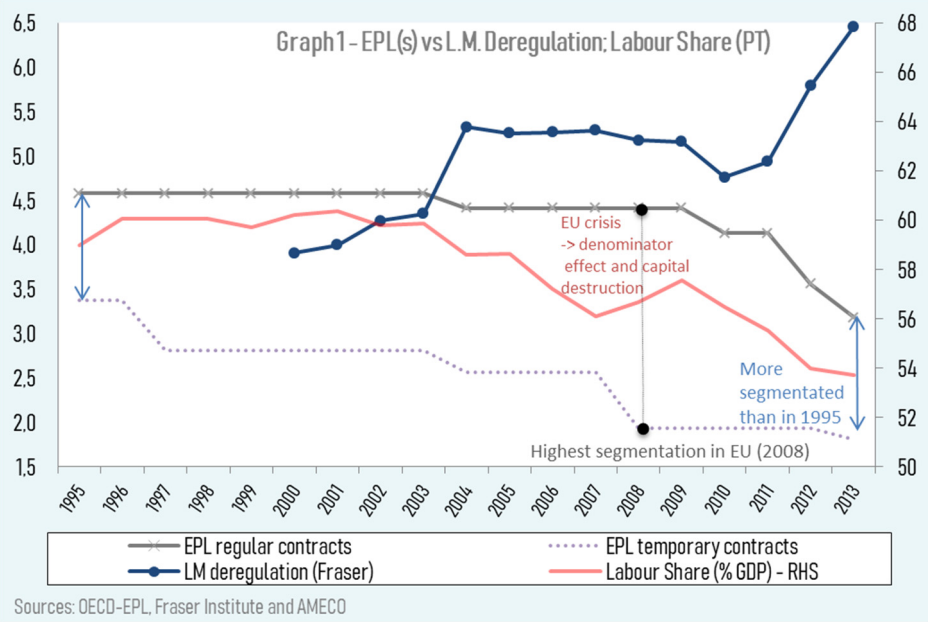
Van Biesebroeck, J. (2014). "How tight is the link between wages and productivity?: a survey of the literature". ILO.

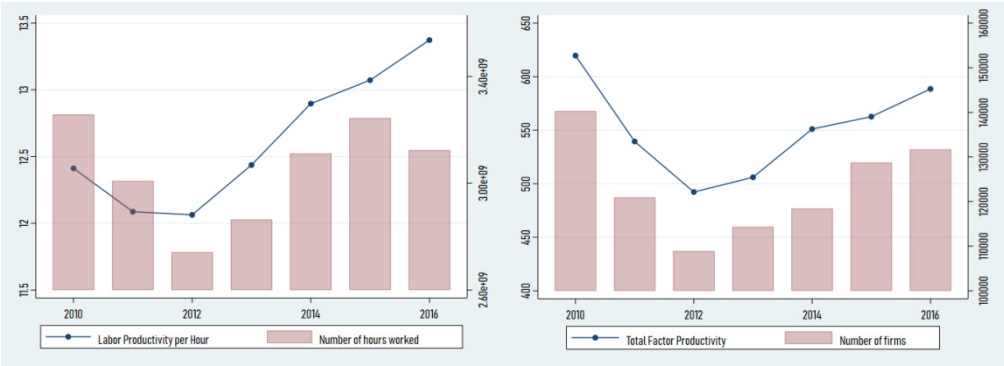
Vergeer, R., & Kleinknecht, A. (2010). The impact of labor market deregulation on productivity: a panel data analysis of 19 OECD countries (1960-2004). Journal of Post Keynesian Economics, 33(2), 371-408.

Wagner, J. (2007). Exports and productivity: A survey of the evidence from firm-level data. World Economy, 30(1), 60-82.

Zhang, J., & Liu, X. (2013). The evolving pattern of the wage–labor productivity nexus in China: Evidence from manufacturing firm-level data. Economic Systems, 37(3), 354-368.

Annex





Graphs 2 and 3 – Labour productivity per hour and number of hours worked; Total Factor Productivity and number of firms in dataset.

	Obs.	Mean	Std. Dev.	Min.	Max.
Labour Productivity	1,144,644	18328	16853	261	202655
Total Factor Productivity	1,135,969	491	3491	0,00	726544
Labour Prod. (hours)	1,144,644	11	10	0,32	108
Average wage	1,144,644	9897	4967	1014	39037
L.P. Growth	819,160	14,7	70,7	-84,8	584,5
Wage Growth	819,160	4,2	25,1	-53,8	153,6
Training	228,291	0,008	0,028	0,00	1
Irregular contracts	831,029	0,068	0,187	0,00	1
Export status	1,144,644	0,073	0,260	0,00	1
Innovation status	1,144,644	0,156	0,363	0,00	1
Electricity / EBITA	649,808	0,157	0,198	0,00	1
Net Interest / EBITA	595,529	-0,053	11,799	-8617	1
L.M. deregulation	1,144,644	5,66	0,58	4,76	6,46
Minimum wage	1,144,644	8048	285	7758	8657
Board compensation	942,999	0,42	0,32	0,00	1

Summary statistics of main variables

Correlation matrix	L.P.	TFP	Avg. Wage	Training	Irreg. Contr.	Export	Innov.	Electr.	Net Int.	Labor Mar.	Min. wage	Board
Labour Prod.	1											
TFP	0.0833	1										
Avg. Wage	0.5443	0.1131	1									
Training	0.0467	0.0191	-0.0085	1								
Irreg. Contr.	-0.0041	-0.0049	-0.0294	0.0288	1							
Export	0.1665	0.0279	0.2549	-0.0035	-0.0067	1						
Innov.	0.1129	0.0604	0.2228	0.0129	0.0279	0.2257	1					
Electr.	-0.2296	-0.0331	-0.1324	-0.0188	-0.0043	0.0018	0.0260	1				
Net Int.	0.0173	-0.0031	0.0060	0.0062	-0.0024	0.0010	-0.0013	-0.0155	1			
Labor Mar.	0.0147	-0.0131	-0.0131	-0.0055	-0.0118	0.0282	0.0045	-0.0013	-0.0051	1		
Min. wage	0.0240	-0.0024	0.0004	-0.0124	-0.0107	0.0034	-0.0106	-0.0086	0.0026	0.3392	1	
Board	-0.0081	-0.0626	-0.1454	0.0358	-0.0408	-0.1626	-0.1931	-0.1026	-0.0004	-0.0039	-0.0100	1

Correlation's matrix of main variables

Output 1 - Great Divergences(s) - log Wage (p90/p50) and (p50/10)						
	(1)	(2)	(3)	(4)	(5)	(6)
	log Wage (p90/p50)			log Wage (p50/p10)		
log LP (p90/p50)	-0.0974**					
	(0.0392)					
log TFP (p90/p50)		0.00586				
		(0.0192)				
log TFP_ols (p90/p50)			0.0698			
			(0.0778)			
log LP (p50/p10)				0.218***		
				(0.0581)		
log TFP (p50/p10)					0.119**	
					(0.0545)	
log TFP_ols (p50/p10)						0.136***
						(0.0107)
Observations	134	126	135	134	126	135
Number of sectors	20	18	20	20	18	20
Sector and Year fixed effects	YES	YES	YES	YES	YES	YES
R^2 adjusted	0.109	0.059	0.009	0.224	0.187	0.189

Standard errors are clustered at the sector level and in parentheses : * p < 10%, ** p < 5%, *** p < 1%.

Graph 4 – TFP divergenge as in Figure 3, combining overall sectoral dispersion ($90^{th}/10^{th}$ percentile's ratio) with top-half ($90^{th}/50^{th}$) and bottom-half ($50^{th}/10^{th}$).

Output 2	(1) log LP (p90/p50)	(2) log TFP (p90/p50)	(3) log TFP_ols (p90/p50)	(4) log LP (p50/p10)	(5) log TFP (p50/p10)	(6) log TFP_ols (p50/p10)
log Wage (p90/p50)	-1.048	0.243	0.198			
	(0.844)	(0.939)	(0.289)			
log Wage (p50/p10)				0.576**	0.650**	0.654**
				(0.226)	(0.237)	(0.233)
Observations	134	126	135	134	126	135
Number of sectors	20	18	20	20	18	20
Sector and Year fixed effects	YES	YES	YES	YES	YES	YES
R^2 adjusted	0.195	0.009	0.024	0.258	0.055	0.127

Note: Standard errors are clustered at the sector level and in parentheses : * p < 10%, ** p < 5%, *** p < 1%.

Output 3	(1) Avg. Wage	(2) Avg. Wage	(3) Lab. Prod.	(4) Lab. Prod.
Lab. Prod.(t)	0.0769***			
	(0.000669)			
Lab. Prod.(t-1)		0.00765***		
		(0.000485)		
Wage(t)			1.401***	
			(0.00831)	
Wage(t-1)				0.0507***
				(0.00887)
Observations	1144661	852934	1144661	852934
Number of firms	291727	226597	291727	226597
Year and Sector F.E.	YES	YES	YES	YES
R^2	0.118	0.0110	0.117	0.00885

Labor Productivity			Total Factor Productivity			Average Wages		
sector	Mean	Std Dev	sector	Mean	Std Dev	sector	Mean	Std Dev
D	55.313	47.595	D	5.661	3.874	D	15.779	7.690
E	31.225	29.524	R	1.621	1.906	O	13.558	5.853
L	28.518	33.543	Q	946	1.000	**J**	13.426	7.391
A	24.168	21.987	F	729	1.186	**K**	12.243	6.493
Q	24.157	19.956	G	446	1.468	E	11.871	5.357
K	23.683	16.396	**H**	309	1.318	**B**	11.505	4.885
J	23.278	18.413	**N**	227	1.081	**M**	11.432	5.918
B	23.092	21.032	S	121	589	P	10.905	4.923
O	21.998	23.119	E	116	249	G	10.407	5.263
M	20.880	17.432	**M**	101	186	**H**	10.329	5.586
H	19.056	14.223	P	100	74	Q	10.251	4.743
G	18.999	16.372	**C**	75	617	**C**	10.161	4.482
N	18.617	17.326	**B**	64	44	**N**	9.813	5.478
R	18.217	18.699	**J**	63	279	L	9.482	5.047
C	18.140	14.957	**A**	46	71	R	9.336	4.975
F	17.370	17.821	**K**	28	50	F	9.270	4.405
P	16.988	12.122	**I**	8	5	**A**	8.924	4.150
S	12.743	11.635	L	5	36	S	8.290	3.740
I	10.732	8.959	O	-	-	**I**	7.526	2.876
Total	**18.328**	**16.853**	**Total**	**329**	**1.101**	**Total**	**9.897**	**4.967**

Tables present the macro sector average and standard deviation for different variables.
Tradable sectors are in bold and based on the methodology proposed by Canas and Gouveia (2016).
Yellow refers to the primary sector; Dotted corresponds to broad industry (secondary sector);
Red for FIRE sectors; Green and White for Market-Services and Non-Market Services, respectively.

According to Eurostat, slightly after Germany, Portugal has the highest electricity price for households, being 28% above the Euro Area (EA) average, for the period 2010-2016. Although the situation is less striking when it comes to non-household consumers, prices were still 20% higher than the EA average. Moreover, since 2016, these have been 28% higher than in Spain, with the Portuguese largest generator/company having almost the double of the market share (47% vs 25%). Sector D refer to the production, transportation and sale of energy (electricity, gas, vapour, water and air). High market concentration should have a big influence on productivity measures and wages. Note, however, that it is also the sector with the highest ratio and lowest correlation between labour productivity and wages.

Ratio LP to Wages			Corr(LP, Wages)			Corr(TFP, Wages)		
sector	Mean	Std Dev	sector	Mean	Std Dev	sector	Mean	Std Dev
D	3,55	3,20	O	0,523	0,551	R	0,097	0,619
L	3,25	4,08	P	0,480	0,537	F	0,078	0,583
A	2,89	2,71	**M**	0,450	0,575	**M**	0,070	0,574
E	2,56	2,03	**N**	0,440	0,574	Q	0,070	0,558
Q	2,52	2,30	**K**	0,439	0,654	P	0,058	0,568
K	2,08	1,43	**J**	0,428	0,570	**H**	0,053	0,569
R	2,02	2,01	Q	0,417	0,538	**B**	0,036	0,537
B	2,00	1,61	F	0,399	0,549	**J**	0,011	0,591
F	1,95	2,09	S	0,395	0,557	L	0,011	0,616
H	1,94	1,29	**C**	0,392	0,506	**N**	-0,003	0,592
M	1,94	1,69	**H**	0,387	0,583	**A**	-0,018	0,565
N	1,94	1,61	**I**	0,379	0,557	**K**	-0,022	0,639
J	1,87	1,63	G	0,375	0,531	S	-0,023	0,602
G	1,83	1,38	R	0,368	0,589	**C**	-0,028	0,547
C	1,77	1,24	L	0,320	0,663	**I**	-0,053	0,592
O	1,58	1,15	**A**	0,306	0,540	G	-0,066	0,579
P	1,56	1,03	E	0,271	0,583	D	-0,092	0,539
S	1,51	1,25	**B**	0,260	0,547	E	-0,104	0,568
I	1,41	1,04	D	0,115	0,616	O	-	-
Total	**1,88**	**1,66**	**Total**	**0,388**	**0,542**	**Total**	**-0,015**	**0,578**

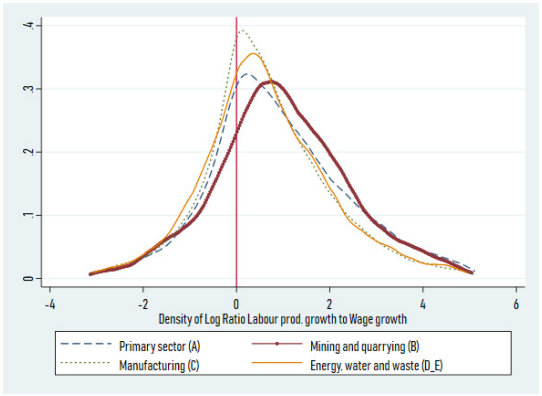
Tables present the macro sector average and standard deviation for different variables.
Tradable sectors are in bold and based on the methodology proposed by Canas and Gouveia (2016).
Yellow refers to the primary sector; Dotted corresponds to broad industry (secondary sector);
Red for FIRE sectors; Green and White for Market-Services and Non-Market Services, respectively.

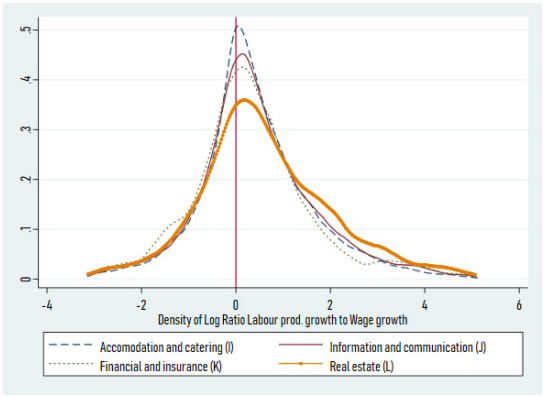
GVA per worker	Laggards	Top 10%	Difference	p-value
Labor productivity	17,312.47	62,344.64	-45,03217	0.00
Labor productivity (hours)	10.17	34.83	-24.65	0.00
Total Factor Productivity	462.75	1,373.20	-910.45	0.00
Average wage	9,528.73	17,081.60	-7,552.88	0.00
Correlation (LP, Wage)	0.43	0.35	0.07	0.00
Correlation (TFP, Wage) *	-0.02	-0.02	0.00	0.68
Ratio of LP / Wage	1.92	4.74	-2.81	0.00
Gross value added	256,698	1,278,324	-1,021,625.65	0.00
Profits (net)	25,916	298,431	-272,515.14	0.00
Workers	13.39	20.03	-6.64	0.00
Fixed tangible Assets	287,206	1,658,594	-1,371,388.35	0.00
Intangible Assets	45,459	1,033,203	-987,744.12	0.00
Capital Intensity (tangible)	2.05	5.73	-3.68	0.00
Training / labor costs	0.0075	0.0099	-0.0024	0.00
Export status (BoP)	0.07	0.20	-0.12	0.00
Irregular contract / workers	0.0685	0.0645	0.0039	0.00
Innovation status	0.15	0.24	-0.08	0.00
Electricity costs / EBITA	0.17	0.05	0.12	0.00
Size (1=Micro - 4=Large)	1.27	1.41	-0.14	0.00
Age	14.96	15.86	-0.91	0.00
Leveradge (Liabilities/Equity) *	12.30	8.05	4.25	0.44
Equity ratio (Equity/Assets)	0.40	0.47	-0.07	0.00
NPL / Equity *	0.38	0.30	0.08	0.92
Board comp. / labor costs	0.33	0.36	-0.03	0.00
ICT per worker	39.15	182.41	-143.25	0.00

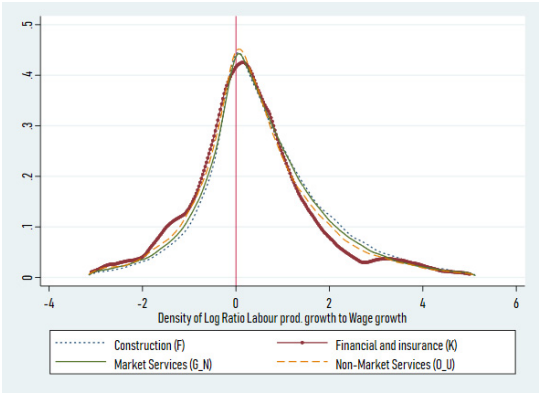
* indicates that the difference between the Frontier and Laggards is not statistically significant, **significant at 5% level, *** only significant at 10% level.

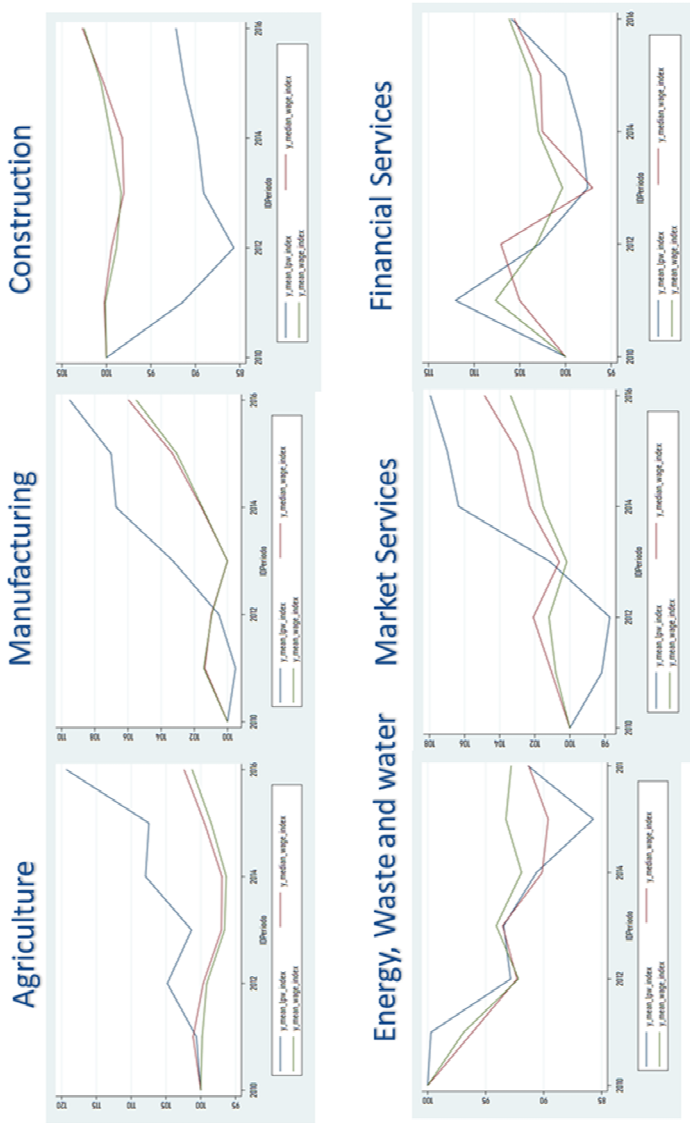
Total Factor Productivity	Laggards	Top 10%	Difference	(p-value)
Labor productivity	21,258.97	26,871.61	-5,612.64	0.00
Labor productivity (hours)	12.33	15.45	-3.12	0.00
Total Factor Productivity	82.79	4,791.85	-4,709.06	0.00
Average wage	10,186.40	11,170.51	-984.11	0.00
Correlation (LP, Wage)	0.42	0.40	0.02	0.00
Correlation (TFP, Wage)	-0.03	0.08	-0.11	0.00
Ratio of LP / Wage	2.16	2.58	-0.42	0.00
Gross value added	340,251.83	527,839.95	-187,588.12	0.00
Profits (net)	48,818.26	92,663.79	-43,845.53	0.00
Workers	13.69	17.29	-3.60	0.00
Fixed tangible Assets	396,420.20	674,666.92	-278,246.73	0.00
Intangible Assets	138,133.95	464,673.93	-326,539.99	0.00
Capital Intensity (tangible)	2.46	2.02	0.44	0.00
Training / labor costs ***	0.01	0.01	-0.00	0.09
Export status (BoP)	0.09	0.06	0.02	0.00
Irregular contract / workers	0.07	0.06	0.00	0.00
Innovation status	0.16	0.18	-0.01	0.00
Electricity costs / EBITA	0.16	0.11	0.05	0.00
Size (1=Micro - 4=Large)	1.27	1.39	-0.11	0.00
Age	14.96	15.89	-0.93	0.00
Leveradge (Liabilities/Equity) *	12.15	9.14	3.01	0.59
Equity ratio (Equity/Assets)	0.41	0.40	0.02	0.00
NPL / Equity *	0.40	0.06	0.34	0.67
CEO pay % labor costs	0.34	0.28	0.06	0.00
ICT per worker *	54.21	48.25	5.96	0.31

* indicates that the difference between the Frontier and Laggards is not statistically significant, **significant at 5% level, *** only significant at 10% level.


Density of Log Ratio Labour prod. growth to Wage growth
Primary sector (A)
Mining and quarrying (B)
Manufacturing (C)
Energy, water and waste (D_E)


Density of Log Ratio Labour prod. growth to Wage growth
Accomodation and catering (I)
Information and communication (J)
Financial and insurance (K)
Real estate (L)


Density of Log Ratio Labour prod. growth to Wage growth
Construction (F)
Financial and insurance (K)
Market Services (G_N)
Non-Market Services (O_U)


Construction
Financial Services
Manufacturing
Market Services
Agriculture
Energy, Waste and water

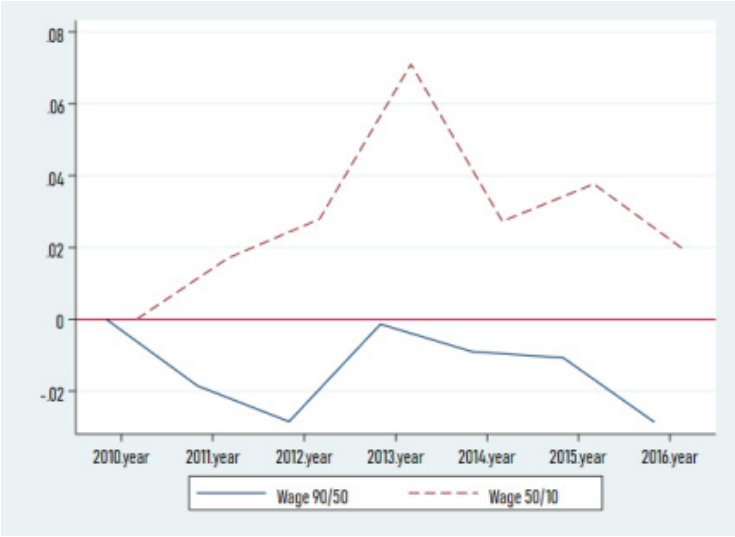
Output 4 - Robustness checks - log (LP/wage) ratio

	(1) Pooled OLS	(2) Time F.E.	(3) Time and Industry F.E.	(4) Firm F.E.	(5) Random Effects	(6) Subsample[1]
Training	1.426***	1.431***	1.228***	1.007***	1.256***	1.319***
Export status	0.0801***	0.0806***	0.0750***	0.0594***	0.0619***	0.0633***
Irregular contracts	0.102***	0.102***	0.0733***	0.0675***	0.0869***	0.0535***
Innovation status	-0.0290***	-0.0276***	-0.0269***	-0.0108**	-0.0208***	-0.00821
Electricity costs	-0.648***	-0.646***	-0.744***	-0.730***	-0.677***	-0.695***
Net Interest	0.0338**	0.0336**	0.0299**	0.0189*	0.0237**	0.0121**
L.M. deregulation	0.0206***	0.0473***	0.0461***	0.00295	0.00872***	0.0258***
Minimum wage	0.0000503***	-0.00000209	-0.0000122	0.0000181***	0.0000332***	-0.0000226***
Board compensation	0.136***	0.137***	0.123***	0.121***	0.137***	0.153***
Size	-0.0445***	-0.0447***	-0.0440***	-0.0245***	-0.0432***	-0.0266***
Leveradge	-0.00000939*	-0.00000946*	-0.00000887*	-0.00000831*	-0.00000704**	-0.00000608
Capital intensity	0.0180***	0.0180***	0.0148***	0.0139***	0.0154***	0.0127***
Capital intensity^2	-0.0000247**	-0.0000247***	-0.0000199***	-0.0000135***	-0.0000176***	-0.0000127***
NPL / Equity	-0.00000332**	-0.00000315**	-0.00000394***	0.00000167***	0.00000105***	0.00000167***
Observations	99684	99684	99684	99684	99684	85584
Number of firms	41134	41134	41134	41134	41134	35422
Year fixed effects	NO	YES	YES	NO	NO	YES
Industry fixed effects	NO	NO	YES	NO	NO	NO
Firm fixed effects	NO	NO	NO	YES	NO	YES
R^2	0.155	0.156	0.206	0.0892	0.0870	0.0895
R^2 overall	---	---	---	0.146	0.152	0.129
R^2 between	---	---	---	0.150	0.159	0.138

Robust standard errors are clustered at the firm level and available upon request : * p < 10%, ** p < 5%, *** p < 1%.

[1] Subsample corresponds to the main model excluding the following sectors: Agriculture, forestry and fishing; Mining and quarrying; Financial and insurance activities; Public administration and defence, compulsory social security; Education; Human health services; Residential care and social work activities; Arts, entertainment and recreation; Other services; Activities of households as employers; Activities of households for own use; and Activities of extra-territorial organizations and bodies.

Figure 4 from main text enlarged



Output 5	Unconditional Quantile Regressions with Fixed Effects					
Labour Productivity	(1)	(2)	(3)	(4)	(5)	(6)
	Q(10)	Q(50)	Q(90)	Q(10)	Q(50)	Q(90)
Average Wage	0.460***	1.243***	3.651***	0.474***	1.257***	3.731***
Training	9624.1***	18870.7***	65003.0***	9488.7***	18007.4***	58816.0***
Export status	-1.179	1727.0***	6504.7***	86.09	1545.9***	7122.7***
Irregular contracts	-2835.9***	139.8	5182.0***	-2842.1***	-17.28	4165.1**
Innovation status	-15.07	572.9***	-1372.7*	-17.60	289.8	-1513.9**
Electricity costs	-5934.1***	-17104.9***	-31737.5***	-6843.8***	-17888.4***	-31092.0***
Net Interest	613.2***	393.5***	517.2	725.9***	449.9**	674.5
L.M. deregulation	13.72	33.25	467.3	-14.39	46.66	235.9
Minimum wage	1.030***	0.797***	0.519	1.088***	0.986***	1.021
Board compensation	-943.2***	159.2	11212.1***	-982.4***	753.2	10283.4***
Size				41.24	338.7	-2661.4***
Leveradge				-0.237	-0.263*	-0.0714
Capital intensity				19.69**	199.9***	1076.5***
Capital intensity^2				-0.0268**	-0.281***	-1.590***
NPL / Equity				-0.0328	0.0956***	-1.567***
Observations	108176	108176	108176	99684	99684	99684
Number of industries	82	82	82	82	82	82
Industry and Year fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.101	0.322	0.169	0.103	0.328	0.181
R^2 overall	0.115	0.349	0.177	0.117	0.357	0.195
R^2 between	0.224	0.606	0.556	0.221	0.650	0.620

Robust standard errors are clustered at the sector level and in parentheses : * p < 10%, ** p < 5%, *** p < 1%.

Output 6	Unconditional Quantile Regressions with Fixed Effects					
Average Wage	(1)	(2)	(3)	(4)	(5)	(6)
	Q(10)	Q(50)	Q(90)	Q(10)	Q(50)	Q(90)
Labour Productivity	0.0418***	0.106***	0.326***	0.0451***	0.104***	0.320***
Training	-2479.9**	-7875.7***	-14658.4***	-2479.6**	-8264.2***	-13190.5***
Export status	146.0	1576.8***	5417.5***	-38.08	643.3***	3903.9***
Irregular contracts	-3136.9***	-1183.8***	1179.7	-3103.5***	-1208.0***	1146.4
Innovation status	413.2***	1532.5***	2196.2***	327.5***	895.7***	1348.2***
Electricity costs	986.4***	-226.7	1084.2	971.1***	-697.8	657.8
Net Interest	65.39	27.66	-182.9*	139.9**	2.182	-242.6*
L.M. deregulation	-197.6***	-180.6***	-424.0***	-176.8***	-76.96**	-337.7***
Minimum wage	0.512***	0.181**	-0.323	0.464***	0.186**	-0.442
Board compensation	-2165.3***	-2798.8***	-1162.6**	-2201.4***	-1323.0***	761.5
Size				376.8***	1955.9***	2647.8***
Leveradge				-0.175*	-0.237***	-0.0243
Capital intensity				-73.61***	-84.48***	-183.3***
Capital intensity^2				0.0926***	0.122***	0.284***
NPL / Equity				0.0130***	0.0991***	-0.0896
Observations	108176	108176	108176	99684	99684	99684
Number of industries	82	82	82	82	82	82
Industry and Year fixed effects	YES	YES	YES	YES	YES	YES
R^2	0.0758	0.183	0.178	0.0904	0.221	0.190
R^2 overall	0.0815	0.203	0.191	0.0995	0.240	0.203
R^2 between	0.172	0.547	0.544	0.200	0.555	0.433

Robust standard errors are clustered at the sector level and in parentheses : * p < 10%, ** p < 5%, *** p < 1%.

Output 7	Logit model - Top 10% TFP dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
Average wage	0.0000239***				0.0000110***	0.0000154***
Irregular cont. (%)	0.00795				-0.0462	-0.0679
Board comp.		-0.532***		-0.549***	-0.494***	-0.511***
Training		1.875***		1.830***	1.764***	1.776***
Size		-0.0641***		0.0749***	-0.0816***	0.0548***
Age		-0.00423***		-0.00345***	-0.00396***	-0.00344***
Export status			-0.548***	-0.936***		-0.986***
Innovation status			-0.0517***	-0.164***		-0.184***
log(Herfindahl)			0.112***	0.137***		0.123***
Observations	808461	191921	1113268	191921	165654	165654
Pseudo-R^2	0.00210	0.00348	0.00360	0.0127	0.00348	0.0126
Correctly classified cutoff = 0.10	61.41%	31.36%	55.17%	39.78%	32.79%	41.09%

Output 8	Alternative Logit model - Top 10% TFP dummy					
	(1)	(2)	(3)	(4)	(5)	(6)
Wage Premium	0.366***				0.321***	0.338***
Temp. Cont.	0.00000462				-0.0579**	-0.0458***
Part-time Cont.	-0.00582***				-0.00538***	-0.00808***
Indep. Workers	0.0000263				0.00176*	0.00168*
Board (Man. Bonus)		-0.667***		-0.684***	-0.542***	-0.561***
Training per worker		0.0000509***		0.0000523***	0.0000550***	0.0000552***
Size		-0.0664***		0.0550***	0.0288	0.135***
Age		-0.00441***		-0.00401***	-0.00496***	-0.00496***
Exports / Turnover			-0.816***	-1.405***		-1.428***
Innov. (R&D)			-0.448***	-0.701***		-0.579***
log(Herfindahl)			0.115***	0.143***		0.150***
Observations	457302	191757	1113268	191757	122804	122804
Pseudo-R^2	0.00468	0.00347	0.00452	0.0141	0.00810	0.0172
Correctly classified cutoff = 0.10	51.52%	31.15%	56.26%	39.90%	44.97%	48.03%

Correlation matrix between Frazer Institute's Labour Market Deregulation index and OECD-EPL of overall and regular contracts (versions 1 and 3)

	FR_der~M	EPL_rc_1	EPL_rc_3	EPL_r_1	EPL_r_3
FR_dereg_LM	1.0000				
EPL_rc_1	-0.9952	1.0000			
EPL_rc_3	-0.9932	0.9988	1.0000		
EPL_r_1	-0.9952	1.0000	0.9988	1.0000	
EPL_r_3	-0.9932	0.9988	1.0000	0.9988	1.0000