The Great Divergence(s)

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Abstract

This report provides new evidence on the increasing dispersion in wages and productivity using novel micro-aggregated firm-level data from 16 countries. First, the report documents an increase in wage and productivity dispersions in a large set of countries, for both manufacturing and non-financial business services. Second, it shows that these trends are driven by differences within rather than across sectors. Third, it suggests that wage divergence is linked to increasing differences between high and low productivity firms. Fourth, the increase in wage inequality is driven by a pull from the bottom (i.e. from the low-wage firms), while divergence at the top only occurs in the service sector, and only after 2005. Fifth, it suggests that both globalisation and digitalisation imply higher wage divergence, but strengthen the link between productivity and wage dispersion. Finally, it offers preliminary analysis of the role of minimum wage, employment protection legislation, trade union density, and coordination in wage setting on wage dispersion and its link to productivity dispersion.

Keywords: Dispersion, Productivity, Sorting, Wages.

JEL codes: D2, J3

"Why are similar workers paid differently? Why do some jobs pay more than others? I have argued that wage dispersion of this kind reflects differences in employer productivity... Of course, the assertion that wage dispersion is the consequence of productivity dispersion begs another question. What is the explanation for productivity dispersion?"

— Mortensen (2003, p. 129)

1. INTRODUCTION

In the last decades economies have observed increasing inequality in income between the rich and the poor (OECD, 2015; Piketty, 2014) and in earnings between workers, for instance between high- and low-skilled workers (Autor, Levy, et al., 2003), and between those employed in large versus small businesses (Song et al., 2015). At the same time divergence is becoming evident also amongst businesses: between high and low productivity firms (OECD, 2015; Andrews et al., 2016); between those with high and low returns to capital (Furman and Orszag, 2015); and between large and small firms (Mueller et al., 2015).

Recent evidence suggests that these trends might be intertwined. A significant part of the rising income inequality observed in the last decades in OECD economies can indeed be accounted for by rising earnings inequality, which in turn is driven by an increase in the wage differentials between firms. In fact, the important role of the increase in between-firm wage differentials as the most significant driver of the increase in earnings inequality has been found in different countries: in the US (Dunne et al., 2004; Song et al., 2015; Barth et al., 2014), Germany (Card, Heining, et al., 2013; Goldschmidt and Schmieder, 2015; Baumgarten, 2013), Sweden (e.g. Håkanson et al. (2015)), Portugal (Card, Cardoso, and Kline, 2016), Brazil (Helpman et al., forthcoming), Denmark (Bagger et al., 2013), the UK (Faggio et al., 2010), and Italy (Card, Devicienti, et al., 2014).[1]

This widespread evidence hints to the fact that the forces driving the increase in between-firm wage dispersion are likely to be global rather than just specific to a single country. Some of the evidence goes one step further in identifying productivity as an important element of the "between-firm" component (Faggio et al., 2010; Davis and Haltiwanger, 1992; Mortensen, 2003; Dunne et al., 2004; Christensen and Bagger, 2014). However, the debate is still open, in particular regarding the main factors driving this trend and the role that policies and institutional factors have in determining them. Most analyses of the increase in wage inequality have focused on the role of Information and Communication Technologies (ICT) and the increase in globalisation and trade competition, especially from low-wage countries.

As suggested by Mortensen (2003, see quote above), if the increase in "between-firm" differences plays such an important role in accounting for the overall increase in wage inequality, then a natural question arises: what drives the productivity dispersion? And, more importantly, what are the possible causes of its evolution over the last decades? The literature in this area is unanimous in acknowledging an increase in within-sector productivity dispersion across OECD economies (Andrews et al., 2016), e.g. Italy (Gatto et al., 2008; Calligaris et al., 2016), Japan (Ito and Lechevalier, 2009), US (Syverson, 2004), and the UK (Faggio et al., 2010). As to wages, the jury is still on what is the main driver driving this divergence: in particular, the questions remain on the relative contribution of globalisation and digitalisation to these trends and how much policies[2] have mediated their impact on wage inequality.

It is therefore important to understand not only the link between the observed divergences in wages and productivity, but also how structural changes, such as globalization and digitalization, affect this link. The evidence here is much more scarce and in this report we take some initial steps towards exploring these links. Finally, from the perspective of policy makers, it is essential to gather evidence on whether policies and institutional features affect wage inequality and their evolution vis-à-vis structural changes, and whether they do so without weakening the link between the distribution of wages and productivity. In the report, we focus on the role of pay-setting institutions and outline the next steps for looking at the role of product market regulation (PMR), such as barriers to entry and barriers to trade and investment.

This report contributes to this literature by providing new evidence on the 'divergences' in productivity and wages using a novel data source, collected in the OECD MultiProd project, based on representative firm-level data for 16 countries. The analysis sheds light on the nature of the increase in wage inequality, with a particular focus on the link with productivity dispersion and its determinants - structural changes such as globalisation and digitalisation. The report provide also new evidence on the link with policies and institutions (minimum wage levels, employment protection legislation, wage setting, and unions) and the role these might have in attenuating the impact of structural change.

We try to contribute to the ongoing debate in several ways. First, we provide new evidence on the evolution of between-firm wage dispersion across 16 countries from the mid-1990s to the recent post-recession period 2012 (Section 3). We start by showing that, even though we only have information on average wages at the firm level, the picture of inequality we provide is still relevant: the inequality measures based on our between-firms measures are indeed strongly correlated with measures based on earnings at the individual level. Moreover the newly collected data from the MultiProd project allow us to look at different measures of dispersion using firm-level data. The evidence suggests that an important divergence occurred in wages offered by firms, even within the same sector.

Second, the report looks at the evolution of productivity dispersion (Section 4). The MultiProd data allow us to use different measures of productivity (both labour and multi-factor productivity) and its dispersion, and to quantify the importance of within- versus between-sector dispersion in explaining the overall trends.

Third, we document the evolution of the wage-productivity link over the same period and, thanks to the richness of the data, we investigate the extent to which wages and productivity are correlated along the whole productivity distribution, as well as control for other features, such as capital intensity and the skill composition at the sectoral level (Section 5).

Fourth, we conduct a new analysis of the role of technological changes, increased globalisation, and changes in the competitive environment and the institutional framework in explaining changes in productivity dispersion, wage inequality, and the relationship between the two (Section 6). The current analysis aims at identifying economic and statistically significant relations and does not aim at identifying causality. Robust and economic significant correlations and interactions between the policy environment and changes in the technology and global environment are still informative.

Last, but not least, we conduct a new analysis of the role of pay setting institutions and features of the labour market that might attenuate the impact of structural changes on wage dispersion and on the link between productivity and wage dispersion (Section 6.2).

In the existing literature, three potential explanations of the increase in productivity dispersion in the last fifty years have been brought to the table. First, the important role of technological change: different rates of adoption of new technologies might lead to increased productivity dispersion and, in turn, to increased wage inequality (see in particular Caselli, 1999). This result might emerge through the persistent co-existence of a dual economy with, on the one hand, high-paying high-productivity firms employing the new technology and high-skilled workers, and, on the other hand, low-paying low-productivity firms employing the old technology (Acemoglu, 1998). Second, growing globalisation and the increased integration of economies will affect the distribution of productivity (Melitz, 2003). The mechanisms at play might have countervailing effects on productivity dispersion. Trade might lower dispersion as a consequence of the exit of the least productive firms due to the increase in competition. At the same time, trade might increase dispersion because of differences across firms in how much they can benefit from knowledge spillovers and from the increased demand provided by the larger (global) market size. On top of this, recent evidence suggests that an increase in trade, in the form of increased import competition from low wage countries such as China, might push some firms to innovate and adopt IT technologies (Bloom et al., 2016), which again might increase dispersion. Third, changes in the competitive environment and firm organization, such as increases in consolidation or changes in demand (Syverson, 2004), might also lead to higher dispersion.

Technological progress and globalisation have also been put forward as sources of change in the distribution of wages, and the increase in wage inequality in particular. For instance the increase in import penetration and offshoring has put workers in direct competition with low-skilled low-paid workers in developing countries (e.g. China starting in the late 1990s), bringing down their wages and increasing wage inequality (Autor, Dorn, et al., 2013). Similarly skill-biased technological change, through the rise of ICT, increases the productivity and the demand of high-skilled workers, thus raising their relative wages vis-à-vis low-skilled workers (Card and DiNardo, 2002; Autor and Acemoglu, 2011). In addition to globalisation and skill-biased technological change, research has focused on the role of policy and institutions in explaining the observed increase in wage dispersion, in particular the decline in real minimum wage (DiNardo et al., 1996) and for the UK and the US in unionisation (e.g. Card, Lemieux, et al., 2004, and for an overview Machin, 2016). For continental European economies the focus has been on the centralization level of bargaining, given that, even in countries with low union densities, bargaining agreements are generality extended to non-unionised workers (see Dell'Aringa and Pagani, 2007; Card and Rica, 2006 and more recently Dahl et al., 2013). The evidence linking the centralisation of wage bargaining and wage dispersion is mixed and often based on cross-sectional analysis. Recent studies based on longitudinal matched employer-employee data (e.g. Dahl et al., 2013 using Danish data) suggest that decentralization of wage bargaining is associated with higher wage dispersion. They also find evidence that under firm level bargaining wages are more likely to reflect individual productivity, thus their result might also suggest a stronger alignment between firm-level wages and productivity distributions.

Much less evidence exists on the role of policies and institutional factors in mediating the effects of globalization and technological change on wage inequality. In recent years evidence from France (Carluccio et al., 2015), from Germany (Baumgarten, 2013) and Sweden (Håkanson et al., 2015) suggest that collective wage agreements might dampen the effect of trade on wage inequality.

More recently, a growing body of evidence points to the fact that much of the increase in wage inequality of individuals can be attributed to a rise in the variance of wages between establishments rather than within them, as found by Dunne et al. (2004) and more recently by Barth et al. (2014), who show that the growth in the between-establishment wage dispersion contributed to around 79% of the growth in the variance of individual wages between the 1970s and the 2010s in the United States. Even more sharply, Song et al. (2015) conclude that the increased dispersion of average earnings across firms accounted for a large part of the steep increase in US individual earnings inequality during 1982-2012. A similar important role for between-firm dispersion has been found in other countries: Germany (Card, Heining, et al., 2013; Goldschmidt and Schmieder, 2015), Sweden (Skans et al., 2009) and (Håkanson et al., 2015), Brazil (Helpman et al., forthcoming) and Italy (Card, Devicienti, et al., 2014)

This strand of research points to the important role played by sorting (of workers) and assortative matching as potential reasons for the growing role of employers' heterogeneity in accounting for the rise in wage inequality.[3] The mechanism is explained by the fact that the most productive workers increasingly work for the most productive firms, with a clustering of high-skilled workers in high-paying firms. Rent sharing, i.e. workers of high profit - high productivity firms enjoying a share of the firms' rents, are also found to play a role in explaining this trend (Card, Devicienti, et al., 2014; Card, Heining, et al., 2013).

This growing 'segregation' of high-productivity workers in high-productivity, high-paying firms might reflect the increase in the use of domestic outsourcing by firms: non-core activities are outsourced to other firms, cutting low-skilled workers in low-skilled occupations from the rent sharing (Goldschmidt and Schmieder, 2015). But the segregation might also reflect the increasing importance of skill-skill or skill-capital complementaries, the role of trade (Helpman et al., forthcoming), and technological change (Dunne et al., 2004; Håkanson et al., 2015) in line with the theoretical models of Caselli (1999) and Acemoglu (1998). Finally if there is rent sharing, the widening gap between workers in high- versus low-paying firms might reflect the widening in profits and profitability across firms, which in turn might lead to lower worker mobility and entrepreneurial ventures, i.e. to lower dynamism in the economy (Furman and Orszag, 2015).

The rest of the paper is organised as follows: in section Section 2, we describe the new data source and the measures that we use for the analysis. Sections 3 and 4 provide evidence on the evolution of between-firm wage dispersion and productivity, respectively, across 16 countries from the mid-1990s to the recent post-recession period 2012. Section 5 investigates the evolution of the wage-productivity link. Section 6 analyses the role of structural change and policies on wage divergence and its link to increased productivity dispersion.

2. DATA

This sections provides an overview of the data, and the main measures of productivity and dispersion used in the report. More details on the data sources, the variables available in MultiProd and the methodology are available in Berlingieri et al. (2016).

2.1 Data source: the OECD MultiProd project

The analysis conducted in this report relies on the work undertaken in the last few years within the OECD "MultiProd" project. The data collected in MultiProd are computed by running a standardised STATA® routine on firm-level data based on production surveys and business registers, in the context of a *distributed microdata analysis*. This is a method of collecting statistical moments of the distribution of firm characteristics (employment, productivity, wages, age, etc.) by a centrally written routine that is flexible and automated enough to run across different data sources in different countries.

In recent years, the policy and research communities' interest in harmonised cross-country microdata has increased significantly, mainly reflecting the recognition of the need of microdata for understanding the growing complexity in the way economies work. Significant obstacles remain, however, for transnational access to official microlevel data. The rationale for undertaking a distributed microdata analysis is to create harmonized cross-country statistics and, at the same time, overcome the confidentiality constraints of firm-level datasets by providing detailed protocols and programs to accredited researchers in each country. It was pioneered in the early 2000s in a series of cross-country projects on firm demographics and productivity (Bartelsman, Scarpetta, et al., 2005; Bartelsman, Haltiwanger, et al., 2009). The OECD currently follows the distributed microdata approach in three ongoing projects: MultiProd, DynEmp and MicroBerd.[4]

The MultiProd program relies on two main data sources in each country. First, a production survey (PS), which contains all the variables needed for the analysis of productivity but may be limited to a sample of firms. Second, a business register (BR), which contains a more limited set of variables (mainly employment, sector of activity, age and ownership) but for the entire population of firms. The program works also in the absence of a business register. However, its availability substantially improves the representativeness of the results and, thus, their comparability across countries. In particular, given the coverage and the continuity of the administrative information collected for each firm, BR data allow for: i) the calculation of the population breakdowns necessary for obtaining the sampling weights used in the analysis; ii) a much more precise treatment of entry and exit; iii) the calculation of more precise sectoral modes and conversion tables in case of changes in the sectoral classification at the firm level - as the whole life cycle of the business is observed - or of a change in the whole sectoral classification system - as the entire population of businesses is observed.

At the time of writing, 16 countries have been successfully included in the MultiProd database (namely, Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Hungary, Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand and Sweden). For most countries the time period spans from early 2000s to 2012. For Luxembourg, Belgium and Chile the time horizon is shorter (starting in 2003, 2004 and 2005 respectively), whereas for Finland, France, Japan and Norway data are available since 1996.

Table 1: Data coverage

Country	Years	Firms	Employees
Australia	2002-2012	68,499	761,602
Austria	2008-2012	255,701	2,258,626
Belgium	2004-2011	103,126	1,790,926
Canada	2000-2012	509,460	8,058,557
Chile	2005-2012	339,492	5,273,453
Denmark	2000-2012	80,030	1,281,035
Finland	1996-2012	86,054	991,675
France	1996-2012	819,560	11,555,687
Hungary	1998-2012	191,064	1,786,685
Italy	2001-2012	317,181	1,549,184
Japan	1996-2011	25,917	10,684,964
Luxemburg	2003-2012	1,136	105,252
Netherlands	2000-2012	39,375	332,449
Norway	1996-2012	64,113	898,400
New Zealand	2000-2011	90,973	992,208
Sweden	2002-2012	176,652	1,889,764

Note: Manufacturing and services only. Numbers are averages across years.

Table 1 details years covered, and for each of these years, the average number of firms and employees by country. The high number of firms and employees represented in our data allows us to get an accurate picture of the overall wage inequality, as we show in Section 3.1. Still, one of the big challenges of working with firm-level production surveys is that focusing on a selected sample of firms might yield a partial and biased picture of the economy. Whenever available, business registers, which typically contain the whole population of firms, are used to compute a population structure by year-sector-size class; this structure is then used to re-weight data contained in the production surveys in order to construct data that are as representative as possible of the whole population of firms and comparable across countries.

Table 2 shows for 2010 the share of firms and employment with respect to both the BR (when available) and Eurostat statistics (Business demography by size class). Comparing across different data sources is never easy, but data from Eurostat give a good benchmark to compare our data. The table is constructed for the manufacturing and non-financial market service sectors, and the data from Eurostat refer to the total number of firms in a country or the total number of firms with at least one employee depending on the data used in MultiProd. The coverage is rather high in most of the countries; and for those with a lower coverage the full BR is available, and thus the samples can be re-weighted. For

Table 2: Representativeness, 2010

	Share of firms (%)		Share of employment (%)	
	BR	Eurostat	BR	Eurostat
Austria		69		92
Belgium		70		97
Denmark		100		115
Finland	98	100	98	100
France		100		107
Hungary		92		99
Italy	11	11	52	52
Netherlands	7	5	57	44
Norway		71		89
Sweden		96		87

Note: Share of business registers and Eurostat data present in MultiProd. Manufacturing and non-financial market services only. Year 2010.

instance Italy has a skewed distribution with a large mass of very small firms which cannot be captured by production surveys. The survey used by MultiProd contains only 11% of the total population of firms (both with respect to the BR and to the data published by Eurostat) but it accounts for 52% of total employment. At the same time we have access to the entire population of firms from the business register, which we use to reweight our sample moments. In the Netherlands the situation is similar, with the only existing survey of firms representing a very small share of firms, but the BR allows us to re-weight those firms ex-post in order to make the reported statistics representative of the total economy.[5]

2.2 Measures of productivity

The analysis relies on three measures of productivity. The first, labour productivity, is the most widely used in the literature and aims at capturing the amount of output produced by a firm for a given amount of labour input. It is computed at the firm level as the (real) value-added per worker:

$$\text{LP\_VA}_{it} = \frac{VA_{it}}{L_{it}} \tag{1}$$

where VA_{it} is the value-added of firm i at time t, and L_{it} is its employment.[6] The advantage of this measure is that it is widely available, and fairly immune to measurement errors. Moreover, it can be easily aggregated into sector-level or country labour productivity using employment weights.

One of the main drawbacks of labour productivity is that it does not separate the impact of other inputs, such as capital, while for some policy questions it might be important to disentangle whether labour productivity gains are actually driven by physical capital. In order to do this, the MultiProd data contain two measures of multi-factor productivity (henceforth MFP), which is a productivity measure that accounts not only for labour but also for capital productivity.[7]

The main measure of MFP in the data, that we label MFP_W, is econometrically estimated at the firm-level using Wooldridge (2009) instrumental variable approach. Firms are assumed to have a Cobb-Douglas production function, but not necessarily constant returns to scale:

$$Y_{it} = A_{it} K_{it}^{\beta_K} L_{it}^{\beta_L} \tag{2}$$

where A_{it}, firm i's MFP at time t, is typically unobserved and has to be estimated. Rewriting Equation (2) in logs:

$$y_{it} = \beta_K k_{it} + \beta_L l_{it} + (\omega_{it} + \varepsilon_{it}) \tag{3}$$

where we split the unobserved $\log A_{it}$ into ω_{it}, the component known to the firm, and ε_{it}, the component that is not. Since ω_{it} is known at the time of choosing its inputs k_{it} and l_{it}, these will be correlated with ω_{it} and therefore with $\log A_{it}$. A straightforward OLS estimation of Equation (3) would yield the following productivity estimate:

$$\widehat{\log A_{it}} = y_{it} - \widehat{\beta_L^{OLS}} l_{it} - \widehat{\beta_K^{OLS}} k_{it} \tag{4}$$

This estimate is likely to be biased because k_{it} and l_{it} are correlated with the error term in Equation (3).

Instrumental approaches to solve this problem were pioneered by Olley and Pakes (1996), who suggested using investment as a proxy for productivity. Due to its volatility and frequent presence of zeros, investment is a poor proxy for productivity; to remedy this, Levinsohn and Petrin (2003) suggested a two-step estimation procedure that uses intermediate inputs as a proxy. However, Ackerberg et al. (2006)[8] pointed out that identification of the coefficient on the variable input is likely problematic in Levinsohn and Petrin (2003). This identification problem can be overcome with the one-step procedure suggested by Wooldridge (2009), which, while more data-intensive, yields consistent standard errors without the need for bootstrapping. The procedure relies on estimating variable inputs with a polynomial of lagged inputs and a polynomial of intermediates. This is the approach on which our main measure of MFP, which we label MFP_W, relies.

For robustness, we also include an accounting measure of MFP that does not rely on production function estimation. More specifically, we compute a productivity measure similar to a Solow residual, which we label MFP_SW, by assuming the following production function in gross output:

$$Y_{it} = A_{it} M_{it}^{\beta_M^{SW}} L_{it}^{\beta_L^{SW}} K_{it}^{\beta_K^{SW}} \tag{5}$$

where input elasticities β_M^{SW}, β_L^{SW} and β_K^{SW} of firm i are assumed to be the sector-specific median of factor shares across countries and years. With an additional assumption of constant returns to scale, productivity is computed in logs:

$$\text{MFP\_SW}_{it} = \log GO_{it} - \beta_L^{SW} l_{it} - \beta_M^{SW} m_{it} - \left(1 - \beta_L^{SW} - \beta_M^{SW}\right) k_{it} \tag{6}$$

While this measure is less data intensive, it relies on important assumptions, departures from which would bias our measure of productivity. Nonetheless, most results obtained when using our estimated MFP_W also carry through using MFP_SW.

2.3 Measures of dispersion

In order to capture heterogeneity in the data, we calculate several measures of dispersion for productivity and wages within macro-sectors and 2-digit industries.[9] This report focuses on four measures of dispersion: variance; and 90-10, 90-50, 50-10 ratios. MultiProd also contains other measures such as the interquartile range, i.e., the difference between the 75^{th} and the 25^{th} percentile, and the standard deviation. Another measure of dispersion used in literature is the ratio between mean and median. It helps to understand the distribution of a variable: the distribution is right-skewed if the ratio is greater than 1 while is left-skewed if the ration is less than 1, and the further from 1 is the value the more skewed is the distribution.

In this report we will focus on the measures of dispersion shortly described below:

- The variance is defined as the expectation of the squared deviation of a random variable from its mean, and as such it measures how far a set of observations are spread out from their mean. In literature it is probably the most used measure to asses how stretched or squeezed the distribution of wages and productivity is. In the report we decompose the variance of wage and productivity in: (i) a within and between sector component; (ii) in a within and between-quantile of the productivity distribution (for wages only).
- 90-10 wage (productivity) ratio is defined as the ratio of the 90^{th} percentile to the 10^{th} percentile of the wage (productivity) distribution. It is used widely in both the inequality and the productivity literature to assess the spread of the distribution of wages and productivity. The measures are quite intuitive since a ratio of X can be interpreted as 'firms at the top of the wage (productivity) distribution, proxied by firms at the 90^{th} percentile, paying (or producing, given the same amount of inputs) X times as much as firms at the bottom of the distribution, proxied by firms at the 10^{th} percentile'.
- 90-50 wage (productivity) ratio is defined as the ratio of the 90^{th} percentile to the 50^{th} percentile, i.e. the median, of the wage (productivity) distribution. It captures dispersion in the upper tail of the distribution.
- 50-10 wage (productivity) ratio is defined as the ratio of the 50^{th} percentile to the 10^{th} percentile of the wage (productivity) distribution. It captures dispersion in the bottom tail of the distribution.

3. DIVERGENCE IN WAGES

3.1 Overall vs Between-Firm Inequality

The database of the MultiProd project is constructed using data sources at the level of the firm. This implies that the measure of wages contained in the dataset, firm's total labor costs divided by the number of employees, corresponds to the average wage at the firm level and that the dispersion of wages within the firm is not observed. Therefore whenever we discuss wage dispersion we analyse the dispersion of wages between firms, and not the overall dispersion of workers' wages. This is because at present the MultiProd network does not have access to matched employer-employee data sources that would be needed to carry out the analysis both at the worker and at the firm level. This means that we cannot control for worker level characteristics (such as age, experience, tenure, gender and education), nor calculate overall or within-firm wage dispersion.[10]

When analysing the evolution of overall wage inequality in the last decades, this is a clear shortcoming, but not as severe as it might appear. There is in fact mounting evidence that the observed increase in overall wage inequality over time is driven by increasing between-firm wage differentials, as opposed to within-firm differences due to worker specific characteristics. For instance amongst OECD economies, evidence for the US (Dunne et al., 2004; Song et al., 2015) shows that over two thirds of the increased wage inequality observed in the last three decades is accounted for by increased variance across businesses. In Germany, the increase in wage variance across workers and across businesses seem to contribute equally to the increase in overall wage inequality (Card, Heining, et al., 2013), with evidence for Sweden (Håkanson et al., 2015) and Italy (Card, Devicienti, et al., 2014) following a similar pattern. Similar evidence has also been found for emerging economies: Helpman et al. (forthcoming) find that in Brazil the between-firm component accounts for 86% of the increase in wage inequality within sector and occupations over the 1986-1995 period, while wage variance across workers only accounts for 2% of the total.

The widespread evidence that a significant part of the increase in earnings inequality observed in the last decades is driven by an increase in the wage differentials between firms prompts us to conclude that, despite the data limitations mentioned above, we can draw meaningful conclusions for trends in overall wage inequality.[11]

Table 3 reports the estimates of a pooled OLS regression, where the dependent variable is the overall earning dispersion measured as the 90^{th}-10^{th} percentile ratio and the regressors are the between-firm wage dispersion, also measured as the 90^{th}-10^{th} percentile ratio. Each regressor corresponds to the dispersion in each macro-sector across the countries and years contained in the MultiProd database; the sectoral coverage is somewhat country specific with manufacturing and non-financial market services covering the largest number of countries.[12] All sectors display a positive and strongly significant correlation between the MultiProd between-firm wage dispersion and the overall earnings inequality at the country level.

Further, we investigate whether changes in wage inequality at the country level are related to changes in between-firm wage dispersion at the sectoral level. Given the limited amount of country-level longitudinal information on overall earnings dispersion, we can only conduct the panel data analysis on a handful of countries (i.e. Finland, France, Japan and Norway). Despite the limited number of observations, as shown in Table 4, we find that the evolution of overall earnings dispersion in these countries is related to the changes in between-firm wage dispersion from the MultiProd database. The correlation is significant and positive for construction, non-financial market services and non-market services, which is not surprising given that the dependent variable is at the country level and that these are the largest sectors, accounting for more than two thirds of overall employment.[13]

Table 3: Overall country-level wage inequality on sectoral between-firm inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agriculture, Forestry and Fishing [A]	0.053***						
	(0.013)						
Mining and quarrying [B]		0.043***					
		(0.005)					
Manufacturing [C]			0.052***				
			(0.008)				
Electricity, gas, water, and waste [D-E]				0.062***			
				(0.012)			
Construction [F]					0.063***		
					(0.010)		
Non-Financial Market Services [G-N]						0.042***	
						(0.007)	
Non Market Services [O-U]							0.047***
							(0.008)
N	127	161	172	163	154	172	171
Adj. R-Square	0.089	0.216	0.143	0.222	0.137	0.135	0.159
Num. Countries	12	15	17	16	16	17	16

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

The dependent variable is the inequality in earnings (90-10 percentile ratio) from OECD Stats.

The regressor is the between-firm wage inequality (90-10 percentile ratio) in the relevant sector.

Table 4: Overall country-level wage inequality on sectoral between-firm inequality (within-country variation)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Agriculture, Forestry and Fishing [A]	0.016						
	(0.013)						
Mining and quarrying [B]		0.003					
		(0.016)					
Manufacturing [C]			0.038				
			(0.063)				
Electricity, gas, water, and waste [D-E]				-0.009*			
				(0.005)			
Construction [F]					0.065***		
					(0.015)		
Non-Financial Market Services [G-N]						0.057***	
						(0.011)	
Non Market Services [O-U]							0.014***
							(0.004)
N	51	69	69	69	51	69	69
Adj. R-Square	0.932	0.944	0.944	0.945	0.946	0.959	0.948
Country FE	3	4	4	4	3	4	4

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

The dependent variable is the inequality in earnings (90-10 percentile ratio) from OECD Stats.

The regressor is the between-firm wage inequality (90-10 percentile ratio) in the relevant sector.

Overall, these results reassure us that even if we can provide evidence only on between-firm wage dispersion, because of data limitations, our results can still provide valuable evidence related to overall wage inequality.

3.2 Divergence in Between-Firm Wage Dispersion

Now that we have shown that between-firm wage dispersion and its changes over time from the MultiProd data capture a significant part of the overall wage dispersion both in the cross-section and over time, we can examine the evolution of between-firm wage dispersion and provide evidence for why it makes sense to speak of a "Great Divergence".

Table 5: Wage 90-10 ratio in 2001 and 2012

	90-10 wage ratio	
	Manuf.	Services
2001	3	4.27
2012	3.13	5.09

Note: Macro-sector 90-10 wage ratio, averaged across countries using employment as weights.

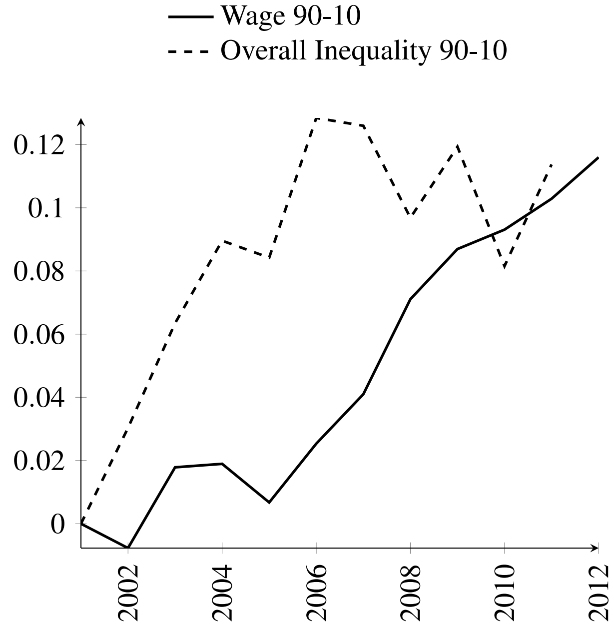
We start by showing that there is significant wage dispersion between firms within countries and sectors. Table 5 reports the average 90-10 wage ratio, that is the 90^{th}-10^{th} percentile ratio of wages within the manufacturing and services sectors, averaged across countries at the beginning of the sample period, in 2001, and at the end, in 2012. The magnitude of the spread between the top and bottom decile of the wage distribution gives us an insight into the inequality of wages. For instance, in manufacturing in 2012, wages in the highest paying firms, i.e., those at the 90th percentile of the wage distribution, were 3.13 times those at the bottom decile. The spread is even more pronounced in non-financial business services, where the ratio is 5.09.

We can also see from Table 5 that wage dispersion has increased. The difference between wages in the highest-paying firms and those in the lowest-paying firms has increased over time: the ratio has increased from 3 to 3.13 in manufacturing and even more in services, where it has gone from 4.27 to 5.09, which corresponds to a 19% increase. Our dataset is not balanced and the unconditional averages might be affected by changes in the sample over time. Therefore in the next subsection we complement this evidence by providing econometric evidence on the existence of what we call the "Great Divergence" of wages.

3.2.1 The evolution of between-firm wage dispersion

Simply looking at cross-country averages of wage dispersion in each macro-sector raises three concerns. First, variation in the number of countries over which data is averaged might affect the trends over time. Second, there are significant differences across countries in these trends but the average trend masks this variation. Third, by looking at dispersion of wages within macro-sectors, instead of within finer sectors,

Figure 1: The "Great Divergence" of wages
Wage dispersion over time within sectors and countries



Note: The figure plots the estimated year dummies $\boldsymbol{year}_t$ of a regression of log-wage dispersion (90th and 10th percentiles ratio) within country-sector pairs, as estimated in Equation (7) using data from the following countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE . The line referring to overall inequality plots the year fixed effects of a similar regression using the dispersion in earnings from the OECD Earnings Distribution database within each country. The data on overall inequality are only available at the country level and for a more limited set of countries: FIN, FRA, HUN, JPN, NOR, NZL for the whole period; AUS, ITA, SWE from 2002; and NLD between 2002 and 2010.

we might confound two features of the economy: changes in within-sector dispersions, and changes in the 2-digit sector composition within macro-sectors.

To address these concerns, we use an econometric approach to measure the evolution of wage dispersion that removes country by 2-digit sector fixed effects, in order to capture more precisely the increase in wage dispersion within countries and sectors. More precisely, we estimate the following regression:

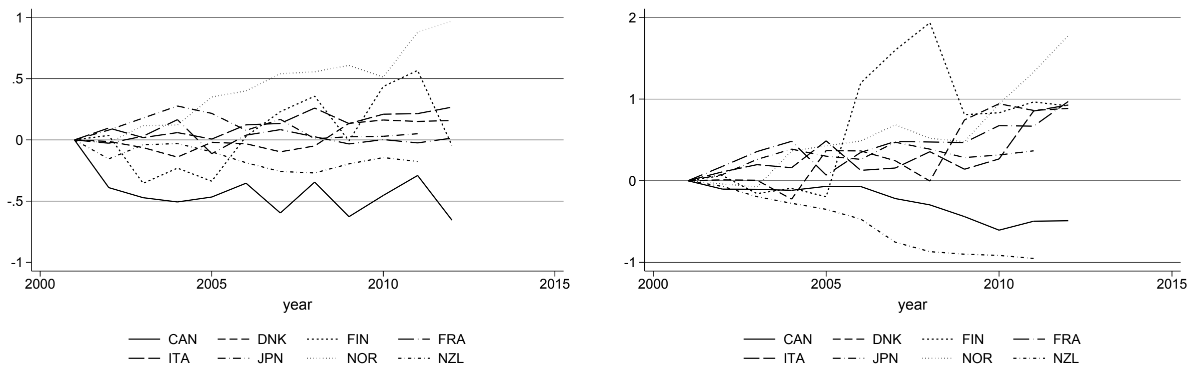
$$\left(\log \frac{W_{90}}{W_{10}}\right)_{cjt} = \alpha + \boldsymbol{y}_t + \boldsymbol{z}_{cj} + \varepsilon_{cjt} \tag{7}$$

where $\frac{W_{90}}{W_{10}}$ is the 90th to 10th wage ratio, and where c denotes countries, j denotes 2-digit sectors and t years.[14] Year dummies $\boldsymbol{y}_t$ capture the average dispersion in a given year controlling for specific country-sector fixed effects $\boldsymbol{z}_{cj}$. The latter control for the specific levels of dispersion in each country and sector, so that the estimates of the year dummies $\boldsymbol{y}_t$ coefficients capture a more accurate evolution of wage dispersion within each 2-digit sector in each country relative to simply looking at the unconditional cross-country average of the 90-10 wage ratio over time.

Figure 1 shows that within-country sector wage dispersion has been increasing over time, indicating that by 2012, the within country-sector 90-10 wage ratio is 12.3% higher than in 2001.[15] It is in that respect that it makes sense to speak of a "Great Divergence" of wages. To get a sense of the magnitude of the results and whether the between-firm wage dispersion captures a meaningful share of overall wage inequality, we run a similar regression using the overall wage inequality in earnings from the OECD Earnings Distribution database. Figure 1 shows that the evolution of overall wage inequality follows a similar pattern, and in particular that the magnitude of the increase over the analysed period is a remarkably similar (12.1 % in 2011). It is not possible to draw strong conclusions from this comparison because of differences in the data sources and availability (data on overall inequality are only available at the country level and for a more limited set of countries). But the results clearly show that the increase in the between-firm wage dispersion is in the same ballpark figure of the increase in overall income inequality.[16]

Figure 2: 90-10 wage ratio, by country

(a) Manufacturing **(b) Services**



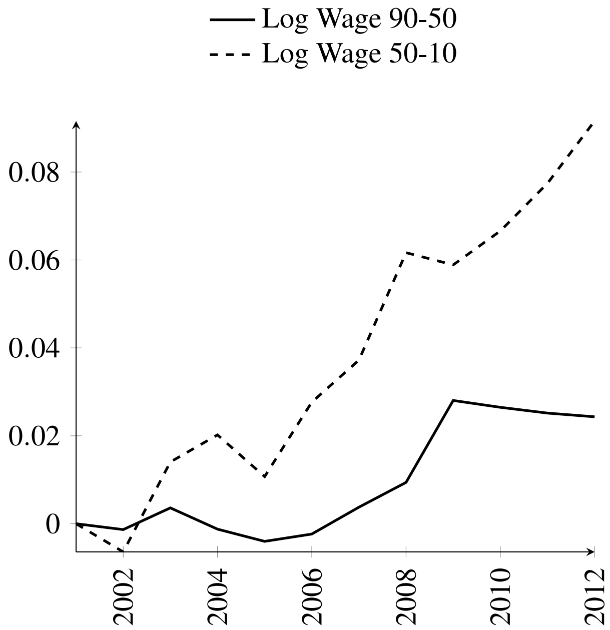
Note: Change in the 90-10 ratio of real wages (computed as the ratio of 90th percentile of wages over the 10th percentile of wages) since 2001, respectively for manufacturing and services. By construction, it is equal to 0 in 2001. Countries with data starting after 2001 are not included in this graphs; Hungary and the Netherlands are also excluded.

Our main result concerning the Great Divergence of wages should not hide the fact that there exists important variation across countries in our sample. Figure 2 plots changes in the 90-10 wage ratio since 2001, country by country, for manufacturing and services. For instance in both manufacturing and services the 90-10 wage ratio increased in most countries, with the exception of New Zealand and Canada, where it decreased significantly.[17]

3.2.2 Evolution of dispersion at the top and at the bottom of the wage dispersion

There has also been variation in the nature of the within-country wage divergence over time. An interesting question is whether the divergence is driven by an increasingly strong push outward at the top of the distribution, i.e. firms at the top increasingly paying more than the median firm, or whether firms at the bottom of the wage distribution are paying increasingly less relative to the median firm. To answer this question, we perform an exercise similar to the econometric approach of Equation (7) but separately for the 90-50 and the 50-10 wage ratios. That is, we estimate econometrically the yearly average wage dispersion within countries and sectors, but separately for the top 90-50 ratio and bottom 50-10 ratio of the wage distribution, to ascertain where the divergence was more pronounced.

Figure 3: Wage dispersion at the top versus bottom of the distribution



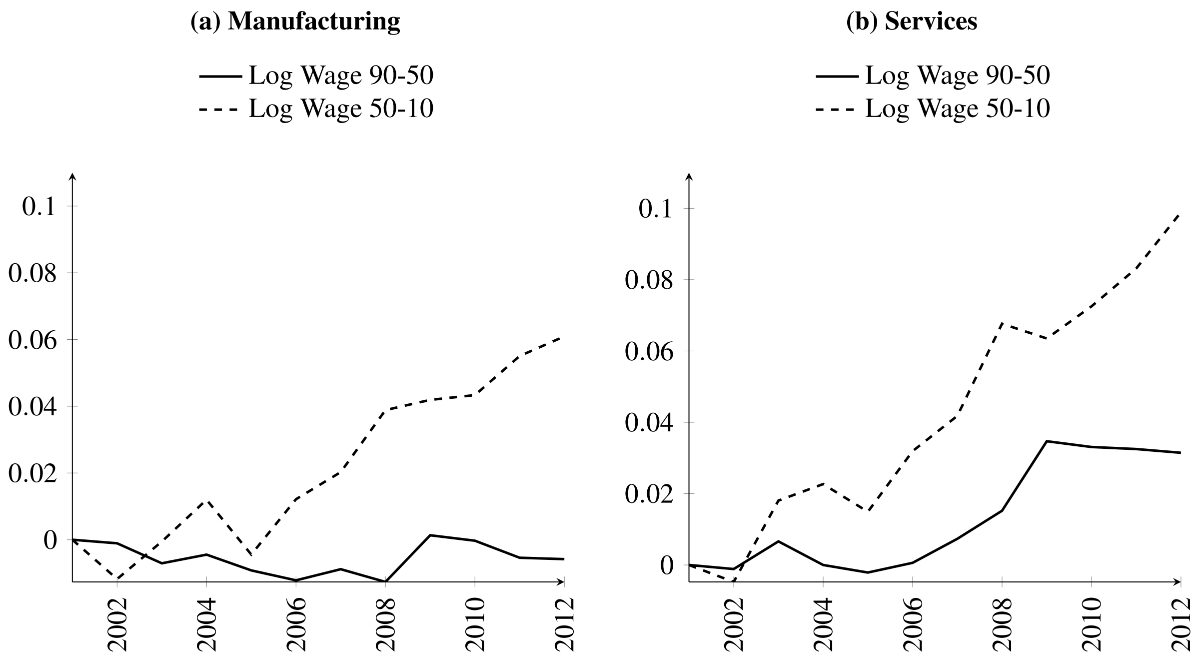
Note: The figure plots the year fixed-effects of a regression of log-wage dispersion at the top (90th and 50th percentiles ratio) and at the bottom (50th and 50th percentiles ratio) within country-sector pairs, using data from the following countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

Results, shown in Figure 3 and Figure 4, suggest that the divergence has been more severe at the bottom of the wage distribution *within each country-sector pair*. Interestingly, this pattern seems to have been exacerbated since the Great Recession, suggesting that workers in lowest-paying firms might have disproportionally borne the cost of the crisis relative to workers in the median firm. At the same time dispersion at the top of the distribution has declined (mostly in services), again suggesting that the workers in the tail of the distribution (in this case the highest paying firms) have lost their pay-advantage relative to workers in the median firm during the crisis. These two countervailing forces – compression at the top and increased dispersion at the bottom – are masked when looking at the 90-10 ratio, whose trend does not seem to be particularly affected by the Great recession (Figure 1).

3.3 Sectoral Decomposition of Wage Variance

After establishing that wage dispersion has gone up across the whole economy and within each country-sector pair, we now turn to show that wage dispersion has indeed occurred mostly *within* narrowly defined sectors. Thanks to the MultiProd data, we can show that wage dispersion is not driven by differences in average wages across sectors but rather by differences in wages offered by firms within the same sectors. That is, even controlling for type of activity, there remains important heterogeneity in wages across firms. This analysis corroborates what shown in the previous section and confirms that the variation within country-sector pairs captures most of the variation over time.

Figure 4: Wage dispersion at the top versus bottom of the distribution



Note: The figure plots the year fixed-effects of a regression of log-wage dispersion at the top (90$^{\text{th}}$ and 50$^{\text{th}}$ percentiles ratio) and at the bottom (50$^{\text{th}}$ and 50$^{\text{th}}$ percentiles ratio) within country-sector pairs, separately for manufacturing and services.

We decompose the total wage variance $\operatorname{Var} W_t$ into two components: a within-sector component, $\operatorname{Var}^W W_t$, and a cross-sector component, $\operatorname{Var}^X W_t$. The within-sector component of wage variance captures how much a firm's average wage differs from its sector (labour-weighted) average; the cross-sector component captures instead how much sectoral average wages vary from each other. More precisely, we use the following decomposition:

$$\operatorname{Var} W_t = \underbrace{\sum_j \frac{L_{jt}}{L_t} \sum_{i \in j} \frac{L_{it}}{L_{jt}} \left(W_{it} - \overline{W}_{jt}\right)^2}_{\operatorname{Var}^W W_t} + \underbrace{\sum_j \frac{L_{jt}}{L_t} \left(\overline{W}_{jt} - \overline{W}_t\right)^2}_{\operatorname{Var}^X W_t} \tag{8}$$

where i indexes firms and j denotes 2-digit sectors. This decomposition enables us to compute, in each period, the share of total cross-sectional wage variance $\operatorname{Var} W_t$ that comes from within-sector wage variance $\operatorname{Var}^W W_t$ and the share coming from the sectoral composition of the economy.

The first result of this cross-sectional decomposition is that within-sector dispersion accounts for the majority of wage dispersion in all countries and years. Table 6 reports the share of within-sector (defined at A38 level) wage variance in, respectively, manufacturing and services wage variance, in either 2011 or 2012 for the countries where data at the two-digit level are available. In our sample, within-sector dispersion accounts for at least 65% of wage dispersion in manufacturing, and at least 72% in services.

This indicates that wage variance is mainly due to the fact that firms within the same two-digit sector have very different average wages, rather than a reflection of the fact that firms in certain sectors (e.g. I.T. or telecommunications) offer average wages that are very different from those in the rest of

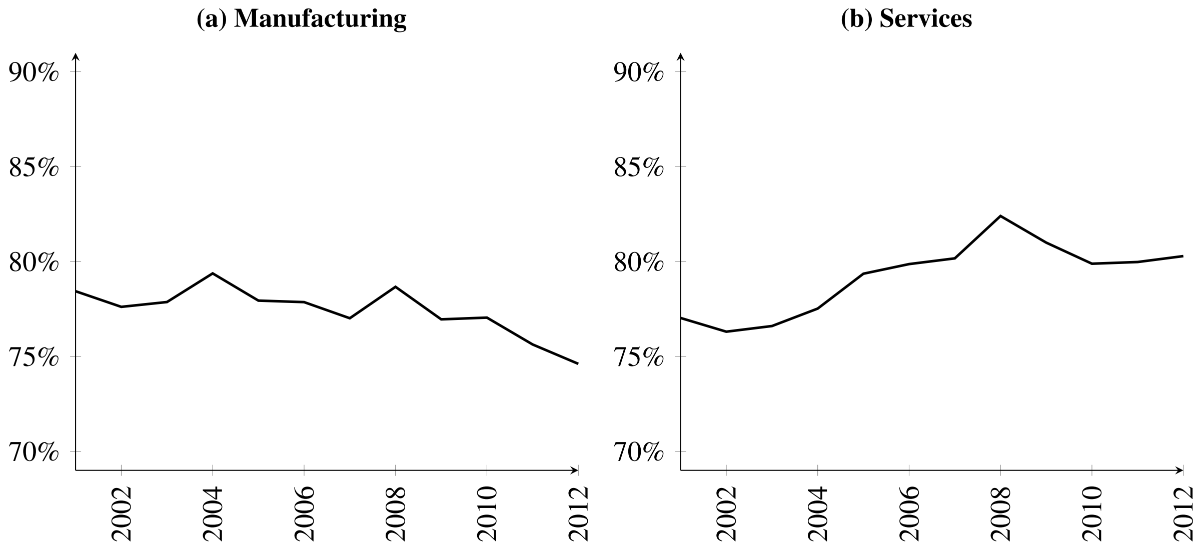
Table 6: Share of within-sector wage variance

	% Wage dispersion	
	Manufacturing	Services
Australia (2012)	87	75
Austria (2012)	76	84
Belgium (2011)	65	72
Chile (2012)	69	86
Denmark (2012)	85	73
Finland (2012)	65	74
France (2012)	74	77
Hungary (2012)	69	84
Italy (2012)	79	82
Japan (2011)	79	80
Netherlands (2012)	71	96
Norway (2012)	87	82
Sweden (2012)	77	79

Note: Share of within-sector variance in total macro-sector wage variance. Firms and sectors weighted by the number of employees.

the economy. The decomposition also allows us to identify which sectors contribute the most to the (within-sector) wage variance; in Appendix A.3, Tables A.6 and A.7 report for each country the top three contributors to wage variance, for manufacturing and services respectively. The tables show that across countries some sectors, such as wholesale and retail trade, legal and accounting in services, and food, beverages and tobacco in manufacturing, regularly appear amongst the sectors characterised by the highest wage dispersion. This result suggests that the distribution of firms within these sectors share some features, such as the range or spread of the distribution, that might affect the distribution of wages.

Figure 5: Share of within-sector wage dispersion



Note: Share of within-sector dispersion in overall macro-sector wage dispersion. Average across countries and sectors, weighted by employment. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

Finally, the sectoral decomposition of wage variance also allows us to examine how the share of within-sector wage variance evolved over time. In Figure 5, we plot the cross-country labour-weighted averages of the within-sector component over time. Our data indicate two very different dynamics in manufacturing vis-à-vis services. In the service macro-sector the evolution of wage dispersion is increasingly driven by a divergence in firm pay within 2-digit industries. On the other hand, the manufacturing macro-sector shows an opposite trend: although still relatively small, the role of the sectoral composition has been increasing over time and explains, as of 2012, one quarter of the observed wage inequality (up from 21% in 2001).

4. DIVERGENCE IN PRODUCTIVITY

In the previous section we have shown that over the last decade there has been a steady increase in wage dispersion, which can be attributed mostly to differences in pay across firms operating within the same sectors. Taking as a starting point the quote of Mortensen's work on wage inequality reported at the beginning of the report:

> Why are similar workers paid differently? Why do some jobs pay more than others? [...] wage dispersion of this kind reflects differences in employer productivity. [...] Of course, the assertion that wage dispersion is the consequence of productivity dispersion begs another question. What is the explanation for productivity dispersion?

We now look at whether the observed pattern in wage divergence is paralleled by a divergence in productivity within country-sectors during our sample period.

4.1 Productivity dispersion and its evolution over time

Table 7: Productivity 90-10 ratio in 2001 and 2012

	Log-LP 90-10 ratio		Log-MFP 90-10 ratio	
	Manuf.	Services	Manuf.	Services
2001	1.42	1.74	1.86	2.14
2012	1.87	2.43	5.1	5.3

Note: Macro-sector 90-10 productivity ratio, averaged across countries using employment and value added as weights for labour productivity and MFP respectively. Countries: AUS, AUT, BEL, CAN, CHL, DNK, FIN, FRA, HUN, ITA, JPN, LUX, NLD, NOR, NZL, SWE.

First, a simple descriptive account of dispersion in productivity, measured as the difference between the 90^{th} and 10^{th} percentiles of the log productivity distribution, is given in Table 7. The table illustrates two important features of the (log) productivity distribution. First, there is a rather significant dispersion in both manufacturing and services between the top and the bottom performing firms in terms of labour productivity (LP) and multi-factor Productivity (MFP). Second, dispersion has increased significantly, whether in terms of LP or MFP, and both in manufacturing and services. In 2012, on average across countries, firms in the top decile of the distribution can produce almost six and a half times as much value added per worker as firms in the bottom decile in the same country's manufacturing sector, and more than 11 times as much in services [18]. When looking at (log) MFP, the 90-10 difference differences increased manyfold between 2001 and 2012. [19]

The previous simple cross-country averages are likely to be affected by changes in the sample over time. So we now look at whether the observed pattern in productivity divergence across countries is paralleled by a divergence in productivity within countries over the same period. Productivity divergence will have taken place within a country's macro-sector (e.g. manufacturing and services), if productivity for the group of most productive firms increased faster than it did for the least productive firms. To illustrate trends in the relative productivity performance of top performers vs. laggards, Figures 6 and 7 plot the difference between the 90th and 10th percentiles of log-productivity (labour productivity and MFP, respectively) over time, normalized at 0 in 2001. In each figure, the left panel represents log-productivity dispersion in manufacturing and the right panel represents log-productivity dispersion in (non-financial) market services.

Figures 6 and 7 illustrate the increasing trend in productivity dispersion in the countries of our sample, both in manufacturing and in services. For the majority of countries dispersion in 2012 is higher than in 2001: in services this is the case for all countries but New Zealand when considering labour productivity; in manufacturing for all but Italy in terms of both labour and multi-factor productivity, and again New Zealand in terms of labour productivity.

As with the divergence of wages in Section 3, we need to ensure that the observed increase in productivity dispersion is not driven by changes in the underlying sample of countries and/or sectors. To analyse productivity divergence more rigorously, as we did for wages, we therefore estimate the following regression:

$$\left(\log\frac{P_{90}}{P_{10}}\right)_{cjt} = \alpha + y_t + z_{cj} + \varepsilon_{cjt} \tag{9}$$

where $\frac{P_{90}}{P_{10}}$ is the ratio of the 90th to 10th productivity percentile, for a given productivity measure P, and where c denotes countries, j sectors and t years. Year dummies y_t capture the average within country-sector dispersion in a given year, and as such can be used to depict the evolution of productivity dispersion within countries-sectors over time.

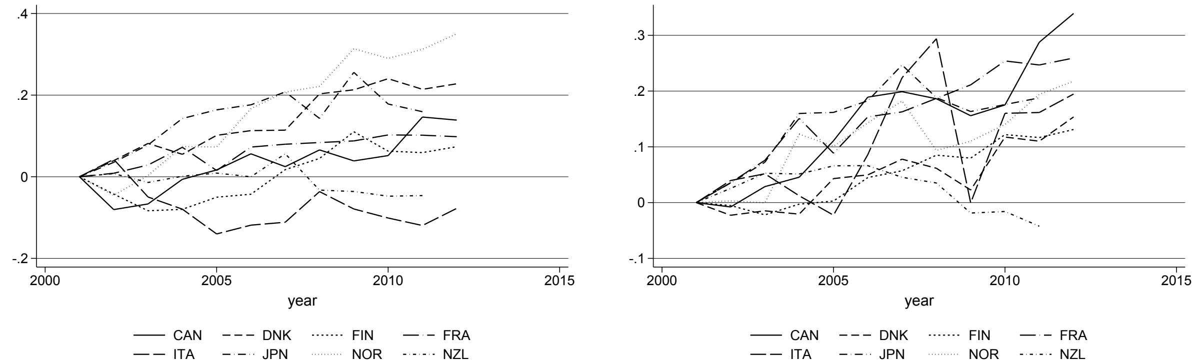
Figure 8 shows that for both labour and multi-factor productivity within-sector dispersion has increased over time on average across all countries.[20]

4.2 Evolution of productivity dispersion at the top and at the bottom of the distribution

An interesting question is whether the productivity divergence is driven by an acceleration of frontier firms or by a slowing down of productivity at the bottom relative to the median firm. To answer this question, we estimate the yearly average productivity dispersion within countries and sectors, separately for the top 90-50 ratio and bottom 50-10 ratio of the productivity distribution.

Figure 6: Divergence of (log) Labour Productivity over time

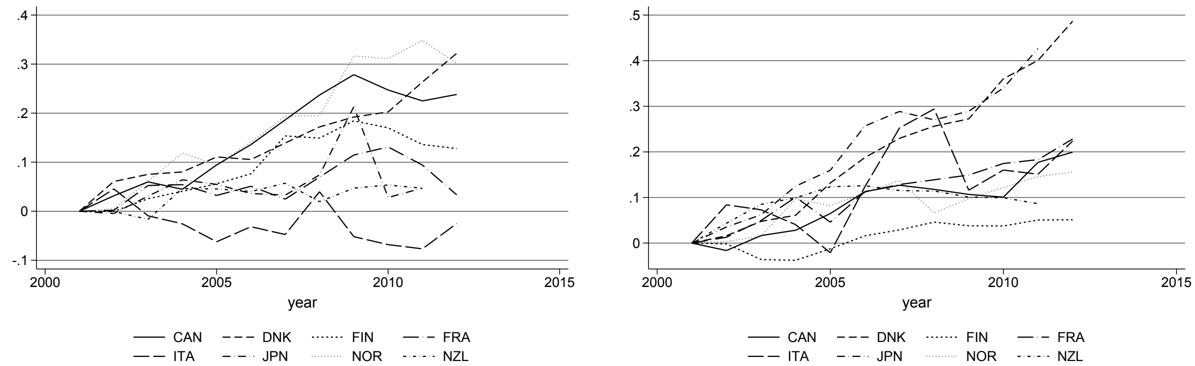
(a) Manufacturing **(b) Services**



Note: Change in 90-10 ratio of log-labour productivity for manufacturing and services since 2001. By construction, it is normalized at 0 in 2001. Only countries with data going back to 2001 are included in the graphs. Data are averaged across sectors, weighted by the number of firms in each sector.

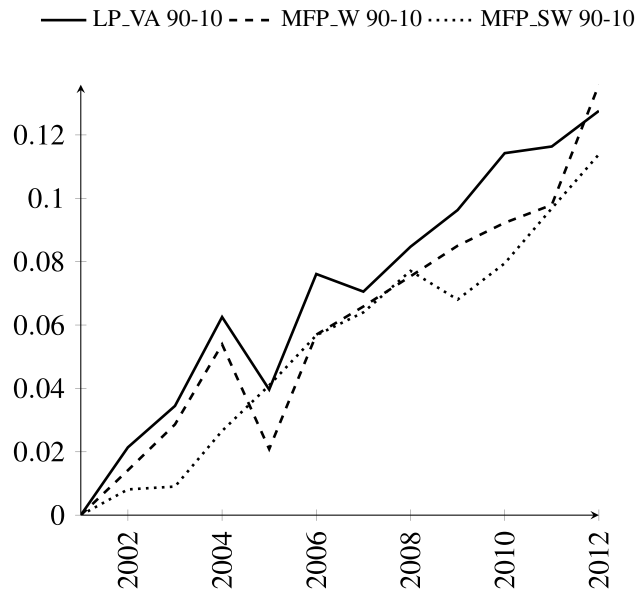
Figure 7: Divergence of (log) MFP over time

(a) Manufacturing **(b) Services**



Note: Change in the 90-10 ratio of log-MFP (Wooldridge) for manufacturing (left panel) and services (right panel) since 2001. By construction it is normalized at 0 in 2001. Only countries with data going back to 2001 are included in the graphs. Data are averaged across sectors, weighted by the number of firms in each sector.

Figure 8: The "Great Divergence" in productivity: 90-10 ratio of Productivity



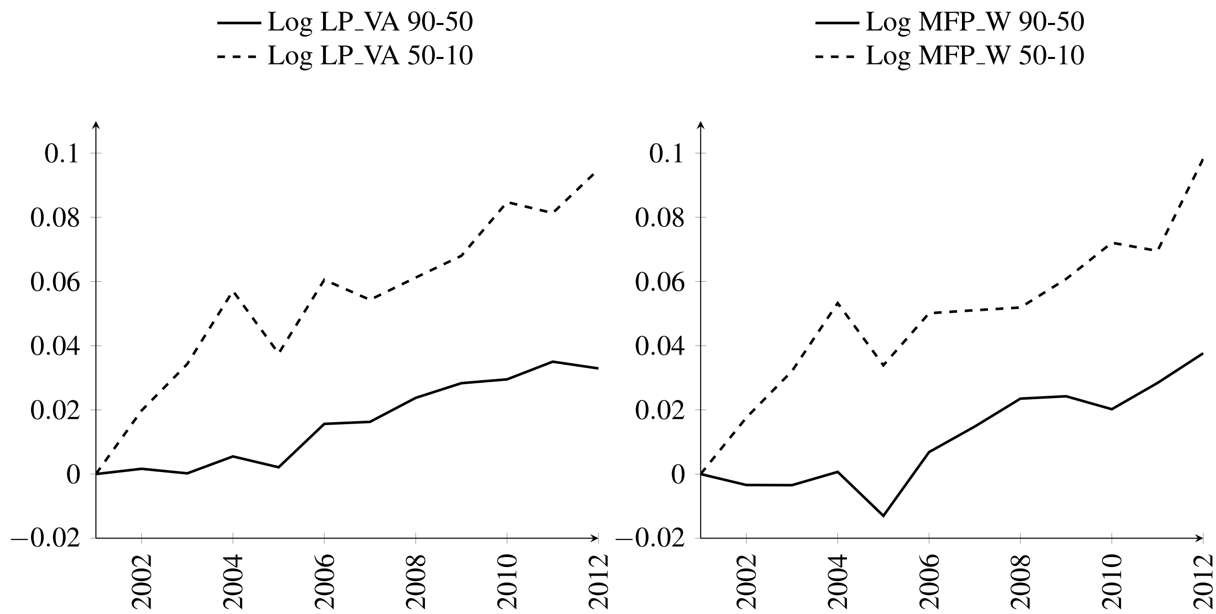
Note: The figure plots the year fixed-effects y_t of a regression of log-productivity dispersion (measured as the difference between the 90th and 10th percentiles of log-productivity) within country-sector pairs, using data from the following counntries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

The estimates, shown in Figure 9, suggest that the divergence has happened both at the top and at the bottom of the distribution. The dispersion at the top starts growing after 2005, slightly flattens out during the crisis years but increases again as of 2010. The gap between the median firm and firms in the bottom decile of the distribution has been steadily increasing since 2000 and, especially when focusing on trends in MFP dispersion, the crisis has widened the gap even further. Looking at the same pattern separately for manufacturing and services (Figure 10 and Figure 11), we see that the service sector behaves roughly as the aggregate figure given its large weight in the economy, but the manufacturing sector displays interesting differences. The dispersion at the top even decreases before 2005, and this pattern contributes significantly to the flat dispersion found in the aggregate economy; after 2005 the dispersion peaks up but to a lesser extent compared to services. The dispersion at the bottom still displays a higher growth over the period, but it is more volatile, especially for MFP. In particular the dispersion drops significantly during the Great Recession, possibly showing that relatively more capital intensive firms at the middle of the productivity distribution were severely hit during the crisis.

One of the main takeaways from Figure 9 is that the within-country sector divergence has been more severe at the bottom of the productivity distribution at the beginning of the 2000s and after the crisis, while it has been similar at the bottom and top around the mid 2000s. When thinking of what is driving the divergence at the bottom, there can be two forces at work: an increasing gap between the median and the worst performing firms might reflect a faster growth at the median relative to the bottom firms, but it could also reflect a worsening of the selection effect at the bottom of the distribution, with unproductive firms managing to remain in the market despite their low productivity. This would mean that the process of productivity enhancing resource allocation has worsened since the early 2000s.

Until the mid 2000s, median firms were gaining a productivity advantage relative to bottom performing firms and they were keeping up with the top performing firms. However, since the mid-2000s they have started to lose ground vis-à-vis their national frontier firms, which have steadily become relatively more productive.

Figure 9: Productivity dispersion at the top versus bottom of the productivity distribution



Note: The figure plots the year fixed-effects of a regression of log-LP_VA and log-MFP_W dispersion, respectively, at the top (90th and 50th percentiles ratio) and at the bottom (50th and 10th percentiles ratio) within country-sector pairs. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

4.3 Sectoral Decomposition of Productivity Variance

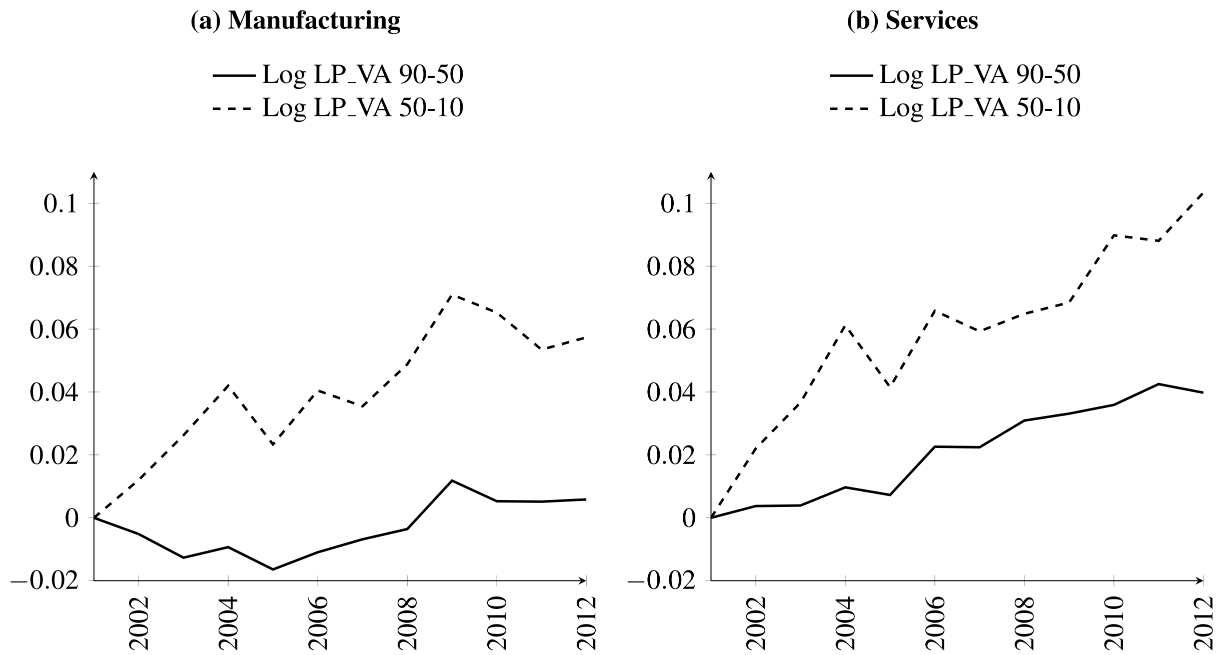
To better understand the drivers of the observed productivity dispersion, it is possible to decompose the total variance of productivity, $\text{Var} P_t$, into two components: a within-sector component $\text{Var}^W P_t$ and a cross-sectoral component, $\text{Var}^X P_t$. The within-sector component captures how much a firm's individual productivity differs from the sector (weighted) average. The cross-sectoral component captures instead how much sectors differ from each other in terms of average productivity. We then get the following identity:

$$\text{Var} P_t = \text{Var}^W P_t + \text{Var}^X P_t \tag{10}$$

where, the within-sector variance $\text{Var}^W P_t$ is the average over all sectors j of the square deviation of firms' productivity P_{it} from their sector's weighted average productivity $\overline{P}_{jt}$; focusing, for simplicity, on labour productivity, this can be written as :

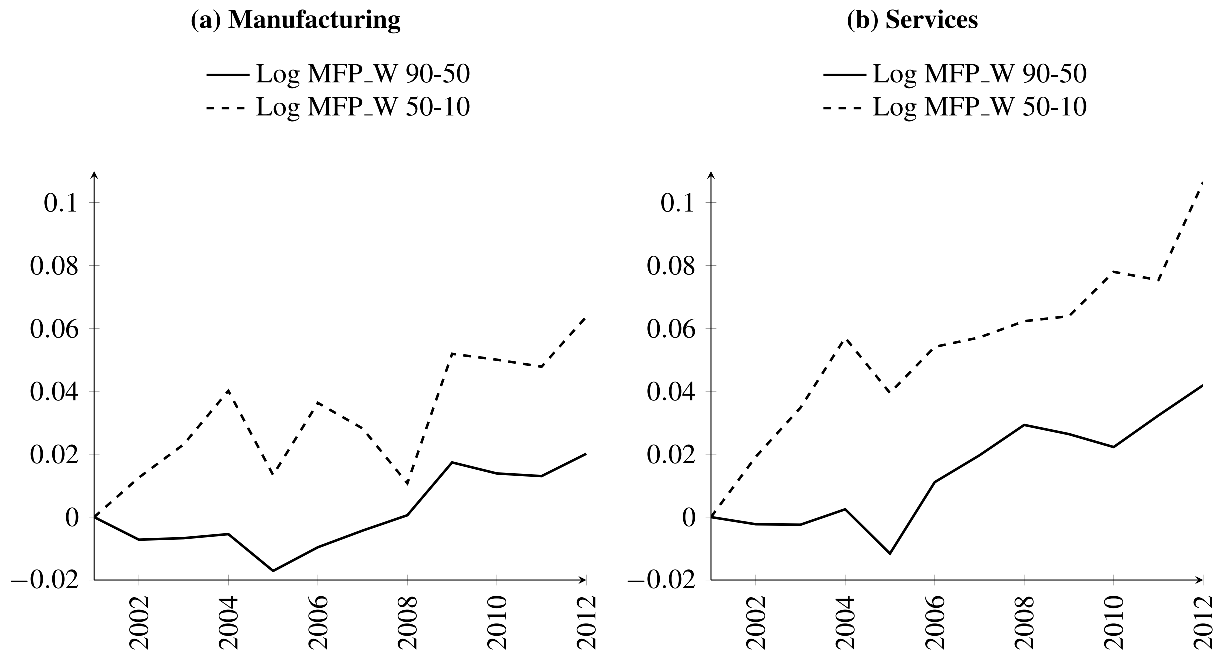
$$\text{Var}^W P_t \equiv \frac{1}{L_t} \sum_j \sum_{i \in j} L_{it} \left(LP_{it} - \overline{LP}_{jt} \right)^2 = \sum_j \frac{L_{jt}}{L_t} \sum_{i \in j} \frac{L_{it}}{L_{jt}} \left(LP_{it} - \overline{LP}_{jt} \right)^2 = \sum_j \frac{L_{jt}}{L_t} \delta_{jt}^2 \tag{11}$$

Figure 10: Labour productivity dispersion at the top versus bottom of the productivity distribution, for manufacturing and services



Note: The figure plots the year fixed-effects of a regression of log-wage dispersion at the top (90^{th} and 50^{th} percentiles ratio) and at the bottom (50^{th} and 10^{th} percentiles ratio) within country-sector pairs, separately for manufacturing and services. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

Figure 11: Log MFP_W dispersion at the top versus bottom of the productivity distribution, for manufacturing and services



Note: The figure plots the year fixed-effects of a regression of log-wage dispersion at the top (90^{th} and 50^{th} percentiles ratio) and at the bottom (50^{th} and 10^{th} percentiles ratio) within country-sector pairs, separately for manufacturing and services. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

and the cross-sectoral component $\text{Var}^X P_t$ is the average of the squared deviation of sector j's average labour productivity $\overline{LP}_{jt}$ from the economy-wide productivity $\overline{LP}_t$:

$$\text{Var}^X P_t \equiv \sum_j \frac{L_{jt}}{L_t} \left(\overline{LP}_{jt} - \overline{LP}_t\right)^2 \tag{12}$$

with $\frac{L_{jt}}{L_t}$ denoting the labour share of sector j at time t, and $\delta^2_{jt} \equiv \sum_{i \in j} \frac{L_{it}}{L_{jt}} \left(LP_{it} - \overline{LP}_{jt}\right)^2$ the labour-weighted variance of firm-level labour productivity in sector j.

The same sectoral decomposition can be done for the variance of MFP, although the choice of weights is less trivial as discussed in more detail in Appendix A.4.

This decomposition can help understand how much of the dispersion in productivity comes from microeconomic dispersion within narrowly defined sectors, and how much comes from differences in productivity performance that affect whole sectors, due for example to sector-specific technological factors. This is achieved by looking at the share of aggregate dispersion accounted for by within-sector variance, which reflects the importance of factors that are firm specific, and different for firms within the same sector. The decomposition suggested here is a cross-sectional decomposition of productivity dispersion in a given period t.

Table 8: Share of within-sector variance of labour productivity

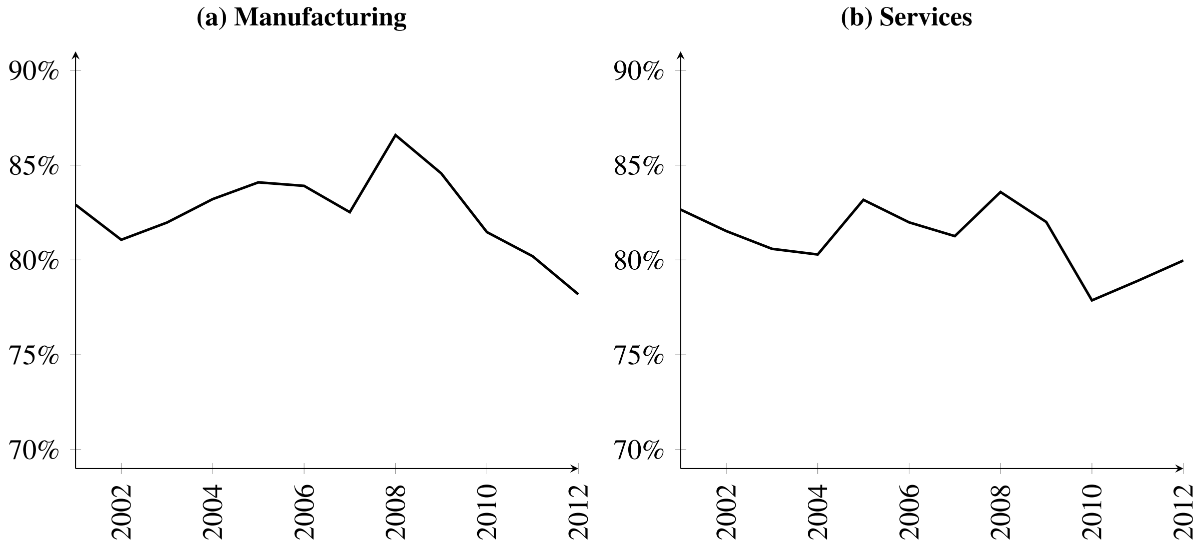
	% LP dispersion	
	Manuf.	Services
Australia (2012)	98	98
Austria (2012)	87	91
Belgium (2011)	68	81
Chile (2012)	61	98
Denmark (2012)	83	65
Finland (2012)	79	72
France (2012)	63	84
Hungary (2012)	78	99
Italy (2012)	82	80
Japan (2011)	75	89
Netherlands (2012)	84	90
Norway (2012)	88	73
Sweden (2012)	62	74

Note: Share of within-sector variance of labour productivity in total macro-sector productivity variance.

The results of the decomposition are given in Table 8. The two columns report the share of total labour productivity dispersion accounted for by within-sector dispersion, for manufacturing and services respectively. The results show that on average within-sector dispersion accounts for more than two thirds of the overall labour productivity dispersion observed across firms: there is still a large amount of heterogeneity in terms of labour productivity *between firms within the same two-digit sector*. In other words, a substantial part of productivity heterogeneity does not come from the type of activity that firms engage in, per se, but rather by more intrinsic differences between frontier firms and laggards, even within the same sector of activity in the same country. This suggests that productivity policies that aim at reducing economy-wide dispersion through structural adjustments in sectoral composition are unlikely to be effective in decreasing the gap between these two groups of firms on their own. These policies ought to be complemented by policies that work towards effective catching up of laggards to the national frontier firms that operate in the same sector.

The decomposition also allows us to identify which sectors contribute the most to the (within-sector) productivity variance; in Appendix A.5, Tables A.9 and A.10 report for each country the top three contributors to labour productivity variance, for manufacturing and services respectively. The same is performed for MFP_W variance in Tables A.11 and A.12. The tables suggest that across countries some sectors, such as wholesale and retail trade, legal and accounting in services, and food, beverages and tobacco, or metal products in manufacturing, regularly appear amongst the sectors characterised by the highest productivity dispersion. This result suggests that the distribution of firms within these sectors share some features, such as the spread of the size or capital-intensity distributions, that might affect the distribution of productivity.

Figure 12: Share of within-sector Log-labour productivity dispersion



Note: Share of within-sector dispersion in overall macro-sector Log-labour productivity dispersion. Average across countries and sectors, weighted by employment. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

We now describe how the share of within-sector variance of labour productivity evolves over time, particularly in the light of the Great Recession. The results, displayed in Figure 12, suggest that within-sector variance of labour productivity remained the most important component of overall variance, well above 75%, but its importance declined in both manufacturing and services after 2008. In other words, this suggests that in the aftermath of the crisis a larger share of the productivity dispersion came from productivity differences *across* rather than within sectors. This might suggest that the aggregate shock of the Great Recession might have affected systematically more certain sectors, such as durables, relative to how systematically it has affected firms at the top and the bottom of the productivity distribution within sectors. Nonetheless, this impact still left a large part of productivity heterogeneity that cannot be explained by sectoral differences, suggesting that cross-sectoral analyses are likely to underestimate the amount of productivity divergence in the economy.

5. THE LINK BETWEEN WAGE INEQUALITY AND PRODUCTIVITY DISPERSION

The analysis of wages and productivity has enabled us to show two results: 1. heterogeneity in wages and productivity is significant, even between firms operating within the same sectors; and 2. this heterogeneity has increased over time, a phenomenon we called 'Great Divergences'. In a well-functioning economy, wages should reflect the marginal productivity of workers, and as such should reflect firms' productivity. It is therefore legitimate to consider whether the Great Divergence in wages and the Great Divergence in productivity are merely two sides of the same coin.

5.1 Looking at the correlation between wages and productivity

Before diving into the analysis of the forces that might affect the dispersion of wages and productivity, it is instructive to provide a more precise picture of their relationship.

First, Table 9 shows that productivity and wages are positively correlated at the firm level. Interestingly, the firm-level correlation are very similar across the manufacturing and the service sectors and whether the measure of productivity considered is labour or multi-factor productivity, with correlation coefficients ranging between 0.44 and 0.56. The other interesting result is that the correlation between wages and productivity appears to be lower in the more recent year. The table therefore confirms that firms with higher productivity levels tend to be also the ones that pay higher wages, although a bit less today than at the beginning of the period.

Table 9: Firm-level correlation Wage-Productivity

	corr(W,LP)		corr(W,MFP)	
	Manuf.	Services	Manuf.	Services
2001	0.5	0.47	0.56	0.55
2012	0.46	0.44	0.45	0.44

Note: Firm-level correlation between wage and productivity, averaged across countries and sectors using the number of firms as weights. Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.

Second, we investigate further the correlation between productivity and wages along the whole productivity distribution. The MultiProd data allows us to explore how the link between wage and productivity dispersion changes across the distribution of productivity. Table 10 shows the relative strength of the correlation between wages and productivity at different quantiles of the productivity distribution, for both labour productivity and MFP. A strong and robust pattern emerges: wages and productivity are less correlated at the tails of the distribution. The estimated coefficients for the bottom and the top decile of the productivity distribution are in fact negative relative to the baseline category, which is the centre of the distribution (fourth and fifth deciles). That seems to suggest that some sections of the productivity distribution encompass relatively more information about wages.

Table 10: Wage-productivity correlation by quantiles of productivity

LogLP_VA

	(1)	(2)
1.prod_percentile	-0.108***	-0.106***
	(0.004)	(0.004)
2.prod_percentile	0.108***	0.108***
	(0.004)	(0.003)
4.prod_percentile	0.104***	0.108***
	(0.004)	(0.003)
5.prod_percentile	-0.080***	-0.078***
	(0.005)	(0.004)
Observations	12626	12626
Adj. R-Square	0.366	0.648
Country-sector FE	NO	YES
Year FE	YES	YES
Nb Countries	10	10

*** p<0.01, ** p<0.05, * p<0.1.
Countries: AUS AUT BEL DNK FIN HUN ITA JPN NLD NOR.

LogMFP_W

	(1)	(2)
1.prod_percentile	-0.109***	-0.090***
	(0.007)	(0.005)
2.prod_percentile	0.076***	0.085***
	(0.009)	(0.004)
4.prod_percentile	0.107***	0.103***
	(0.005)	(0.004)
5.prod_percentile	-0.045***	-0.031***
	(0.007)	(0.007)
Observations	11838	11838
Adj. R-Square	0.245	0.663
Country-sector FE	NO	YES
Year FE	YES	YES
Nb Countries	10	10

*** p<0.01, ** p<0.05, * p<0.1.
Countries: AUS AUT BEL DNK FIN HUN ITA JPN NLD NOR.

The channels behind the weaker correlation between wages and productivity might be very different between the top and the bottom of the distribution. In addition the weaker correlation might reflect firms paying too high or too low wages relative to their productivity level. The weaker correlation at the bottom might be driven by the fact that less productive firms might have to pay wages that are relatively too high compared to their productivity because of the existence of policies (e.g., minimum wage) that might weaken the link between average wages and productivity. It might also be the case that they pay wages that are excessively too low, given their productivity, because workers in these firms might be willing to accept excessively low wages (e.g. if they have no experience, are immigrants etc.). At the top it might be that competition for talents might push firms to pay excessively high wages relative to the productivity of workers (especially managers), which would be in line with recent models of CEO pay (Gabaix and Landier, 2008). Alternatively, firms at the top of the productivity distribution might pay wages that do not fully reflect their productivity advantage, in line with the fact that most of the productivity gains of these top performers are not translated into wage gains for their workers, as suggested by the recent literature on decoupling between wages and productivity.

5.2 Looking at the link between growing wage inequality and increase in productivity dispersion

We now turn to investigate the main question of our report, namely whether wage dispersion is correlated with productivity dispersion. To examine this claim, we run the following regressions:

$$WD_{cjt} = \alpha + \beta \cdot PD_{cjt} \quad \left(+\gamma \cdot \text{High-Skilled}_{cjt}\right) + y_t + \varepsilon_{cjt} \tag{13}$$

$$WD_{cjt} = \alpha + \beta \cdot PD_{cjt} \quad \left(+\gamma \cdot \text{High-Skilled}_{cjt}\right) + y_t + z_{cj} + \varepsilon_{cjt} \tag{14}$$

and

$$\Delta WD_{cjt} = \alpha + \beta \cdot \Delta PD_{cjt} \quad \left(+\gamma \cdot \Delta\text{High-Skilled}_{cjt}\right) + y_t + \varepsilon_{cjt} \tag{15}$$

where WD_{cjt} denotes wage dispersion,[21] PD_{cjt} denotes productivity dispersion, z_{cj} and y_t indicate respectively country-sector and year fixed effects, and Δ in Equation (15) denotes long differences. We run this specification with and without controlling for High-Skilled$_{cjt}$, the share of skilled workers. Equation (13) is a pooled regression that relates wage dispersion to productivity dispersion, while Equation (14) is a fixed effect regression, as it includes year as well as country-sector fixed effects. It thus identifies the relationship between changes in wage and productivity dispersion over time within each country-sector. The estimates obtained using fixed-effects control for any unobserved time invariant country-sector specific factor, reducing the problem of omitted variables. However, fixed-effects models might be affected by measurement error, as they might be contaminated by temporary fluctuations: the 'signal' of structural changes in productivity dispersion might be overwhelmed by the 'noise' of transitory changes, causing the variation left for identification to largely reflect transitory and idiosyncratic changes, rather than longer term changes (McKinnish, 2008).

Therefore, to confirm the robustness of the estimates of Equation (14), Equation (15) estimates the link between changes in wage inequality and in productivity dispersion using long differences between 2005 and 2012, the period for which we can compute long differences for a significant number of countries.

In all three regression equations, the coefficient of interest is β. Table 11, Table 12 and Table 13 report, for the three estimation models, the estimates of β using different measures of productivity. In all three tables, Columns (1) and (4) report the specification where productivity is measured by logged labour productivity; Columns (2) and (5) report estimates where the measures of productivity is the dispersion of logged MFP_W; and Columns (3) and (6) report estimates of regressions where MFP is a Solow residual (MFP_SW). The first three columns of each table do not include any control, while the last three control for the level of skills in the sectors.

Unsurprisingly, given the discussion in the previous subsection, the β estimates from the pooled regression reported in Table 11 are positive and strongly significant. The result suggests that there is a strong cross-sectional correlation between dispersion in wages and dispersion in productivity, for all the productivity measures considered and whether the model controls for skill or not.

More interestingly, fixed effects estimates reported in Table 12 indicate that an increase of 10% in the dispersion of logged labour productivity correlates with an increase of logged wage dispersion by 3.58% (2.88% when controlling for skills), a coefficient that is positive and statistically different from zero. In Column (2) an increase of 10% in the dispersion of logged MFP_W corresponds to a statistically significant increase of 2.24% in wage dispersion (or 2.21% controlling for skills, Column 4); at 0.47%, the effect is smaller for the dispersion of MFP_SW (Column 3) but still significant (resp. 0.74% controlling for skills, Column 6).

Table 11: Regressing wage dispersion on productivity dispersion (pooled regression)

	(1) log Wage (90-10)	(2) log Wage (90-10)	(3) log Wage (90-10)	(4) log Wage (90-10)	(5) log Wage (90-10)	(6) log Wage (90-10)
log LP (90-10)	0.840^{***}			0.669^{***}		
	(0.0103)			(0.0143)		
log MFP_W (90-10)		0.529^{***}			0.467^{***}	
		(0.00784)			(0.00840)	
log MFP_SW (90-10)			0.586^{***}			0.491^{***}
			(0.0194)			(0.0187)
% hrs by skilled workers				0.247^{***}	0.283^{***}	0.115^{***}
				(0.0556)	(0.0680)	(0.0700)
N	3740	3624	3713	2265	2191	2251
Adj. R-Square	0.730	0.358	0.420	0.532	0.311	0.324
Year FE	YES	YES	YES	YES	YES	YES
Country-sector FE	NO	NO	NO	NO	NO	NO
Nb Sectors	22	22	22	22	22	22
Nb Countries	14	14	14	11	11	11

Standardized beta coefficients; Standard errors in parentheses
Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.
* $p < .1$, ** $p < .05$, *** $p < .01$

Table 12: Regressing wage dispersion on productivity dispersion (country-sector fixed effects)

	(1) log Wage (90-10)	(2) log Wage (90-10)	(3) log Wage (90-10)	(4) log Wage (90-10)	(5) log Wage (90-10)	(6) log Wage (90-10)
log LP (90-10)	0.358^{***}			0.288^{***}		
	(0.0193)			(0.0254)		
log MFP_W (90-10)		0.224^{***}			0.221^{***}	
		(0.0162)			(0.0209)	
log MFP_SW (90-10)			0.047^{***}			0.074^{***}
			(0.0139)			(0.0168)
% hrs by skilled workers				-0.201^{***}	-0.165^{***}	-0.156^{***}
				(0.142)	(0.146)	(0.144)
N	3739	3624	3712	2265	2191	2250
Adj. R-Square	0.987	0.986	0.986	0.970	0.969	0.969
Year FE	YES	YES	YES	YES	YES	YES
Country-sector FE	YES	YES	YES	YES	YES	YES
Nb Sectors	22	22	22	22	22	22
Nb Countries	14	14	14	11	11	11

Standardized beta coefficients; Standard errors in parentheses
Countries: AUS, AUT, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.
* $p < .1$, ** $p < .05$, *** $p < .01$

Table 13: Regressing wage dispersion on productivity dispersion (2005-2012 change)

	(1) Δ log Wages (90-10)	(2) Δ log Wages (90-10)	(3) Δ log Wages (90-10)	(4) Δ log Wages (90-10)	(5) Δ log Wages (90-10)	(6) Δ log Wages (90-10)
Δ log LP (90-10)	0.348^{***}			0.258^{**}		
	(0.0709)			(0.152)		
Δ log MFP_W (90-10)		0.435^{***}			0.421^{***}	
		(0.0600)			(0.109)	
Δ log MFP_SW (90-10)			0.126			0.285^{***}
			(0.0959)			(0.0899)
Δ % hrs by skilled workers				0.089	0.110	0.130^{*}
				(0.539)	(0.433)	(0.494)
N	1710	1664	1689	774	754	770
Adj. R-Square	0.125	0.122	0.013	0.059	0.099	0.048
Nb Sectors	22	22	22	22	22	22
Nb Countries	13	13	13	9	9	9

Standardized beta coefficients; Standard errors in parentheses
The number of observations reported is for all years, but the regression is run on long differences, with one observation per country-sector.
Countries: AUS, BEL, CHL, DNK, FIN, FRA, HUN, ITA, JPN, NLD, NOR, NZL, SWE.
* $p < .1$, ** $p < .05$, *** $p < .01$

Long difference effects estimates reported in Table 13 similarly confirm that, irrespective of the measure of productivity used and whether controls for skills are included or not, an increase in the dispersion of logged labour productivity correlates with a significant increase in logged wage dispersion. These results suggest that sectors in which the distribution of productivity becomes more polarised over time are also sectors in which wages polarise, even while accounting for changes in the composition of the labour force.

Interestingly, the estimated coefficient on the skill share is positive and significant in the cross-sectional model in Table 11, which reflect the fact that the higher the share of high skilled workers in a sector the higher the dispersion in wages across firms. However, it becomes negative and significant in the fixed effects and long difference models of Table 12 and Table 13, which suggests that increases in the share of high skills in a sector are linked to a decrease in wage dispersion. Taken at face value, this would imply that increasing the workers' skills, in terms of quantity and/or quality, might be a potential avenue for containing wage inequality.

Table 14: Regressing wage dispersion on productivity dispersion, controlling for business dynamism and capital dispersion

	(1) log Wage (90-10)	(2) log Wage (90-10)	(3) log Wage (90-10)
log LP (90-10)	0.212^{***}		
	(0.0312)		
log MFP_W (90-10)		0.156^{***}	
		(0.0303)	
log MFP_SW (90-10)			0.140^{***}
			(0.0459)
LogK coeff of var.	0.106^{***}	0.128^{***}	0.124^{***}
	(0.512)	(0.529)	(0.516)
Log Entry rate	0.099^{***}	0.106^{***}	0.106^{***}
	(0.0112)	(0.0115)	(0.0113)
Log Mean of age (unweighted)	0.115^{***}	0.116^{***}	0.121^{***}
	(0.0262)	(0.0284)	(0.0267)
N	1388	1371	1388
Adj. R-Square	0.993	0.992	0.992
Year FE	YES	YES	YES
Country-sector FE	YES	YES	YES
Nb Sectors	22	22	22
Nb Countries	8	8	8

Standardized beta coefficients; Standard errors in parentheses

Countries: AUT, BEL, CHL, DNK, HUN, ITA, JPN, NOR.

* $p < .1$, ** $p < .05$, *** $p < .01$

In addition to skills there might be other factors that might drive both the wage and productivity dispersions: heterogeneity of capital, difference in entry rates (see Aghion et al. (2009) for the role of entry in the increase in inequality and Decker et al. (2016) for the link between entry rates and productivity dispersion) or firm age composition between sectors. The results, reported in Table 14, show that the correlations between wage and productivity dispersions are robust to including those controls. In other words, we can rule out that these factors could lead to a spurious correlation between wage and productivity dispersions. In the next section we will explore in more detail the role of structural changes for wage and productivity divergence and their correlation, while we report additional results in the Appendix (see Table A.13).

6. A FIRST INVESTIGATION OF THE DRIVERS OF THE GREAT DIVERGENCE(S)

In the previous sections we have looked at the divergence in wages and in productivity within sectors and countries over the last fifteen years. In this section, we investigate the role of structural factors as well as policies and institutional features of the economy that might have strengthened or weakened the correlation between wage and productivity dispersion, and thus might contribute to explain the different evolution of distribution of wages and productivity.

6.1 Divergence and structural factors

As discussed in the introduction of the report, we start by exploring the role of increased globalisation and digitalisation of the economy. As anticipated, this first attempt is limited by the availability of data on these two phenomena both in terms of country and sectoral coverage, but also in their capacity of capturing these phenomena in their entirety. Tables 15 and 16 try to capture trends in sectors' globalisation by controlling for changes in imports and exports of goods, and in the sector openness, measured as the sum of imports and exports (in logs). Moreover we seek to investigate the role of digitalisation by including the share of ICT in gross non-residential fixed assets and the share of hours worked by high skilled persons as regressors.[22] Table 15 shows the results for labour productivity and Table 16 for MFP. As before all regressions include country by sector and year fixed effects, so they investigate the impact of structural changes on changes in the dispersion of wages within country-sectors.[23]

Analysing the results from the tables we first note that the correlation between wage and productivity dispersion remain strong even after controlling for these structural changes that however significantly and independently also affect wage dispersion. More importantly for our analysis, the estimates suggest that both of the structural factors analysed, globalisation and digitalisation, seem to strengthen the correlation between wages and productivity dispersion, resulting in a stronger increase of wage inequality when the dispersion of productivity increases. In the case of MFP, exports seem to have quite a strong link with wage dispersion both directly and via an increased correlation with productivity. In a horse race regression where we include ICT, imports and exports at the same time (column 6), the latter comes out stronger than import when looking at LP and MFP; while ICT remains strongly significant only when considering LP.

In fact, in the case of labour productivity, ICT has the strongest link with wage dispersion, both directly and by increasing the correlation between wages and productivity dispersion. Interestingly, ICT

Table 15: Divergences and structural factors (LP)

	(1)	(2)	(3)	(4)	(5)	(6)
Log LP (90-10)	0.187***	0.170***	0.179***	0.191***	0.165***	0.053***
	(0.025)	(0.025)	(0.025)	(0.024)	(0.031)	(0.020)
Log Import (goods)	-0.020					0.046
	(0.031)					(0.029)
Log LP (90-10) × Log Import (goods)	0.060***					-0.023
	(0.011)					(0.020)
Log Export (goods)		0.051				-0.024
		(0.031)				(0.031)
Log LP (90-10) × Log Export (goods)		0.086***				0.070***
		(0.013)				(0.023)
Log Openness			0.021			
			(0.032)			
Log LP (90-10) × Log Openness			0.075***			
			(0.012)			
Sh. of ICT in fixed assets				0.106***		0.098***
				(0.027)		(0.025)
Log LP (90-10) × Sh. of ICT in fixed assets				0.033***		0.044***
				(0.011)		(0.015)
Sh. high-skilled (in total hours)					-0.074**	
					(0.032)	
Log LP (90-10) × Sh. high-skilled (in total hours)					0.076***	
					(0.015)	
N	1817	1817	1817	2003	2263	1089
Adj. R-Square	0.926	0.927	0.927	0.966	0.972	0.949
Country-sector year FE	YES	YES	YES	YES	YES	YES
Num. Countries	12	12	12	8	11	8

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

All regressions include the logarithm of total gross output in the sector as extra control.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR SWE.

Table 16: Divergences and structural factors (MFP)

	(1)	(2)	(3)	(4)	(5)	(6)
Log MFP_W (90-10)	0.802***	0.795***	0.810***	0.351***	0.171**	0.682***
	(0.096)	(0.093)	(0.094)	(0.095)	(0.074)	(0.106)
Log Import (goods)	0.073**					0.089**
	(0.034)					(0.036)
Log MFP_W (90-10) × Log Import (goods)	0.290***					0.030
	(0.041)					(0.094)
Log Export (goods)		0.191***				0.005
		(0.036)				(0.037)
Log MFP_W (90-10) × Log Export (goods)		0.402***				0.206**
		(0.046)				(0.098)
Log Openness			0.149***			
			(0.035)			
Log MFP_W (90-10) × Log Openness			0.355***			
			(0.043)			
Sh. of ICT in fixed assets				0.139***		0.072**
				(0.031)		(0.033)
Log MFP_W (90-10) × Sh. of ICT in fixed assets				0.028		0.035
				(0.054)		(0.076)
Sh. high-skilled (in total hours)					-0.057*	
					(0.032)	
Log MFP_W (90-10) × Sh. high-skilled (in total hours)					0.042	
					(0.041)	
N	1779	1779	1779	1917	2190	1051
Adj. R-Square	0.919	0.922	0.921	0.962	0.969	0.946
Country-sector year FE	YES	YES	YES	YES	YES	YES
Num. Countries	12	12	12	8	11	8

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

All regressions include the logarithm of total gross output in the sector as extra control.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR SWE.

does not seem to increase the correlation between MFP and wage dispersion; this result can be rationalised by the fact that MFP is already controlling for the increase in (ICT) capital. The share of high-skilled persons in total hours worked increases the correlation between labour productivity and wages, showing that sectors that becomes more skill intensive over time will tend to experience a stronger connection between productivity and wage dispersion. This result is not robust in case of MFP, possibly highlighting a complementarity between high skills and capital, which is already accounted for in MFP. On the other hand the direct effect of high skills remains negative as in the estimates discussed in the previous section, confirming that sectors that have increased their share of high skilled workers have experienced a decrease in wage dispersion. This result might come from a selection effect: the composition of the workforce in the sector has become more skilled over time with the share of low skilled people decreasing, hence resulting in a more homogeneous labour force and a less dispersed wage distribution.

6.2 The Role of Policies

Policies and regulations within countries may also shape the wage and productivity distributions and how they have changed over time. The data collected through the MultiProd project matched with information on framework conditions in different countries allow us to shed light on these important questions. Furthermore, policies might have heterogeneous impact on wages and their correlation with productivity depending of whether workers are employed by high or low-productivity (and low-pay) firms. As discussed in Section 2, the MultiProd data contain information on the wage-productivity correlation by segments of the productivity distribution. This detailed information will offer a direct way of analysing the relationship between wage and productivity for firms characterised by different productivity levels, thus offering further evidence on the channels that link policy, wages and productivity.

Moreover policies might also counteract some of the effects that structural factors have on wages and productivity. The different extent to which decoupling between changes in productivity and wages arises can be linked to labour market institutions (OECD, 2016). Similarly, some decoupling between productivity and wages can be observed when the effective length, breadth and regional coverage of collective bargaining agreement is very long and thus might weaken the actual link between productivity and wages. If the link between wages and productivity is broken, it becomes more difficult for resources to be allocated efficiently both across industries and across firms within industries. Conversely if wages and productivity move in the same direction, it is more likely that less productive firms shrink and their resources are allocated to firms at the top.

Countries which attempt to shield workers during adverse market conditions may feature less wage and productivity dispersion. On the one hand, this is of course beneficial to the workers as their jobs and salaries would be better protected and shielded by the cycles. Since workers are generally more risk adverse this may be welfare improving in the short run and, in addition, such regulations would also support equity amongst workers during the economic cycle. On the other hand, less dispersion in wages and productivity due to regulations may actually inadvertently impact aggregate productivity by distorting the flow of resources from less to more productive firms. Thus, policies that might be welfare improving in the short-run may have a detrimental impact in the long run: policies that hinder the reallocation of resources away from poorly performing to highly productive firms can result in slower aggregate productivity growth.

There are other elements of this relationship that play a role. If economic policies play a role in shaping the wage distribution, one might expect that they will have a differential impact across segments of the productivity distribution. For example, in a country with a high minimum wage, one might expect the wage dispersion of the bottom quantile of the productivity distribution to be more compressed in comparison to countries with no or low minimum wages. On the other hand, the variance at the top quantile could be quite similar, since employees there earn higher wages in the first place. The shape of the overall wage distribution might then be just the result of a compression from the firms at the bottom while firms at the top of the distribution might not display any change in their wage policy.

In a nutshell we would like to understand whether country-specific policies affect wage dispersion and its link with productivity dispersion. To do so, we consider three main policies or institutional features of a country: i) minimum wage (both in terms of hourly real minimum wage and the minimum relative to average wages of full-time workers); ii) employment protection legislation (strictness of employment protection for both individual and collective dismissals); iii) trade union density and; iv) coordination in wage setting.[24,25] We run a first set of regressions in which we regress wage dispersion on productivity dispersion, the specific policy and their interaction. What we want to test is the direct effect of policies on wage dispersion as well as whether they strengthen or weaken the link of wage dispersion and productivity.

Table 17 shows the results of the exercise in the case of MFP. The first four columns report estimates when looking at minimum wage (columns 1 and 2 using hourly real minimum wage and columns 3 and 4 using minimum wage relative to average wage in the country sector year); columns 5 and 6 look at Employment Protection legislation; estimates of trade union density can be found in columns 7 and 8 and estimates of coordination in wage setting can be found in columns 9 and 10. Each regression is run with two sets of fixed effects: first we only include year fixed effects to analyse the cross-sectional relationship controlling for overall macroeconomic shocks, captured by year dummies, reported in columns 1, 3, 5, 7, and 9; secondly, we include a full set of country-sector and year fixed effects to control for any country-sector specific unobservable factor and focus on the within sector country variation over time, reported in columns 2, 4, 6, 8, and 10.

The results show that the link between wage and productivity dispersion is not broken by the considered policies and still displays a robust positive sign. The policies have the intended consequence of reducing wage dispersion and hence overall inequality. At the same time they tend to significantly affect the link between wage and productivity dispersion. An interesting result, reported in the first four columns, is that the minimum wage seems to have different effects in the short and in the long term: the link with lower wage inequality is stronger in the longer term. The sign of the interaction term between minimum wage and productivity dispersion which is negative in the cross-section becomes positive when looking at variation within sectors and countries over time.

Table 17: Divergences and Policy (MFP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log MFP_W (90-10)	0.467***	0.075***	0.494***	0.063**	0.622***	0.437***	0.064	0.370***	0.757***	0.285***
	(0.025)	(0.026)	(0.021)	(0.025)	(0.052)	(0.084)	(0.045)	(0.070)	(0.027)	(0.067)
Real Min Wage (hour)	-0.016	-0.369***								
	(0.012)	(0.045)								
Log MFP_W (90-10) × Real Min Wage (hour)	-0.139***	0.054***								
	(0.023)	(0.017)								
Relative Min Wage (wrt av)			-0.093***	-0.124***						
			(0.019)	(0.024)						
Log MFP_W (90-10) × Relative Min Wage (wrt av)			-0.135***	0.059***						
			(0.024)	(0.015)						
EPL (indiv. and coll.)					-0.106***	-0.091***				
					(0.023)	(0.021)				
Log MFP_W (90-10) × EPL (indiv. and coll.)					-0.546***	-0.152**				
					(0.096)	(0.064)				
Trade union density							-0.093***	-0.361***		
							(0.029)	(0.042)		
Log MFP_W (90-10) × Trade union density							-0.688***	0.016		
							(0.086)	(0.057)		
Wage Setting									-0.081***	-0.103***
									(0.013)	(0.026)
Log MFP_W (90-10) × Wage Setting									-0.832***	-0.132**
									(0.041)	(0.054)
N	1804	1804	1804	1804	3456	3456	3456	3456	3456	3456
Adj. R-Square	0.662	0.970	0.656	0.967	0.296	0.966	0.346	0.968	0.486	0.966
Year FE	YES		YES		YES		YES		YES	
Country-sector year FE		YES		YES		YES		YES		YES
Num. Countries	7	7	7	7	13	13	13	13	13	13

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR NZL SWE.

This result seems to suggest that the countries that have a higher minimum wage are also the ones that have a weaker link between wage and productivity dispersion. At the same time increases in the minimum wage, both in real and relative terms, are associated with a stronger correlation between wage and productivity dispersions, partially undoing the wage compression coming from the direct effect. A few explanations could rationalise this result: i) the exit of firms at the bottom of the productivity distribution; ii) an improvement in firms' performance (higher efficiency and/or higher innovation) in order to survive in an environment characterised by higher labour costs; iii) a reduction in labour inputs (head counts or hours worked), a substitution of labour with capital, and/or a change in the composition of the workforce towards more productive workers, which again would result in productivity improvements.

To further investigate this channel, we look at the link between firm-level wages and productivity in each of the quantiles of the productivity distribution and at how the minimum wage affects this link at the different level. To do so, we regress the correlation between firm-level productivity computed at the sector-year-productivity quantile level on dummies for each of the productivity quantile and their interaction with the value of minimum wage relative to average wage in the country sector year. Table 18 shows the results of this exercise, which is performed as before with two sets of fixed effects. The correlation displays the same pattern across quantiles already seen in Table 10: it tends to be weaker at the bottom and at the top of the productivity distribution. Moreover the table shows that a higher minimum wage weakens the correlation between wages and productivity, and this is stronger for the quantiles at the bottom of the distribution. When we analyse the within country-sector results (Columns 2 and 4) and consider only the within variation, this effect is reduced. This is particularly true at the top of the productivity distribution, where an increase of the minimum wage over time actually tends to significantly strengthen the correlation between wages and productivity. This pattern holds true for both labour productivity (columns 1 and 2) and MFP (columns 2 and 4).

Analysing the other policies, a higher employment protection legislation is associated with a decrease in wage dispersion as well as a weaker link with productivity. This is true both for the cross-section and over time. The same result applies to trade union density: both in levels and over time a higher union density is associated with lower wage dispersion. But the effect on the link between productivity and wage dispersion is not robust to controlling for fixed effects.

The measure of coordination in wage setting is significant and negative both directly and when interacted with productivity, and both in the cross section and within country-sectors over time. This policy measure captures the extent to which wage setting arrangements are likely to generate more or less coordination, whereby the lowest level indicates that the wage bargaining is fragmented and confined largely to individual firms or plants while the highest level corresponds to centralized bargaining (with or without government involvement). Hence more centralized bargaining helps limiting the extent of wage dispersion, but at the same time weakens the link between wages and productivity, which might be detrimental for long run growth.[26]

Revisiting the results in terms of labour productivity (Table 19) the pattern is more mixed. The most robust result is the direct negative impact that policies have on wage dispersion over time. The effect of the minimum wage on the link between wage and productivity dispersion still changes sign between the cross-sectional and the within country-sector estimates, but the coefficient is positive and significant only for one of the two measures of minimum wage. Similarly, the estimates of the interaction term between labour productivity and the other policies are smaller in magnitude and partially lose significance with respect to MFP. Some of the cross-sectional results are at odds with the previous ones for MFP. Much of this could be driven by unobservable characteristics that are not controlled for in the cross-section, but, still, the results clearly deserve further investigation. In particular, labour productivity is driven by the level of capital intensity of the firms, and the impact of the policy will depend on whether firms substitute capital with labour, or whether capital and labour are gross complement.[27]

Finally we investigate whether policies and structural factors interact with each other. More specifically, we look at whether policies affect the link between productivity and wage dispersions differently in sectors that are more or less exposed to import competition. Table 20 shows similar results to the previous ones for MFP (Table 17) but with a further interaction with imports (Table A.18 shows similar results with exports). Compared to Table 17, it is interesting to see that, over time, minimum wage tends to reduce wage dispersion even further in sectors that have experienced an increase in both MFP dispersion and imports (columns 1 and 2). On the other hand, the effect of a more centralised wage bargaining on wage dispersion gets weaker with higher import competition (column 5). As before, a more coordinated wage setting tends to reduce wage dispersion, and particularly so in sectors with higher productivity dispersion. But the effect is more limited if the sector gets also more exposed to import competition (the coefficient of the triple interaction term is positive, counteracting the overall negative effect of wage setting). One potential explanation is that higher imports may work as an external and credible threat for firms (for instance via the threat of offshoring); this would give them more bargaining power, resulting in lower workers' surplus, and wages closer to workers' productivity. Aligning productivity with wages would, all else equal, increase the correlation between productivity dispersion and wage dispersion.

Table 18: Wage-productivity correlation and policy by quantiles of productivity

	(1) Corr W&LP_VA	(2) Corr W&LP_VA	(3) Corr W&MFP_W	(4) Corr W&MFP_W
Prod Perc 0-10	-0.072***	-0.067***	-0.085***	-0.083***
	(0.006)	(0.004)	(0.005)	(0.006)
Prod Perc 10-40	0.093***	0.097***	0.082***	0.083***
	(0.007)	(0.005)	(0.006)	(0.005)
Prod Perc 60-90	0.109***	0.110***	0.104***	0.100***
	(0.004)	(0.005)	(0.008)	(0.007)
Prod Perc 90-100	-0.099***	-0.102***	-0.025*	-0.019
	(0.007)	(0.006)	(0.015)	(0.015)
Prod Perc 0-10 × Relative Min Wage (wrt av)	-0.093***	-0.021**	-0.064***	-0.029***
	(0.005)	(0.008)	(0.005)	(0.009)
Prod Perc 10-40 × Relative Min Wage (wrt av)	-0.079***	-0.010	-0.042***	-0.010
	(0.007)	(0.008)	(0.007)	(0.008)
Prod Perc 40-60 × Relative Min Wage (wrt av)	-0.057***	0.005	-0.045***	-0.014*
	(0.004)	(0.007)	(0.004)	(0.008)
Prod Perc 60-90 × Relative Min Wage (wrt av)	-0.102***	-0.038***	-0.061***	-0.025***
	(0.004)	(0.007)	(0.007)	(0.008)
Prod Perc 90-100 × Relative Min Wage (wrt av)	-0.005	0.056***	-0.018**	0.051***
	(0.007)	(0.010)	(0.008)	(0.011)
N	5531	5531	5085	5085
Adj. R-Square	0.469	0.626	0.307	0.536
Year FE	YES		YES	
Country-sector year FE		YES		YES
Num. Countries	5	5	5	5

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

The dependent variable is the correlation between wages and productivity.

All regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS BEL HUN JPN NLD.

Table 19: Divergences and Policy (LP)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log LP (90-10)	0.597***	0.237***	0.553***	0.256***	0.419***	0.268***	0.349***	0.262***	0.421***	0.237***
	(0.016)	(0.037)	(0.016)	(0.038)	(0.017)	(0.024)	(0.024)	(0.025)	(0.021)	(0.025)
Real Min Wage (hour)	0.121***	-0.295***								
	(0.010)	(0.047)								
Log LP (90-10) × Real Min Wage (hour)	-0.071***	0.041**								
	(0.015)	(0.021)								
Relative Min Wage (wrt av)			0.047***	-0.097***						
			(0.013)	(0.023)						
Log LP (90-10) × Relative Min Wage (wrt av)			-0.063***	0.022						
			(0.018)	(0.015)						
EPL (indiv. and coll.)					0.014	-0.050***				
					(0.014)	(0.017)				
Log LP (90-10) × EPL (indiv. and coll.)					0.065***	-0.037*				
					(0.014)	(0.021)				
Trade union density							0.063***	-0.359***		
							(0.013)	(0.037)		
Log LP (90-10) × Trade union density							-0.131***	-0.005		
							(0.023)	(0.017)		
Wage Setting									0.130***	-0.068***
									(0.012)	(0.017)
Log LP (90-10) × Wage Setting									-0.037**	-0.029**
									(0.017)	(0.013)
N	1890	1889	1890	1889	3564	3563	3564	3563	3564	3563
Adj. R-Square	0.794	0.970	0.788	0.969	0.507	0.969	0.570	0.971	0.555	0.969
Year FE	YES		YES		YES		YES		YES	
Country-sector year FE		YES		YES		YES		YES		YES
Num. Countries	7	7	7	7	13	13	13	13	13	13

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR NZL SWE.

Table 20: Divergences, Policy and External Factors (Imports)

	(1)	(2)	(3)	(4)	(5)
Log MFP_W (90-10)	0.326***	0.322***	0.945***	0.473***	0.578***
	(0.040)	(0.040)	(0.109)	(0.098)	(0.084)
Real Min Wage (hour)	-0.387***				
	(0.060)				
Import (goods)	-0.075**	-0.091***	-0.027*	0.011	-0.013
	(0.031)	(0.027)	(0.016)	(0.019)	(0.014)
Log MFP_W (90-10) × Real Min Wage (hour)	-0.016				
	(0.029)				
Log MFP_W (90-10) × Import (goods)	0.058**	0.025	0.125***	0.120**	0.113***
	(0.024)	(0.019)	(0.035)	(0.059)	(0.026)
Real Min Wage (hour) × Import (goods)	-0.022				
	(0.015)				
Log MFP_W (90-10) × Real Min Wage (hour) × Import (goods)	-0.050***				
	(0.015)				
Relative Min Wage (wrt av)		-0.133***			
		(0.031)			
Log MFP_W (90-10) × Relative Min Wage (wrt av)		0.023			
		(0.021)			
Relative Min Wage (wrt av) × Import (goods)		-0.026**			
		(0.010)			
Log MFP_W (90-10) × Relative Min Wage (wrt av) × Import (goods)		-0.027**			
		(0.012)			
EPL (indiv. and coll.)			-0.006		
			(0.023)		
Log MFP_W (90-10) × EPL (indiv. and coll.)			-0.414***		
			(0.090)		
EPL (indiv. and coll.) × Import (goods)			-0.007		
			(0.012)		
Log MFP_W (90-10) × EPL (indiv. and coll.) × Import (goods)			-0.006		
			(0.040)		
Trade union density				-0.492***	
				(0.057)	
Log MFP_W (90-10) × Trade union density				-0.583***	
				(0.103)	
Trade union density × Import (goods)				0.021	
				(0.016)	
Log MFP_W (90-10) × Trade union density × Import (goods)				0.054	
				(0.055)	
Wage Setting					-0.207***
					(0.022)
Log MFP_W (90-10) × Wage Setting					-0.425***
					(0.054)
Wage Setting × Import (goods)					0.019*
					(0.010)
Log MFP_W (90-10) × Wage Setting × Import (goods)					0.058**
					(0.027)
N	879	879	1779	1779	1779
Adj. R-Square	0.928	0.924	0.921	0.930	0.931
Country-sector year FE	YES	YES	YES	YES	YES
Num. Countries	6	6	12	12	12

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

All regressions include the logarithm of total gross output in the sector as extra control.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR SWE.

7. CONCLUSIONS AND NEXT STEPS

The last decades have seen a growing divergence in wages and productivity. Most of the existing evidence has documented these two trends separately, and often using evidence from a single country. In this report we attempt to contribute to this literature exploiting a novel data set that contains harmonized microaggregated statistics for 16 countries over the last fifteen years on productivity and wage dispersion, based on the ongoing OECD MultiProd project. Thanks to this unique data source we have been able to provide a detailed accounting of the evolution of wage and productivity dispersion and the link between the two. By linking the database to information on structural factors, such as ICT intensity and openness, as well as policies and institutions that affect the pay settings environment, such as minimum wage and unionisation, we can look at how these policies affect the link between productivity and wage dispersion.

We can summarize the findings of the report in five main takeaways:

1. Between-firm wage dispersion is found to be significantly and positively correlated to the overall wage dispersion and its evolution over time. Most of the between-firm wage variance is driven by differences in pay across firms within sectors rather than by differences in average wages across sectors. There has been a steady increase in wage inequality, measured as the 90-10 wage ratio, driven mainly by an increased dispersion at the bottom of the distribution; the dispersion at the top plays a role only in the service sector since 2005.

2. Similarly, we find that dispersion in productivity, whether measured as real value added per worker (labour productivity) or as multi-factor productivity (MFP), has also significantly increased in the last decades. Most of the increase is driven by within-sector productivity differentials across firms, rather than by cross-sectoral differences. Similar dynamics of increase at the bottom in the early 2000s and at the top after 2005 are also present in the productivity data, which might point to a link between the co-evolution of wage and productivity dispersion.

3. The evidence suggests that wage dispersion is linked to increasing differences between high and low productivity firms, even controlling for sectors' skill composition. This relationship holds in levels and when looking at short- and long-term changes over time. Moreover, firm level correlation between wages and productivity is systematically weaker at the top and at the bottom of the productivity distribution.

4. When looking at the role of structural changes, preliminary estimates suggest that both globalisation, proxied by measures of openness, import penetration and export intensity at the sectoral level, and digitalisation, proxied by ICT capital intensity at the two-digit sector level, are associated with higher wage divergence and tend to strengthen the link between productivity and wage dispersion within sectors and countries over time.

5. Finally, the report provides some preliminary analysis of the role of policy on the link between wage inequality and productivity dispersion focusing on minimum wage, employment protection legislation, trade union density, and coordination in wage setting. While the results are preliminary and only suggestive, as they capture conditional correlations rather than causal effect of policies,

they point to a positive link between higher minimum wages, unionization, EPL and reduced wage inequality, and, in the case of the minimum wage, to a strengthening of the link between productivity and wages dispersion over time.

The results presented in the report are preliminary and will be extended in several ways in the next few months.

First, few additional countries might be able to provide data in the framework of the MultiProd project.[28]

Second, we aim at improving our measures of structural factors, by using different measures for both globalisation and digitalisation. For instance, we plan to focus on the impact of import penetration from China as well as include other measures of digitalisation that can help us identify sectors where winner-takes-all dynamics are more likely to arise, versus sectors where technological progress has translated into increased automation of production. We also want to investigate further the hypothesis that attributes increased divergence across both businesses and workers to rising market concentration, which is possible thanks to new information on sector concentration collected within the MultiProd project.

Third, we will extend the set of policies analysed, with a particular focus on policies related to product market regulation (in particular barriers to entry and barriers to trade and investment), possibly focusing on those service sectors where more detailed information on regulation is available. Another interesting avenue for future research would involve looking at policies that affect more directly the top of the productivity distribution, such as the tax treatment of stock options, or deferred compensation.

Finally, we recognize that a full account of the link between wage inequality and productivity divergence would ideally rely on linked employer-employee data. Unfortunately, this is a goal that might not be achievable in the very short term but we hope that future waves of the MultiProd project will be able to access these data, at least for the set of countries in which they are available. A wider availability of matched employer-employee data across countries would allow us to provide more detailed answers to these very policy relevant questions.

Notes

[1]See also Card, Cardoso, Heining, et al. (2016) for a recent overview.

[2]E.g. wage setting policies and institutions such as minimum wage, trade unions, wage coordination, employment protection legislation and product market regulation.

[3]For recent evidence of growing sorting over the last two decades see for example Bagger et al. (2013)

[4]The DynEmp (Dynamics of Employment) project provides harmonised micro-aggregated data to analyse employment dynamics (Criscuolo et al., 2014b; Criscuolo et al., 2014a) and MicroBerd provides information on R&D activity in firms from official business R&D surveys.

[5]In the Netherlands the coverage of the survey changes year by year as in some benchmark years Statistics Netherlands surveys a larger number of firms; for instance, in 2009 the share increases to 7.3%.

[6]The preferred measure for the labour input is headcount (HC); if not available, the full time equivalent (FTE) is used.

[7]For the MFP calculations a measure of capital stock is needed. If investments are available, the capital input is measured through the Perpetual Inventory Method (PIM); otherwise, the book value of capital is used.

[8]Later published as Ackerberg et al. (2015).

[9]More precisely the data of MultiProd are collected at the A38 level, which is slightly more aggregated than 2-digit (for the exact definition, see Berlingieri et al., 2016). Still, we use the two terms interchangeably throughout the paper. Outcomes are also available at a more aggregated A7 or macro-sector level.

[10]An analysis with matched employer-employee data has not been attempted because of the higher level of complexity that this would entail in terms of coordination both within and across countries, but most importantly because such an analysis would severely limit cross-country comparison as these data are not yet available in many countries. A future step of the MultiProd project will be to access matched employer-employee data for a subset of countries in which the data are available.

[11]A caveat of the within-sector between-firm analysis carried out in the rest of the report is that the occupation structure is not observed in the micro-data. This contrasts with studies where the object of interest is the residual wage inequality between workers with the same characteristics (e.g. sector and occupation). To overcome this issue we will control for the level of skills at the sectoral level over time, which can partially capture the changing occupation structure at the sectoral level. We intend to extend the current analysis in future research to explicitly control for the occupation and skill structure at the sectoral level. In any case it is reassuring that Helpman et al. (forthcoming) find that the sectoral component is more important than the occupation component (it accounts for a larger share of the overall change in wage inequality: 27% versus 8% of the occupation component).

[12]Australia, Austria, Belgium, Canada, Chile, Denmark, Finland, France, Hungary, Italy, Japan, Luxembourg, Netherlands, Norway, New Zealand and Sweden.

[13]In results not reported here we find that the correlation more than doubles in magnitude and becomes significant also in agriculture and mining when the 90^{th}-50^{th} percentile ratio is analysed.

[14]Since the data in MultiProd are micro-aggregated moments (and means in particular) from firm-level data, in all regressions we weight each observation cjt by the number of firms reporting a non-missing information for the relevant variable in a given country-sector-year (using analytical weights in STATA®).

[15]Note that the figure reports log wage ratios. The 12.3% figure is calculated as $100[exp(c)-1]$ where c is the coefficient of the 2012 year dummy in equation 7. The Detailed results of the regression are presented in Table A.1 in Appendix A.1.

[16]Note that in the rest of the paper we will use - for brevity sake - “wage dispersion” to indicate “between-firm wage dispersion” as the latter is the only type of dispersion we can calculate given the information available in MultiProd.

[17]Using data from the 1997 to 2013 Labour Force Survey for Canada, Fortin and Lemieux (2015) find that overall wage inequality has decreased in a few Canadian provinces due to the extractive resources sector boom.

[18]these figures are obtained by taking the exponential of the log LP 90-10 differences reported in the table; 1.87 and 2.43, respectively.

[19]These figures might appear very large relative to estimates for the manufacturing sector reported for example in **syverson˙econlit˙2011** However, one must not forget that these figures report dispersion across the whole non-financial business services sector and thus might also reflect differences in productivity across sectors within services.

[20]The exact regression results are given in Table A.2 in the Appendix.

[21]More precisely: $WD_{cjt} \equiv \left(\log \frac{W_{90}}{W_{10}}\right)_{cjt}$, the 90-10 percentile ratio of log wages.

[22]Trade data come from the OECD STAN Bilateral Trade Database by Industry and End-use category (BTDIxE), while the ICT data from the OECD Annual National Accounts, ISIC Revision 4. Further information and details are available on http://stats.oecd.org. The data on skills are ISIC Revision 4 estimates based on the ISIC 3 original data from the World Input Output Tables (WIOD), Socio Economic Accounts, July 2014 (See Timmer et al., 2015).

[23]The sample is regression specific due to the data limitation of these structural factors, for instance trade data are available only for manufacturing.

[24]Note that we might not be able to fully capture the effects of policies that target more directly workers (e.g. minimum wage) rather than the firm (e.g. EPL) in terms of implications for both wages and labour mobility. This is because we only have average wage at the firm level which does not allow us to look at employees’ tenure, skill composition within the firm etc ...

[25]The data on minimum wage and EPL come from OECD Stats, further information on the detailed national sources is available on http://stats.oecd.org. Trade union density is the ratio of wage and salary earners that are trade union members, divided by the total number of wage and salary earners; the data on trade union members are from the the ICTWSS database (Institutional Characteristics of Trade Unions, Wage Setting, State Intervention and Social Pacts, release 3.0), while the number of workers are from the OECD Labour Force Statistics. Coordination in wage setting identifies the extent to which institutional features of wage setting arrangements are likely to generate more or less coordination (on a scale from 1 to 5, where 1 corresponds to ’Fragmented wage bargaining, confined largely to individual firms or plants’ and 5 to ’Maximum or minimum wage rates/increases based on centralized bargaining’) and comes from the ICTWSS database, release 5.0, November 2015.

[26]Manasse and Manfredi (2014) discuss how the collective bargaining system in Italy might be the cause of the misalignment between productivity and wages.

[27]We cannot test these hypotheses with the data currently available in the MultiProd database. But we intend to collect information that might help shed further light on these results in the next wave of MultiProd.

[28]For example, data for Indonesia and Portugal were received few weeks ago and will be included in the database in the coming weeks. Other countries such as the UK and Spain are also actively participating in the project and we hope to include them in the analysis in the near future.

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APPENDIX

A. ADDITIONAL RESULTS

A.1 Documenting the dispersion increase

Results of regressing wage and productivity dispersion on time dummies, as given in Equation (7) and Equation (9), are given in Table A.1 and Table A.2, respectively.

Table A.1: Regressing wage dispersion on year fixed effects show an increase of wage dispersion over time, using the specification given in Equation (7).

	(1) LogW_pd90_10	(2) LogW_pd90_10
2002.year	-0.008	
2003.year	0.018**	
2004.year	0.019**	
2005.year	0.007	
2006.year	0.025***	
2007.year	0.041***	
2008.year	0.071***	
2009.year	0.087***	
2010.year	0.093***	
2011.year	0.103***	
2012.year	0.116***	
year		0.012***
Observations	3110	3110
Adj. R-Square	0.987	0.987
Country-sector FE	YES	YES
Nb Sectors	22	22
Nb Countries	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

For robustness, we also regress wage productivity dispersion on a time trend, with country-sector fixed effects, according to the following model:

$$\left(\log \frac{P_{90}}{P_{10}}\right)_{cjt} = \alpha + \beta year + z_{cj} + \varepsilon_{cjt} \tag{A.1}$$

The results are given in column 2 of Table A.1 for wage dispersion, and in Table A.3 for productivity dispersion.

Table A.2: Regressing productivity dispersion on year fixed effects show an increase of productivity dispersion over time, using the specification given in Equation (9).

	(1) LogLP_VA_pd90_10	(2) LogMFP_W_pd90_10	(3) LogMFP_SW_pd90_10
2002.year	0.021***	0.014	0.008
2003.year	0.034***	0.029***	0.009
2004.year	0.063***	0.054***	0.027***
2005.year	0.040***	0.021**	0.041***
2006.year	0.076***	0.057***	0.057***
2007.year	0.071***	0.066***	0.064***
2008.year	0.085***	0.075***	0.077***
2009.year	0.096***	0.085***	0.068***
2010.year	0.114***	0.092***	0.079***
2011.year	0.116***	0.098***	0.097***
2012.year	0.128***	0.136***	0.114***
Observations	3122	2997	3088
Adj. R-Square	0.987	0.997	0.962
Country-sector FE	YES	YES	YES
Nb Sectors	22	22	22
Nb Countries	14	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.3: Regressing productivity dispersion on a time trend shows an increase of productivity dispersion over time, according to Equation (A.1).

	(1) LogLP_VA_pd90_10	(2) LogMFP_W_pd90_10	(3) LogMFP_SW_pd90_10
year	0.011***	0.011***	0.010***
Observations	3122	2997	3088
Adj. R-Square	0.987	0.997	0.962
Country-sector FE	YES	YES	YES
Nb Sectors	22	22	22
Nb Countries	14	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A.2 Correlation between productivity and wages

In order to better explore the link between productivity and wages, the MultiProd dataset has collected correlations between productivity and wages at the firm level. We can therefore investigate how the correlation has evolved over time by running the following regressions:

$$\text{Corr}(W,P)_{cjt} = \alpha + y_t + z_{cj} + \varepsilon_{cjt} \tag{A.2}$$

where $\text{Corr}(W,P)$ is the between-firm correlation between wage and productivity.

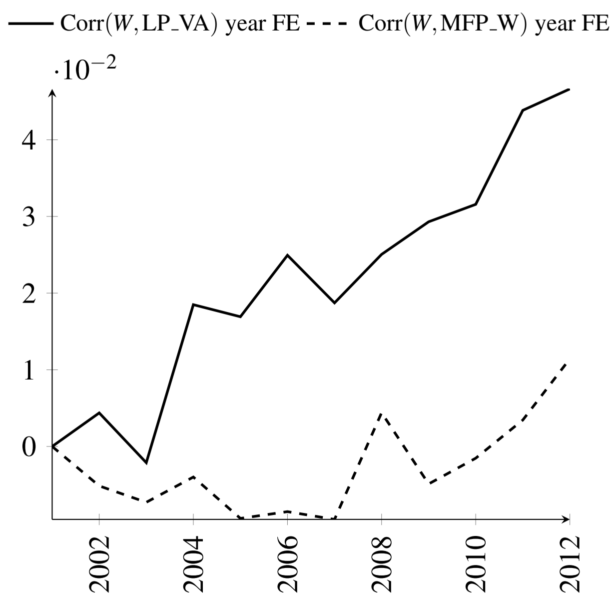
The results are reported in Figure A.13 and in Table A.4. The figure shows that the correlation between wages and labour productivity has increased substantially over time, while the correlation with MFP only increased to a smaller extent and in a non-linear way. The pattern is interesting and it deserves a further investigation. At this stage note that an increased correlation between the level of wages and productivity is not necessary for the dispersions of wages and productivity to be correlated. In fact it is well possible for the correlation to remain constant over time and, at the same time, for the dispersions to evolve hand-in-hand.

For robustness, we also regress the between-firm correlation between wage and productivity on a time trend, with country-sector fixed effects, according to the following model:

$$\text{Corr}(W,P)_{cjt} = \alpha + \beta year + z_{cj} + \varepsilon_{cjt} \tag{A.3}$$

The results are given in Table A.5.

Figure A.13: Wage-productivity correlation over time



Note: Plotting the year fixed-effects y_t on the firm-level correlation between wages and productivity, controlling for country-sector fixed effects. Year fixed effects are reported in Table A.4.

Table A.4: Regressing the correlation between wage and productivity on year fixed effects, using the specification given in Equation (A.2).

	(1) corr_W_LP_VA	(2) corr_W_MFP_W
2002.year	0.004	-0.005
2003.year	-0.002	-0.007**
2004.year	0.018***	-0.004
2005.year	0.017***	-0.009***
2006.year	0.025***	-0.009**
2007.year	0.019***	-0.010***
2008.year	0.025***	0.004
2009.year	0.029***	-0.005
2010.year	0.032***	-0.002
2011.year	0.044***	0.003
2012.year	0.047***	0.011***
Observations	3160	3069
Adj. R-Square	0.920	0.969
Country-sector FE	YES	YES
Nb Sectors	22	22
Nb Countries	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table A.5: Regressing the correlation between wage and productivity on a time trend, using the specification given in Equation (A.3).

	(1) corr_W_LP_VA	(2) corr_W_MFP_W
year	0.002	-0.009***
year2	0.000	0.000***
Observations	3160	3069
Adj. R-Square	0.920	0.969
Country-sector FE	YES	YES
Nb Sectors	22	22
Nb Countries	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

A.3 Top three sector contributors to wage variance

Tables A.6 and A.7 present for each country the three sectors that contribute the most to within-sector wage variance, for manufacturing and services respectively.

A.4 Sectoral decomposition of MFP variance

The same sectoral decomposition of productivity done in Section 4.3 for labour productivity can also be performed on the variance of MFP, yielding an equation similar to Equation (10):

$$\operatorname{Var} P'_t = \sum_j \omega_{jt} \sum_{i\in j} \frac{\omega_{it}}{\omega_{jt}} \left(P'_{it} - \overline{P'_{jt}}\right)^2 + \sum_j \omega_{jt} \left(\overline{P'_{jt}} - \overline{P'_t}\right)^2 \tag{A.4}$$

where $\overline{P'_{jt}} \equiv \sum_{i\in j} \omega_{it} P'_{it}$ and $\overline{P'_t} \equiv \sum_j \omega_{jt} \sum_{i\in j} \omega_{it} P'_{it}$ are, respectively, the weighted MFP average in sector j and in the whole economy. Again, the first term is the within-sector variance of MFP, while the second captures variance between sectors.

However, while Equation (10) gives the exact variance decomposition of labour productivity by using labour weights, the choice of the appropriate weights $\{\omega\}_i$ becomes less straightforward with MFP. Because of the multiple inputs, using labour weights would results in underweighting capital-intensive firms or sectors. In the literature it is common to use output weights (either GO or VA depending on how MFP is estimated) and for this decomposition we use VA weights for MFP.[29] The results are given in Table A.8.

A.5 Top three sector contributors to productivity variance

Tables A.9 and A.10 present for each country the three sectors that contribute the most to within-sector LP_VA variance, for manufacturing and services respectively. Tables A.11 and A.12 present the three sectors that contribute the most to within-sector Log-MFP_W variance, for manufacturing and services respectively.

A.6 Link between wage and productivity dispersion: robustness

In this section we investigate the robustness of the link between wage and productivity dispersion. First we replicate the results of Section 5 adding more controls related to the structural factors studied in the following sections of the report (Table A.13). Then, thanks to the richness of the MultiProd data, we can extend the analysis to other factors that could drive the wage and productivity dispersions simultaneously. In particular one might thing that the increase in dispersion of revenue productivity could be entirely driven by an increase in the misallocation of production factors over time. The results, reported in Table A.14, show that the correlations between wage and productivity dispersions are robust to including

Table A.6: Top three sectors in the share of within-sector wage variance for Manufacturing

	Manufacturing	
	Sector	% Var. share
AUS (2012)	Basic metals and fabricated metal products, except	24
	Food products, beverages and tobacco [CA]	16
	Wood and paper products, and printing [CC]	13
AUT (2012)	Furniture; other manufacturing; repair and install	17
	Food products, beverages and tobacco [CA]	15
	Basic metals and fabricated metal products, except	14
BEL (2011)	Chemicals and chemical products [CE]	21
	Basic metals and fabricated metal products, except	17
	Food products, beverages and tobacco [CA]	16
CHL (2012)	Chemicals and chemical products [CE]	17
	Food products, beverages and tobacco [CA]	13
	Coke and refined petroleum products [CD]	12
DNK (2012)	Food products, beverages and tobacco [CA]	29
	Machinery and equipment n.e.c. [CK]	23
	Furniture; other manufacturing; repair and install	11
FIN (2012)	Computer, electronic and optical products [CI]	26
	Wood and paper products, and printing [CC]	19
	Machinery and equipment n.e.c. [CK]	14
FRA (2012)	Food products, beverages and tobacco [CA]	18
	Transport equipment [CL]	11
	Computer, electronic and optical products [CI]	10
HUN (2012)	Basic metals and fabricated metal products, except	18
	Transport equipment [CL]	17
	Food products, beverages and tobacco [CA]	13
ITA (2012)	Machinery and equipment n.e.c. [CK]	18
	Basic metals and fabricated metal products, except	14
	Rubber and plastics products, and other non-metall	11
JPN (2011)	Transport equipment [CL]	20
	Food products, beverages and tobacco [CA]	16
	Chemicals and chemical products [CE]	14
NLD (2012)	Food products, beverages and tobacco [CA]	23
	Chemicals and chemical products [CE]	21
	Machinery and equipment n.e.c. [CK]	11
NOR (2012)	Furniture; other manufacturing; repair and install	36
	Food products, beverages and tobacco [CA]	14
	Machinery and equipment n.e.c. [CK]	12
NZL (2011)	Furniture; other manufacturing; repair and install	38
	Food products, beverages and tobacco [CA]	25
	Basic metals and fabricated metal products, except	11
SWE (2012)	Machinery and equipment n.e.c. [CK]	14
	Furniture; other manufacturing; repair and install	14
	Basic metals and fabricated metal products, except	14

Note: For each country, top three sectors that contribute the most to within-sector wage variance in manufacturing. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.7: Top three sectors in the share of within-sector wage variance for Services

	Services	
	Sector.	% Var. share
AUS (2012)	Wholesale and retail trade, repair of motor vehicl	38
	Administrative and support service activities [N]	26
	Legal and accounting activities, etc [MA]	13
AUT (2012)	Wholesale and retail trade, repair of motor vehicl	33
	Legal and accounting activities, etc [MA]	22
	Transportation and storage [H]	12
BEL (2011)	Wholesale and retail trade, repair of motor vehicl	39
	Transportation and storage [H]	18
	Legal and accounting activities, etc [MA]	14
CHL (2012)	Wholesale and retail trade, repair of motor vehicl	30
	Advertising and market research; other professiona	22
	Transportation and storage [H]	10
DNK (2012)	Wholesale and retail trade, repair of motor vehicl	41
	Transportation and storage [H]	17
	Legal and accounting activities, etc [MA]	12
FIN (2012)	Wholesale and retail trade, repair of motor vehicl	36
	Legal and accounting activities, etc [MA]	18
	Transportation and storage [H]	17
FRA (2012)	Legal and accounting activities, etc [MA]	34
	Wholesale and retail trade, repair of motor vehicl	25
	Administrative and support service activities [N]	11
HUN (2012)	Wholesale and retail trade, repair of motor vehicl	29
	IT and other information services [JC]	16
	Legal and accounting activities, etc [MA]	16
ITA (2012)	Wholesale and retail trade, repair of motor vehicl	32
	IT and other information services [JC]	15
	Transportation and storage [H]	13
JPN (2011)	Wholesale and retail trade, repair of motor vehicl	37
	Legal and accounting activities, etc [MA]	36
	Administrative and support service activities [N]	9
NLD (2012)	Administrative and support service activities [N]	55
	Wholesale and retail trade, repair of motor vehicl	23
	Transportation and storage [H]	8
NOR (2012)	Wholesale and retail trade, repair of motor vehicl	30
	Legal and accounting activities, etc [MA]	17
	Transportation and storage [H]	13
NZL (2011)	Wholesale and retail trade, repair of motor vehicl	39
	Legal and accounting activities, etc [MA]	20
	Administrative and support service activities [N]	12
SWE (2012)	Wholesale and retail trade, repair of motor vehicl	29
	Legal and accounting activities, etc [MA]	24
	IT and other information services [JC]	10

Note: For each country, top three sectors that contribute the most to within-sector wage variance in services. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.8: Share of within-sector variance of productivity

	% Log MFP dispersion	
	Manuf.	Services
Australia (2012)	53	75
Austria (2012)	9	4
Belgium (2011)	44	63
Chile (2012)	62	47
Denmark (2012)	21	26
Finland (2012)	14	25
France (2012)	16	55
Hungary (2012)	61	92
Italy (2012)	71	62
Japan (2011)	27	8
Netherlands (2012)	50	52
Norway (2012)	69	38
Sweden (2012)	18	1

Note: Share of within-sector variance of MFP-Woodldrige in total macrosector productivity variance.

those controls. In other words, we can rule out that misallocation is the only element driving the link between wage and productivity dispersion.

A.7 The drivers of the dispersion increase

In this section we show how external factors affect the dispersion of wages and productivity individually, that is without considering the interaction between the two as in the main text. Table A.15, Table A.16 and Table A.17 show the results of the exercise respectively for wages, labour productivity and MFP.

Table A.9: Top three sectors in the share of within-sector LP_VA variance for Manufacturing

	Manufacturing	
	Sector	% Var. share
AUS (2012)	Food products, beverages and tobacco [CA]	35
	Basic metals and fabricated metal products, except	35
	Chemicals and chemical products [CE]	7
AUT (2012)	Basic metals and fabricated metal products, except	17
	Wood and paper products, and printing [CC]	14
	Transport equipment [CL]	14
BEL (2011)	Basic pharmaceutical products and pharmaceutical p	29
	Chemicals and chemical products [CE]	27
	Food products, beverages and tobacco [CA]	16
CHL (2012)	Coke and refined petroleum products [CD]	87
	Basic metals and fabricated metal products, except	4
	Food products, beverages and tobacco [CA]	3
DNK (2012)	Furniture; other manufacturing; repair and install	26
	Machinery and equipment n.e.c. [CK]	18
	Food products, beverages and tobacco [CA]	16
FIN (2012)	Computer, electronic and optical products [CI]	58
	Basic pharmaceutical products and pharmaceutical p	17
	Chemicals and chemical products [CE]	6
FRA (2012)	Basic pharmaceutical products and pharmaceutical p	21
	Computer, electronic and optical products [CI]	20
	Rubber and plastics products, and other non-metall	13
HUN (2012)	Machinery and equipment n.e.c. [CK]	41
	Computer, electronic and optical products [CI]	22
	Food products, beverages and tobacco [CA]	11
ITA (2012)	Machinery and equipment n.e.c. [CK]	17
	Transport equipment [CL]	14
	Basic pharmaceutical products and pharmaceutical p	12
JPN (2011)	Coke and refined petroleum products [CD]	25
	Chemicals and chemical products [CE]	17
	Machinery and equipment n.e.c. [CK]	11
NLD (2012)	Chemicals and chemical products [CE]	50
	Basic pharmaceutical products and pharmaceutical p	15
	Coke and refined petroleum products [CD]	11
NOR (2012)	Machinery and equipment n.e.c. [CK]	21
	Basic metals and fabricated metal products, except	13
	Food products, beverages and tobacco [CA]	10
NZL (2011)	Coke and refined petroleum products [CD]	83
	Food products, beverages and tobacco [CA]	8
	Furniture; other manufacturing; repair and install	3
SWE (2012)	Food products, beverages and tobacco [CA]	19
	Computer, electronic and optical products [CI]	15
	Machinery and equipment n.e.c. [CK]	15

Note: For each country, top three sectors that contribute the most to within-sector LP_VA variance in manufacturing. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.10: Top three sectors in the share of within-sector LP_VA variance for Services

	Services	
	Sector	% Var. share
AUS (2012)	Wholesale and retail trade, repair of motor vehicl	30
	Transportation and storage [H]	23
	Legal and accounting activities, etc [MA]	21
AUT (2012)	REAL ESTATE ACTIVITIES [L]	37
	Wholesale and retail trade, repair of motor vehicl	28
	Administrative and support service activities [N]	15
BEL (2011)	Wholesale and retail trade, repair of motor vehicl	31
	Legal and accounting activities, etc [MA]	20
	Transportation and storage [H]	17
CHL (2012)	Wholesale and retail trade, repair of motor vehicl	47
	REAL ESTATE ACTIVITIES [L]	32
	Transportation and storage [H]	10
DNK (2012)	Transportation and storage [H]	24
	Wholesale and retail trade, repair of motor vehicl	21
	REAL ESTATE ACTIVITIES [L]	12
FIN (2012)	REAL ESTATE ACTIVITIES [L]	62
	Wholesale and retail trade, repair of motor vehicl	16
	Telecommunications [JB]	7
FRA (2012)	Telecommunications [JB]	35
	Wholesale and retail trade, repair of motor vehicl	15
	Legal and accounting activities, etc [MA]	14
HUN (2012)	Administrative and support service activities [N]	37
	Wholesale and retail trade, repair of motor vehicl	23
	Transportation and storage [H]	15
ITA (2012)	Wholesale and retail trade, repair of motor vehicl	21
	Telecommunications [JB]	21
	REAL ESTATE ACTIVITIES [L]	18
JPN (2011)	Wholesale and retail trade, repair of motor vehicl	37
	Legal and accounting activities, etc [MA]	34
	Administrative and support service activities [N]	11
NLD (2012)	Wholesale and retail trade, repair of motor vehicl	39
	Administrative and support service activities [N]	33
	Transportation and storage [H]	8
NOR (2012)	Telecommunications [JB]	34
	Transportation and storage [H]	31
	Wholesale and retail trade, repair of motor vehicl	16
NZL (2011)	Wholesale and retail trade, repair of motor vehicl	31
	Transportation and storage [H]	24
	Administrative and support service activities [N]	13
SWE (2012)	REAL ESTATE ACTIVITIES [L]	41
	Telecommunications [JB]	16
	Wholesale and retail trade, repair of motor vehicl	13

Note: For each country, top three sectors that contribute the most to within-sector LP_VA variance in services. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.11: Top three sectors in the share of within-sector Log-MFP_W variance for Manufacturing

	Manufacturing	
	Sector	% Var. share
AUS (2012)	Food products, beverages and tobacco [CA]	28
	Basic metals and fabricated metal products, except	28
	Machinery and equipment n.e.c. [CK]	16
AUT (2012)	Computer, electronic and optical products [CI]	21
	Furniture; other manufacturing; repair and install	17
	Electrical equipment [CJ]	15
BEL (2011)	Food products, beverages and tobacco [CA]	30
	Basic metals and fabricated metal products, except	28
	Rubber and plastics products, and other non-metall	10
CHL (2012)	Basic metals and fabricated metal products, except	39
	Food products, beverages and tobacco [CA]	34
	Wood and paper products, and printing [CC]	9
DNK (2012)	Furniture; other manufacturing; repair and install	25
	Food products, beverages and tobacco [CA]	20
	Machinery and equipment n.e.c. [CK]	15
FIN (2012)	Wood and paper products, and printing [CC]	22
	Machinery and equipment n.e.c. [CK]	19
	Basic pharmaceutical products and pharmaceutical p	13
FRA (2012)	Food products, beverages and tobacco [CA]	29
	Computer, electronic and optical products [CI]	24
	Rubber and plastics products, and other non-metall	11
HUN (2012)	Machinery and equipment n.e.c. [CK]	24
	Food products, beverages and tobacco [CA]	16
	Transport equipment [CL]	13
ITA (2012)	Machinery and equipment n.e.c. [CK]	18
	Basic metals and fabricated metal products, except	12
	Food products, beverages and tobacco [CA]	11
JPN (2011)	Food products, beverages and tobacco [CA]	25
	Chemicals and chemical products [CE]	14
	Machinery and equipment n.e.c. [CK]	14
NLD (2012)	Chemicals and chemical products [CE]	35
	Food products, beverages and tobacco [CA]	24
	Basic metals and fabricated metal products, except	15
NOR (2012)	Machinery and equipment n.e.c. [CK]	22
	Basic metals and fabricated metal products, except	16
	Furniture; other manufacturing; repair and install	13
SWE (2012)	Computer, electronic and optical products [CI]	53
	Wood and paper products, and printing [CC]	12
	Basic metals and fabricated metal products, except	9

Note: For each country, top three sectors that contribute the most to within-sector Log-MFP_W variance in manufacturing. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.12: Top three sectors in the share of within-sector Log-MFP_W variance for Services

	Services	
	Sector	% Var. share
AUS (2012)	Wholesale and retail trade, repair of motor vehicl	56
	Transportation and storage [H]	16
	Legal and accounting activities, etc [MA]	11
AUT (2012)	REAL ESTATE ACTIVITIES [L]	36
	Transportation and storage [H]	25
	Wholesale and retail trade, repair of motor vehicl	19
BEL (2011)	Wholesale and retail trade, repair of motor vehicl	44
	Legal and accounting activities, etc [MA]	16
	Transportation and storage [H]	13
CHL (2012)	Wholesale and retail trade, repair of motor vehicl	62
	Transportation and storage [H]	14
	Advertising and market research; other professiona	9
DNK (2012)	Wholesale and retail trade, repair of motor vehicl	31
	Legal and accounting activities, etc [MA]	20
	Administrative and support service activities [N]	13
FIN (2012)	Wholesale and retail trade, repair of motor vehicl	35
	REAL ESTATE ACTIVITIES [L]	17
	Administrative and support service activities [N]	14
FRA (2012)	Wholesale and retail trade, repair of motor vehicl	29
	Transportation and storage [H]	14
	Legal and accounting activities, etc [MA]	13
HUN (2012)	Wholesale and retail trade, repair of motor vehicl	41
	Transportation and storage [H]	20
	Administrative and support service activities [N]	14
ITA (2012)	Wholesale and retail trade, repair of motor vehicl	31
	Transportation and storage [H]	17
	Administrative and support service activities [N]	14
JPN (2011)	Wholesale and retail trade, repair of motor vehicl	36
	Legal and accounting activities, etc [MA]	26
	Telecommunications [JB]	13
NLD (2012)	Wholesale and retail trade, repair of motor vehicl	73
	Transportation and storage [H]	14
	Legal and accounting activities, etc [MA]	5
NOR (2012)	Wholesale and retail trade, repair of motor vehicl	36
	Telecommunications [JB]	18
	Transportation and storage [H]	16
SWE (2012)	REAL ESTATE ACTIVITIES [L]	87
	IT and other information services [JC]	4
	Wholesale and retail trade, repair of motor vehicl	3

Note: For each country, top three sectors that contribute the most to within-sector Log-MFP_W variance in services. The last columnn reports the share of within-sector variance that occurs in each sector.

Table A.13: Regressing wage dispersion on productivity dispersion - controls for structural changes.

	(1) log Wage (90-10)	(2) log Wage (90-10)	(3) log Wage (90-10)
log LP (90-10)	0.108***		
	(0.0332)		
log MFP_W (90-10)		0.940***	
		(0.0322)	
log MFP_SW (90-10)			0.002
			(0.0337)
% hrs by skilled workers	0.170**	0.105	0.206***
	(0.242)	(0.240)	(0.244)
Sh. ICT in fixed assets	0.269**	0.291**	0.259*
	(0.707)	(0.701)	(0.724)
Export (total trade)	-0.121***	-0.114***	-0.132***
	(4.52e-10)	(4.42e-10)	(4.61e-10)
Trade union density	1.242***	1.243***	1.293***
	(0.00238)	(0.00233)	(0.00244)
N	838	806	835
Adj. R-Square	0.937	0.935	0.934
Year FE	YES	YES	YES
Country-sector FE	YES	YES	YES
Nb Sectors	12	12	12
Nb Countries	8	8	8

Standardized beta coefficients; Standard errors in parentheses

Countries: AUS, AUT, BEL, DNK, FIN, FRA, ITA, NLD.

* $p < .1$, ** $p < .05$, *** $p < .01$

Table A.14: Regressing wage dispersion on productivity dispersion (with misallocation controls)

	(1) log Wage (90-10)	(2) log Wage (90-10)	(3) log Wage (90-10)
log LP (90-10)	0.266***		
	(0.0224)		
log MFP_W (90-10)		0.116***	
		(0.0180)	
log MFP_SW (90-10)			0.023***
			(0.0148)
Covar(L,LogLP_VA) / average of L	0.042***	0.059***	0.054***
	(0.0279)	(0.0284)	(0.0281)
Covar(VA,LogMFP_W) / average of VA	-0.056*	-0.054	-0.017
	(0.0136)	(0.0146)	(0.0139)
Total efficiency gains in baseline HK case	-0.000	0.006	0.004
	(0.0000102)	(0.0000134)	(0.0000115)
N	3028	3015	3010
Adj. R-Square	0.987	0.986	0.987
Year FE	YES	YES	YES
Country-sector FE	YES	YES	YES
Nb Sectors	22	22	22
Nb Countries	12	12	12

Standardized beta coefficients; Standard errors in parentheses

Countries: AUS, AUT, BEL, CHL, DNK, FIN, HUN, ITA, JPN, NLD, NOR, NZL.

* $p < .1$, ** $p < .05$, *** $p < .01$

Table A.15: Wage divergence and structural factors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Import (goods)	-0.021				-0.015		-0.115***	
	(0.036)				(0.024)		(0.041)	
Log Export (goods)		0.093**				-0.043*		-0.111***
		(0.039)				(0.026)		(0.043)
Sh. of ICT in fixed assets			0.143***		0.069***	0.048**		
			(0.032)		(0.022)	(0.019)		
Sh. high-skilled (in total hours)				-0.067**			0.116***	0.105***
				(0.033)			(0.021)	(0.020)
Log Import (goods) × Sh. of ICT in fixed assets					0.038***			
					(0.013)			
Log Export (goods) × Sh. of ICT in fixed assets						0.033**		
						(0.013)		
Log Import (goods) × Sh. high-skilled (in total hours)							-0.060***	
							(0.012)	
Log Export (goods) × Sh. high-skilled (in total hours)								-0.074***
								(0.013)
N	1973	1973	2015	2271	1101	1101	1252	1252
Adj. R-Square	0.915	0.915	0.961	0.969	0.940	0.939	0.930	0.930
Country-sector year FE	YES	YES	YES	YES	YES	YES	YES	YES
Num. Countries	13	13	8	11	8	8	11	11

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR NZL SWE.

Table A.16: Labour Productivity divergence and structural factors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Import (goods)	0.001				-0.023		0.014	
	(0.026)				(0.029)		(0.037)	
Log Export (goods)		0.062**				0.027		0.080**
		(0.028)				(0.031)		(0.040)
Sh. of ICT in fixed assets			0.060**		0.082***	0.040*		
			(0.025)		(0.026)	(0.023)		
Sh. high-skilled (in total hours)				0.080***			-0.025	-0.000
				(0.021)			(0.019)	(0.020)
Log Import (goods) × Sh. of ICT in fixed assets					0.073***			
					(0.011)			
Log Export (goods) × Sh. of ICT in fixed assets						0.068***		
						(0.014)		
Log Import (goods) × Sh. high-skilled (in total hours)							0.032***	
							(0.011)	
Log Export (goods) × Sh. high-skilled (in total hours)								0.029**
								(0.014)
N	1976	1976	2037	2289	1108	1108	1259	1259
Adj. R-Square	0.959	0.959	0.957	0.978	0.934	0.933	0.961	0.961
Country-sector year FE	YES	YES	YES	YES	YES	YES	YES	YES
Num. Countries	13	13	8	11	8	8	11	11

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

The dependent variable is Log LP (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR NZL SWE.

Table A.17: MFP divergence and structural factors

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Log Import (goods)	-0.097***				-0.113***		-0.088**	
	(0.027)				(0.033)		(0.038)	
Log Export (goods)		-0.075***				-0.075**		-0.042
		(0.029)				(0.037)		(0.041)
Sh. of ICT in fixed assets			0.035		0.054**	0.003		
			(0.027)		(0.025)	(0.022)		
Sh. high-skilled (in total hours)				0.051**			0.007	0.017
				(0.021)			(0.021)	(0.022)
Log Import (goods) × Sh. of ICT in fixed assets					0.078***			
					(0.012)			
Log Export (goods) × Sh. of ICT in fixed assets						0.058***		
						(0.015)		
Log Import (goods) × Sh. high-skilled (in total hours)							0.046***	
							(0.011)	
Log Export (goods) × Sh. high-skilled (in total hours)								0.053***
								(0.015)
N	1924	1924	1931	2203	1056	1056	1219	1219
Adj. R-Square	0.997	0.997	0.998	0.996	0.998	0.998	0.996	0.996
Country-sector year FE	YES	YES	YES	YES	YES	YES	YES	YES
Num. Countries	13	13	8	11	8	8	11	11

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

The dependent variable is Log MFP_W (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR NZL SWE.

A.8 The policy role of the dispersion increase

Table A.18 shows the interaction effects of policies, MFP dispersion and exports on wage dispersion.

Table A.18: Divergences, Policy and External Factors (Exports)

	(1)	(2)	(3)	(4)	(5)
Log MFP_W (90-10)	0.301***	0.316***	0.919***	0.508***	0.584***
	(0.039)	(0.040)	(0.108)	(0.101)	(0.084)
Real Min Wage (hour)	-0.433***				
	(0.060)				
Export (goods)	-0.076**	-0.059**	-0.029	0.038	-0.006
	(0.032)	(0.027)	(0.020)	(0.023)	(0.015)
Log MFP_W (90-10) × Real Min Wage (hour)	0.010				
	(0.025)				
Log MFP_W (90-10) × Export (goods)	0.026	0.028	0.155***	0.250***	0.123***
	(0.028)	(0.022)	(0.045)	(0.082)	(0.037)
Real Min Wage (hour) × Export (goods)	-0.060***				
	(0.019)				
Log MFP_W (90-10) × Real Min Wage (hour) × Export (goods)	-0.031				
	(0.021)				
Relative Min Wage (wrt av)		-0.163***			
		(0.032)			
Log MFP_W (90-10) × Relative Min Wage (wrt av)		0.028			
		(0.019)			
Relative Min Wage (wrt av) × Export (goods)		-0.076***			
		(0.014)			
Log MFP_W (90-10) × Relative Min Wage (wrt av) × Export (goods)		-0.033**			
		(0.016)			
EPL (indiv. and coll.)			-0.002		
			(0.022)		
Log MFP_W (90-10) × EPL (indiv. and coll.)			-0.391***		
			(0.090)		
EPL (indiv. and coll.) × Export (goods)			0.000		
			(0.014)		
Log MFP_W (90-10) × EPL (indiv. and coll.) × Export (goods)			0.066		
			(0.041)		
Trade union density				-0.497***	
				(0.058)	
Log MFP_W (90-10) × Trade union density				-0.540***	
				(0.099)	
Trade union density × Export (goods)				0.049*	
				(0.027)	
Log MFP_W (90-10) × Trade union density × Export (goods)				0.165*	
				(0.089)	
Wage Setting					-0.198***
					(0.022)
Log MFP_W (90-10) × Wage Setting					-0.407***
					(0.052)
Wage Setting × Export (goods)					0.052***
					(0.016)
Log MFP_W (90-10) × Wage Setting × Export (goods)					0.118***
					(0.043)
N	879	879	1779	1779	1779
Adj. R-Square	0.927	0.921	0.921	0.930	0.930
Country-sector year FE	YES	YES	YES	YES	YES
Num. Countries	6	6	12	12	12

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

The dependent variable is Log Wage (90-10), all regressors are standardized and the coefficients can be interpreted as the effect at the mean.

All regressions include the logarithm of total gross output in the sector as extra control.

The largest set of countries include: AUS AUT BEL DNK FIN FRA HUN ITA JPN NLD NOR SWE.

B. EVOLUTION OF MISALLOCATION OVER TIME

The MultiProd database also contains a set of measures related to the efficiency of the allocation of resources or their misallocation. In particular it contains various measures of static allocative efficiency, computed as covariances à la Olley and Pakes (1996) for both labour productivity and MFP, and various sets of weights. Moreover it contains estimates of misallocation for capital, labour, and the total economy following the methodology of Hsieh and Klenow (2009) and various modifications to it (e.g. drop the assumptions of constant return to scale, unique elasticity across sectors etc.). Investigating the determinants of the evolution of misallocation, its impact on wages and productivity, the role of policies etc. would certainly require a separate more detailed analysis, which is left for future research. Here we limit ourselves to show some interesting patterns over time, which can be taken as food for thought for the next steps of the analysis. More details on the methodology and the description of the variables contained in MultiProd can be found in Berlingieri et al. (2016).

As in the case of wages and productivity we investigate the patterns over time running the following regression:

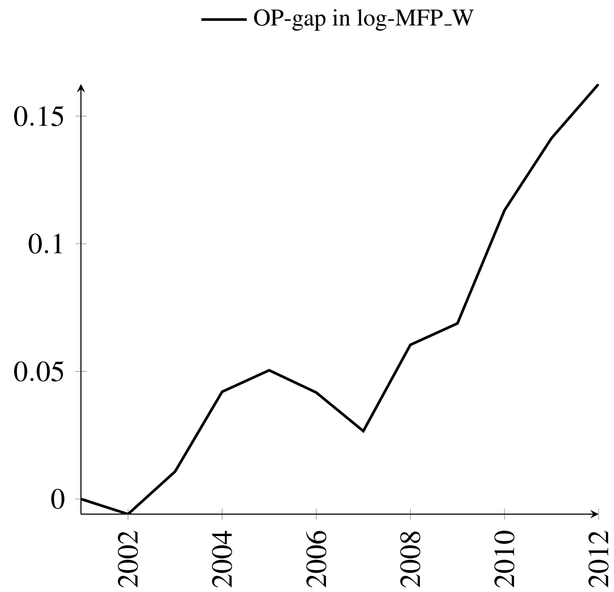
$$M_{cjt} = \alpha + y_t + z_{cj} + \varepsilon_{cjt} \tag{B.5}$$

where M_{cjt} is a measure of misallocation.

Figures B.14, B.15, and B.16 together with Table B.19 show the results of the exercise for the OP gap computed on MFP and various measures of misallocation. A first interesting pattern is that both the OP gap and almost all measures of misallocation increase over time. Since an increase in the Olley and Pakes's (1996) covariance term is normally interpreted as an increase in the efficiency of the allocation of resources, we are left with a conflicting message that deserves further exploration. There are various theoretical and empirical reasons for why the two measures might differ, but given their widespread use and the importance of an efficient allocation of resources in guiding policy prescriptions, it would be key to understand exactly what is driving this pattern. A second result is that looking at the increase of misallocation over time in Figure B.15, it emerges that is is almost entirely driven by an increase in the misallocation of capital. The result is not new in the literature, for instance Gopinath et al. (2015) find a similar patter for southern European countries, but the MultiProd data allows us to expand the evidence to a much larger set of countries.

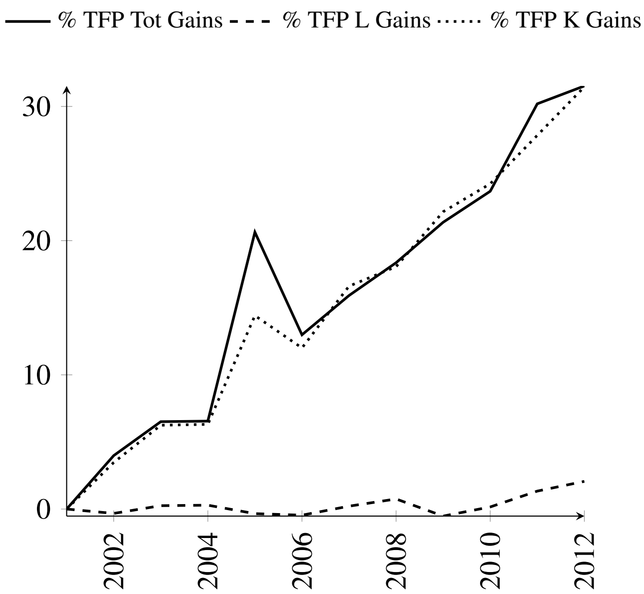
Results of regressing various misallocation measures on time dummies, similar to Equation (9), are given in Table B.19. For robustness, we also regress misallocation measures on a time trend, with country-sector fixed effects. The results are given in Table B.20

Figure B.14: Increase of OP-gap over time



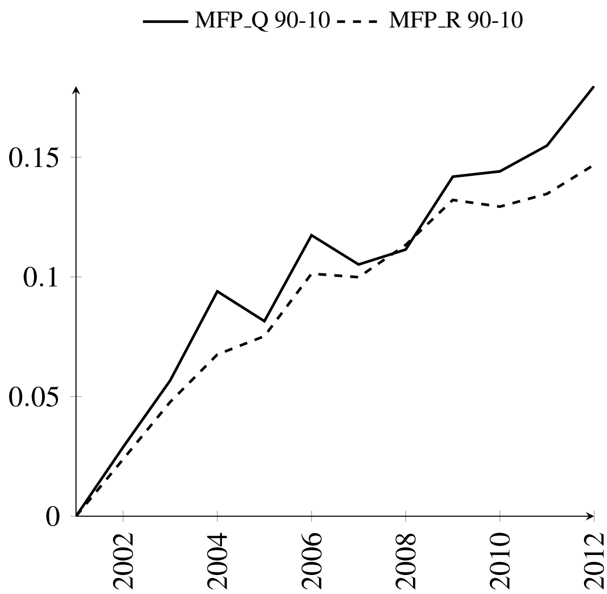
Note: Plotting the year fixed-effects y_t on misallocation measured as the Olley and Pakes (1996) gap, controlling for country-sector fixed effects. Year fixed effects are reported in Table B.19.

Figure B.15: Increase in misallocation



Note: Plotting the year fixed-effects y_t of a regression of misallocation measures on year and country-sector fixed effects. Misallocation is measured as % TFP gains available by removing firm-level wedges, following Hsieh and Klenow (2009) methodology. Year fixed effects are reported in Table B.19.

Figure B.16: Increase in 90-10 interquantile range of structurally estimated productivity



Note: Plotting the year fixed-effects y_t of a regression of firm-level MFP dispersion on year and country-sector fixed effects. MFP is structurally estimated following Hsieh and Klenow (2009) methodology.

Table B.19: Regressing misallocation measures on year fixed effects show an increase of inefficiencies over time.

	(1) LogLP_VA_w_L_opgap	(2) LogMFP_W_w_VA_opgap	(3) HK_gain_perc_1	(4) HK_gain_perc_1_L	(5) HK_gain_perc_1_K
2002.year	0.003	-0.006	3.983	-0.326	3.470
2003.year	0.018***	0.011	6.511	0.251	6.246
2004.year	0.033***	0.042**	6.552	0.288	6.313
2005.year	0.022***	0.050***	20.629	-0.342	14.416
2006.year	0.032***	0.042**	12.984	-0.457	12.004
2007.year	0.045***	0.027	15.912	0.214	16.609
2008.year	0.044***	0.060***	18.356	0.751	18.060
2009.year	0.036***	0.069***	21.369	-0.524	22.153
2010.year	0.047***	0.113***	23.680	0.156	24.237
2011.year	0.041***	0.141***	30.196**	1.337**	27.846
2012.year	0.043***	0.163***	31.526**	2.063***	31.457
Observations	3159	2567	3180	3180	3180
Adj. R-Square	0.933	0.997	0.716	0.965	0.656
Country-sector FE	YES	YES	YES	YES	YES
Nb Sectors	22	22	22	22	22
Nb Countries	14	12	14	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table B.20: Regressing misallocation measures on a time trend shows an increase of inefficiencies over time.

	(1) LogLP_VA_w_L_opgap	(2) LogMFP_W_w_VA_opgap	(3) HK_gain_perc_1	(4) HK_gain_perc_1_L	(5) HK_gain_perc_1_K
year	0.004^{***}	0.015^{***}	2.681^{***}	0.140^{***}	2.753^{**}
Observations	3159	2567	3180	3180	3180
Adj. R-Square	0.932	0.997	0.717	0.964	0.657
Country-sector FE	YES	YES	YES	YES	YES
Nb Sectors	22	22	22	22	22
Nb Countries	14	12	14	14	14

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$