Labour share developments over the past two decades: The role of technological progress, globalisation and "winner-takes-most" dynamics

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Abstract

In about one half of OECD countries labour shares have declined significantly over the past two decades while they have remained broadly constant or increased in the remaining half. Countries with falling labour shares have experienced larger declines in investment prices and have witnessed larger declines in labour shares at the technological frontier than the remaining countries. Using a combination of industry- and firm-level data, this paper finds that declines in investment prices related to technological change in the investment goods-producing sector have compressed labour shares, especially in industries specialising in routine-intensive tasks. The labour share-compressing effect of declining investment prices overwhelmingly operates through the reallocation of market shares from high to low labour share-firms. In particular, labour share declines at the technological frontier mainly reflect the entry of firms with low labour shares rather than declines in incumbent frontier firms, suggesting that thus far they are mainly explained by technological dynamism rather than anti-competitive forces.

JEL Classification codes: D33, F66, L11, O33.

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1. Introduction

Real wage gains are normally the most direct mechanism through which productivity gains are transmitted to workers, but over the past two decades real wages in a number of OECD countries have decoupled from labour productivity as labour shares have declined. Since wages are typically the main source of market income for low- and middle-income households, this decoupling tends to raise income inequality, especially in a context of declining redistribution through taxes and benefits.[3] Consequently, understanding the drivers of labour shares, in particular whether they reflect changes in the pace and the nature of technological change or changes in institutions that influence the extent and the distribution of producer rents, has become a central public policy issue.

A number of recent studies suggest that labour share declines in some OECD countries over the past few decades can be explained by global factors, such as technology-induced changes in market structure, the global decline in investment prices or the offshoring of the most labour-intensive stages of production (Autor et al, 2020; IMF, 2017; Karabarbounis and Neiman, 2014). The starting point of these studies is the observation that the labour share has declined across most high-income countries, as exposure to global factors among these countries has been similar. However, this observation has been challenged by a number of other recent studies finding large differences in labour share developments across countries once a number of conceptual and measurement issues are addressed (Cette et al., 2019; Gutierrez and Piton, 2019; Rognlie, 2015; Schwellnus et al., 2017).

This paper uses disaggregated data at the industry- and firm levels to analyse labour share developments across countries. The main contributions to the existing body of research are threefold. Firstly, it documents labour share developments across countries when accounting for changes in housing rents and self-employment. Secondly, it relates cross-country differences in labour share developments to differences in firm dynamics, in particular to developments at the technological frontier as opposed to the remaining firms. Thirdly, it relates cross-country differences in labour share developments to differences in the extent of technological change using industry- and firm-level data rather than country-level data, which allows more credibly identifying its impact and the underlying firm dynamics.

The main findings are as follows. In about one half of the covered OECD countries labour shares have declined significantly over the past two decades while they have remained broadly constant or increased in the remaining half. Countries with falling labour shares have experienced large decoupling of wages from productivity at the technological frontier while no such decoupling has been experienced by the remaining countries. Countries with falling labour shares and large decoupling of wages from productivity at the technological frontier have also witnessed larger declines in investment prices. Declines in investment prices – which are largely driven by technological progress in the ICT-producing sector – reduce labour shares, mainly by reallocating market shares to low labour-share firms rather than by reducing labour shares within firms. Differences in investment price developments account for about 35% of the difference in labour share developments between countries with declining labour shares and the remaining ones.

Overall, this paper is consistent with a technology-based explanation of labour share developments across countries as technology-driven declines in investment prices give rise

[3] Declines in redistribution through taxes and benefits across OECD countries are documented in Causa et al. (2017).

to the substitution of capital for labour. In contrast to previous studies putting forward technology-based explanations, this paper shows that declines in investment prices have been far from uniform across countries, as countries with larger declines in investment prices experienced larger substitution of capital for labour at the technological frontier and larger declines of aggregate labour shares. In contrast to studies emphasising institution-related lack of competition as the driver of declining labour shares (Gutiérrez and Philippon, 2018), this paper suggests that it partly reflects high productivity growth driven by rapid technology adoption. Moreover, declines in labour shares at the technological frontier reflect net entry of low labour share firms into the frontier rather than the decoupling of wages from productivity in existing frontier firms, suggesting that thus far this process is mainly explained by technological dynamism rather than weakening product market competition.

The remainder of the paper is structured as follows. Section 2 describes the data and provides a number of cross-country stylised facts on aggregate and firm-level labour shares as well as investment prices. Section 3 analyses the impact of technology-related changes in investment prices on industry- and firm-level labour shares. Section 4 concludes.

2. Labour share dynamics across countries: Data and descriptive statistics

2.1. Data

The aggregate and industry-level labour shares in this paper cover the period 1995-2017 and are defined as labour compensation of salaried and self-employed workers as a share of value added at factor costs in the total economy excluding the primary, housing and non-market industries. They are constructed from industry-level data in the OECD Annual National Accounts Database, complemented with additional data from the archives of the OECD STAN database, OECD Annual Labour Force Statistics and the EU-KLEMS database. Labour compensation is the sum of compensation of salaried workers and the imputed compensation of self-employed workers, with the imputation based on the average compensation of salaried workers in the corresponding industry.[4] Value added at factor costs is defined as value added at basic prices less taxes net of subsidies on production. Using value added at factor costs in the denominator ensures that labour and capital shares of value added sum to one.[5]

2.2. Aggregate dynamics

The aggregate OECD labour share excluding the primary, housing and non-market sectors – which is the focus of this paper – has declined over the past two decades, but there have been large differences in labour share developments across countries (Figure 1). While between 1995 and 2017 labour shares declined significantly for about half of the covered

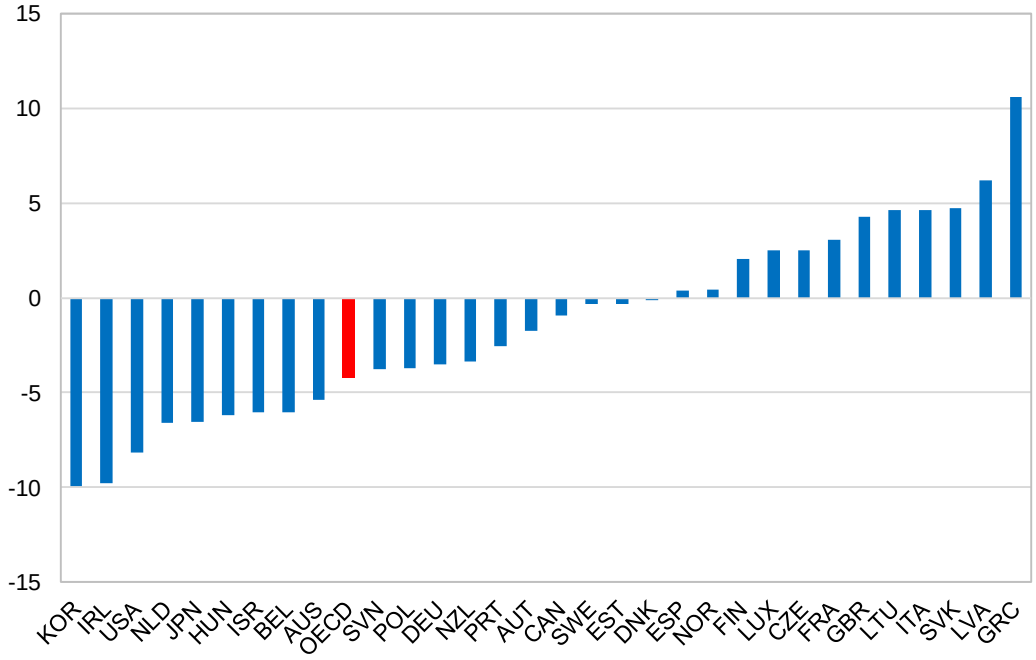
[4] Depending on data availability, the imputation is based on hourly labour compensation or on per-capita labour compensation of salaried workers. This measure is based on the assumption that within industries, average wages of salaried and self-employed workers are the same.

[5] For Canada and Israel, value added is at basic prices, since data on taxes net of subsidies on production are unavailable. Ireland's labour share is computed over the period 1995-2014 since value added in 2015-16 is distorted by the relocation of intellectual property assets by multi-national enterprises in 2015 (OECD, 2018).

countries (including Germany, Japan and the United States), they remained constant or increased for the other half (including France, Italy and the United Kingdom).[6]

Figure 1. Changes in labour shares

Excluding the primary, housing and non-market industries, percentage points, 1995-2017



Note: The OECD average is the GDP-weighted average of changes in labour shares over the 31 countries covered by the aggregate analysis. Start year is two-year average or 1994-1995 for Australia, Denmark, Finland, France, Japan, Korea, New Zealand, Norway, Sweden and United States; 1995-1996 for Austria, Belgium, Czech Republic, Estonia, Germany, Greece, Hungary, Ireland, Israel, Italy, Latvia, Lithuania, Luxembourg, Netherlands, Portugal, Slovak Republic, Slovenia, Spain and United Kingdom; 1997-1998 for Canada; 2000-2001 for Poland. End year is average of 2016-2017 for all countries except for France, Norway, Slovak Republic, Slovenia, Sweden, United Kingdom and United States (2015-2016); Canada, Israel, Japan, Korea and New Zealand (2014-2015); Ireland (2013-2014).
Source: OECD National Accounts Database, OECD STAN Database, OECD Annual Labour Force Statistics Database and EU KLEMS Database.

Declines in labour shares excluding primary, housing and non-market sectors are typically less pronounced than in the total economy (Table 1). Total-economy labour shares may partly be driven by developments in specific industries for which there are significant conceptual issues. For instance, changes in total-economy labour shares are partly

[6] The larger cross-country heterogeneity in terms of changes in labour shares with respect to Karabarbounis and Neiman (2014) likely reflects differences in sampling periods (mid-1990s to 2016 in this paper versus mid-1970s to 2012 in Karabarbounis and Neiman, 2014) and treatment of self-employed workers (imputation of self-employed workers' wages using industry-level wages in this paper versus focus on the non-financial corporate sector in Karabarbounis and Neiman, 2014). In a number of countries, including Germany and Italy, the non-financial corporate sector includes large numbers of self-employed workers. In these countries, focusing on the non-financial corporate sector rather than imputing wages of the self-employed appears to bias changes in labour shares over the past 20 years downward (Pionnier and Guidetti, 2015).

explained by developments in housing rents, which may in turn be driven by factors other than those driving capital income in the business sector and may have different distributional consequences (Rognlie, 2015).

A further issue with total-economy labour shares is that, over the medium term, they are partly driven by commodity price developments and by imputation choices in the non-market sector. For countries with large agricultural or mining (i.e. primary) sectors, developments in total-economy labour shares are largely driven by developments in commodity prices; when commodity prices increase, aggregate profits rise without commensurate increases in aggregate wages.[7] In Australia, for instance, where the mining sector is large, the non-housing labour share declined by around 7 percentage points over the period 1995-2017, but it declined by only around 3 percentage points when the agriculture, mining and non-market sectors are excluded (Figure 1). Moreover, national accounting conventions in the non-market sector may bias developments in labour shares. Value added in the non-market sector is equal to the sum of wage compensation and capital consumption, which artificially limits variation over time.[8]

[7] The decline in the aggregate labour share partly reflects a change in industry composition: as commodity prices increase, the share of the mining sector – for which the labour share is low – in total value added increases.

[8].The finance sector is included in the analysis. Excluding the finance sector would only have a marginal effect on labour share developments for most countries, the exception being Australia and Luxembourg for which the exclusion of the finance sector would make the change in the labour share 2-3 percentage points more positive over the period and Hungary for which it would make it 2 percentage points more negative.

Table 1. Contributions to changes in total economy labour shares

Percentage points, 1995-2017

	Changes in labour share	Contributions of			
	Total economy	Non-primary business sector	Housing sector	Primary industries	Non-market sector
Australia	-7.1	-3.6	-0.6	-3.5	0.6
Austria	-4.2	-1.2	-1.4	-1.8	0.2
Belgium	-2.2	-4.1	0.9	0.2	0.8
Canada	-2.4	-0.8	0.5	-1.8	-0.3
Czech Republic	1.8	1.8	-0.8	-0.3	1.1
Denmark	0.7	0.0	0.0	0.0	0.7
Estonia	-0.4	-0.1	-1.3	-1.2	2.2
Finland	-2.3	1.3	-2.1	-1.0	-0.5
France	0.2	1.9	-1.1	-1.0	0.5
Germany	-2.6	-2.5	0.2	-0.6	0.2
Greece	6.6	6.0	-1.9	0.5	2.0
Hungary	-5.9	-4.1	-1.0	-1.9	1.1
Ireland	-9.1	-7.2	-0.7	-0.7	-0.5
Israel	-7.2	-3.8	-1.8	-0.2	-1.4
Italy	0.4	3.0	-2.1	-0.3	-0.2
Japan	-5.8	-4.9	-1.1	-0.5	0.7
Korea	-11.5	-7.3	0.0	-3.9	-0.3
Latvia	2.6	4.2	-2.6	-2.4	3.4
Lithuania	3.3	3.0	0.9	-1.0	0.5
Luxembourg	3.6	1.9	1.2	-0.2	0.8
Netherlands	-2.2	-4.5	0.7	0.9	0.6
New Zealand	-1.1	-2.2	-0.3	-0.5	1.9
Norway	-0.9	-0.1	0.5	-1.9	0.6
Poland	-9.6	-2.9	0.7	-7.0	-0.5
Portugal	-5.3	-1.7	-2.3	-0.4	-0.9
Slovak Republic	2.9	3.5	0.4	-1.2	0.2
Slovenia	-11.1	-2.8	0.5	-8.6	-0.1
Spain	-2.9	0.1	-2.7	-0.3	-0.1
Sweden	2.7	-0.2	2.5	-0.2	0.7
United Kingdom	5.9	2.9	0.6	1.1	1.3
United States	-4.7	-5.3	-0.5	-0.1	1.3
OECD (GDP weighted average)	-3.3	-3.0	-0.6	-0.5	0.7
OECD (unweighted average)	-2.2	-1.0	-0.5	-1.3	0.5
G7 (unweighted average)	-1.3	-0.8	-0.5	-0.5	0.5

Note: See Figure 1 for sample period and Annex A for analytical details on the statistical decomposition.

Source: See Figure 1.

Cross-country differences in labour share developments may partly reflect cross-country differences in exposure to technological change and globalisation. For instance, initial specialisation patterns may have influenced countries' exposure to the ICT revolution and the entry of China into the world trading system, with some countries substituting ICT for labour or offshoring labour-intensive stages of production to a larger extent than others. Country-specific institutions, including policies influencing the intensity of competition on

product markets, may also have influenced the pace of ICT adoption, potentially giving rise to cross-country differences in firm dynamics. For instance, the evidence in Autor et al. (2020) suggests that more intensive competition and rapid technology adoption may give rise to "winner-takes-most" dynamics by which a small number of highly innovative firms with low labour shares rapidly gain market shares. By contrast, Covarrubias, Gutiérrez and Philippon (2019) suggest that rising market concentration reflects anti-competitive forces rather than technological dynamism, implying particularly large labour share declines in countries with low productivity growth and low rates of technology adoption.

2.3. Firm dynamics

Using firm-level data from the ORBIS dataset and industry-level data on investment prices as a measure of ICT-related technological change allows analysing whether firm dynamics over the period 2001-15 are consistent with technology-related "winner-takes-most" dynamics.[9] In a standard model with heterogeneous firms, the best firms' labour share is low because the fixed overhead labour cost needed for production is distributed over a larger output and/or because large market shares allow them to charge higher markups (Autor et al., 2020). Technology-related "winner-takes-most" dynamics imply that, as the best firms adopt more advanced technologies, their productivity and output relative to the remaining firms increase further and their labour share declines. These developments should be particularly pronounced in countries with rapid ICT-related technological change.

In countries that experienced declines in labour shares over the period 2001-15, wages in technologically leading firms decoupled from productivity but closely tracked productivity in the remaining firms (Figure 2). This implies that in these countries labour shares within the group of leading firms declined while they remained broadly constant in the remaining firms, which is consistent with technology-related "winner-takes-most" dynamics.[10] The best firms in these countries diverged from the remaining firms in terms of both productivity and wages, but wage divergence was much less pronounced than productivity divergence.[11] Given that technologically-leading firms account for approximately 25% of

[9] The ORBIS firm-level dataset is available for a broad range of OECD countries and contains information from firms' income statements and balance sheets, including information on revenues, value added, employment and compensation. Coverage of firms is generally unsatisfactory before the year 2000 and is uneven across countries thereafter, with data for some countries covering a large fraction of firms, such as for Finland, Italy, Portugal, Sweden and Spain, but only a small fraction in others, such as the United States (only listed firms) and the first half of the 2000s for Germany. To minimise issues related to the under-representation of small firms in ORBIS, the analysis in this section is constrained to firms with more than 20 employees. The main characteristics of leading and other firms are described in Table A B.2.

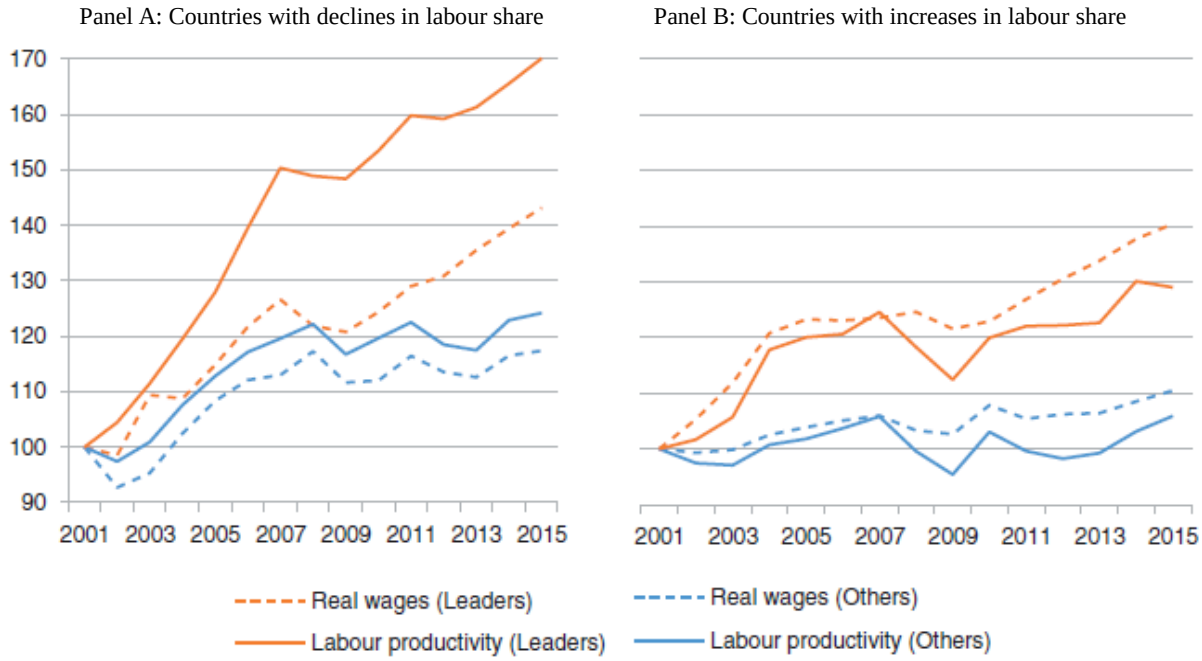
[10] Leaders are defined as the top 5% of firms in terms of labour productivity within each country group in each industry and year, implying that the composition of firms at the technological frontier is allowed to vary over time.

[11] The decoupling of wages from productivity in leading firms does not appear to reflect an increase in stock option compensation. Stock option compensation is typically found to be particularly prevalent in finance and ICT services (Elsby, et al., 2013). The finance industry is not covered by ORBIS so that the role of increasing stock option compensation can be assessed by removing the ICT industry from the analysis in Figure 2. Since the figure remains qualitatively and quantitatively

aggregate value added of the firms in these countries (Table A B.2), developments in leading firms contributed significantly to the decline in the aggregate labour share.

In countries that did not experience declines in labour shares, real wage growth outpaced labour productivity growth in both leading firms and the remaining firms. Productivity and wages in leading firms diverged from those of the remaining firms, but labour shares were broadly constant before the crisis of 2008-09 and increased in both groups thereafter. Productivity growth in countries with increasing labour shares was significantly lower than in the remaining countries, both based on the firm-level data reported in Figure 2 and national accounts data reported in Figure A B.1. This suggests that in countries with increases in labour shares over the period 2001-15 technology-related "winner-takes-most" dynamics were less pronounced.

Figure 2. Average wages and productivity in the best firms and the rest, 2001=100



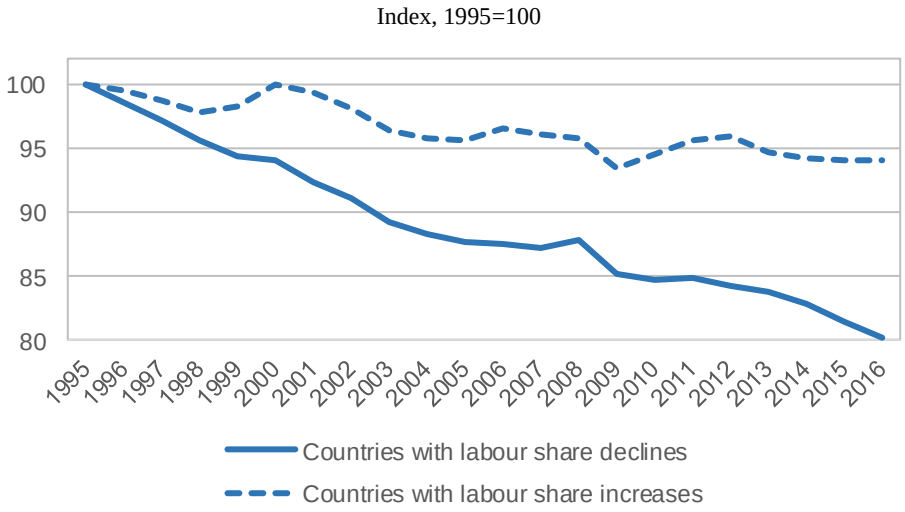
Note: Labour productivity and real wages are computed as the unweighted mean across firms of firm-level nominal value added per worker and nominal labour compensation per worker deflated by the industry-level value added deflator. Leaders are defined as the top 5% of firms in terms of labour productivity within each country group in each industry and year. The countries that are covered by ORBIS with declines in the labour share excluding the primary, housing, financial and non-market industries over the period 2001-2015 are: Belgium, Denmark, Germany, Ireland, Korea, Netherlands, Sweden, United Kingdom and United States (Table A B.1). The countries with increases are: Austria, Estonia, Finland, France, Italy and Spain. Excluding countries with limited coverage in ORBIS (Australia, Denmark, Estonia, Ireland, Netherlands and United States) does not qualitatively change the results.
Source: OECD calculations based on ORBIS.

Declines in investment prices (relative to the value added deflator) have been significantly more pronounced in countries with declining labour shares than in the remaining countries, which is consistent with the hypothesis that the decoupling of wages from productivity at the technological frontier reflects technological dynamism rather than anti-competitive forces (Figure 3). Prices for investment goods are largely determined on world markets but

unchanged, increasing non-cash compensation is unlikely to be the main driver of decoupling of wages from productivity in leading firms in countries with declining labour shares (Figure A B.3).

there can nonetheless be significant differences across countries depending on the composition of investment. Over the past two decades, price declines have been particularly pronounced for ICT equipment so that countries with larger shares of ICT equipment in total investment have typically experienced larger investment price declines than other countries (Figure A A.1). Consequently, the observed firm dynamics are consistent with the hypothesis that in the countries with declining labour shares a number of firms took advantage of declining ICT prices to raise productivity and substitute ICT equipment for labour to a much larger extent than in other countries.

Figure 3. Larger decline in investment prices in countries with declining labour shares



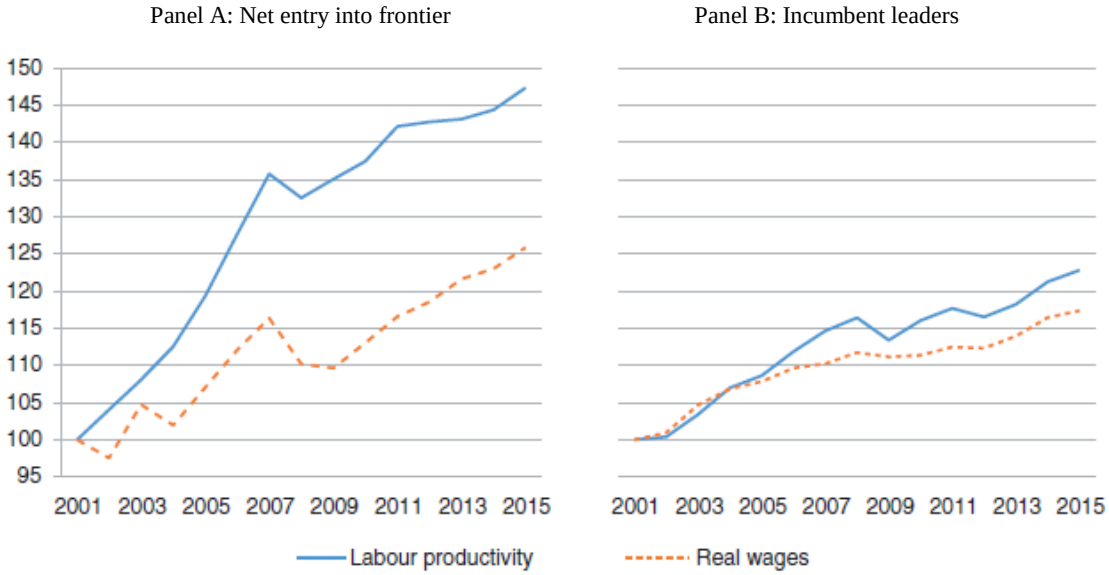
Note: The investment price is defined as the price deflator for gross fixed capital formation divided by the value added price deflators excluding the primary, housing and non-market industries. Country-level changes in investment prices are aggregated using value added weights. Countries with labour share declines over 1995-2016: Australia, Austria, Belgium, Canada, Denmark, Estonia, Germany, Hungary, Ireland, Japan, Korea, Netherlands, Poland, Portugal, Slovenia, Sweden, United States. Countries labour share increases over 1995-2016: Czech Republic, Finland, France, Greece, Italy, Luxembourg, Lithuania, Latvia, Norway, Slovak Republic, Spain, United Kingdom.
Source: OECD.

The decoupling of wages from productivity in technologically-leading firms reflects mainly the entry of new firms with lower labour shares into the technological frontier (Figure 4). The decoupling of wages from productivity in leading firms can be decomposed into contributions from firms staying at the technological frontier ("incumbents") and firms entering and exiting it ("net entry"). While productivity and wages remained closely linked in incumbent technological leaders, net entry into the frontier drove a large wedge between wage and productivity growth. This implies that labour shares of firms entering the technological frontier were significantly lower than those exiting it. This result suggests that the decline of labour shares at the technological frontier was not driven by increasing markups or capital intensity in firms remaining at the technological frontier but rather by the new firms with higher markups or higher capital intensity entering it, which is

consistent with evidence for the United States that, at the firm level, low labour shares are transient (Kehrig and Vincent, 2018).[12]

Figure 4. Net entry explains most of the decoupling of wages from productivity in leading firms

Contributions to labour productivity and real wage growth at the frontier, countries with declines in labour shares



Note: Contributions to real wage growth and labour productivity growth are based on the decomposition $\Delta X = \left[s_2^{stay} X_2^{stay} - s_1^{stay} X_1^{stay}\right] + \left[s_2^{entry} X_2^{entry} - s_1^{exit} X_1^{exit}\right] = \left[s_1^{stay} \Delta X^{stay}\right] + \left[s_1^{exit}\left(X_2^{entry} - X_1^{exit}\right)\right] + \varepsilon$, where X denotes the logarithm of labour productivity or real wages; s denotes the share of each group of firms in the total number of leading firms; superscripts denote groups of firms; and subscripts denote the period (Baily et al., 1992). The way in which the frontier is constructed implies $\varepsilon = 0$ (Annex B) so that the first term in squared brackets in the second equality can be interpreted as the contribution of incumbents to growth of labour productivity and wages at the frontier (Panel B) and the second term the contribution of net entry (Panel A). The countries with a decline in the labour share excluding the primary, housing, financial and non-market industries over the period 2001-2013 are: Belgium, Denmark, Germany, Ireland, Korea, Netherlands, Sweden, United Kingdom and United States (Table A B.1).

Increases in the size of firms at the technological frontier have put further downward pressure on labour shares, given that across countries and industries labour shares in leading firms are lower than in the remaining firms (Figure A B.4). Both countries with declining labour shares and the remaining countries experienced increases in the size of firms at the technological frontier relative to the remaining firms (Figure A B.2). However, in countries with constant or increasing labour shares, the downward impact on aggregate labour shares from reallocation between frontier- and non-frontier firms has been offset by increases in labour shares within both groups of firms. This suggests that in countries with constant or increasing labour shares productivity growth does not appear to have primarily been driven by the substitution of capital for labour, which is consistent with the fact that they experienced smaller declines investment prices than the remaining countries.

[12] Firms entering the technological frontier were about 90% more capital intensive than those exiting it (Table A B.3).

Over all, the labour share decline experienced in a number of countries appears to be driven by the labour share decline at the technological frontier and by the increase in the relative size of frontier firms. The decline in frontier firms' labour share reflects net entry of firms with low labour shares rather than declines in incumbent frontier firms, suggesting that the decoupling of wages from productivity at the technological frontier is not primarily driven by the entrenchment of a small number of superstar firms that raise their markups, but instead by new firms with lower labour shares leapfrogging incumbent frontier firms. The role of new firms at the frontier provides a new perspective on "winner takes most"-based explanations of declining labour shares that emphasises firm turnover at the frontier rather than labour share developments among incumbent frontier firms. While low labour shares in firms entering the technological frontier may to some extent reflect high markups, the fact that these firms leapfrog incumbents suggests that high markups likely reflect innovation rents rather than a lack of entry barriers. Moreover, productivity growth and technology-related declines in investment prices have been more pronounced in countries with declining labour shares, suggesting that thus far labour share dynamics mainly reflect technological dynamism rather than barriers to entry.

3. Labour shares and investment prices: Empirical results

Capital-augmenting technological change or technology-driven declines in equipment prices may reduce the labour share by raising capital intensity. If factor prices are determined competitively, the labour share declines with capital intensity so long as the elasticity of substitution between capital and labour is above unity. Most estimates of the elasticity of substitution are based on within-country time series variation of factor shares and factor prices. These estimates generally imply an elasticity of substitution below one (Chirinko, 2008). By contrast, Karabarbounis & Neiman (2014) use cross-country and cross-industry variation in labour shares and relative investment prices to obtain an elasticity of substitution in the range of 1.2-1.5. According to their estimations, large declines in equipment prices across a broad range of high-income and emerging economies explain around 50% of the global decline of the labour share.

Over time, capital may have become more easily substitutable for labour. On the one hand, new technology extends the range of existing tasks that can be carried out by machines, thereby displacing workers and reducing the labour share (Acemoglu and Restrepo, 2018). On the other hand, new technology also creates new tasks that cannot be carried out by machines. As the nature of technological progress changes, the balance between labour displacement and task creation from new technologies may shift. Evidence for the United Kingdom and the United States, for instance, suggests that the elasticity of substitution between ICT capital and labour is significantly higher than for other capital goods and is well above one (Tevlin and Whelan, 2003; Bakshi, Oulton and Thompson, 2003). In line with this finding, recent evidence on labour share developments for the United States suggests that technological progress has become more labour displacing over time, with particularly large labour-displacing effects in the 2000s (Autor and Salomons, 2018).

Globalisation in the form of increased trade integration may have similar effects on the labour share as increases in capital intensity (Acemoglu & Autor, 2010). For instance, offshoring of the most labour-intensive stages of production or increased import competition may lead to worker displacement and an increase in capital intensity. If the aggregate elasticity of substitution between capital and labour is above unity, this would reduce the labour share. The cross-country evidence in Harrison (2005) and the cross-industry evidence for the United States in Elsby et al. (2013) are consistent with this hypothesis. In a cross-country, cross-industry study IMF (2017) find that increased

participation in global value chains has reduced the labour share in low-income countries but that there is no effect in high-income countries.

3.1. The empirical model

This section uses a combination of firm- and industry-level data to test the hypothesis that technology-related declines in investment prices reduce labour shares. Using firm- and industry-level data to model labour shares is both conceptually and econometrically appealing. From a conceptual standpoint, the fact that changes in aggregate labour shares overwhelmingly reflect developments within industries rather than cross-industry reallocation justifies modelling within-industry dynamics to explain aggregate developments (Figure A A.2).[13] From an econometric standpoint, the within-industry approach has the advantage that fixed effects can account for country- and industry-specific trends.

The first hypothesis tested by the empirical model is that a decline in the relative investment price reduces the labour share, with the reduction being larger in industries using a larger share of routine labour. Declines in relative prices of capital goods lead to the substitution of capital for routine labour, which reduces the overall labour share under the assumption of an elasticity of substitution between capital and routine labour above unity (Karabarbounis & Neiman, 2014). The model also tests whether the negative effect of a given relative investment price decline on the labour share is larger in industries with large shares of routine labour, which would be the case under the assumption that the elasticity of substitution with capital is higher for routine than for non-routine labour (IMF, 2017; Schwellnus et al., 2018).

The second hypothesis tested by the empirical model is that offshoring reduces the labour share. On the one hand, the decline in the cost of offshoring leads to the substitution of imported intermediate goods for domestic routine labour and thereby to a reduction in the domestic wage bill as a share of gross output. On the other hand, offshoring of previously domestically-produced output leads to a reduction in domestic value added as a share of gross output. In addition to these within-firm effects, offshoring may also reallocate production across firms with different labour shares. The theoretical ambiguity of the effect of offshoring is consistent with conflicting results on the impact of offshoring on the labour share in the empirical literature. While a number of studies find a negative impact (Elsby et al, 2013; IMF, 2017), other studies find that the negative impact on the wage bill is smaller in magnitude than the impact on value added so that the labour share increases in response to offshoring (Autor et al., 2020).

The estimated baseline empirical specification is as follows:

$$\Delta LS_{cjt} = \beta_1 \Delta P_{cjt}^{Inv} + \beta_2 \Delta T_{cjt} + \beta_3 X_{cjt} + \alpha_{ct} + \alpha_{jt} + \varepsilon_{cjt} \quad (1)$$

[13] At the level of industry disaggregation used in this paper, labour share developments within industries explain around 80% of aggregate labour share developments, which is broadly in line with previous studies (Bassanini, et al., 2012; Karabarbounis and Neiman, 2014; IMF, 2017). Given that reallocation across industries explains only a small fraction of aggregate labour share developments, weighting industries with shares in aggregate value added in the regression analysis allows making direct statements on aggregate effects.

where subscripts *c*, *j* and *t* denote, respectively, countries, industries and periods; ΔLS_{cjt} denotes the medium-term (5-year) change in the labour share; ΔP_{cjt}^{Inv} denotes the medium-term change in the (log) investment price relative to the value added deflator; ΔT_{cjt} denotes the medium-term change in (log) participation in global value chains; X_{cjt} denotes control variables that vary at the country-industry-period level, including initial routine task intensity; α_{ct} and α_{jt} denote country-by-period and industry-by-period fixed effects. Given that the model is estimated in differences, the fixed effects pick up country-period and industry-period specific trends, including changes in the business cycle.[14]

The construction of industry-level labour shares is described in Section 2.1 and industry-level relative investment price indices are constructed from the OECD Annual National Accounts database (with additional data from the EU-KLEMS database and the archives of the OECD STAN database). Price deflators for gross fixed capital formation are divided by value added price deflators in the corresponding industry. The same reference year (2000) is used for all indices.

In line with previous studies, industry-level participation in global value chains is constructed as the sum of backward and forward linkages in vertical specialisation of production. Backward linkages measure the offshoring of intermediate inputs used in exports and are defined as foreign value added embodied in exports. Forward linkages measure trading partners' offshoring of intermediate inputs and are defined as domestic value added used as intermediate inputs in trading partners' exports.[15] For the sample of high-income countries included in this paper, increases in backward and forward linkages are likely to have similar effects on labour shares: offshoring raises specialisation on the most capital-intensive stages of production while trading partners' offshoring raises demand for capital-intensive intermediate goods. The data are sourced from the OECD TiVA database, the OECD Annual Accounts database and EU-KLEMS database.

The industry-level routine intensity index is based on the occupation-level routine intensity index of Marcolin, Miroudot and Squicciarini (2016) and the skill indicators are constructed from the OECD Survey of Adult skills (PIAAC). The occupation-level routine intensity index provides a measure of the routine content of occupations, based on data from PIAAC. The routine intensity index measures the degree of independence and freedom in planning and organising the tasks to be performed on the job. The occupation-level index is translated into an industry-level index by constructing the weighted average of the occupation-based index by industry, with the occupational weights by industry

[14] Identification in this specification is obtained through deviations of labour shares and the explanatory variables from country-specific and global industry-specific 5-year trends. Among other things, the country-period fixed effects pick up changes in the business cycle. Results from estimating equation (1) replacing the country-period fixed effects with changes in the output gap, are reported in Table A A.1.

[15] Backward and forward linkages are normalised by industry-level value added to account for the overall trade openness of the industry. In order to avoid spurious correlations with the denominator of the labour share, 5-year changes in global value chain participation are defined as follows: $\Delta GVCP_{cjt} = \Delta ln\left(\frac{FWP_{cjt} + BWP_{cjt}}{EXGR_{cjt}}\right) \times \frac{EXGR_{cjt_0}}{VA_{cjt_0}}$, where FWP_{cjt} and BWP_{cjt} are forward and backward linkages in in country *c*, industry *j* and year *t*; $EXGR_{cjt0}$ and VA_{cjt0} are respectively gross exports and value added; and t_0 is the initial year of each five-period in the empirical analysis.

obtained from the European Labour Force Survey (1995-2015).[16] PIAAC also allows constructing industry-level skill indicators.[17]

The econometric model is estimated for 22 OECD countries for which industry-level labour shares and all explanatory variables are available over the period 1995-2015.[18] The focus is on medium-term changes, which is achieved by splitting the data into four non-overlapping 5-year periods (1995-2000, 2000-05, 2005-10 and 2010-15). The analysis of medium-term changes rather than long-term changes over the entire period permits a more precise estimation of the structural drivers of labour shares while allowing labour shares sufficient time to adjust given that the elasticity of substitution between labour and capital is likely to be higher in the medium term than in the short term.[19]

3.2. Industry-level results

According to the baseline specification in equation (1), declines in relative investment prices and increases in GVC participation reduce the labour share (Table 2, Column 1).[20] The estimated semi-elasticity of the labour share to the relative investment price is 0.24, which suggests that on average across industries a decline in relative investment prices of 10 percent reduces the labour share by approximately 2.4 percentage points. The estimated semi-elasticity of the labour share to GVC participation is around -0.07, which suggests that an increase of backward and forward linkages of 10 percentage points of value added reduces the labour share by 0.7 percentage point. The results on global value chains are both statistically and economically weaker than the results on investment prices but broadly consistent with the hypothesis that increased trade integration may have similar effects on labour shares as increases in capital intensity.

[16] For Australia, Japan, Korea and the United States, the simple average of the occupational weights across all European countries is used.

[17] The share of low-skilled workers at the industry level is defined as the average share of low-skilled in numeracy, literacy and problem solving in technology-rich environments. The share of low-skilled in each skill area is defined as the share of adults below the first PIAAC competency level for numeracy, literacy and problem solving. Data for problem solving exclude France, Italy and Spain since they did not participate in the assessment of problem solving in technology-rich environments. For these countries, the simple average across all countries is used.

[18] The countries included in the econometric analysis are: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Slovak Republic, Spain, Sweden, the United Kingdom and the United States. Data on global value chain participation is not available after 2015.

[19] Extreme outliers in ICT manufacturing for some countries likely reflect measurement error and are dealt with by using the relative investment price in ICT manufacturing for the United States as an instrumental variable for the relative investment price in ICT manufacturing for all countries. Dropping ICT manufacturing from the regressions neither qualitatively nor quantitatively affects the results reported below. The influence of other extreme outliers in changes in labour shares, relative investment prices and global value chain participation is limited by winsorising changes above 100% and below -100%.

[20] The main results reported below are robust to including country-industry and country-period fixed effects rather than industry-period and country-period fixed effects, except that the interactions of the relative investment price with routine intensity and skill intensity become insignificant (Table A A.2). This reflects the fact that, in a setting with many countries and few periods, including country-industry and country-period fixed effects rather than industry-period and country-period fixed effects leads to less precise estimation of the coefficient of the relative investment price.

Table 2. Baseline specification

Selected OECD countries, 1995-2015

	(1)	(2)	(3)	(4)
	Change in business labour share excluding primary, coke and housing industries			
Change in relative investment price	0.24***	0.17***	0.15***	
	(0.09)	(0.05)	(0.03)	
Change in GVCP	-0.07*	-0.08**	-0.06*	-0.06**
	(0.04)	(0.04)	(0.03)	(0.03)
High share of high routine x Change in relative investment price		0.16**		
		(0.08)		
High share of low skilled x Change in relative investment price			0.22**	
			(0.11)	
Low % of high routine x Low % of low skilled x Change in rel. inv. price				0.13***
				(0.03)
High % of high routine x Low % of low skilled x Change in rel. inv. price				0.18***
				(0.05)
Low % of high routine x High % of low skilled x Change in rel. inv. price				0.28***
				(0.11)
High % of high routine x High % of low skilled x Change in rel. inv. price				0.41***
				(0.13)
High share of high routine	YES	YES	YES	YES
High share of low skilled	YES	YES	YES	YES
Industry x period fixed effects	YES	YES	YES	YES
Country period x fixed effects	YES	YES	YES	YES
Observations	1334	1334	1334	1334
Number of countries	22	22	22	22
Number of industries	19	19	19	19
Adjusted R^2	0.32	0.34	0.36	0.37

Note: The dummy for high-routine intensity is set to 1 when the share of high routine employment in an industry is above the median across countries and industries. The dummy for high share of low-skilled is set to 1 when the share of low-skilled in an industry is above the median across countries and industries. Changes denote 5-year differences. Weighted OLS, with the share of industry-level value added in total value as weights. Standard errors are clustered at the country-industry level. *, **, *** denote statistical significance at the 10%, 5% and 1% levels.

Source: OECD National Accounts Database, OECD TiVA Database, Marcolin et al. (2016), European Labour Force Survey, OECD Economic Outlook Database No. 99.

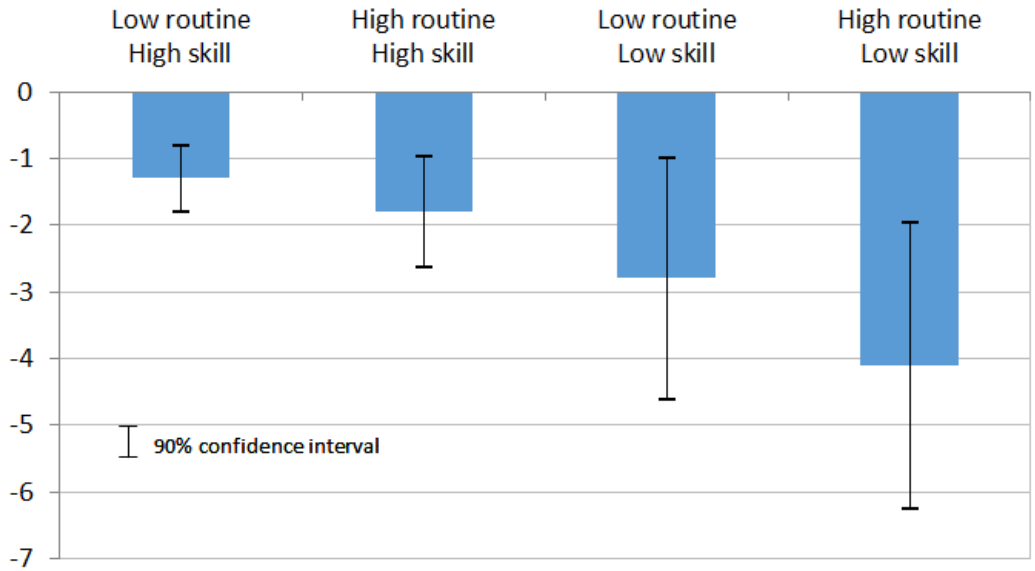
The results are consistent with a large body of macro-level evidence suggesting that the elasticity of substitution is higher for routine and low-skilled labour than for non-routine and high-skilled labour (Duffy, Papageorgiou and Perez-Sebastian, 2004; IMF, 2018; Krusell et al., 2000). The estimated model suggests that a decline in relative investment prices reduces the labour share by more in industries with high initial routine intensity (Table 2, Column 2).[21] The estimated semi-elasticity is 0.33 for high-routine industries whereas it is around 0.17 for low-routine industries, with the difference being statistically significant.[22] Capital-labour substitution also appears to be less pronounced in industries with a high-share of high-skilled labour (Column 3). However, routine and skill intensity indicators are likely to be positively correlated across industries, implying that any impact

[21] To test for heterogeneous effects of changes in the relative investment price across high-routine and low-routine industries, the change in the relative investment price is interacted with an indicator variable that takes a value of 1 if initial routine intensity is higher than in the median industry.

[22] The coefficient on the change in the relative investment price in Column 2 (0.17) denotes the semi-elasticity for low-routine industries. The sum of this coefficient and the estimated coefficient on the relative investment price interacted with the indicator of high routine intensity (0.16) denotes the semi-elasticity for high-routine industries.

of skills on capital-labour substitution may reflect the omission of routine intensity indicators (Figure A A.1). A more rigorous specification reported in Column (4) interacts the routine indicators in the baseline specification with skill intensity indicators. The fact that, irrespective of routine task intensity, the estimated elasticity of substitution is lower in high-skill industries suggests that capital-labour substitution is indeed lower in these industries than in low-skill industries (Figure 5). This could, for instance, be explained by higher-skilled workers being more difficult to replace by machines than lower-skilled workers or being more easily reassigned to non-routine tasks within an industry.

Figure 5. Change in the labour share in response to a 10% decrease in the relative investment price, percentage points



Note: The dummy for high routine is set to 1 if the share of high routine employment in an industry is above the median across countries and industries. The dummy for high skill is set to 1 if the share of high-skilled adults in an industry is above the median across countries and industries.
Source: See Table 2.

Taking the estimated elasticities of the empirical model at face value, differences in investment price developments can account for about 35% of difference in labour share developments between countries with declining labour shares and the remaining countries. The observed average change in the relative investment price in countries with declining labour shares was about 20% whereas it was about 6% in the remaining countries (see Figure 3). Assuming that the elasticities estimated at the industry level are similar to those at the aggregate level, over the period 1995-2015 the baseline results suggest that investment price declines reduced the labour share by about 4.8 percentage points in countries with declining labour shares and by about 1.4 percentage points in the remaining countries.[23] Over the same period, the labour share in countries with declining labour shares fell by about 6.3 percentage points whereas it increased by 3.5 percentage points in the

[23] Industry-level elasticities can plausibly be assumed to be similar to aggregate elasticities because within-industry labour share developments explain the overwhelming part of aggregate developments (Figure A A.2) and the regression analysis weighs industries by shares in value added.

remaining countries, implying that differences in investment price developments contributed about 35% to differences in labour share developments (3.4 percentage points of 9.8 percentage points).

3.3. Within-firm effects or reallocation?

Firm-level analysis can help understand the extent to which relative investment prices and global value chain participation affect industry-level labour shares primarily through changes in labour shares within firms or through changing firm composition. The descriptive analysis in Section 2 suggests that in countries with declining labour shares aggregate developments are mainly driven by changes in firm composition at the technological frontier.

The firm-level analysis is based on the ORBIS dataset. In order to limit the influence of erratic or implausible firm-behaviour, the dataset is cleaned by removing extreme outliers of value added, employment and wages using the procedure described in Andrews, Criscuolo and Gal (2016). For the purpose of the labour share analysis in this paper, the dataset is additionally cleaned by removing observations with extreme values for labour shares and restricted to the industries included in the industry-level analysis.[24] The model is estimated using firm-level data from OECD-ORBIS and industry-level relative investment price indices for 9 countries for which long differences in labour shares can be computed for a sufficient number of firms.[25]

In order to assess whether within-firm labour shares respond to changes in industry-level relative investment prices, the following baseline equation is estimated:

$$\Delta LS_{cjit} = \beta_1 \Delta P_{cjt}^{Inv} + \beta_2 \Delta T_{cjt} + \gamma' X_{cji0} + \alpha_{cj} + \alpha_{ct} + \varepsilon_{cji} \quad (2)$$

where subscripts *c, j, i, t* denote, respectively, countries, industries, firms and period; ΔLS_{cji} denotes the annualised long difference in the firm-level labour share, with long differences computed over the longest period a firm is observed and the sample is constrained to firms that are observed for at least 5 years over the period 2000-15; ΔP_{cjt}^{Inv} denotes the annualised long difference of the log relative investment price; ΔT_{cjt} is the annualised change in global value chain participation; X_{cji} is a set of firm-level controls that include the firm's initial age and size (as measured by employment); α_{cj} denotes country-industry fixed effects and α_{ct} are country-period fixed effects. The rationale for including country-industry fixed effects rather than industry-period fixed effects is that the firm-level analysis can only be conducted for 9 countries rather than 22 countries for the industry-level analysis. With a small number of countries and a large number of periods, identification using accelerations and decelerations over the country-specific industry trend will be more precise than using deviations from period-specific global industry trends.

The overwhelming part of the impact of relative investment prices on labour shares appears to operate through changes in firm composition. Estimating equation (2) on industry-level data using non-overlapping 5-year differences using the country and period sample as well

[24] Observations below the first percentile or above the 99th percentile of the labour share distribution are dropped and observations remaining outside the 0-100% range are winsorised.

[25] The included countries are: Belgium, Finland, France, Germany, Italy, Korea, Spain, Sweden and United Kingdom. In order to ensure that results are not driven by firms with extreme values in long differences in labour shares, firms with long differences outside the [-40,+40] percentage point interval are removed from the analysis. The results are robust to alternative sample restrictions.

as the fixed effects structure of the firm-level analysis yields a semi-elasticity of labour shares to relative investment prices of about 0.22 (Table 3, Column 1), remarkably similar to the industry-level coefficient reported for the full set of countries in Table 1. By contrast, the estimated firm-level semi-elasticity is significantly smaller at about 0.04 (Column 2). Given that the industry-level estimated includes both composition and within-firm effects, these results suggest that the impact of relative investment prices on labour shares mainly operates through changes in firm composition.

Table 3. The impact of relative investment prices on firm-level labour shares is small

Selected OECD countries, 2001-15

	Change in Labour Share			
	(1)	(2)	(3)	(4)
	Industry	Firm	Firm	Firm
Change in Relative Investment Price	0.22***	0.04***	0.04**	0.05***
	(0.06)	(0.01)	-0.02	(0.01)
Change in GVC Participation	0.09	-0.00	0.00	-0.01
	(0.08)	(0.02)	(0.02)	(0.02)
Initial Firm Age		0.06***	0.06***	0.05***
		(0.01)	(0.01)	(0.01)
Initial Firm Employment		-0.05***	-0.05***	-0.03***
		(0.01)	(0.01)	(0.01)
Employment x Change in Relative Investment Price			-0.00	
			(0.00)	
Observations	436	1,211,563	1,211,563	805,608
R-squared	0.51	0.04	0.04	0.06
Length of period	5	≥5	≥5	≥8
Number of Countries	9	9	9	9
Number of Industries	19	19	19	19
Country x Industry FE	Yes	Yes	Yes	Yes
Country x Year FE	Yes	Yes	Yes	Yes

Note: Firm-level controls include age and employment. The included countries are Belgium, Germany, Spain, Finland, France, Italy, Korea, Sweden and United Kingdom. Including countries with limited coverage (Australia, Denmark, Estonia, Ireland, Netherlands and United States) does not change the results. Standard errors are clustered at the country-industry level. *, **, *** denote statistical significance at the 10%, 5% and 1% levels.
Source: OECD calculations based on ORBIS.

Even though large firms (in terms of initial employment) tend to experience larger declines in labour shares, there is no evidence that the impact of relative investment prices depends on the initial size of the firm (Column 3). Hence, the over-representation of large firms in ORBIS does not bias the estimated coefficient of the relative investment price in any obvious way. Using 8-year or longer differences to estimate equation (2) leads to a marginally larger estimated semi-elasticity of labour shares to relative investment prices (Column 4), which is consistent with the view that the elasticity of substitution between capital and labour is larger in the long term than the short-term although the change in estimated elasticity may also reflect the smaller firm sample. In any case, moving to longer time horizons for the firm-level analysis does not change the conclusion that the overwhelming part of the impact of relative investment prices on labour shares operates through reallocation between firms.

4. Conclusion

This paper suggests that technological change has contributed to declines in labour shares observed in a number of countries over the past two decades. These countries have experienced larger declines in investment prices than the remaining countries, which has been associated with larger investment in ICT capital and higher productivity growth. At the same time, wages in these countries have decoupled from productivity at the technological frontier, and the relative size of frontier firms has increased. More generally, the effect of falling investment prices on labour shares appears to overwhelmingly operate through the reallocation of market shares from high labour share to low labour share-firms, which is consistent with the hypothesis that declines of labour shares mainly reflect the emergence of "superstar firms" with low labour shares (Autor et al., 2020).

Further technological advances may further strengthen these developments, with wages decoupling further from productivity at the technological frontier and market shares being reallocated to a small number of "superstar" firms with low labour shares. This paper suggests that the decoupling of wages from productivity thus far mainly reflects the entry of firms with low labour shares into the technological frontier rather than rising markups and falling labour shares in incumbent frontier firms. The risk is that over time incumbent technological leaders attempt to reduce the threat of market entry through anti-competitive practices, e.g. through predatory pricing or mergers and acquisitions of competing firms. Therefore, competition policy will need to find the right balance between preventing anti-competitive practices by incumbent technological leaders and encouraging innovation by allowing entrants into the technological frontier reap the rewards for their innovations. Irrespective of the source of emerging "winner-takes-most" dynamics, policies that raise human capital through education and training will play a crucial role to broaden the sharing of productivity gains by ensuring that workers develop the complementary skills to make the most of ongoing technological advances.

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Annex A. **Industry-level analysis: Supporting technical material**

This annex provides technical material supporting the industry-level analysis.

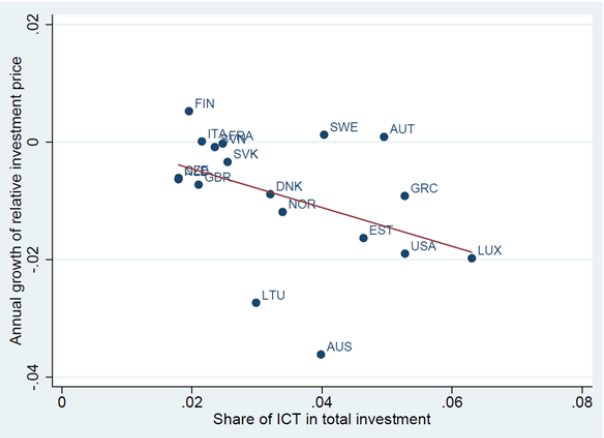
Share of ICT investment and decline in relative investment price

While prices of investment goods are largely determined on global markets, there are nonetheless large cross-country differences in the growth of aggregate investment prices due to cross-country differences in the composition of aggregate investment. The price of ICT equipment has declined more sharply than other investment goods over the sample period so that countries with larger shares of ICT in total investment have typically experienced larger declines in investment prices (Figure A A.1, Panel A). Accounting for the fact that measurement error in relative investment prices might be larger in small countries, for which resources allocated to the statistical system are typically more limited than in large countries, strengthens the negative correlation (Panel B).

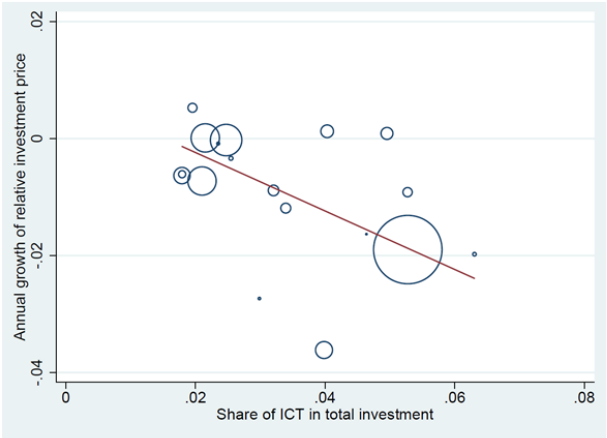
Figure A A.1. Negative correlation between the share of ICT in total investment and growth in relative investment price

Non-primary, non-housing business sector, 1995-2017

Panel A: Unweighted



Panel B: Weighted by value added



Note: The unweighted correlation in Panel A is -0.42 (-0.61 if Australia and Lithuania are excluded). The value added weighted correlation is -0.77. Due to data limitations the annual growth of relative investment prices and shares of ICT in total investment cover the period 1995-2017 for Australia, Austria, Czech Republic, Finland, France and Luxembourg; 1995-2016 for Greece, Italy, Lithuania, Netherlands, Norway, Sweden, UK and the US; 1995-2015 for Denmark; 2000-2016 for Estonia and Slovenia; and 2000-2015 for the Slovak Republic.
Source: OECD.

Decomposition of changes in labour shares

The decomposition of the changes in labour shares for the total economy in Table 1 is obtained as follows:

$$\Delta\overline{LS_{tot,t}} = \sum_{industry\ i} \left[\underbrace{\left(\frac{\overline{\omega_{i,t_0}} + \overline{\omega_{i,t}}}{2}\right)\Delta\overline{LS_{i,t}} + \left(\frac{\overline{LS_{i,t_0}} + \overline{LS_{i,t}}}{2} - LS^*\right)\Delta\overline{\omega_{i,t}}}_{Contribution\ of\ industry\ i} + \underbrace{R_{i,t}}_{Residual} \right] \quad \textbf{(2)}$$

with:

$\omega_{i,t} = \frac{VA_{i,t}}{VA_{tot,t}}$

$\Delta\overline{LS_t} = \overline{LS_t} - \overline{LS_{t0}} = \frac{LS_{t-1} + LS_t}{2} - \frac{LS_{t_0-1} + LS_{t_0}}{2}$

$LS^* = \frac{LS_{tot,t_0} + LS_{tot,t_0-1} + LS_{tot,t} + LS_{tot,t-1}}{4}$

$\Delta\overline{\omega_t} = \overline{\omega_t} - \overline{\omega_{t0}} = \frac{\omega_{t-1} + \omega_t}{2} - \frac{\omega_{t_0-1} + \omega_{t_0}}{2}$

$R_{i,t} = \frac{\omega_{i,t} - \omega_{i,t-1}}{2} \times \frac{LS_t - LS_{t-1}}{2} - \frac{\omega_{i,t0} - \omega_{i,t0-1}}{2} \times \frac{LS_{t0} - LS_{t0-1}}{2} + LS^*\left(\overline{\omega_{i,t}} - \overline{\omega_{i,t_0}}\right)$

The contribution of industry *i* takes into account the evolution of industry *i*'s labour share and the evolution of industry *i*'s value added share between the initial and final dates. A reference labour share level $LS^*$is introduced in the decomposition in order to account for the fact that an increase in the value added share of an industry whose labour share is below the average labour share in the economy (e.g. the housing industry) contributes negatively to the evolution of the aggregate labour share. In practice, the average of the total economy labour share in periods (t_0-*1*), t_0, (*t-1*) and *t* as the reference labour share level LS^* is used. The residual term is negligible for all countries. Note that this residual term only appears because the initial and final labour shares are defined as averages over two consecutive years (e.g. 1994-1995 and 2016-2017 for Australia).

Shift-share analysis

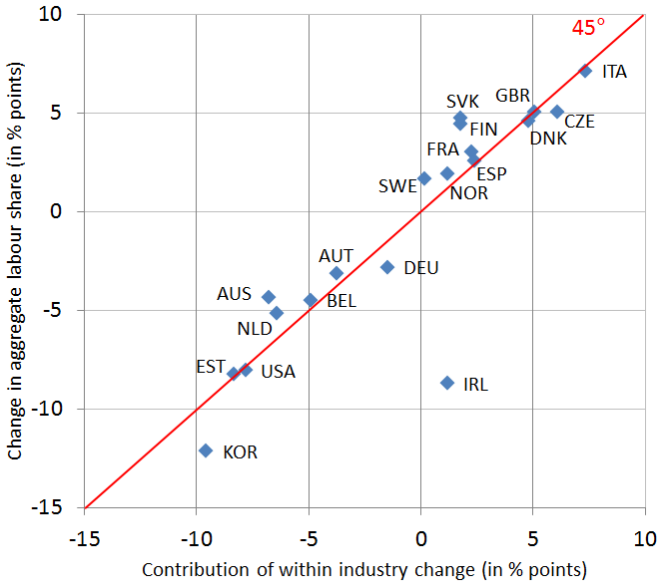
Changes in aggregate labour shares can be decomposed into within-industry changes (within component) and composition effects (between component) as follows:

$$\Delta LS_{i,t} = \underbrace{\sum_j \Delta LS_{i,j,t}\,\overline{\omega_{i,J}}}_{Within\ component} + \underbrace{\sum_j \Delta\omega_{i,j,t}\,\overline{LS_{i,J}}}_{Between\ component}$$

where $\Delta LS_{i,j,t}$ denotes the change in the labour share in country *i*, industry *j* over period *t*; $\Delta\omega_{i,j,t}$ denotes the change in the share of industry *j* in aggregate value added of country *i*; $\overline{LS_{i,J}}$ denotes the average labour share of industry *j* in country *j* over the period; and $\overline{\omega_{i,J}}$ denotes the average share of industry *j* in aggregate value added of country *i* over the period.

Changes in aggregate labour shares overwhelmingly reflect developments within industries (Figure A A.2). In most countries, the within-industry component of aggregate labour share changes is very close to the aggregate change. Only in Ireland has the decline in the labour share mainly been driven by the reallocation of value added to industries with lower labour shares.

Figure A A.2. Shift-share decomposition of aggregate labour share developments
(1995-2011)



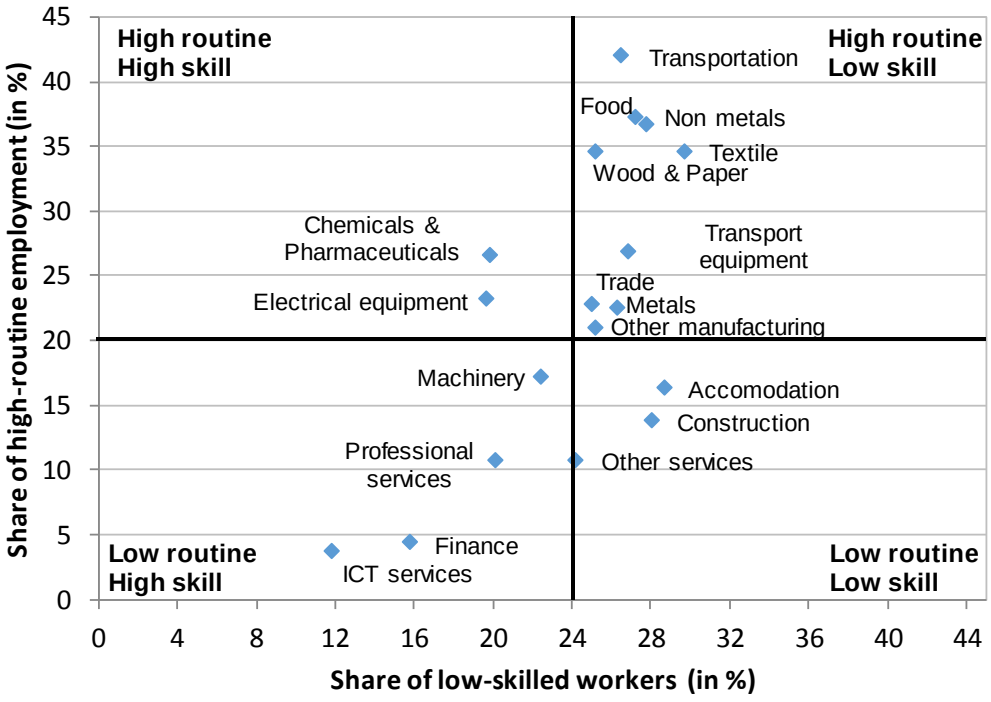
Note: The contribution of the within-industry change is defined as the weighted average of within-industry changes, using industry value added in aggregate value added as weights. It cannot be computed for Japan because of missing data for some industries.
Source: OECD National Accounts Database.

Correlation between routine intensity and skills

The share of high-routine employment and low-skilled workers is positively correlated across industries, but there are nonetheless a number of industries with large shares of high-skilled workers among high-routine industries (chemicals & pharmaceuticals, electrical equipment) and large shares of low-skilled workers among low-routine industries (accommodation, construction, other services, Figure A A.3).

Figure A A.3. High routine intensity does not imply low skill intensity

Selected OECD countries, 2012



Note: The share of low-skilled workers is defined as the average share of workers with skills in numeracy, literacy and problem solving in technology-rich environments below level 1 in PIAAC. The share of high-routine employment is defined as the share of workers in an occupation.
Source: Marcolin et al. (2016), European Labour Force Survey, OECD PIAAC.

Baseline results including the output gap

Replacing the country-period fixed effects in the baseline specification with country fixed effects and changes in the output gap yields similar semi-elasticities of the labour share to the relative investment price, GVC participation and the interactions with routine intensity as in the baseline specification (Table A A.1). Consistent with macro-level evidence the labour share is found to be counter-cyclical.

Table A A.1. Baseline specification including the output gap

Selected OECD countries, 1995-2015

	(1)	(2)	(3)	(4)
	Change in business labour share excluding primary, coke and housing industries			
Change in relative investment price	0.24**	0.17***	0.14***	
	(0.10)	(0.05)	(0.03)	
Change in GVCP	-0.07*	-0.08**	-0.05*	-0.06**
	(0.04)	(0.04)	(0.03)	(0.03)
High share of high routine x Change in relative investment price		0.16*		
		(0.09)		
High share of low skilled x Change in relative investment price			0.24*	
			(0.13)	
Low % of high routine x Low % of low skilled x Change in rel. inv. price				0.12***
				(0.03)
High % of high routine x Low % of low skilled x Change in rel. inv. price				0.17***
				(0.06)
Low % of high routine x High % of low skilled x Change in rel. inv. price				0.29**
				(0.11)
High % of high routine x High % of low skilled x Change in rel. inv. price				0.41***
				(0.15)
Change in output gap	-0.45***	-0.46***	-0.43***	-0.44***
	(0.13)	(0.12)	(0.10)	(0.10)
High share of high routine	YES	YES	YES	YES
High share of low skilled	YES	YES	YES	YES
Industry x period fixed effects	YES	YES	YES	YES
Country fixed effects	YES	YES	YES	YES
Observations	1326	1326	1326	1326
Number of countries	22	22	22	22
Number of industries	19	19	19	19
Adjusted R^2	0.26	0.28	0.31	0.31

Note: The dummy for high routine intensity is set to 1 when the share of high routine employment in an industry is above the median across countries and industries. The dummy for high share of low-skilled is set to 1 if the share of low-skilled in and industry is above the median across countries and industries. Changes denote 5-year differences. Weighted OLS, with the share of industry-level value added in total value as weights. Standard errors are clustered at the country level. *, **, *** denote statistical significance at the 10%, 5% and 1% levels.
Source: OECD National Accounts Database, OECD TiVA Database, Marcolin et al. (2016), European Labour Force Survey, OECD Economic Outlook Database No. 99.

Baseline results with alternative fixed effects structure

Replacing the industry-period fixed effects in the baseline specification with country-industry fixed effects yields similar semi-elasticities of the labour share to the relative investment price, GVC participation and the interactions with routine intensity as in the baseline specification, except that GVC participation and the interactions of the relative investment price with routine intensity and skill intensity become insignificant (Table A A.2).

Table A A.2. Baseline specification with country-industry and country-period fixed effects

Selected OECD countries, 1995-2015

	(1)	(2)	(3)	(4)
	Change in business labour share excluding primary, coke and housing industries			
Change in relative investment price	0.25**	0.18***	0.14***	
	(0.10)	(0.05)	(0.04)	
Change in GVCP	-0.06	-0.07	-0.07	-0.07*
	(0.04)	(0.05)	(0.04)	(0.04)
High share of high routine x Change in relative investment price		0.15		
		(0.10)		
High share of low skilled x Change in relative investment price			0.28	
			(0.17)	
Low % of high routine x Low % of low skilled x Change in rel. inv. price				0.13***
				(0.04)
High % of high routine x Low % of low skilled x Change in rel. inv. price				0.14*
				(0.08)
Low % of high routine x High % of low skilled x Change in rel. inv. price				0.32**
				(0.16)
High % of high routine x High % of low skilled x Change in rel. inv. price				0.45***
				(0.16)
High share of high routine	YES	YES	YES	YES
High share of low skilled	YES	YES	YES	YES
Country x industry fixed effects	YES	YES	YES	YES
Country period x fixed effects	YES	YES	YES	YES
Observations	1334	1334	1334	1334
Number of countries	22	22	22	22
Number of industries	19	19	19	19
Adjusted R^2	0.32	0.34	0.36	0.37

Note: The dummy for high-routine intensity is set to 1 when the share of high routine employment in an industry is above the median across countries and industries. The dummy for high share of low-skilled is set to 1 when the share of low-skilled in and industry is above the median across countries and industries. Changes denote 5-year differences. Weighted OLS, with the share of industry-level value added in total value as weights. Standard errors are clustered at the country-industry level. *, **, *** denote statistical significance at the 10%, 5% and 1% levels.

Source: OECD National Accounts Database, OECD TiVA Database, Marcolin et al. (2016), European Labour Force Survey, OECD Economic Outlook Database No. 99.

Annex B. **Firm-level analysis: Supporting technical material**

This annex provides technical material supporting the firm-level analysis in Section 5.2.

Country groups

In Section 2.3, the sample is split into a group of countries with declining labour shares over 2001-2015 and a group with increasing labour shares (Table A B.1). Countries with decreasing labour shares include Belgium, Denmark, Germany, Ireland, Korea, Netherlands, Sweden, United Kingdom and United States. Countries with increasing labour shares include Austria, , Estonia, Finland, France, Italy and Spain. Productivity growth in countries with increases in labour shares was significantly lower than in the remaining countries, both based on the ORBIS firm-level data and on national accounts data (Figure A B.1).

Table A B.1. Changes in labour shares between 2001 and 2015

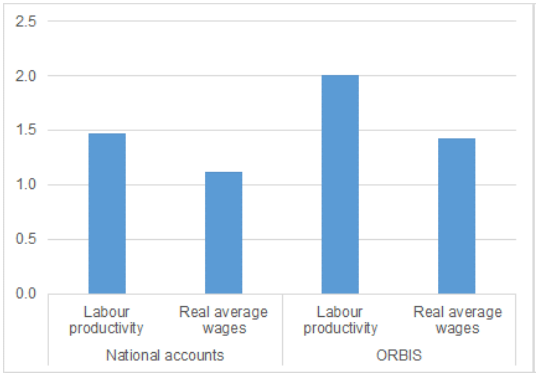
Percentage points, excluding the primary, coke and refined petroleum, housing and non-market industries

Countries with declines in labour shares		Countries with increases in labour shares	
Belgium	-3.3	Austria	0.6
Denmark	-2.1	Estonia	6.0
Germany	-2.7	Finland	8.2
Ireland	-3.6	France	5.6
Korea	-4.2	Italy	7.7
Netherlands	-2.1	Spain	1.5
Sweden	-1.4		
United Kingdom	-1.7		
United States	-5.6		

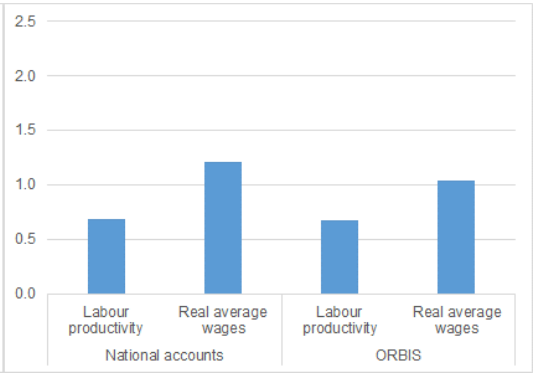
Notes: Start year is two-year average of 2000-2001. End year is average of 2014-2015 except for Ireland (2013-2014).
Source: OECD National Accounts Database, OECD STAN Database, OECD Annual Labour Force Statistics Database and EU KLEMS Database.

Figure A B.1. Average growth rates of labour productivity and real average wages in national accounts and in ORBIS

Panel A: Countries with declines in labour share



Panel B: Countries with increases in labour share



Note: ORBIS figures are calculated as the unweighted mean of firm-level growth rates. The countries with declines in the labour share excluding the primary, housing, financial and non-market industries over the period 2001-2015 are: Belgium, Denmark, Germany, Ireland, Korea, Netherlands, Sweden, United Kingdom and United States (Table A B.1). The countries with increases are: Austria, Estonia, Finland, France, Italy and Spain.
Source: OECD calculations based on ORBIS.

Characteristics of leading firms

In countries that experienced declines in labour shares, technologically leading firms were on average 7 times more productive than the other firms (Table A B.2, Panel A). While they were also paying higher real wages, the difference with other firms was less pronounced, implying lower labour shares in leading firms. Value added, sales and capital intensity were higher in leading firms, but the average number of employees was similar to that of other firms. Similar conclusions hold for countries that experienced increases in labour shares (Table A B.2, Panel B), although the differences between leaders and other firms were less pronounced. Firms entering the technological frontier were on average 90% more capital intensive than those that exited it, while capital intensity was similar to that of incumbent leaders (Table A B.3).

Table A B.2. Mean firm characteristics in 2015

Panel A: Countries with declines in labour shares

Variables	Leaders			Others		
	Mean	St.dev.	N	Mean	St.dev.	N
Labour productivity[1]	392.4	341.4	4,284	59.9	49.7	89,498
Real wages[2]	114.7	99.8	4,284	40.9	34.4	89,498
Labour share[3]	38.5	25.1	4,284	71.5	21.9	89,498
Real value added[4]	24.9	40.1	4,284	5.8	8.8	89,498
Real revenue[4]	83.5	146.1	4,284	21.9	36.7	89,498
Capital-labour ratio[1]	187.2	434.3	4,284	30.3	56.7	89,498
Number of employees	62.8	91.1	4,284	96.5	125.5	89,498

Panel B: Countries with increases in labour shares

Variables	Leaders			Others		
	Mean	St.dev.	N	Mean	St.dev.	N
Labour productivity[1]	233.3	182.0	6,808	50.0	35.0	134,068
Real wages[2]	88.4	68.1	6,808	39.3	24.4	134,068
Labour share[3]	46.1	24.8	6,808	79.1	17.2	134,068
Real value added[4]	9.2	14.5	6,808	2.6	3.6	134,068
Real revenue[4]	29.5	54.3	6,808	8.4	13.1	134,068
Capital-labour ratio[1]	148.7	310.9	6,808	21.0	40.0	134,068
Number of employees	39.3	60.1	6,808	53.0	57.2	134,068

Notes: The set of firms is restricted to a sample where all variables reported in the table are jointly available. Productivity is defined the ratio of real value added to the number of employees. Capital-labour ratio is defined as the ratio of capital stock to the number of employees.
[1]: in thousands of 2005 USD (using PPP conversions) per employee
[2]: in thousands of 2005 USD (using PPP conversions)
[3]: in %
[4]: in millions of 2005 USD (using PPP conversions).
Source: OECD calculations based on OECD-ORBIS.

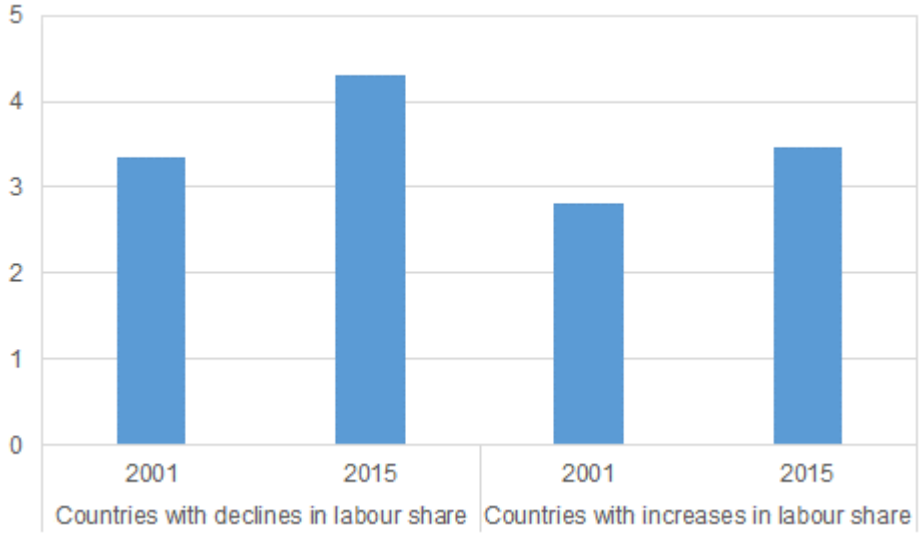
Table A B.3. Comparing capital intensity between groups of firms

2002-2015

	Countries with decreases in labour share			Countries with increases in labour share		
Ratio of capital intensity	Mean	Median	St. dev.	Mean	Median	St. dev.
(Entrants into frontier) / (Exiters)	1.9	1.5	1.5	2.3	1.8	2.2
(Entrants into frontier) / (Incumbent leaders)	0.9	0.8	0.5	0.9	0.8	0.5

Note: Within each country group in each industry and year, cells with less than 10 firms are dropped. Capital intensity is measured by the capital-labour ratio.
Source: OECD calculations based on OECD-ORBIS.

Figure A B.2. Size of frontier firms relative to other firms



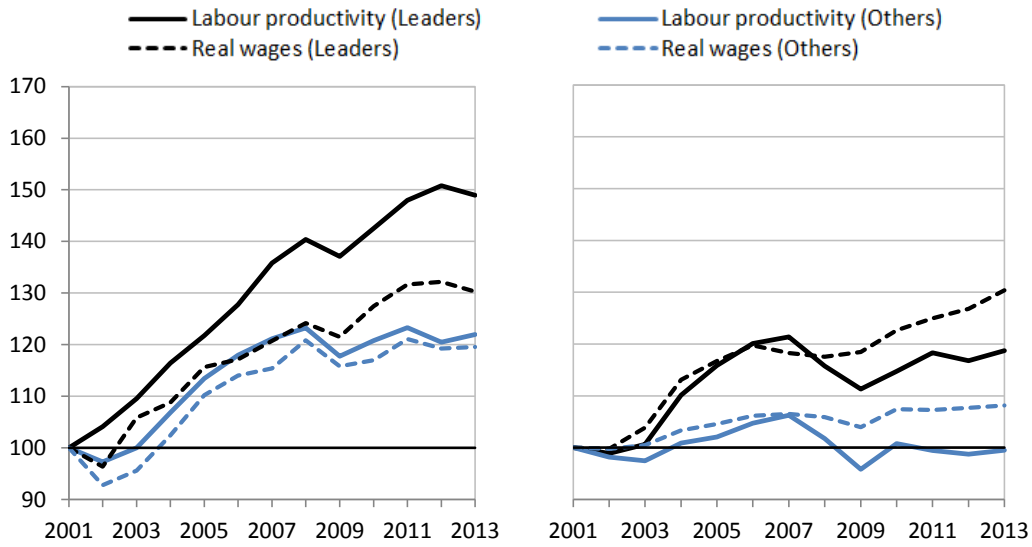
Note: Relative size is defined as the ratio of mean value added in frontier firms to mean value added in the remaining firms.
Source: OECD calculations based on OECD-ORBIS.

The role of increasing stock option compensation

The decoupling of wages from productivity in leading firms does not appear to reflect an increase in stock option compensation. Labour compensation in ORBIS includes cash compensation and non-cash compensation such as firm-level health insurance and pension plans, but it does not include stock option compensation. A shift toward stock option compensation would thus imply a mechanic decline in the labour share in ORBIS (the ratio of labour compensation to value added) without necessarily implying a decline in the share of value added appropriated by workers. A straightforward test of the validity of this hypothesis is to remove industries from the analysis for which there have been large increases in stock option compensation over the period 2001-2013. While industry-level data on stock option compensation are not readily available, the evidence in Elsby et al. (2013) suggests that this type of compensation is particularly prevalent in finance and ICT services. The finance industry is not covered by ORBIS so that the role of increasing stock option compensation can be assessed by removing the ICT industry from the analysis in Figure 2. Since the figure remains qualitatively and quantitatively unchanged, increasing non-cash compensation is unlikely to be the main driver of decoupling of wages from productivity in leading firms in countries with declining labour shares (Figure A B.3).

Figure A B.3. Average wages and productivity of firms excluding ICT services

2001=100



Note: Labour productivity and real wages are computed as the unweighted mean across firms of real value added per worker and real labour compensation per worker. Leaders are defined as the top 5% of firms in terms of labour productivity within each country group in each industry and year. The countries with a decline in the labour share excluding the primary, housing, financial ICT services and non-market industries over the period 2001-2013 are: Belgium, Denmark, Germany, Ireland, Japan, Korea, Sweden, United Kingdom and United States. The countries with an increase are: Austria, Czech Republic, Estonia, Finland, France, Italy, Netherlands and Spain.
Source: OECD calculations based on OECD-ORBIS.

Decomposition of labour productivity and real wage growth in leading firms

Contributions to labour productivity and real wages growth at the frontier can be decomposed as follow (Baily et al., 1992):

$$\Delta X = \underbrace{\left[s_2^{stay} X_2^{stay} - s_1^{stay} X_1^{stay}\right]}_{Contibution\ of\ incumbents} + \underbrace{\left[s_2^{entry} X_2^{entry} - s_1^{exit} X_1^{exit}\right]}_{Contribution\ of\ net\ entry} \quad \textbf{(3)}$$

where X denotes the logarithm of labour productivity or real wages; s denotes the share of each group of firms in the total number of leading firms; superscripts denote groups of firms; and subscripts denote the period.

Equation (3) can also be written as follows:

$$\Delta X = \left[\overline{s^{stay}} \Delta X^{stay}\right] + \left[\overline{s^{net\ entry}} \left(X_2^{entry} - X_1^{exit}\right)\right] + \varepsilon \quad \textbf{(4)}$$

where $\overline{s^{stay}} = \frac{s_1^{stay} + s_2^{stay}}{2}$, $\overline{s^{net\ entry}} = \frac{s_1^{exit} + s_2^{entry}}{2}$ and $\varepsilon = \frac{X_1^{stay} + X_2^{stay}}{2} \Delta s^{stay} + \frac{X_1^{exit} + X_2^{entry}}{2} \left(s_2^{entry} - s_1^{exit}\right)$

The numerator of s_1^{stay} and s_2^{stay} is the number of firms staying at the frontier from year *1* to year *2* and the denominator the total number of leading firms in years *1* and *2*. The total number of firms at the frontier is held constant over the period 2001-2013 (Andrews, et al., 2016) so that $s_1^{stay} = s_2^{stay}$.[26]

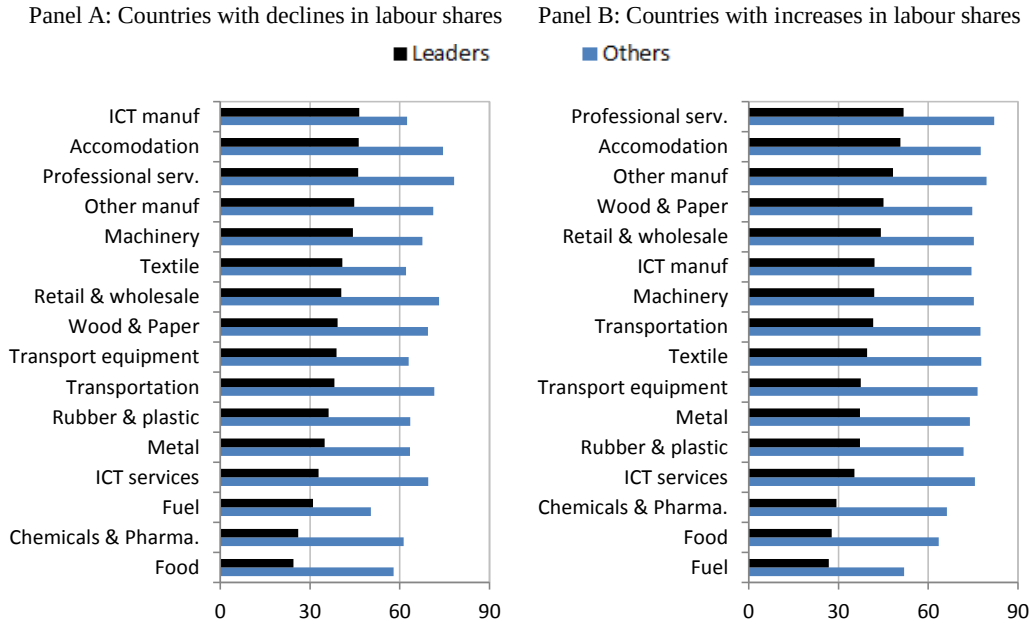
Since $s_1^{stay} + s_1^{exit} = 1$ and $s_2^{stay} + s_2^{entry} = 1$, $s_1^{stay} = s_2^{stay}$ implies that $s_1^{exit} = s_2^{entry}$ and $\varepsilon = 0$. As a consequence, equation (4) can be simplified as follows:

$$\Delta X = \underbrace{\left[s_1^{stay}\Delta X^{stay}\right]}_{Contribution\ of\ incumbents} + \underbrace{\left[s_1^{exit}\left(X_2^{entry} - X_1^{exit}\right)\right]}_{Contribution\ of\ net\ entry} \quad \textbf{(5)}$$

Labour shares in leading and other firms: Disaggregated industries

Labour shares in leading firms are lower than in other firms in all sub-industries of manufacturing and services across both country groups (Figure A B.4).

Figure A B.4. Labour shares in leading and other firms in manufacturing and services, 2001-2013



Note: The labour share is computed as the unweighted mean across firms of the ratio of total labour compensation to value added over the period 2001-13. Leaders are defined as the top 5% of firms in terms of labour productivity within each country group in each industry and year. The countries with a decline in the labour share excluding the primary, housing, financial and non-market industries over the period 2001-2013 are: Belgium, Denmark, Germany, Ireland, Japan, Korea, Sweden, United Kingdom and United States. The countries with an increase are: Austria, Czech Republic, Estonia, Finland, France, Italy, Netherlands and Spain.
Source: OECD calculations based on OECD-ORBIS.

[26] Andrews, Criscuolo and Gal (2016) define the technological frontier as the top 5% of a fixed number of firms, where the fixed number of firms is the median number of firms in each industry over the period 2001-13.