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Modelling Economic Policy Issues

OECD labour share trends: Factor efficiency vs. market distortions in a neoclassical framework[☆]Fernando Del Río^{a,*} , Francisco Rebelo^b ^a *ECOBAS and University of Santiago de Compostela, Facultade de CC. Económicas e Empresariais, Avda. Xoan XXIII s/n, 15702 Santiago de Compostela, Spain*^b *Católica Porto Business School, Rua de Diogo Botelho, 1327, 4169-005, Porto, Portugal*

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ABSTRACT

We find that, for the vast majority of the 29 OECD countries, capital efficiency has declined, while labour efficiency has increased. Moreover, capital and labour exhibit a relatively high degree of complementarity. On average, countries with a larger relative decline in capital efficiency have also experienced a greater decline in the labour share. This pattern is consistent with the neoclassical theory of functional income distribution: if capital and labour are gross complements, a decline in the relative efficiency of capital reduces the demand for labour, thereby lowering equilibrium wages and the labour share. In some countries — including the United States, the United Kingdom and Australia — this mechanism can accurately account for much of the observed evolution in the labour share, while in others — including the three largest European economies (Germany, France and Italy) — market frictions and distortions affecting labour demand have played a more prominent role. Policies aimed at halting the decline in capital efficiency, or mitigating market frictions and distortions, can therefore enhance productivity and support wage growth.

1. Introduction

Although the debate remains open due to technical considerations such as the treatment of capital depreciation, indirect taxes, and housing, the apportionment of mixed income, and intangible capital, there is broad consensus that the labour share has declined in many countries in recent decades. Although many papers have reported the decline in the labour share, [Blanchard \(1998\)](#) was the first to report a decline in the labour share in several European countries. The causes of this trend, however, remain under active discussion.¹

Some authors have suggested that the cause of this decline is capital deepening, others attribute it to an increase in the firm labour

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¹ [Rodríguez and Jayadev \(2013\)](#) estimated a declining trend in the labour share using an equally-weighted average of 129 countries.

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wedge (i.e. the gap between a firm's marginal product of labour and the real wage, including market frictions and distortions that cause wages to deviate from marginal productivity, such as taxes, mark-ups or adjustment costs, [Gali et al., 2007](#)), and still others to the bias of technological progress—or more broadly, to the relative evolution in the efficiency of capital and labour.²

This paper examines these three possibilities from a neoclassical perspective for a large number of OECD countries.³ Distinguishing between them is not only a theoretical curiosity, but has also strong economic policy implications, as the policies required may differ substantially.

We first estimate the elasticities of capital-labour substitution and factor augmentation rates for a set of 29 OECD countries for two purposes and we assess whether technical change is capital- or labour-biased, which implies assessing whether the gross complementarity ($\sigma < 1$) or the gross substitutability ($\sigma > 1$) hypothesis between capital and labour holds, and whether technical change is net labour-augmenting or net capital-augmenting.⁴ Second, evaluate the extent to which technical bias, capital deepening and changes in the firm labour wedge can account for the observed evolution of the labour share across OECD countries.⁵

We apply the normalized supply-side system approach developed by [Klump et al. \(2007\)](#) to estimate the elasticity of capital-labour substitution and the rates of factor-augmenting technical change for 29 OECD countries, allowing us to provide a comparative analysis of the results. Normalization consists in expressing the production relations in an indexed number and its importance stems from the seminal work of [de La Grandville \(1989\)](#). Previous works have typically applied the methodology to a single country (an exception is the work of [Mućk, 2017](#), who analyses 12 advanced economies). The main advantages of a system approach (rather than a single equation approach) are the ability to simultaneously include optimising behaviour (from the first-order conditions) and technology (from the production function); in addition, the inclusion of cross-equation parameter constraints increases the degrees of freedom and may improve parameter identification. Normalization enhances these advantages by allowing some parameters to be preset, thus simplifying the estimation of the elasticity of substitution and factor augmentation rates ([León-Ledesma et al., 2010](#)).

We find that, in most OECD countries, the elasticity of substitution is likely to be less than one and that labour efficiency has increased, while capital efficiency has declined. This implies that technical change has been both net labour-augmenting and capital-biased. The former conclusion has also been obtained in recent studies ([Table 1](#)) not only for the US economy (e.g. [Klump et al., 2007](#); [Herrendorf et al., 2015](#); [Del Río and Lores, 2019](#)), but also for different geographical scopes (e.g. [Klump et al., 2008](#); [Mallick, 2012](#); [Bellocchi and Travaglini, 2023](#)). Moreover, the net labour-augmentation result is also consistent with other studies focusing on the American economy (e.g. [Young, 2013](#); [León-Ledesma et al., 2015](#)) or with different geographical scopes (e.g. [Luoma and Luoto, 2010](#), for Finland, or [Mućk, 2017](#), for 12 advanced economies, who also estimated negative rates of capital-augmenting technical change). Our results suggest that if technical progress has been net labour-augmenting in almost all the countries in the sample, this is essentially due to the fact that the rate of capital-augmenting technical progress has also been negative in almost all countries. This means that capital efficiency has experienced a significant decline in the vast majority of OECD countries.

Unlike most previous work, we consider two alternative specifications of technological change. First, we adopt the standard assumption of constant rates of technological change, and second, we employ a [Box-Cox \(1964\)](#) specification for the technological change functions, which allows for rates of technological change to vary over time and has already been used in some recent studies (e.g. [Klump et al., 2007](#); [Stewart and Li, 2018](#); [Serrano-Quintero, 2023](#)). Given the Box-Cox specification and the large geographical coverage of our study, we can conclude that not only is labour-augmentation a common feature to most countries, but also that in most countries the observed decline in capital efficiency has accelerated over time, while the observed increase in labour efficiency has decelerated.

While some authors (e.g., [Karabarbounis and Neiman, 2014](#); [Piketty and Zucman, 2014](#); [Piketty, 2014](#); [Bellocchi and Travaglini, 2023](#)) attribute the decline in the labour share to capital deepening, our work identifies technological bias as the main driving force. We find that, despite the strong capital deepening observed in all OECD countries, the prevalence of net labour-augmentation is reflected in a decline in the effective capital-labour ratio for most OECD countries, which, in a context of gross complementarity, accounts for a large part of the decline in the labour share. Technical change bias thus appears to be the key factor accounting for the decline in the labour share, rather than capital deepening or changes in the firm labour wedge. Indeed, we find that capital deepening worked in the opposite direction, contributing to an increase in the labour share, and that the contribution of the firm labour wedge to the decline in the labour share was negligible. On average, the bias of technological progress contributed to reducing the labour share by about 0.33 per cent per year and capital deepening contributed to increasing it by about 0.28 per cent per year. Moreover, on average, in countries where the decline rate of labour share was greater, the rate of labour- (resp. capital-) biased technical change was

² The *labour wedge* represents the gap between a firm's marginal product of labour and a household's marginal rate of substitution which can be decomposed into the *firm labour wedge* and the *household labour wedge*—the gap between the real wage and a household's marginal rate of substitution—(see [Karabarbounis, 2014](#)).

³ We use an aggregate production function and the demand functions for the factors of production involved to carry out our estimations and simulations. The use of such a framework, and therefore the results obtained, are subject to the Cambridge Critique (UK) against neoclassical capital theory, which was mainly defended by economists from Cambridge (USA). Hence, the debate is known as the Cambridge–Cambridge Controversy. According to the Cambridge Critique, aggregate capital cannot be measured independently of the functional distribution of income. This critique constitutes an attack on the very foundations of neoclassical production and distribution theory.

⁴ Technical change is net labour- (resp. capital-) augmenting if the rate of labour-augmenting technical change is higher (resp. lower) than the rate of capital-augmenting technical change.

⁵ The relationship between productive inputs and technological change is often more intricate than what an aggregate production function suggests. Alternative technological frameworks, such as that proposed by [Acemoglu and Autor \(2011\)](#), offer valuable insights for understanding this dynamic and evaluating the effects of technological change on the factorial distribution of income.

Table 1
Recent empirical studies of elasticity of substitution and technical change.

Author(s)	Geographical scope	Period	Technical change assumption	Production function	Estimated σ	Estimated annual rate of efficiency change		
						Hicks-neutral: $\widehat{\xi}_L = \widehat{\xi}_K$	Labour-augmenting: $\widehat{\xi}_L$	Capital-augmenting: $\widehat{\xi}_K$
Karagiannis <i>et al.</i> (2005)	82 countries	1960-1987	Hicks-neutral	VES	$\sigma > 1$	–1.5 to –1.2		
Klump <i>et al.</i> (2007)	USA	1953-1998	Factor-augmenting	Normalized CES	0.50 to 0.60		1.50 to 1.70	0.40
Klump <i>et al.</i> (2008)	Euro area	1971-2005 (quarterly)	Factor-augmenting	Normalized CES	0.70		1971-1997: 1.45 1997-2005: -3.08	1971-1997: 0.56 1997-2005: 4.06
Luoma and Luoto (2010)	Finland	1902-2004	Factor-augmenting	Normalized CES	0.45		2.90	–0.70
Mallick (2012)	90 countries	1950-2000	Hicks-neutral	Normalized CES	0.34	?		
Young (2013)	USA	1960–2005	Factor-augmenting	Normalized CES	0.18 (norm.) to 0.62 (non-norm.)		6.10	3.50
Karabarbounis and Neiman (2014)	59 countries	1975-2012	Factor-augmenting	CES	1.25		?	0.90
Herrendorf <i>et al.</i> (2015)	USA	1947-2010	Factor-augmenting	Normalized CES	0.84		2.2	–1.0 (not significant)
Kreuser <i>et al.</i> (2015)	South Africa	1994-2012	Factor-augmenting	Normalized CES	1.32		–1.96	5.0
Le�n-Ledesma <i>et al.</i> (2015)	USA	1952-2009	Factor-augmenting	Normalized CES	0.44 to 0.72		2.0	0.2 to 0.5
Mu�k (2017)	12 advanced economies	1980-2006	Factor-augmenting	Normalized CES	0.70		2.60 to 2.80	–3.40 to –3.10
Semieniuk (2017)	i) UK ii) France iii) Germany iv) Australia v) Canada vi) Japan vii) Italy	1970-2010	Hicks-neutral	CES	i) 0.08 to 0.33 ii) 0.16 to 0.52 iii) 0.16 to 0.33 iv) 0.26 to 0.59 v) 0.18 to 0.47 vi) 0.41 to 0.96 vii) 0.30 to 1.38	?		
Stewart and Li (2018)	Canada	1961–2012	Factor-augmenting	Normalized CES	0.92 to 2.22		–5.30 to 3.30	–3.40 to 10.70
Jiang and Le�n-Ledesma (2018)	USA	1950-2014	Factor-augmenting	Normalized CES	0.82 to 0.86		0.50 to 1.00	4.00 to 5.90
Del R�o and Lores (2019)	USA	1947-2014	Factor-augmenting	VES	$\sigma < 1$		>0	<0
Bellocchi and Travaglini (2023)	i) France ii) Germany iii) Italy iv) Spain v) UK vi) USA	1980-2020	Hicks-neutral	CES and VES	$\sigma < 1$. Exceptions: - Italy (perfect competition); - USA (VES, imp. competition)		i) –0.55 to 0.15 ii) 0.22 to 0.36 iii) –2.05 to –0.39 iv) –0.37 to –0.20 v) –0.06 to 0.61 vi) –0.90 to –0.57	

smaller (resp. greater), while the contribution of capital deepening was greater.

Examining the entire trend of the labour share and not just its decline, we find that the perfect competition model with capital-biased technological change accurately captures the trend component of the labour share in ten OECD countries: Australia, Belgium, Estonia, Finland, Ireland, Slovenia, Spain, Sweden, the United Kingdom, and the United States. Moreover, in all these countries, the firm labour wedge appears to have played only a minor role in accounting for the trend component of the labour share. For the Czech Republic, the perfect competition model also correctly adjusts the trend component of the labour share, but according to our estimates, technical change in this country was labour-biased. The perfect competition model with only neutral technical change (i. e. without biased technical change) performs quite well for the United Kingdom, the Czech Republic and Sweden, although taking account of technical bias improves the fit.

It is worth highlighting that the perfect competition model has limited predictive capacity regarding the evolution of the functional distribution of income in the three largest Euro area economies, namely France, Germany and Italy. In these countries, the firm labour wedge seems to have played a significant, even prominent role in accounting for the evolution of the trend component of the labour share. The same applies to other European countries, Latvia, Lithuania, Luxembourg, the Netherlands, and Slovakia. The evidence is not as strong for Japan and Canada, countries in which the firm labour wedge played a significant, but not prominent, role in accounting for evolution of the labour share.

Our results therefore suggest that these market frictions and distortions might have played a relatively important role in the trend adjustment of the labour share in Japan, Canada and most European countries, including the three largest euro area economies (France, Germany and Italy). However, for the Anglo-Saxon economies of the US, Australia and the UK, as well as for some European countries (Belgium, Estonia, Finland, Ireland, the Czech Republic, Slovenia, Spain and Sweden), competitive forces appear to be more important.

Our analysis suggests that in many countries the reduction in the firm labour wedge in recent years has counteracted the negative effect of capital-biased technical change on the labour share. Since approximately 2008, the firm labour wedge has been on a downward trajectory in numerous countries. In particular, it underwent a pronounced decline in eighteen countries (Austria, Canada, the Czech Republic, Estonia, France, Germany, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, and the United States) and exhibited a discernible increase in only two (Greece and Ireland). In many countries, this decrease coincides with an increase, or at least a stabilization, in the labour share.

Focusing on the United States, the decrease in the firm labour wedge contributed to halting the decline in the labour share from around 2011. However, [De Loecker et al. \(2020\)](#) find that the US firm labour wedge has increased since the early 1980s and that the increase has intensified since the Great Recession. Our results do not fully support those of these authors. We find that the US firm labour wedge increased in the 1970s and the first decade of this century but declined in the 1980s and from around 2012.

Our work contributes to the literature on these topics in three important ways. First, the geographical breadth of the study (29 countries) must be highlighted. To date, most studies estimating a standardised system have focused on a single country or a small group of countries. Our estimates cover almost all OECD countries. This geographical breadth allows us to test whether the productive relationship between capital and labour and the technological change driving accumulation and growth are similar or significantly different across countries, and whether the forces that drive the factor distribution of income are the same or different across countries. Second, we have been flexible in the specification of technological processes. The vast majority of previous studies assume that rates of technical progress are constant, while we also allow them to be variable by adopting a Box-Cox specification of the technical change function. This allows us to test the robustness of our results to changes in the specification of the technical change processes and reveals an additional result: in most countries, the decline in capital efficiency has accelerated, while the increase in labour efficiency has decelerated. Third, there is an important debate in the literature about the possible causes of the decline in the labour share. The results of our work point to the overriding importance of the technological bias, although they also suggest that market frictions and distortions may have played a central role in explaining the trend movement of the labour share in the main European economies over recent decades. Moreover, our results suggest that the recent recovery, or at least stabilisation, of the labour share in many countries may have been driven by a significant reduction in these market frictions and distortions.

The remainder of this article is organised as follows. [Section 2](#) provides the contextual background for our study. [Section 3](#) describes the production function and the corresponding first-order conditions that will be used to estimate the elasticities of substitution and rates of technical change, as well as the econometric estimation framework. [Section 4](#) describes the data used in the estimations, while the estimation results are presented and discussed in [Section 5](#). [Section 6](#) analyses the cross-country relationship between the decline in the labour share and technical bias. [Section 7](#) evaluates the suitability of the neoclassical model in predicting labour share changes across countries. [Section 8](#) analyses the robustness of our results to an alternative technical change specification. Policy implications are discussed in [Section 9](#), and [Section 10](#) concludes with a summary of the main results.

2. The functional distribution of income: capital deepening, technical bias, or firm labour wedge

According to the neoclassical economic theory, movements in the functional income distribution can be driven by changes in capital intensity, the direction of technical change or changes in the firm labour wedge. Moreover, the elasticity of substitution between capital and labour, which plays an important role in a wide range of topics, is a key variable in determining the response of the functional income distribution to these changes; indeed, the concept itself was first introduced by [Hicks \(1932, p. 117\)](#) to study how the functional distribution of income changes with an increase in the supply of any factor: “An increase in the supply of any factor will increase its relative share (i.e., its proportion of the National Dividend) if its “elasticity of substitution” is greater than unity”.

Given an arbitrary production function with constant returns to scale, output is given by $Y_t = f(k_t)A_t^L L_t$, where $k_t = A_t^K K_t / A_t^L L_t$ represents the effective capital-labour ratio. The labour share is $s_t = \mu_t^{-1} \frac{f(k_t) - k_t f'(k_t)}{f(k_t)}$, where μ_t is the firm labour wedge. Given the definition of the elasticity of capital-labour substitution $\sigma(k_t) = -\frac{f'(k_t)[f(k_t) - k_t f'(k_t)]}{k_t f''(k_t) f(k_t)}$, then the evolution of the labour share, $d \ln(s_t)$, can be expressed as

$$d \ln(s_t) = (1 - s_t) \left[\frac{1 - \sigma(k_t)}{\sigma(k_t)} \right] d \ln(k_t) - d \ln(\mu_t), \tag{1}$$

where $d \ln(k_t)$ is equal to the rate of capital deepening minus the rate of net labour-augmenting technical change,

$$d \ln(k_t) = d \ln(K_t / L_t) - d \ln\left(\frac{A_t^L}{A_t^K}\right). \tag{2}$$

Therefore, if capital and labour are gross substitutes (complements), i.e., $\sigma > 1$ ($\sigma < 1$), then the labour share decreases (increases) with the effective capital-labour ratio. The rate of change of the effective capital-labour ratio depends positively on the rate of capital deepening and negatively on the rate of net labour-augmenting technical change. If $d \ln\left(\frac{A_t^L}{A_t^K}\right)$ is greater (resp. less) than zero, technical change is said to be net labour- (resp. capital-) augmenting. Irrespective of the elasticity of capital-labour substitution, an increase in the firm labour wedge reduces the labour share. When the elasticity of capital-labour substitution is equal to one (the Cobb-Douglas case), the labour share does not depend on the effective capital-labour ratio and only changes in the firm labour wedge affect the labour share.

When technical change increases the relative share of capital (resp. labour), it is capital (resp. labour)-biased. Thus, technical change is capital (resp. labour)-biased if $\sigma < 1$ (resp. $\sigma > 1$), and $d \ln\left(\frac{A_t^L}{A_t^K}\right) > 0$ or if $\sigma > 1$ (resp. $\sigma < 1$) and $d \ln\left(\frac{A_t^L}{A_t^K}\right) < 0$. That is, if capital and labour are gross complements (resp. substitutes), then, if technical change increases labour efficiency faster than capital efficiency, technical change is capital (resp. labour) biased and reduces (resp. increases) the labour share.

Eqs. (1) and (2) can be used as a guide to examine different explanations for the decline in the labour share observed in many countries over recent decades:

i. Capital deepening

Several studies have argued that the labour share decline in many countries was caused by capital deepening in a context in where capital and labour are gross substitutes, i.e., $\sigma > 1$. Karabarbounis and Neiman (2014) argued that the decline in the relative price of investment goods induced capital deepening, which, combined with an elasticity of capital-labour substitution greater than one (around 1.25), implied the observed decline in the labour share. Focusing on the eight largest developed economies, Piketty and Zucman (2014) also linked the decline to an increase in the capital-output ratio (which has increased more than the capital share and implied a decline in the average return to domestic capital), together with an elasticity of capital-labour substitution greater than unity. Piketty (2014) even mentions that the historical elasticity of capital-labour substitution should be in the range of 1.3 to 1.6. Bellocchi and Travaglini (2023), while estimating elasticities of capital-labour substitution below unity for six countries (UK, USA, Spain, Italy, France and Germany), attribute a good part of the decline in the labour share in these countries to capital deepening because they assume a production function with a variable and increasing elasticity of capital-labour substitution with capital intensity.⁶

If the decline in the labour share is due to the increase in capital intensity, then we should focus on policies that stop the substitution of labour for capital or on redistributive policies: increasing progressive taxation on capital (higher taxes on capital gains, dividends, and inheritances, wealth taxes on large fortunes to curb capital concentration, stronger enforcement against tax havens to prevent capital from escaping taxation, and a global progressive tax on wealth); investing in human capital to ensure that workers can complement capital rather than be replaced by it (expanding vocational training and lifelong learning programmes and increasing public funding for STEM education and digital skills development); strengthening labour’s bargaining power (stronger trade unions and collective bargaining, and higher minimum wages);⁷ promoting labour-intensive public investment (infrastructure spending can create jobs in less capital-intensive sectors, and investment in healthcare, education, and social services increases the demand for labour); corporate governance and profit-sharing reforms (worker representation in corporate decision-making, and profit-sharing mechanisms such as employee stock ownership plans or profit-sharing mandates for large corporation could redistribute earnings

⁶ They also find that increasing markups played a relevant role in accounting for the decline in the labour share.

⁷ It must be acknowledged that strong unions and higher minimum wages might have ambiguous effects on the labour share. On one hand, they may raise wages and bargaining power, increasing the labour share by shifting income from capital to labour. On the other hand, if wage increases exceed productivity growth, they can lead to job losses, automation, or offshoring, potentially lowering total labour income. Moreover, strong bargaining institutions may benefit only specific groups of workers, reinforcing labour market segmentation. Thus, the overall impact depends on institutional settings, productivity dynamics, and the inclusiveness of wage growth.

to workers); regulating automation and AI-driven capital deepening (tax incentives for firms that use AI to augment rather than replace labour and automation taxes to slow excessive capital deepening).

ii. Technical change

Technical change bias as a possible explanation for the decline in the labour share has received attention from some authors. The dominant conclusion of empirical studies has been an elasticity of capital-labour substitution lower than one (see [Chirinko, 2008](#)). Under gross complementarity, net labour-augmenting technical change is capital-biased and, if it is sufficiently rapid, it offsets capital deepening and reduces the labour share. Therefore, strong net labour-augmenting technical change makes it possible to reconcile capital deepening with the decline in the labour share in the context of gross complementarity, as the effective capital-labour ratio falls despite the increase in capital intensity. [Lawrence \(2015\)](#) argues that, despite the increase in capital intensity of the US economy, the effective capital-labour ratio has declined because of faster net labour-augmenting technical change in the sectors and industries that account for most of the decline in the labour share. [Del Río and Lores \(2019\)](#) also find that the decline in the US labour share was mostly caused by the decline in the effective capital-labour ratio due to a large decline in capital efficiency (see also [Del Río and Lores, 2021](#)).⁸ They also show that the US labour share decline was not due to the labour reallocation across sectors. [Alvarez-Cuadrado et al. \(2018\)](#) develop a two-sector model with different, but less than unity, elasticities of capital-labour substitution and find that net labour-augmenting technical change and structural change drove the decline in the labour share in several developed economies (including the US). [Guimarães and Mazedo Gil \(2022\)](#) conclude that technological factors are the more promising candidate to explain the fall in the US labour share. [Zhang et al. \(2024\)](#) identify a reduction in the labour share in Chinese firms following the application of industrial robots and [Yang et al. \(2023\)](#) find a comparable impact of digital transformation. [Mallick and Sousa \(2017\)](#) use firm-level data to explore the relationship between technology and the skilled-unskilled wage ratio and find that it depends on the type of industry. More recently, [Drydakis \(2024\)](#) finds that English workers with knowledge, skills and capabilities in technologies related to artificial intelligence received more and better, higher-paid job offers. Technical progress may also influence the factorial distribution of income by increasing the rate of obsolescence and thus altering the rental price of capital (see [Boucekkine et al., 2009](#), and [Del Río and Sampayo, 2014](#)). The increase of the obsolescence costs of capital caused by technical change can also affect job reallocation by decreasing job creation and increasing job destruction (see [del Río, 2010](#)), which also may alter the factorial distribution of income.

Here, we find that for most OECD countries that capital and labour are gross complements, and that capital efficiency declined, while labour efficiency increased. Therefore, technical change is net labour-augmenting and capital-biased. Our results suggest that economic policies addressing inefficiencies behind the decline in capital efficiency will not only enhance productivity but also positively affect the labour share.⁹

The decline in capital efficiency may be motivated by a variety of reasons: resource misallocation across sectors or firms due to regulations, barriers and tax burdens affecting sectors or firms differently; inefficient public investment (e.g., politically motivated projects or corruption); financial imperfections leading to overinvestment in some sectors (e.g., real estate bubbles); capital underutilization due to macroeconomic or regulatory uncertainty; unproductive use of capital due to rigid regulations (labour, environmental or other); institutional weaknesses, such as poor protection of property rights and contract enforcement, increasing transaction costs and leading to unproductive uses of capital (to protect against or to carry out rent-seeking activities, for example); the lack of workers with qualifications adapted to technological demands and new capital goods, which leads to underutilization of capital (the skills gap may be due to a defective educational system or to the absence of incentives for on-the-job training because high turnover or temporary employment caused by inadequate labour legislation); low quality of public infrastructure, which fails to reduce transaction costs and improve connectivity; investment in intangibles, often poorly measured in statistics, such as organisational capital or customer capital, also influences the more or less efficient use that companies make of their stock of tangible assets; finally, any error in the measurement of tangible or intangible capital will impact our measurement of its efficiency.

iii. The firm labour wedge

Many works have attributed the decline in the labour share to changes in the firm labour wedge, reflecting market frictions and distortions, such as imperfect competition or search frictions, and labour market institutions and policies.¹⁰ The literature has highlighted the role of changes in the worker's bargaining power ([Blanchard and Giavazzi, 2003](#)), the role of product market competition ([Azmat et al., 2012](#); [Autor et al., 2020](#); [Barkai, 2020](#)) and labour market institutions ([Bentolila and Saint-Paul, 2003](#); [Bental and](#)

⁸ [Del Río and Lores \(2021, 2023a and 2023b\)](#), using dynamic macroeconomic models, show that the direction of technological progress and the possibilities of substituting labour and capital at the aggregate level are important factors to consider in understanding the economic growth experience of countries such as the United States and Spain, as well as in accounting for economic recessions.

⁹ This study examines the determinants of labour share dynamics in advanced OECD economies. In contrast, developing economies may exhibit distinct driving factors. [Luo and Zhang \(2010\)](#) contend that foreign direct investment and privatization exert a negative impact on labour share in China. They emphasize that China's case is distinctive due to its economic development model, shaped by policies promoting openness to foreign capital and the restructuring of state-owned enterprises. The authors conclude that these structural factors, rather than technological change alone, largely account for the decline in labour share in China during the period under study. Conversely, [van Treeck and Wacker \(2020\)](#), analysing a sample of 40 developing countries, find no evidence that foreign investment accounts for the post-1990 decline in labour share in these economies.

¹⁰ Productive complementarities can amplify the effect of distortions on resource allocation (see [del Río and Sampayo, 2017](#)).

Demougin, 2010). Recently, Ibarra and Ros (2023) find that higher unemployment, the erosion of union density and informal labour productivity (domestic factors that weaken workers' bargaining power) play an important role in accounting for the decline of the manufacturing labour share in Mexico after 2002. Some studies of the Chinese economy indicate that alterations in economic policies that influence the firm labour wedge could have had a considerable effect on the labour share. In their study of the Chinese economy, Cheng et al. (2024) identify an increase in the Chinese labour share resulting from improvements to competition policy. Similarly, Si et al. (2024) find that an increase in banking competition led to an increase in the Chinese labour share. Furthermore, Yu et al. (2023) conclude that the implementation of the Social Insurance Law led to a notable reduction in the labour share of Chinese firms.¹¹

Policies that reduce and correct the market frictions and distortions that influence the firm labour wedge will not only increase employment and hours worked, but will also increase the labour share. A wide variety of distortions contribute to the firm labour wedge: The firm's monopsony power in the labour market or its monopoly power in the product market generates mark-ups that separate the marginal productivity of labour from the wage received by workers; search and matching frictions lead to a labour wedge due to unemployment and job vacancies; strict labour regulations, severance pay, and employment protection legislation might increase the cost of labour adjustment and affect the firm labour wedge; subsidies and affirmative may also distort labour allocation and firms' hiring decisions; if wages do not adjust downward during recessions (due to nominal rigidities), firms may not hire at the optimal level, worsening the wedge; technological advances may shift labour demand, creating short-term labour mismatches; firms facing demand volatility may reduce hiring due to uncertainty, increasing the labour wedge; firms with limited financing may underinvest in hiring, keeping employment below the efficient level; strong labour unions may push wages above the market-clearing level, leading to inefficiencies in labour allocation.

In this work, we find that the main cause of the decline in the labour share has been capital-biased technical change. However, we also find that the firm labour wedge has played an important role in accounting for the evolution of the labour share in many OECD countries. In particular, the decline in the firm labour wedge since around 2008 has contributed to increasing or at least stabilising the labour share in many OECD countries. Parisi (2017) assesses the impact of social policies and labour market institutions on the labour share for a group of countries with different labour market and education structures, and welfare regimes. She finds significant differences between four groups of developed countries: Continental European countries, Southern European countries, Scandinavian countries and Anglo-Saxon countries. According to her findings, the first three groups of countries have been more successful in halting the decline in the labour share through different types of social policies. Moreover, after the financial crisis of 2007, social policies, especially welfare spending, played an important role in preserving labour income in many countries.

2.1. Globalization

Economic globalization interacts with the three drivers of the evolution of the functional distribution of income described above. Globalization can influence the capital intensity of firms, the firm labour wedge and the direction of technological change in very different ways. Using data for a large sample of companies from six European countries, Perugini et al. (2017) find that the labour share is lower in exporting companies, in firms with greater foreign direct investment or in firms with more intense offshoring. Their results suggest that globalisation has played an important role in accounting for the decline in the labour share. Focusing on the Chinese economy, Zhang et al. (2017) find that the expansion of road infrastructure (which is a sign and a driver of greater economic integration) had a negative impact on the labour share. Decreuse and Maarek (2017) examine the effects of globalization on the labour share. They find that trade openness with developing countries reduces the labour share in rigid wage countries by shifting resources towards capital-intensive sectors but has no effect in free wage countries. Like our findings, they observe differences between Anglo-Saxon and continental European countries. Specifically, their analysis of the KLEMS dataset for eight OECD countries (1970–2005) shows that capital-intensive sectors grew significantly in continental Europe, whereas their share remained stable or declined in the United States and the United Kingdom.

3. Model specification and estimation methods

The normalized Constant Elasticity of Substitution (CES) production function including the factor efficiency parameters is given by:

$$Y_t = Y_0 \left[(1 - s_0) \left(\frac{A_t^K K_t}{A_0^K K_0} \right)^\psi + s_0 \left(\frac{A_t^L L_t}{A_0^L L_0} \right)^\psi \right]^{\frac{1}{\psi}}$$

where s_0 is the labour share in the normalization point, and the elasticity of substitution between capital and labour is $\sigma = \frac{1}{1-\psi}$ with $\psi < 1$.

The first-order conditions for capital and labour state that the real rental prices of capital and labour ($\frac{R_t}{P_t}$ and $\frac{W_t}{P_t}$, respectively) are equal to their marginal productivities. Therefore, the normalized first-order conditions for capital and labour are

¹¹ Del Río and Lores (2017) argue that governments may use economic regulations and policies to favour certain groups for political gain, potentially shifting income distribution in favour of capital owners over workers.

$$\frac{R_t}{P_t} = (1 - s_0) \left(\frac{\frac{Y_t}{Y_0}}{\frac{K_t}{K_0}} \right)^{1-\psi} \frac{Y_0}{K_0} \left(\frac{A_t^K}{A_0^K} \right)^\psi$$

and

$$\frac{W_t}{P_t} = s_0 \left(\frac{\frac{Y_t}{Y_0}}{\frac{L_t}{L_0}} \right)^{1-\psi} \frac{Y_0}{L_0} \left(\frac{A_t^L}{A_0^L} \right)^\psi.$$

The definition of the normalization point is particularly important for the quality of the estimation results. For empirical estimations of the normalized CES production function, it becomes an interesting question how the baseline values should be determined. If the estimation data were deterministic, this would be unproblematic: every sample point would be equally suitable for the point of normalization. However, since actual data are inevitably stochastic, this convenience does not carry over because the production function does not hold exactly in any sample point. Therefore, following Klump et al. (2012), for each country, we use sample averages (geometric for growing variables, such as capital and labour, and arithmetic for approximately stationary variables, such as the factor shares). In this way, we diminish the size of cyclical and stochastic components in the point of normalization.

However, as the CES production function is non-linear, the sample average of production may not be the same as the level of production implied by the production function using sample averages of each variable. Therefore, Klump et al. (2007) introduced an additional estimated parameter ξ , called the normalization constant and whose expected value is around one.¹² For each country, the normalization point is therefore defined as $Y_0 = \xi \bar{Y}$, $K_0 = \bar{K}$, $L_0 = \bar{L}$, $s_0 = \bar{s}$ and $t_0 = \bar{t}$, where the bar denotes the sample average (geometric in the case of the first three variables, and arithmetic in the case of the last two). If the estimated values of the distribution parameter and the normalization constant differ significantly from their initial values, the estimation results should be questioned. In this sense, normalization is also useful as a means of *a posteriori* validation of the estimated parameters.

Assuming that technical change is represented by factor augmentation at constant exponential rates $\frac{A_t^K}{A_0^K} = e^{\zeta_K(t-t_0)}$ and $\frac{A_t^L}{A_0^L} = e^{\zeta_L(t-t_0)}$, the logarithmic forms of the normalized CES production function and the first-order profit maximisation conditions can be expressed as follows:

$$y_l - \bar{y}l = \ln(\xi) + \zeta_L(t - \bar{t}) + \frac{1}{\psi} \ln \left[(1 - \bar{s}) \left(e^{(\zeta_K - \zeta_L)(t - \bar{t})} \frac{\frac{K_t}{K_0}}{\frac{L_t}{L_0}} \right)^\psi + \bar{s} \right]$$

$$y_k - \bar{y}k = -\sigma[\ln(1 - \bar{s}) + \bar{y}k] + (1 - \sigma)\ln(\xi) + \sigma r_t + (1 - \sigma)\zeta_K(t - \bar{t})$$

$$y_l - \bar{y}l = -\sigma[\ln(\bar{s}) + \bar{y}l] + (1 - \sigma)\ln(\xi) + \sigma w_t + (1 - \sigma)\zeta_L(t - \bar{t})$$

where y , y_k , y_l , r_t and w_t represent, respectively, the natural logarithms of Y , Y/K , Y/L , R/P and W/P respectively. Tables 2 and 3 display the summary statistics for these variables. The next section describes how the data were constructed.

The estimation is carried out using the Non-Linear Seemingly Unrelated Regression (NLSUR) approach, which is the most used estimation method in the recent literature on this topic (e.g. Klump et al., 2007, 2008; Stewart and Li, 2018; Jiang and León-Ledesma, 2018). Since the first-order conditions are obtained from the same production function, it seems plausible to admit that their errors terms are correlated, so the equations might be seemingly unrelated (Berthold et al., 2002). Unobserved productivity shocks or measurement errors that affect one input decision may also influence the other, leading to cross-equation error correlation. Estimating the system using NLSUR allows us to exploit this cross-equation covariance structure, thereby improving the efficiency and precision of parameter estimates relative to separate single-equation estimation (Zellner, 1962).

Furthermore, due to the endogeneity problem within the production function framework, we also consider the GMM estimator, using the first lags of the dependent and independent variables and the time trend as instruments. More precisely, we use the first lags of the natural logarithms of the normalized labour and capital productivities, real rental price of capital and real wage, normalized employment, capital stock and log-output and the time trend (Young, 2013; León-Ledesma et al., 2015). Inputs such as labour and capital are typically endogenous due to simultaneity with unobserved productivity shocks, measurement errors, and omitted variables that are correlated with input choices (Olley and Pakes, 1996; Levinsohn and Petrin, 2003). In a macroeconomic context, where factor allocation decisions are based on previously available information, lagged variables are assumed to be predetermined — correlated with current inputs (instrument relevance) but uncorrelated with current shocks (instrument exogeneity) (Arellano and Bond, 1991). This dynamic structure reflects the intertemporal optimization behavior, where past input choices influence current decisions. Consequently, lagged inputs and outputs serve as valid instruments in system GMM estimation of production functions (Blundell and Bond, 1998). Instrument strength is assessed using the Staiger and Stock (1997) rule. The first-stage F-statistics from auxiliary

¹² Note that ξ would be exactly equal to 1 in the case of the log-linear Cobb-Douglas production function.

Table 2
Summary statistics of regression variables: y , yk and rp .

Country	Period	Obs.	y			yk			rp			
			Mean	St. Dev.	Δ	Mean	St. Dev.	Δ	Mean	St. Dev.	Δ	
Australia	AU	1978:3-2019:4	166	7.8103	0.3844	1.2485	-3.0280	0.0433	0.0566	-4.0396	0.1425	0.3929
Australia1	AU1	1978:3-2019:4	166	7.8103	0.3844	1.2485	-3.0280	0.0433	0.0566	-3.9795	0.1229	0.3953
Austria	AT	1995:1-2019:4	100	6.5174	0.1251	0.4356	-2.9224	0.0320	-0.0811	-4.0484	0.0711	0.0991
Belgium	BE	1995:1-2019:4	100	6.7093	0.1357	0.4627	-2.7802	0.0491	-0.1387	-3.9156	0.0484	-0.0272
Canada	CA	1997:1-2019:4	92	8.2295	0.1475	0.5587	-2.7098	0.0870	-0.1899	-3.8193	0.1008	-0.1543
Canada1	CA1	1997:1-2019:4	92	8.2295	0.1475	0.5587	-2.7098	0.0870	-0.1899	-3.7697	0.1016	-0.1677
Czech Republic	CZ	1996:1-2019:4	96	9.0924	0.1838	0.6033	-2.9487	0.0407	0.0408	-3.7504	0.0458	-0.0922
Denmark	DK	1995:1-2019:4	100	8.2479	0.0998	0.3819	-2.8456	0.0445	-0.0691	-3.9209	0.0637	-0.0694
Estonia	EE	2000:1-2019:4	80	3.7028	0.1753	0.6794	-2.8520	0.0960	-0.0556	-3.7176	0.1543	-0.1937
Finland	FI	1990:1-2019:4	120	5.9966	0.1953	0.4606	-2.8269	0.0801	-0.2083	-3.9055	0.1829	0.1581
France	FR	1990:1-2019:4	120	8.3183	0.1419	0.4469	-3.0034	0.0421	-0.1062	-4.2362	0.0750	-0.0437
Germany	DE	1991:1-2019:4	116	8.7080	0.1062	0.3516	-3.0643	0.0385	0.0816	-4.1786	0.0712	0.0372
Greece	GR	1995:1-2019:4	100	6.0685	0.1451	0.1050	-2.9562	0.2005	-0.3987	-3.9075	0.2663	-0.4872
Hungary	HU	1995:1-2019:4	100	11.0777	0.1696	0.5922	-2.7841	0.0673	-0.1488	-3.7077	0.0538	0.1421
Ireland	IE	1995:1-2019:4	100	6.0690	0.3459	1.3612	-2.3273	0.1651	-0.3575	-3.0929	0.1999	0.1884
Italy	IT	1996:1-2019:4	96	8.2099	0.0380	0.0929	-3.0040	0.0590	-0.1090	-4.0780	0.0857	-0.1121
Japan	JP	1994:1-2019:4	104	14.0483	0.0601	0.1950	-3.0908	0.0251	0.0231	-3.9729	0.0786	0.1123
Latvia	LV	1995:1-2019:4	100	3.7670	0.2928	0.9171	-2.6766	0.2239	-0.5172	-3.4903	0.2631	-0.7114
Lithuania	LT	1995:1-2019:4	100	4.1514	0.3068	1.0413	-2.4268	0.1132	-0.2134	-3.2260	0.1180	-0.3678
Luxembourg	LU	1995:1-2019:4	100	4.5721	0.2358	0.8113	-2.4637	0.0512	-0.1193	-3.3174	0.0665	-0.0601
Netherlands	NL	1996:1-2019:4	96	7.2600	0.1117	0.4517	-2.7101	0.0523	-0.0910	-3.8370	0.0661	-0.0188
Norway	NO	1995:1-2019:4	100	8.7994	0.1397	0.5218	-2.8066	0.0878	-0.2328	-3.6087	0.1245	-0.2338
Poland	PL	1995:1-2019:4	100	7.9922	0.2816	1.0164	-2.4402	0.0237	0.0188	-3.3585	0.1293	0.1872
Portugal	PT	1995:1-2019:4	100	5.9786	0.0745	0.3328	-3.0895	0.0647	-0.0388	-4.1427	0.0527	0.1107
Slovak Republic	SK	1995:1-2019:4	100	4.8987	0.2825	0.9091	-2.7257	0.0571	0.0780	-3.4472	0.0768	-0.1312
Slovenia	SI	1995:1-2019:4	100	4.2671	0.1862	0.6677	-2.8308	0.0717	-0.0621	-4.2054	0.1384	0.6167
Spain	ES	1995:1-2019:4	100	7.7105	0.1432	0.5032	-2.8224	0.0969	-0.1702	-3.8541	0.0673	-0.0063
Sweden	SE	1993:1-2019:4	108	8.9408	0.1896	0.6652	-2.8319	0.0603	-0.1420	-3.7810	0.0912	-0.0943
Switzerland	CH	1990:1-2019:4	120	7.2101	0.1594	0.4826	-2.9791	0.0829	0.2016	-4.0321	0.1034	0.1229
United Kingdom	UK	1995:1-2019:4	100	8.3030	0.1336	0.4936	-2.5673	0.0510	-0.1197	-3.6034	0.0888	-0.2411
United States of America	US	1970:1-2019:4	200	10.0882	0.4122	1.3711	-2.6611	0.0348	-0.0695	-3.7029	0.0595	0.2071
United States of America1	US1	1970:1-2019:4	200	10.0882	0.4122	1.3711	-2.6611	0.0348	-0.0695	-3.5587	0.0303	0.0797

Note: AU1, CA1 and US1 represent the summary statistics obtained when adjusting the labour share by the income of self-employed workers.

Table 3
Summary statistics of regression variables: yl and wp .

Country	Period	Obs.	yl			wp			
			Mean	St. Dev.	Δ	Mean	St. Dev.	Δ	
Australia	AU	1978:3-2019:4	166	-15.6425	0.1889	0.5782	-16.0995	0.1359	0.3928
Australia ¹	AU1	1978:3-2019:4	166	-15.6425	0.1889	0.5782	-16.1342	0.1461	0.3848
Austria	AT	1995:1-2019:4	100	-14.7419	0.0968	0.2772	-15.1357	0.0683	0.1992
Belgium	BE	1995:1-2019:4	100	-15.8531	0.0715	0.2271	-16.2415	0.0575	0.1728
Canada	CA	1997:1-2019:4	92	-15.8466	0.0762	0.2838	-16.2475	0.0699	0.2670
Canada ¹	CA1	1997:1-2019:4	92	-15.8466	0.0762	0.2838	-16.2728	0.0714	0.2727
Czech Republic	CZ	1996:1-2019:4	96	-12.4566	0.1758	0.5816	-13.0529	0.1988	0.6898
Denmark	DK	1995:1-2019:4	100	-12.4762	0.0822	0.2734	-12.8941	0.0764	0.2736
Estonia	EE	2000:1-2019:4	80	-15.7862	0.1749	0.6711	-16.3359	0.2125	0.7631
Finland	FI	1990:1-2019:4	120	-14.7182	0.1542	0.4732	-15.1405	0.1111	0.3035
France	FR	1990:1-2019:4	120	-14.7110	0.1065	0.3419	-15.0561	0.1002	0.3170
Germany	DE	1991:1-2019:4	116	-14.7036	0.0929	0.3307	-15.1020	0.0838	0.3530
Greece	GR	1995:1-2019:4	100	-15.5020	0.1075	0.0291	-15.9930	0.1075	0.0870
Hungary	HU	1995:1-2019:4	100	-10.2834	0.1830	0.5348	-10.7930	0.1435	0.3464
Ireland	IE	1995:1-2019:4	100	-14.4906	0.2544	0.9134	-15.1369	0.1487	0.3752
Italy	IT	1996:1-2019:4	96	-14.8924	0.0209	0.0250	-15.3109	0.0187	0.0267
Japan	JP	1994:1-2019:4	104	-11.4109	0.0932	0.3074	-11.9474	0.0565	0.2497
Latvia	LV	1995:1-2019:4	100	-16.2009	0.3529	1.0849	-16.7928	0.3690	1.2101
Lithuania	LT	1995:1-2019:4	100	-16.1345	0.3162	1.0376	-16.7362	0.3025	1.1607
Luxembourg	LU	1995:1-2019:4	100	-14.0798	0.0421	0.1135	-14.6361	0.0337	0.0729
Netherlands	NL	1996:1-2019:4	96	-14.5952	0.0673	0.2116	-14.9873	0.0624	0.1791
Norway	NO	1995:1-2019:4	100	-11.8009	0.0756	0.2483	-12.4000	0.0673	0.2491
Poland	PL	1995:1-2019:4	100	-14.7848	0.2571	0.9614	-15.3041	0.1880	0.8477
Portugal	PT	1995:1-2019:4	100	-15.5742	0.0724	0.2243	-16.0073	0.0381	0.1411
Slovak Republic	SK	1995:1-2019:4	100	-15.7893	0.2566	0.8599	-16.4575	0.2755	1.0405
Slovenia	SI	1995:1-2019:4	100	-15.5351	0.1739	0.6459	-15.8310	0.1385	0.4749
Spain	ES	1995:1-2019:4	100	-15.0624	0.0595	0.1528	-15.5042	0.0438	0.0662
Sweden	SE	1993:1-2019:4	108	-12.3783	0.1289	0.4343	-12.8686	0.1430	0.4062
Switzerland	CH	1990:1-2019:4	120	-15.4678	0.0977	0.2992	-15.8974	0.0942	0.3442
United Kingdom	UK	1995:1-2019:4	100	-14.9194	0.0823	0.2851	-15.3588	0.1076	0.3543
United States of America	US	1970:1-2019:4	200	-16.0410	0.2279	0.7418	-16.4784	0.1912	0.5987
United States of America ¹	US1	1970:1-2019:4	200	-16.0410	0.2279	0.7418	-16.5653	0.2089	0.6447

Note: AU1, CA1 and US1 represent the summary statistics obtained when adjusting the labour share by the income of self-employed workers.

instrumental variables regressions always exceed the conventional threshold of 10 (see Table 4), indicating that the instruments are not weak. This supports the consistency and approximate unbiasedness of the GMM estimates, and underpins valid statistical inference and reliable identification of causal effects.

The non-linearity of the normalized systems requires furthermore the choice of initial parameter values as the estimation procedure relies on iterative numerical methods that require a starting point to ensure convergence and identification. In this matter, we follow Young (2013) and estimate the capital and labour single equation first-order conditions by OLS as a two-equation system; the resulting estimates are then set as initial values in the system estimation, allowing the iterative optimization routine to begin from economically meaningful and data-informed starting points.

4. Data

The estimation is carried out for the 29 OECD economies listed in Table 2 (as well as in Table 3) covering the longest period span for which all data are available for each country until the end of 2019 (before the Covid-19 pandemic). Seasonally adjusted data at the quarterly frequency are taken mainly from the OECD Quarterly National Accounts (QNA) database. In particular, real output (Y_t) is the difference between nominal gross domestic product and taxes less subsidies on production and imports deflated by the price index of gross output (P_t),¹³ while real investment (I_t) is derived from gross fixed capital formation also deflated by P_t .

¹³ Note that information on taxes less subsidies on productions and imports was not available for Japan, so in this case nominal output was considered at market prices.

Table 4
Instrument relevance tests (first-stage F-statistics).

Country	Production Function	Capital first order condition	Labour first order condition
AU	13514.72	1448.43	6298.64
AT	3174.65	302.87	1790.58
BE	10075.44	213.13	2247.54
CA	10520.92	375.80	1797.95
CZ	2839.39	177.34	3441.89
DK	2677.99	91.98	1114.01
EE	1837.29	294.24	1376.51
FI	7934.22	1244.79	2385.86
FR	38908.4	1070.11	21137.23
DE	4251.42	266.31	5240.31
GR	3330.21	1179.30	512.29
HU	13775.93	67.33	1455.28
IE	4206.21	276.82	1655.49
IT	2146.59	364.59	97.41
JP	8199.17	336.06	2255.78
LV	13503.32	842.69	4056.51
LT	11029.05	354.12	3734.36
LU	132.41	15.16	57.71
NL	4443.44	310.24	978.03
NO	6356.68	383.82	298.99
PL	24855.52	146.71	1623.94
PT	2016.10	73.40	143.72
SK	8363.62	80.62	5750.48
SI	13991.82	325.26	4122.98
ES	8423.67	472.44	692.98
SE	10066.80	369.50	5118.42
CH	582.68	1136.09	8618.04
UK	8416.39	460.76	2917.21
US	22698.51	640.50	55406.34

The real labour stock (L_t) corresponds to total hours worked in the QNA database (HT): $L_t = HT_t$.¹⁴ When this information was not available in the QNA database, it was calculated from the OECD Economic Outlook 110 by multiplying hours worked per worker, total economy (HRS) by total employment, national accounts basis (ET_NA):¹⁵ $L_t = HRS_t \times ET_NA_t$. When the latter information was not available, by multiplying hours worked per worker, total economy (HRS) by total employment, labour force survey basis (ET):¹⁶ $L_t = HRS_t \times ET_t$.

To determine total labour compensation, $W_t L_t$, we impute to self-employed workers the same hourly wage received by employees, $\frac{CE_t}{L_t}$ (Kravis, 1959; Giandrea and Sprague, 2017). More precisely, using the QNA variables compensation of employees (CE) and hours worked by employees (HE), total labour compensation is equal to:

$$W_t L_t = CE_t + \frac{CE_t}{L_t} L_{S,t} = CE_t \frac{L_{E,t}}{L_t},$$

where $L_{S,t}$ are hours worked by self-employed and $L_{E,t} = L_t - L_{S,t}$ are hours worked by employees. The labour share is

$$s_t = \frac{W_t L_t}{P_t Y_t} = \frac{CE_t}{P_t Y_t} \frac{L_{E,t}}{L_t},$$

Hours worked by employees ($L_{E,t}$) corresponds to the hours worked by employees in the QNA database (HE): $L_{E,t} = HE_t$. When this information was not available in the QNA database, it was calculated from the OECD Economic Outlook 110 by multiplying hours worked per worker, total economy (HRS) by total number of employees, national accounts basis (EM_NA): $L_{E,t} = HRS_t \times EM_NA_t$. When the latter information was not available, by multiplying hours worked per worker, total economy (HRS) by total employment, labour force survey basis (EM): $L_{E,t} = HRS_t \times EM_t$.

¹⁴ OECD countries exhibit considerable variation in measuring workers (employees and self-employed) and hours worked for national accounts, driven by differences in definitions, data sources, and labor regulations. These disparities are particularly pronounced between developed nations with stringent regulations (e.g., Germany) and those with significant informal economies (e.g., Mexico or Colombia), especially in accounting for self-employed workers. The OECD provides harmonized standards emphasizing actual hours worked, yet challenges like informal economies and inconsistent data collection persist. Nonetheless, OECD guidelines indicate that these data, while less suitable for absolute level comparisons, are reliable for trend analysis due to consistent national methodologies over time. For instance, harmonized OECD series adjust national data to reveal trends in hours worked or labor share, highlighting patterns such as the rise in part-time employment or the decline in labor share due to technological and structural shifts.

¹⁵ This was the case for Belgium, Switzerland and the USA.

¹⁶ This was the case for Australia, Canada and Japan.

Although the adjustment described in the preceding paragraphs is usually preferable (see Gollin, 2002), another adjustment is possible. In national accounts, the income of the self-employed appears under the heading Mixed Income (MI). However, the income of the self-employed generally includes incomes from both labour and capital. We can allocate them by assuming that the fraction attributable to each factor is the same as for employees. In particular, the fraction of total income generated by employees is $\frac{CE_t}{PY_t - MI_t}$. Then, total wage income is

$$WL_t = CE_t + \frac{CE_t}{P_t Y_t - MI_t} MI_t = CE_t \frac{P_t Y_t}{P_t Y_t - MI_t},$$

and the labour share is

$$s_t = \frac{WL_t}{P_t Y_t} = \frac{CE_t}{P_t Y_t - MI_t}.$$

However, the OECD QNA database and the OECD Economic Outlook only have seasonally adjusted MI series for two countries: Canada and Australia. To test the robustness of our estimates, we performed our estimates for both labour share measures for these two countries and the United States. The labour share data for the United States, adjusted for the mixed income of the self-employed, were constructed by Del Río and Lores (2023) using NIPA data. Australia, Canada, and the United States are shown as separate entries in Fig. 1 and in Tables 2, 3, and 5 when using this alternative measure of labour income, labeled respectively as Australia1, Canada1, and United States1. As it can be seen in Fig. 1, the two labour share measures give similar results for these countries. It is therefore not surprising that the estimation results are similar (see Table 5). Although we only have data for these three countries, we have no reason to believe that the situation would be different for the remaining countries. As we do not find significant differences between the two measures with the available data, we focus our analysis on the first measure. Since the two measures produce different values for the labour share, the values for the factor shares also change at the normalization point. Therefore, the estimates for Australia, Canada, and the United States under both measures also serve as a sensitivity analysis of our results to the choice of normalization point.

To compute the real wage ($\frac{W_t}{P_t}$), $W_t L_t$ is divided by L_t and deflated by P_t . Taking into account that under perfect competition and constant returns to scale income is exhausted in the remuneration of the factors of production, we calculate the rental price of capital as follows: $\frac{R_t}{P_t} = \frac{Y_t P_t - W_t L_t}{K_t P_t}$, where K_t is the stock of capital, which is calculated as explained in the following paragraph.

To construct the series of capital, we apply the perpetual inventory method (PIM), proposed by Goldsmith (1951) and subsequently used and extended in several studies. Given an initial level of capital for each country, the remaining values of the capital series are computed as $K_t = I_t + (1 - \delta)K_{t-1}$, where δ is the depreciation rate. Denoting the investment rate as $i_t = I_t / Y_t$ and g_K as the growth rate of the capital stock, we set the initial stock of capital as follows: $K_0 = \frac{iY_0}{g_K + \delta}$. To avoid relying on a single observation for the level of investment in the first period, since this variable may be subject to short-term fluctuations, and the growth rates of investment and capital accumulation change depending on the position of the country relative to its steady state level, we use the Hodrick-Prescott filter to determine Y_0 . Furthermore, we use the first ten years (forty quarters) of the sample to calculate the average of the investment rates (which we use as i_0) and to calculate the average growth rate of real output, which is assumed to approximate the growth rate of the real capital stock. The average depreciation rate for each country is calculated from the Penn World Table 12.

Accurately measuring capital stock can be challenging due to several reasons, which can lead to incorrect or misleading estimates. Below are some key factors that contribute to measurement errors in capital stock: (i) Capital stock is often measured based on assumptions about depreciation rates. If these rates are inaccurately estimated, the resulting capital stock will be distorted, affecting subsequent analyses. (ii) The valuation of capital assets, particularly physical capital like machinery, buildings or infrastructure, often relies on market prices, which may not always reflect the true value of the asset in use. In some cases, assets may not have an observable market price, especially for unique or specialized equipment. (iii) The value of capital goods, such as machinery, equipment, or infrastructure, is often estimated using historical cost which might not reflect the true market value of the capital goods, leading to incorrect estimates of capital stock. (iv) In modern economies, intangible assets like intellectual property, software, and organizational capital contribute significantly to output. These are much harder to measure compared to physical capital goods, and if neglected, capital services can be miscalculated. (v) Capital goods are heterogeneous, meaning different types of capital (e.g., machinery, buildings, vehicles, etc.) contribute differently to production. Aggregating different types of capital into a single measure, especially if they have different productivity levels, can result in inaccurate capital service estimates. Over time, the composition of capital (e.g., the proportion of machines versus human capital or information technology) changes. If these changes are not properly accounted for, it can distort the measurement of capital services. When capital stock is aggregated across industries or sectors, there may be misalignments in how different types of capital contribute to production. Some industries may have more capital-intensive processes than others, leading to aggregation errors if this heterogeneity is not properly handled. (vi) The price of different types of capital can change at different rates over time. For example, the price of information technology may fall rapidly, while the price of infrastructure might rise. Not accounting for these price changes can distort the capital stock measurement. (vii) Maintenance and renovation expenditures are crucial for extending the life and productivity of capital assets. If these costs are not properly accounted for, the capital stock may be underestimated because it fails to reflect the improvements in capital that result from maintenance.

The evolution of the labour share and capital intensity in each country is shown in Fig. 1. Of the 29 OECD countries considered, 17 showed a downward trend in their labour shares, 7 of them by more than 10 %: Australia, Finland, Hungary, Ireland, Poland, Slovenia and the United States. Even if shorter time periods are considered for Australia and the United States, significant declines can be observed: in both countries, the labour share has fallen by more than five percentage points since 2001 (5.8 and 5.5 percentage points respectively); however, it should be noted that in the case of Australia, the labour share has shown a clear downward trend since the early 1980s, while in the case of the United States a downward trend can be observed in the early years of the period, after which the

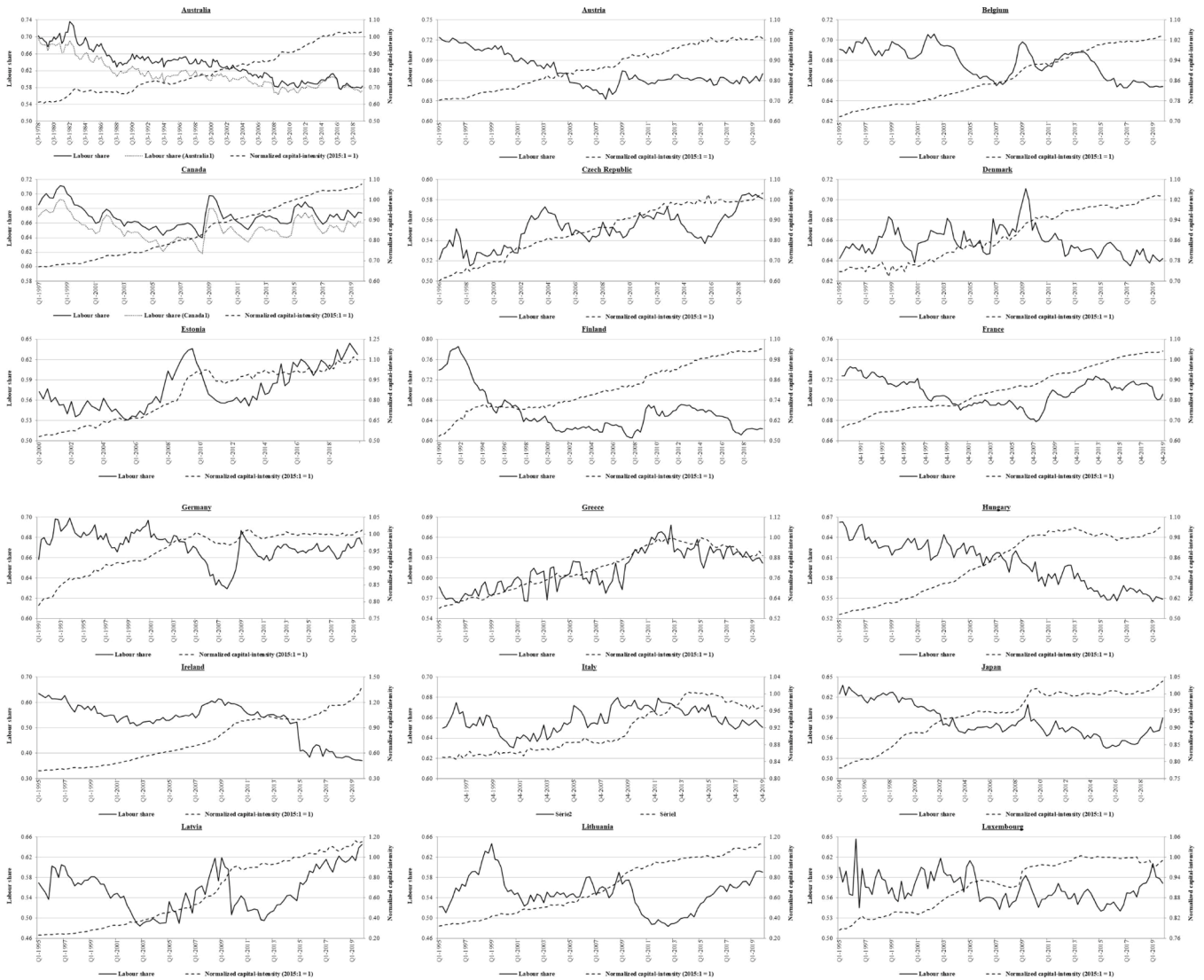


Fig. 1. Evolution of the labour share and capital-intensity in OECD countries.

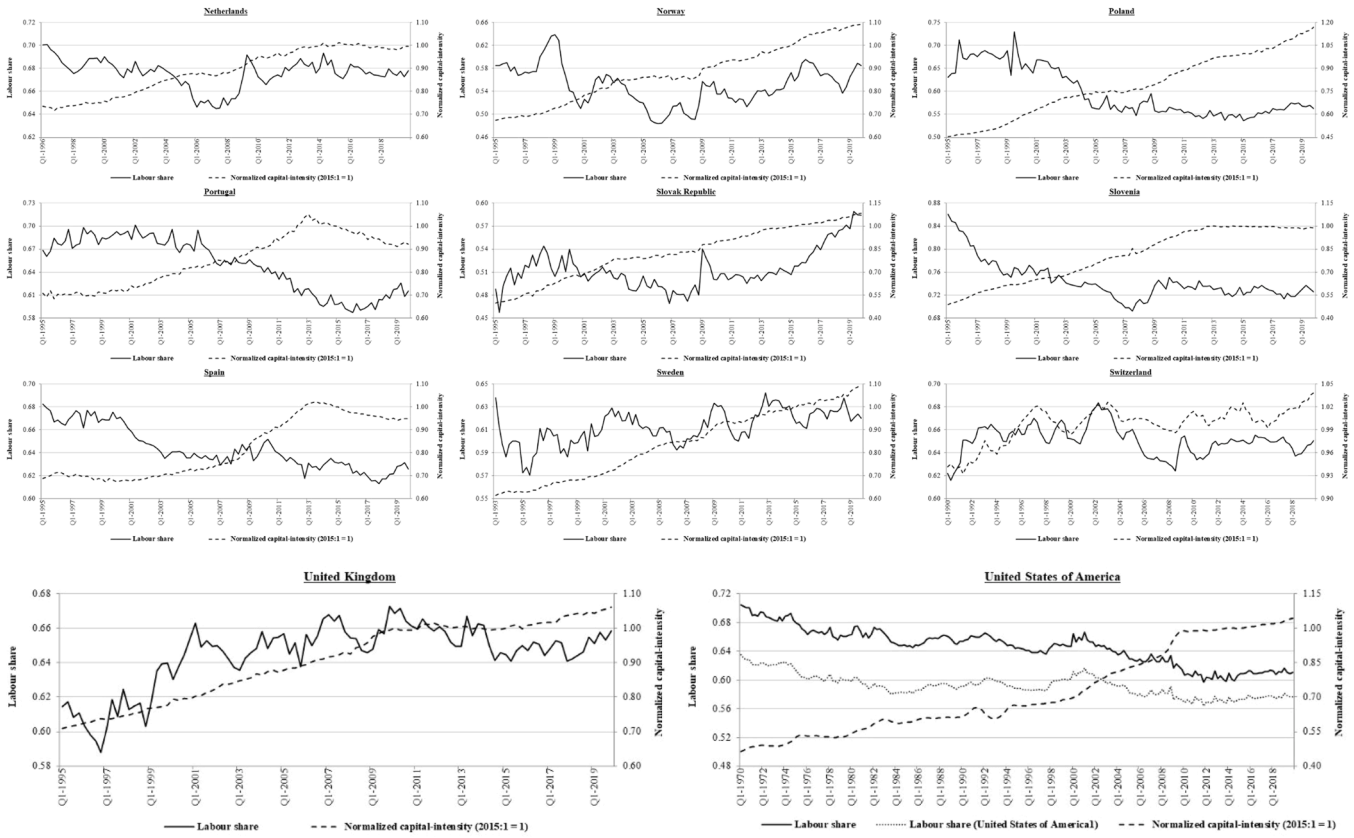


Fig. 1. (continued).

labour share remained fairly stable, despite some cyclical fluctuations, until the end of the twentieth century. The largest decline was in Ireland, where the labour share fell by more than 26 percentage points since 1995. Within Europe, Spain also shows a clear downward trend until 2018, while outside Europe, the case of Japan is also noteworthy, where the labour share fell by almost 13 % until 2015, but has shown signs of recovery in recent years.

Conversely, several countries experienced strong increases in their labour shares, in particular Eastern European countries such as the Slovak and Czech Republics or the Baltic States. The largest euro area economies, Germany and France, show relatively stable labour shares when comparing the starting and the final situation, despite the overall opposite trends (+1.5 percentage points in the case of Germany and –1.8 percentage points in the case of France). It should be noted, however, that Germany experienced a sharp decline in its labour share from the beginning of the century until 2008, but this figure recovered in the following year and has remained fairly stable over the last decade; a similar trend can also be seen in France, but in this case the decline in the labour share started at the beginning of the period. As far as the United Kingdom and Italy are concerned, their labour shares have been fairly stable over the last decade, although in the case of the latter there has been a slight downward trend since 2015; in the case of the United Kingdom, however, there is a clear increase in the labour share in the first half of the period. Outside Europe, the relative stability of the labour share in recent years can also be observed for Canada.

Capital intensity increased in all countries relative to its initial value. Rapid growth rates were observed throughout the period, particularly in Eastern European countries (such as Poland), the Baltic countries, Finland and Ireland. Nevertheless, in recent years capital intensity seems to have stabilised in some countries, such as Germany (since 2005), the Netherlands (since 2013) or Japan (over the last decade), while in other countries, particularly in Southern Europe, a clear downward trend can be observed from 2013 to 2015, namely in Greece, Italy, Portugal and Spain.

5. Estimation results

The estimates of the aggregate elasticities of capital-labour substitution and the rates of factor-augmenting technical change are displayed in [Table 5](#). The estimated coefficients are almost all statistically significant at the 1 per cent level, and in virtually all countries the normalization constant is almost indistinguishable from unity.

Elasticity of capital-labour substitution. The NLSUR and GMM point estimates of the elasticity of substitution, as well as the 95 (and also the 99) per cent confidence intervals, lie entirely below unity for all countries, corresponding to the case of gross complementarity between capital and labour. Nevertheless, in a few cases the estimated elasticity of substitution is not far from this value, namely in Greece (0.99), Hungary (0.95–0.97) and Sweden (in this case using the GMM method only: 0.99), and therefore the Cobb-Douglas case should not be discarded. The lowest estimates are obtained for Poland (0.16–0.17), Germany (0.24 or 0.31) and Norway (0.26) and consequently the Leontief case (zero elasticity of substitution) is never obtained (not even within the 99 per cent confidence intervals). The estimated elasticity of capital-labour substitution for the US ranges between 0.70 (NLSUR) and 0.76 (GMM), which is not far from the result obtained in previous studies focusing on this economy (e.g. [Klump et al., 2007](#); [León-Ledesma et al., 2015](#)). Besides Germany, the largest European economies, United Kingdom, France and Italy, have estimates in the range of 0.45 to 0.55, while the estimates for Spain are between 0.71 and 0.72. Outside Europe, Australia, Canada and Japan have estimates comprised between 0.36 and 0.41 (with the only exception being Australia using the GMM method, whose result is 0.59).

Factor-augmenting technical change. As far as the estimates of factor augmentation are concerned, the dominant conclusion is the finding of net labour-augmentation rates (in 27 of the 29 countries using the NLSUR method, the exceptions being the Czech Republic and Greece, or in 26 countries using the GMM method, including Sweden as an exception), which generally result from a positive rate of labour-augmenting technical change combined with a negative rate of capital-augmenting technical change. In fact, positive rates of capital-augmentation were found only for a few European countries, namely the Czech Republic, Estonia, Germany, Greece, the Slovak Republic, Sweden and Switzerland, while negative rates of labour-augmentation were estimated only for Greece, Italy (using the NLSUR method), the Czech Republic (using the GMM method, although not statistically significant) and Sweden (using the GMM method).

The estimated rates of capital-augmenting technical change for the US are either 0.0031 or 0.0039, while the estimated rates of labour-augmenting technical change are 0.0054 or 0.0058, resulting in a net labour-augmenting rate of 0.0086 or 0.0097, which is significantly higher in absolute terms than those recorded for the largest European economies (namely Germany, France, the United Kingdom and Italy, although it should be stressed that they have different time periods). Outside Europe, Canada has capital-augmentation rates close to those recorded for the United States, while the same can be observed for Australia in the case of labour-augmentation rates; for Japan, capital-augmentation rates are close to zero (0.0004 or 0.0008), while labour-augmentation rates are either 0.0034 or 0.0039.

Note that the estimates of technical change obtained for Greece are considerably higher than for the other countries, which is probably related to the estimated value of the elasticity of capital-labour substitution close to unity: in the Cobb-Douglas case, the bias of technical change cannot be determined empirically, which may also explain the deviation of the normalization constant from unity. To a lesser extent, this is also the case for the other countries where the estimated elasticity of capital-labour substitution is close to unity, namely Hungary and Sweden (using the GMM method). Beyond these countries, the fastest rates of net labour-augmentation were found for Latvia, Lithuania, Ireland and Spain, while the lowest rates were found for Germany, Italy and Switzerland.

6. Technical change and the labour share decline

First, we are interested in analysing what was the main cause of the decline in the labour share in OECD countries. As we argue

Table 5
Estimates of aggregate elasticities of substitution and technical change rates.

Country	NLSUR				GMM			
	σ	ζ_K	ζ_L	ξ	σ	ζ_K	ζ_L	ξ
AU	0.4136*** (0.0035)	-0.0008*** (0.0001)	0.0047*** (0.0000)	1.0021*** (0.0016)	0.5931*** (0.0319)	-0.0023*** (0.0004)	0.0057*** (0.0002)	1.0065*** (0.0014)
AU1	0.3858*** (0.0028)	-0.0003*** (0.0000)	0.0045*** (0.0000)	1.0011*** (0.0016)	0.4527*** (0.0214)	-0.0006*** (0.0001)	0.0048*** (0.0001)	1.0045*** (0.0012)
AT	0.3046*** (0.0029)	-0.0018*** (0.0000)	0.0037*** (0.0001)	1.0011*** (0.0011)	0.3344*** (0.0136)	-0.0020*** (0.0001)	0.0036*** (0.0001)	0.9975*** (0.0009)
BE	0.3337*** (0.0012)	-0.0022*** (0.0000)	0.0027*** (0.0001)	0.9982*** (0.0013)	0.3616*** (0.0227)	-0.0023*** (0.0001)	0.0028*** (0.0000)	0.9993*** (0.0009)
CA	0.3629*** (0.0016)	-0.0033*** (0.0001)	0.0028*** (0.0001)	1.0021*** (0.0015)	0.3793*** (0.0144)	-0.0035*** (0.0001)	0.0025*** (0.0001)	1.0036*** (0.0011)
CA1	0.3641*** (0.0016)	-0.0033*** (0.0001)	0.0029*** (0.0001)	1.0016*** (0.0017)	0.3850*** (0.0164)	-0.0035*** (0.0001)	0.0025*** (0.0001)	1.0031*** (0.0011)
CZ	0.7629*** (0.0013)	0.0042*** (0.0002)	0.0032*** (0.0002)	1.0026*** (0.0039)	0.8806*** (0.0271)	0.0087*** (0.0023)	-0.0006 (0.0018)	0.9929*** (0.0028)
DK	0.3588*** (0.0016)	-0.0015*** (0.0001)	0.0030*** (0.0001)	1.0012*** (0.0015)	0.4614*** (0.0377)	-0.0016*** (0.0001)	0.0030*** (0.0001)	1.0032*** (0.0012)
EE	0.6379*** (0.0031)	0.0008** (0.0003)	0.0039*** (0.0004)	0.9949*** (0.0050)	0.6831*** (0.0340)	0.0022** (0.0009)	0.0030*** (0.0007)	1.0014*** (0.0040)
FI	0.3985*** (0.0041)	-0.0020*** (0.0001)	0.0046*** (0.0002)	0.9990*** (0.0040)	0.4598*** (0.0200)	-0.0025*** (0.0002)	0.0043*** (0.0002)	1.0006*** (0.0035)
FR	0.4867*** (0.0008)	-0.0011*** (0.0000)	0.0035*** (0.0001)	0.9986*** (0.0013)	0.5109*** (0.0110)	-0.0009*** (0.0001)	0.0030*** (0.0001)	0.9969*** (0.0014)
DE	0.3094*** (0.0021)	0.0008*** (0.0000)	0.0027*** (0.0001)	1.0003*** (0.0011)	0.2363*** (0.0350)	0.0008*** (0.0001)	0.0026*** (0.0000)	0.9999*** (0.0010)
GR	0.9864*** (0.0011)	0.1545*** (0.0098)	-0.1028*** (0.0061)	1.1029*** (0.0076)	0.9889*** (0.0011)	0.1848*** (0.0140)	-0.1219*** (0.0090)	1.1163*** (0.0081)
HU	0.9492*** (0.0028)	-0.0517*** (0.0029)	0.0389*** (0.0019)	1.0375*** (0.0044)	0.9695*** (0.0030)	-0.0838*** (0.0078)	0.0602*** (0.0051)	1.0579*** (0.0070)
IE	0.3776*** (0.0046)	-0.0067*** (0.0001)	0.0115*** (0.0003)	1.0066*** (0.0039)	0.4556*** (0.0110)	-0.0075*** (0.0002)	0.0111*** (0.0003)	1.0148*** (0.0030)
IT	0.4960*** (0.0010)	-0.0013*** (0.0001)	-0.0002** (0.0001)	1.0003*** (0.0018)	0.5101*** (0.0219)	-0.0014*** (0.0001)	0.0001 (0.0001)	1.0015*** (0.0014)
JP	0.3709*** (0.0041)	-0.0004*** (0.0001)	0.0034*** (0.0001)	1.0013*** (0.0012)	0.4102*** (0.0510)	-0.0008*** (0.0003)	0.0039*** (0.0002)	0.9997*** (0.0012)
LV	0.5114*** (0.0032)	-0.0068*** (0.0003)	0.0118*** (0.0003)	0.9949*** (0.0061)	0.5645*** (0.0382)	-0.0070*** (0.0004)	0.0112*** (0.0004)	0.9907*** (0.0042)
LT	0.4916*** (0.0033)	-0.0035*** (0.0003)	0.0107*** (0.0003)	1.0072*** (0.0056)	0.6059*** (0.0450)	-0.0045*** (0.0004)	0.0117*** (0.0003)	0.9917*** (0.0034)
LU	0.3060*** (0.0019)	-0.0017*** (0.0001)	0.0010*** (0.0001)	1.0023*** (0.0020)	0.5941*** (0.0990)	-0.0028*** (0.0005)	0.0018*** (0.0004)	0.9982*** (0.0018)
NL	0.4136*** (0.0012)	-0.0018*** (0.0001)	0.0021*** (0.0001)	1.0008*** (0.0013)	0.4492*** (0.0246)	-0.0018*** (0.0001)	0.0020*** (0.0001)	1.0023*** (0.0014)
NO	0.2551*** (0.0026)	-0.0029*** (0.0001)	0.0020*** (0.0002)	0.9994*** (0.0020)	0.2612*** (0.0141)	-0.0031*** (0.0001)	0.0018*** (0.0001)	1.0016*** (0.0017)
PL	0.1672*** (0.0074)	-0.0010*** (0.0001)	0.0087*** (0.0001)	1.0015*** (0.0017)	0.1627*** (0.0363)	-0.0014*** (0.0003)	0.0091*** (0.0002)	1.0038*** (0.0015)
PT	0.3818*** (0.0127)	-0.0033*** (0.0002)	0.0033*** (0.0001)	1.0011*** (0.0013)	0.3958*** (0.0506)	-0.0045*** (0.0005)	0.0037*** (0.0003)	1.0039*** (0.0011)
SK	0.5376*** (0.0032)	0.0018*** (0.0002)	0.0088*** (0.0003)	1.0019*** (0.0032)	0.5955*** (0.0349)	0.0024*** (0.0002)	0.0078*** (0.0002)	0.9910*** (0.0027)
SI	0.3073*** (0.0058)	-0.0029*** (0.0002)	0.0053*** (0.0002)	1.0035*** (0.0032)	0.4271*** (0.0465)	-0.0039*** (0.0003)	0.0062*** (0.0002)	0.9896*** (0.0028)
ES	0.7103*** (0.0034)	-0.0068*** (0.0001)	0.0039*** (0.0001)	1.0022*** (0.0012)	0.7191*** (0.0178)	-0.0074*** (0.0004)	0.0041*** (0.0002)	1.0016*** (0.0012)
SE	0.7096*** (0.0015)	0.0004** (0.0002)	0.0025*** (0.0002)	1.0247*** (0.0027)	0.9916*** (0.0014)	0.0897*** (0.0107)	-0.0540*** (0.0067)	1.0377*** (0.0036)
CH	0.3457*** (0.0010)	0.0022*** (0.0000)	0.0029*** (0.0000)	0.9976*** (0.0008)	0.4030*** (0.0144)	0.0022*** (0.0000)	0.0029*** (0.0000)	0.9971*** (0.0007)
UK	0.4546*** (0.0017)	-0.0005*** (0.0001)	0.0020*** (0.0001)	1.0005*** (0.0023)	0.5434*** (0.0205)	-0.0007*** (0.0001)	0.0017*** (0.0001)	0.9985*** (0.0016)
US	0.7017*** (0.0023)	-0.0031*** (0.0001)	0.0054*** (0.0000)	1.0034*** (0.0017)	0.7594*** (0.0307)	-0.0039*** (0.0006)	0.0058*** (0.0003)	1.0063*** (0.0017)
US1	0.7588*** (0.0012)	-0.0021*** (0.0001)	0.0052*** (0.0000)	1.0006*** (0.0016)	0.8047*** (0.0298)	-0.0025*** (0.0004)	0.0053*** (0.0003)	1.0030*** (0.0015)
Mean ^c	0.4773	0.0020 ^a	0.0019 ^a	1.0053	0.5416	0.0049 ^b	0.0000 ^b	1.0071

Notes: Figures enclosed in parentheses are the estimated standard errors; *significant at the 10 % level; **significant at the 5 % level; ***significant at the 1 % level; AU1, CA1 and US1 represent the estimates obtained when adjusting the labour share by the income of self-employed workers

^a mean excluding Greece: $\zeta_K = -0.0035$ and $\zeta_L = 0.0057$

^b mean excluding Greece: $\zeta_K = -0.0016$ and $\zeta_L = 0.0043$

^c mean excluding labour share adjusted results.

below, our results show that the main driving force has been net labour-augmenting technical change, which, in a context of gross complementarity, has led to capital-biased technical change.

Hereafter, we work with the series of the labour share, s and the capital intensity, $\frac{K}{L}$, filtered with the Hodrick-Prescott filter. By paying attention to the trend component of the labour share, we isolate the analysis from high-frequency fluctuations that could cause stochastic technological shocks. We use both the NLSUR and GMM estimates for the calculations. In general, there are no significant differences between using one or the other estimate.

We can decompose the average quarterly rate of change in the labour share, φ_s , over the sample period (which differs across countries) into the contribution of three components: (i) capital deepening, $\varphi_{K/L}$, (ii) net labour-augmenting technical change, $\varphi_{\zeta_L - \zeta_K}$, and (iii) the change in the firm labour wedge, φ_μ . For s and K/L we have data, for $\varphi_{\zeta_L - \zeta_K}$ we use the estimated values and φ_μ is calculated as a residual.

From Eqs. (1) and (2), using the following approximation $d \ln(x_t) = \frac{1}{T} \ln \left(\frac{x_{t+T}}{x_t} \right)$ and assuming that the elasticity of capital-labour substitution and the rates of factor-augmenting technical change are constant, it follows that

$$\underbrace{\frac{1}{T} \ln \left(\frac{s_{t+T}}{s_t} \right)}_{\varphi_s} = (1 - \bar{s}) \underbrace{\left(\frac{1 - \sigma}{\sigma} \right) \frac{1}{T} \ln \left(\frac{\frac{K_{t+T}}{L_{t+T}}}{\frac{K_t}{L_t}} \right)}_{\varphi_{K/L}} - (1 - \bar{s}) \underbrace{\left(\frac{1 - \sigma}{\sigma} \right) (\zeta_L - \zeta_K)}_{\varphi_{\zeta_L - \zeta_K}} - \underbrace{\frac{1}{T} \ln \left(\frac{\mu_{t+T}}{\mu_t} \right)}_{\varphi_\mu},$$

where \bar{s} is the arithmetic average of the labour share over the sample period. The contributions of these three variables to the rate of change in the labour share are reported in Tables 6 and 7. The first three columns of Tables 6 and 7 display \bar{s} , the estimated elasticities of capital-labour substitution and the quarterly average rates of net labour-augmenting technical change. The last columns display the quarterly average rates of change in both capital intensity and the effective capital-labour ratio. In the final columns, we display the contributions of capital deepening, net labour-augmenting technical progress and the firm labour wedge.¹⁷ The periods analysed are the sample periods.

The results show that, despite the strong capital deepening in all countries, the predominant finding of net labour-augmentation is reflected in a decline in the effective capital-labour ratio for most OECD countries and, consequently, in the model-predicted labour share. The exceptions are either countries experiencing net capital-augmentation (the Czech Republic, Greece and Sweden, in this case using the GMM method) or countries where the rate of net labour-augmenting technical change was not fast enough to generate a decline in the effective capital-labour ratio (Estonia, Germany, the Slovak Republic, Switzerland, the United Kingdom and Italy, in this last case only using the NLSUR method), which explains the observed increase in the labour share as predicted by the neoclassical model.

The contribution of net labour-augmenting technical change was large and negative for most countries, while the contribution of capital deepening was also large but positive, and the contribution of changes in the firm labour wedge was close to 0. The average contribution of net labour-augmenting technical change is either 0.0035 or 0.0031, depending on the estimation method, while the average contributions of capital deepening are 0.0030 and 0.0025, respectively, and the average contributions of the firm labour wedge are either 0.0001 or 0.0002. In 26 (GMM method) or 27 (NLSUR method) countries, the contributions of capital deepening and net labour-augmenting technical change have opposite signs, positive for the former and negative for the latter.

Fig. 2 displays the cross-country correlations between the rate of change in the labour share and the contributions from capital deepening, net labour-augmenting technical change and the change in the firm labour wedge. The correlation of the rate of change in the labour share with the contribution from capital deepening is negative, while it is positive with the contributions from net labour-augmenting technical change and the change in the firm labour wedge. Therefore, in countries where the rate of decline in the labour share was higher, the contributions of net labour-augmenting technical change and the change in the firm labour wedge were, on average, larger, while the contribution of capital deepening was smaller.

Therefore, from our analysis it follows that net labour-augmenting technical change —which, in a context of gross complementarity, led to capital-biased technical change — was a common force driving the labour share decline in OECD countries, whereas capital deepening worked in the opposite direction and the contribution of the change in the firm labour wedge was negligible.

7. Technical change and the firm labour wedge

Although technical change appears to have been the common force driving the decline in the labour share across OECD countries, the ability of the neoclassical model with biased technical progress to predict the trend evolution of the labour share varies widely across countries, as we will see in this section.

In this section, as in the previous section, we work with the Hodrick-Prescott filtered labour share and capital intensity series. The firm labour wedge, μ_t , is defined such that the trend component of the labour share, s_t , is equal to the model-predicted labour share,

¹⁷ A similar procedure was adopted by Lawrence (2015) to study the decline in the US labour share.

$$\widehat{s}_t = \bar{s} \left[(1 - \bar{s}) \left(\frac{K_t/K_0}{L_t/L_0} \right)^\psi e^{(\zeta_K - \zeta_L)(t - \bar{t})\psi} + \bar{s} \right]^{-1},$$

times the inverse of the firm labour wedge: $s_t = \widehat{s}_t \mu_t^{-1}$. The trend component of the labour share and the model-predicted labour share for each OECD country are displayed in Fig. 3. If the model-predicted labour share does accurately not match the trend component of the labour share, then for some countries other forces reflected in the firm labour wedge play a significant role in accounting for the evolution of the labour share.

We assess the model fit in two ways. First, following a procedure similar to Bellocchi and Travaglini (2023), we regress the trend component of the labour share against the model-predicted value, and compute the residual sum of squares (RSS) and R² coefficients (see Table 8). Second, we compute Lin’s (1989, 2000) concordance correlation coefficient (CCC) for both variables, which is often used as a measure of goodness of fit for non-linear models.

For the Anglo-Saxon countries (Australia, the United Kingdom and the United States of America, but not Canada), which have high values for R² and CCC, the model accurately accounts for the evolution of the trend component of the labour share. The same can be said for some European countries, namely Spain, the Czech Republic, Ireland, Sweden and Belgium. We do not include Greece and Hungary in the group because, although both countries have high R² and CCC values, the results for these two countries should be treated with caution because the estimates of the technical progress rates are very imprecise, as mentioned above. For the same reason, we also doubt the Swedish GMM estimates, but have no reason to be suspicious of the NLSUR estimates. The values of R² (with NLSUR and GMM) are around 0.95 for Australia, 0.84 and 0.86 for the United States, and 0.88 and 0.86 for the United Kingdom. For these countries, the CCC values are also high: 0.98 for Australia, 0.92 for the United States, and 0.93 and 0.87 for the United Kingdom. The R² and CCC are also higher than 0.80 for Spain, Czech Republic, Ireland, Sweden, Belgium, Hungary and Greece. However, in Japan, Canada and most European countries, the R² and CCC values are significantly lower, suggesting that the firm labour wedge might play a significant, even predominant role in accounting for the evolution of the trend component of the labour share. For some European countries, the R² and CCC values are particularly low: for example, in France, the values of R² are 0.14 and 0.31 (using the NLSUR and the GMM methods, respectively), while in Germany they are 0.03 and 0.07. For these countries, the values of the CCC are low: France, 0.34 and 0.20, and Germany, −0.17 and −0.21. The CCC values for Germany even reflect a small discordance between prediction and data.

In order to deepen the understanding of the role technical bias in the evolution of the labour share, we carry out a counterfactual exercise. In particular, we calculate for all countries the labour share predicted by the model under the estimated values of the elasticity of capital-labour substitution if the technical change were neutral, $\zeta_K - \zeta_L = 0$,

$$\widehat{s}_{n,t} = \bar{s} \left[(1 - \bar{s}) \left(\frac{K_t/K_0}{L_t/L_0} \right)^\psi + \bar{s} \right]^{-1},$$

and evaluate its ability to match the evolution of the trend component of the labour share. The counterfactual exercise needs to be well understood. The exercise is not intended to show that the model with neutral technical change can or cannot accurately match the trend component of the labour share because, as it is likely to provide a better fit under gross capital-labour substitution. The purpose of the exercise is to show whether biased technical change is needed to accurately account for the evolution of the trend component of the labour share under gross capital-labour complementarity. The series are displayed in Fig. 4.

We calculate the same statistics as above to assess the goodness of fit (see Table 9). The R² values are generally high and most of the CCC values are negative, reflecting a significant mismatch between the prediction and the data. In particular, if technical progress had been neutral, capital deepening would have moved the labour share in the opposite direction to that observed for its trend component in most OECD countries (see Fig. 4). However, for a small number of European countries (the Czech Republic, Estonia, Sweden and the United Kingdom) both the R² and the CCC are positive and high.¹⁸ Therefore, our results suggest that for these countries the biased technical progress may not have played a very important role in accounting for the evolution of the trend component of the labour share.

Next, we analyse in more detail the behaviour of the firm labour wedge in OECD countries and its influence on the evolution of the labour share. As mentioned above, the firm labour wedge is defined as the ratio of the model-predicted labour share to the trend component of the labour share, $\mu_t = \widehat{s}_t/s_t$. To make the comparison between the trend component of the labour share and the firm labour wedge, we have multiplied the inverse of the latter by \bar{s} —which is the average value of the labour share—and thus overcome the difference in scale between the variables.

The trend component of the labour share and the inverse of the firm labour wedge for OECD countries are displayed in Fig. 5. Looking closely at Fig. 5, it can be seen that for most countries the inverse of the labour wedge increased in the latter part of the period analysed, around 2008. In particular, it increased significantly after 2008 in eighteen countries: Austria, Canada, the Czech Republic, Estonia, France, Germany, Japan, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain and the United States. Only in Greece and Ireland has the inverse of the firm labour wedge fallen significantly, although, as we have said, our results for Greece should be taken with a pinch of salt. Moreover, in many countries this increase coincides with an increase, or at least a stabilization, of the labour share. Focusing on the United States, it is clear that the increase in

¹⁸ With the exception of the CCC value for Sweden under the GMM estimation, but, as mentioned above, the GMM estimation for Sweden may be problematic.

the inverse of the firm labour wedge contributed to halting the decline in the labour share from around 2011. The analysis therefore suggests that in many countries the reduction in the firm labour wedge in recent years has counteracted the negative effect of capital-biased technical change on the labour share.

We calculate the same statistics as above to assess the goodness of fit (see Table 10). For both estimation methods, the values of CCC and R² are low in Australia, Belgium, Czech Republic, Spain, Sweden and the United States. They are also low in the United Kingdom for the NLSUR method.¹⁹ In these countries, the R² values are below 0.15 and the CCC values below 0.25, the latter even being slightly negative for Sweden and Belgium. For these countries, the firm labour wedge adjusts the trend evolution of the labour share very poorly, whereas the adjustment of the perfect competition model with biased technical progress is quite precise, so we can venture that for these countries the firm labour wedge has played a minor role in accounting for the trend evolution of the labour share.

The three largest economies in the euro area have high R² and CCC values. Restricting ourselves to the NLSUR estimates, the values of these statistics are 0.63 and 0.79 for France, 0.44 and 0.55 for Germany, and 0.48 and 0.67 for Italy. The values for Japan, 0.34 and 0.57, respectively, are not very high, but they are not low either. Other economies with particularly high values for these statistics are Canada, Finland, Latvia, Lithuania, Luxemburg, Netherlands, Norway, Slovakia and Slovenia. Bearing in mind that for these economies, the fit of the perfect competition model is not particularly good, we can conclude that in Canada, Japan and most European countries, including the three largest economies in the euro area (Germany, France and Italy), the firm labour wedge played a significant, even prominent, role in accounting for the trend evolution of the labour share.

8. An alternative technical change specification

In line with the majority of the empirical studies, so far we have assumed constant technical change rates. However, it is also reasonable to admit that the rate of technical change may not be constant over time and consequently to consider more flexible functional specifications for the shape of factor-augmentation, such as the Box-Cox transformation. In the normalized form, this implies that $A_t^i = A_0^i e^{g_i(t)}$, where $g_i(t) = \frac{\zeta_i t_0}{\lambda_i} \left[\left(\frac{t}{t_0} \right)^{\lambda_i} - 1 \right]$, with $\frac{dg_i(t)}{dt} = \zeta_i \left(\frac{t}{t_0} \right)^{\lambda_i - 1}$ representing the rate of i -factor-augmenting technical change which depends on the level parameter ζ_i and on the curvature parameter λ_i . The rate of i -factor-augmenting technical change is positive (resp. negative) if $\zeta_i > 0$ (resp. $\zeta_i < 0$). The curvature parameter λ_i determines the shape of the technical change function. If $\lambda_i = 1$, the technical change function is linear and its change rate is constant (ζ_i). However, λ_i can also assume different values: if $\lambda_i > 1$, the technical change function is exponential and i -factor-augmenting technical change is accelerating over time; if $0 < \lambda_i < 1$, the technical change function is also exponential, but i -factor-augmenting technical change is decelerating; if λ_i equals 0, the technical change function becomes log-linear and if it is negative the function becomes hyperbolic (in both cases, i -factor-augmenting technical change is decelerating).

Assuming that technical change is represented by factor augmentation at variable exponential rates $\frac{A_t^K}{A_0^K} = e^{\frac{\zeta_K t_0}{\lambda_K} \left[\left(\frac{t}{t_0} \right)^{\lambda_K} - 1 \right]}$ and $\frac{A_t^L}{A_0^L} = e^{\frac{\zeta_L t_0}{\lambda_L} \left[\left(\frac{t}{t_0} \right)^{\lambda_L} - 1 \right]}$, the logarithmic forms of the normalized CES production function and the first-order profit maximization conditions can be expressed as follows:

$$y_t - \bar{y} = \ln(\xi) + \frac{1}{\psi} \ln \left[(1 - \bar{s}) \left(e^{\frac{\zeta_K \bar{t}}{\lambda_K} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_K} - 1 \right]} \frac{K_t}{\bar{K}} \right)^\psi + \bar{s} \left(e^{\frac{\zeta_L \bar{t}}{\lambda_L} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_L} - 1 \right]} \frac{L_t}{\bar{L}} \right)^\psi \right]$$

$$y k_t - \bar{y} \bar{k} = -\sigma [\ln(1 - \bar{s}) + \bar{y} \bar{k}] + (1 - \sigma) \ln \xi + \sigma r p_t + (1 - \sigma) \frac{\zeta_K \bar{t}}{\lambda_K} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_K} - 1 \right]$$

$$y l_t - \bar{y} \bar{l} = -\sigma [\ln \bar{s} + \bar{y} \bar{l}] + (1 - \sigma) \ln \xi + \sigma w p_t + (1 - \sigma) \frac{\zeta_L \bar{t}}{\lambda_L} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_L} - 1 \right]$$

where y , $y k$, $y l$, $r p$ and $w p$ represent, respectively, the natural logarithms of Y , Y/K , Y/L , R/P and W/P respectively.

The estimation is carried out using the Non-Linear Seemingly Unrelated Regression (NLSUR) approach.²⁰ The estimates of the aggregate elasticities of capital-labour substitution and the parameters of the technical change function are displayed in Table 11. The estimated coefficients are almost all statistically significant at the 1 per cent level, and in virtually all countries the normalization constant is almost indistinguishable from unity.

Elasticity of capital-labour substitution. The estimate of the elasticity of substitution is quite robust to the change in the specification of the technical change processes. For all countries, the estimates of the elasticity of substitution under the hypothesis of constant rates

¹⁹ The values of the CCC and R² are also low for Greece and Hungary, but we have some reservations about the results of these countries, as we pointed out above.

²⁰ The NLSUR method is the most widely used in the literature on this subject. We have also estimated using the GMM method, but the results do not change significantly. For the sake of brevity, we have preferred to present only the estimates obtained using the first method.

Table 6
Contributions to the changes in the labour share (NLSUR method).

Country	\bar{s}	Estimation results		Effective capital		φ_s	Contributions		
		σ	$\zeta_L - \zeta_K$	$d \ln\left(\frac{K}{L}\right)$	$d \ln(k)$		$\varphi_{K/L}$	$\varphi_{\zeta_L - \zeta_K}$	φ_μ
AU	0.6343	0.4136	0.0056	0.0032	-0.0024	-0.0011	0.0016	-0.0029	0.0001
AT	0.6748	0.3046	0.0054	0.0036	-0.0018	-0.0008	0.0027	-0.0040	0.0005
BE	0.6783	0.3337	0.0049	0.0037	-0.0012	-0.0005	0.0024	-0.0031	0.0002
CA	0.6699	0.3629	0.0061	0.0052	-0.0009	-0.0002	0.0030	-0.0035	0.0003
CZ	0.5511	0.7629	-0.0010	0.0057	0.0067	0.0011	0.0008	0.0001	0.0002
DK	0.6585	0.3588	0.0045	0.0035	-0.0010	0.0000	0.0021	-0.0027	0.0006
EE	0.5780	0.6379	0.0031	0.0092	0.0061	0.0012	0.0022	-0.0007	-0.0003
FI	0.6568	0.3985	0.0066	0.0057	-0.0009	-0.0014	0.0030	-0.0034	-0.0010
FR	0.7083	0.4867	0.0046	0.0038	-0.0008	-0.0002	0.0012	-0.0014	0.0000
DE	0.6715	0.3094	0.0019	0.0022	0.0002	0.0002	0.0016	-0.0014	0.0000
GR	0.6127	0.9864	-0.2573	0.0043	0.2616	0.0006	0.0000	0.0014	-0.0008
HU	0.6016	0.9492	0.0906	0.0069	-0.0837	-0.0019	0.0001	-0.0019	-0.0001
IE	0.5296	0.3776	0.0183	0.0128	-0.0054	-0.0054	0.0100	-0.0142	-0.0012
IT	0.6582	0.4960	0.0011	0.0014	0.0003	0.0000	0.0005	-0.0004	-0.0001
JP	0.5854	0.3709	0.0038	0.0028	-0.0010	-0.0006	0.0019	-0.0027	0.0002
LV	0.5548	0.5114	0.0187	0.0162	-0.0025	0.0013	0.0069	-0.0079	0.0023
LT	0.5490	0.4916	0.0142	0.0126	-0.0016	0.0012	0.0059	-0.0066	0.0020
LU	0.5737	0.3060	0.0028	0.0024	-0.0004	-0.0004	0.0023	-0.0027	-0.0000
NL	0.6757	0.4136	0.0039	0.0032	-0.0008	-0.0003	0.0015	-0.0018	0.0000
NO	0.5503	0.2551	0.0049	0.0049	-0.0001	0.0000	0.0064	-0.0065	0.0001
PL	0.5971	0.1672	0.0097	0.0095	-0.0002	-0.0011	0.0191	-0.0195	-0.0007
PT	0.6494	0.3818	0.0065	0.0027	-0.0039	-0.0008	0.0015	-0.0037	0.0014
SK	0.5133	0.5376	0.0069	0.0079	0.0010	0.0018	0.0033	-0.0029	0.0014
SI	0.7446	0.3073	0.0081	0.0072	-0.0010	-0.0017	0.0041	-0.0047	-0.0012
SE	0.6432	0.7103	0.0107	0.0033	-0.0075	-0.0009	0.0005	-0.0016	0.0002
SE	0.6126	0.7096	0.0021	0.0054	0.0033	-0.0003	0.0009	-0.0003	-0.0008
CH	0.6509	0.3457	0.0007	0.0008	0.0001	0.0004	0.0005	-0.0005	0.0003
UK	0.6447	0.4546	0.0025	0.0041	0.0016	0.0007	0.0017	-0.0011	0.0000
US	0.6462	0.7017	0.0086	0.0041	-0.0045	-0.0007	0.0006	-0.0013	-0.0000
Mean	0.6233	0.4773	-0.0001*	0.0054	0.0055	-0.0004	0.0030	-0.0035	0.0001

Note:

* mean excluding Greece = 0.0091.

of technical change are similar to the estimates under the Box-Cox specification. It should be noted, however, that the Box-Cox specification of technical change reinforces the conclusion that capital and labour are gross complements at the aggregate level. In particular, the estimated elasticities of substitution under the Box-Cox specification are less than one for all countries and are generally somewhat lower than those estimated assuming constant rates of factor-augmenting technical change. Under the Box-Cox specification, they are higher than under the constant technical change assumption for only five countries (Denmark, Ireland, Slovenia, Spain and the United States). Even for Hungary and Greece, countries for which a unitary elasticity could not be ruled out under the assumption of constant rates of factor-augmenting technical change, the Box-Cox specification implies elasticities of substitution that are high but significantly less than one.

Factor-augmenting technical change. Assuming a Box-Cox specification of the technical change function does not also alter our conclusion that technical change has been mostly net labour-augmenting because capital efficiency has been falling in most countries, while labour efficiency has been rising. Furthermore, our Box-Cox estimates suggest that in most countries the decline in capital efficiency has accelerated while the increase in labour efficiency has slowed. The estimated level parameter of the capital-augmenting technical change function, ζ_K , is negative for 23 countries (positive for 6: Czech Republic, Estonia, Germany, Greece, Slovakia, and Switzerland). With a 95 % confidence level, ζ_K could be zero in two countries: Australia and Estonia. The level parameter of the labour-augmenting technical change function, ζ_L , is positive for 27 countries (negative for 2: Greece and Italy). With a 95 % confidence level, there is no country for which the value of ζ_L could be zero. Therefore, the Box-Cox specification confirms the results obtained assuming constant rates of factor-augmenting technical change: in most countries capital efficiency has been declining during the analysed period, while labour efficiency has been increasing. Thus, technical progress has been mostly net labour-augmenting. The estimated curvature parameter of the capital-augmenting technical change function, λ_K , is greater than 1 in 21 countries (less than 1 in 8: Austria, Czech Republic, Greece, Ireland, Japan, Slovenia, Spain, and the United States), while the estimated curvature parameter of the labour-augmenting technical change function, λ_L , is less than 1 in 23 countries (greater than 1 in 6: Denmark, Greece, Ireland, Italy, Spain, and the United States). With a 95 % confidence level, the curvature parameter of the capital-augmenting technical change function could be 1, and hence the capital-augmenting rate of technical change constant, for 8 countries (Austria, Czech Republic, Denmark, Hungary, Luxemburg, Poland, Portugal, and Switzerland) and the curvature parameter of the labour-augmenting technical change function could be 1, and hence the labour-augmenting rate of technical change constant, for only 2 countries (Italy and Switzerland). Therefore, our results imply that in most countries the pace of decline in capital efficiency has been increasing, while the pace of increase in labour efficiency has been decreasing.

Table 7
Contributions to the changes in the labour share (GMM method).

Country	\bar{s}	Estimation results		Effective capital		φ_s	Contributions		
		σ	$\zeta_L - \zeta_K$	$d \ln \left(\frac{K}{L} \right)$	$d \ln(k)$		$\varphi_{K/L}$	$\varphi_{\zeta_L - \zeta_K}$	φ_μ
AU	0.6343	0.5931	0.0080	0.0032	-0.0048	-0.0011	0.0008	-0.0020	0.0001
AT	0.6748	0.3344	0.0056	0.0036	-0.0020	-0.0008	0.0023	-0.0036	0.0005
BE	0.6783	0.3616	0.0051	0.0037	-0.0014	-0.0005	0.0021	-0.0029	0.0002
CA	0.6699	0.3793	0.0060	0.0052	-0.0008	-0.0002	0.0028	-0.0033	0.0003
CZ	0.5511	0.8806	-0.0093	0.0057	0.0150	0.0011	0.0003	0.0006	0.0002
DK	0.6585	0.4614	0.0046	0.0035	-0.0011	0.0000	0.0014	-0.0018	0.0004
EE	0.5780	0.6831	0.0008	0.0092	0.0084	0.0012	0.0018	-0.0002	-0.0005
FI	0.6568	0.4598	0.0069	0.0057	-0.0012	-0.0014	0.0023	-0.0028	-0.0010
FR	0.7083	0.5109	0.0039	0.0038	-0.0001	-0.0002	0.0011	-0.0011	-0.0002
DE	0.6715	0.2363	0.0018	0.0022	0.0003	0.0002	0.0023	-0.0019	-0.0002
GR	0.6127	0.9889	-0.3067	0.0043	0.3110	0.0006	0.0000	0.0013	-0.0008
HU	0.6016	0.9695	0.1440	0.0069	-0.1371	-0.0019	0.0001	-0.0018	-0.0002
IE	0.5296	0.4556	0.0186	0.0128	-0.0058	-0.0054	0.0072	-0.0105	-0.0022
IT	0.6582	0.5101	0.0015	0.0014	-0.0000	0.0000	0.0005	-0.0005	0.0000
JP	0.5854	0.4102	0.0047	0.0028	-0.0020	-0.0006	0.0016	-0.0028	0.0006
LV	0.5548	0.5645	0.0182	0.0162	-0.0021	0.0013	0.0056	-0.0063	0.0020
LT	0.5490	0.6059	0.0162	0.0126	-0.0035	0.0012	0.0037	-0.0047	0.0023
LU	0.5737	0.5941	0.0047	0.0024	-0.0023	-0.0004	0.0007	-0.0014	0.0003
NL	0.6757	0.4492	0.0038	0.0032	-0.0006	-0.0003	0.0013	-0.0015	-0.0001
NO	0.5503	0.2612	0.0049	0.0049	-0.0000	0.0000	0.0062	-0.0062	0.0000
PL	0.5971	0.1627	0.0105	0.0095	-0.0009	-0.0011	0.0197	-0.0217	0.0008
PT	0.6494	0.3958	0.0082	0.0027	-0.0055	-0.0008	0.0014	-0.0044	0.0021
SK	0.5133	0.5955	0.0054	0.0079	0.0025	0.0018	0.0026	-0.0018	0.0010
SI	0.7446	0.4271	0.0101	0.0072	-0.0029	-0.0017	0.0025	-0.0034	-0.0007
ES	0.6432	0.7191	0.0114	0.0033	-0.0082	-0.0009	0.0005	-0.0016	0.0003
SE	0.6126	0.9916	-0.1437	0.0054	0.1491	-0.0003	0.0000	0.0005	-0.0008
CH	0.6509	0.4030	0.0008	0.0008	0.0000	0.0004	0.0004	-0.0004	0.0004
UK	0.6447	0.5434	0.0024	0.0041	0.0017	0.0007	0.0012	-0.0007	0.0002
US	0.6462	0.7594	0.0097	0.0041	-0.0056	-0.0007	0.0005	-0.0011	-0.0001
Mean	0.6233	0.5416	-0.0049*	0.0054	0.0103	-0.0003	0.0025	-0.0031	0.0002

Note:

* mean excluding Greece, Hungary and Sweden = 0.0063.

The labour share. For each OECD country, the trend component of the labour share, s_t , the model-predicted labour share

$$\hat{s}_t = \bar{s} \left[(1 - \bar{s}) \left(\frac{K_t/K_0}{L_t/L_0} \right)^\psi e^{\left[\frac{\zeta_K}{\lambda_K} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_K} - 1 \right] - \frac{\zeta_L}{\lambda_L} \left[\left(\frac{t}{\bar{t}} \right)^{\lambda_L} - 1 \right] \right] \bar{i}_\psi} + \bar{s} \right]^{-1}$$

and the inverse of the firm labour wedge, $\mu_t^{-1} = s_t/\hat{s}_t$, are displayed in Fig. 6.²¹ In Table 12, for each OECD country we display residual sum of squares (RSS), the R² coefficient and the concordance correlation coefficient (CCC) for both the model-predicted labour share's fit and firm labour wedge's fit.

The Box-Cox specification of factor-augmenting technical change improves the fit of the model but does not alter the main conclusion of our earlier analysis assuming constant rates of factor-augmenting technical change: the firm labour wedge seems have played a significant role in the largest economies in the euro area (France, Germany and Italy), but not in the Anglo-Saxon countries of Australia, United Kingdom and the United States. In general, the values of the R² and CCC statistics for the model-predicted labour share's fit are higher with the Box-Cox specification than assuming constant factor-augmenting rates of technical change. For example, in the former case, the average values for OECD countries of the R² and CCC are 0.59 and 0.57, respectively, while in the latter case, these values are 0.50 and 0.43. Under the Box-Cox specification, the Anglo-Saxon countries (including now Canada) have high values of R² and CCC for the model-predicted labour shares' fit: Australia, 0.94 and 0.97, Canada, 0.76 and 0.84, United Kingdom, 0.78 and 0.88, and the United States, 0.93. These countries (excepting Canada) also have low values of R² and CCC for the firm labour wedge's fit: Australia, 0.02 and 0.07, Canada, 0.32 and 0.43, United States, 0.04 and 0.14, and United Kingdom, 0.03 and 0.14), but the values of these statistics for the three largest economies of the Eurozone are higher (France, 0.79 and 0.70, Germany, 0.65 and 0.53, and Italy, 0.46 and 0.62). Therefore, it can be concluded that, even with the Box-Cox specification, the model fits the evolution of the labour share in the Anglo-Saxon countries of Australia, United Kingdom and the United States quite well, while the evolution of the firm labour wedge does not seem to have played a relevant role, unlike in the three largest economies in the euro area (France, Germany and Italy) where the firm labour wedge seems have played a significant role in accounting for the evolution of the labour share. However,

²¹ The inverse of the firm labour is multiplied by \bar{s} .

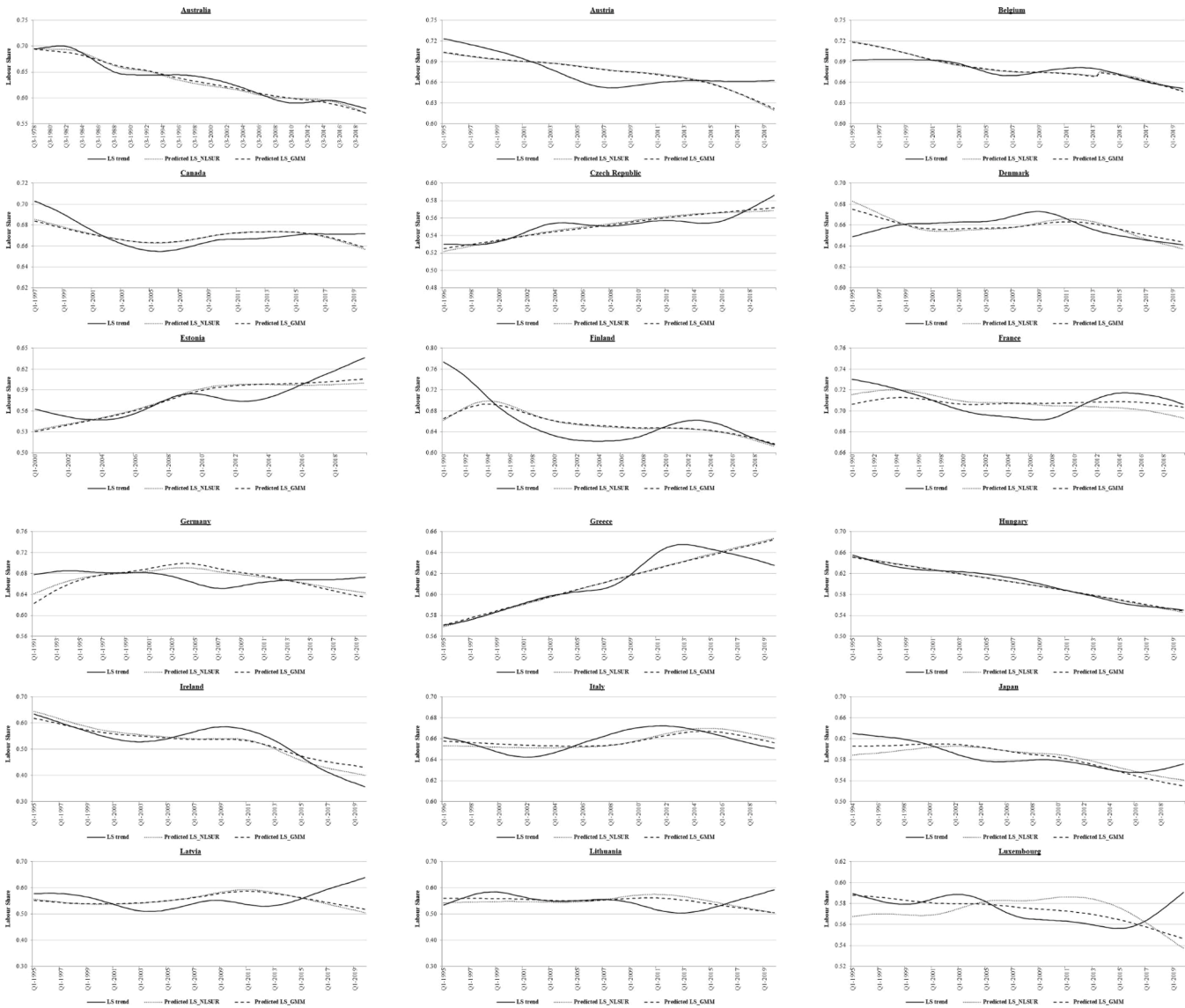


Fig. 3. Evolution of the trend components of the labour share and the predicted labour share.

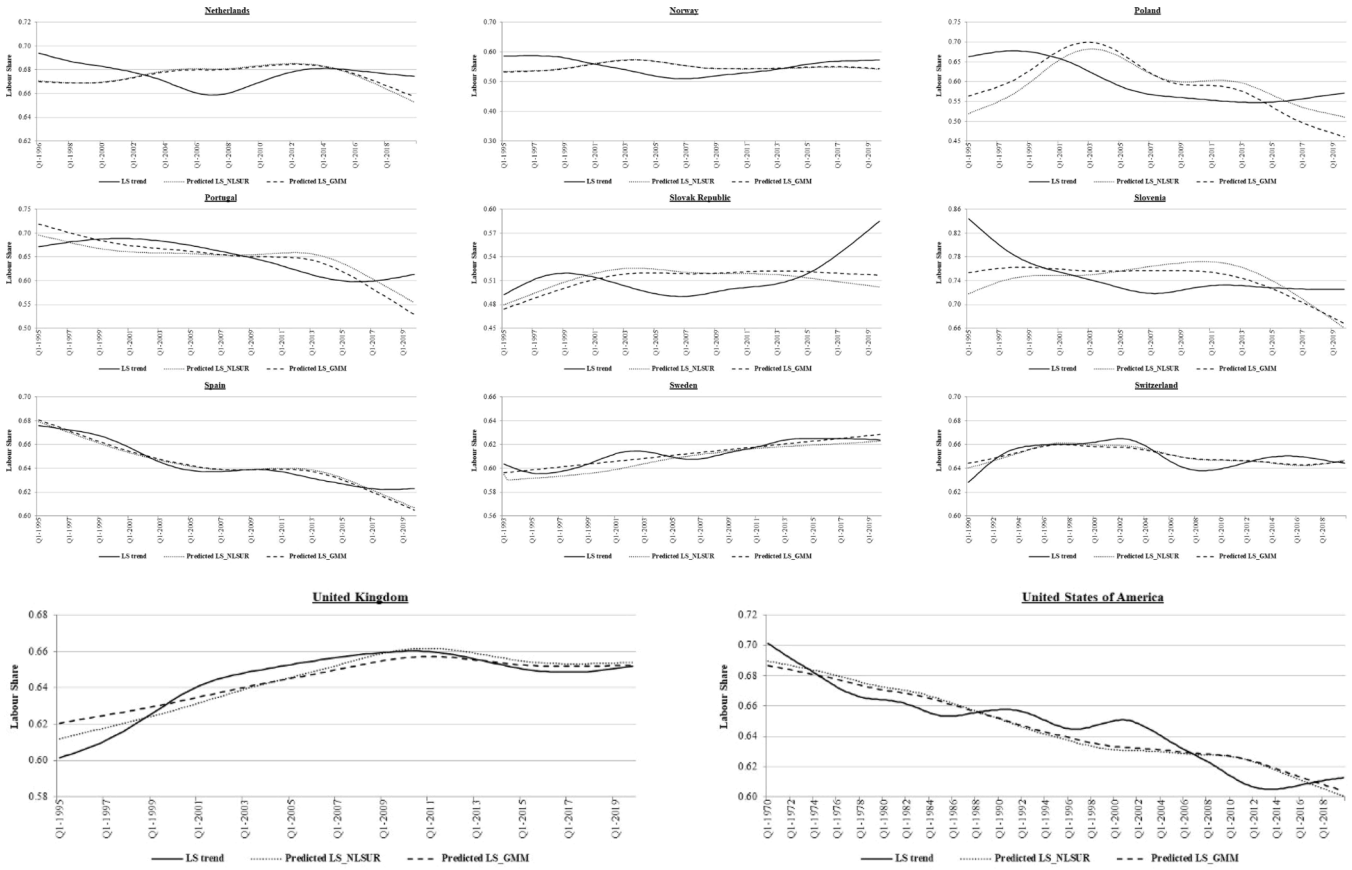


Fig. 3. (continued).

Table 8
Model-predicted labour shares' fit: R^2 , RSS, and CCC.

Country	NLSUR			GMM		
	RSS	R^2	CCC	RSS	R^2	CCC
AU	0.0101	0.9542	0.9770	0.0102	0.9536	0.9760
AT	0.0284	0.4172	0.6440	0.0269	0.4488	0.6670
BE	0.0031	0.7888	0.8210	0.0030	0.7980	0.8260
CA	0.0046	0.6110	0.6430	0.0046	0.6071	0.6050
CZ	0.0033	0.7989	0.8920	0.0030	0.8168	0.9030
DK	0.0066	0.1392	0.3730	0.0066	0.1461	0.3620
EE	0.0181	0.6087	0.7800	0.0152	0.6719	0.8190
FI	0.1117	0.4150	0.5450	0.1106	0.4210	0.5130
FR	0.0130	0.1383	0.3360	0.0104	0.3144	0.1980
DE	0.0115	0.0310	-0.1660	0.0111	0.0683	-0.2100
GR	0.0078	0.8759	0.9360	0.0078	0.8751	0.9340
HU	0.0016	0.9824	0.9910	0.0018	0.9809	0.9900
IE	0.0724	0.8490	0.9180	0.0775	0.8383	0.8620
IT	0.0052	0.3905	0.5950	0.0052	0.3928	0.5040
JP	0.0342	0.3763	0.6040	0.0226	0.5871	0.7620
LV	0.0716	0.2674	-0.4840	0.0767	0.2153	-0.3990
LT	0.0320	0.4216	-0.6070	0.0524	0.0523	-0.2070
LU	0.0100	0.1815	-0.4260	0.0100	0.1829	0.4270
NL	0.0062	0.1693	-0.4080	0.0061	0.1923	-0.4230
NO	0.0512	0.2072	-0.3340	0.0497	0.2308	-0.3440
PL	0.2416	0.0178	0.1330	0.1928	0.2159	0.4460
PT	0.0604	0.4750	0.6850	0.0399	0.6531	0.7840
SK	0.0427	0.1262	-0.2820	0.0486	0.0044	0.0570
SI	0.0889	0.0158	-0.1250	0.0786	0.1308	0.3550
ES	0.0024	0.9160	0.9570	0.0022	0.9230	0.9590
SE	0.0017	0.8330	0.8290	0.0014	0.8652	0.9300
CH	0.0031	0.6788	0.7890	0.0035	0.6363	0.7250
UK	0.0033	0.8777	0.9340	0.0037	0.8641	0.8700
US	0.0197	0.8400	0.9160	0.0174	0.8587	0.9240
Mean	0.0333	0.4967	0.4299	0.0310	0.5154	0.5109

Note: Residual Sum of Squares (RSS); Concordance Correlation Coefficient (CCC).

it should also be noted that with the Box-Cox specification, the fit of the model for Japan is greatly improved, while the fit of the firm's labour wedge is significantly reduced. In addition, for some European countries (Estonia, Slovenia, Finland and especially France) the fit of the model improves significantly with the Box-Cox specification.²²

9. Policy implications

Our results imply that in most countries technical change is net labour-augmenting, and capital and labour are gross complements. Therefore, technical change is capital biased, meaning that it increases the demand for capital by more than the demand for labour. Capital-biased technical change has several important policy implications, particularly in terms of its effects on income inequality, employment, and economic growth.

9.1. Meeting the challenges of capital-biased technical change

Capital-biased technological change increases capital demand relative to labour, potentially leading to higher returns for capital owners while stagnating or lowering wages for workers, particularly in routine or low-skill jobs (Autor, 2022; Acemoglu et al., 2020). To address rising inequality, policymakers may need redistributive measures like progressive taxation or universal basic income, as well as labour protections such as retraining programs.

Automation and capital-intensive production can displace workers, especially in routine and manual labour industries (Acemoglu and Restrepo, 2018, 2019; Qin et al. 2024). If automation increases labour market competition (e.g., through gig work and temporary contracts), workers may have less negotiating power, leading to slower wage growth. Retraining and reskilling initiatives, along with education reforms, could prepare workers for a technology-driven labour market. Strengthening social safety nets and policies like job guarantees or universal basic income may help mitigate labour displacement.

Technological progress, particularly artificial intelligence and automation, can also lead to market concentration, favouring large firms that can invest in capital-intensive innovations (Autor et al., 2020; De Loecker et al., 2020; Khan, 2016). AI-driven technologies can further favour the creation of "superstar" firms (e.g., Google, Amazon) that achieve high productivity with relatively few workers,

²² In the case of France, the improvement in the fit of the labour share predicted by the model is due to the fact that the fit of the model is very good up to the year 2000, but not thereafter (see Fig. 6).

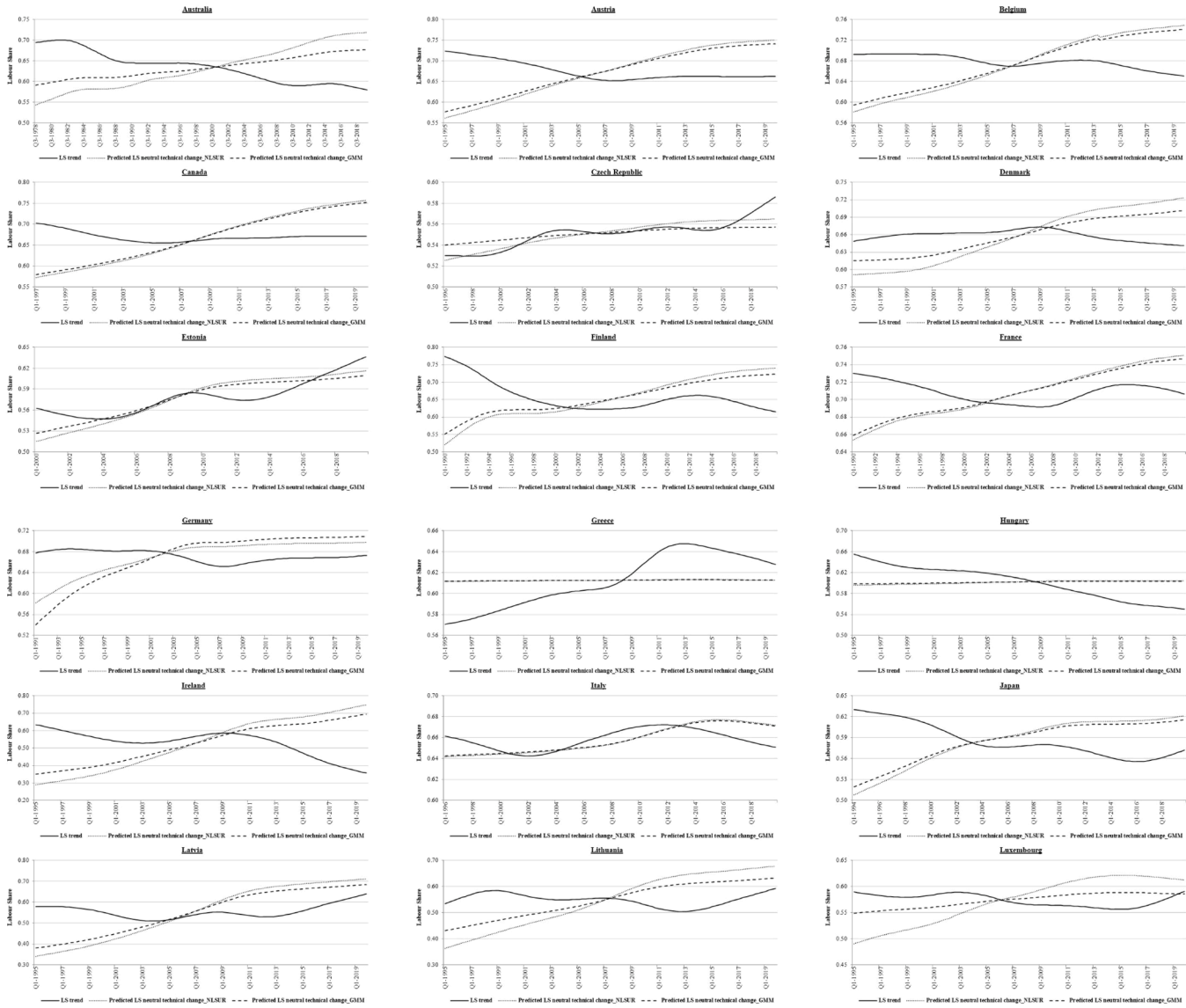


Fig. 4. Evolution of the trend components of the labour share and the predicted labour share with neutral technical change.

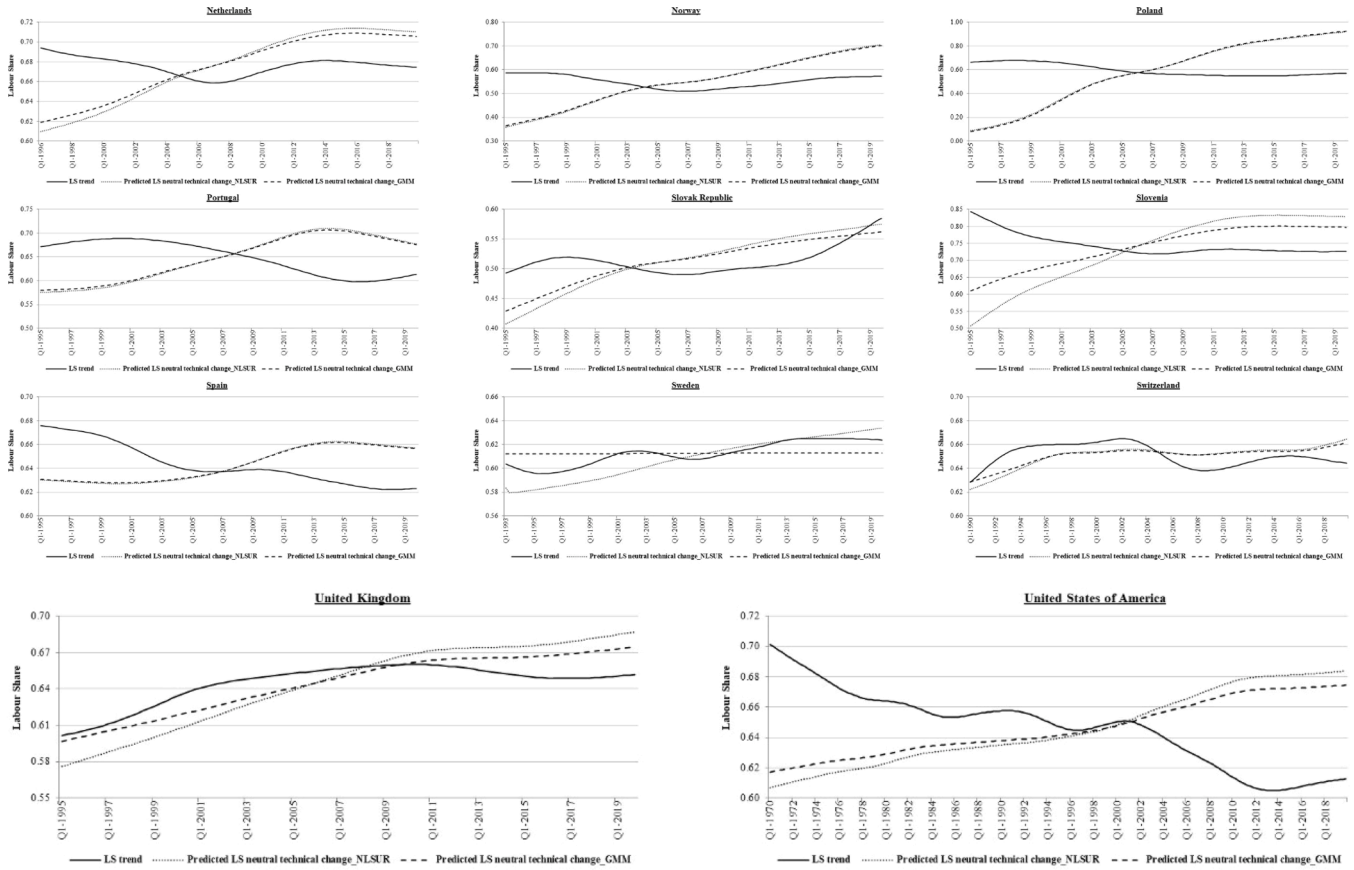


Fig. 4. (continued).

Table 9
Model-predicted labour shares' fit (neutral technical change): R^2 , RSS and CCC.

Country	NLSUR			GMM		
	RSS	R^2	CCC	RSS	R^2	CCC
AU	0.0203	0.9079	-0.9010	0.0212	0.9036	-0.8850
AT	0.0122	0.7497	-0.5630	0.0124	0.7462	-0.6210
BE	0.0044	0.7021	-0.3550	0.0044	0.7042	-0.4010
CA	0.0107	0.0935	-0.1110	0.0107	0.0926	-0.1180
CZ	0.0035	0.7893	0.8850	0.0035	0.7893	0.6100
DK	0.0067	0.1304	-0.1310	0.0067	0.1351	-0.1950
EE	0.0145	0.6863	0.7910	0.0145	0.6869	0.8240
FI	0.1172	0.3866	-0.5800	0.1181	0.3817	-0.6130
FR	0.0143	0.0556	-0.1630	0.0143	0.0547	-0.1730
DE	0.0057	0.5239	-0.4190	0.0057	0.5211	-0.3000
GR	0.0020	0.9688	0.0410	0.0020	0.9688	0.0340
HU	0.0168	0.8210	-0.1720	0.0168	0.8212	-0.1020
IE	0.2491	0.4802	-0.5290	0.2454	0.4878	-0.6280
IT	0.0057	0.3293	0.5450	0.0057	0.3292	0.5530
JP	0.0035	0.9359	-0.9080	0.0035	0.9359	-0.9500
LV	0.0929	0.0501	0.1040	0.0928	0.0505	0.1240
LT	0.0432	0.2197	-0.2060	0.0433	0.2169	-0.3000
LU	0.0051	0.5818	-0.3660	0.0051	0.5832	-0.7530
NL	0.0066	0.1192	-0.1630	0.0066	0.1177	-0.1840
NO	0.0595	0.0783	-0.1340	0.0595	0.0781	-0.1370
PL	0.0273	0.8889	-0.3400	0.0268	0.8911	-0.3340
PT	0.0177	0.8462	-0.8680	0.0176	0.8467	-0.8840
SK	0.0408	0.1647	0.3150	0.0408	0.1649	0.3580
SI	0.0193	0.7859	-0.4850	0.0213	0.7640	-0.7070
ES	0.0093	0.6730	-0.8070	0.0093	0.6730	-0.8000
SE	0.0015	0.8513	0.7480	0.0015	0.8515	0.0680
CH	0.0089	0.0678	0.2600	0.0089	0.0676	0.2530
UK	0.0076	0.7184	0.6600	0.0077	0.7147	0.7880
US	0.0066	0.9462	-0.9720	0.0066	0.9461	-0.9210
Mean	0.0287	0.5363	-0.1663	0.0287	0.5353	-0.2205

Note: Residual Sum of Squares (RSS); Concordance Correlation Coefficient (CCC).

concentrating income in capital owners rather than employees. This raises concerns about monopolies, necessitating stronger antitrust regulations and policies that encourage competition (Zac et al., 2024).

A widening skill gap may emerge, where high-skilled workers benefit while low-skilled workers struggle (Goldin and Katz, 2009). Policy responses could include improving education systems with a focus on STEM, lifelong learning and adaptability (Arif, 2021).

Capital-biased technical change can impact environmental sustainability in industries like manufacturing and energy, either reducing pollution or increasing resource extraction (Acemoglu et al., 2012). Governments could align technological advancements with sustainability goals by promoting green innovations and energy-efficient solutions (Chen et al., 2024; Zhao et al., 2025; Zhu et al., 2025).

Global disparities in technology adoption may widen economic inequalities between nations (Comin and Hobijn, 2004). International cooperation in technology transfer, digital infrastructure, and innovation access could help bridge these gaps and support global economic stability.

9.2. Dealing with the consequences of the decline in the labour share

Capital-biased technical change may lead to a declining labour share, increasing income inequality and potentially causing social unrest (Elsby et al., 2013). To mitigate this, governments could implement progressive taxation, raising taxes on capital income (e.g., dividends, interest, capital gains) and considering policies like universal basic income (Conesa et al., 2020). Inclusive growth strategies, such as strengthening social safety nets, affordable healthcare, and equitable wealth distribution, may also be necessary.

Public pressure for fairer profit distribution may push governments to adopt policies like CEO-worker pay ratio transparency (Shi, 2024) and corporate governance reforms (Lindgreen and Swaen, 2010). Encouraging profit-sharing, employee ownership programs or tax incentives for worker-focused investments could promote fairer economic practices.

A shrinking labour share may reduce workers' disposable income, weakening consumption demand (Onaran et al., 2011; Li et al., 2024). In response, governments might implement fiscal stimulus, investing in infrastructure, education and healthcare, alongside monetary policies to boost consumer spending.

Tax burdens could shift as capital income is often taxed less than labour income. Policymakers may need to reform tax systems to ensure fairer taxation of capital gains and dividends, supporting income equality and maintaining social program funding (Delestre et al., 2024).

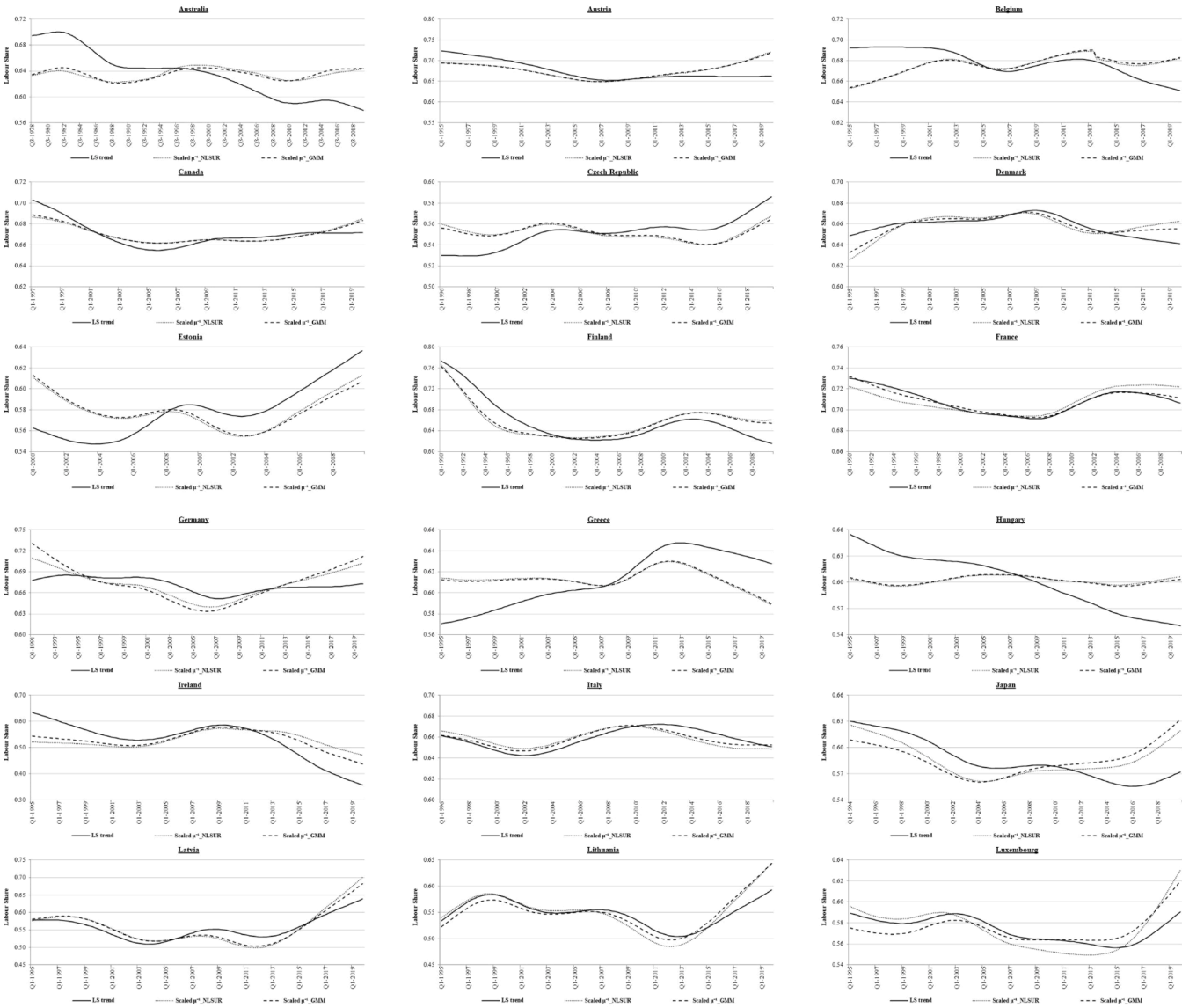


Fig. 5. Evolution of the trend components of the labour share and the inverse of the firm labour wedge.

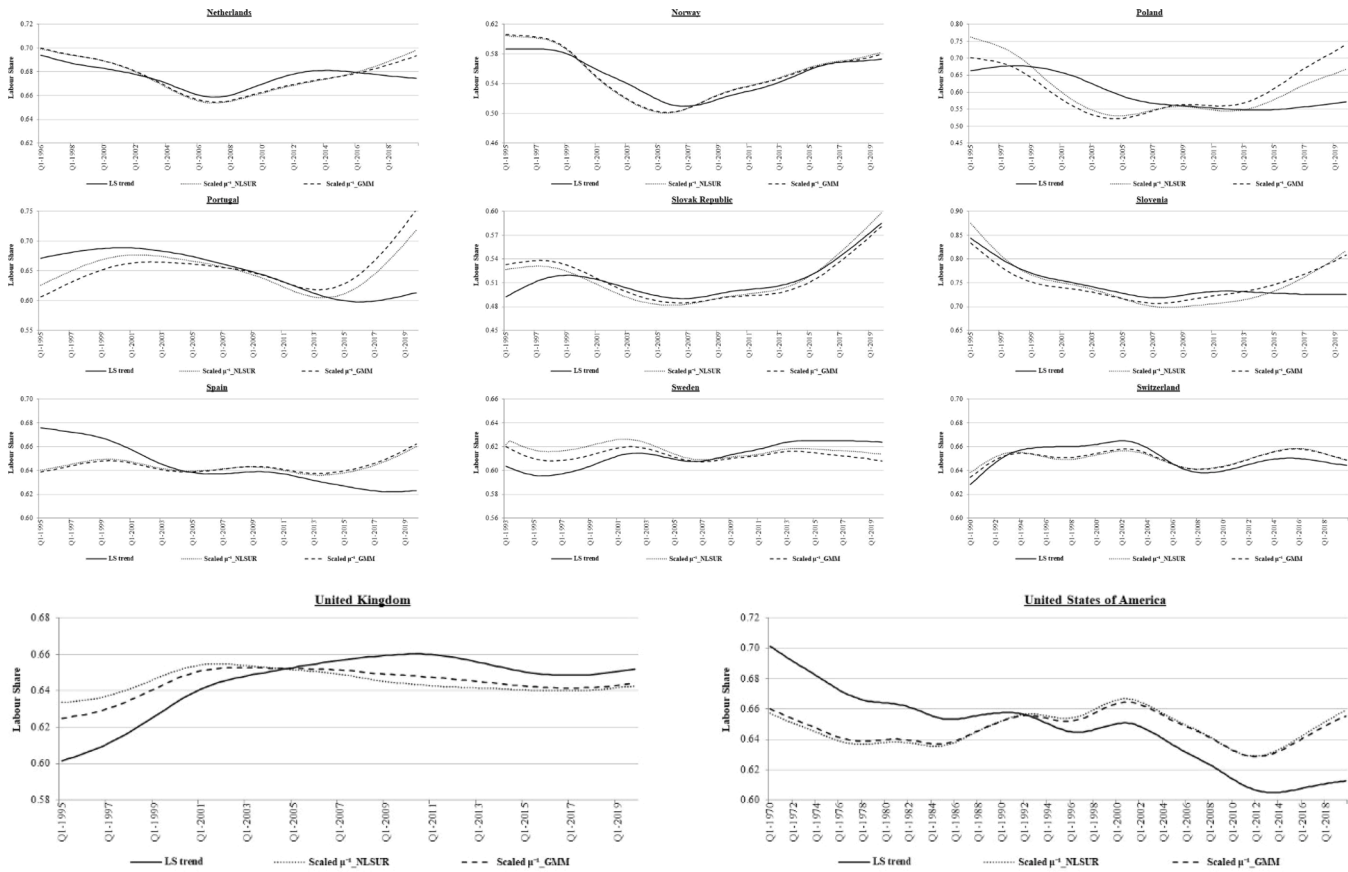


Fig. 5. (continued).

Table 10
Firm labour wedge's fit: R^2 , RSS and CCC.

Country	NLSUR			GMM		
	RSS	R^2	CCC	RSS	R^2	CCC
AU	0.2192	0.0049	0.0290	0.2164	0.0178	0.0550
AT	0.0382	0.2166	0.4570	0.0383	0.2134	0.4500
BE	0.0129	0.1329	-0.3280	0.0125	0.1576	-0.3610
CA	0.0029	0.7575	0.8060	0.0022	0.8117	0.8440
CZ	0.0165	0.0056	0.0580	0.0164	0.0123	0.0830
DK	0.0055	0.2854	0.5300	0.0034	0.5537	0.7440
EE	0.0405	0.1237	0.3210	0.0437	0.0557	0.2090
FI	0.0584	0.6941	0.8020	0.0450	0.7643	0.8430
FR	0.0057	0.6258	0.7910	0.0004	0.9720	0.9820
DE	0.0067	0.4391	0.5500	0.0074	0.3751	0.4250
GR	0.0597	0.0467	0.1320	0.0564	0.0996	0.1930
HU	0.0934	0.0026	0.0130	0.0856	0.0865	0.0800
IE	0.3684	0.2312	0.3350	0.1657	0.6541	0.6440
IT	0.0045	0.4793	0.6730	0.0021	0.7514	0.8430
JP	0.0364	0.3362	0.5680	0.0531	0.0312	0.1690
LV	0.0143	0.8538	0.8470	0.0123	0.8743	0.8870
LT	0.0070	0.8736	0.8520	0.0136	0.7532	0.8320
LU	0.0038	0.6925	0.7200	0.0085	0.3104	0.5550
NL	0.0020	0.7368	0.7740	0.0016	0.7870	0.8170
NO	0.0058	0.9104	0.9290	0.0053	0.9179	0.9330
PL	0.1390	0.4348	0.6240	0.2271	0.0764	0.2660
PT	0.0892	0.2247	0.4590	0.1144	0.0063	-0.0780
SK	0.0066	0.8654	0.9040	0.0134	0.7262	0.8470
SI	0.0359	0.6029	0.7280	0.0528	0.4163	0.6440
ES	0.0276	0.0270	0.0900	0.0283	0.0030	-0.0300
SE	0.0101	0.0063	-0.0520	0.0094	0.0732	0.1770
CH	0.0052	0.4540	0.5830	0.0037	0.6119	0.7030
UK	0.0229	0.1470	0.2420	0.0090	0.6668	0.6090
US	0.1176	0.0458	0.1510	0.1068	0.1338	0.2430
Mean	0.0502	0.3882	0.4686	0.0467	0.4108	0.4692

Note: Residual Sum of Squares (RSS); Concordance Correlation Coefficient (CCC).

9.3. Mitigating the decline in the labour share

To counteract the decline in the labour share, policymakers may strengthen labour protections, such as minimum wage laws, collective bargaining rights and improved working conditions. Additionally, enhancing labour market flexibility while protecting workers' rights — through retraining, job placement and reskilling programs — could help workers adapt to economic changes (Ciminelli et al., 2022). Facilitating access to new technologies may also reduce labour mismatch, boost innovation and enhance human capital (Ma et al., 2024; Xu et al., 2024; Qiao et al., 2025).

Encouraging investment in sectors that create well-paying jobs or technologies that complement labour rather than replace it is another strategy (Rodrik, 2022). Tax incentives and subsidies could support industries like renewable energy, healthcare and education, which typically have high labour demand.

Global supply chain restructuring and the outsourcing of labour-intensive jobs to low-wage countries may also contribute to the decline in the labour share (Hummels et al., 2018). Policymakers might address this through trade policies that balance globalization's benefits with worker protections, such as labour standards in trade agreements or incentives for reshoring jobs.

10. Concluding remarks

In recent decades, while capital intensity has increased across most OECD countries, the labour share has undergone notable changes, declining in countries like Australia and the United States, and rising in some Eastern European and Baltic nations. We identify capital-biased technical change as the primary driver of labour share decline. If capital and labour are gross complements, net labour-augmenting technical change can offset capital deepening and reduce the labour share.

Our estimated elasticities of capital-labour substitution are consistently below unity, indicating gross complementarity, and net labour-augmenting technical change is confirmed for most countries. Notably, the Czech Republic, which saw a labour share increase, is an exception. In countries like the UK and Germany, slower net labour-augmenting technical change prevented a decline in the effective capital-labour ratio, explaining labour share increases as predicted by the neoclassical model. However, in the US and Australia, rapid labour-augmenting technical change contributed significantly to the labour share decline.

Our results are robust to changes in the specification of technological change, whether assuming constant rates or using a Box-Cox function. In both cases, technical change is predominantly net labour-augmenting, and capital and labour are gross complements. The Box-Cox specification further reinforces these findings and shows that in most countries the decline in capital efficiency has accelerated while the increase in labour efficiency has slowed.

Table 11
Estimates of aggregate elasticities of substitution and technological change rates (Box-Cox specification).

Country	NLSUR					
	σ	ζ_K	ζ_L	λ_K	λ_L	ξ
AU	0.3137*** (0.0042)	-0.0001* (0.0001)	0.0044*** (0.0000)	4.5949*** (1.2050)	0.9311*** (0.0171)	1.0076*** (0.0017)
AT	0.2627*** (0.0021)	-0.0015*** (0.0001)	0.0033*** (0.0001)	0.9768*** (0.0876)	0.6871*** (0.0351)	1.0040*** (0.0018)
BE	0.2569*** (0.0020)	-0.0019*** (0.0000)	0.0022*** (0.0000)	1.8557*** (0.0568)	0.5569*** (0.0299)	1.0133*** (0.0009)
CA	0.3234*** (0.0025)	-0.0033*** (0.0001)	0.0025*** (0.0001)	1.3216*** (0.0575)	0.4728*** (0.0394)	1.0119*** (0.0016)
CZ	0.7093*** (0.0013)	0.0036*** (0.0002)	0.0032*** (0.0002)	0.9518*** (0.1302)	0.4366*** (0.0885)	1.0136*** (0.0047)
DK	0.3753*** (0.0018)	-0.0015*** (0.0001)	0.0030*** (0.0001)	1.0407*** (0.1387)	1.2549*** (0.0686)	0.9976*** (0.0021)
EE	0.6225*** (0.0031)	0.0001 (0.0001)	0.0027*** (0.0003)	10.0308*** (2.5548)	-0.0801 (0.0828)	1.0133*** (0.0047)
FI	0.2870*** (0.0048)	-0.0013*** (0.0002)	0.0036*** (0.0001)	3.2071*** (0.3446)	0.2151*** (0.0337)	1.0376*** (0.0038)
FR	0.3767*** (0.0008)	-0.0009*** (0.0000)	0.0027*** (0.0001)	1.8189*** (0.1735)	0.5000*** (0.0256)	1.0097*** (0.0017)
DE	0.2714*** (0.0021)	0.0008*** (0.0001)	0.0025*** (0.0001)	1.8473*** (0.2154)	0.6062*** (0.0334)	1.0034*** (0.0014)
GR	0.8683*** (0.0025)	0.0071*** (0.0008)	-0.0102*** (0.0006)	0.3884*** (0.0097)	2.0757*** (0.1404)	1.0904*** (0.0075)
HU	0.8397*** (0.0031)	-0.0157*** (0.0005)	0.0144*** (0.0003)	1.0886*** (0.0515)	0.7909*** (0.0310)	1.0347*** (0.0052)
IE	0.4162*** (0.0042)	-0.0070*** (0.0002)	0.0124*** (0.0003)	0.8205*** (0.0573)	1.4016*** (0.0583)	0.9936*** (0.0059)
IT	0.4934*** (0.0010)	-0.0013*** (0.0001)	-0.0002** (0.0001)	1.8708*** (0.2550)	1.2118 (1.2837)	1.0067*** (0.0026)
JP	0.3473*** (0.0027)	-0.0003*** (0.0001)	0.0033*** (0.0001)	0.2571 (0.1930)	0.6190*** (0.0296)	1.0056*** (0.0016)
LV	0.4629*** (0.0046)	-0.0067*** (0.0003)	0.0103*** (0.0003)	1.5256*** (0.1281)	0.5620*** (0.0429)	1.0398*** (0.0069)
LT	0.3766*** (0.0031)	-0.0035*** (0.0002)	0.0099*** (0.0002)	1.5439*** (0.2156)	0.6211*** (0.0371)	1.0325*** (0.0062)
LU	0.2688*** (0.0019)	-0.0017*** (0.0001)	0.0009*** (0.0001)	1.0970*** (0.1120)	0.1723* (0.0959)	1.0061*** (0.0023)
NL	0.3484*** (0.0022)	-0.0018*** (0.0001)	0.0019*** (0.0001)	1.2777*** (0.0882)	0.3453*** (0.0327)	1.0100*** (0.0012)
NO	0.1327*** (0.0037)	-0.0029*** (0.0001)	0.0016*** (0.0001)	1.6947*** (0.0699)	0.1973*** (0.0554)	1.0177*** (0.0022)
PL	0.1346*** (0.0077)	-0.0010*** (0.0001)	0.0085*** (0.0001)	1.2972*** (0.2199)	0.7297*** (0.0185)	1.0134*** (0.0021)
PT	0.3646*** (0.0131)	-0.0031*** (0.0001)	0.0030*** (0.0001)	1.1217*** (0.0893)	0.7527*** (0.0431)	1.0078*** (0.0016)
SK	0.4565*** (0.0026)	0.0022*** (0.0002)	0.0069*** (0.0002)	2.0085*** (0.2764)	0.5138*** (0.0470)	1.0017*** (0.0047)
SI	0.4757*** (0.0031)	-0.0035*** (0.0002)	0.0054*** (0.0002)	0.0637 (0.0396)	0.3381*** (0.0360)	1.0097*** (0.0036)
ES	0.7369*** (0.0044)	-0.0069*** (0.0002)	0.0042*** (0.0001)	0.7864*** (0.0383)	1.1155*** (0.0461)	0.9943*** (0.0014)
SE	0.6008*** (0.0016)	-0.0003* (0.0002)	0.0026*** (0.0001)	3.8801*** (1.3634)	0.3048*** (0.0623)	1.0422*** (0.0023)
CH	0.3448*** (0.0010)	0.0022*** (0.0000)	0.0029*** (0.0001)	1.0056*** (0.0331)	0.9903*** (0.0440)	0.9976*** (0.0012)
UK	0.3372*** (0.0023)	-0.0010*** (0.0001)	0.0020*** (0.0001)	2.6015*** (0.3731)	0.4595*** (0.0509)	1.0126*** (0.0020)
US	0.7437*** (0.0026)	-0.0037*** (0.0001)	0.0059*** (0.0001)	0.7915*** (0.0347)	1.0697*** (0.0201)	0.9936*** (0.0022)
Mean	0.4327	-0.0019	0.0040	1.8195	0.6845	1.0146

Notes: Figures enclosed in parentheses are the estimated standard errors; *significant at the 10 % level; **significant at the 5 % level; ***significant at the 1 % level.

Our analysis reveals a consistent empirical pattern: on average, countries that experienced larger declines in the labour share also exhibited greater contributions from net labour-augmenting technical change and smaller contributions from capital deepening. Capital deepening, in fact, has not reduced the labour share; rather it has contributed to its increase.

The perfect competition model with biased technical change accurately accounts for the labour share trend in countries like the US,

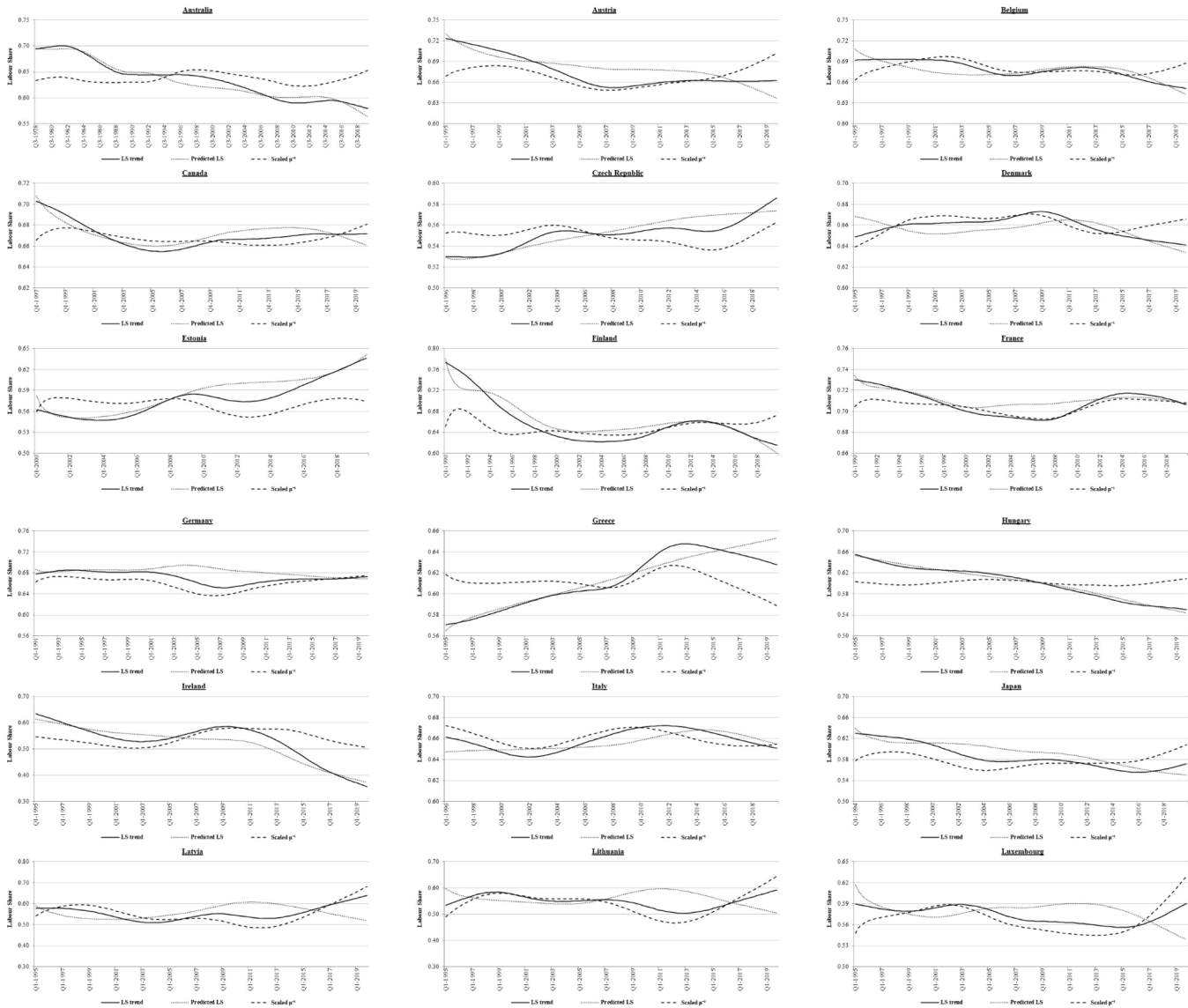


Fig. 6. Evolution of the trend component of the labour share, predicted labour share and the inverse of the firm labour wedge (NLSUR method, Box-Cox technical change specification).

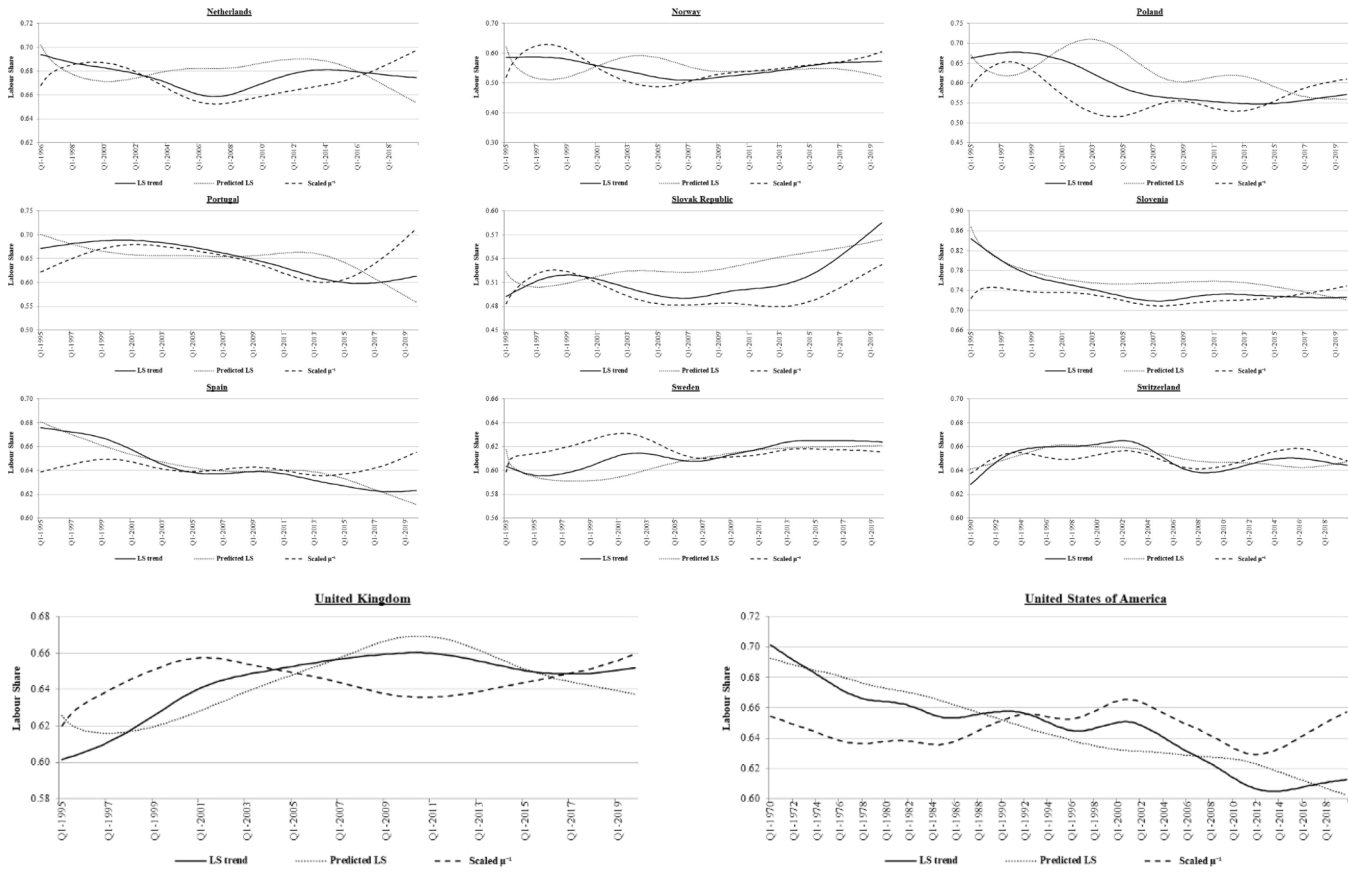


Fig. 6. (continued).

Table 12Model-predicted labour share's fit and firm labour wedge's fit (Box-Cox specification, NLSUR method): R^2 , RSS, and CCC.

Country	Model-predicted labour shares' fit			Firm labour wedge's fit		
	RSS	R^2	CCC	RSS	R^2	CCC
AU	0.0128	0.9417	0.9680	0.2152	0.0231	0.0710
AT	0.0184	0.6216	0.7360	0.0337	0.3075	0.4670
BE	0.0065	0.5612	0.7360	0.0119	0.1963	0.4060
CA	0.0028	0.7612	0.8400	0.0080	0.3160	0.4310
CZ	0.0034	0.7936	0.8740	0.0165	0.0059	-0.0620
DK	0.0051	0.3458	0.5530	0.0055	0.2906	0.5020
EE	0.0059	0.8716	0.8860	0.0461	0.0041	0.0380
FI	0.0202	0.8940	0.9150	0.1227	0.3574	0.3470
FR	0.0030	0.7991	0.7160	0.0032	0.7859	0.6970
DE	0.0118	0.0056	0.0390	0.0042	0.6505	0.5320
GR	0.0067	0.8923	0.9440	0.0598	0.0459	0.1230
HU	0.0015	0.9840	0.9920	0.0921	0.0168	0.0330
IE	0.0656	0.8631	0.9150	0.4302	0.1022	0.2070
IT	0.0045	0.4782	0.6410	0.0046	0.4569	0.6240
JP	0.0146	0.7340	0.8080	0.0481	0.1232	0.2640
LV	0.0931	0.0474	-0.2140	0.0316	0.6771	0.7630
LT	0.0274	0.5037	-0.6560	0.0082	0.8510	0.7670
LU	0.0117	0.0458	-0.1920	0.0057	0.5341	0.6040
NL	0.0075	0.0001	-0.0110	0.0038	0.5000	0.6260
NO	0.0522	0.1911	-0.4330	0.0151	0.7655	0.7840
PL	0.1724	0.2989	0.4470	0.1527	0.3792	0.5090
PT	0.0694	0.3972	0.6220	0.0811	0.2954	0.5330
SK	0.0294	0.3985	0.4470	0.0268	0.4505	0.4860
SI	0.0127	0.8593	0.7740	0.0597	0.3399	0.3060
ES	0.0020	0.9311	0.9630	0.0257	0.0961	0.1530
SE	0.0030	0.7046	0.7470	0.0102	0.0018	0.0320
CH	0.0031	0.6812	0.7870	0.0051	0.4726	0.5940
UK	0.0059	0.7787	0.8810	0.0261	0.0302	0.1390
US	0.0177	0.8560	0.9250	0.1182	0.0412	0.1380
Mean	0.0238	0.5945	0.5741	0.0576	0.3144	0.3832

Note: Residual Sum of Squares (RSS); Concordance Correlation Coefficient (CCC).

UK, Australia, and some European nations, but not in the largest euro area economies (Germany, France and Italy), where the firm labour wedge plays a more significant role. Similarly, in Canada and Japan, the firm labour wedge is relevant, though less influential. The firm labour wedge has generally declined since 2008, contributing to a stabilisation or even increase in the labour share.

These differences across countries suggest varied policy needs. Some may focus on addressing the effects of the decline in capital efficiency, while others may prioritize tackling market frictions and regulatory failures. Understanding the determinants of capital efficiency and the firm labour wedge is key to getting economic policy right.

Future research could examine how technological progress impacts various sectors (e.g., manufacturing vs. services, high-tech vs. low-tech) in relation to the labour share, as sectoral differences in capital intensity and reliance on skilled labour affect outcomes. Firm-level data analysis could explore how different firms adopt technology and its impact on labour demand and share. Additionally, studying the relationship between market concentration, capital-biased technologies and the labour share would provide valuable insights.

Further research also could incorporate market frictions (e.g., markups) to assess the robustness of technical progress estimates and the elasticity of capital-labour substitution. Another important avenue is understanding how the technological bias affects the labour share in developing vs. developed economies, shedding light on its role in global income inequality. Exploring the institutional, regulatory and economic drivers of the technological bias, as well as the interaction between capital-biased and skill-biased technological changes, could provide crucial insights into wage inequality. Research should also investigate how capital or high-skilled labour-biased technological progress alters factor income distribution, contributing to income inequality. The implications of automation, AI and digital transformation on new forms of work, labour share and globalization are also key topics for future studies. Finally, adopting theoretical frameworks that extend beyond the aggregate production function could enhance our understanding of the factors influencing the functional distribution of income.

In short, given the complex nature of technological progress, labour share and inequality, future research should focus on sectoral differences, specific technologies and the intersection of policy and technology, helping to ensure that technological advances benefit society broadly rather than exacerbating inequalities.

CRedit authorship contribution statement

Fernando Del Río: Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Conceptualization. **Francisco Rebelo:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Resources, Methodology, Investigation, Formal analysis,

Data curation, Conceptualization.

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