Intangible capital, the labour share, and national 'growth regimes'

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Abstract

This paper examines how far an increase in the intangible capital to output ratio contributes to changes in the labour share. We focus on a selection of OECD countries using industry-level data from 1995 to 2017. We show that the relationship between intangible capital and labour share is heterogeneous, and whether it is positive or negative depends on the types of intangibles and the growth regime of the national economy. In the Nordic countries, whose growth regimes balance domestic demand and exports of high-value services, the net effect of intangible capital on the labour share is tiny but positive. In contrast, it is negative for countries with high-quality manufacturing exporting sectors, such as Germany, Belgium and Austria. For countries like the USA and the UK, the evidence suggests that there are counteracting impacts across countries on the labour share from intangible capital assets, although the net effect is positive. We examine the bidirectional causality between the labour share and intangibles, showing that those behave as gross complements in the Nordic countries and as gross substitutes in the high-quality manufacturing export-led regimes; in the rest of the regimes, it depends on the asset.

Keywords: growth regimes, intangible capital, labour share, OECD economies

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Introduction

The labour share has fallen in many OECD countries since the early 1980s, raising concerns about increasing inequality between workers and owners of capital. The determinants of the declining labour share have been extensively researched, with numerous studies, inter alia, on the effects of trade liberalisation, capital openness, offshoring, technological change, market concentration and, more recently, managerial practices. In this paper, we contribute a new analysis of the impact of investment in intangible capital on the labour share in selected OECD countries and examine the mediation of that relationship by the political-economic institutions of national 'growth regimes.'

Exposure to international trade has been shown to increase competition and triggers input costs savings, a weakening of the bargaining power of workers and declining real wages, leading to lower labour income shares (Diwan, 2001; Harrison, 2002; Guscina, 2007; Jayadev, 2007; and Elsby, 2013). Likewise, technological change has transformed the organisation of firms', inducing substantial changes in the demand for labour, reducing costs and increasing productivity. These changes have contributed to shrinkage in the labour share (Acemoglu and Restrepo, 2020; Schwellnus, Pak, Pionnier and Crivellaro, 2018). Empirical evidence using national and industry-level data indicates a negative relationship between proxies of technological change and labour share in OECD countries (Bentolila and Saint-Paul, 2003; Bassanini and Manfredi, 2012). Karabarbounis and Neiman (2014) argue that the cost of capital versus the cost of labour has plummeted, driven by a sharp decline in the prices of technological equipment. Thus, the fall in the relative price of investment goods explains the declining labour share in advanced and developing economies (Karabarbounis and Neiman, 2014; Dao *et al.,* 2019).

In recent studies, Autor *et al.* (2020) focus on high-tech firms and propose a 'superstar firms' model. They observe that industries with greater market concentration are those where the labour share has declined most significantly, suggesting that the fall is driven by between-firm reallocation. On managerial practices, Acemoglu, He and Maire (2022) show that managers with business degrees reduce their employees' wages and the labour share, drawing on empirical data from the USA and Denmark. Firms appointing managers with business degrees report a reduction in wages within five years of the appointment, leading to a lower labour share. Firms with non-business managers appointed do not observe an adverse wage effect.

Notwithstanding the growing body of research on labour share, most existing studies on technological change are related to physical capital, ICT investment and robots. Yet, in the development of knowledge-based and digital economies, investment in intangible assets has taken on increasing significance (Hall, 2021). Existing research on intangible capital and labour share has developed in two directions: 1) on measurement issues affecting the labour share trend, and 2) on the causal relationship between intangibles and the labour share. Koh et al. (2020) show that including the capitalisation of intellectual property products (IPP) in the national accounts unambiguously lowers the level of the labour share in the USA. They argue that changes in the methodology implemented by the Bureau of Economic Analysis (BEA) attribute IPP's entire rents to capital income, leading to an apparent decline in the labour share. Atkeson (2020)'s findings also suggest that the change in the BEA methodology to account for firms' expenditures on IPP has substantially impacted the labour share figures in the non-financial corporate sector. He corrects the labour share figures, including expenditures on IPP as expenditures on intermediate goods rather than final goods, and finds the USA's negative trend of the labour share vanishes.

O'Mahony *et al.* (2021) investigate the impact of intangible capital accumulation on the dynamic of the labour share in OECD countries from 1995 to 2007; they find that the direction and the size of the effects vary across intangibles. 'Economic competencies' tend to reduce the labour share while 'other innovative properties' are not significant or lead to the opposite. O'Mahony *et al.* (2021)'s work acknowledges capital heterogeneity and raises further questions for research, for instance, whether that relationship is sector-specific and country-specific.

In this paper, we argue that significant differences in the political-economic structures of OECD countries shape the relationship between intangible capital and labour. We find that the substitutability (complementarity) of labour with intangible capital is conditional on the type of intangible and the regime that a country chooses to achieve economic growth. Thus, we draw on the recent literature on 'growth regimes' and national 'growth models' to examine the relationship between intangible capital assets and the labour share in groups of different national economies (Hassel and Palier, 2021; Hall, 2021; Baccaro and Pontusson, 2021). A 'growth regime' is a 'mode of governance' of the economy, 'which encompasses the

institutional, policy, and organisational frameworks that shape the specialisation of firms and the consumption and savings patterns of the population, as well as the use of technology and work organisation.' (Hassel and Palier, 2021: 17).

For this paper, we draw on the classification of growth regimes developed in the literature, allocating countries into five groups using seven indicators that describe supply and demand-side features of national economies: wage-setting, households' credit access, the inclusiveness of the post-compulsory education system, the generosity of social protection, the development of the knowledge-based economy and the sector that leads economic growth, that is, exports or domestic demand.

The paper examines the relationship between labour share and intangible capital using the growth regimes perspective. We study a selection of 22 OECD countries using industry-level data from 1995 to 2017. We estimate a panel vector autoregressive (PVAR) model with country-industry fixed effects and GMM estimators to take account of endogeneity issues. The paper's first contribution is to comprehensively examine four intangible assets and their impact on the labour share for the entire sample, using the 2019 KLEMS dataset containing information on intangible capital and investment. We explore whether there is a heterogeneous association between intangible capital and labour, which depends on the intangible asset. With this analysis, we obtain our benchmark results.

The paper's second contribution is to assess the complementarity (substitutability) between intangible capital and labour, conditional on the growth regimes. As mentioned above, growth regimes shape both the conditions in which intangible capital is deployed and utilised, and the effects on the labour share of increased investment in intangible capital assets. Nonetheless, two countries with a developed exporting sector, and high levels of financialisation can display heterogeneous relationships between intangible capital and the labour share due to differences in labour market regulations and the inclusiveness of the education system. Overall, we hypothesise that differences in the growth regimes of advanced countries can determine whether the relationship between labour and (intangible) capital is positive or negative.

The paper's third contribution consists in examining whether there exists bidirectional causality between labour share and intangible capital. Traditionally, the economic literature has

emphasised one direction of the causality between (intangible) capital and labour: to explain the decline of the labour share as a causal consequence of increased (intangible) capital investment. However, this literature neglects the fact that fluctuations in the labour share may impact capital accumulation decisions in respect of intangibles. We explore this idea using a model that allows us to define all variables as endogenous and test the bi-causality.

The paper's fourth contribution consists in providing empirical evidence about the substitutability and complementarity among the types of intangible capital for the baseline model and the growth regimes' analyses. The selection of a PVAR model for this study also allows us to check the relationship across intangibles. To the best of our knowledge, no other studies examine i) the relationship between the labour share and intangible using growth regimes, ii) the bi-directional causality related to the labour share and intangible capital, and iii) the relationship among the types of intangible capital.

Our findings show that increases in the intangible capital to value-added ratio trigger a decline in the labour share in OECD countries without controlling for heterogeneity across the sample. The results suggest that capital invested in 'economic competencies', 'other innovative research' and 'research and development' are the leading factors that drive the negative relationship between labour share and intangible capital. On the contrary, capital to value-added invested in 'software and databases', in the aggregate, does not significantly affect the labour share. However, it is worth noting that this intangible component is the smallest among the intangibles and has an effect when we conduct the analysis by growth regimes.

In the second part of the analysis, we split our sample, classifying countries according to the five growth regimes outlined by Hassel and Palier (2021); we argue that this framework allows us to group countries according to their structural heterogeneities.

We are among the first to study the effect of the intangibles on the labour share. To the best of our knowledge, we are the first to examine i) the bidirectional causality between intangibles and the labour share and ii) the substitutability or complementarity across types of intangible capital. Our findings show that countries from different growth regimes observe marked differences in the relationship between intangible capital and labour. For instance, the effects in Nordic countries turn positive, particularly for other innovative properties. In contrast, the impact is significant and negative for economies in the high-quality manufacturing export-led

growth regime. These results are mediated by the sector that commands economic growth, the nature of the economy, focused on the goods or services sectors, the regulation of the labour market and the type of high-education system that shapes the workforce's skills.

The rest of the paper is structured as follows. Section 2 briefly explains the growth regimes framework. Section 3 lays out the empirical strategy, including the model for the empirical estimations. Section 4 describes the data. Section 5 presents the results of the baseline estimations. Section 6 presents the results by growth regimes, and Section 7 concludes.

Growth regimes

The literature on 'growth regimes' draws on but augments and develops the political economy approaches of the varieties of capitalism (VoC) (Hall and Soskice, 2001). This framework classifies countries into two main groups based on supply-side characteristics: the regulation of the labour market, structures of education and training provision, the role of the financial sector, modes of innovation, and the welfare state. Thus, the Liberal Market Economies (LME) grouping includes all the English-speaking countries with flexible labour markets, investment in general rather than vocationally specific skills, extensive market-competition between firms, and a large role for deregulated financial services. In comparison, the Nordic and Continental European countries are grouped as Coordinated Market Economies (CME) with regulated labour markets, strong trade unions, coordination between firms over vocational training and skills development, and frictions in the financial system.

The growth regime perspective augments this supply-side analysis with the neo-Kaleckian demand-side approach to national growth models, developed by Baccaro and Pontusson (2016, 2021) and the 'worlds of welfare' capitalism analysis pioneered by Esping-Andersen (1990). A 'growth regime' is a 'mode of governance' of the economy, 'which encompasses the institutional, policy, and organisational frameworks that shape the specialisation of firms and the consumption and savings patterns of the population, as well as the use of technology and work organisation.' (Hassel and Palier, 2021: 17).

The literature on growth regimes classifies the advanced economies into five growth regimes utilising seven indicators that describe supply and demand-side features of national economies as follows:

1) the component of the aggregate demand that drives economic growth in a country either the exporting sectors or domestic demand.
2) the extent of the deregulation of the financial system, which includes capital liberalisation and the ease of households' access to credit. Countries with a high level of financialisation tend to report larger shares of household debt to GDP (Nordics, the US and UK). Thus, countries could have increased or regulated/low financialisation.
3) the development of the knowledge-based economy driven by the ICT sector. Countries focusing on financial and high-tech services such as the US, the UK and the Nordic countries, are classified as high knowledge-based economies because their share of the ICT sector is extensive. In contrast, the Southern European economies or Central and Eastern European countries with a small ICT sector are considered low in this category.
4) the inclusiveness of the education system indicates whether education access is public or private. Countries with strong publicly funded education systems, typical of the Nordic, Central and Eastern European countries, are considered inclusive. Education systems with an extensive role for the private sector in post-compulsory education, as in most English-speaking countries and some Southern European economies, are considered strongly stratified or elitist education systems.
5) the regulation of the labour market, whether flexible or coordinated and covered by bargaining agreements, determines workers' bargaining power when they face technological innovations.
6) the welfare states' coverage and generosity for guaranteeing social protection and social investment. Generous welfare states such as those in the Nordic countries provide universal social provision and social investment. In contrast, the social insurance systems of Germany and other manufacturing export-orientated growth regimes provide social protection for labour market 'insiders' and more limited coverage for 'outsiders.' Welfare states are often residual and parsimonious and supplemented by private insurance and investment in countries like the UK and the USA.
7) whether countries show a deficit or surplus in the current account.

Table 1 condenses the information about the seven indicators that describe the growth regimes, explaining the commonalities among countries with membership in the same group. We describe the growth regimes as follows:

The dynamic services export-led growth regime: Countries that balance domestic demand and exports, with dynamic ICT services and finance driving export growth, comprising the Nordic countries, Luxembourg and the Netherlands, see Table 1, first column. A solid exporting service sector characterises this group focused on high technology, high financialisation and deregulation of the financial system, a surplus in the current account, inclusive social policies and education systems, and coordinated wage setting.

The high-quality manufacturing export-led growth regime: Countries in this group have a strong manufacturing sector oriented to the external market, which sustains a surplus on the current account. Domestic consumption and wage growth is restrained in these economies, and the regulation of the market economy is oriented to incentivise savings and investment. There is an emphasis on the regulation of the financial system and the labour market, leading to low financialisation and high levels of coordination in workers' wage negotiations. The public education and vocational training systems generate a high-skilled workforce for the manufacturing sector. This growth regime includes Austria, Belgium, Germany, Switzerland, and Japan. We exclude Switzerland from the study because of the lack of data in the 2019 KLEMS for this country, see Table 1, the second column.

The financed-based domestic demand-led growth regime: This regime comprises the Anglo-Saxon countries except for the Republic of Ireland, characterised by strong domestic consumption and deficits on the current account. These economies present a high level of financialisation and household access to credit, which sustains consumption. Countries in this group have high shares of household debt to GDP. The labour market is deregulated, and the private sector heavily finances the post-compulsory education system and the social protection. This growth regime includes Australia, Canada, New Zealand, the UK, and the USA. However, using the 2019 KLEMS dataset, information on intangibles and the labour share is only available for the USA and the UK; thus, we have restricted our study to only these two countries, as noted in Table 1, the third column.

The FDI-financed export-led growth regime: This group refers to those countries with exporting solid sectors and relatively high domestic demand, namely those of Central and Eastern Europe, with Ireland sharing the dependence on FDI. These economies have undergone a significant capital liberalisation that has led them to rely extensively on foreign direct

investment (FDI) to drive exports and economic growth. However, the development of the knowledge-based economy is low; the labour market is deregulated, and the education system is inclusive to a medium level of education. Thus, the impact of intangible capital can be larger for these economies because the composition of their labour force is skewed towards low-skilled workers. Table 1 shows that our study includes the Czech Republic, Estonia, Hungary, Republic of Ireland, Lithuania, Latvia, Poland, Slovak Republic and Slovenia, column four. Our sample excludes Poland and Latvia for the lack of data for intangibles in the 2019 EUKLEMS dataset.

The publicly financed domestic demand-led growth regime: Countries in this group include the Southern European economies and France, which are characterised by growth through domestic consumption although in a regulated financial system that limits household credit. These countries are further away from the frontier of knowledge-based economies as the development of ICT is low. That, combined with an elitist education system, leads to a labour market with a limited group of high-skilled workers. However, since the knowledge-based economy is not highly developed, investment in specific components of intangible capital initially could complement the labour share. The labour market is regulated, and social investment is less generous than in the Nordic countries. Table 1, column five, lists the countries in this regime with data available, France, Greece, Italy, Portugal, and Spain.

Table 1. Growth regimes characteristics

Hassel and Palier (2021) terms	Dynamic services export-led	High-quality manufacturing export-led	Financed-based domestic demand-led	FDI-financed export-led	Publicly financed domestic demand-led
Countries	DK, FI, LU, NL, SE.	AT, BE, DE, JP	US, UK	CZ, EE, HU, LT, LV, SK, SI	EL, ES, FR, IT
Demand driver of economic growth	Exports	Exports	Domestic consumption	Exports	Domestic consumption
Current account	Surplus	Surplus	Deficit	Mixed	Deficit
Financialisation	High	Regulated/low	High	Regulated/low	Regulated/low
Knowledge economy (ICT sector)	High	Medium	High	Low	Low
Education system	Inclusive at high-level	Inclusive at medium-level	Elitist or private	Inclusive at medium-level	Elitist or private
Wage-setting	Coordinated	Coordinated	Deregulated	Deregulated	Regulated
Social protection	Social investment	Social insurance	Private insurance & investment	Social insurance	Social insurance

Source: Based on Hassel and Palier (2021). Note: AT: Austria, BE: Belgium, CZ: Czech Republic, DE: Germany, DK: Denmark, EE: Estonia, EL: Greece, ES: Spain, FI: Finland, FR: France, HU: Hungary, IE: Ireland, IT: Italy, JP: Japan, LU: Luxemburg; LV: Latvia; LT: Lithuania, NL: Netherlands, SE: Sweden, SI: Slovenia, SK: Slovak Republic, UK: United Kingdom, and US: United States.

We expect investment in intangible capital and the effect of that investment on the labour share to be mediated by the political-economic institutions of these different growth regimes. Countries with high levels of ICT, high-value services and financialisation, inclusive education systems and coordinated wage bargaining are expected to see high levels of investment in intangible capitals. The supply of highly qualified workers should ensure that intangibles become complementary to workers' skills through inclusive education systems, and investment returns shared with labour through coordinated and centralised wage bargaining.

We expect that countries with high-quality manufacturing export sectors have high levels of investment in intangible capital due to their specialisation in the goods sector. The regulation of the labour market restrains wages to preserve international competitiveness but allows the share of investment returns with 'insiders' working in manufacturing firms; despite that, we expect that the labour share to fall due to the substitution effect between lower skilled 'outsiders' and intangible capital. In the UK and US economies, there are high levels of investment in intangibles with particular emphasis on sectors like ICT, finance, and professional services. However, the stratified and elitist post-compulsory education system and the deregulation of the labour market dampen the distribution of returns to the labour share equitably, benefitting high skills workers at the expense of middle- and lower-income workers.

In the growth regimes that comprise Central and Southern European economies, intangible capital investments are lower, which limits the impact on the labour share. More importantly, the public sector is a principal employer in countries from the publicly-financed domestic demand-led growth regime. Thus, the labour share is not necessarily determined by the market forces and the effect of intangibles, but it depends on the coordinated wage negotiations. Finally, economies in the FDI-financed export-led growth regime have a medium investment in intangibles and low development of the ICT sector. That, combined with non-inclusive education systems and coordinated wage bargaining to ensure equitable distribution of returns to labour, is expected to lead to adverse effects on the labour share due to investment in intangibles.

Empirical Strategy

The labour share and the capital-output ratio

We estimate the impact of intangibles capital on the labour share in a sample of 22 OECD countries using data at the industry level from 1995 to 2017. Following Bentolila and Saint-Paul (2003), we depart from the traditional assumption of a Cobb-Douglas production function to present the relationship between capital and labour share. We use a standard constant elasticity of substitution (CES) production function, with three factors: intangible and tangible capital, and labour as follows:

$$Y_{i,j,t} = \left[\alpha(K_{i,j,t}^{int})^{\sigma} + \beta(K_{i,j,t}^{tan})^{\sigma} + (1-\alpha-\beta)(B_t L_{i,j,t})^{\sigma}\right]^{\frac{1}{\sigma}} \quad (1)$$

where $K_{i,j,t}^{int}$ and $K_{i,j,t}^{tan}$ correspond to intangible and tangible capital in industry i, country j at time t, respectively; $L_{i,j,t}$ and $Y_{i,j,t}$ stand for labour and output in industry i, country j; α and β denote the share of intangible and tangible capital, B_t is the labour-augmenting, and σ represents to the parameter of substitution between labour and capital.

The labour share in the i industry, country j, $S_{i,t}^{L}$ is defined as the compensation of labour over the monetary value of production in i industry j country, equivalent to one minus capital share. In our case, we disaggregate capital into intangible and tangible as follows:

$$S_{i,j,t}^{L} \equiv \frac{W_{i,j,t}L_{i,t}}{Y_{i,j,t}} = 1 - \frac{R_{i,j,t}^{int}K_{i,j,t}^{int}}{Y_{i,j,t}} - \frac{R_{i,j,t}^{tan}K_{i,j,t}^{tan}}{Y_{i,j,t}} \quad (2)$$

where $R_{i,j,t}^{int}$ and $R_{i,j,t}^{tan}$ denote the real return on intangible and tangible capital, respectively. Firms maximise profits using the technology denoted by production function (1) subject to the total costs described by the following cost function:

$$C_{i,j,t} = W_{i,j,t}L_{i,j,t} + R_{i,j,t}^{int}K_{i,j,t}^{int} + R_{i,j,t}^{tan}K_{i,j,t}^{tan} \quad (3)$$

The first-order condition of labour and capital inputs yield the optimal real wage rate $W_{i,j,t}$, in the industry:

$$W_{i,j,t} = (1-\alpha-\beta)\left(B_{i,j,t}L_{i,j,t}\right)^{\sigma}\frac{Y_{i,j,t}^{1-\sigma}}{L_{i,j,t}} \quad (4)$$

$$R_{i,j,t}^{int} = \alpha\left(\frac{K_{i,j,t}^{int}}{Y_{i,j,t}}\right)^{\sigma} \quad (5)$$

$$R_{i,j,t}^{tan} = \beta \left(\frac{K_{i,j,t}^{tan}}{Y_{i,j,t}} \right)^{\sigma} \quad (6)$$

As we are interested in the relationship between the labour share and capital, we plug the optimal return on capital into equation (2) to re-write the labour share as a function of the capital to output ratio as follows:

$$S_{i,j,t}^{L} == 1 - \alpha k_{i,j,t}^{int\ \sigma} - \beta k_{i,j,t}^{tan\sigma} \quad (7)$$

where $k_{i,j,t}^{int} = \frac{K_{i,j,t}^{int}}{Y_{i,j,t}}$ and $k_{i,j,t}^{tan} = \frac{K_{i,j,t}^{tan}}{Y_{i,j,t}}$; from equation (7), it is straightforward to note that the relationship between intangible capital and the labour share depends on two parameters, α and σ, the former is by definition greater than zero. The value of σ determines the substitutability (> 0) or complementarity (< 0) between labour and each type of capital.

We log-linearise (7) to express the labour share as below:

$$ln\ s_{i,j,t}^{L} = \mu_0 + \mu_1 ln\ k_{i,j,t}^{int} + \mu_2 ln\ k_{i,j,t}^{tan} \quad (8)$$

where μ_1 and μ_2 stand for the partial elasticities of intangibles and tangibles capital to output ratios on the labour share. Thus, $\mu_1, \mu_2 < 0$ implies that (in)tangible capital and labour behave as substitutes, and they are complements if $\mu_1, \mu_2 > 0$. Equation (8) is our fundamental expression to convey the empirical analysis we detail in the next section.

Panel VAR (PVAR)

To examine the effect of the intangible capital on the labour share, we re-write equation (8) in a dynamic form with p lags per variable as below:

$$ln\ s_{i,j,t}^{L} = \mu_{0,i,j} + \mu_{11} ln\ s_{i,j,t-1}^{L} + \ldots + \mu_{1p} ln\ s_{i,j,t-p}^{L} + \mu_{21} ln\ k_{i,j,t}^{int} + \cdots + \mu_{2p} ln\ k_{i,j,t-p}^{int} + \mu_{31} ln\ k_{i,t}^{tan} + \ldots + \mu_{3p} ln\ k_{i,t-p}^{tan} + \varepsilon_{i,j,t} \quad (9)$$

where coefficients $\mu_{11}, \mu_{12,\ldots,}\mu_{1p}$, $\mu_{21}, \mu_{22}, \ldots, \mu_{2p}$, and $\mu_{31}, \mu_{32}, \ldots, \mu_{3p}$ reflect the effects of the lagged labour share, intangible and tangible capital at each of the p lags; $\mu_{0,i,j}$ stands for the country-industry fixed effects and $\varepsilon_{i,j,t}$ is the standard error term.

The expression in equation (9) resembles a panel VAR, henceforth PVAR(p) model initially introduced by Holtz-Eakin, Newey and Rosen (1988). The reduced form of equation (9) is as follows:

$$\Upsilon_{i,j,t} = \Gamma(L)\Upsilon_{i,j,t} + \Psi \mathrm{X}_{i,j,t} + \mu_{0,i,j} + \varepsilon_{i,j,t} \tag{10}$$

where $i = 1,2,..,K$ denotes industries, $i = 1,2,..,N$ stands for countries and $t = 1,2,..,T$ denotes periods. $\Upsilon_{i,j,t}$ is a $(1XK)$ vector of stationary variables; $X_{i,j,t}$ is a $(1XZ)$ of covariates we include as controls. $\Gamma(L)$ is as (KXK) matrix polynomial where the lag operator is defined as $\Gamma(L) = \Gamma_1 L^1 + \Gamma_2 L^2 + \cdots + \Gamma_p L^{\cdot}$. Ψ is a (lXK) vector with the coefficients to estimate the exogenous variables, $\mu_{0,i,j}$ represents a vector size of country-industry fixed effects and $\varepsilon_{i,j,t}$ is the idiosyncratic error term.

In a dynamic panel, the fixed-effects estimator is not consistent because fixed effects are correlated with the regressors due to lags of the dependent variables. The usual practice is to use the first differences of the variables as in Arellano and Bond (1991) or the forward mean differences as in Arellano and Bover (1995). The former tends to magnify gaps when working with unbalanced panels while the forward differences preserve homoskedasticity and no autocorrelation; we implement this latter approach.

In the analysis, a potential endogeneity issue arises because countries with a low labour share may invest more in new capital, leading to the opposite causality to the one we aim to test, namely the effect of the intangible capital on the labour share. To tackle this issue, we identify these effects by setting a system of equations rather than a single equation, where intangible capital and labour share are fully identified and set as endogenous variables in the system. We also address the endogeneity by estimating the PVAR model using GMM estimators, acknowledging the work of Abrigo and Love (2016).[3]

We estimate a model where the endogenous variables are the labour share and intangible capital to output ratio. We examine the effect of four types of intangible capital using the classification

[3] We test the stationarity of the series to ensure the system's stability. We use the Fisher's test using Augmented Dickey-Fuller (ADF) and the Phillips Perron (PP) specifications. The results of the tests are available upon request.

described in the following section. We control the impact of other types of capital according to previous work on labour share (Bentolila and Saint Paul, 2003; Bassanini and Manfredi, 2014). Thus, we introduce as exogenous or control variables: i) tangible capital and ii) Foreign Direct Investment (FDI).

Data Section

We examine the case of 22 OECD countries from 1995 to 2017 with information at the industry level according to the ISIC Rev. 4 (NACE Rev. 2) classification. 2019 EUKLEMS comprises two datasets, the traditional statistical and the new analytical databases. The fundamental difference is that the latter contains more detailed information on intangible capital stock as described below. Thus, we use the analytical database for variables related to intangible capital.

We define the labour share as the compensation of employees over GDP at factor cost per person, adjusted by self-employment, including subsidies and excluding taxes. The labour share comes from the 2019 EUKLEMS dataset, with information by industry. We calculate this variable for both the analytical and statistical datasets; we compare the moments of the distributions for proxies of both sources; the differences are minimal. Therefore, we selected the labour share from the analytical dataset for consistency.

Intangible capital

Since the global financial crisis, intangible assets in OECD countries have grown at higher rates than tangible assets. Recent literature has advanced methodologies to incorporate the value of intangible assets into national accounts (Corrado, Haskel, and Jona-Lasinio, 2013; Haskel and Westlake, 2018), classifying intangible capital into three categories: i) economic competencies, ii) innovative properties, and iii) computerised information.[4] The 2019 EUKLEMS dataset includes information about four big components of intangible capital following Corrado *et al.* (2016, 2017). The intangibles are classified as i) economic competencies, ii) other innovative properties, iii) computerised information, and iv) research and development; for more details on the methodology, see Stehrer *et al.* (2019). EUKLEMS dataset contains information about intangible capital and investment at the industry level for a

[4] For an explanation of this methodology, see the INTAN-Invest project: http://www.intaninvest.net/.

wide range of OECD countries.

Table 2 shows the equivalence in intangible's classification between Haskel and Westlake, 2018 and the 2019 EUKLEMS methodology. Intangible assets categorised as *economic competencies* include firms' investment in advertising the company and spending on market research and branding, staff training and organisational processes.[5] *Other innovative properties* comprise two elements: the design and development of products.[6] And the investment in other intellectual property products. The latter includes spending on mineral exploration and evaluating projects for companies related to the mining industry and investment in entertainment, literary and artistic originals (relevant for the services sector).[7] *Computerised information* comprises any software and databases purchased or developed by the companies, including any algorithms developed. As Table 2 denotes, Haskel and Westlake (2018) categorise '*research and development'* as a component of innovative properties while it qualifies as a separate item for 2019 EU KLEMS.

Table 2. Intangible assets classification

Intangible assets	
Haskel and Westlake (2018)	2019 KLEMS
Economic competencies	**Economic competencies**
Market research and branding	Advertising (brand) and market research
Business process, re-engineering:	Purchased organisational capital
Purchased and own-account organisation capital	Vocational training
Training	
Innovative property	**Other innovative properties**
Design and other product development costs	Design and other product developments
Mineral exploitation and artistic originals	Other IPP assets:
Research and Development	Mineral exploration and evaluation
Computerised information	Entertainment, literary or artistic originals
Software and databases purchased and own account.	Other intellectual property products
	Research & Development
	Research and development
	Computerised information
	Software and databases purchased and own account.

Source: Authors' elaboration.

[5] In our estimations, we do not include vocational training because of the lack of data at the industry-level, which would significantly reduce our sample.

[6] Design and development of products also cover investment in paintings, maps, architectural plans, building designs, etc.

[7] Investment in entertainment, literary and artistic originals account for the acquisition and development of films, recordings, manuscripts, drama performances, radio and television programming, musical performances, sporting events, and literary and artistic output.

This paper uses 2019 EUKLEMS data and its classification because it contains available information for sample OECD countries for which the data on intangible capital and labour share is available for 1995 to 2017.[8] For our empirical analysis, we calculate the capital to output ratio of intangibles using the value-added per industry and country and the stock of capital of the four types of intangibles: i) economic competencies, ii) other innovative properties, iii) software and databases and iv) research and development (R&D).

Figure 1 displays the four intangible components as a share of value added by the growth regimes. We observe a couple of significant facts on how the different growth regimes have invested in intangible capital. The most significant components are other innovative properties and economic competencies; the size of research and development is mixed and more conditional on the regime with an increase in 2016 for the financed-based domestic led, high-quality manufacturing export-led and publicly-financed domestic demand-led regimes. Software and databases are the smallest intangible component in all the regimes. It shows, however, a spectacular increase not affected by the global financial crisis in four of the growth regimes, with the exception of the plateau in the financed-based domestic-led regime. Although we observe a generally positive trend of intangibles in most regimes, there are some exceptions, like other innovative properties for the financed-based domestic-led and FDI-financed export-led regimes or research and development for the Nordic economies.

The extensive investment in intangibles has contributed to developing the knowledge-based economy in some growth regimes. Countries in the dynamic services export-led regime present the largest share of intangibles to value added in our sample, other innovative properties and economic competencies being the most significant. Despite being the largest component, research and development have substantially declined since the global financial crisis. Countries in the financed-based domestic-led regime (the USA and UK) are services-based economies; we hypothesise this may be the reason that, in this regime, other innovative properties present a downward trend since this component is more related to the goods sector industries as it includes mineral exploration and product designs and developments. On the

[8] Countries in the sample are Austria, Belgium, Czech Republic, Germany, Denmark, Estonia, Greece, Finland, France, Hungary, Italy, Japan, Lithuania, Luxemburg Netherlands, Spain, Sweden, Slovenia, Slovak Republic, United Kingdom, and the United States. We exclude Latvia, Luxembourg Portugal and Poland because the intangible data for these countries is scarce.

contrary, capital to value-added on the other three intangible components is increasing, particularly research and development and software and databases in the final years of our sample.

The high-quality manufacturing export-led growth regime includes Austria, Belgium, Germany and Japan; those countries are characterised by their strong goods exporting sectors. They have significant investment in intangibles in all the components, the most notable being research and development, economic competencies and other innovative properties. Investment in software and databases doubled from 1995 to 2017. After countries on the dynamic services export-led growth regime, this is the group of economies that have invested most in intangible capital.

For countries in the FDI-financed domestic demand-led growth regime, other innovative properties, economic competencies and research and development are the most significant intangibles, the first concentrated in the goods sector and the others in the tradeable services, see Figure A1 in Online Appendix. Finally, countries in the publicly-financed domestic demand growth regime have focused on innovative properties, economic competencies and software and databases for the services sector; research and development is concentrated in the goods sector and software and databases on the services, see Online Appendix. In this regime, we observe a significant increase in research and development and software and databases in 2016 and 2017.

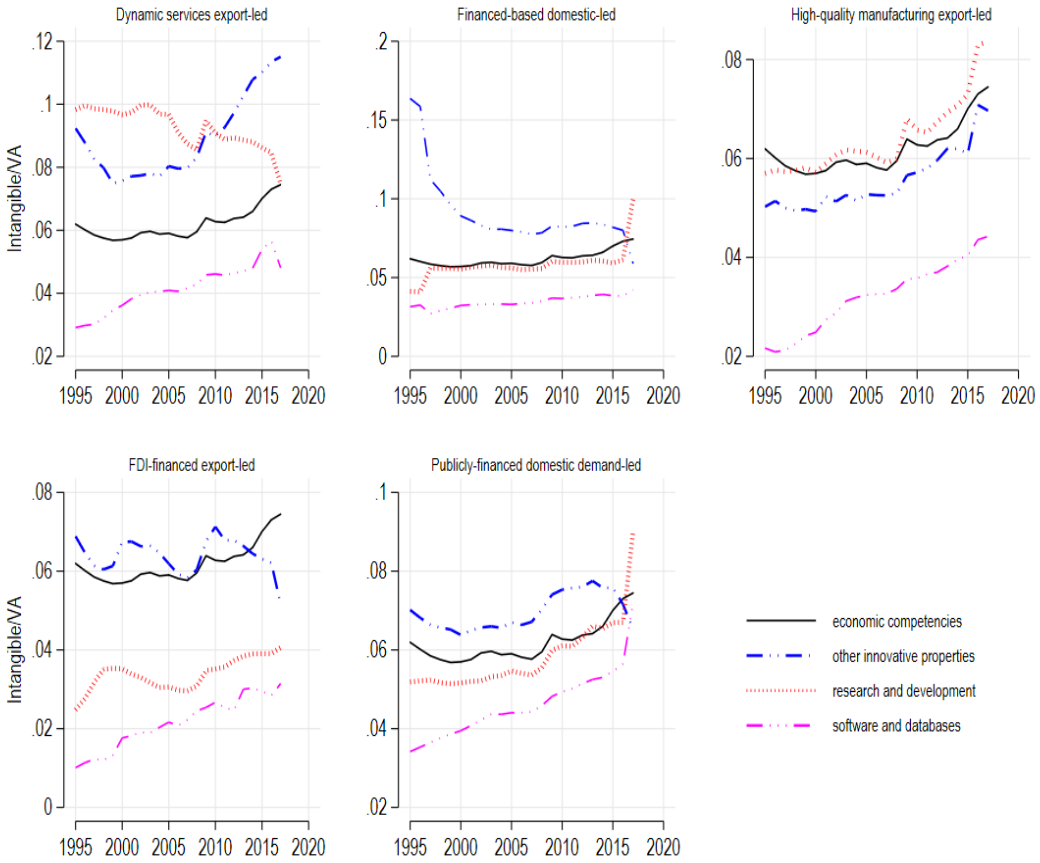

Figure 1. Intangibles to value-added by growth regimes, 1995-2017.
Authors' calculation with data from 2019 EU KLEMS.

Control variables

We calculate the tangible capital to output ratio aggregating other capital components. We include: i) spending on computer hardware and ii) telecommunications equipment (no software), and iii) capital related to machinery, transport equipment, other equipment, buildings, etc.; these three components of tangible capital are mutually exclusive with intangible capital. We also include Foreign Direct Investment (FDI) as a control variable, which positively correlates with the shares of intangibles in GDP. Thus, countries with more exposure to international financial markets and trade markets correspond to the more advanced countries transitioning towards a higher level of intangibles in the economy (Haskel and Westlake, 2018; Hassel and Palier, 2021). We use the share of FDI inflows in GDP; this variable comes from the *World Development Indicators* from the World Bank.

Labour share, intangible capital to value-added and tangible capital to value added from the

2019 EUKLEMS are used at constant 2010 prices in national currency. We transform these variables into comparable units by converting the data to purchasing power parity (PPP) using the USA numeraire.[9] Finally, all variables are in the 0 to 1 domain, where 2007 equals 1, the base year before the global financial crisis.

Baseline estimations

We estimate a PVAR(p) model with a sample of 22 OECD countries from 1995 to 2017. Our estimation uses the four indicators for intangible capital to value-added: i) economic competencies, ii) other innovative properties, iii) research and development and iv) software and databases. We include as exogenous variables: i) tangible capital and ii) FDI inflows to GDP and set this model as our baseline estimation.

Structural breakpoints: As our sample includes the global financial crisis, we presume there could be a potential structural break in the series. Thus, we test for single and multiple breaking points following the theoretical developments of Bai and Perron (1998), Karavias et al (2022), and we perform the test for dynamic panels using the algorithm developed by Ditzen, Karavias and Westerlund (2022).[10]

We conduct the structural break examination in two stages. First, we implement the Chow test year by year for single known breakpoints. We start in 2006, a period before the global financial crisis and evaluate if a given year is a structural break point in the panel. We find that 2007 and 2014 are break points at the 90% and 95% confidence levels; see Table A2 in the Online Appendix. We also test for unknown multiple breakpoints, following Ditzen, Karavias and Westerlund (2022), where the null hypothesis is that there are no breaking points, and the alternative suggests that there are at least s breakpoints and sequentially detects them, see the hypothesis as follows

$$H_0: \delta_1 = \delta_2 = \ldots = \delta_{s+1}$$
$$H_1: \delta_m \neq \delta_n \text{ for some m} \neq n$$

[9] We implement the conversion to PPP units, although all the variables we use are presented as value-added shares. Therefore, the effect of the transformation is not relevant.

[10] We thank Jan Ditzen for kindly making available the STATA package for testing single and multiple breaking points in dynamic panel data.

The test starts with a null hypothesis that states there are no breakpoints, the alternative F(1|0) suggests that there is a breakpoint. If the null hypothesis is rejected, then the algorithm test for F(2|1), where the null states that there is one breakpoint against the alternative that suggests the existence of two breakpoints. The algorithm stops when the null is not rejected. Table 3 presents our results allowing for multiple and unknown breakpoints.

Table 3, the first row shows that 2008 and 2014 are breakpoints at the 95% confidence level. These results confirm the structural changes due to the global financial crisis and tangible-specific breaks in 2014. To investigate the variables leading to structural changes in the panel, we perform the tests with partial specification; that is, we include in the test the labour share with each of the other variables one at a time. We find that economic competencies and other innovative properties are the series with breakpoints in 2007 and 2014 and 2008 and 2014, respectively; the test for research and development finds a breakpoint only for 2014. Software and databases, tangible capital and FDI to GDP do not have detectable breakpoints.

We take as primary results the tests from the multiple unknown breaks because the critical values of the statistics are calculated using a non-standard distribution, the supremum of F-tests over all possible break dates. In this regard, Ditzen *et al*. (2022) argue that those critical values are more robust and "honest" than the Chow test. Therefore, we conclude that there are two structural breaks in the sample, 2008 and 2014 see Table 3, first row. These breaks are related to the global financial crisis and changes in capital-specific components. We incorporate these results about structural breaks into the empirical estimation. More precisely, we update equation (10) by adding a dummy variable for breakpoint expanding the vector $X_{i,j,t}$ of exogenous variables accordingly.

Table 3. Structural multiple unknown breaks

Variables	H0	Sup F(s)	Years
All variables	F(2|1)	4.25**	2008, 2014
Economic competencies	F(2|1)	32.86***	2007, 2014
Other innovative properties	F(2|1)	22.70***	2008, 2014
Research and development	F(1|0)	19.74***	2014
Software and databases	F(2|1)	0.02	no breaks
Tangible capital	F(2|1)	2.88	no breaks
FDI to GDP	F(2|1)	3.68	no breaks

Bai & Perron (1998) critical values; *** p<0.001, ** p<0.05, * p<0.10.

The selection of the lag order in the PVAR(p) specification and the moments' conditions following Andrews and Lu (2001) is determined by Hansen's (1982) J statistic of overidentifying restrictions and the Akaike information criteria (AIC) (Akaike, 1969), respectively. We estimate a PVAR (2) model with the first three lags of the dependent variables as instruments; according to Hansen's J statistic, we do not reject the overidentification restrictions see the footnote in Figure 2.

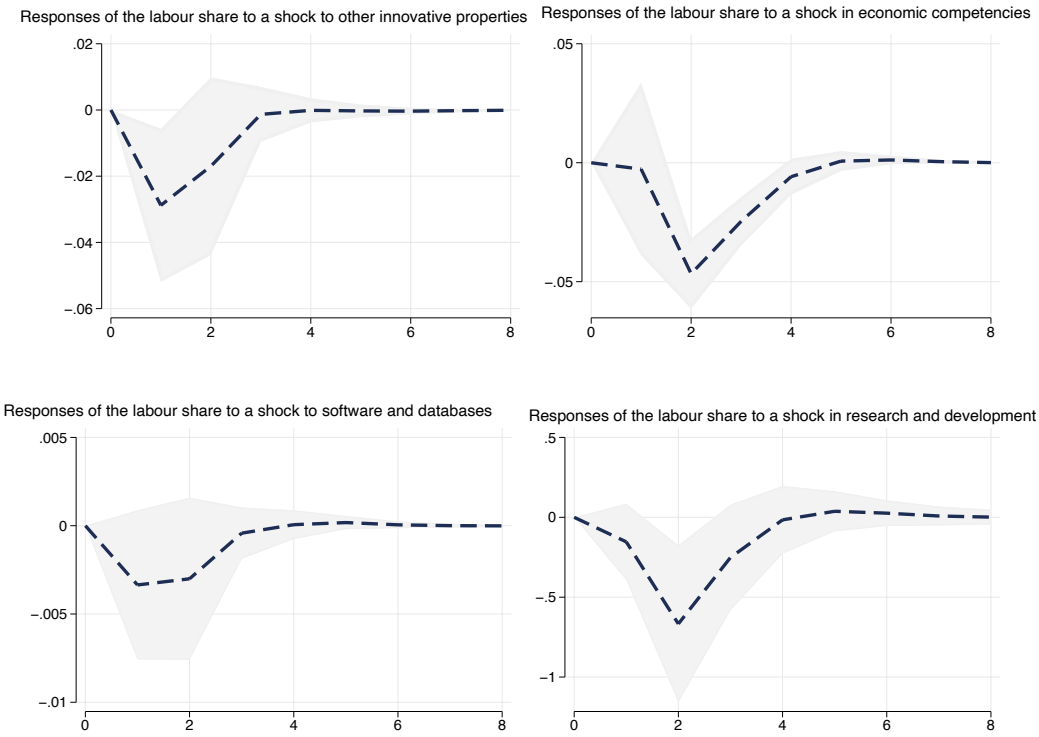

Figure 2. Baseline model: impulse responses to a shock of an std deviation on each variable one at a time. The dashed area corresponds to the 90% confidence interval. Hansen test $\chi^2(25) = 24.860, p - value: 0.470.$

Figure 2 presents the labour share responses to an increase in a standard deviation of each intangible; each shock is triggered at a time. We observe that the rise in economic competencies and research and development drive down the labour share in OECD countries at the 95% confidence level and other innovative properties at 90%. Intangible capital in software and databases do not impact the labour share. This result seems sensible because the percentage of this component in the total intangibles is the smallest among OECD countries.

Granger causality test

We take our model and test bi-directional causality for our variables (Granger, 1980) using our PVAR (2) model. We examine whether intangible capital Granger-cause the labour share. We

aim to determine if the intangible capital to value-added is a good predictor of the labour share and feedback effects from the labour share to the intangible capital. Granger causality uses a Wald test, where the null hypothesis sets that X variable does not Granger-cause Y. Thus, p-values lower than 0.05 denote the null hypothesis is rejected.

Table 4 indicates the Granger causality results. We find evidence to suggest that economic competencies, other innovative properties and research and development Granger cause changes in the labour share, which aligns with the impulse responses. Our findings are consistent with the work of Mahony et al. (2020) on economic competencies. They examine half of our period of analysis, 1995-2007, using static IV estimators and conclude that economic competencies negatively affect the labour share while the coefficient for other innovative properties is insignificant. We find a negative and significant coefficient in both intangible assets plus causality from research and development to the labour share at the 95% confidence level.

Our analysis allows us to examine the bidirectional causality between the labour share and the intangible capital and the relationship across intangibles. In this regard, we find that the labour share Granger causes the decline in capital invested in economic competencies and software and databases; the results are significant at the 95% confidence level; with the rest of the intangibles, the effects are not different from zero. These findings suggest that countries with a lower labour share increase their accumulation of these types of intangible capital. On the contrary, economies with a large labour share are discouraged from investing in economic competencies, software, and databases compared to those with a lower labour share.

Columns two to four in Table 4 indicate the existing bi-directional causality among different types of capital; we find that economic competencies, other innovative properties and research and development Granger cause to each other and the impact is negative. It implies that these three intangibles behave as gross substitutes i.e., when research and development increases, innovative properties and economic competencies go down or when economic competencies go up the opposite occurs with other innovative properties and research and development; for more details, see Figure A3 in Online Appendix.

Table 4. Baseline model: Granger causality test

Baseline model	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	$\chi^2(q)$	p-value	(+/-)	$\chi^2(q)$	p-value	(+/-)	$\chi^2(q)$	p-value	(+/-)	$\chi^2(q)$	p-value	(+/-)	$\chi^2(q)$	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	19.24	**0.00**	**(-)**	0.46	0.79	n.s.	0.07	0.97	n.s.	6.50	**0.04**	**(+)**
Economic competencies	162.18	**0.00**	**(-)**	n.a.	n.a.	n.a.	5.06	**0.08**	**(-)**	5.54	**0.06**	**(-)**	10.80	**0.01**	**(-)**
Other innovative properties	4.78	**0.09**	**(-)**	16.30	**0.00**	**(-)**	n.a.	n.a.	n.a.	8.84	**0.01**	**(-)**	1.26	0.53	n.s.
Research and development	11.17	**0.00**	**(-)**	5.37	**0.07**	**(-)**	11.20	**0.00**	**(-)**	n.a.	n.a.	n.a.	5.43	**0.07**	**(+)**
Software and databases	2.03	0.36	n.s.	6.79	**0.03**	**(-)**	1.64	0.44	n.s.	3.10	0.21	n.s.	n.a.	n.a.	n.a.
ALL	222.48	**0.00**	**(-)**	45.39	**0.00**	**(-)**	24.64	**0.00**	**(-)**	20.64	**0.01**	**(-)**	29.32	**0.00**	**(-)**

Note: n.a. means not applicable, and n.s. stands for no significant.

Growth regimes and the labour share

In this section, we incorporate the growth regimes framework. We argue that the political economy features of countries in our sample determine the relationship that intangible capital has with labour share. To conduct this examination, we split the sample into the five growth regimes described in Table 1. We re-estimate the baseline model for each regime and test the Granger bi-causality.

a) Dynamic services export-led growth regime

We estimate a PVAR (1) model for countries in this regime; we use the first three lags of the dependent variables as instruments; the Hansen's J statistic indicates that the model does not reject the over-identification restrictions see footnote of Figure 3. We find a unidirectional effect from the intangibles to the labour share, as Table 5 first row shows; thus, countries in this regime deviate from the existence of bi-causality between labour share and intangibles that we find in the baseline estimations.

The unidirectional existing effects, however, are heterogeneous. More precisely, the increase in economic competencies, software, and databases lead to the decline in the labour share at the 95% confidence level in countries under this regime. On the contrary, the increase in other innovative properties tends to raise the labour share with the same confidence level, see Table 5, first column and Figure 3. Countries in this growth regime have developed a strong combination of services and goods sectors. Economic competencies and software and databases are concentrated on the services. While the size of other innovative properties in the

goods sector has doubled the size of services, see Figure A1 in Online Appendix.

Thus, we argue that the public non-compulsory education system in these countries allows a significant high-skilled labour force which could complement intangible capital in the goods sector, leading to a positive impact on labour share. Moreover, the coordination of the labour market works in favour of workers' bargaining power, mitigating the stagnation of wage growth, and further contributing to a positive effect between other innovative properties and the labour share. These findings denote a significant difference relative to the baseline model in two directions: i) the unidirectional causality between labour and intangibles and ii) the positive effect of other innovative properties on the labour share.

Across types of intangible capital, we find that economic competencies have a negative relationship with the other three intangibles, which are bi-directional for research and development and unidirectional for other innovative properties, software and databases, and research and development. However, the increase in other innovative properties has positive spillovers in economic competencies; the counteracting effects between these two intangibles leave a net positive impact which indicates intangible-specific complementarity. Table 5 shows that software and databases also lead to a decline in other innovative properties and research and development. These findings suggest both types of relationships across intangibles, component-specific substitutability led by economic competencies and software and databases and component-specific complementarity from other innovative properties. We can foresee the case of an increase in other innovative properties that positively affect the labour share, with a negative indirect impact coming from the complementarity between this intangible with economic competencies, which in turn leads to the decline in the labour share. Looking at Figure 3, the net effect would still be positive but more negligible.

Table 5. Dynamic services export-led regime: Granger causality test

Variables	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	1.49	0.22	n.s.	0.36	0.55	n.s.	0.14	0.71	n.s.	0.81	0.37	n.s.
Economic competencies	**10.02**	**0.00**	**(-)**	n.a.	n.a.	n.a.	**13.58**	**0.00**	**(-)**	**7.29**	**0.01**	**(-)**	**10.67**	**0.00**	**(-)**
Other innovative properties	**4.82**	**0.03**	**(+)**	**3.18**	**0.07**	**(+)**	n.a.	n.a.	n.a.	**3.35**	**0.07**	**(-)**	0.05	0.83	n.s.
Research and development	0.25	0.62	n.s.	**3.21**	**0.07**	**(-)**	1.29	0.26	n.s.	n.a.	n.a.	n.a.	**7.67**	**0.01**	**(-)**
Software and databases	**17.38**	**0.00**	**(-)**	0.17	0.68	n.s.	**6.97**	**0.01**	**(-)**	**15.64**	**0.00**	**(-)**	n.a.	n.a.	n.a.
ALL	41.70	0.00		4.65	0.33		21.38	0.00		20.45	0.00		24.13	0.00	

Note: n.a.: not applicable and n.s. stands for no significant; in bold letters significance at the 99%, 95% and 90% of confidence level.

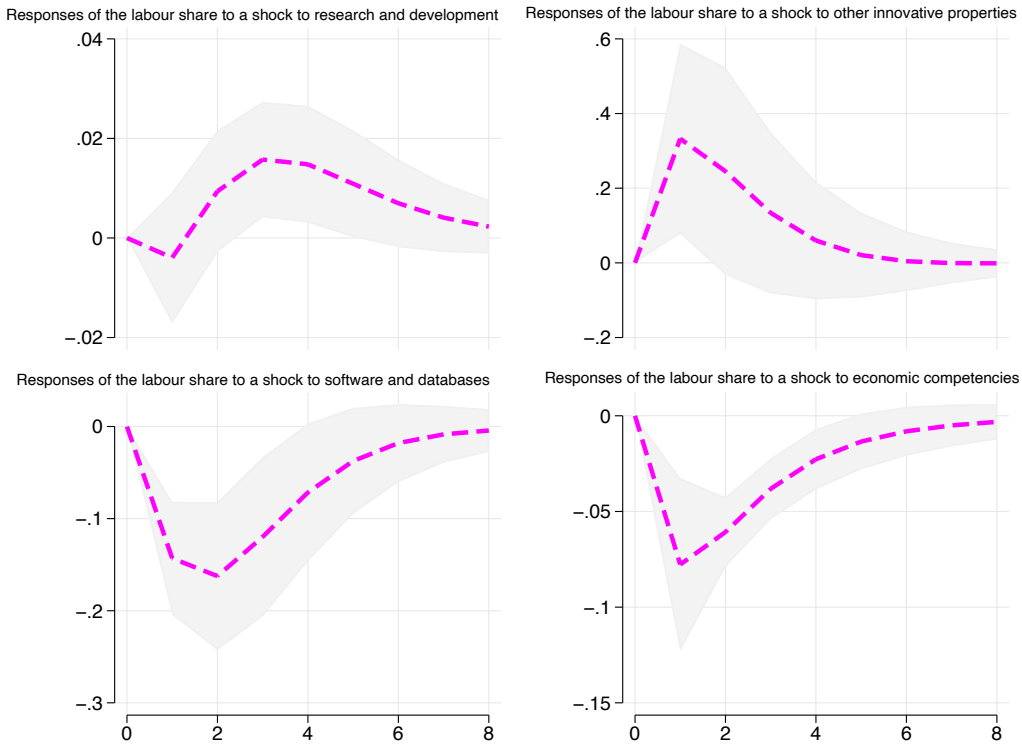

Figure 3. Dynamic services export-led regime: impulse responses of the labour share to a shock of a std deviation on each intangible capital one at a time. The dashed area corresponds to the 90% confidence interval. Hansen test of a PVAR(1) model, $\chi^2(75) = 85.743$, p-value: 0.186.

b) *High-quality manufacturing export-led*

We estimate a PVAR (1) model using the first three lags of the dependent variables as instruments; the Hansen's J statistic indicates that the model does not reject the over-identification restrictions, see Figure 4. For countries in this regime, there is a bidirectional effect from the other innovative properties to the labour share that is significant at the 95% and 90% confidence level; this intangible capital is closely related to intangible investment in the goods sector, in which these countries are specialised. The effect of other innovative properties on the labour share in this regime must be driving the overall impact observed for this reverse causality in the baseline model.

We also find a negative impact of the labour share and other innovative properties on economic competencies (see Table 6). We could find the case where a decline in the labour share due to

an increase in other innovative properties could lead to two opposite effects: i) an increase in intangible capital invested in economic competencies and ii) the decline on economic competencies due to the substitutability with other innovative properties. Our estimations indicate the later effect is more extensive, see Figure A5 in Online Appendix.

Although research and development and software and databases do not seem to affect the labour share, they impact other intangibles. Software and databases are gross complements of economic competencies and other innovative properties, meaning their increase leads to higher investment in these other intangibles, creating positive spillovers towards them. On the contrary, research and development are substitutes for economic competencies; when the former increases, the latter goes down. The results of this regime are determined by the robust manufacturing sector that emphasises the negative effect of other innovative properties on the labour share, as opposed to the positive impact observed in the baseline model and the dynamic services export-led growth regime.

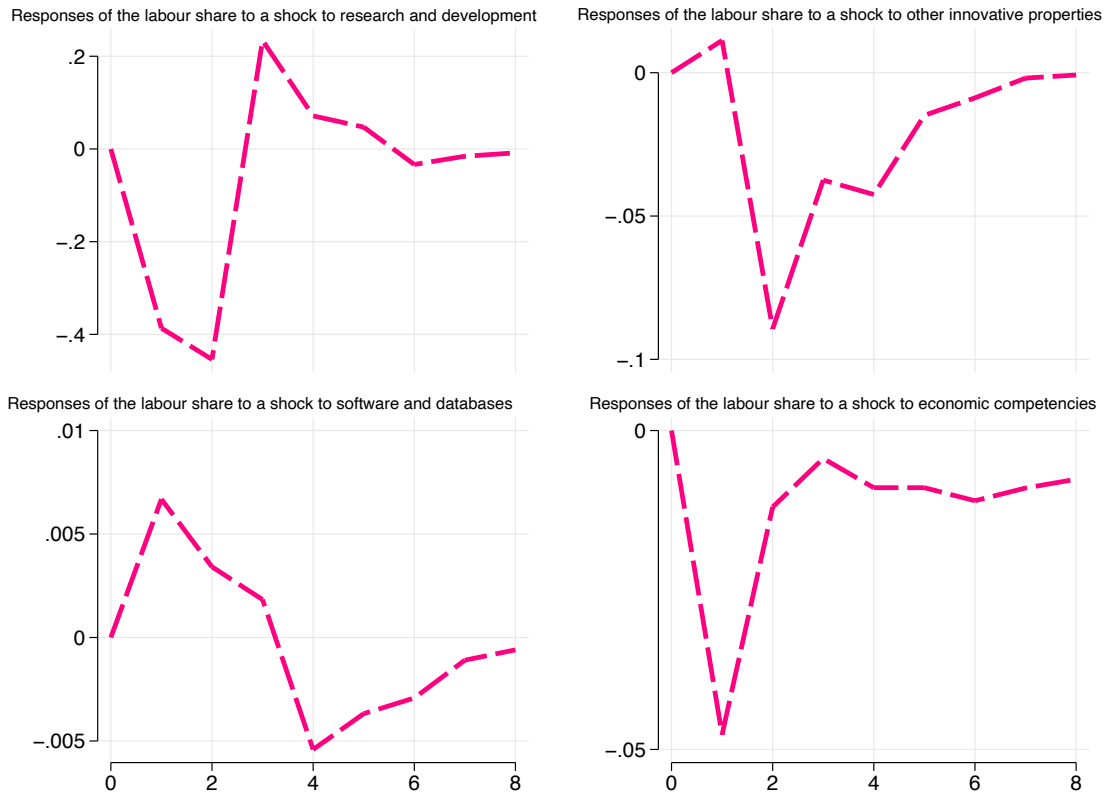

Figure 4. High-quality manufacturing export-led regime: impulse responses of the labour share to a shock of a std deviation on each intangible capital one at a time. Hansen test of a PVAR (1) model, $\chi^2(25) = 29.166$, p-value: 0.257.

Table 6. High-quality manufacturing export-led regime: Granger causality test

Variables	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	χ^2(q)	p-value	(+/-)	χ^2 (q)	p-value	(+/-)	χ^2 (q)	p-value	(+/-)	χ^2 (q)	p-value	(+/-)	χ^2 (q)	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	10.586	0.01	**(-)**	15.67	0.00	**(-)**	1.31	0.52	n.s.	1.67	0.44	n.s.
Economic competencies	0.52	0.77	n.s.	n.a.	n.a.	n.a.	3.81	0.15	n.s.	3.35	0.19	n.s.	1.25	0.54	n.s.
Other innovative properties	5.79	0.06	**(-)**	5.59	0.06	**(-)**	n.a.	n.a.	n.a.	7.61	0.02	**(+)**	4.62	0.10	**(-)**
Research and development	2.66	0.27	n.s.	2.14	0.34	**(-)**	1.76	0.42	n.s.	n.a.	n.a.	n.a.	3.5	0.17	n.s.
Software and databases	0.53	0.77	n.s.	4.82	0.09	(+)	11.339	0.00	**(+)**	2.05	0.36	n.s.	n.a.	n.a.	n.a.
ALL	14.464	0.07		49.918	0.00		33.078	0.00		24.68	0.00		28.172	0.00	

Note: n.a.: not applicable and n.s. stands for no significance; in bold letters, significance is at the 99%, 95% and 90% confidence level.

c) *Financed-based domestic demand-ed*

For countries in this regime, we estimate a PVAR (1) model using the first two lags of the dependent variables as instruments. The Hansen's J statistic indicates that the model does not reject the over-identification restrictions see footnote of Figure 5.

Table 7 shows that software and databases hold a positive and bi-directional causality with the labour share, significant at the 95% confidence level. Similarly, research and development increase when the labour share does it, see Table 7, first row. These findings depart from the results in the baseline model and countries in regimes with a high development of the knowledge-based economy.

We observe that the relationship across intangibles is similar to other regimes, although it is unidirectional compared to the baseline model. Changes in economic competencies lead to a decline in the other three types of intangible capital. Research and development cause the unidirectional decrease in software and databases. There is only a positive effect from other innovative properties to software and databases; see Figure A6 in Online Appendix. Our findings for this regime suggest that intangibles keep a relationship that is predominantly of substitution.

We acknowledge that the UK labour share has departed from the negative trend observed in the rest of the OECD economies, which may bias our results. We do not split the sample further because of the limited number of observations. However, this could be a further topic of research.

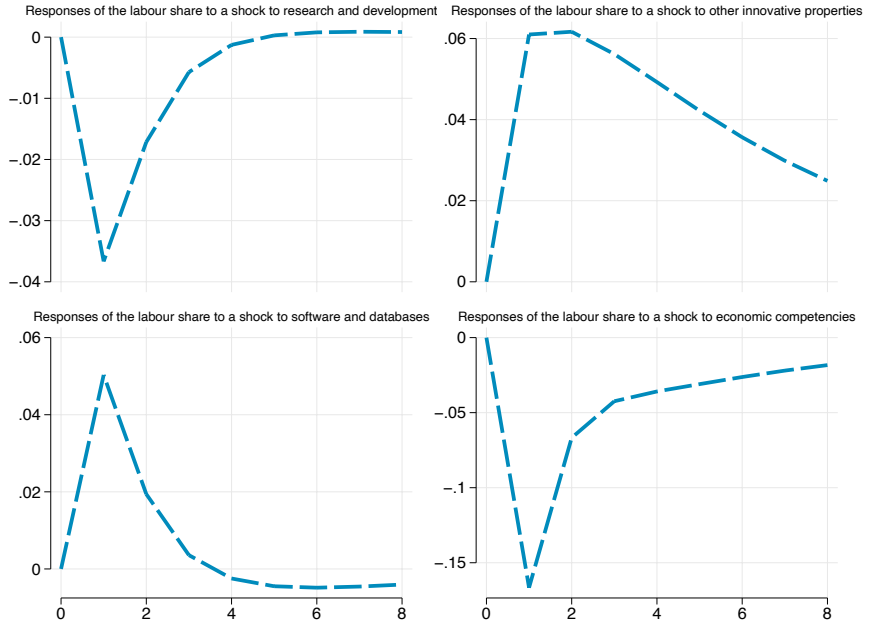

Figure 5. Financed-based domestic demand-led regime: impulse responses of the labour share to a shock of a std deviation on each intangible capital one at a time. Hansen test of a PVAR(1) model, $\chi^2(25) = 31.006$, p-value: 0.189.

Table 7. Financed-based domestic demand-led regime: Granger causality test

Anglo-Saxon	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	2.04	0.15	n.s.	1.25	0.27	n.s.	2.89	0.09	**(+)**	7.62	0.01	**(+)**
Economic competencies	1.47	0.23	n.s.	n.a.	n.a.	n.a.	19.72	0.00	**(-)**	14.34	0.00	**(-)**	21.18	0.00	**(-)**
Other innovative properties	0.23	0.64	n.s.	0.43	0.51	n.s.	n.a.	n.a.	n.a.	1.73	0.19	n.s.	11.10	0.00	**(+)**
Research and development	1.74	0.19	n.s.	0.15	0.70	n.s.	0.50	0.48	n.s.	n.a.	n.a.	n.a.	0.95	0.33	**(-)**
Software and databases	4.31	0.04	**(+)**	0.17	0.68	n.s.	2.88	0.09	**(-)**	0.69	0.41	n.s.	n.a.	n.a.	n.a.
ALL	9.40	0.05		5.93	0.20	n.s.	37.70	0.00		16.00	0.00		88.83	0.00	

d) FDI-financed export-led

Following the same methodology, we estimate a PVAR (1) model using the first three lags of the dependent variables as instruments; the Hansen's J statistic indicates that the model does not reject the over-identification restrictions see footnote of Figure 6. Countries in this growth regime are of great interest because in most of the intangibles, we do not find Granger-causality between labour share and intangibles with exception of the unidirectional negative impact of research and development on the labour share, as Table 8 and Figure 6 shows.

The other significant effects are across intangibles; see Table 8. Specifically, increases in

research and development Granger cause positive changes in other innovative properties and software and databases, which are not reflected in further changes in the labour share as there is no significant impact in that direction. Counteracting effects are found between other innovative properties and software and databases; the net result is, however, positive, see Figure A7 in the Online Appendix.

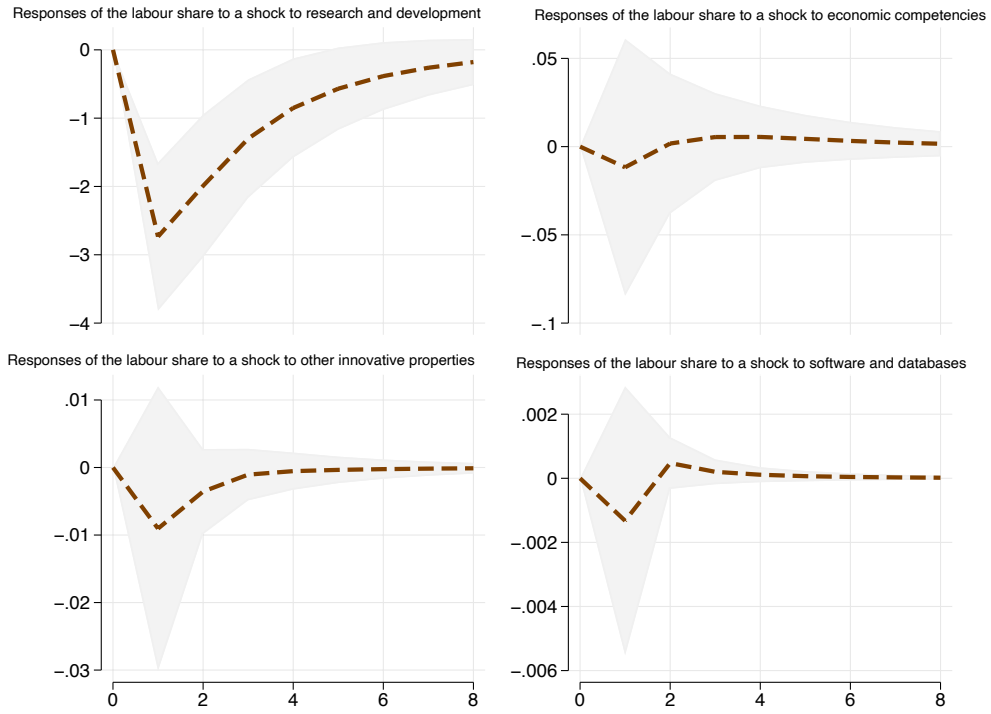

Figure 6. FDI-financed export-led regime: impulse responses of the labour share to a shock of an std deviation on each intangible capital one at a time. Hansen test of a PVAR(1) model, $\chi^2(50) = 57.320$, p-value: 0.222.

Table 8. FDI-financed domestic demand-led regime: Granger causality test

FDI-financed domestic-led	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)	χ^2(q)	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	1.40	0.24	n.s.	0.44	0.51	n.s.	0.09	0.77	n.s.	2.47	0.12	n.s.
Economic competencies	0.07	0.79	n.s.	n.a.	n.a.	n.a.	0.02	0.89	n.s.	2.36	0.13	n.s.	2.55	0.11	n.s.
Other innovative properties	0.47	0.49	n.s.	0.29	0.59	n.s.	n.a.	n.a.	n.a.	0.08	0.78	n.s.	5.15	**0.02**	**(+)**
Research and development	19.47	**0.00**	**(-)**	19.54	**0.00**	**(-)**	11.75	**0.00**	**(+)**	n.a.	n.a.	n.a.	7.75	**0.01**	**(+)**
Software and databases	0.27	0.61	n.s.	1.02	0.31	n.s.	9.46	**0.00**	**(-)**	1.35	0.25	n.s.	n.a.	n.a.	n.a.
All	21.78	**0.00**		24.41	**0.00**		18.47	**0.00**		7.41	0.12		13.32	**0.01**	

Note: n.a.: not applicable and n.s. stands for no significance; in bold letters, significance is at the 99%, 95% and 90% confidence levels.

e) *Publicly-financed domestic demand-led*

For this growth regime, we estimate a PVAR (1) model using the first four lags of the dependent variables as instruments; the Hansen's J statistic indicates that the model does not reject the over-identification restrictions see footnote of Figure 7.

Unlike the other growth regimes, we do not find any significant effects on the labour share due to changes in intangibles or in the reverse causality, from the labour share to intangibles, see Table 9 and Figure 7. This regime includes Greece, Italy, Spain and France, those with low development of the ICT sector but regulated labour markets, deregulated financial sector and an elitist higher education system, and a large public sector that employs workers. We hypothesise that jobs in the public sector do not respond to the law of the markets, thus, the non-existing effect of new intangibles on the labour share. We presume that the dynamics of the latter are more related to the regulation of the labour market. Then, the political economy structures play the role of sustaining wages through the labour market institutions, which is significant for countries like France.

Our findings on the Granger-causality across intangibles indicate a negative and bidirectional causality among economic competencies and other innovative properties and unidirectional effect with research and development. In all the cases, it is significant at the 95% confidence level. Quite the reverse, software and databases Granger cause a positive effect on other innovative properties and research and development.

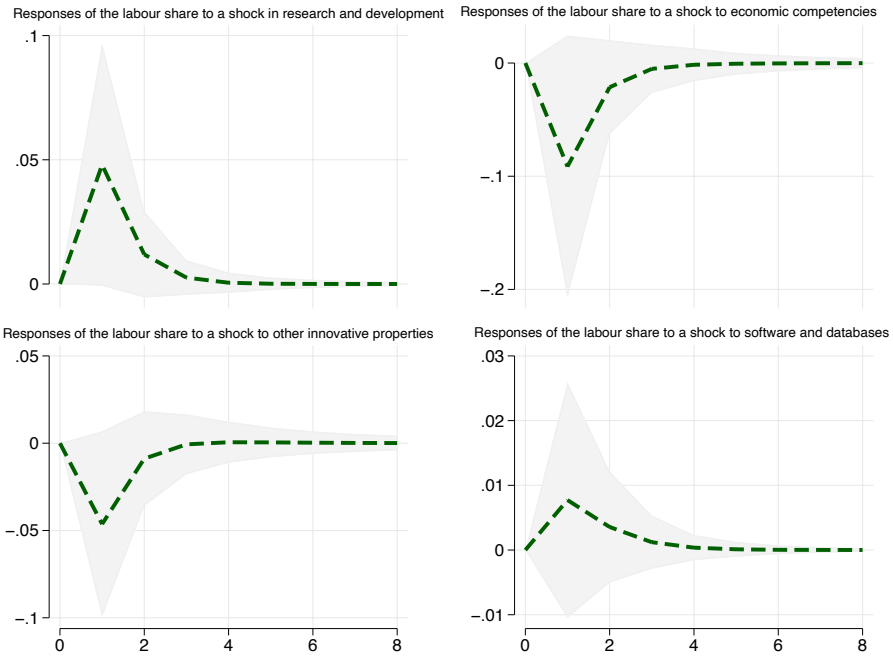

Figure 7. Publicly-financed domestic-led regime: impulse responses of the labour share to a shock of an std deviation on each intangible capital one at a time. Hansen test of a PVAR(1) model, $\chi^2(50) = 58.353$, p-value: 0.195.

Table 9. Publicly-financed domestic demand-led regime: Granger causality test

Variables	Labour share			Economic Competencies			Other innovative properties			Research and development			Software and databases		
	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)	(q)	p-value	(+/-)
Labour share	n.a.	n.a.	n.a.	6.48	0.01	n.s.	0.31	0.58	n.s.	0.00	0.97	n.s.	0.28	0.60	n.s.
Economic competencies	1.88	0.17	n.s.	n.a.	n.a.	n.a.	10.31	0.00	**(-)**	3.09	0.08	**(-)**	2.28	0.13	n.s.
Other innovative properties	0.17	0.68	n.s.	4.46	0.04	**(-)**	n.a.	n.a.	n.a.	0.03	0.87	n.s.	0.12	0.73	n.s.
Research and development	0.34	0.56	n.s.	1.82	0.18	n.s.	0.26	0.61	n.s.	n.a.	n.a.	n.a.	1.77	0.18	n.s.
Software and databases	1.54	0.22	n.s.	2.28	0.13	n.s.	12.69	0.00	**(+)**	5.35	0.02	**(+)**	n.a.	n.a.	n.a.
All	4.24	0.37		35.33	0.00		30.70	0.00		11.31	0.02		4.69	0.32	

Note: n.a.: not applicable and n.s. stands for no significance; in bold letters, significance is at the 99%, 95% and 90% confidence levels.

Discussion

Our analysis of intangibles and the labour share by growth regimes illustrates the complex relationships between these input factors. These relationships are mediated not only by the sectorial composition of the economies and whether they are focused on the exporting sector or domestic demand but also by the regulation of institutions that affect the labour market, the financial system, the non-compulsory education system and even the welfare state.

Countries with high levels of ICT, high-value services and financialisation, inclusive education systems, coordinated wage bargaining and the supply of a highly qualified workforce, show a stronger link between intangibles and the labour share. More precisely, the labour share in the dynamic-services export-led growth regime presents a net positive effect from the increase in other innovative properties. As discussed by O' Mahony *et al* (2021), other innovative properties are considered intensive in the use of skilled workers. Thus, the public education systems in countries of this regime contribute to provide the supply of highly qualified workers required by firms with a significant investment in these intangibles.

On the contrary, our results suggest a negative effect of intangibles on labour share for economies on the high-quality manufacturing export-led growth regime. These effects are driven by the bi-directional causality between labour share and other innovative properties and the unidirectional effect from labour share to economic competencies. We argue that since these economies are concentrated in the exporting manufacturing goods sectors, the demand for workers with medium skills is greater; thus, the increase of other innovative properties that are skilled intensive leads to a negative impact on the labour share. Moreover, firms in these economies face international competition to lower costs, which controls wage growth and sustains competitiveness. Therefore, the coordinated wage settings in these economies contribute to meeting export competitiveness through the decline in labour share.

Countries in the FDI-financed domestic demand-led and publicly-financed and domestic demand-led growth regimes observe little or no effect on the labour share due to changes in intangibles. The reasons are the low development of the knowledge-based economy and the minimal investment in intangibles compared to other regimes. For a publicly-financed demand-led growth regime, the size of the public sectors determines that a large percentage of employment is not subject to labour market forces, allowing other political economy factor to set wages. The results are unexpected for the financed-based domestic demand-led growth regimes, that is, the UK and US. We find a positive effect on the labour share when software and databases increase; we argue that more research is needed, particularly because the UK is an economy with a distinct dynamic for the labour share, which could potentially bias our results.

Our results are consistent with the existing literature on intangibles and labour share, O'Mahony *et al.* (2021) finds a positive relationship between the labour share and other

innovative properties and a negative relationship between the labour share and economic competencies. Unlike O'Mahony *et al.* (2021), we examine the labour share and intangibles from a growth regimes' perspective. This type of analysis provides us with a rich range of heterogeneous effects that depend on political economy structures and growth strategies.

Table 10. Overall effects

Intangible	Baseline model		Dynamic services export-led		High-quality manufacturing export-led		FDI-financed and export-led		Public-financed and domestic demand-led		Financed-based domestic demand-led	
	Int. LS	LS Int.	Int. LS	LS Int.	Int. LS	LS Int.	Int. LS	LS Int.	Int. LS	LS Int.	Int. LS	LS Int.
Economic competencies	(-)	(-)	(-)	n.s.	n.s.	(-)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Other innovative properties	(-)	n.s.	(+)	n.s.	(-)	(-)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
Research and development	(-)	n.s.	n.s.	n.s.	n.s.	n.s.	(-)	n.s.	n.s.	n.s.	n.s.	(+)
Software and databases	n.s.	(+)	(-)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.	(+)	(+)
Total impact	(-)	(+)	(-)	n.s.	(-)		(-)		n.s.		(+)	
Net impact	Negative		Positive ~ nill		Negative		Negative		None		Positive	

Conclusions

This paper examines the effect of intangible assets on labour share using data at the industry level in a selection of 22 OECD countries from 1995 to 2017. To overcome endogeneity issues, we estimate a series of PVAR (1) models with GMM estimators. We find evidence suggesting that the increase in economic competencies, other innovative properties and research and development leads to a decline in the labour share; those are the leading factors driving the negative relationship between the labour share and intangible capital in the analysis of the entire sample.

Our second contribution to the paper investigates the relationship between labour share and intangibles, accounting for structural heterogeneities across countries. We use the growth regimes framework outlined by Hassel and Palier (2021), where advanced OECD economies are divided into five groups. We re-estimate the full model for each of the regimes. The labour share in Nordic countries and the Netherlands, also named the dynamic services export-led growth regime, rises as other innovative properties increase. We find evidence that economic competencies contribute to reducing labour share. The net impact on the labour share from both intangibles is positive but tiny.

The high-quality manufacturing export-led group of countries present a bi-directional negative relationship between intangibles and the labour share. These effects are dominated by the role of other innovative properties in the goods sector, in which these countries are specialised. In the FDI-financed export-led, we find weak evidence that research and development explain the declining labour share. For countries in the publicly-financed domestic demand-led growth regimes, that is, Greece, Italy, Spain, and France, we did not find evidence in any direction between intangibles and the labour share. That is principally explained by the large public sector in these economies, which reduces the proportion of occupations subject to wage market negotiations.

Finally, in the economies with membership in the financed-based domestic demand-led growth regime, that is, the USA and the UK, we find evidence that intangibles lead to the rise in the labour share due to changes in research and development and software and

databases. The caveat in the results for this growth regime is that the UK labour share has shown a fluctuating labour share in the last decades, in opposition to the declining trend of countries like the US and other OECD economies. Therefore, in future research, we aim to provide additional findings with micro-data that allows to split the sample further and examine the effect of intangibles on the UK labour share.

We are among the first to study the effect of the intangibles on the labour share. To the best of our knowledge, we are the first to examine i) the bidirectional causality between intangibles and the labour share and ii) the substitutability or complementarity across types of intangible capital. Our findings show that countries from different growth regimes observe marked differences in the relationship between intangible capital and labour. The effects in Nordic countries turn positive, particularly for other innovative properties. In contrast, the impact is significant and negative for economies in the high-quality manufacturing export-led growth regime. These results are mediated by the sector that commands economic growth, the nature of the economy, focused on the goods or services sectors, the regulation of the labour market and the type of high-education system that shapes the workforce's skills.

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