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Service Industries, Capital Intensity, and Labour Productivity

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Abstract

We analyse the development of labour productivity in five service industries in Europe, the United States, and Japan. Vis-à-vis a group of peer countries, labour productivity in service industries is relatively low in Finland. We further find that the respective gap in capital intensity (capital stock to hours worked) is even greater. Using the growth accounting framework and panel estimations, we find that in 1995–2023 overall capital intensity was positively associated with the level of labour productivity in European countries. This is also the case if the capital stock is disaggregated into four parts with ICT, R&D, software and database, and all other capital analysed separately. Furthermore, the annual change in overall capital intensity, or capital deepening, is positively associated with the change in labour productivity in service industries. The association is weaker when capital is disaggregated into parts, with the strongest association found for the traditional capital stock, while the results for ICT and IPP capital deepening depend on the service industry analysed.

Tiivistelmä

Palvelutoimialat, pääomaintensiivisyys ja työn tuottavuus

Analysoimme työn tuottavuuden kehitystä viidellä palvelualalla Euroopassa, Yhdysvalloissa ja Japanissa. Verrattuna vertailumaajoukkoon työn tuottavuus palvelualoilla on Suomessa suhteellisen alhainen. Lisäksi havaitsemme, että vastaava ero pääomaintensiteetissä (pääomakanta suhteessa tehtyihin tunteihin) on tätäkin suurempi. Kasvulaskennan ja paneeliestimaattien avulla havaitsemme, että kokonaispääomaintensiteetti liittyi positiivisesti työn tuottavuuden tasoon Euroopassa vuosina 1995–2023. Tulos on voimassa myös, jos pääomakanta jaetaan neljään osaan: tieto- ja viestintätekniikkaan, tutkimukseen ja tuotekehitykseen, ohjelmistoihin ja tietokantoihin sekä kaikkeen muuhun pääomaan. Lisäksi kokonaispääomaintensiteetin muutos eli pääoman syveneminen liittyy positiivisesti palvelualojen työn tuottavuuden muutokseen. Yhteys on kuitenkin heikompi, kun pääoma on hajautettu osiin. Vahvin yhteys löytyy perinteisestä pääomakannasta, kun taas tieto- ja viestintäteknisen sekä aineettoman pääoman syvenemisen osalta tulokset riippuvat analysoidusta palvelualasta.

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Keywords: Service industries, Productivity, Capital intensity, ICT, R&D, Software and databases

Asiasanat: Palvelualat, Tuottavuus, Pääomaintensiivisyys, ICT, T&k, Ohjelmistot ja tietokannat

JEL: C23, O14, O30, O47

1 Introduction

Machinery and other investment goods, as well as research and development (R&D), have been boosting labour productivity in agriculture, mining, and manufacturing since the beginning of the industrial revolution. Meanwhile, production of services has in many cases remained more labour intensive and productivity development there slower. However, especially investment in information and communication technology (ICT) and, more broadly, digitalisation is a tool for increasing productivity in many service sectors, though understandably more in some than others.

In this research paper, we review the development of labour productivity in five private knowledge-intensive service industries in Europe, and data allowing also in the USA and Japan, and examine reasons for the different productivity levels and developments across countries and industries using the growth accounting framework and mostly national accounts data from Eurostat with the last data update run on 20.1.2025. We also use data from the EUKLEMS & INTANProd database, 2025 release (see Bontadini et al., 2023).

We concentrate on wholesale and retail trade (NACE Rev. 2 code G), transportation and storage (H), information and communication (J), financial and insurance activities (K), and professional, scientific and technical activities (M). Of these, the first two, i.e. trade, and transportation and storage, are distributive industries. Highly automated storage and port facilities have been developed and, as technology develops, transportation too may become more automated. The prospects for the use of digital solutions in information and communication, and financial and insurance activities are obvious.

We first review earlier literature and the growth accounting framework in Sections 2 and 3. Earlier research has found evidence that especially ICT and R&D investment, and overall digitalisation, are positively associated with productivity growth in service industries. On the other hand, these results are constrained by, among other things, the level of human capital (skill level of the work force) in firms as well as institutional factors such as competition policies.

Using Finnish data, we then show that labour productivity growth after the global financial crisis has varied considerably between different industries. We find both relatively good and weak performers in both manufacturing and services. Consequently, the argument that has occasionally been made that productivity growth is generally weaker in services than manufacturing has not been accurate during this period. We also find a slowdown in productivity growth in service industries, albeit this depends on the specific industry and is also affected by the recent, exceptional business cycle impact of the pandemic and the war in Ukraine.

Compared with a peer group of post-industrialised countries[1], PPP-adjusted labour productivity in Finland is above average only in trade. In the other four service industries, productivity is lower than in the peer countries. Using nominal exchange rates (not PPPs), removes this advantage from trade as well.

Using the growth accounting framework and an extensive dataset of service industries in European countries in 1995–2023, we find evidence that supports the conclusion that capital intensity has been positively associated with the level of labour productivity (value added per hours worked). This holds true also when we disaggregate the capital stock into four parts: ICT, R&D, software and database, and all other capital (i.e. construction capital, machinery and equipment, and transport equipment). We further find that the change in overall capital intensity has been positively associated with changes in labour productivity. When the capital stock is disaggregated, we find that the association between capital deepening and productivity growth is the strongest in 'all other'

[1] Austria, Belgium, Britain, Denmark, Germany, Finland, France, the Netherlands, Norway, Sweden, Switzerland, and the USA.

capital but varies by industries when ICT and IPP (intellectual property products) capital deepening is analysed.

We also find that labour quality (education) is positively associated with the level of labour productivity. Furthermore, the lagged level of productivity is negatively associated with its growth rate, thus indicating that it has been growing faster in countries with lower productivity than in countries with higher productivity (β convergence) when changes in capital intensity have been controlled for.

A division into two periods 1995–2008 and 2009–2023, divided by the financial crisis, shows relatively few differences. In terms of productivity levels, the coefficient of R&D capital intensity as an independent variable is positive and statistically significant in the first period but becomes negative and statistically significant in the latter period. In terms of productivity changes, the coefficient of total capital intensity is clearly lower in the second period. The change in ICT capital intensity is statistically insignificant in the first period but becomes positive and statistically significant in the second. Meanwhile the R&D capital intensity behaves in the opposite way.

We find that, compared to a peer group of European countries—and relative to the level of labour productivity—the total capital intensity, as well as the combined ICT-IPP capital intensity, is relatively low in Finland. This raises the question whether more capital deepening, if optimally targeted, would not help contribute to higher labour productivity and industry growth. However, it needs to be accompanied by a regulatory framework that supports competition and an efficient reallocation and movement of labour and capital across firms, as well as a skilled labour force that can use, benefit from, and develop the capital stock and business practices to produce higher value products.

2 Literature review

The development of productivity in service sectors in Finland and other countries has been analysed and discussed in several studies. In Finnish research, Kaitila et al. (2006) analysed productivity developments of service industries in Finland and other industrialised countries in 1980–2003, while Kaitila et al. (2008) reviewed manufacturing industries in addition to private service sectors. These studies were both made before the financial crisis and the period of overall slower productivity growth that followed.

The Finnish Productivity Board (2019) describes and analyses TFP and labour productivity developments in Finland and some ten other industrialised countries using a more up-to-date EUKLEMS dataset. They find that productivity in private service sectors developed quite similarly in Finland and the other countries in 2000–2016. When they controlled for the sectoral structure, the development was a little weaker in Finland. Productivity growth in Sweden outpaced that in the other countries, including the United States. Growth in labour productivity in private services in Finland in 2001–2015 was relatively good in comparison, albeit slower than in the US, Sweden, or Britain. The report by OECD (2023) notes that allocative efficiency has improved in Finland in digital services after the financial crisis.

Using EUKLEMS data in their analysis of US and EU economies, Gordon and Sayed (2020) argue that ICT stimulus to productivity growth operates through spillovers to TFP growth, and not just via the ICT capital deepening effect as measured in the growth accounting exercise. However, according to their results, this only applies to the information and communication industry in Europe. Bloom et al. (2012) credit the better adoption of new information technologies and faster productivity growth in US companies (also the ones operating in Europe) than in European firms largely on their style of people management of promotions, rewards, hiring, and firing.

Nikolov et al. (2024) analyse TFP developments in the EU vis-à-vis the USA in 2000–2019 using the EUKLEMS database. They find that cumulative TFP growth in the EU came primarily from wholesale and retail trade, IT services, and manufacturing of transport equipment, chemicals and pharmaceuticals. On the other hand, in the US the largest contribution came from IT services, and manufacturing of computers and electronics, as well as from professional services, and finance and insurance, which have developed poorly in the EU. They find a positive association between intangible investment activity and TFP growth, but it is not statistically significant unless cyclical development is controlled for in which case a weak statistical significance is found. On the other hand, in sectors that are more intensive in intangible capital, its elasticity with TFP is stronger than in the whole economy on average, albeit still not statistically significant.

Using Italian firm-level data, Nucci et al. (2023) find a positive and statistically significant association between digital adoption and TFP variation, with AI technology having the largest effect. The estimated effect of digital adoption on productivity is the largest in service industries, larger firms, and older firms. Hall et al. (2013) use Italian manufacturing firm-level data to find that R&D is important for innovation, and ICT investment for productivity developments.

On the other hand, Anderton et al. (2023) find, using a large European firm-level dataset, that digitalisation is on average positively associated with TFP growth, but firms have in most cases been unable to use digitalisation to raise productivity. Frontier firms with more intangible assets are best equipped to make full use of digital technologies. Indeed, Andrews et al. (2018) find evidence that low managerial quality, lack of ICT skills and poor matching of workers to jobs weaken digital technology adoption. Furthermore, policies that promote market access, competition, and the efficient reallocation of labour and capital are important.

Bloom et al. (2010) use a large cross-country firm-level database on ICT and productivity in Europe and find that high product and especially labour market regulation is associated with a lower productivity impact of ICT.

According to Chen et al. (2016), the output elasticity of intangible capital (scientific R&D, firm-specific human capital, new financial product development, new architectural and engineering design, market research, advertising expenditures, and organisational structures) is stronger in more ICT-intensive industries than elsewhere. They find evidence that intangible capital deepening—mainly organisational capital and R&D—contributes more to growth when it is complemented with ICT investment. Their data covers ten European countries in 1995–2007. This classification of intangible capital goes beyond the data sphere in our study or in the EUKLEMS database. Likewise, Koutroumpis et al. (2020) find, using European firm-level data, that ICT firms are associated with a greater effect of R&D investment on firm revenues and performance that non-ICT firms.

Using firm-level German data for industry and services, Czarnitzki et al. (2023) find evidence of a positive and significant association between the use of artificial intelligence and firm productivity. Firms with higher value added (or sales), and bigger firms in terms of employment and capital stock, are thus associated with using AI more than smaller firms or low-productivity firms. This is understandable, because bigger firms have more financial and human resources to invest in and use new technologies. On the other hand, many new (start-up) firms may be more agile and tech-savvy. Indeed, according to Borowiecki et al. (2021), intangibles (level of digital skill intensity) has had a positive and statistically significant impact on firm-level productivity growth in service sectors and for younger firms in the Netherlands. Software investment has been beneficial for productivity in low-productivity firms. Furthermore, ICT hardware investment and an increase in broadband speed have been associated positively with productivity developments. Mostly these results are much weaker or do not exist for manufacturing industries. They also argue that digital technology and intangible investment could contribute to higher aggregate productivity at the national level (GDP) through a better allocation of resources across firms. On the other hand, Mosiashvili and Pareliussen

(2020) find for Estonia that digital solutions have stronger productivity effects in services than in manufacturing.

Andrews et al. (2016) find an increasing labour productivity divergence between global frontier and non-frontier firms in 24 OECD countries in 1997–2014. They argue that the reason could be increasing costs for non-frontier firms of moving from a production-based economy to one that is based on ideas, or due to rising entry barriers and a decline in the contestability of markets. According to the data, the divergence is greater in services than in manufacturing, and particularly large in ICT-intensive services. Gal et al. (2019) use cross-country firm-level data and find that digital adoption is associated with productivity growth. The association is stronger in manufacturing than in services, but also stronger in more productive firms and weaker when there are skill shortages. Digital adoption may thus have increased growing dispersion of productivity performance.

To sum up, past research with various data sources indicates that ICT investment, and R&D and other intangible investment, digital adoption, and artificial intelligence are positively associated with the level of productivity and/or its growth. The positive association depends on available intangible assets, the skill level of the work force, people management practices, market access, less market regulation, and supportive competition policies.

3 Growth accounting framework

We analyse the development of value added as we are interested in labour productivity. This means that we will not consider the use of intermediate products, such as energy, materials, or services. Summing value added across all industries amounts to gross domestic product (less net taxes on products), and thus income on labour and capital in the economy.

Following Timmer et al. (2010), we present the volume of value added Y in industry i as a function f of capital K, labour L, and technology T as

$$Y_i = f_i\left(K_i, L_i, T_i\right). \qquad (1)$$

Assuming competitive factor markets, full input utilisation, and constant returns to scale, and using a translog functional form, we can decompose growth in industry i's value added with a Cobb-Douglas production function as the sum of contributions from capital, labour, and technical change (total factor productivity) A as

$$\Delta \ln Y_i = \Delta \ln A_i^Y + \bar{v}_{K,i}^Y \Delta \ln K_i + \bar{v}_{L,i}^Y \Delta \ln L_i , \qquad (2)$$

where Δ denotes the change from one year to the next (with time indicator t suppressed for easier readability) and $\bar{v}$ is the period-average share of each input in value added with $\bar{v}_{K,i}^Y + \bar{v}_{L,i}^Y = 1$. Total factor productivity is calculated as a residual. Data allowing, we will divide the capital stock into smaller entities:

$$\bar{v}_{K,i}^Y \Delta \ln K_i = \bar{v}_{ICT,i}^Y \Delta \ln K_i^{ICT} + \bar{v}_{RD,i}^Y \Delta \ln K_i^{RD} + \bar{v}_{SWDB,i}^Y \Delta \ln K_i^{SWDB} + \bar{v}_{other,i}^Y \Delta \ln K_i^{other} .$$

The ICT capital stock includes computer hardware and telecommunications equipment. RD refers to research and development. SWDB includes computer software and databases. Together, RD and SWDB are intellectual property products (IPP). Other capital stock then includes everything else, i.e. construction capital, machinery and equipment, and transport equipment. Furthermore, the change in the labour input can be divided into a change in the total actual number of hours worked H and a change in labour composition LC, or the ‘quality’ of labour:

$$\Delta \ln L_i = \Delta \ln H_i + \Delta \ln LC_i \,,$$

where the latter is measured with data on education levels, age, and gender, as calculated in the EUKLEMS database. However, these data are not fully comparable across countries.

We insert these two into equation (2) and get

$$\begin{aligned}\Delta \ln Y_i = \Delta \ln A_i^Y + \overline{v}_{ICT,i}^Y \Delta \ln K_i^{ICT} + \overline{v}_{RD,i}^Y \Delta \ln K_i^{RD} + \overline{v}_{SWDB,i}^Y \Delta \ln K_i^{SWDB} \\ + \overline{v}_{other,i}^Y \Delta \ln K_i^{other} + \overline{v}_{L,i}^Y \Delta \ln LC_i + \overline{v}_{L,i}^Y \Delta \ln H_i .\end{aligned} \tag{3}$$

We can calculate the change in labour productivity by subtracting $\Delta \ln H_i$ from both sides. Now labour productivity is given by $y_i = Y_i / H_i$ and the ratio of ICT, R&D, SWDB, and other capital services to total hours worked by $k_i = K_i / H_i$. Then the change in labour productivity is given by

$$\begin{aligned}\Delta \ln y_i = \Delta \ln A_i^Y + \overline{v}_{ICT,i}^Y \Delta \ln k_i^{ICT} + \overline{v}_{RD,i}^Y \Delta \ln k_i^{RD} + \overline{v}_{SWDB,i}^Y \Delta \ln k_i^{SWDB} \\ + \overline{v}_{other,i}^Y \Delta \ln k_i^{other} + \overline{v}_{L,i}^Y \Delta \ln LC_i\end{aligned} \tag{4}$$

which shows it as a sum of TFP growth, capital deepening, and changes in labour composition.

4 Development of labour productivity in Finland

Manufacturing industry is often seen as outperforming service industries in productivity growth over time. If we look at the development in Finland in 2010–2023, after the global financial crisis, we can see that there are strong and weak industries in both manufacturing and services (see Table 1). The best-performing service industries—information and communication, and financial and insurance activities—developed at least as well as the best 2-digit manufacturing industries. These are also industries where it is easy to picture the use of ICT and digital solutions as tools to increase productivity. It should be noted, however, that major external factors and shocks affected the economy in 2020–2023, and these also had temporary effects on productivity.

To better understand the long-term trends, Figures 1 and 2 show the development of labour productivity growth in Finnish private knowledge-intensive service industries (NACE codes G, H, J, K, and M) from 1980 onwards. This longer period provides a broader perspective, although our subsequent analysis will cover the years after 1995. We can first see that there is considerable volatility in annual growth rates. To address this, we have calculated and included trends using the Hodrick-Prescott (HP) filter, a statistical tool that helps smooth short-term fluctuations and highlight the underlying trends in productivity growth.

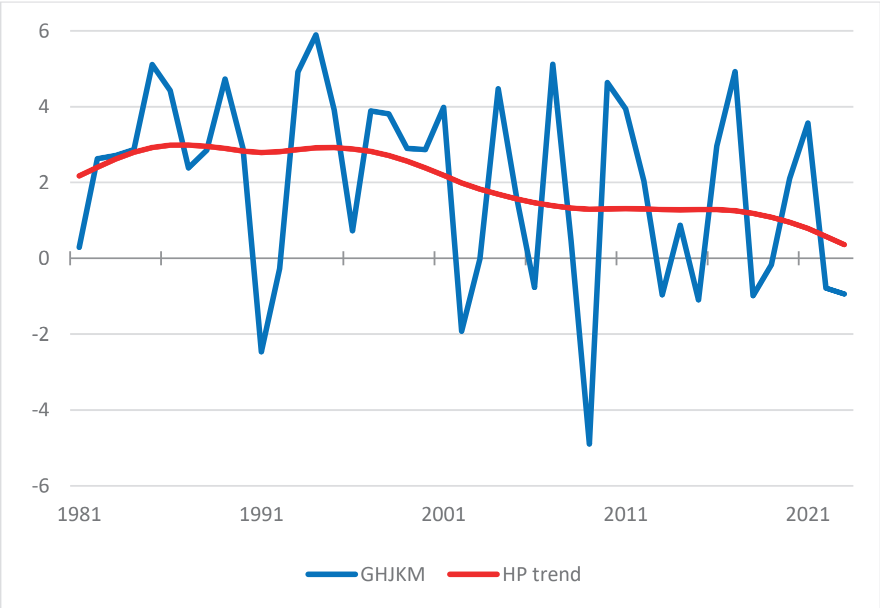
Aggregate trend productivity growth remained relatively stable up until about the mid-1990s (Figure 1). After that, there was a slowdown that lasted until about 2009, followed by a break in the decline, which seems to have resumed towards the end of the 2010s. This latter development is most likely partly due to the Covid-19 pandemic and its aftermath, as well as an indirect impact on Finnish service sectors following Russia’s invasion of Ukraine. It may still be too early to say anything definitive about this for now.

Table 1 **Change in average annual labour productivity (value added per hours worked) in Finland in 2010–2023, %**

Industry	Productivity growth, %
Agriculture, forestry and fishing (A)	2.0
Mining and quarrying (B)	-1.8
Manufacturing (C)	-0.2
Manuf. of food products and beverages	-0.5
Manuf. of textiles, wearing apparel, leather	1.2
Forest industries	0.7
Chemical industries	-0.7
Manuf. of other non-metallic mineral products	1.4
Manuf. of basic metals	0.6
Manuf. of fabricated metal products	-2.3
Manuf. of computer, electronic, electric, optical products	-1.8
Manuf. of machinery and equipment	0.8
Manuf. of transport equipment	0.9
Energy, water supply, waste management (D_E)	0.6
Construction (F)	-1.5
Trade (G)	1.0
Transportation and storage (H)	-0.3
Accommodation and food service activities (I)	-1.1
Information and communication (J)	1.9
Financial and insurance activities (K)	1.9
Real estate activities (L)	1.6
Professional, scientific and technical activities (M)	0.7
Administrative and support service activities (N)	-1.4
Total economy (A_T)	0.1

Note: Service industries NACE Rev. 2 codes from O to T are not shown individually. Sources: Statistics Finland, own calculations.

Figure 1 **Aggregate labour productivity growth in Finnish private service industries (GHJKM), log-changes and HP trend, 1981–2023**



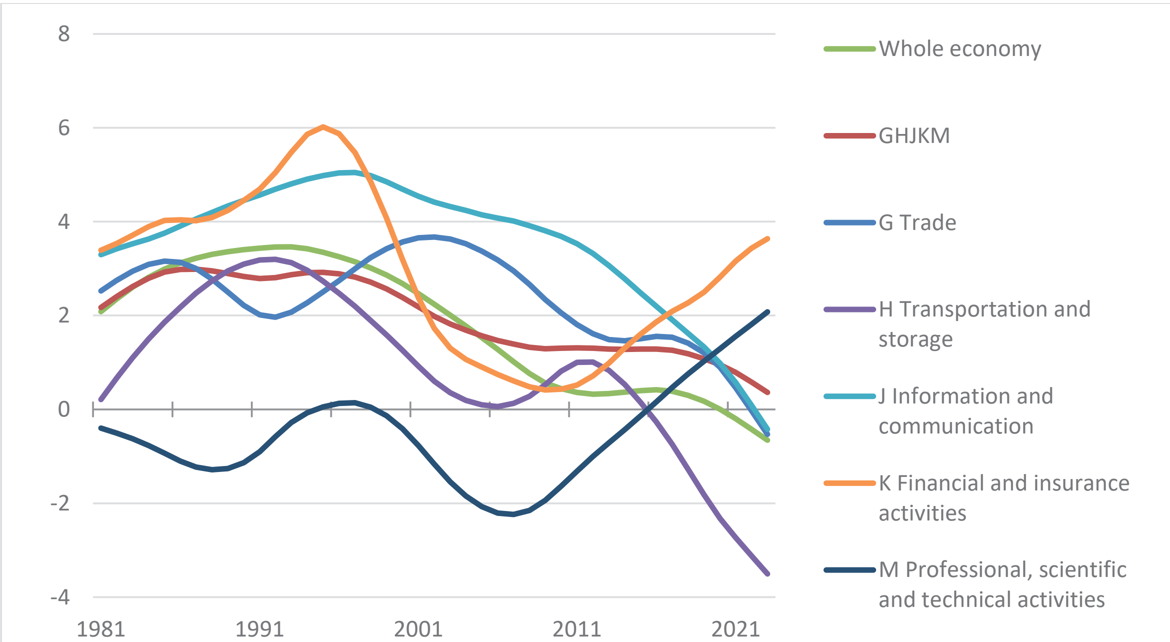
Note: The aggregate has been calculated using the sum of value added and hours worked across the individual service industries. Hodrick-Prescott (HP) filter with λ = 100. Sources: Statistics Finland, own calculations.

Figure 2 shows the HP trends for each of the five service industries together with their aggregate total and the overall economy in Finland. Regardless of the two above-mentioned exceptional shocks experienced from 2020 onwards, there is an upswing in productivity growth in financial and insurance activities, and professional, scientific and technical activities. However, value added in financial and insurance activities is subject to measurement challenges and is likely to have been temporarily inflated by the impact of higher interest rates. On the other hand, the strengthening of productivity in professional, scientific and technical activities may have a more solid base.

Meanwhile, there is a decline in trend productivity growth in the other industries: trade, transportation and storage, and information and communication services. At the early stages of the pandemic, trade benefitted from an increase in demand that contributed to value added also, which has recently adjusted back down. In contrast, the transportation sector was hit hard during the pandemic, when value added in air transport turned negative in 2020–2021 and remained very weak also in 2022–2023. This is likely to eventually be a temporary phenomenon, but it affects the HP trends in the short term in an unfavourable way.

In addition to these considerable differences in productivity growth rates, there are important differences in the levels of labour productivity. In 2023, hourly value added in Finland was on average 48 euros in constant 2015 prices in the five industries but varied from 33 euros in transportation and storage to 105 euros in financial and insurance activities, as calculated from Statistics Finland data. Which industries develop the most or least has therefore a significant effect on the total average. This also applies to 2-digit sub-sectors. The industrial structure may differ greatly between countries, and this will also have an impact on productivity levels and development. Furthermore, there are of course differences in productivity levels and development at the firm level.

Figure 2 Labour productivity growth HP trends in Finnish private service industries, 1981–2023



Note: Hodrick-Prescott (HP) filter with λ = 100. Sources: Statistics Finland, own calculations.

5 Labour productivity in international comparison

Next, let us make an international comparison. Figure 3 shows labour productivity levels and development in our five service industries in 1995–2023 in twelve countries: eight current EU countries, Norway, Switzerland, Britain, and the US. Britain is included in the analysis up to 2018, where data provided by the Eurostat end. The US is included up to 2019 as data were available from the OECD database. We use production-side PPPs from the GGDC Productivity Level Database (see Inklaar et al., 2023), to compare productivity levels across countries. The price level is given by the latest year available, i.e. 2017. The national accounts value-added data has 2015 as the base year. The PPP-adjustment only affects the levels, not the developments. The vertical axes are the same in the pair of graphs covering the same industry to help comparisons.

We can include the United States in parts of our analysis as a reference for the European nations, depending on the availability of data. As aggregate productivity growth has been faster in the US than in Europe, it is important to make a comparison between the two. Eurostat data is used in Figure 3 for the European countries, but for the US we have to use OECD STAN data that end in 2019. While aggregate productivity growth at the national GDP level was slower in the EU already before that, the difference has been even larger thereafter.

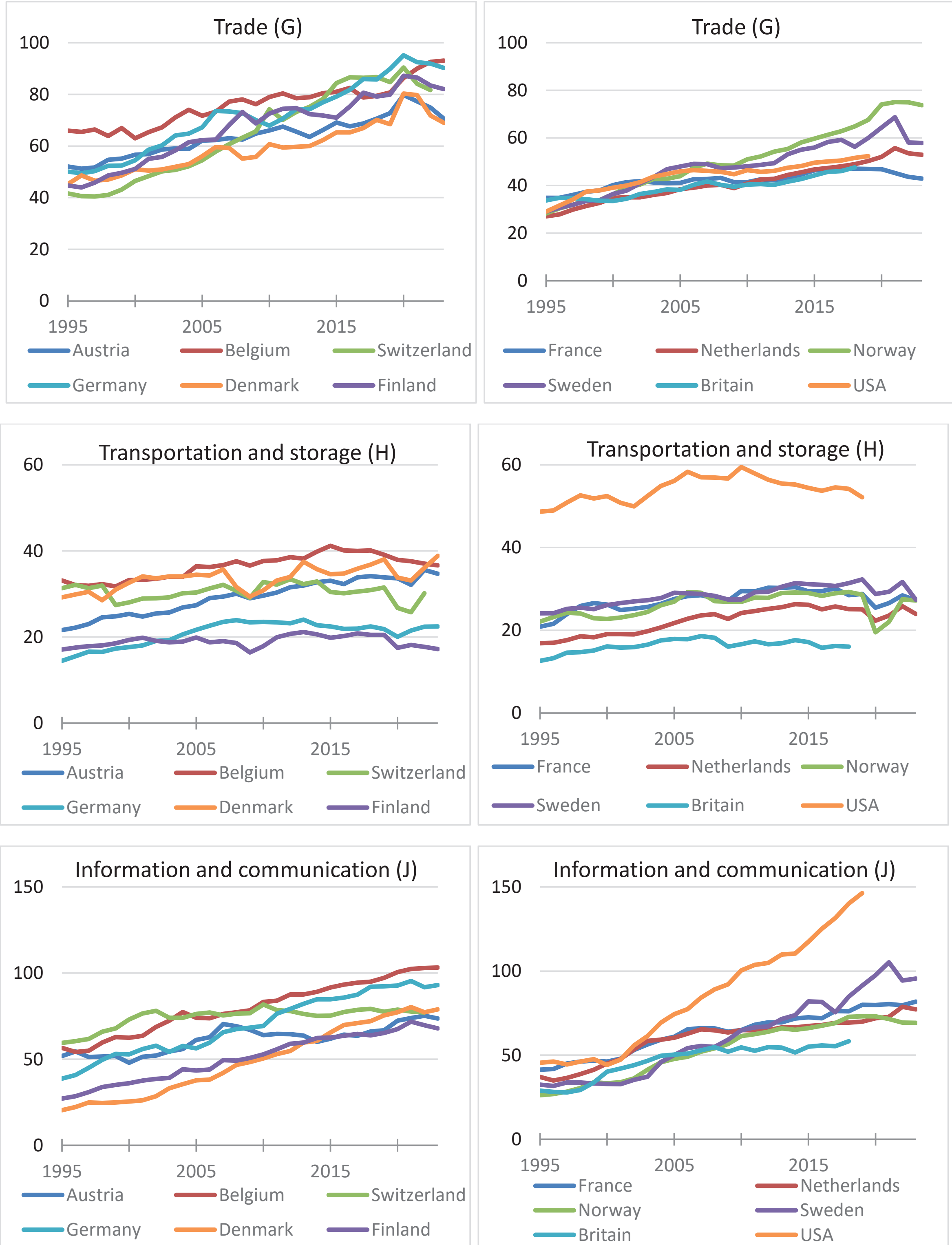
US data is also shown in Appendix A1 where we find EUKLEMS data of a decomposition of labour productivity changes, as well as in Appendices A2 and A3 with trade restrictiveness data published by the OECD. On the other hand, as we use Eurostat data in our econometric estimations below, we cannot include the US in this part of our analysis.

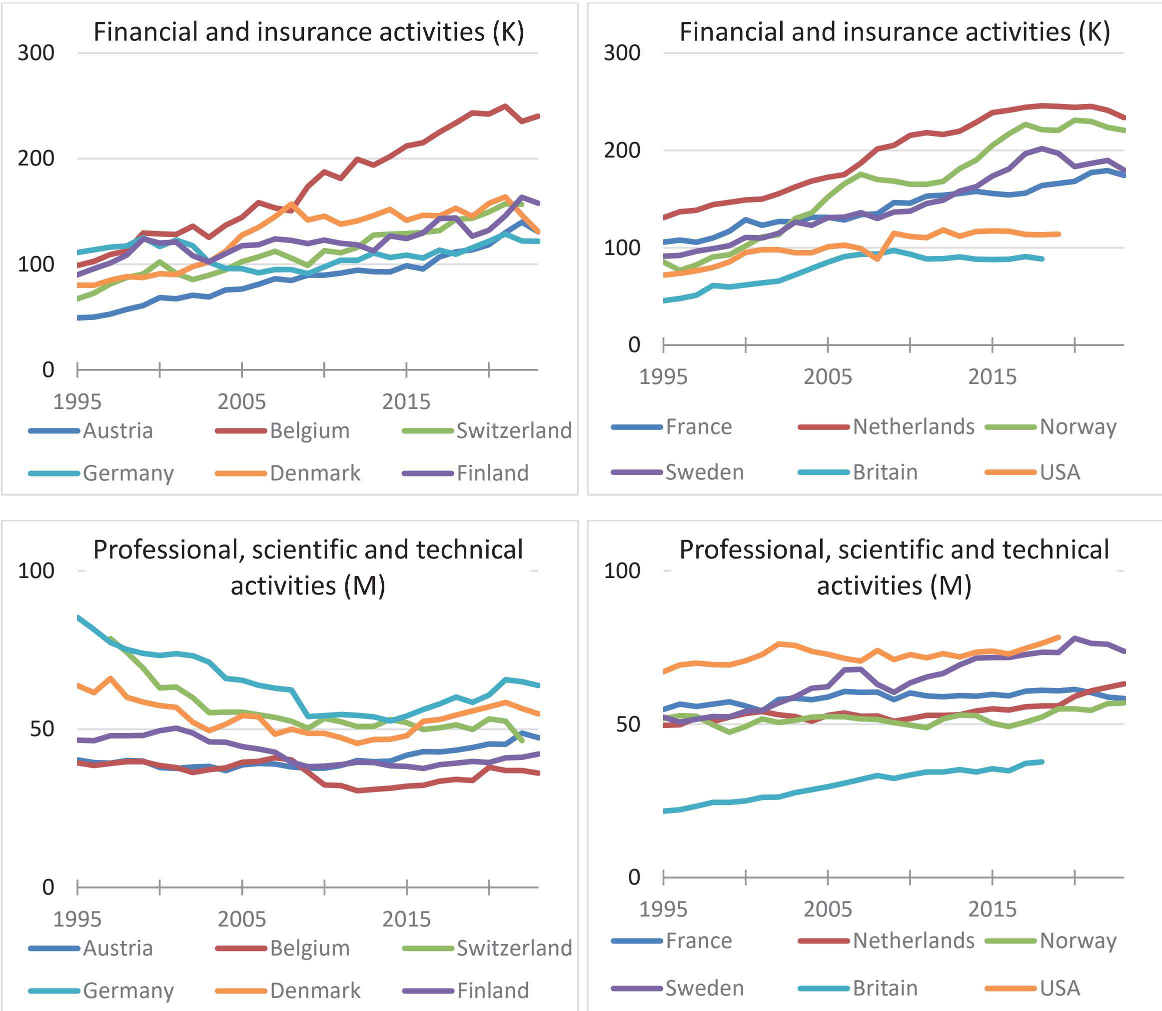
We can see in Figure 3 that—for the most part—labour productivity has increased in the countries shown in the graphs. In trade, PPP-adjusted labour productivity is the highest in Belgium and Germany, but quite high in Finland and Switzerland also. This is the only one of the five industries, where productivity in Finland is higher than the arithmetic average of ten countries (i.e. excluding the UK and the US for which we do not have recent data). On the other hand, in Sweden trade is the only industry where productivity is below this average.

We can see from the data that the level of labour productivity in 2019 was much higher in the US than in Europe in transportation and storage, and information and communication, but also with a smaller margin in professional, scientific and technical activities. On the other hand, in trade as well as in financial and insurance activities the USA does not seem to be that strong. The low level of productivity in British financial and insurance activities is also somewhat unexpected given its strong status as a financial centre before Brexit. Finally, given very high GDP per capita in Switzerland, the level of productivity in service industries seems relatively moderate.

In transportation and storage, PPP-adjusted labour productivity is the highest in Denmark, Belgium, and Austria among the European countries, and the lowest in Finland and Germany, and most probably Britain given the pre-Brexit development. In information and communication, labour productivity is the highest—after the USA—in Belgium, Sweden, and Germany. Finland has one the lowest levels of labour productivity. In financial and insurance activities, Belgium, the Netherlands, and Norway have the highest levels of labour productivity, followed by Sweden, France, and Finland. In professional, scientific and technical activities, labour productivity is the highest in Sweden, Germany, and the Netherlands in Europe, with Finland a relative weak performer.

Figure 3 PPP-adjusted labour productivity (value added per hour) in selected countries, USD





Sources: Eurostat, OECD, Inklaar et al. (2023), and own calculations.

If we look at labour productivity development in Finland at a more disaggregated 2-digit level, we find that trade and repair of motor vehicles is a weak performer in overall trade, as are postal and courier activities in transportation and storage (in addition to there not being any sub-industry with productivity growth), and auxiliary activities in finance and insurance. In professional, scientific and technical activities, the strongest recent productivity growth is in veterinary activities, and to a lesser degree in the activities of head offices, management consultancy, legal and accounting, advertising and market research, architectural and engineering, and technical testing and analysis. On the other hand, telecommunication is a stellar part of the information and communication industry with very rapid productivity growth.

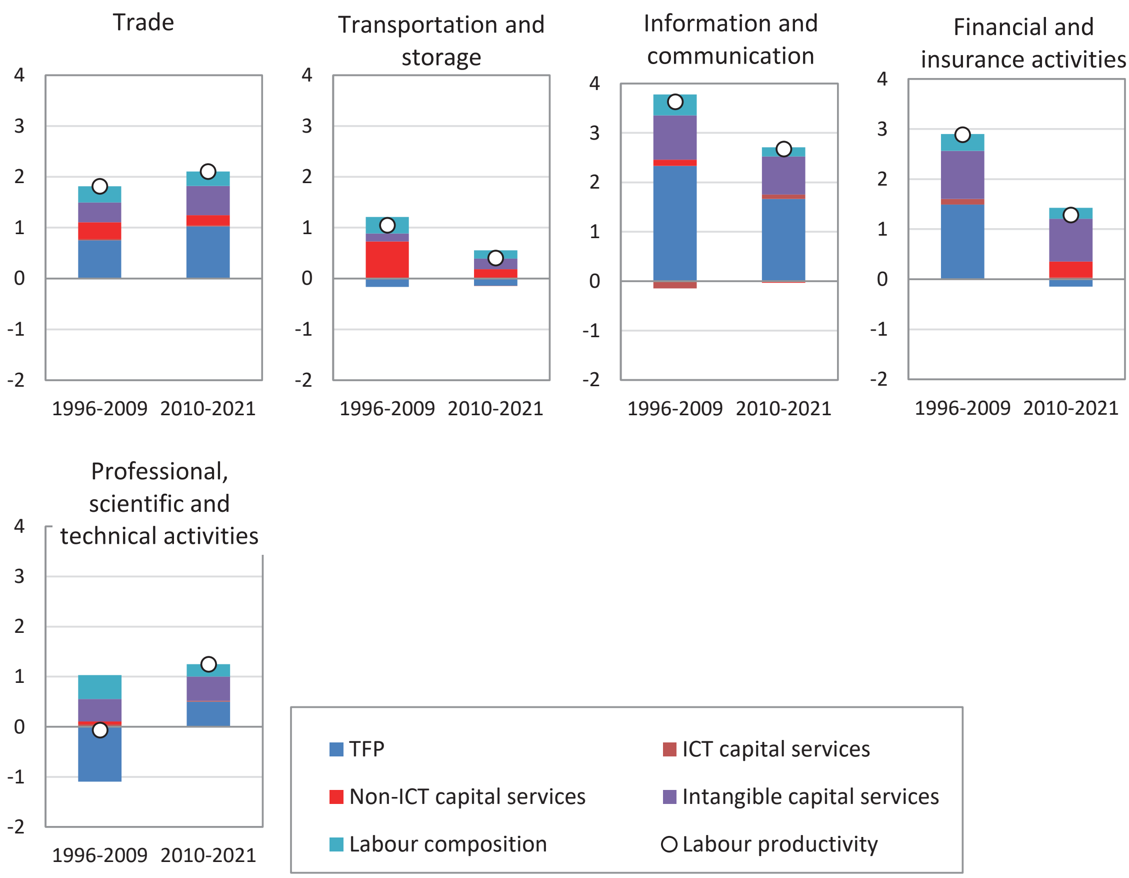
As discussed above in the context of the growth accounting framework, labour productivity growth can be divided into components. Following the EUKLEMS database release 2025 (see Bontadini et al., 2023), these components are TFP, (tangible) ICT capital services, (tangible) non-ICT capital services, intangible capital services, and labour composition (skill level).

Tangible ICT capital services include IT computer hardware and telecommunications equipment; tangible non-ICT capital services include dwellings, other buildings and structures, transport equipment, other machinery and equipment, weapons systems, and cultivated biological resources; intangible capital services include research and development, computer software and databases, and entertainment and artistic originals.

Figure 4 shows the arithmetic averages of the composition of annual labour productivity growth in twelve countries before and after the financial crisis, i.e. in 1996–2009 and 2010–2021 in each service industry. Figures A1.1 – A1.5 in Appendix A1 show the respective composition in each country separately. The countries included are Austria, Belgium, Britain, Denmark, Finland, France, Italy, the Netherlands, Spain, and Sweden in Europe, along with Japan and the US from outside of Europe.

It is worth noting that productivity growth varies considerably from year to year even in large economies, as does its composition. Consequently, the selected period influences the averages shown in the graphs, and moving the time span by just one year may affect the interpretations. The business cycles in individual countries are not aligned, and in the second period ending in 2021, though in some cases 2019 or 2020 (see Appendix A1), the pace of recovery from the pandemic may also have been different.

Figure 4 Averages of labour productivity growth and its composition in twelve industrialised countries (see Appendix A1), percentage points



Note: Arithmetic averages of annual percentage-point contributions to labour productivity growth in twelve industrialised countries: Austria, Belgium, Britain, Denmark, Finland, France, Italy, Japan, the Netherlands, Spain, Sweden, and the US. Results for the individual countries are presented in Appendix A1. Vertical axes are the same for all industries to help comparisons. Source: Euklems & INTANProd database, release 2025.

We can see from the graphs in Appendix A1 that, typically, labour productivity growth is dominated by TFP in retail and wholesale trade. About half of productivity growth has come from TFP if we calculate arithmetic averages over the twelve countries as shown in Figure 4, with a quarter originating from intangible capital services. Labour productivity growth has been on average about 2 per cent. There are differences between the countries and the two periods. For example, TFP growth has been very dominant in Denmark but rather non-existent in Japan. In Finland and the USA, labour productivity and TFP growth were slower in the second period than in the first, but the situation was the opposite in Italy, Spain, and Denmark.

On the other hand, TFP has on average had a negative contribution to labour productivity in transportation and storage, albeit a very small one. Overall average labour productivity growth has also been quite slow, about one per cent before the financial crisis and about half of that thereafter. On the other hand, transportation was particularly hard hit by the Covid19 pandemic and in many cases the recovery was still under way in 2021 thus affecting the data. Non-ICT capital services, and more recently also intangible capital services have had a positive impact on labour productivity growth in this industry.

Of the five industries, labour productivity growth has on average been the fastest in information and communication, and TFP growth has been a dominant factor in this development, followed by intangible capital services. Average growth has slowed after the financial crisis. Growth has been the fastest in the UK, followed by the USA. Productivity growth slowed down in the former after the financial crisis but accelerated in the latter. Of the EU countries, we find fastest growth in Sweden and Denmark with TFP and intangible capital services most important factors behind labour productivity growth. In the USA, also non-ICT capital services have been important. Labour productivity growth in this industry has been very slow in Austria, Italy, and Japan.

Labour productivity growth in financial and insurance activities slowed down after the financial crisis when previously important TFP growth became non-existent. Intangible capital services then dominated the now weaker labour productivity growth. Looking at individual countries, growth slowed down markedly in the USA, Denmark, Spain, and the UK, and even turned negative in the latter two. TFP had a negative impact in all four countries. On the other hand, productivity growth was relatively close to its pre-financial-crisis level in the other eight countries.

Average TFP growth turned positive in professional, scientific and technical activities after the financial crisis and this development helped boost labour productivity growth to over one per cent annually. This acceleration can be seen in most countries, with just the UK experiencing slower, and in fact zero, growth after the financial crisis.

6 Data and estimations

Following the growth accounting framework discussed above, we will next estimate labour productivity levels and changes (volumes in euros) for the five service industries discussed in this research. Labour quality is included when estimating productivity levels without year dummies. Otherwise, it does not work as a variable and is excluded, because its coefficient or the adjusted R2 value in the whole specification may be negative. Quality is determined by the share of the highly skilled in employment (hours worked), regardless of their age or gender. These data are from EU KLEMS and end in 2021, which limits the number of observations in the estimations when this variable is included.

The data include at best the years 1995–2023 and 27 European countries: Austria, Belgium, Cyprus, Czechia, Germany, Denmark, Estonia, Greece, Spain, Finland, France, Croatia, Hungary, Ireland, Italy, Lithuania, Luxembourg, Latvia, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Sweden, Slovenia, and Slovakia. The national accounts data are from Eurostat and therefore the selection of countries is limited to the EU (and Norway). Bulgaria is not included because their capital stock data appeared troublesome.

Compared to manufacturing, many service industries are operating in a relatively closed economy with more limited foreign competition. As an institutional variable we will therefore include the

OECD STRI data (Services trade restrictiveness index, see Appendices A2 and A3) when analysing productivity levels. The STRI sub-variables are barriers to competition (STRI Competition in the regression tables), restrictions on foreign entry (STRI Foreign entry), restrictions to movement of people (STRI People), regulatory transparency (STRI Regulatory), and other discriminatory measures (STRI Other). Using the STRI data further limits the number of observations when it is used.

We will show aggregate estimations for labour productivity levels and growth rates next. This means that all five industries are included with fixed effects and industry dummies. Appendix A4 presents the estimation results for labour productivity levels in each industry separately, and Appendix A5 the ones with labour productivity changes as the dependent variable. The results shown in these Appendices are discussed in the main text here below.

6.1 Productivity levels

Table 2 for aggregate results with industry dummies and Tables A4.1 – A4.5 in Appendix A4 by industries show the estimations with the level of labour productivity as the dependent variable, as discussed above in the context of the growth accounting framework. Fixed effects are used throughout the panel estimations. Year dummies (not shown) are used in the first three specifications in these tables. The other specifications are without year dummies.

According to the results, capital intensity, i.e. the volume of the capital stock relative to the number of hours worked, is always positively associated with the level of labour productivity when it is the only independent variable. The positive relationship is as expected. Our division of the capital stock into ICT equipment, R&D, computer software and databases (SW&DB), and all other capital also clearly shows that higher capital intensity is positively associated with higher levels of labour productivity. These results exist regardless of the use of year dummies.

If we look at the industry-specific results in Appendix 4, we find somewhat mixed results. The use of year dummies makes a little difference, but mostly the results are relatively similar to the aggregate ones. In trade, ICT, R&D, and other capital intensities are positively associated with the level of labour productivity. In transportation and storage, SW&DB capital intensity is negatively associated with productivity levels, while the other three are positively associated as expected.

In information and communication, we find a positive association in ICT, SW&DB, and other capital intensities, and in financial and insurance activities with ICT, and other capital intensities. In both industries, all four capital intensities are relevant when year dummies are not included. In professional, scientific and technical activities all but the SW&DB capital stock are positively associated with productivity. Overall, we can therefore argue that ICT and IPP capital intensities are typically positively associated with the level of labour productivity throughout service industries in Europe, with some exceptions in terms of R&D and SW&DB capital intensities.

Our labour quality variable does not function as expected, as discussed above. If we do not include year dummies, the results indicate a positive association between labour quality and productivity in specifications (6)–(8), except in transportation and storage. The association is a little weak also in financial and insurance activities.

The STRI variable is positively associated with the level of productivity, albeit it is not always statistically significant at the industry level. This implies that—after capital intensity (and labour quality) are controlled for—service trade is restricted more in countries where productivity is higher. Of the STRI sub-variables, regulatory transparency stands out more than the other sub-variables.

Table 2 Level of labour productivity in all services (GHJKM)

	(1) Year dummies	(2) Year dummies	(3) Year dummies	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.217***		0.342***	0.444***		0.303***	0.335***	0.342***
	(16.557)		(12.483)	(32.390)		(13.524)	(11.061)	(11.317)
ICT cap. int.		0.0945***			0.134***			
		(10.991)			(16.753)			
R&D cap. int.		0.0343***			0.0450***			
		(5.452)			(6.990)			
SW & DB cap. int.		0.0535***			0.114***			
		(5.780)			(13.979)			
Other cap. int.		0.158***			0.151***			
		(7.816)			(7.268)			
Labour quality						0.191***	0.270***	0.244***
						(8.064)	(5.404)	(4.763)
STRI			1.792***				1.796***	
			(4.655)				(4.065)	
STRI Competition								0.665
								(0.416)
STRI Foreign entry								2.244***
								(2.725)
STRI People								0.924
								(1.478)
STRI Regulatory								6.523***
								(4.416)
STRI Other								-0.455
								(-0.144)
Constant	3.825***	5.100***	4.222***	4.791***	5.945***	3.674***	3.216***	3.288***
	(79.397)	(47.509)	(39.335)	(112.159)	(80.905)	(30.347)	(13.845)	(13.633)
Observations	3502	1936	935	3502	1936	1625	700	700
Adjusted R^2	0.442	0.506	0.329	0.208	0.466	0.101	0.131	0.146

Note: Luxembourg excluded as an outlier. * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parenthesis. Fixed effects with industry dummies.

6.2 Productivity changes

Next, we analyse annual log-changes in labour productivity by taking log differences in the growth accounting framework. Capital intensity is therefore also calculated as log-changes, while the labour quality variable has been excluded as discussed above. The OECD STRI variable is also excluded. On the other hand, we include the lagged level of labour productivity in some estimations to see whether countries with a lower level of productivity have been growing faster than others, indicating β convergence. Year dummies (not shown) are used in the first four specifications in the estimations with productivity changes as the dependent variable. The other specifications are without year dummies, but otherwise the same as the first four.

The log-change in aggregate capital intensity is positively associated with a change in labour productivity when we sum over all five service industries (see Table 3) whether we include year dummies or not. This is the case also individually in trade, information and communication, financial and insurance activities, and professional, scientific and technical activities, but for transportation and storage only if year dummies are included. (see Tables A5.1 – A5.5 in Appendix A5).

In the aggregate (Table 3), changes in all individual capital intensities show a positive association vis-à-vis labour productivity growth when lagged productivity and year dummies are excluded. Otherwise, ICT and R&D lose their statistical significance. Also including the lagged level of productivity leads to some decline in the statistical significance of the capital intensity variables. Meanwhile, the lagged level of productivity is always negative and statistically significant implying that countries with lower productivity have experienced faster growth.

At the industry level, ICT capital deepening is positively associated with productivity growth in trade, and in information and communication—and in professional, scientific and technical activities if year dummies are included. R&D capital deepening is positively associated in professional, scientific and technical activities. Changes in software and database capital intensity are positively associated with productivity development in information and communication, and partly in financial and insurance activities. There are some exceptions depending on whether lagged productivity and/or year dummies are included or not. Finally, other capital deepening is by far the most relevant of the four with a strong positive association in all five industries. This is perhaps an unexpected result.

The lagged level of labour productivity has always a negative coefficient and is always statistically significant in the industry-level estimations. This suggests that productivity has been growing faster in countries with lower levels of productivity than in countries with higher productivity (β convergence) when changes in capital intensity have been controlled for.

Table 3 Change in labour productivity in all services (GHJKM)

	(1) Year dummies	(2) Year dummies	(3) Year dummies	(4) Year dummies	(5)	(6)	(7)	(8)
Change in total cap. int.	0.360***	0.345***			0.326***	0.289***		
	(17.748)	(17.572)			(16.213)	(14.683)		
Change in ICT cap. int.			0.0108	0.0172			0.0188*	0.0069
			(0.969)	(1.613)			(1.669)	(0.630)
Change in R&D cap. int.			0.0115	0.0074			0.0135*	0.0098
			(1.490)	(0.993)			(1.676)	(1.254)
Change in SW & DB cap. int.			0.0223***	0.0147*			0.0215**	0.0100
			(2.717)	(1.862)			(2.545)	(1.207)
Change in other cap. int.			0.569***	0.555***			0.503***	0.488***
			(19.101)	(19.427)			(16.695)	(16.626)
Lagged productivity		-0.109***		-0.101***		-0.077***		-0.067***
		(-15.431)		(-12.666)		(-13.686)		(-10.297)
Constant	0.0153**	0.350***	-0.0002	0.320***	0.0160***	0.278***	0.0130***	0.248***
	(2.026)	(15.295)	(-0.022)	(12.045)	(12.047)	(14.491)	(8.063)	(10.841)
Observations	3372	3372	1863	1863	3372	3372	1863	1863
Adjusted R^2	0.092	0.154	0.231	0.295	0.038	0.090	0.158	0.205

Note: Luxembourg excluded as an outlier. * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parenthesis. Fixed effects with industry dummies.

6.3 Before and after the financial crisis

As a final econometric analysis, we will consider two time periods 1995–2008 and 2009–2023 using the combined dataset, only capital intensity variables, and industry dummies. The results are presented in Table 4 for productivity levels and Table 5 for the changes, both with and without year dummies.

Looking at the differences between the two periods, in terms of productivity levels, we can see that the coefficient of R&D capital intensity as an independent variable is positive and statistically significant in the first period but becomes negative and statistically significant in the latter period. Otherwise, the results are relatively similar in the two periods.

We find more differences between the two periods in terms of productivity changes. The coefficient of total capital intensity retains its strong statistical significance but is clearly smaller in the second period. The change in ICT capital intensity is statistically insignificant in the first period but becomes positive and statistically significant in the second. Meanwhile, R&D capital intensity performs in the opposite way. The coefficient of lagged productivity is always negative and statistically significant, but the value is much larger in the second period.

Table 4 Level of labour productivity in all services (GHJKM) 1995–2008 vs. 2009–2023

	1995–2008				2009–2023			
	(1) Year dummies	(2) Year dummies	(3)	(4)	(5) Year dummies	(6) Year dummies	(7)	(8)
Total cap. int.	0.240***		0.444***		0.294***		0.380***	
	(13.399)		(23.048)		(14.706)		(17.105)	
ICT cap. int.		0.0986***		0.136***		0.0702***		0.0919***
		(7.962)		(12.543)		(5.996)		(7.211)
R&D cap. int.		0.0737***		0.0865***		-0.0325***		-0.0156**
		(6.982)		(8.162)		(-4.633)		(-2.062)
SW & DB cap. int.		0.0587***		0.0773***		0.0469***		0.176***
		(5.772)		(7.850)		(3.199)		(14.235)
Other cap. int.		0.259***		0.270***		0.300***		0.213***
		(8.773)		(8.985)		(10.380)		(6.868)
Constant	3.909***	5.832***	4.727***	6.394***	4.308***	4.984***	4.660***	5.839***
	(62.841)	(40.756)	(76.362)	(63.074)	(68.917)	(38.329)	(69.185)	(47.289)
Observations	1645	896	1645	896	1857	1040	1857	1040
Adjusted R^2	0.449	0.575	0.196	0.554	0.294	0.386	0.081	0.259

Note: Luxembourg excluded as an outlier. * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parenthesis. Fixed effects with industry dummies.

Table 5 Change in labour productivity in all services (GHJKM) 1995–2008 vs. 2009–2023

	(1) Year 95-08	(2) Year 95-08	(3) 95-08	(4) 95-08	(5) Year 09-23	(6) Year 09-23	(7) 09-23	(8) 09-23
Change in total cap. int.	0.468***		0.452***		0.233***		0.177***	
	(17.439)		(16.422)		(7.670)		(5.921)	
Change in ICT cap. int.		-0.0076		-0.0249		0.0331**		0.0329**
		(-0.441)		(-1.419)		(2.356)		(2.195)
Change in R&D cap. int.		0.0348***		0.0361***		-0.0127		-0.0092
		(3.015)		(3.025)		(-1.070)		(-0.732)
Change in SW & DB cap. int.		0.0146		0.0122		0.0272		0.0197
		(1.524)		(1.231)		(1.638)		(1.142)
Change in other cap. int.		0.559***		0.555***		0.611***		0.505***
		(12.598)		(12.223)		(13.906)		(11.401)
Lagged productivity	-0.131***	-0.121***	-0.077***	-0.063***	-0.253***	-0.227***	-0.191***	-0.162***
	(-10.985)	(-7.757)	(-8.189)	(-5.151)	(-15.611)	(-12.434)	(-13.106)	(-9.887)
Constant	0.419***	0.387***	0.273***	0.235***	0.876***	0.811***	0.683***	0.593***
	(11.136)	(7.682)	(8.789)	(5.620)	(15.779)	(12.675)	(13.395)	(10.128)
Observations	1515	823	1515	823	1727	967	1727	967
Adjusted R^2	0.203	0.253	0.148	0.191	0.116	0.296	0.052	0.196

Note: Luxembourg excluded as an outlier. * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parenthesis. Fixed effects with industry dummies.

7 Capital intensity and labour productivity

We have seen in our estimations that the capital-stock-to-labour ratio, or capital intensity, is clearly positively associated with labour productivity, as also the growth accounting framework implies. In this final section we will plot these two variables in European countries relative to each other and further review how combined ICT and IPP (i.e. ICT, research and development, and computer software and databases) capital intensity fits in with labour productivity. Figure 5 shows these graphs using the total capital stock and Figure 6 using the combined ICT and IPP capital stock in 2021, the most recent year we have an extensive number of countries with disaggregated data.

We can observe from the graphs, with R2 values shown for linear trends, that there is a clear positive association between labour productivity and overall capital-stock-to-labour ratios, as well as vis-à-vis ICT-and-IPP-capital intensities. The latter is more pronounced except in transportation and storage.

If we take averages across all five industries, the highest capital-stock-to-labour ratios are in Belgium and Sweden, followed by Denmark, Austria, and Norway. The Danish capital stock is inflated by the large maritime transport fleet and that of Norway by the oil and gas pipeline network. Average capital intensity in Finland is well below the arithmetic European average and less than one-third of the ratio in Sweden.

In terms of combined ICT and IPP, Finland has the same capital intensity as on average the other countries we have data for. The differences in ICT and IPP capital intensities are very large between the countries, however, with the highest values in Sweden, Norway, and Belgium. The Finnish figure is less than half of the Swedish one.

Looking at the graphs, we can also see that—apart from ICT-and-IPP-capital intensity in finance and insurance—Finland lies above and to the left of the trend line. Consequently, relative to the other countries, capital intensity seems to be low relative to the level of labour productivity. Table 6 underlines the differences between Finland and eight European peers. All the figures—labour productivity and capital intensities—are lower in Finland than the arithmetic average of the other countries. Furthermore, the difference between Finland and the other countries is greater in the capital-stock-to-labour ratios than in labour productivity.

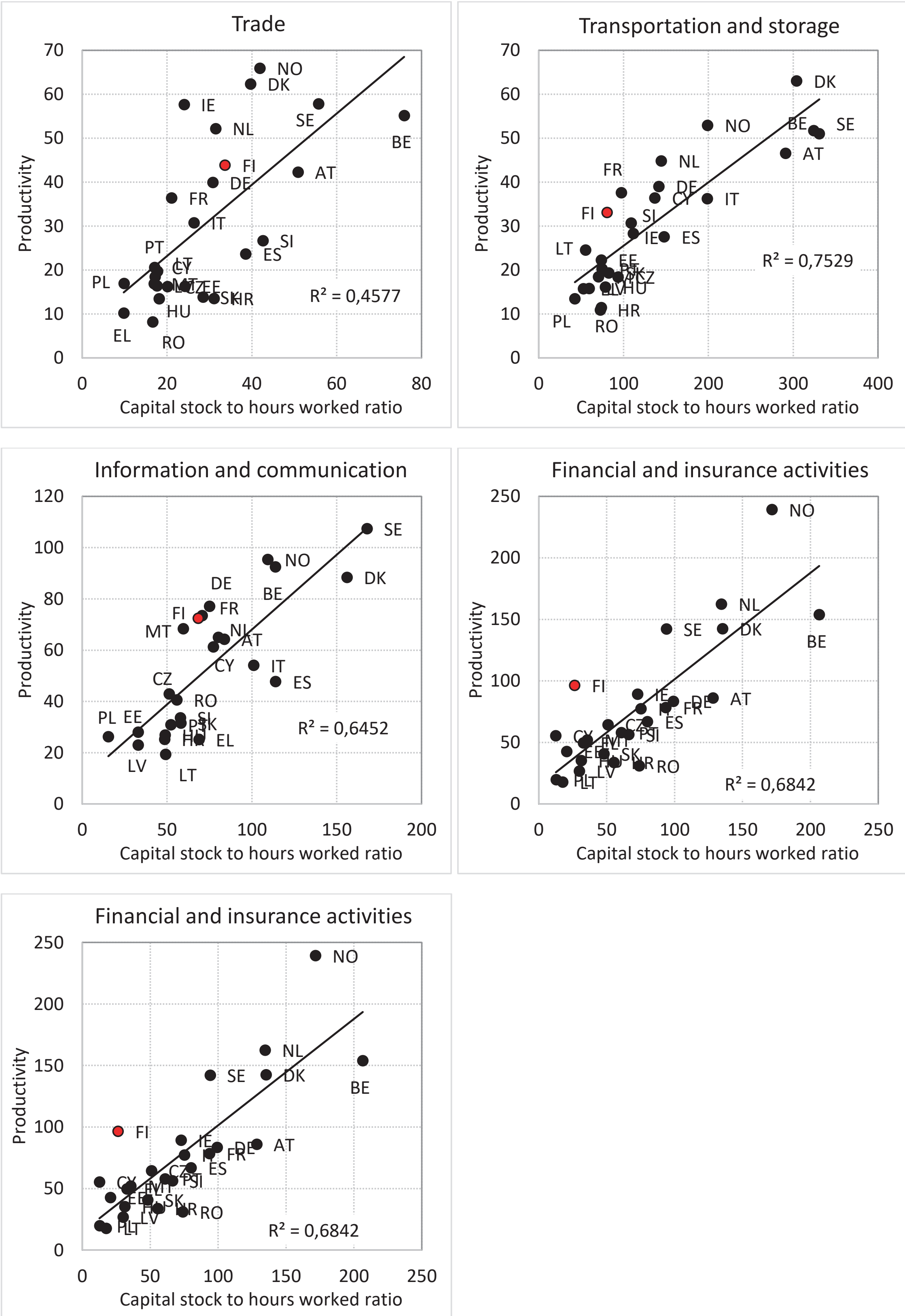
Table 6 Labour productivity and capital-stock-to-labour ratios in Finland relative to peer countries in 2021

	Trade	Transportation and storage	Information and communication	Financial and insurance activities	Professional, scientific and technical activities
Labour productivity	0.85	0.68	0.87	0.71	0.73
Capital-stock-to-labour ratio	0.78	0.35	0.64	0.20	0.55
ICT & IPP capital stock to labour ratio	0.44	0.43	0.62	0.65	0.56

Note: 'Peer countries' are the arithmetic average for Austria, Belgium, Denmark, France, Germany, the Netherlands, Norway, and Sweden. The ICT and IPP data do not include Denmark or Germany, however, because of lack of data. Calculated using constant 2015 euros. Sources: Eurostat, own calculations.

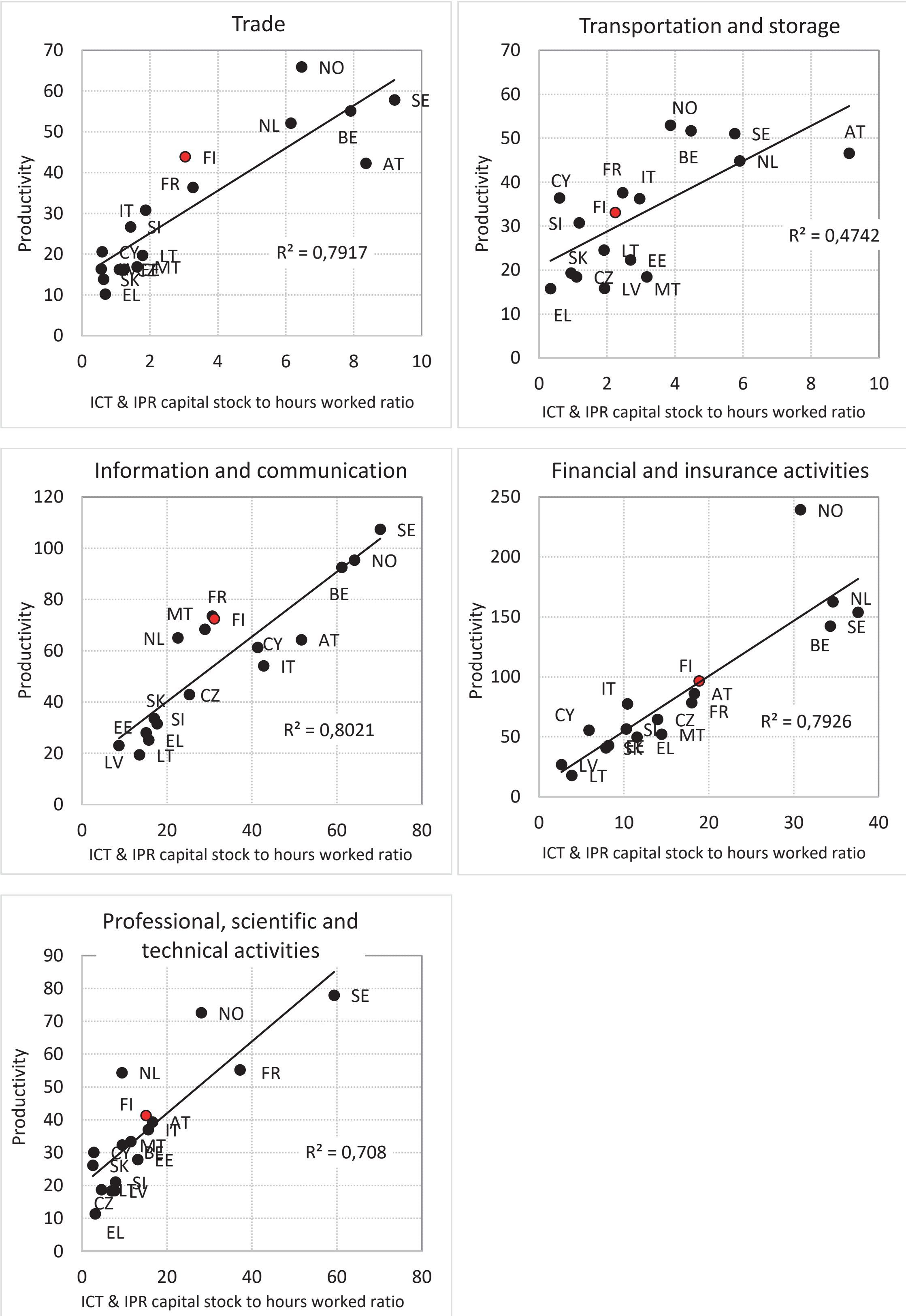
If we plot (not shown in graphs), in a similar way, the skill level of labour as used in this research from the EUKLEMS database and the level of labour productivity by industries, we find that the R2 values are very close to zero and that in three of the five industries the relationship is negative. In every industry, we find that Finland is above the linear trend, indicating that the level of productivity is higher than on average given the skill level of the labour force. These tertiary education (skill) levels are quite high in many low-productivity countries. Relative to the peer group countries' average, as in Table 6, the skill level of the Finnish labour force is higher in every industry except transportation and storage where it is the same. Regardless, the level of labour productivity is lower as we have seen. These results (the near-zero R2) do not mean that labour skills or human capital do not matter. It may be that the skill variable we have used is too crude or that the skills are not optimally allocated. Also, the variable ignores organisational and many other issues within the industries and companies.

Figure 5 Total-capital-stock-to-labour ratios and labour productivity in 2021



Note: Luxembourg excluded as an outlier. Labour productivity (value added per hour worked) and net capital stocks to hours worked in constant 2015 euros. Sources: Eurostat, own calculations.

Figure 6 ICT and IPP capital stock to labour ratios and labour productivity in 2021



Note: Luxembourg excluded as an outlier. Labour productivity (value added per hour worked) and net capital stocks to hours worked in constant 2015 euros. Sources: Eurostat, own calculations.

8 Summary and discussion

We have discussed the level and development of labour productivity, as well as its composition, in five service industries in European countries, with some comparisons made with the United States and Japan as data have allowed. Using the growth accounting framework, we also performed estimations for EU countries and Norway with labour productivity or its change as the dependent variable.

We find that labour productivity in European countries is positively associated with overall capital intensity in service industries. This result is valid also when we decompose capital intensity into four parts: ICT, R&D, computer software and database, and all other capital stock (i.e. construction capital, machinery and equipment, and transport equipment), per total hours worked, albeit there are some exceptions at the industry level and on whether year dummies are used or not. At the industry level, the results are the most robust for ICT and all other capital stock. Furthermore, labour quality, as measured with education levels, is (mostly) positively associated with the level of labour productivity when capital intensity is controlled for.

Meanwhile, the change in overall capital intensity, or capital deepening, is positively associated with labour productivity growth. When we disaggregate the overall capital stock into four parts, this association is most visible in other capital intensity, but to some extent also in ICT and IPP capital intensities, depending on the industry and the use of year dummies. Meanwhile, the lagged level of productivity is negatively associated with its growth rate indicating β convergence when changes in capital intensity have been controlled for.

A division into two periods 1995–2008 and 2009–2023 reveals limited differences. In terms of productivity levels, the coefficient of R&D capital intensity as an independent variable is positive and statistically significant in the first period but becomes negative and statistically significant in the latter period.

In terms of productivity changes, the coefficient of total capital intensity is clearly lower in the second period. The change in ICT capital intensity is statistically insignificant in the first period but becomes positive and statistically significant in the second. Meanwhile the R&D capital intensity makes an opposite turn. The coefficient of lagged productivity is always negative and statistically significant, but its value is much larger in the second period.

We find that, compared to a peer group of European countries—and relative to the level of labour productivity—the total capital intensity, as well as the combined ICT-IPP capital intensity, is relatively low in Finland. This raises the question whether more capital deepening, if optimally targeted, would not help contribute to higher labour productivity and industry growth. Excessive capital investment will, however, lead to a decline in the marginal productivity of capital and dampen total factor productivity. Furthermore, the level of human capital needs to be high enough. Here Finland has been falling behind other OECD countries in relative terms.

The OECD report by Sorbe et al. (2019) lists measures to boost the diffusion and efficient use of digital technologies. These include a regulatory framework that supports ICT investment, pro-competition reforms in telecommunication sectors to enable broader and cheaper access to high-speed internet, improving the quality of labour through training, reducing administrative burden etc. to enable the efficient reallocation of labour and capital across firms and industries, reducing financial constraints for young innovative firms, and enhancing intra and cross-border competition in digital markets and trade. The OECD Services Trade Restrictiveness Indices (STRI) suggest that many Finnish service industries have relatively high trade barriers.

Overall, investment in general, and probably digitalisation, ICT, and intangible investment in particular, are important in supporting productivity development in services. However, they need to be accompanied by a regulatory framework that supports competition and innovativeness, and an efficient reallocation and movement of labour and capital across firms, as well as a skilled labour force that can use, benefit from, and develop the capital stock to produce higher value products.

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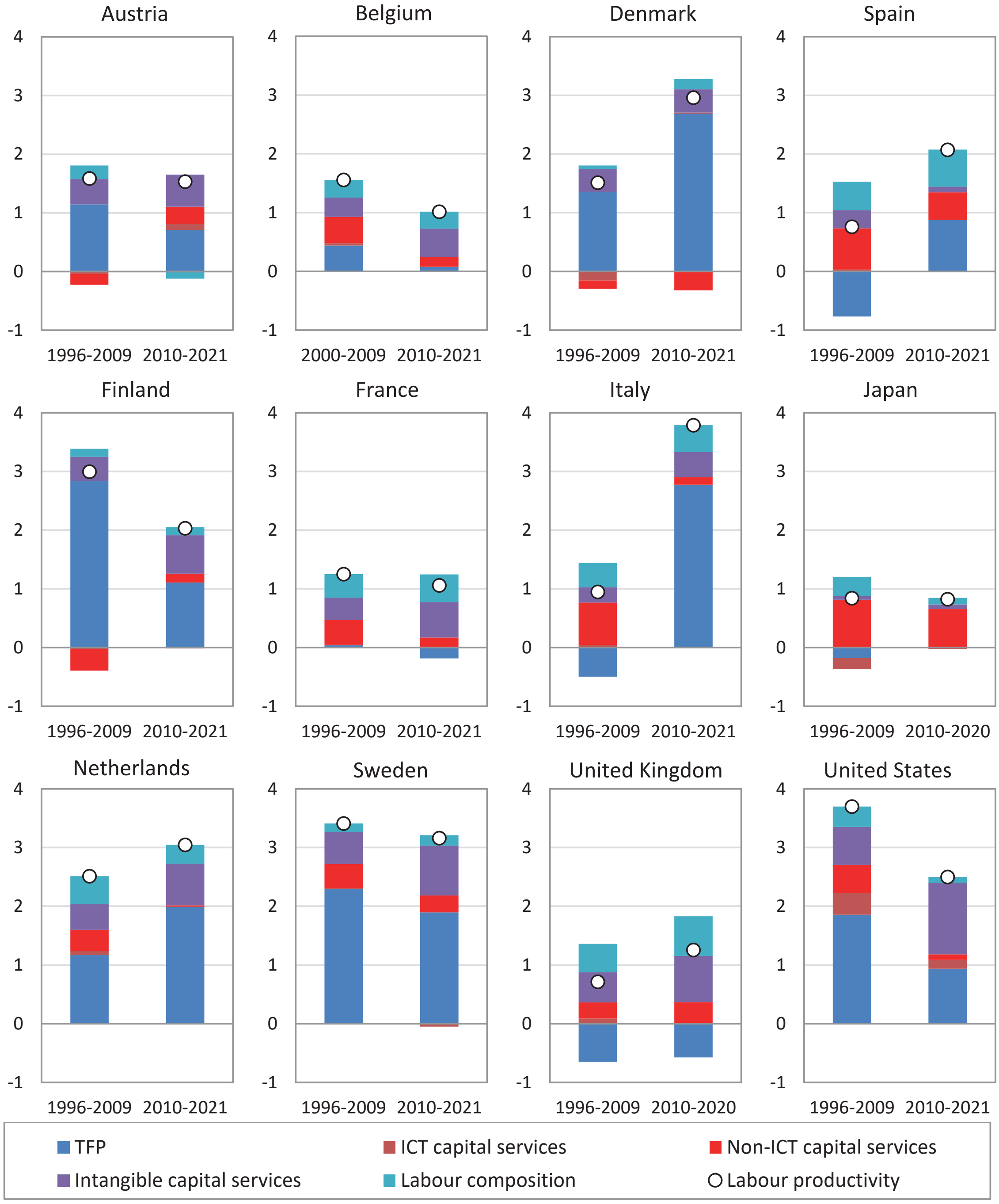
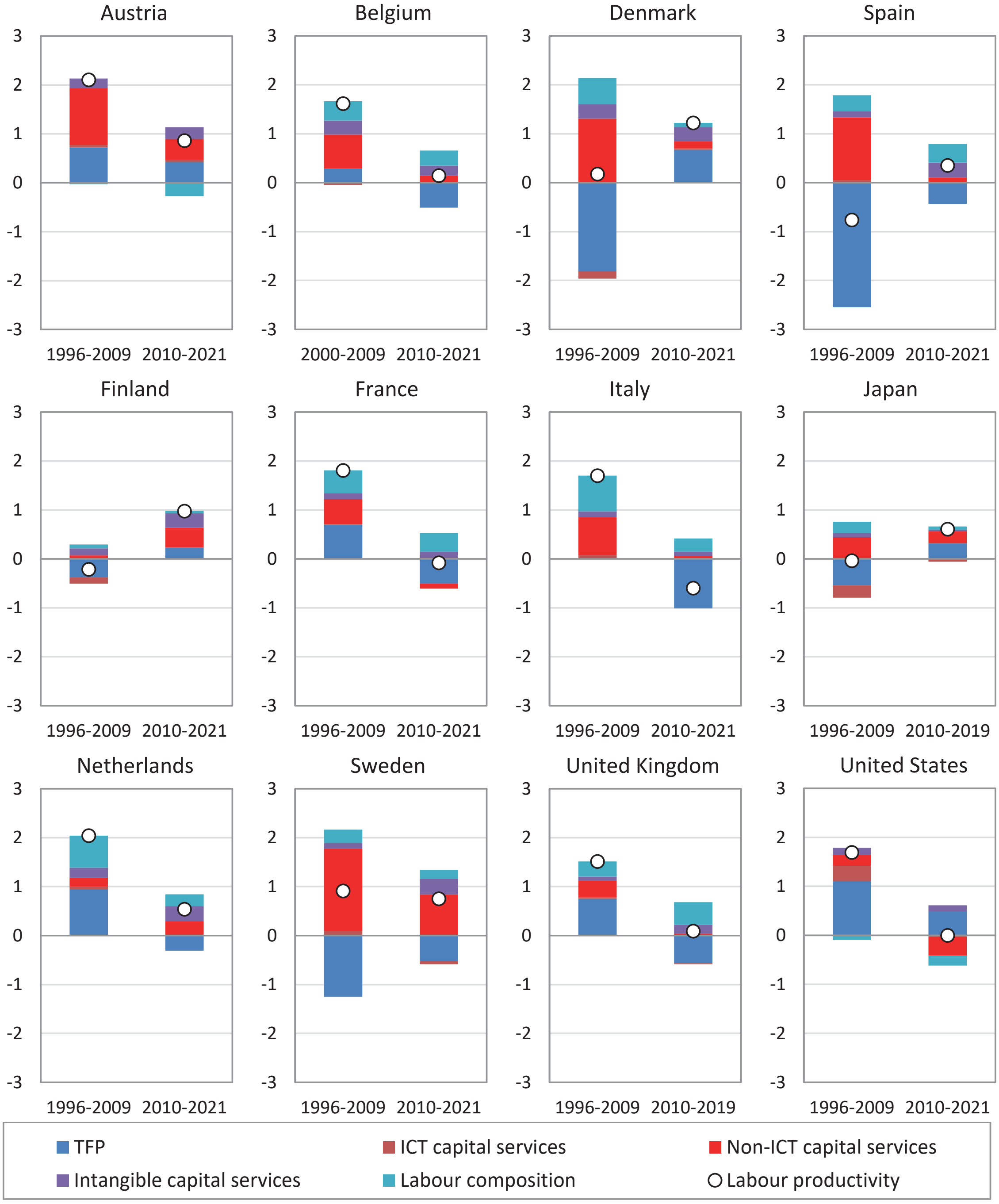
Appendix A1 Composition of labour productivity changes

Figure A1.1 Composition of labour productivity changes in trade (G), percentage points



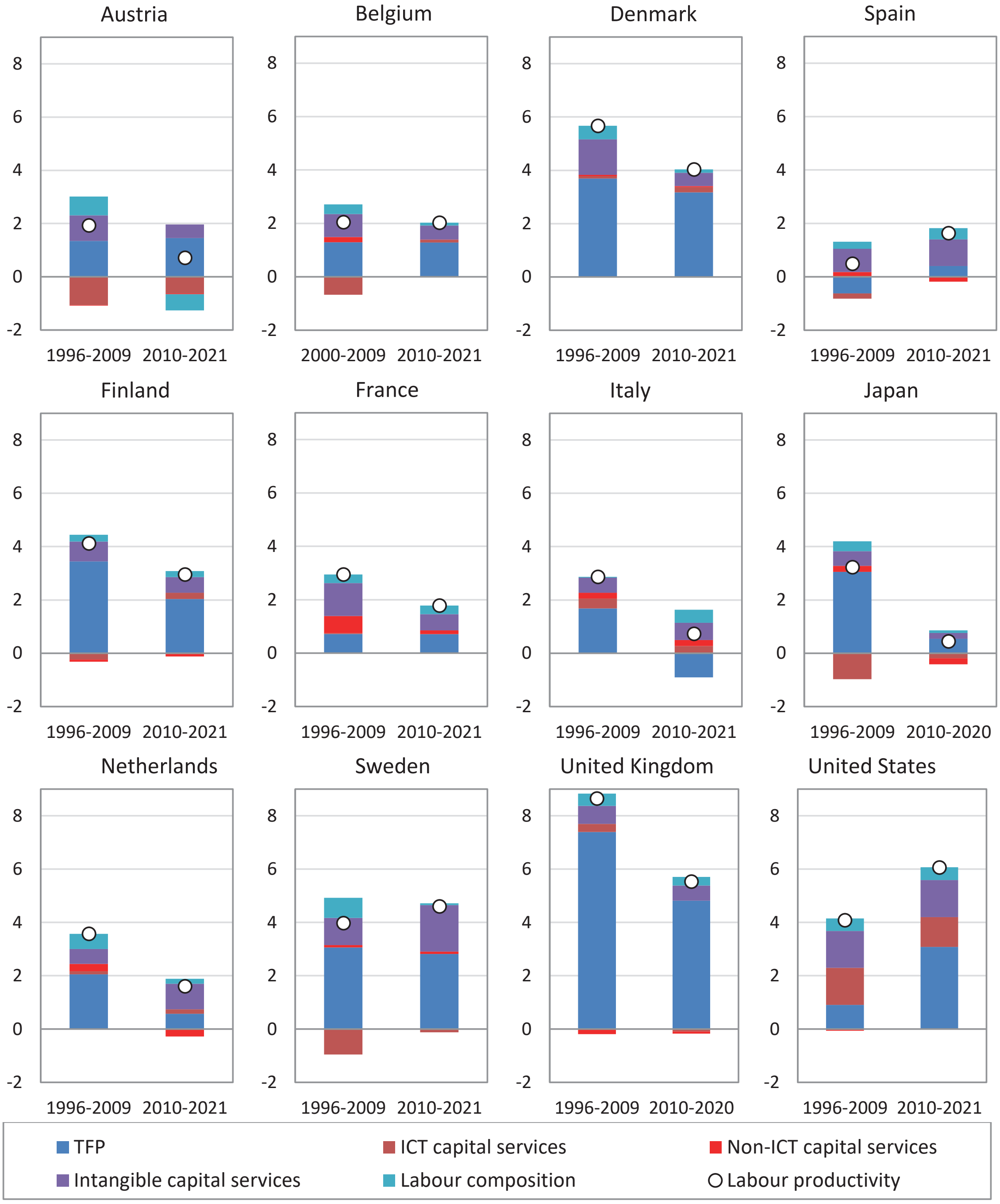
Note: Averages of annual percentage-point contributions. Vertical axes are the same for all countries to help comparisons. The second period is not always the same because of 1) lack of data or 2) abnormal developments during the pandemic. Source: Euklems & INTANProd database, release 2025.

Figure A1.2 Composition of labour productivity changes in transportation and storage (H) , percentage points



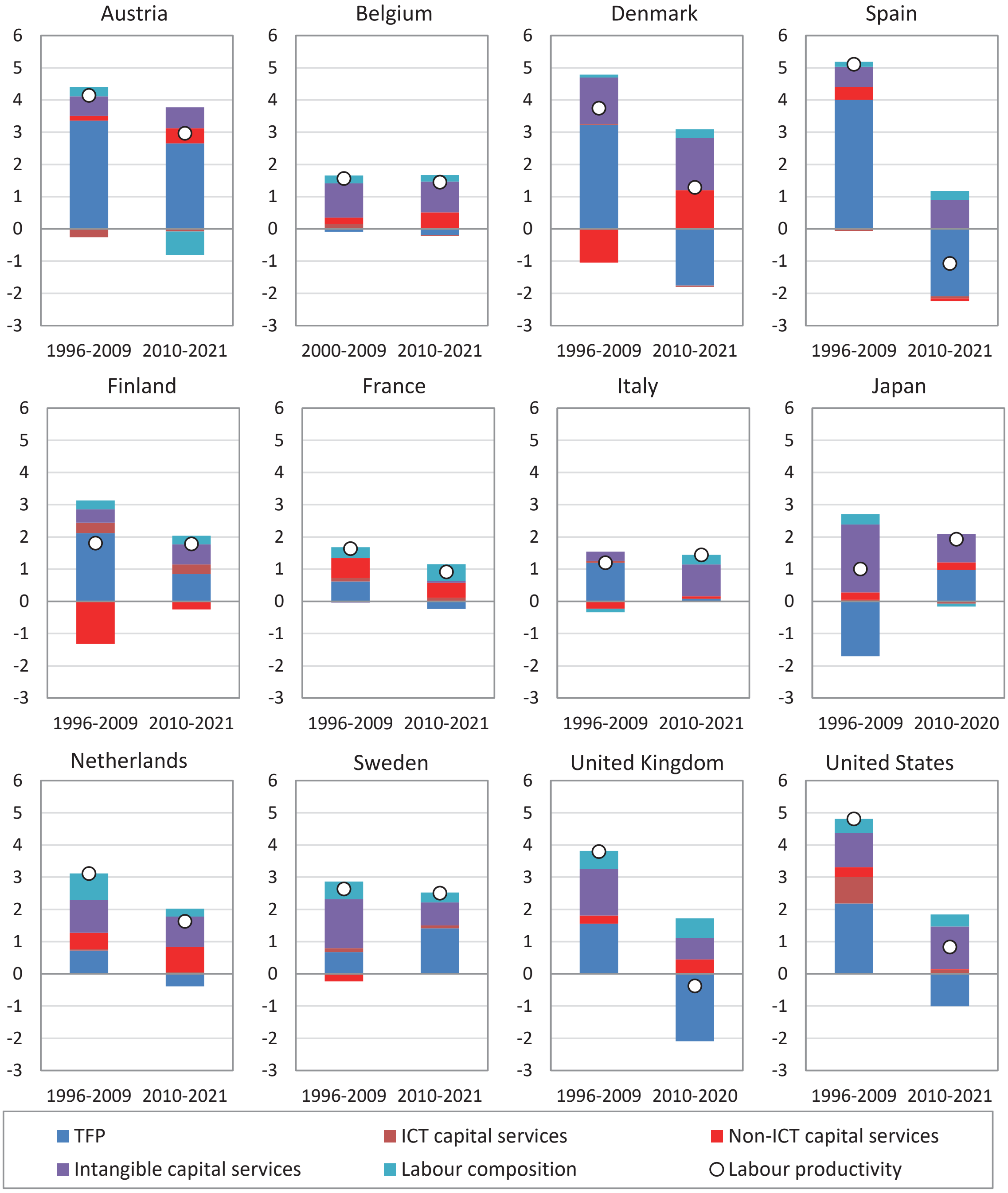
Note: Averages of annual percentage-point contributions. Vertical axes are the same for all countries to help comparisons. The second period is not always the same because of 1) lack of data or 2) abnormal developments during the pandemic.
Source: Euklems & INTANProd database, release 2025.

Figure A1.3 Composition of labour productivity changes in information and communication (J), percentage points



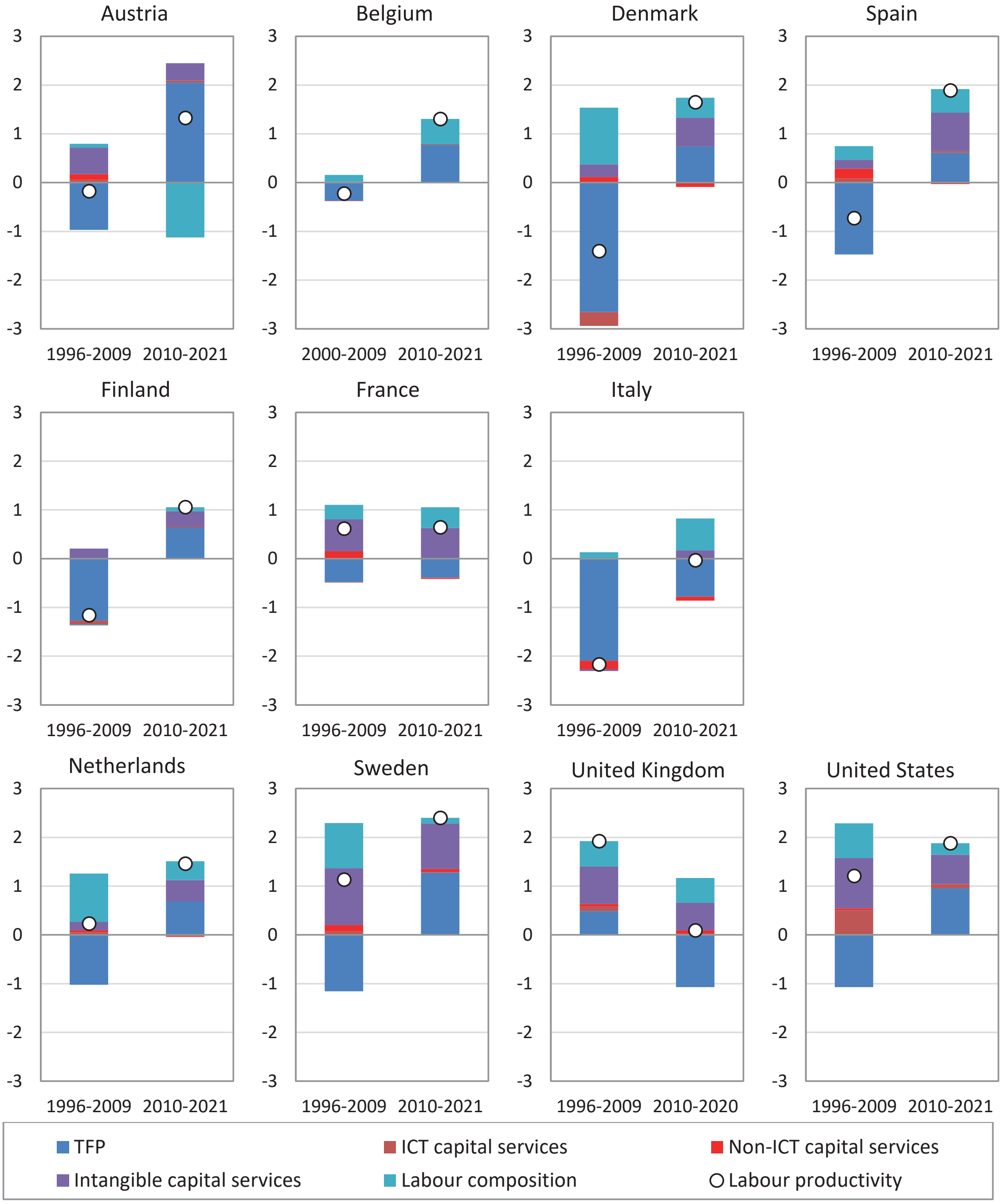
Note: Averages of annual percentage-point contributions. Vertical axes are the same for all countries to help comparisons. The second period is not always the same because of 1) lack of data or 2) abnormal developments during the pandemic.
Source: Euklems & INTANProd database, release 2025.

Figure A1.4 Composition of labour productivity changes in financial and insurance activities (K), percentage points



Note: Averages of annual percentage-point contributions. Vertical axes are the same for all countries to help comparisons. The second period is not always the same because of 1) lack of data or 2) abnormal developments during the pandemic.
Source: Euklems & INTANProd database, release 2025.

Figure A1.5 Composition of labour productivity changes in professional, scientific and technical activities (M), percentage points



Note: Averages of annual percentage-point contributions. Vertical axes are the same for all countries to help comparisons. The second period is not always the same because of 1) lack of data or 2) abnormal developments during the pandemic. No data for Japan. Source: Euklems & INTANProd database, release 2025.

Appendix A2 Trade restrictiveness in service sectors

The OECD have calculated Services Trade Restrictiveness Indices (STRI) to assess regulatory barriers in 22 service industries across 50 countries. We will use these data in our econometric analysis below. Overall, the OECD data show that barriers to services trade have become higher over time.

Appendix A2 shows data for OECD STRI in 2014 and 2022 in selected aggregated service industries and 25 countries. The data are also available at a more disaggregated industry level which is used in our estimations.

In the retail and wholesale trade, we find that the STRI index is relatively elevated for Finland which means that regulatory barriers to trade are quite high. In fact, out of the 25 countries shown in the graphs (Appendix A2), the STRI index was higher in only Greece in 2022. These barriers have typically risen in the OECD countries after 2014, as has also happened in Finland. The biggest move toward higher barriers has occurred in Hungary and Poland. Barriers have declined in Portugal. The average STRI index across the countries in 2022 was 0.176 and the Finnish score was 0.241.

In transportation and storage, the trade restrictiveness index for Finland is again relatively elevated and it has moved upwards since 2014. The average STRI index across the countries in 2022 was 0.239 and the Finnish score was 0.286. The STRI index value was higher than in Finland in just Switzerland, Norway, and the US. Consequently, all other EU countries had lower barriers than Finland. The STRI score for this industry is calculated as the average of the index values for its subsectors: rail freight transport (H4912), road freight transport (H4941), maritime transport (H5012), air transport (H51), logistics storage and warehouse (H52), and courier services (H53).

In information and communication services, Finland scores 0.228 in 2022, while the average is 0.196. Again, both the Finnish score and the average have increased between 2014 and 2022. There are some countries where barriers have declined, notably Estonia. Considerable increases have occurred in Poland, Slovenia, and Norway. The STRI score for this industry is calculated as the average of the STRI index values for its subsectors: broadcasting (J591 and J601), telecom services (J61), and computer services (J62 and J63).

The average STRI index value in financial and insurance activities in 2022 was 0.179 and in Finland 0.244, i.e. much higher. It was higher than this is only Greece and Norway. The STRI score for this industry is calculated as the average of the STRI index values for its subsectors: commercial banking (K64) and insurance (K65).

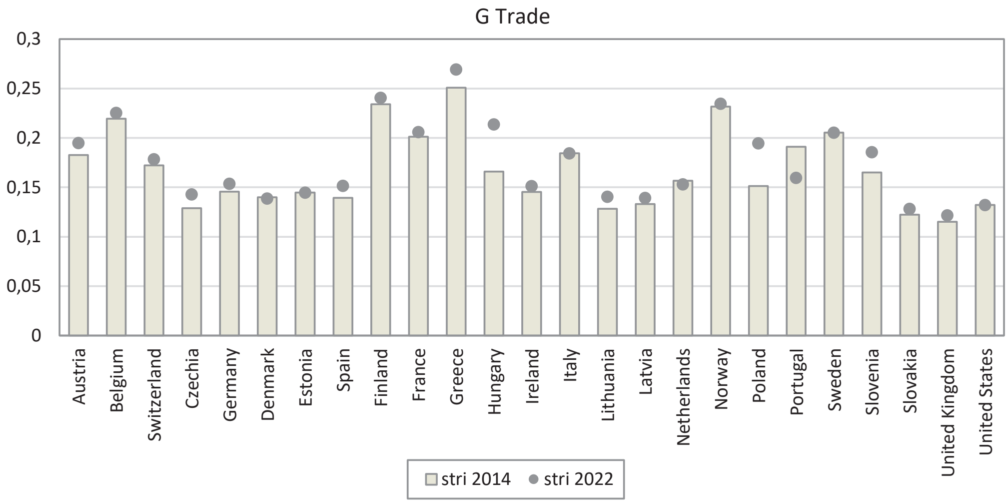
The average STRI index value in professional, scientific and technical activities was 0.251 in 2022, while it was 0.179 in Finland. This is thus the only industry at this level of aggregation where the index value is below average in Finland. The STRI score for this industry is calculated as the average of the STRI index values for its subsectors: legal (M691), accounting (M692), architecture (M7111), and engineering services (M7112).

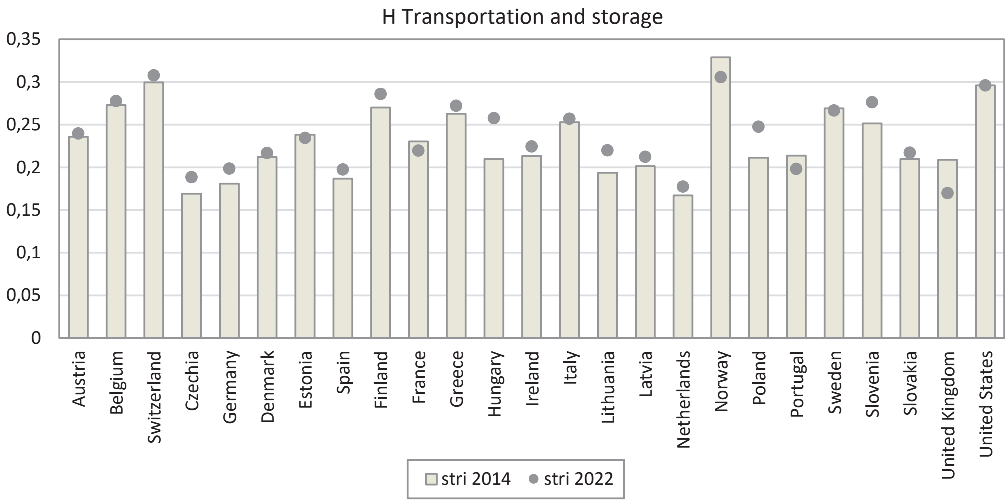
We thus see that typically trade barriers in services are relatively more elevated in Finland than in other European OECD countries and the US. This is potentially a factor that contributes to less competition, and thus probably to higher prices and lower productivity.

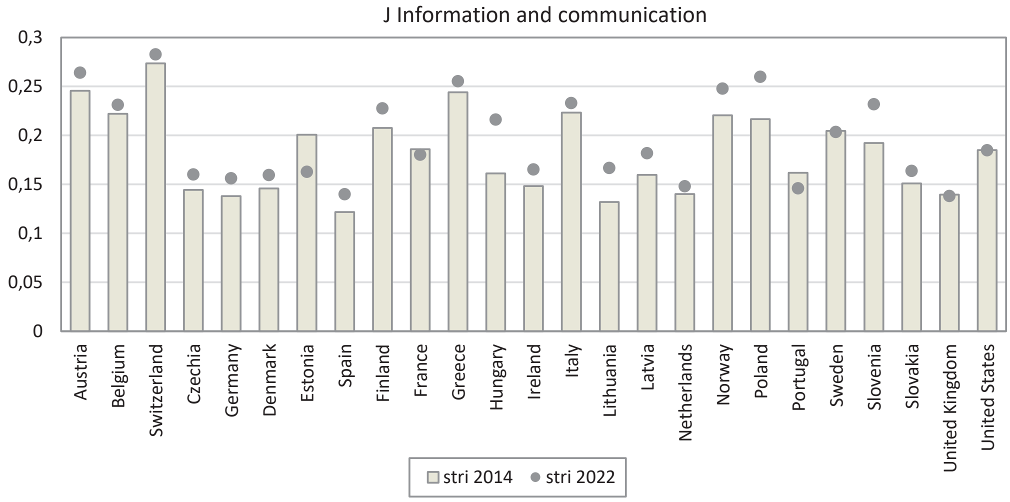
The OECD data shown in Appendix A3 reveals where the differences between Finland and the other countries come from. Here the other countries have been combined into larger groups, namely “Western Europe” and “Southern and Eastern Europe”. The US is shown separately. We can see that there is typically not much difference between the two European aggregates.

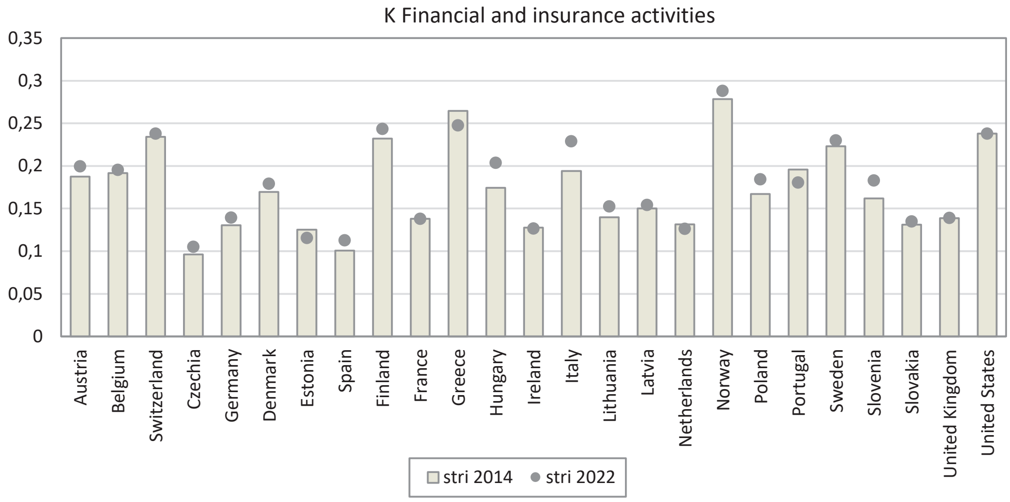
According to the data, most – and in many cases well over 100 per cent – of the higher barriers to trade of Finland relative to our group of Western Europe (average of Austria, Belgium, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, and Britain) are due to restrictions on foreign entry. Typically, restrictions on foreign entry decrease the presence of foreign companies in the domestic market and decrease competition leading to higher prices, lower innovativeness, a lower level of productivity and slower productivity growth.

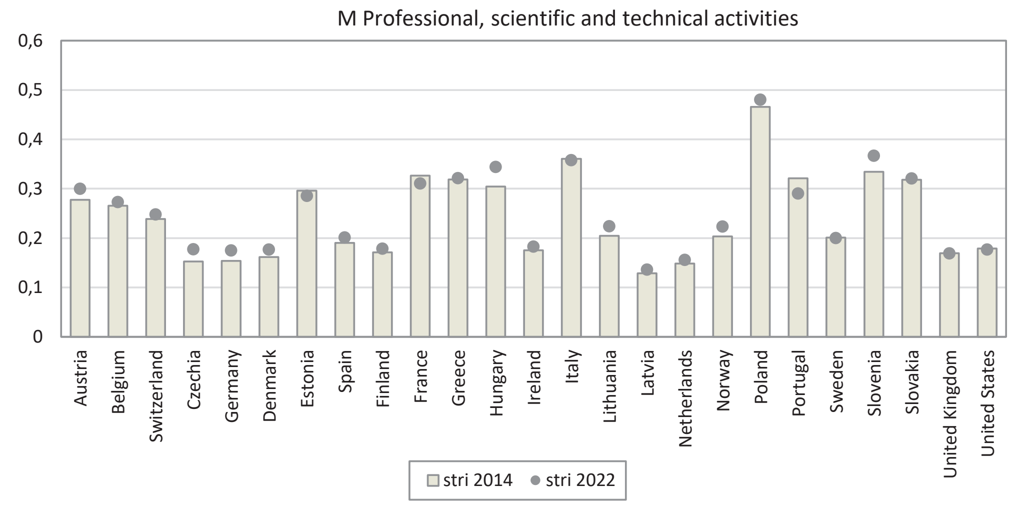
Figure A2.1 OECD Services Trade Restrictiveness Index (STRI) in 2014 and 2022 in selected industries











Source: OECD STRI.

Appendix A3 OECD Services Trade Restrictiveness Index (STRI) in 2022 in Finland and country groups at disaggregated industry and index levels

Table A3.1 Wholesale and retail trade (G46 and G47)

	Indicator STRI	Restrictions on foreign entry	Restrictions to movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
Finland	0.241	0.114	0.032	0.026	0.043	0.026
Europe west*	0.179	0.073	0.034	0.016	0.037	0.020
Europe south and east**	0.171	0.075	0.028	0.019	0.035	0.015
Europe***	0.184	0.078	0.031	0.019	0.036	0.020
USA	0.132	0.050	0.024	0.030	0.019	0.008

Note: Indicator STRI is the sum of the five subtopics. The regional data are calculated as the arithmetic averages over the countries listed below. Source: OECD STRI. * = Austria, Belgium, Britain, Denmark, France, Germany, Ireland, Luxembourg, the Netherlands, Norway, Sweden, and Switzerland. ** = Czechia, Estonia, Greece, Hungary, Italy, Latvia, Lithuania, Poland, Portugal, Slovak Republic, Slovenia, and Spain. *** = All Europe including Iceland and Turkey.

Table A3.2 Information and communication (J)

	Indicator STRI	Restrictions on foreign entry	Restrictions to movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
Television and broadcasting services J591 and J601						
Finland	0.263	0.169	0.015	0.015	0.025	0.039
Europe west*	0.229	0.129	0.017	0.017	0.022	0.045
Europe south and east**	0.228	0.140	0.013	0.019	0.023	0.033
Europe***	0.245	0.148	0.015	0.019	0.023	0.040
USA	0.265	0.169	0.012	0.025	0.000	0.059
Telecommunication services J61						
Finland	0.186	0.067	0.023	0.034	0.048	0.015
Europe west*	0.162	0.043	0.025	0.031	0.041	0.022
Europe south and east**	0.163	0.054	0.020	0.036	0.033	0.022
Europe***	0.172	0.054	0.023	0.033	0.040	0.021
USA	0.153	0.038	0.018	0.034	0.048	0.015
Computer services J62 and J63						
Finland	0.234	0.093	0.073	0.024	0.015	0.029
Europe west*	0.197	0.046	0.080	0.023	0.015	0.033
Europe south and east**	0.188	0.055	0.062	0.028	0.016	0.027
Europe***	0.204	0.058	0.073	0.026	0.016	0.030
USA	0.137	0.015	0.058	0.048	0.000	0.015

See note in Table A3.1.

Table A3.3 Transportation and storage (H)

	Indicator STRI	Restrictions on foreign entry	Restrictions to movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
Rail freight transport H4912						
Finland	0.266	0.134	0.041	0.012	0.069	0.010
Europe west*	0.194	0.067	0.041	0.012	0.060	0.014
Europe south and east**	0.198	0.078	0.034	0.014	0.062	0.010
Europe***	0.200	0.076	0.038	0.013	0.062	0.012
USA	0.143	0.034	0.034	0.025	0.042	0.010
Road freight transport H4941						
Finland	0.259	0.096	0.040	0.020	0.057	0.046
Europe west*	0.220	0.051	0.042	0.020	0.045	0.061
Europe south and east**	0.199	0.051	0.036	0.023	0.040	0.048
Europe***	0.218	0.057	0.040	0.022	0.045	0.054
USA	0.209	0.014	0.026	0.050	0.057	0.061
Maritime transport H5012						
Finland	0.274	0.138	0.078	0.028	0.023	0.007
Europe west*	0.216	0.085	0.071	0.029	0.023	0.008
Europe south and east**	0.249	0.112	0.065	0.036	0.026	0.010
Europe***	0.241	0.105	0.070	0.032	0.024	0.009
USA	0.356	0.199	0.078	0.038	0.023	0.018
Air transport H51						
Finland	0.439	0.282	0.021	0.014	0.111	0.009
Europe west*	0.396	0.237	0.023	0.014	0.110	0.011
Europe south and east**	0.404	0.244	0.019	0.018	0.115	0.008
Europe***	0.411	0.248	0.022	0.017	0.114	0.010
USA	0.521	0.357	0.017	0.038	0.090	0.019
Logistics storage and warehouse H52						
Finland	0.248	0.126	0.041	0.014	0.044	0.023
Europe west*	0.196	0.056	0.045	0.014	0.030	0.052
Europe south and east**	0.174	0.059	0.037	0.018	0.021	0.039
Europe***	0.199	0.064	0.042	0.016	0.029	0.048
USA	0.198	0.028	0.033	0.029	0.018	0.091
Postal and courier activities H53						
Finland	0.229	0.137	0.025	0.021	0.036	0.010
Europe west*	0.183	0.082	0.028	0.021	0.036	0.016
Europe south and east**	0.171	0.075	0.023	0.025	0.035	0.013
Europe***	0.194	0.090	0.026	0.024	0.039	0.016
USA	0.350	0.168	0.031	0.050	0.079	0.022

See note in Table A3.1.

Table A3.4 Financial and insurance activities (K)

	Indicator STRI	Restrictions on foreign entry	Restrictions to movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
Commercial banking K64						
Finland	0.237	0.166	0.031	0.010	0.019	0.011
Europe west*	0.195	0.096	0.034	0.010	0.039	0.016
Europe south and east**	0.173	0.097	0.028	0.011	0.026	0.010
Europe***	0.193	0.104	0.032	0.011	0.034	0.012
USA	0.201	0.151	0.025	0.019	0.000	0.005
Insurance K65						
Finland	0.250	0.210	0.022	0.009	0.000	0.010
Europe west*	0.165	0.113	0.018	0.007	0.012	0.014
Europe south and east**	0.161	0.120	0.016	0.008	0.008	0.009
Europe***	0.173	0.125	0.017	0.008	0.011	0.011
USA	0.276	0.210	0.013	0.014	0.033	0.005

See note in Table A3.1.

Table A3.5 Professional, scientific and technical activities (M)

	Indicator STRI	Restrictions on foreign entry	Restrictions to movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
Legal M691						
Finland	0.267	0.177	0.056	0.006	0.008	0.020
Europe west*	0.340	0.216	0.080	0.012	0.010	0.022
Europe south and east**	0.429	0.282	0.097	0.018	0.011	0.021
Europe***	0.365	0.234	0.086	0.015	0.010	0.021
USA	0.175	0.095	0.042	0.024	0.000	0.013
Accounting M692						
Finland	0.301	0.104	0.120	0.023	0.005	0.049
Europe west*	0.272	0.093	0.115	0.027	0.006	0.030
Europe south and east**	0.259	0.090	0.109	0.025	0.006	0.030
Europe***	0.267	0.093	0.113	0.026	0.006	0.030
USA	0.629	0.230	0.268	0.034	0.018	0.079
Architecture M7111						
Finland	0.163	0.046	0.037	0.025	0.010	0.045
Europe west*	0.178	0.031	0.055	0.024	0.011	0.058
Europe south and east**	0.218	0.033	0.087	0.029	0.012	0.056
Europe***	0.200	0.035	0.068	0.027	0.012	0.058
USA	0.176	0.037	0.044	0.050	0.000	0.045
Engineering M7112						
Finland	0.189	0.072	0.061	0.017	0.008	0.032
Europe west*	0.178	0.040	0.076	0.016	0.008	0.038
Europe south and east**	0.265	0.055	0.144	0.020	0.009	0.037
Europe***	0.224	0.052	0.106	0.018	0.009	0.038
USA	0.188	0.024	0.098	0.034	0.000	0.032

See note in Table A3.1.

Appendix A4 Estimation results for log-levels of labour productivity

Table A4.1 Level of labour productivity in trade (G) with fixed effects

	(1)[1]	(2)[1]	(3)[1]	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.100***		0.240***	0.523***		0.167**	0.539***	0.600***
	(3.591)		(3.413)	(18.624)		(1.971)	(6.874)	(7.690)
ICT cap. int.		0.259***			0.307***			
		(11.233)			(14.841)			
R&D cap. int.		0.0322*			0.0769***			
		(1.691)			(4.197)			
SW & DB cap. int.		-0.0198			0.0156			
		(-1.255)			(1.045)			
Other cap. int.		0.112*			0.127*			
		(1.667)			(1.877)			
Labour quality						0.351***	0.453***	0.374***
						(7.489)	(5.677)	(4.959)
STRI			2.393***				2.815***	
			(4.635)				(4.021)	
STRI Competition								-0.357
								(-0.213)
STRI Foreign entry								2.395*
								(1.893)
STRI People								2.868***
								(2.776)
STRI Regulatory								12.79***
								(5.808)
STRI Other								-5.671*
								(-1.755)
Constant	2.962***	5.424***	3.654***	4.964***	6.629***	2.573***	3.304***	3.885***
	(23.788)	(20.278)	(12.968)	(45.664)	(43.033)	(6.188)	(6.414)	(7.413)
Observations	700	370	187	700	370	325	140	140
Adjusted R^2	0.622	0.738	0.744	0.315	0.714	0.213	0.565	0.652

Note: [1] Specifications (1)–(3) with year dummies. Luxembourg excluded as an outlier. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A4.2 Level of labour productivity in transportation and storage (H) with fixed effects

	(1)[1]	(2)[1]	(3)[1]	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.322***		0.757***	0.465***		0.458***	0.158	0.187
	(12.062)		(6.488)	(22.036)		(7.311)	(1.179)	(1.311)
ICT cap. int.		0.0761***			0.0958***			
		(5.402)			(7.705)			
R&D cap. int.		0.0123*			0.0125*			
		(1.736)			(1.752)			
SW & DB cap. int.		-0.0593***			-0.0478***			
		(-3.743)			(-3.331)			
Other cap. int.		0.501***			0.504***			
		(13.489)			(14.132)			
Labour quality						-0.0615	-0.0315	-0.0879
						(-1.547)	(-0.408)	(-0.995)
STRI			2.688***				2.482**	
			(2.914)				(2.113)	
STRI Competition								-6.288
								(-0.754)
STRI Foreign entry								2.729
								(1.109)
STRI People								1.735
								(1.164)
STRI Regulatory								10.38**
								(2.190)
STRI Other								2.525
								(0.316)
Constant	3.851***	4.663***	4.459***	4.348***	4.992***	4.484***	3.279***	3.784***
	(49.155)	(28.195)	(12.777)	(86.663)	(50.878)	(22.390)	(6.598)	(5.345)
Observations	700	391	187	700	391	325	140	140
Adjusted R^2	0.486	0.619	0.249	0.397	0.600	0.078	-0.118	-0.100

Note: [1] Specifications (1)–(3) with year dummies. Luxembourg excluded as an outlier. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table A4.3 Level of labour productivity in information and communication (J) with fixed effects

	(1)[1]	(2)[1]	(3)[1]	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.240^{***}		0.425^{***}	0.417^{***}		0.370^{***}	0.395^{***}	0.436^{***}
	(11.460)		(11.598)	(12.366)		(9.332)	(8.161)	(9.079)
ICT cap. int.		0.0212^{*}			0.0821^{***}			
		(1.670)			(5.500)			
R&D cap. int.		0.0137			0.0677^{***}			
		(1.164)			(4.836)			
SW & DB cap. int.		0.103^{***}			0.230^{***}			
		(7.749)			(17.190)			
Other cap. int.		0.271^{***}			0.202^{***}			
		(7.689)			(4.977)			
Labour quality						0.474^{***}	0.543^{***}	0.534^{***}
						(7.777)	(3.848)	(3.860)
STRI			1.054				1.480^{*}	
			(1.635)				(1.728)	
STRI Competition								-5.766^{*}
								(-1.942)
STRI Foreign entry								5.588^{***}
								(3.547)
STRI People								0.281
								(0.247)
STRI Regulatory								-1.458
								(-0.475)
STRI Other								5.224
								(0.757)
Constant	3.787^{***}	4.893^{***}	4.698^{***}	4.714^{***}	6.321^{***}	2.739^{***}	2.331^{***}	2.421^{***}
	(54.600)	(28.710)	(35.412)	(53.824)	(39.392)	(10.330)	(3.845)	(4.064)
Observations	728	431	195	728	431	338	147	147
Adjusted R^2	0.704	0.792	0.567	0.148	0.665	0.255	0.286	0.349

Note: [1] Specifications (1)–(3) with year dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis.

Table A4.4 Level of labour productivity in financial and insurance activities (K) with fixed effects

	(1)[1]	(2)[1]	(3)[1]	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.085^{**}		0.422^{***}	0.397^{***}		0.176^{***}	0.442^{***}	0.495^{***}
	(2.275)		(5.592)	(9.194)		(2.721)	(4.810)	(5.015)
ICT cap. int.		0.0862^{***}			0.203^{***}			
		(4.359)			(10.079)			
R&D cap. int.		0.0101			0.0446^{***}			
		(0.745)			(2.782)			
SW & DB cap. int.		-0.0414			0.129^{***}			
		(-1.626)			(5.065)			
Other cap. int.		0.235^{***}			0.238^{***}			
		(5.295)			(4.515)			
Labour quality						0.201^{***}	0.236	0.168
						(2.976)	(1.635)	(1.156)
STRI			2.000^{*}				1.430	
			(1.791)				(1.217)	
STRI Competition								6.479
								(1.533)
STRI Foreign entry								1.058
								(0.631)
STRI People								-2.780
								(-1.197)
STRI Regulatory								17.38^{***}
								(2.746)
STRI Other								-9.949
								(-0.548)
Constant	3.928^{***}	4.910^{***}	4.998^{***}	5.163^{***}	7.118^{***}	3.726^{***}	4.198^{***}	4.544^{***}
	(31.240)	(17.930)	(17.090)	(40.130)	(32.428)	(9.413)	(5.835)	(6.110)
Observations	728	388	195	728	388	338	147	147
Adjusted R^2	0.438	0.625	0.251	0.073	0.447	0.004	0.119	0.170

Note: [1] Specifications (1)–(3) with year dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis.

Table A4.5 Level of labour productivity in professional, scientific and technical activities (M) with fixed effects

	(1)[1]	(2)[1]	(3)[1]	(4)	(5)	(6)	(7)	(8)
Total cap. int.	0.389***		0.124**	0.383***		0.263***	0.161***	0.161***
	(14.795)		(2.423)	(15.393)		(7.949)	(2.798)	(2.782)
ICT cap. int.		0.172***			0.0952***			
		(11.051)			(6.049)			
R&D cap. int.		0.0395***			0.0552***			
		(2.805)			(3.532)			
SW & DB cap. int.		0.00533			-0.0219			
		(0.264)			(-1.138)			
Other cap. int.		0.235***			0.248***			
		(5.097)			(4.749)			
Labour quality						0.355***	0.853***	0.879***
						(4.009)	(3.948)	(3.894)
STRI			0.337				1.359	
			(0.427)				(1.336)	
STRI Competition								14.31
								(0.248)
STRI Foreign entry								-1.927
								(-0.757)
STRI People								1.121
								(0.895)
STRI Regulatory								4.116
								(1.602)
STRI Other								1.171
								(0.145)
Constant	4.851***	6.135***	3.725***	4.787***	5.281***	2.783***	0.0160	0.0485
	(44.614)	(30.270)	(14.004)	(51.901)	(27.910)	(6.832)	(0.016)	(0.043)
Observations	727	430	195	727	430	338	147	147
Adjusted R^2	0.269	0.424	0.462	0.224	0.252	0.158	0.073	0.066

Note: [1] Specifications (1)–(3) with year dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis.

Appendix A5 Estimation results for log-changes of labour productivity

Table A5.1 Change in labour productivity in trade (G)

	(1)[1]	(2)[1]	(3)[1]	(4)[1]	(5)	(6)	(7)	(8)
Change in total cap. int.	0.347***	0.310***			0.325***	0.261***		
	(6.228)	(5.662)			(6.353)	(4.963)		
Change in ICT cap. int.			0.0569**	0.0531**			0.0798***	0.0596**
			(2.475)	(2.349)			(3.441)	(2.527)
Change in R&D cap. int.			0.0061	-0.0033			0.0109	0.0015
			(0.321)	(-0.179)			(0.541)	(0.074)
Change in SW & DB cap. int.			0.0049	0.0033			0.0125	0.0059
			(0.440)	(0.301)			(1.067)	(0.505)
Change in other cap. int.			0.390***	0.381***			0.366***	0.354***
			(4.628)	(4.600)			(4.590)	(4.512)
Lagged productivity		-0.081***		-0.054***		-0.042***		-0.038***
		(-5.788)		(-3.535)		(-4.481)		(-3.428)
Constant	0.0120	0.219***	0.0101	0.152***	0.0186***	0.143***	0.0150***	0.132***
	(0.943)	(5.787)	(0.670)	(3.553)	(7.375)	(5.129)	(4.730)	(3.854)
Observations	674	674	356	356	674	674	356	356
Adjusted R^2	0.135	0.178	0.268	0.294	0.021	0.049	0.092	0.120

Note: [1] Specifications (1)–(4) with year dummies. Luxembourg excluded as an outlier. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis. Fixed effects.

Table A5.2 Change in labour productivity in transportation and storage (H)

	(1)[1]	(2)[1]	(3)[1]	(4)[1]	(5)	(6)	(7)	(8)
Change in total cap. int.	0.185***	0.150**			-0.0906	-0.151**		
	(2.613)	(2.230)			(-1.345)	(-2.357)		
Change in ICT cap. int.			0.0389	0.0465*			0.0484	0.0415
			(1.458)	(1.778)			(1.604)	(1.439)
Change in R&D cap. int.			0.0211*	0.0148			0.0223	0.0125
			(1.740)	(1.237)			(1.587)	(0.924)
Change in SW & DB cap. int.			-0.0241	-0.0321*			-0.0393*	-0.0543**
			(-1.254)	(-1.699)			(-1.776)	(-2.552)
Change in other cap. int.			0.520***	0.464***			0.272***	0.191***
			(7.675)	(6.843)			(3.786)	(2.729)
Lagged productivity		-0.192***		-0.087***		-0.175***		-0.120***
		(-8.115)		(-3.918)		(-8.982)		(-5.945)
Constant	0.0237	0.596***	0.0180	0.288***	0.0153***	0.584***	0.0082**	0.415***
	(1.182)	(8.159)	(0.983)	(4.044)	(3.964)	(9.209)	(2.036)	(6.055)
Observations	674	674	376	376	674	674	376	376
Adjusted R^2	0.132	0.215	0.318	0.346	-0.037	0.076	0.016	0.102

Note: [1] Specifications (1)–(4) with year dummies. Luxembourg excluded as an outlier. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis. Fixed effects.

Table A5.3 Change in labour productivity in information and communication (J)

	(1)[1]	(2)[1]	(3)[1]	(4)[1]	(5)	(6)	(7)	(8)
Change in total cap. int.	0.413***	0.419***			0.416***	0.395***		
	(13.573)	(14.059)			(14.087)	(13.466)		
Change in ICT cap. int.			0.0580**	0.0562**			0.0641**	0.0345
			(2.041)	(2.087)			(2.370)	(1.261)
Change in R&D cap. int.			0.0102	0.0126			0.0089	0.0073
			(0.664)	(0.867)			(0.588)	(0.490)
Change in SW & DB cap. int.			0.0627***	0.0510***			0.0657***	0.0501**
			(3.106)	(2.654)			(3.324)	(2.543)
Change in other cap. int.			0.581***	0.571***			0.565***	0.579***
			(10.490)	(10.878)			(10.491)	(10.959)
Lagged productivity		-0.078***		-0.136***		-0.039***		-0.050***
		(-5.543)		(-6.529)		(-4.824)		(-4.272)
Constant	0.0323**	0.273***	-0.0145	0.427***	0.0281***	0.171***	0.0229***	0.210***
	(2.375)	(6.011)	(-0.896)	(6.158)	(12.130)	(5.756)	(6.979)	(4.783)
Observations	701	701	415	415	701	701	415	415
Adjusted R^2	0.217	0.252	0.394	0.456	0.197	0.222	0.371	0.397

Note: [1] Specifications (1)–(4) with year dummies. * p < 0.10, ** p < 0.05, *** p < 0.01. Standard errors in parenthesis. Fixed effects.

Table A5.4 Change in labour productivity in financial and insurance activities (K)

	(1)[1]	(2)[1]	(3)[1]	(4)[1]	(5)	(6)	(7)	(8)
Change in total cap. int.	0.598***	0.575***			0.561***	0.515***		
	(10.917)	(11.034)			(10.373)	(9.808)		
Change in ICT cap. int.			-0.0326	-0.0256			-0.0194	-0.0294
			(-1.203)	(-1.000)			(-0.736)	(-1.139)
Change in R&D cap. int.			-0.0120	0.00108			-0.0008	-0.0020
			(-0.649)	(0.062)			(-0.043)	(-0.112)
Change in SW & DB cap. int.			0.0374**	0.0244			0.0311*	0.0236
			(1.979)	(1.358)			(1.660)	(1.284)
Change in other cap. int.			0.680***	0.614***			0.547***	0.513***
			(8.516)	(8.050)			(7.100)	(6.786)
Lagged productivity		-0.151***		-0.144***		-0.097***		-0.064***
		(-8.483)		(-6.287)		(-7.180)		(-4.242)
Constant	-0.0002	0.554***	0.0020	0.539***	0.0152***	0.403***	0.0210***	0.287***
	(-0.008)	(8.183)	(0.086)	(6.112)	(4.656)	(7.449)	(5.042)	(4.567)
Observations	701	701	373	373	701	701	373	373
Adjusted R^2	0.146	0.231	0.168	0.256	0.103	0.166	0.102	0.143

Note: [1] Specifications (1)–(4) with year dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis. Fixed effects.

Table A5.5 Change in labour productivity in professional, scientific and technical activities (M)

	(1)[1]	(2)[1]	(3)[1]	(4)[1]	(5)	(6)	(7)	(8)
Change in total cap. int.	0.295***	0.287***			0.282***	0.272***		
	(9.285)	(9.600)			(8.849)	(8.902)		
Change in ICT cap. int.			0.0363*	0.0407**			0.0136	0.0154
			(1.752)	(2.123)			(0.676)	(0.811)
Change in R&D cap. int.			0.0478***	0.0569***			0.0434**	0.0487***
			(2.662)	(3.422)			(2.402)	(2.857)
Change in SW & DB cap. int.			0.0210	0.0225			0.0254	0.0248
			(0.885)	(1.027)			(1.065)	(1.102)
Change in other cap. int.			0.405***	0.397***			0.401***	0.398***
			(8.401)	(8.906)			(8.245)	(8.680)
Lagged productivity		-0.121***		-0.133***		-0.106***		-0.121***
		(-9.047)		(-7.954)		(-7.890)		(-7.088)
Constant	-0.0031	0.398***	-0.0373**	0.415***	0.0059**	0.363***	-0.0002	0.413***
	(-0.215)	(8.590)	(-2.088)	(7.010)	(2.349)	(8.009)	(-0.066)	(7.074)
Observations	700	700	413	413	700	700	413	413
Adjusted R^2	0.134	0.230	0.246	0.356	0.068	0.146	0.174	0.266

Note: [1] Specifications (1)–(4) with year dummies. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parenthesis. Fixed effects.

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