National Productivity Board

Discussion Paper

Human Capital and Labour Productivity

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Table of Contents

List of graphs

List of tables

Introduction

Human capital covers not only people who work or want to work but also the characteristics of these people which impact the productivity of their labour. Over the last 25 years, the profile of workers has considerably changed in terms of gender, education and age. These changes have influenced the evolution of the productivity across most of the EU Member States.

Taking into account these changes in the growth accounting decomposition framework allows to better estimate TFP as indicator of innovation. Moreover, as this labour composition effect differs across countries in terms of timing and magnitude, it also leads to review the comparative evolution of TFP across Member States.

Human capital, or part of it, can also improve TFP as some skills are predominant in the innovation process. Unfortunately, over the last decades, the fields of specialisation of new workers are not enough aligned with the need of innovation and of its diffusion as reflected by the weakening TFP contribution to labour productivity growth.

After a presentation of some stylised facts on labour market evolution since 2000, the paper refines the growth accounting decomposition in order to take into account the heterogeneity of labour. The methodological explanation of labour composition effect estimations is followed by the comparison of its evolution across ten Member States from the North and the South of the Union. The implied change of TFP evolution across these countries is also illustrated. The last section is devoted to the indirect role of human capital on labour productivity growth, through its impact on innovation and thus on TFP.

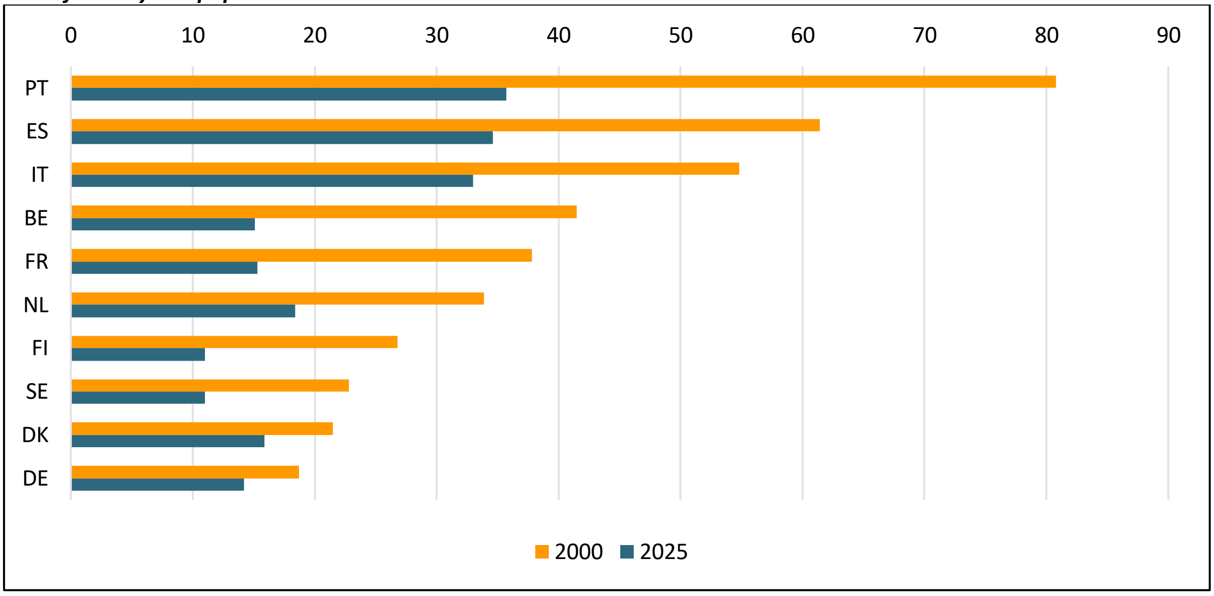
1. Composition of labour: some stylised facts

Over the last decades, the composition of the labour force has been significantly altered. To illustrate these changes, this section presents three stylised facts of the employment evolution over the period 2000-2025 for 10 Member States from the South and the North of the European Union.

1.1. More qualified people at work

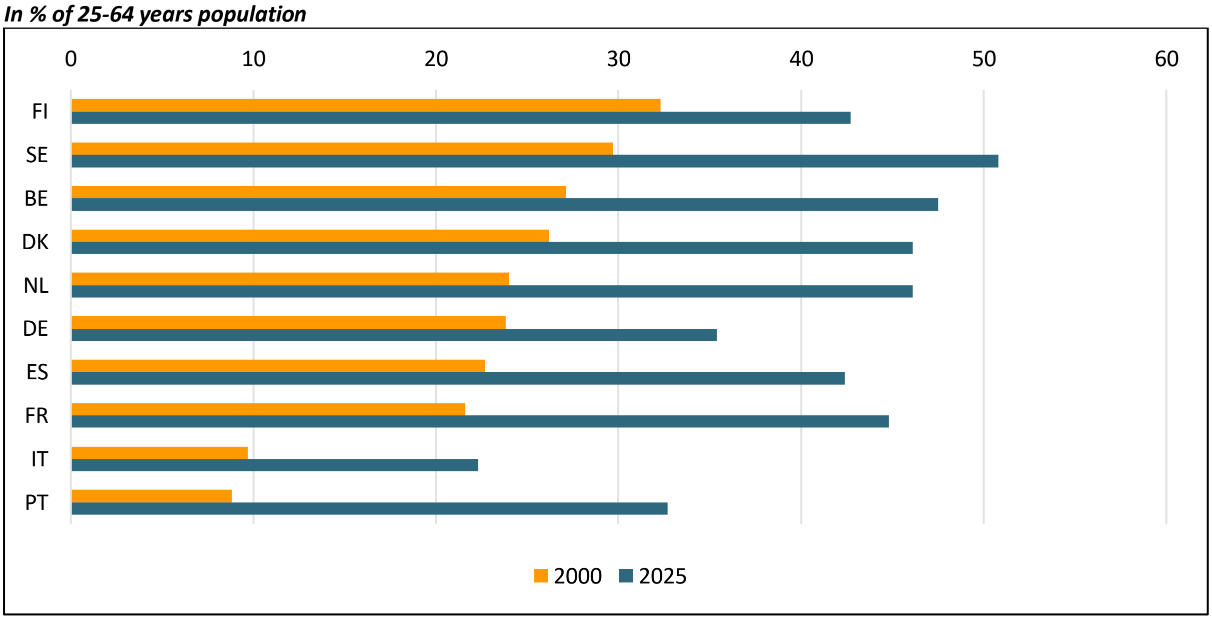
In a generation (25 years), the qualification profile of the working age population of many European countries has dramatically changed. As illustrated in the graphs, since 2000, the share of the population with at most a lower secondary educational attainment (ED 0-2) has fallen while the share of the population owner of a tertiary education diploma (ED 5-8) has increased. The decrease in the proportion of the lower qualified population has been impressive in Portugal and Spain but also in Belgium and France, where the share of people with low skills has fallen by more than half. At the same time, the share of people with a tertiary education level has increased to reach more than the half of the population in Sweden and more than 40% in Finland, Belgium, Denmark, the Netherlands, Spain and France.

Graph 1. Primary and lower secondary education
In % of 25-64 years population



Source: Eurostat, Population in private households by educational attainment level.

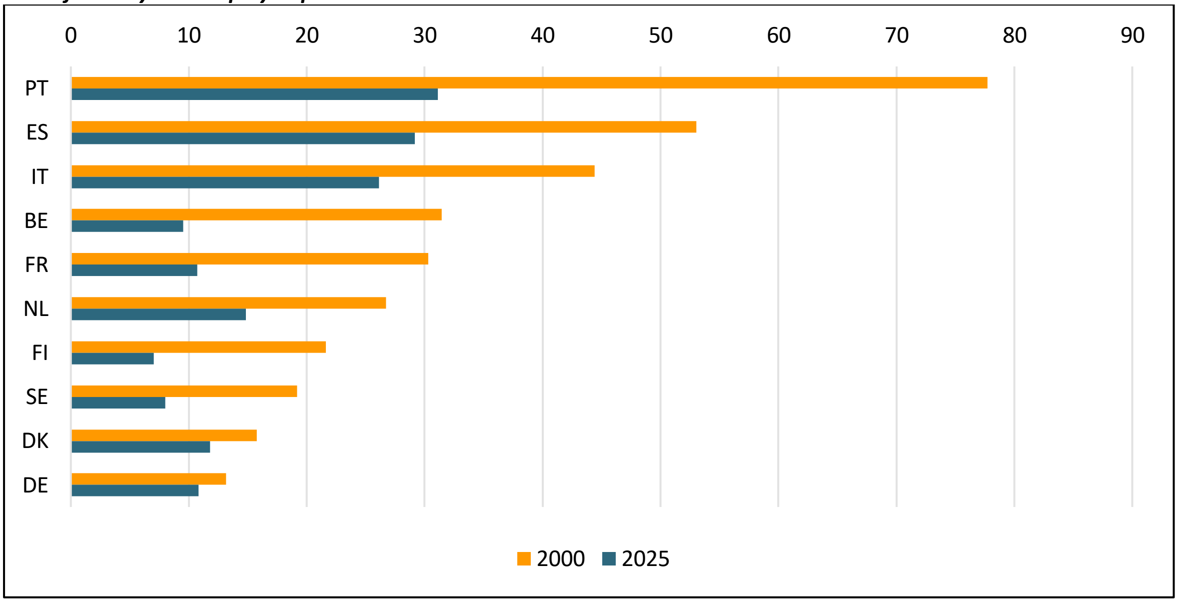
Graph 2. Tertiary education
In % of 25-64 years population



Source: Eurostat, Population in private households by educational attainment level.

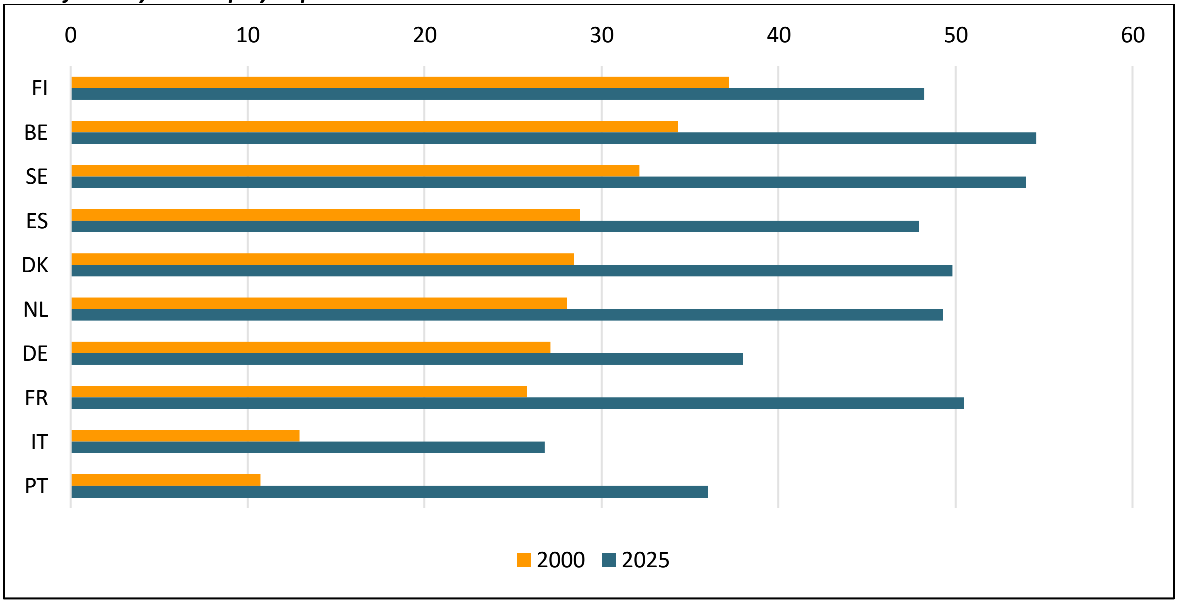
Alongside this change in the labour supply, since 2000, there has been also a shift in the employment structure towards greater qualification as illustrated in the following graphs. In 2025, Finland, Sweden and Belgium are the three countries in which less than 10% of the workers have lower educational attainment. At the same time, Belgium, Sweden and France have more than the half of their employment with a tertiary education diploma.

Graph 3. Primary and lower secondary education
In % of 25-64 years employed persons



Source: Eurostat, Labor Force Survey.

Graph 4. Tertiary education
In % of 25-64 years employed persons



Source: Eurostat, Labor Force Survey.

1.2. More women at work

The continued feminisation of the labour market is another key trend that can be observed over the past 25 years. As illustrated by the table and with the exception of Sweden which already exhibited the highest percentage in 2000, all countries have recorded an increase in the share of women in the total employed persons. In 2025, in Portugal and France, this share was close to half of the employment.

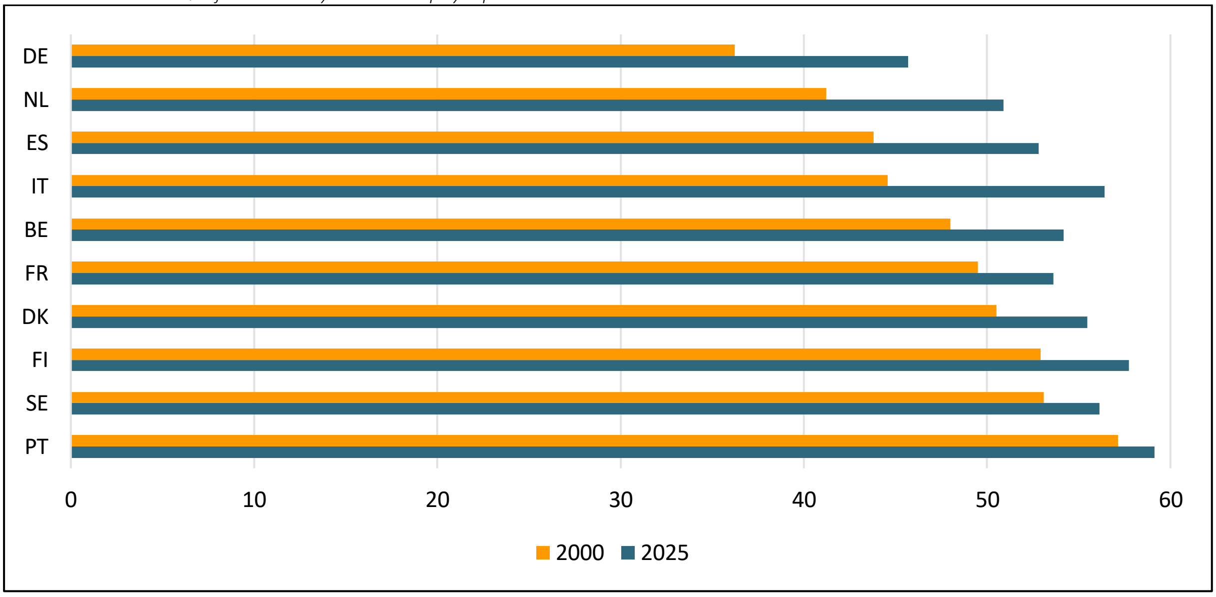
Table 1. Female employment
In % of 25-64 years employed persons

	2000	2025
Spain	36.1	46.7
Italy	36.5	43.0
Netherlands	41.9	47.4
Belgium	42.2	47.7
Germany	43.5	47.3
France	45.0	49.3
Portugal	45.6	49.8
Denmark	46.3	47.5
Finland	47.4	48.6
Sweden	48.1	47.9

Source: Eurostat, Labor Force Survey.

Women have not only increased their share in employed persons, but they have also increased their relative presence among the high skilled workers. In 2025, in all countries except Germany, women accounted for more than half of high skilled workers as illustrated in the following graph.

Graph 5. Women share in high skilled employment
In % of 25-64 tertiary educated employed persons

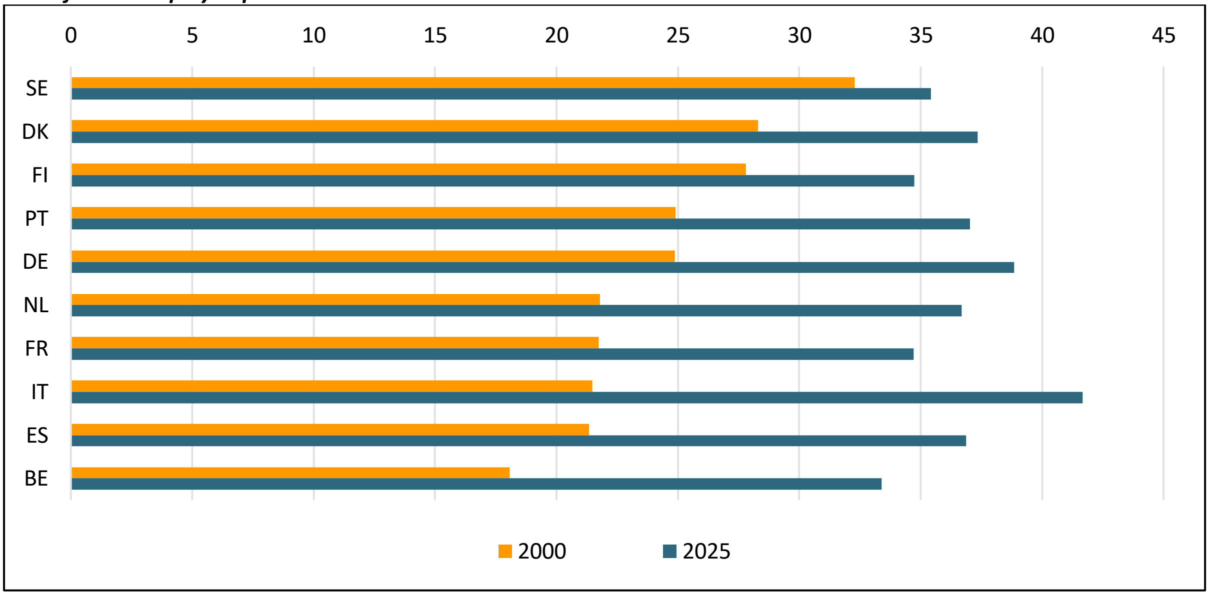


Source: Eurostat, Labor Force Survey.

1.3. More older persons at work

Many European countries have an ageing population and this evolution is also reflected in the labour force. Over 2000-2025, the ten countries of comparison recorded an increase in the share of workers aged from 50 to 64 years in the total employed persons. This increase is particularly noticeable in Italy and Germany while, in 2025, the share of older workers was above 35% in five other countries.

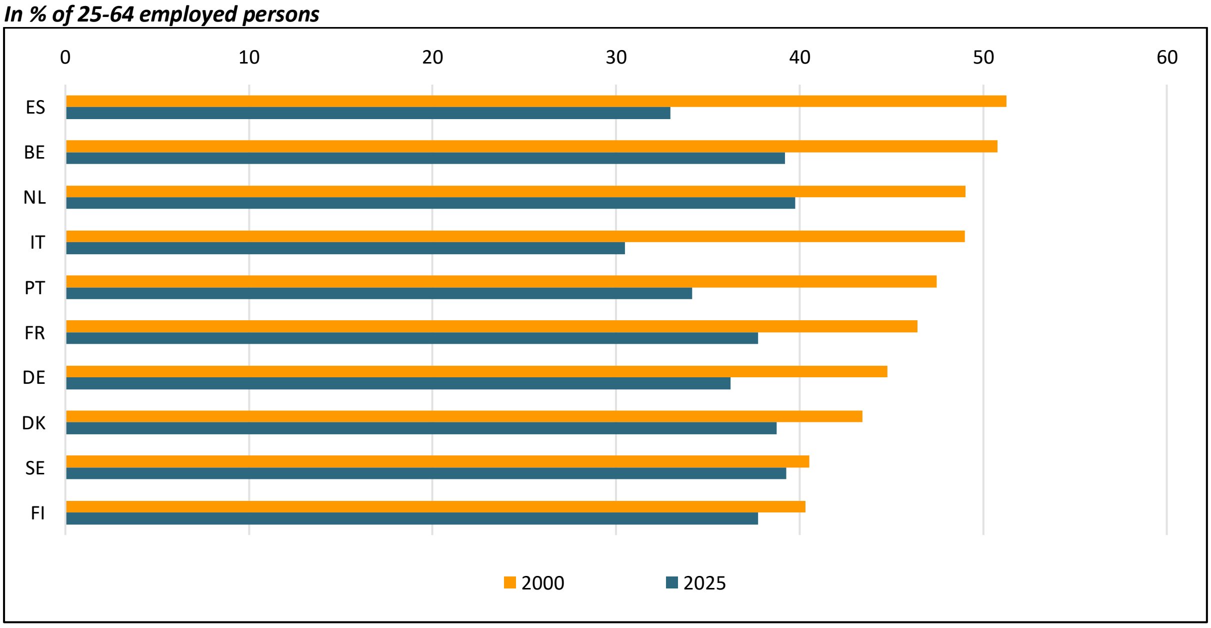
Graph 6. Share of 50-64 years employed persons
In % of 25-64 employed persons



Source: Eurostat, Labor Force Survey.

At the opposite, the share of younger workers, namely employed persons aged from 25 to 39 years, has decreased in the ten countries as illustrated in the following graph. This decrease has been particularly marked in the South of the European Union, in Italy, Spain and Portugal. The decline has been more modest in Finland, Sweden and Denmark but these three countries already recorded the lowest proportion of young workers in 2000.

Graph 7. Share of 25-39 years employed persons
In % of 25-64 employed persons



Source: Eurostat, Labor Force Survey.

In conclusion, compared with 2000, today's jobs are occupied by workers better qualified, often women and older.

2. Composition of labour: effect on labour productivity growth

As shown in the previous section, over the course of a generation, the characteristics of the workforce have deeply changed and these changes might have had an impact on productivity growth. To take this impact into account, the standard growth accounting decomposition needs to be refined and that is the aim of this section.

2.1. Theoretical framework

The standard growth accounting model uses a Cobb-Douglas production function with constant returns to scale, where total value added (Y) is obtained by a combination of factor inputs, mainly capital (K) and la-bour (L), multiplied by total factor productivity (TFP) which measures the efficiency of the combination. The exponent, Alpha, is the labour income share in total value added expressed in nominal terms[1].

$$Y = TFP\,.\,L^{\alpha}.\,K^{1-\alpha} \tag{1}$$

As a result, labour productivity growth comes down to the following expression

$$\left(\frac{\dot{Y}}{L}\right) = T\dot{F}P + (1-\alpha)\left(\frac{\dot{K}}{L}\right) \tag{2}$$

The TFP growth and the growth of capital deepening are therefore the key drivers of labour productivity growth.

This methodological framework has the advantage of simplicity. However, the complexity emerges when it is applied in practice. The most straightforward approach is to (implicitly) assume homogeneous factors of production and to use data from the national accounts to measure value added, capital stock and the number of hours worked in the economy over the period under review[2].

The previous section has, however, shown that major changes have occurred since 2000 in the composition of labour force. To take the effect of these changes on labour productivity growth into account, an alternative consists in measuring the increase in labour input by the evolution of the volume index of labour services given by the following expression

$$\dot{L_t} = \textstyle\sum_l \overline{v_t^l}\dot{H}_t^l \quad \text{with} \quad v_t^l = \frac{p_t^l H_t^l}{\sum_l p_t^l H_t^l} \tag{3}$$

where $\dot{H}_t^l$ is the change of the number of hours worked by labour type l at time t , $\overline{v_t^l}$ is the share of labour type l in total labour compensation and p_t^l is the price of one hour worked by labour type l at time t.

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[1] Growth accounting uses a neoclassical production function characterized by constant returns to scale, diminishing marginal productivity of inputs, and perfect competition in factor and product markets. These assumptions imply that factor remuneration equals their marginal productivity and there is no economic profit.

[2] The labour income share may be measured as compensation of employees divided by value added. However by doing so, net taxes on production and imports, negative or positive if subsidies exceed taxes, are assimilated to capital income. This could be incorrect if some of these net taxes are in fact labour subsidies.

The growth of labour services can be decomposed into two parts:

- the hours worked effect or "quantity" effect which is given by $(\sum_l \dot{H}_t^l)$
- the labour composition effect (LCE) or "quality" effect which is given by $\dot{L}_t - (\sum_l \dot{H}_t^l)$ and takes into accounts the composition of the workforce that worked the hours, with different characteristics corresponding to different levels of productivity and, therefore, different wages[3]. A positive composition effect indicates greater growth in hours worked among workers with higher wages and, consequently, higher labour productivity.

The expression of labour productivity growth becomes

$$\left(\frac{\dot{Y}}{L}\right) = T\dot{F}P + (1-\alpha)\left(\frac{\dot{K}}{L}\right) + \alpha LCE \tag{4}$$

Growth in labour productivity can therefore be broken down into three components: capital deepening, which measures the effect of an increase in capital per hour worked (K/L); the labour composition effect (LCE); and the contribution of TFP.

2.2. Empirical estimates

The Euklems & INTANProd database published by the Luiss University in Rome (Lab of European Economics) provides, in its statistical module, the annual contribution of the labour composition effect to labour productivity growth for the 27 EU Member States, UK, US and Japan over 1995-2021 (release 2024, coverage varies across countries)[4].

The volume index of labour services is based on 18 worker types within each country, industry and year. Worker types are classified by gender categories (male, female), age categories (15-29 years, 30-49 years and 50 years and higher) and educational qualification levels (high, medium and low based on ISCED codes). For each worker type, the share of labour compensation in value added at current prices is computed as the average of year t and year t-1 shares.

The volume index of capital services is based on the 9 assets distinguished in the National Accounts. The capital deepening contribution is broken down into three categories: tangible non-ICT capital deepening, tangible ICT capital deepening and intangible capital deepening.

Table 2 provides the average annual contribution of the labour composition effect to labour productivity growth of total economy for 9 of the 10 countries under review[5].

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[3] Any institutional arrangement that results in wage growth being decoupled from productivity growth reduces the quality of the measure of the LCE.

[4] https://euklems-intanprod-llee.luiss.it/download/ For explanation of the database see: Bontadini F., Corrado C., Haskel J., Iommi M., Jona-Lasinio C. (2023), EUKLEMS & INTANProd: industry productivity accounts with intangibles - Sources of growth and productivity trends: methods and main measurement challenges.

[5] For Portugal, the available period is 2009-2021 and the average annual contribution over this period amounts to 1.30 percentage points.

Table 2. Average annual contribution of LCE to LP growth over 2000-2021 and sub-periods
Percentage points

Countries	2000-2021	2000-2010	2011-2021
Germany	0.10	0.08	0.13
Finland	0.15	0.19	0.11
Belgium	0.20	0.16	0.23
Netherlands	0.25	0.21	0.30
Italy	0.26	0.18	0.34
Denmark	0.28	0.40	0.16
Spain	0.38	0.27	0.49
France	0.39	0.23	0.55
Sweden	0.72	1.23	0.20

Source: Euklems & INTANProd database, 2024 release.

The table illustrates the relative wide range of average positive effects of changes in worker types on productivity growth across countries. It also shows differences in the LCE contribution dynamics over time, with an increase in the effect from one decade to the next for some countries such as Italy, Spain and France, or a clear decrease of this effect, like in Sweden and Denmark.

2.3. Impact on TFP measure

TFP being unobservable, it is computed as a residual in the labour productivity growth decomposition and therefore, it contains all errors and approximations in inputs measurement. The inclusion of the labour composition effect in the labour productivity growth breakdown helps to reduce, to some extent, this imprecision.

The EU KLEMS database provides annual TFP estimations based on this extended breakdown methodology which are presented in Table 3. Labour composition effect improves estimate of TFP as measure of innovation, but results in a lower impact of innovation than previously estimated.

Table 3. Average annual contribution of TFP to LP growth over 2000-2021 and sub-periods
Percentage points

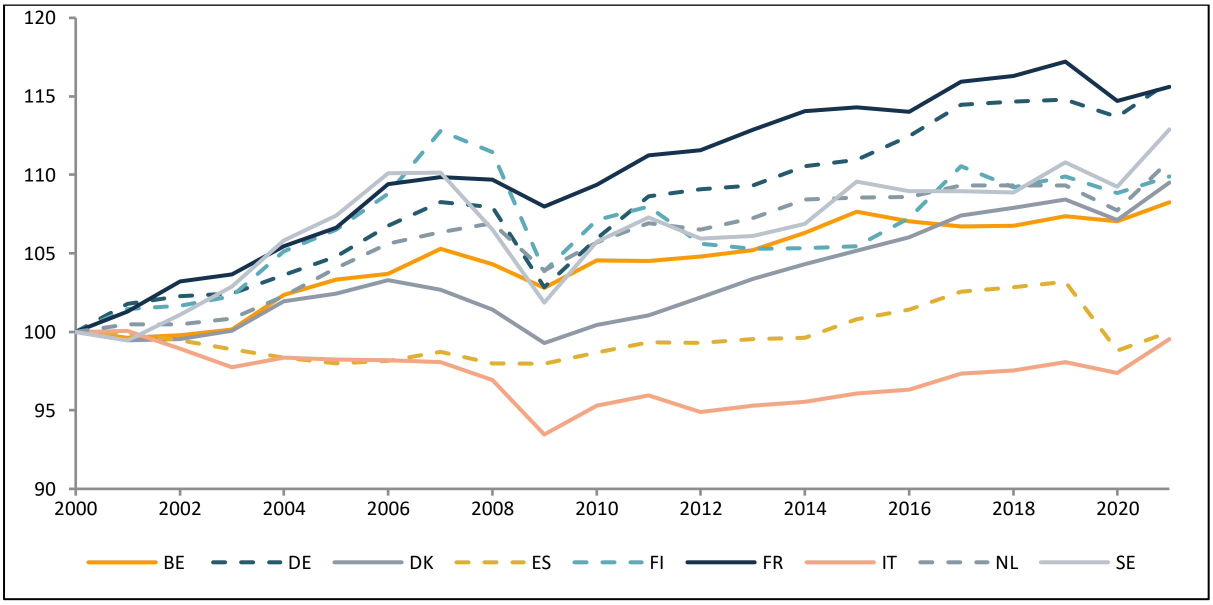
Countries	2000-2021	2000-2010	2011-2021
Germany	0.67	0.64	0.70
Finland	0.51	0.88	0.13
Belgium	0.20	0.30	0.09
Netherlands	0.34	0.53	0.15
Italy	-0.18	-0.41	0.06
Denmark	0.26	-0.11	0.64
Spain	-0.36	-0.35	-0.36
France	0.40	0.84	-0.04
Sweden	-0.01	-0.43	0.40

Source: Euklems & INTANProd database, 2024 release.

The graphs in Annex A present the evolution of TFP including LCE contribution, called TFP1, and TFP excluding LCE contribution, called TFP2, over 2000-2021 in index based in 2000. They show that the cumulative impact of the change in the methodological approach on TFP estimations differs across countries in terms of timing and magnitude. In terms of timing, the effect of the composition of the workforce becomes apparent much earlier in Sweden than in Italy or Spain for instance. In terms of magnitude, the cumulative effect is also much larger in Sweden or France than in Germany or Finland. The graphs in Annex B allow to compare the AMECO TFP with the EU KLEMS TFP.

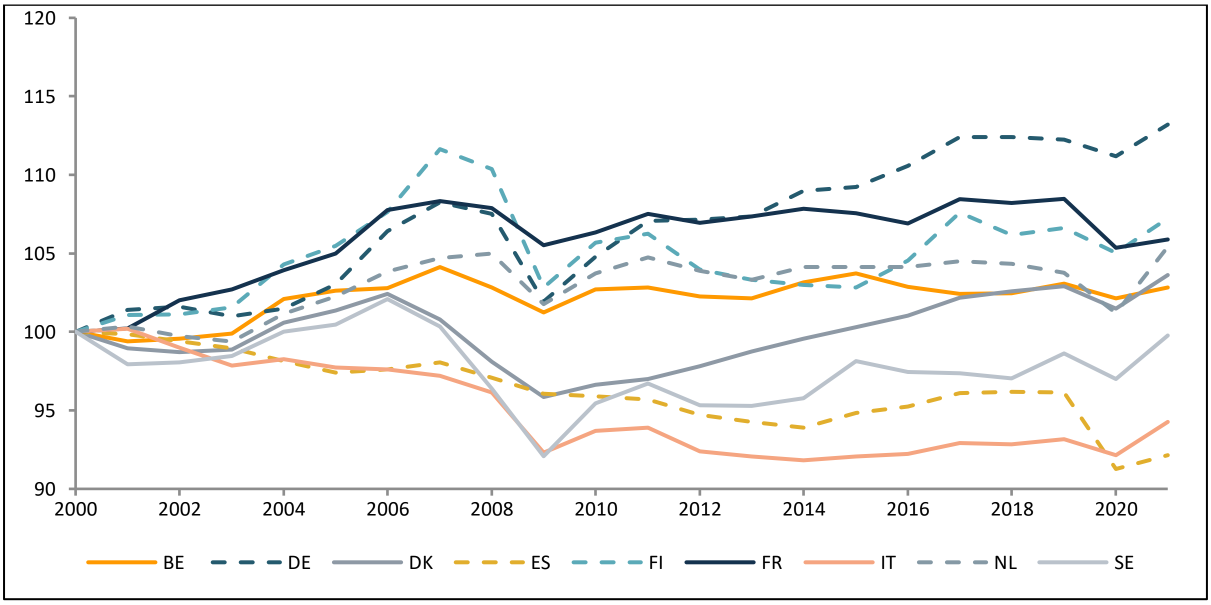
Taking into account the effect of the composition of the workforce also alters the relative trends of TFP across countries over the period as illustrated by the following graphs.

Graph 8. Evolution of standard TFP
2000=100



Source: Euklems & INTANProd database, 2024 release.

Graph 9. Evolution of corrected TFP (excluding LCE contribution)
2000=100



Source: Euklems & INTANProd database, 2024 release.

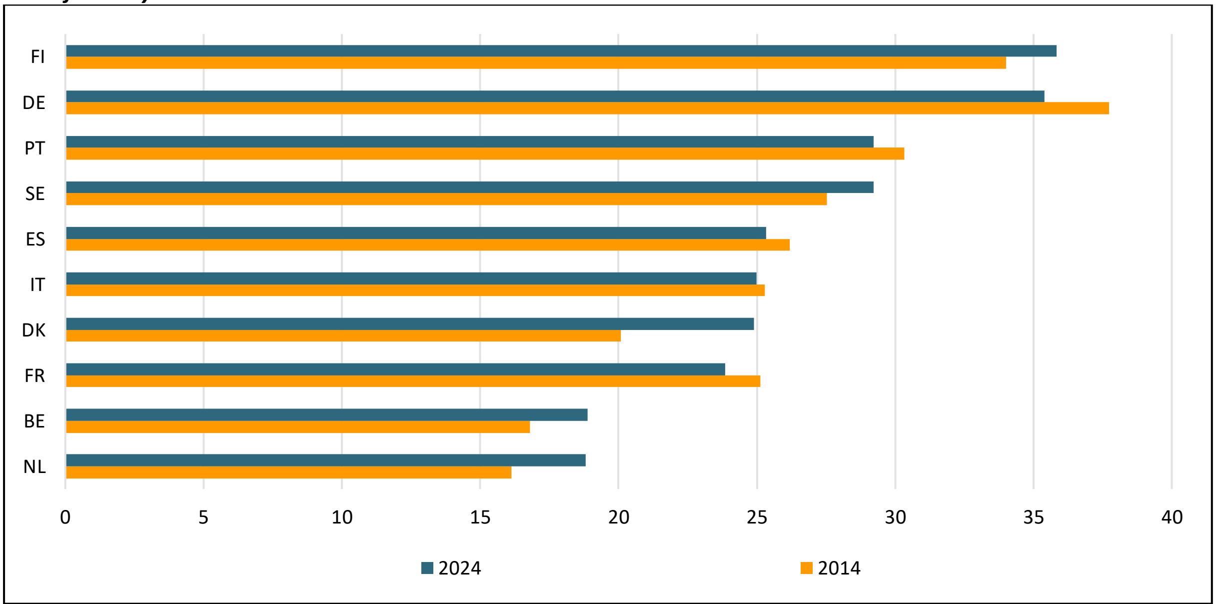
3. Composition of labour: interaction with TFP

Beyond a better TFP estimate by improving the labour productivity growth decomposition, some characteristics of the labour force could also play a role as drivers of TFP. This is the case of a sub-group of workers with tertiary education level, those graduated in STEM (Science, Mathematics, IT, engineering, processing and production corresponding to ISCED 5 to 7) as they are particularly important for the integration of digital technologies into the economy and research and innovation activities[6].

[6] As illustrated by the definition of labour in the R&D production function in the QUEST III R&D model of DG ECFIN.

The limited supply of STEM specialists represents an important challenge for Europe's productivity performance. In EU27, 27.1% of students enrolled in tertiary education were studying STEM fields, a share stable since 2016 and not sufficient to keep up with the growing STEM jobs creation (EU target of 32% in 2030). As illustrated by the following graph, the picture varies widely across countries. Finland and Germany lead the way with more than 35%. By contrast, the Netherlands and Belgium have STEM enrolment rates persistently low, below 20%. Moreover, the dynamic does not necessarily go in the right direction for some Member States such as France or Spain.

Graph 10. Students enrolled in tertiary education in STEM
In % of tertiary education students



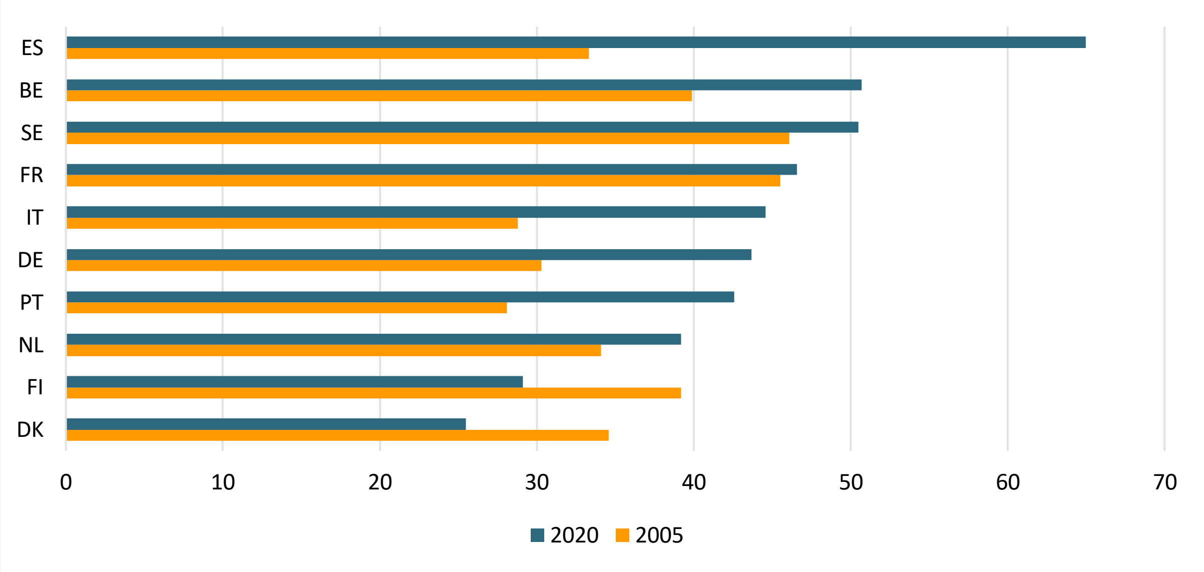
Remark: IT 2016 and SE 2015.
Source: Eurostat, Adult education survey.

In response to this shortage of specialists, and also to update the skills of existing staff, companies have developed strategies for the ongoing training of their workforce, which is essential for the successful integration of new technologies into their production processes.

The Continuing vocational training survey (CVTS) collects data from enterprises with at least 10 employees on the professional training they provide to their employees. As illustrated in the following graph, these data show an increase in the training of the labour force financed by employers in most countries.

In 2020, Spain, Belgium, and Sweden had the highest participation rates (above 50% of persons employed).

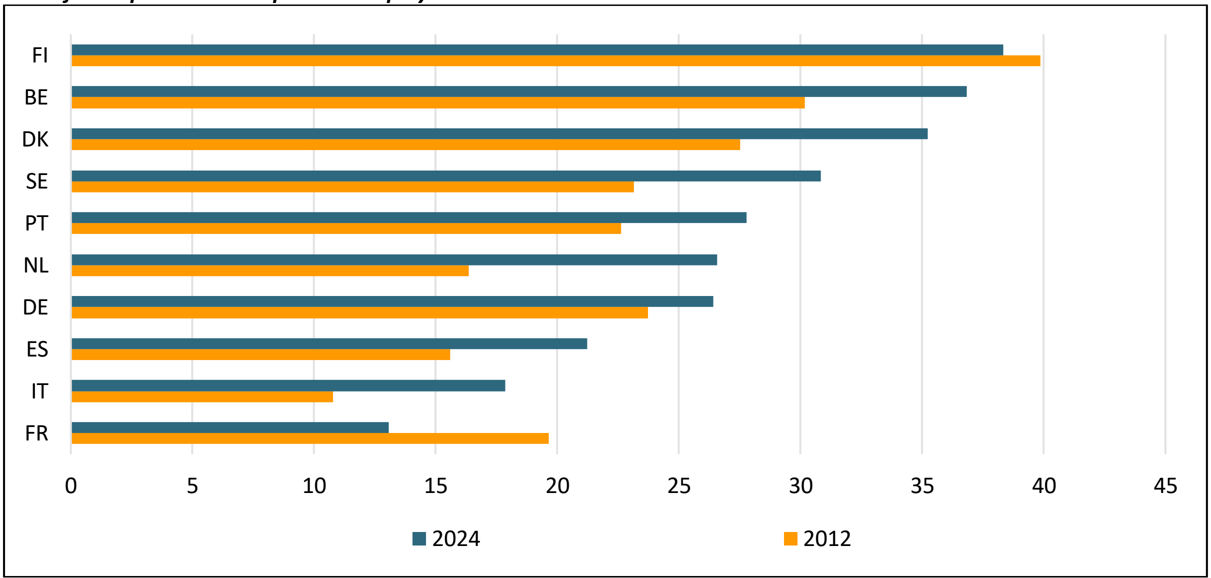
Graph 11. Participants in continuing vocational training (CVT) courses
In % of persons employed in all enterprises (with at least 10 employees)



Remark: The 2020 results may be influenced by COVID (Five-year survey).
Source: Eurostat, Continuing Vocational Training Survey (CVTS)

Training that develops workers' ICT skills is particularly important for the integration of AI within companies. Most countries have recorded an increase in this kind of lifelong learning between 2012 and 2024 as illustrated in the following graph. The highest percentages of enterprises providing ICT training are recorded by countries where the digitalization of enterprises including the use of AI is also the highest, the Scandinavian countries but also Belgium for instance.

Graph 12. Enterprises that provided training to develop ICT skills of their personnel
In % of enterprises with 10 persons employed or more



Source: Eurostat, European ICT usage survey (yearly).

In conclusion, the increase in education level of the workforce, although positive for the productivity growth, is not sufficient to strengthen innovation and its diffusion. The fields of study are very important. Lifelong learning is useful for bridging the gap between demand and supply of STEM, but active policies are also needed to promote scientific careers among young people.

4. Conclusion

Over the past 25 years, the characteristics of the workforce have changed significantly. People currently in work are, on average, better qualified, older and more likely to be women than they were in 2000. These changes have positively impacted the labour productivity growth, not at the same pace or not with the same magnitude across countries.

In the growth accounting framework, taking this effect of the composition of the workforce into account also helps to improve the estimate of TFP as a measure of innovation.

TFP is also directly affected by these changes as innovation activities require specific competencies. In particular, STEM graduates play a significant role in the generation of new ideas. In many of the countries studied, this choice of specialisation is not widespread enough amongst students, which may justify active policies to encourage scientific careers.

As well as generating new ideas, the diffusion of new technologies and their effective integration into production processes requires an update of the skills of current workers. The efforts made by enterprises to develop lifelong learning should therefore also be further encouraged by public policies. The lack of such competencies might indeed partly explain the low TFP growth observed over the past decades.

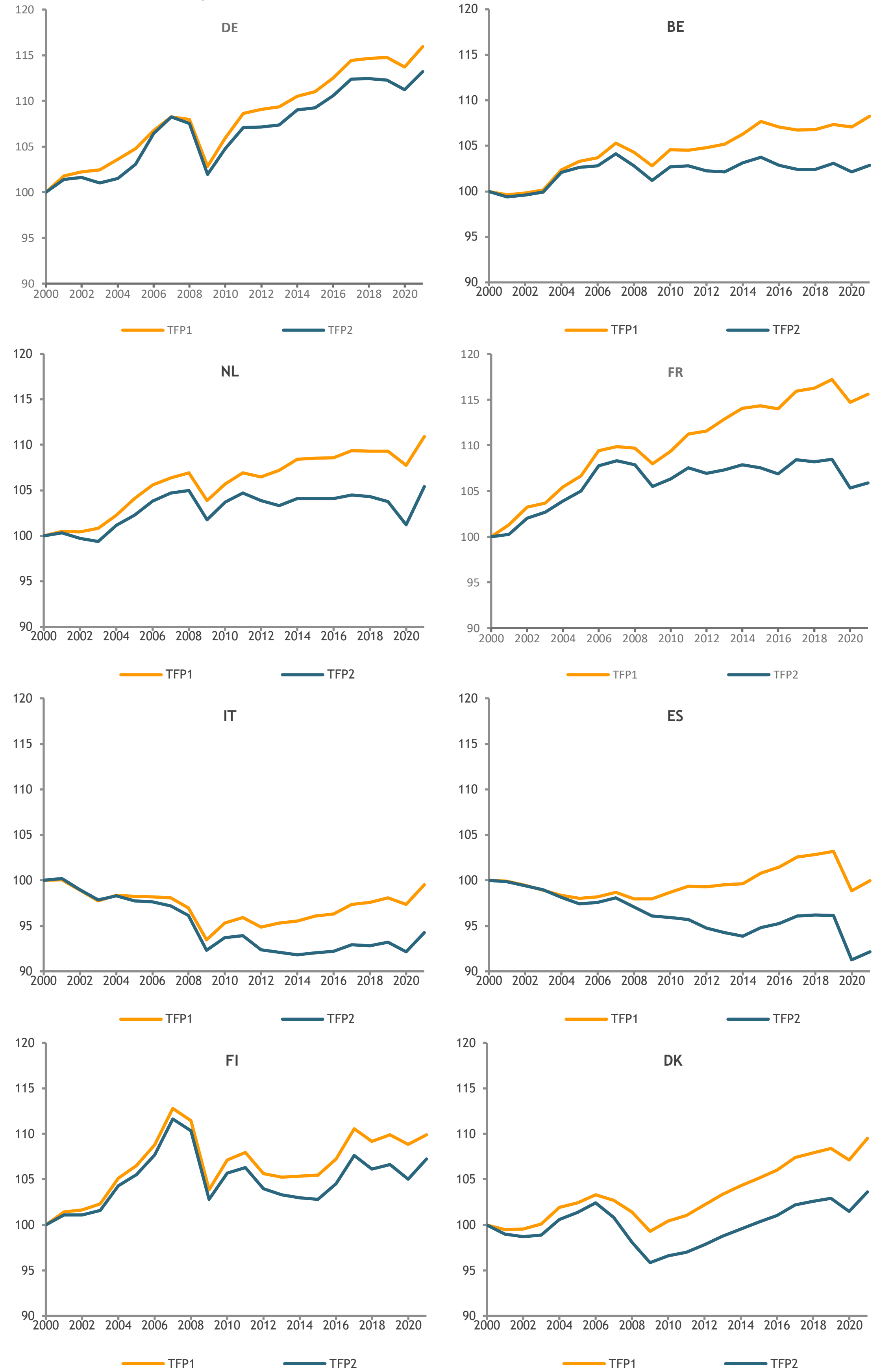
5. Annexes

5.1. Annex A

TFP1 is TFP including the labour composition effect contribution and TFP2 is TFP corrected to remove the effect of the change in the labour composition. Both series are based on Euklems & INTANProd database release 2024.

Graph 13. Comparison of TFP evolutions, Standard TFP (TFP1) versus Euklems (TFP2)

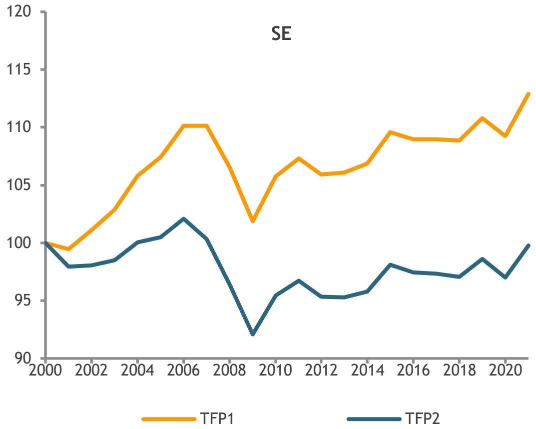
2000=100, except PT 2008=100

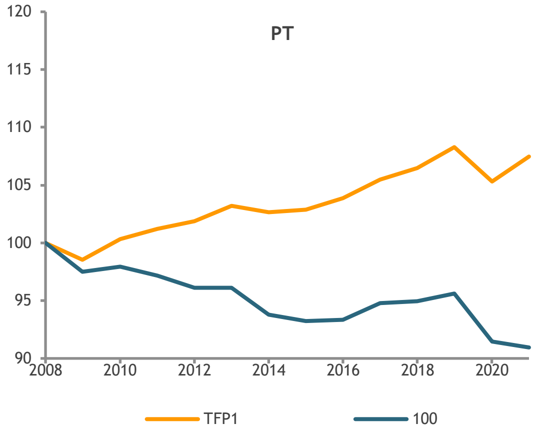


Source: Euklems & INTANProd database, 2024 release.

Comparison of TFP evolutions, Standard TFP (TFP1) versus Euklems (TFP2) (continued)

2000=100, except PT 2008=100





Source: Euklems & INTANProd database, 2024 release.

5.2. Annex B

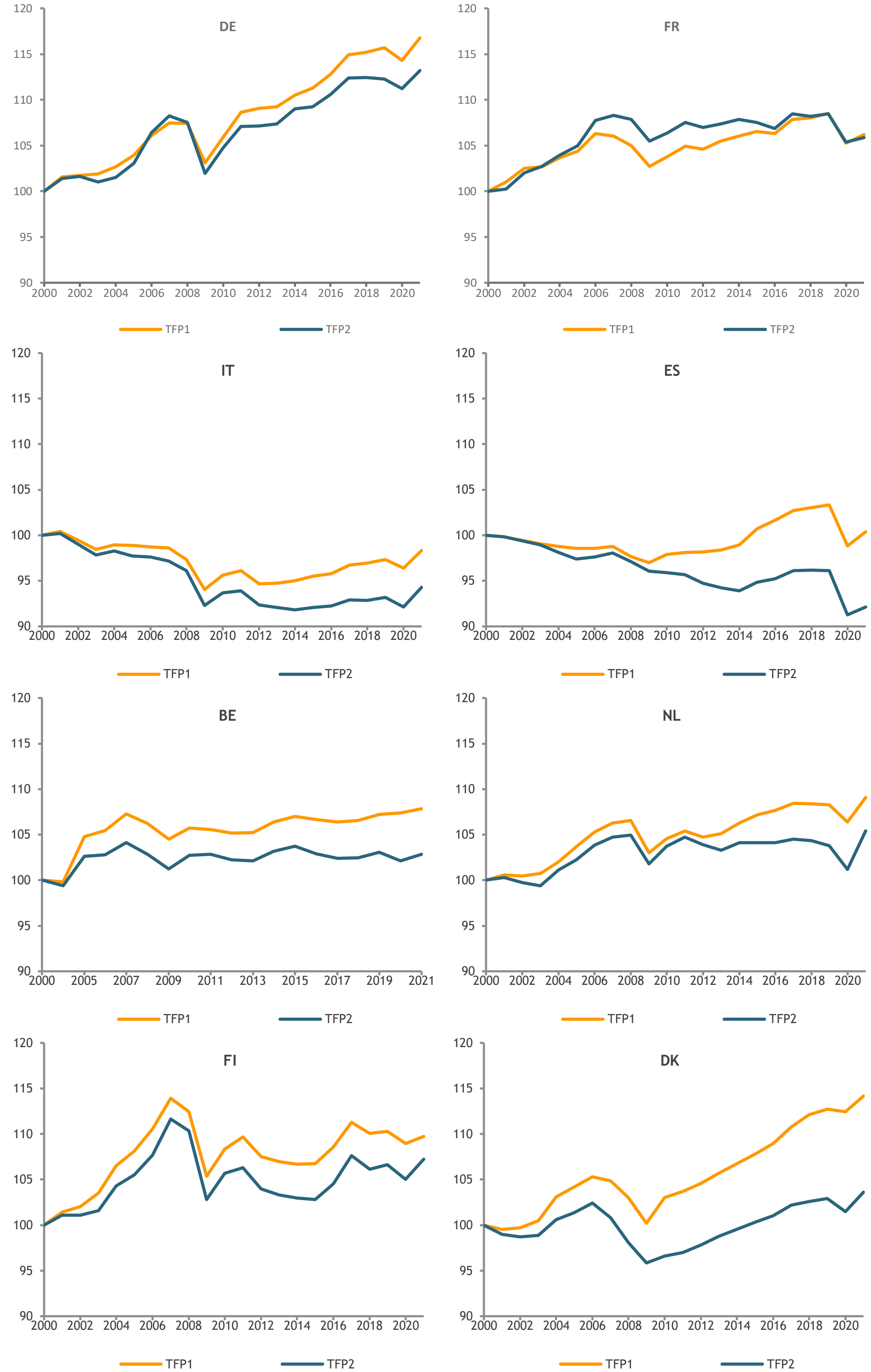
Comparison TFP AMECO (TFP1) and TFP EU KLEMS (TFP2)

The EU KLEMS TFP without LCE is compared with TFP available in AMECO database which is computed based on homogeneous factors of production (implicit) assumption[7] . The Spring Forecasts 2026 release of AMECO is used in this comparison.

[7] Another methodological difference between AMECO and EU KELMS concerns the measure of the term alpha in the production function equation.

Graph 14. Comparison of TFP evolutions, AMECO (TFP1) versus Euklems (TFP2)

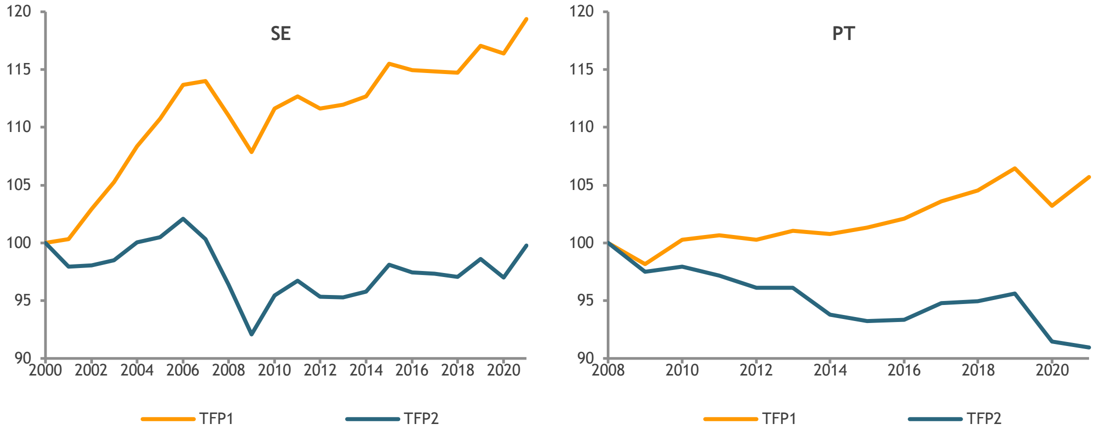
2000=100, except PT 2008=100



Source: AMECO, Spring forecasts 2026 release and Euklems & INTANProd database, 2024 release.

Comparison of TFP evolutions, AMECO (TFP1) versus Euklems (TFP2) (continued)

2000=100, except PT 2008=100



Source: AMECO, Spring forecasts 2026 release and Euklems & INTANProd database, 2024 release.