# Rewiring Europe's Productivity Framework: Aligning Investment, Innovation, and Diffusion

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## Abstract

Europe's productivity gap is often framed around the relative importance of frontier innovation and diffusion in driving future growth. While both matter, this paper argues that the binding constraint lies in the weak transmission of innovation into broad-based productivity gains—particularly through barriers to scaling up, dissemination, and the development of absorptive capacity for new technologies. The analysis proceeds from four angles. First, by examining Europe's productivity shortfall in detail, it shows that slow growth is widespread within industries rather than mainly the result of sectoral composition, highlighting the importance of policies that foster the diffusion of innovations across firms, sectors, and regions. Second, by exploring the links between technology, innovation, and diffusion, with particular attention to artificial intelligence (AI), the paper argues that Europe's thin innovation frontier and long diffusion lags go some way to explaining its difficulty in reversing the productivity slowdown. Third, this difficulty appears to be compounded by weak investment in intangible assets, which limits firms' absorptive capacity and their ability to capture the productivity benefits of broad-based adoption. Fourth, the paper argues that Europe's policy framework needs to better integrate investment, innovation, and diffusion if it is to support broader and more inclusive productivity growth. The main policy recommendation is to give greater prominence to horizontal policies that address weak diffusion within and across sectors by supporting the wider adoption, absorption, and effective use of new technologies and innovations, particularly at national and regional levels. At the same time, effective vertical action at European level will require greater governance capacity, anchored in disciplined, selective, and performance-based industrial policy.

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# 1 Introduction

## 1.1 Europe’s productivity problem: innovation and diffusion

Europe’s persistent productivity shortfall lies at the heart of current concerns about growth, competitiveness, and economic resilience (Draghi, 2024). In policy terms, the debate is often framed around the divide between high-productivity frontier firms and the lagging performance of a long tail of less productive firms (Andrews, Criscuolo and Gal, 2016; André and Gal, 2024). This paper argues that this reality should not be translated into a policy choice between frontier innovation and diffusion: Europe must both strengthen dynamism at the innovation frontier and remove persistent barriers to diffusion across regions, sectors, and firms. At the same time, barriers to dissemination, adoption, and effective use of technologies and innovative practices are the binding constraint on Europe’s ability to turn innovation into stronger and more widely shared productivity growth.

At the global frontier, productivity growth has remained relatively robust and may even have accelerated in recent times, notably due to advances in artificial intelligence (AI) (Bergeaud, 2024; Bontadini et al., 2026). However, Europe’s own national frontier firms, defined as the most productive firms within each country, have lagged behind the global frontier for a much longer period (OECD, 2015; Andrews, Criscuolo and Gal, 2016). These weaknesses stem from structural shortcomings in innovation capacity and business dynamism, including lower R&D intensity, ageing firm populations, and significant barriers that prevent innovative young firms from scaling, all of which contribute to Europe’s widening productivity gap relative to the United States (OECD, 2025a; Adilbish et al., 2025). In addition, major emerging economies, most notably China and India, have sustained faster productivity growth and are gradually narrowing the productivity gap relative to the most advanced economies.

Against this backdrop, recent debates on modern industrial policy in Europe have increasingly focused on these frontier weaknesses, a concern prominently reflected in the Draghi report on the future of European competitiveness (Draghi, 2024). However, focusing solely on frontier innovation obscures the equally important reality that Europe suffers from severe diffusion bottlenecks. Alongside the underperformance of frontier firms, Europe has seen a growing productivity divide between leading and lagging firms, reflecting systemic weaknesses in diffusion and adoption across firms (Berlingieri et al., 2025). Many European firms, especially small and medium-sized enterprises (SMEs), continue to lag in the adoption of digital technologies, advanced production methods, and intangible assets. Technological capabilities accumulate unevenly, reinforcing persistent productivity gaps across firms (OECD, 2015a; Hobler, 2025). Such weaknesses reflect rigid product, labour, and capital market regulations, weak competition and market contestability, financing constraints for young and innovative firms, low business dynamism, and difficulties in adopting tacit, skill-intensive technologies (Amoroso and Martino, 2020; Nicoletti, von Rueden and Andrews, 2020; Añón Higón et al., 2022; Adilbish et al., 2025).

Structural barriers to innovation and diffusion also carry important macroeconomic consequences. For example, productivity growth can reduce employment when technological change is labour-saving and lower prices do not stimulate enough additional demand to offset these effects. In a well-functioning economy, robust diffusion and structural complementarities can mitigate such losses by generating spillovers and expanding activity elsewhere. Yet these spillovers are unevenly distributed and depend critically on the sectoral composition of the economy. For example, knowledge-intensive services, particularly those linked to digital economy activities, tend to generate strong positive externalities. In contrast, a structural shift toward lower-productivity activities can dampen both aggregate productivity and employment growth (Missos, Koratzanis and Rodousakis, 2025).

Finally, the disconnect between frontier innovation and diffusion has a pronounced spatial dimension. Innovation activity in Europe (as in many other geographies) is increasingly spatially concentrated. A limited number of regions – typically major metropolitan areas and established science and technology hubs – are home to a disproportionate share of frontier firms and knowledge-intensive activities. While agglomeration economies underpin this concentration, they can also reinforce regional disparities, as the most prosperous regions are better positioned to attract talent and investment, while lagging regions remain weakly integrated into innovation networks (Rodríguez-Pose, Dijkstra and Poelman, 2024; Pinheiro et al., 2025). This uneven geography of innovation constrains inclusive growth by weakening the diffusion of knowledge, opportunities, and productivity gains across regions, firms, and workers.

## 1.2 Outline and key insights

This paper examines how frontier innovation and diffusion can be reconnected from both analytical and policy perspectives. It adopts a productivity lens for three main reasons. First, innovation and diffusion are both central drivers of productivity growth and broader economic performance. Second, focusing on productivity makes it possible to frame the debate not only in terms of innovation and diffusion, but also in relation to Europe's investment shortfall – or 'investment gap' in the terminology of Draghi (2024). Third, productivity is itself a critical mechanism through which innovation and diffusion can be sustained and their gains are translated into inclusive growth.

Section 2 places Europe's productivity performance in comparative perspective by examining how it has evolved relative to other major geographies, especially the United States. Section 2.1 documents the substantial widening of the transatlantic productivity gap since the late 2010s. Section 2.2 then turns to sectoral evidence showing that the productivity growth gap between the euro area and the United States overwhelmingly reflects weaker productivity growth within industries rather than unfavourable European specialisation in specific low-productivity sectors. Finally, Section 2.3 considers the spatial dimension, highlighting growing sub-national divergence and the emergence of distinct productivity trajectories across European regions.

Section 3 focuses on the paper's central analytical theme of innovation, diffusion, and adoption. Sections 3.1 and 3.2 set out the broader conceptual and historical context for Europe's long-standing weaknesses in innovation and diffusion, identifying key barriers to scaling up, dissemination, and the development of absorptive capacity within firms. Section 3.3 focuses on AI as the most prominent contemporary case through which these dynamics can be examined. Although AI is still in an installation phase, there are already indications of a relatively thin innovation frontier and long diffusion lags for AI in Europe.

Section 4 shows how an investment-based perspective helps explain the weak transmission of innovation into broad-based productivity gains. Section 4.1 builds on the notion of the investment gap highlighted in recent European policy reports (Draghi, 2024; Letta, 2024), concluding that this is less an aggregate investment shortfall than a weakness in intangible investment. Using EUKLEMS INTANProd data through 2021, Section 4.2 highlights how Europe's frontier innovation efforts often fail to scale, and how diffusion is hindered in the absence of complementary investments in management quality, digital capabilities, and other forms of intangible capital. Section 4.3 concludes that, for AI, the main productivity benefits for Europe lie in leveraging the complementary inputs required for its effective use, notably data, human capital and organisational capital.

Section 5 examines the extent to which Europe's current policy framework supports investment, innovation, and diffusion in pursuit of productivity and economic growth. Building on a recently developed typology of pro-productivity policies spanning factor accumulation, innovation and structural transformation, markets and competition, and internationalisation (Van Ark, De Vries and Pilat, 2024), Section 5.1 outlines how these domains are connected through horizontal policies across sectors and firms, and vertical policies within specific sectors and technology areas. Section 5.2 highlights the implications for monetary policy, particularly the risk that the low collateral value of intangible assets weakens monetary transmission and may put downward pressure on the equilibrium interest rate unless rapid technological and non-technological diffusion generates strong demand and productivity effects. Section 5.3 broadens the lens on productivity by examining its contribution to inclusive growth, arguing that Europe can build on its social model by ensuring that innovation and diffusion translate into stronger and more widely shared productivity outcomes across firms and regions.

Section 6 concludes by outlining how more integrated, multi-level governance frameworks in Europe could better align investment, innovation, and diffusion. In the near term, European countries should strengthen and better coordinate horizontal policies that support diffusion. These pro-productivity policies should be implemented mainly by member states, and complemented at the European level, for example through completion of the Single Market. At the same time, the EU needs to develop the governance capacity required for more effective vertical action, including the mobilisation of larger-scale R&D and innovation funding and the coordinated management of an EU-wide industrial strategy. Finally, stronger regional policy frameworks are needed to address the spatial dimensions of productivity, innovation, and diffusion that are essential to fostering inclusive growth.

# 2 Europe’s Shifting Position in the Global Productivity Landscape

To place the roles of investment, innovation, and diffusion in context, it is useful to begin by situating Europe within the broader landscape of comparative productivity performance. The erosion of Europe’s productivity position since the mid-1990s is well documented in the literature (Van Ark, O’Mahony and Timmer, 2008, Van Ark, De Vries and Erumban, 2021; Goldin et al., 2024; Bergeaud, 2024). Understanding how this decline relates to innovation and diffusion, however, requires moving beyond aggregate indicators towards sectoral and firm-level evidence.

Section 2.1 reviews the latest evidence on comparative labour productivity growth and levels at the aggregate (market-economy) level for the euro area as a whole. Section 2.2 explores how the productivity growth gap is reflected in decompositions of between- and within-sector performance between the euro area and the United States. Section 2.3 extends the discussion to sub-national disparities, highlighting how spatial imbalances within countries further reinforce Europe’s broader productivity challenges.

In recent decades, a substantial literature using firm-level data has emerged to better understand productivity differentials across countries and sectors (Bartelsman, Haltiwanger and Scarpetta, 2013; Lopez-Garcia, Di Mauro and the CompNet Taskforce, 2014; Andrews, Criscuolo and Gal, 2016). This literature complements sectoral averages by showing that aggregate productivity depends critically on within-sector heterogeneity, the diffusion of technologies and innovations across firms, and allocative efficiency enabling more productive firms to expand, innovate, and contribute to creative destruction. Although this literature is not discussed separately in this paper (see Berlingieri et al., 2025, for a recent comprehensive review), its insights feature prominently in the later discussion of innovation and diffusion. Recent evidence suggests that AI adoption may be exacerbating productivity dispersion across firms.

## 2.1 Europe’s productivity problem: concepts and measurement

The concept of productivity used throughout most of this paper follows the standard definition in the economic literature. Productivity growth reflects improvements in the efficiency with which economies transform inputs into outputs. In line with the standard view, productivity is driven primarily by technological progress and the dissemination and adoption of innovative practices, supported by competitive markets and business dynamism.

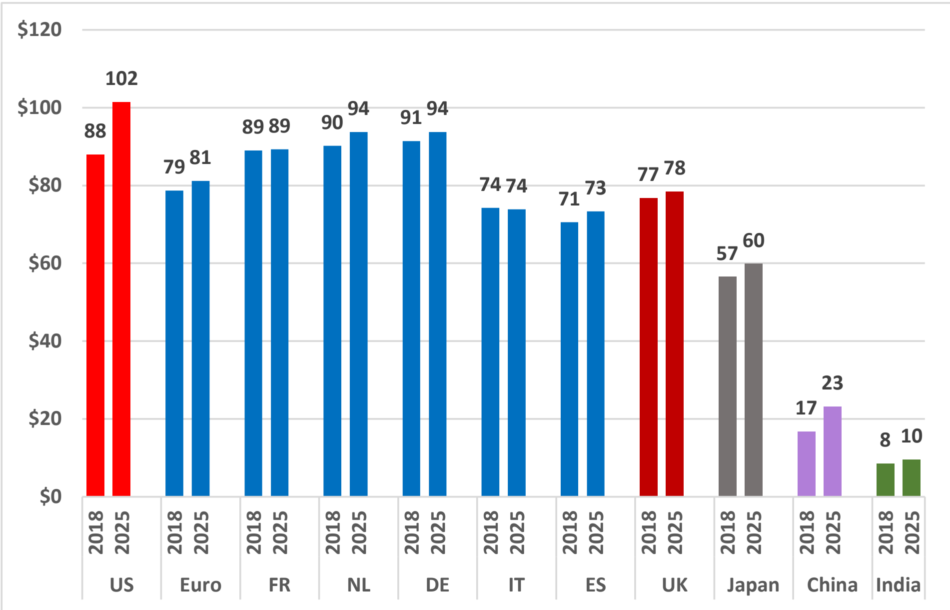
Beyond growth rates, the analysis in this section also considers productivity levels, which more clearly capture how economic outcomes are distributed. High-productivity firms, sectors, and regions tend to generate strong agglomeration forces and persistent advantages, while low-productivity regimes can become entrenched, giving rise to ‘productivity traps’ that are difficult to escape without broader system-wide interventions. These dynamics are particularly evident at the regional level, where substantial divergence continues to persist, as discussed in Section 2.3.

Chart 1 provides a concise overview of Europe's productivity performance relative to the global frontier, represented here by the United States, over the period 2018–2025. It combines productivity levels measured at constant-price PPPs in 2024 US dollars with national time series of GDP per hour worked.[1]

**Chart 1**

Levels of Labour Productivity, 2018 and 2025 (in real 2024 US$)

(GDP per hour worked, US$ constant 2024 based on 2021 PPP,)




Sources: The Conference Board, Total Economy Database, update, 2025;
Note: euro area current membership; FR = France; NL = Netherlands; DE = Germany; IT = Italy; and ES = Spain.

Over this relatively short seven-year period, real GDP per hour in the United States increased by $14 (in 2024 US dollars), bringing the level to just over $100 per hour in 2025. Over the same period, the euro area–US productivity gap widened from $9 per hour in 2018 to $21 in 2025. Within Europe, however, there is considerable variation: the gap relative to the United States ranges from around $8–13 per hour in France, Germany, and the Netherlands to $28–29 in Italy and Spain. At the same time, convergence among euro area member states appears to have continued in recent years, driven largely by Central and Eastern European economies continuing to catch up to the euro area average (Erumban and Van Ark, 2026).

[1] There has recently been a revival of the debate on comparative productivity measurement, revealing inconsistencies between cross-country productivity level comparisons and national time series of productivity growth (Krugman, 2025; Ackerman, 2026; Aghion, Bergeaud and Garicano, 2026). While this issue is explored further in Box A, it has limited impact on the comparisons shown in Chart 1, because it comprises of linking the constant 2021 PPP benchmark comparison with a relatively short time series for seven years, implying that comparative cross-country measures are extrapolated by national time series of productivity for only three years in either direction, introducing only small inconsistencies between current and constant PPP measures.

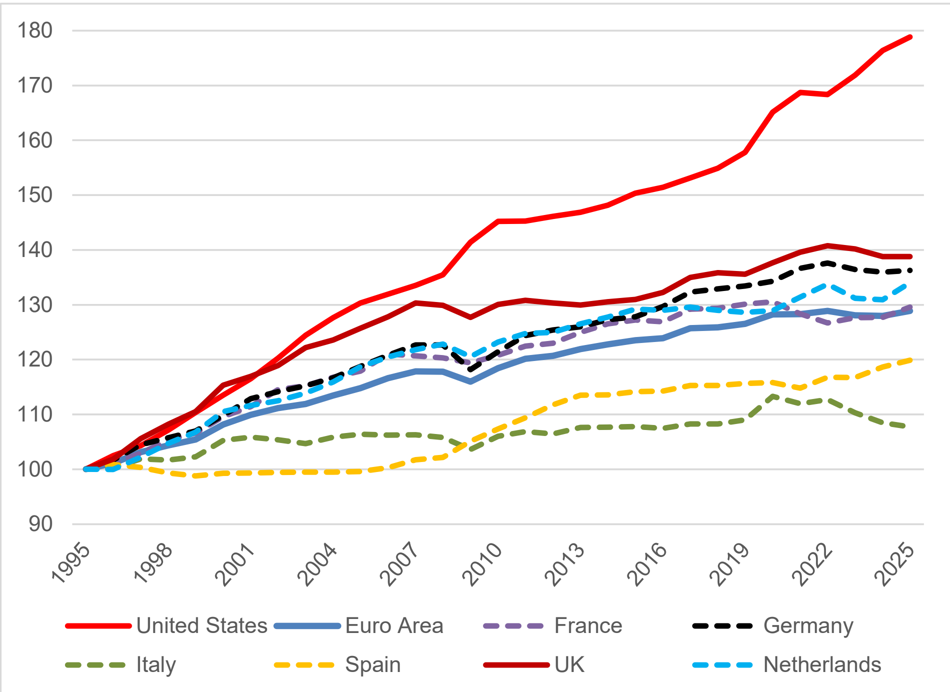
Comparing the euro area with other major economies shows that Japan's productivity gap relative to the United States is even larger than Europe's, reflecting in particular weaker productivity performance in services. China and India, while still at much lower levels of labour productivity than the euro area, have experienced faster growth. China in particular increased labour productivity by about $6 per hour (in 2024 US$) between 2018 and 2025, underscoring its stronger catch-up dynamics relative to the most advanced economies.

Chart 2 compares the growth in GDP per hour worked over three decades, from 1995 to 2025. During the 1990s and early 2000s, the United States and the United Kingdom recorded considerably stronger productivity growth than euro area economies, reflecting the greater role of ICT and the rise of the knowledge economy in both countries (Van Ark, O'Mahony and Timmer, 2008; Martin, 2025). In the aftermath of the GFC, most countries, including the United States, experienced a prolonged period of subdued productivity growth. By the mid-2010s, however, early signs of a second digital era, most notably linked to the rise of cloud computing and AI, began to emerge in the United States (Bontadini et al., 2025). Following significant volatility during the pandemic years (2020–2022), the United States reasserted its position as the productivity leader in the first half of the 2020s, while most European economies did not return even to the already slower growth trajectory observed prior to the pandemic.

**Chart 2**

Growth of GDP per hour worked, 1995-2025 (1995=100)

GDP per hour worked, 1995=100




Sources: De Vries, Martin and Van Ark (2026), based on Eurostat, ONS, BLS and BEA
Note: euro area current membership.

Chart 2 highlights that productivity growth is a cumulative, long-term process. Gains achieved in earlier decades continue to underpin relatively high productivity levels today, contributing to sustained improvements in economic welfare over time. This pattern is evident in the United Kingdom, which outperformed the euro area in the 1990s and early 2000s and, despite slower growth since the global financial crisis, still maintains productivity levels close to the euro area average. By contrast, countries that started from relatively high productivity levels but have experienced persistently weak growth, such as France and Italy, illustrate how relative performance can gradually erode over time.

It is important to recognise a recently revived debate over whether differences in output, per capita income, and productivity growth between Europe and the United States accurately capture underlying disparities in economic performance (Krugman, 2025, 2026; Aghion, Bergeaud and Garicano, 2026). The debate has centred on three main issues: measurement challenges in assessing the output and input data underlying productivity estimates; inconsistencies between comparisons of growth rates over time and cross-country comparisons of levels (see also footnote 2); and the broader question of whether productivity, per capita income, or alternative indicators of economic well-being provide the most appropriate benchmark.

Box A ('Has productivity measurement become more difficult?') discusses the first two issues in greater detail. On the measurement of outputs and inputs, although differences in measurement methods between the US and European countries are important, particularly given the growing role of digital and intangible activities, they are unlikely to explain most of the transatlantic divergence in productivity growth.

However, inconsistencies between cross-country productivity level comparisons and national time series of productivity growth can play a more substantive role (Inklaar, 2026). Comparative levels of economic performance based on constant-price PPPs (such as in Chart 1) should therefore be interpreted with greater caution, especially when the comparison year lies further from the benchmark year.

On whether productivity is the most appropriate metric for comparative economic performance, the answer depends on the purpose of the analysis. Since this paper focuses on the relationship between innovation, diffusion, and productivity, productivity—whether measured as labour productivity here or as total factor productivity in Section 4—provides a useful indicator of how technological and innovative outputs combine with investment to generate economic output (see also Box B in Section 3). At the same time, innovation can widen productivity differences across sectors and firms, with implications for inequality (Benhabib, Perla and Tonetti, 2021; Acemoglu, Autor and Patterson, 2023). These distributional dimensions are taken up in Section 5.3, which adopts a broader productivity perspective encompassing social, community, and natural capital, well-being, and the inclusive distribution of productivity gains (see also Box A).

## 2.2 Structural composition or within-sector productivity growth?

Understanding the relationship between innovation, diffusion, and productivity requires a more detailed sectoral perspective. A central question is whether cross-country differences in productivity growth reflect differences in industry structure or differences in productivity performance within industries. If industry structure is the main driver, policy should emphasise shifting resources towards higher-productivity sectors. If, instead, productivity growth differs mainly within sectors, the focus should be on improving performance within industries, including the performance of individual firms.

Using detailed data for 57 market-sector industries, Chart 3 decomposes the labour productivity growth gap between the euro area and the United States in the market sector over the period 2018–2025. The first and last columns report aggregate productivity growth in each region. The second column applies the US industry structure to the euro area while keeping euro area industry-level growth rates unchanged. The third column does the reverse, applying US productivity growth rates to the euro area industry structure. The results show that about one fifth (0.4 percentage points) of the recent euro area–US productivity growth gap is explained by differences in industry structure, while about 80 percent (1.9 percentage points) reflects faster productivity growth within industries in the United States.[2]

Chart 4 provides a more detailed breakdown of the major sector groups driving the productivity growth gap in the market economy between the euro area and the United States over the period 2018–2025. The chart shows that the digital-producing sector, which includes digital hardware (NACE C26-C27) and digital services (NACE J) makes a disproportionately large contribution to the gap: while accounting for only 12 percent of total value added in the market sector in the United States and 8 percent in the euro area, this sector explains more than one-third of the overall difference when both within-industry and structural effects are taken into account. Notably, around 20 percent of the gap can be attributed to computer programming, consultancy, and information service activities (NACE J62–J63), where average annual productivity growth reached 10.3 percent in the United States compared with only 1.5 percent in the euro area between 2018 and 2025.

Beyond the digital sector, the United States also exhibits stronger productivity growth than Europe in market services (excluding digital service J), driven primarily by faster within-industry productivity gains. Three sectors—G (wholesale and retail trade), M (professional and business services), and N (administrative and support services)—together account for close to 40 percent of the overall productivity growth gap between the two regions, while representing around 34-36 percent of total value added in the market sector in both countries.

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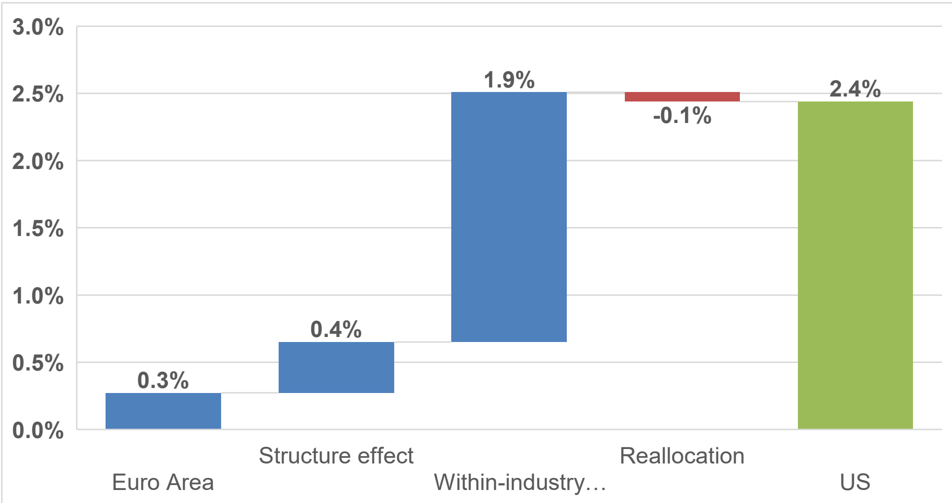
[2] The estimated 'structure' and 'within-industry' effects depend on the level of industry detail, since compositional shifts below the 57-industry level are captured within the latter component. Even so, the 57-industry classification is more granular than most comparable decompositions. It should also be emphasised that structural and within-industry effects are interdependent, since changes in industry structure will inevitably influence productivity dynamics within industries. The decomposition should therefore be read as an accounting exercise that identifies proximate contributions, rather than as an analysis of adjustment mechanisms over time.

**Chart 3**

euro area-US labour productivity growth GAP, market economy, 2018-2025

(percent, labour productivity growth, average annual)

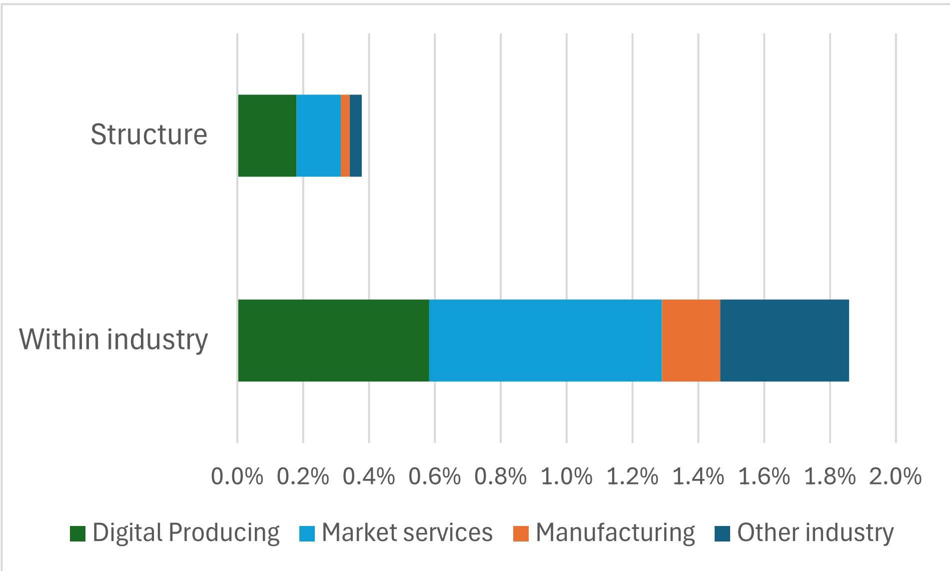



Sources: De Vries, Martin and Van Ark (2026), based on Eurostat, BLS and BEA.
Notes: euro area excludes Cyprus, Estonia, Ireland, Luxembourg and Malta due to data issues. Market sector excludes all public administration and defence, education and health and social care activities. Real estate activities and activities of households as employers are also excluded. The reallocation effect reflects the differences in labour reallocations over this period from low- to high productivity industries, which has been slightly more in favour of the euro area.

**Chart 4**

Decomposition of euro area-US labour productivity growth gap by major sector group, market economy

(Percentage point contribution to combined structure and within-industry gap, value added per hour, average annual %




Sources: De Vries, Martin and Van Ark (2026), based on Eurostat, BLS and BEA. See Chart 3 for total euro area-US labour productivity growth gap
Notes: euro area excludes Cyprus, Estonia, Ireland, Luxembourg and Malta due to data issues. Market sector excludes all public administration and defence, education and health and social care activities. Real estate activities and activities of households as employers are also excluded. Digital producing sector includes NACE sector C26-27 (Computer, electronic and optical products; electrical equipment) and sector J (Motion picture, video, television programme production; programming and broadcasting activities; telecommunications; Computer programming, consultancy, and information service activities). Market services exclude sector J. Other industry includes agriculture (A), mining (B), utilities (D-E) and construction (F)

While the available data do not allow the contribution of digitalisation to productivity growth within market services to be identified separately, there is clear evidence that productivity growth in wholesale and retail trade benefited substantially from digitalisation in the late 1990s and early 2000s. More recently, digital technologies, including AI, have also supported productivity gains in professional services in the U.S.. The implications of AI innovation and adoption for productivity are discussed further in Sections 3 and 4.

The relatively limited role of differences in industry structure between the euro area and the United States suggests that policies aimed at reshaping the euro area economy to mirror the US sectoral composition would yield only modest benefits. Instead, greater gains are likely to come from boosting productivity growth within existing industries. Instead, the large role for within industry productivity differences highlight the importance of policies that foster diffusion of innovations and support the widespread dissemination of new technologies in ways that encourage adoption and broad-based innovation across sectors, thereby generating faster productivity growth across the board, rather than relying on narrowly focused strategies that prioritise frontier innovation in a limited number of industries.

## 2.3 Sub-national productivity divergence

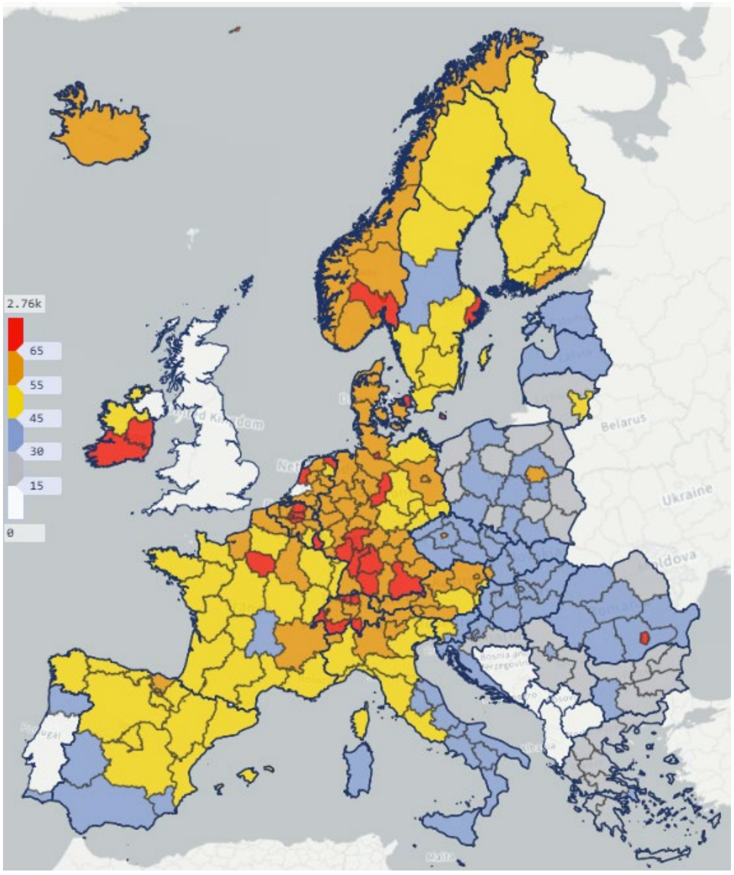
In recent years, increasing attention has been paid to productivity differences at the regional rather than the national level (Rodríguez-Pose et al., 2024). Chart 5 presents output per hour across NUTS-2 regions in the European Union in 2024. It highlights strong regional productivity hubs, often centred on major agglomerations such as the Southern and Eastern regions of Ireland, Bavaria, Stockholm, Paris, Amsterdam, and Brussels. By contrast, most regions in Southern, Central, and Eastern Europe remain relatively peripheral in productivity terms, with limited variation apart from a small number of capital regions (see also Chart 6).

A growing body of evidence suggests that convergence in productivity levels across European regions has largely come to an end. While the dispersion of output per hour across EU regions fell sharply during the 1990s and early 2000s, convergence has largely stalled since the GFC. Strikingly, once Central and Eastern European regions—where rapid catch-up followed EU accession—are excluded, productivity divergence across remaining regions has increased significantly since the GFC (Chart 7).

## Chart 5

Nominal Productivity per Hour Worked, EU Regions (NUTS-2), 2024

GDP in current prices per hour worked, NUTS 2 level, in euro national PPP converted, 2024

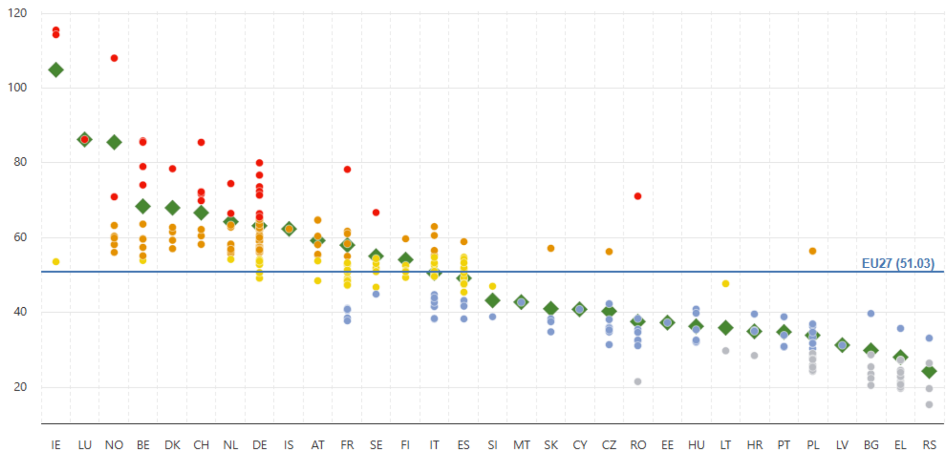



Sources: European Commission, ARDECO, accessed on 12-6-2026
Note: Key is for labour productivity converted using country-level purchasing power parities (PPP) from Eurostat/OECD; Estimates are in 15-30€ (grey), 30-45€ (blue), 45-55€ (yellow), 55-65€ (orange) and over 65€ (red).

## Chart 6

Distribution of Nominal Productivity per Hour Worked, EU Regions (NUTS-2), 2024

GDP in current prices per hour worked, NUTS 2 level, in euro PPP converted, 2024

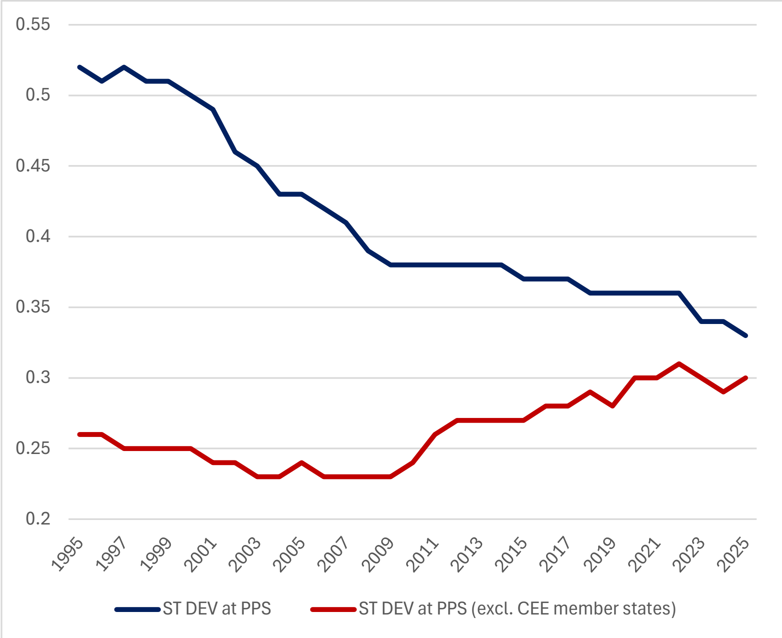



Sources: European Commission, ARDECO, accessed on 12-6-2026
Note: See Chart 5 for definition of variable and colour scheme. Green data point represents the average for the country.

**Chart 7**

Dispersion of Labour Productivity Levels, EU Regions (NUTS-2), 1995-2024

Standard deviation of GDP per hour worked, NUTS 2 level, in euro PPP converted




Sources: European Commission, ARDECO, accessed on 12-6-2026
Note: See Chart 5 for definition of variable.

Recent analysis suggests that, rather than converging uniformly, European regions tend to cluster into distinct productivity clubs, with leading regions maintaining their advantage while lagging regions risk falling into persistent productivity traps that reflect uneven patterns of innovation and diffusion. For example, Harb, Bassil and El Sahli (2024) find that high-performing clubs are predominantly concentrated in long-standing EU member states, especially in Northern and Western Europe. R&D intensity, high-technology employment, and innovation capacity appear to be among the strongest predictors of membership in high-productivity clubs. Many regions in Southern Europe, which often lack these capabilities, show signs of being trapped in persistently weak productivity trajectories. By contrast, newer member states often exhibit relatively rapid total factor productivity (TFP) growth, although this tends to occur mainly within distinct national or sub-national clusters rather than through convergence with the frontier.

Using EU NUTS-2 data, Zwerschke and Kluge (2025) identify four distinct convergence clubs within Europe, underscoring the role of regional agglomeration and disparities in shaping aggregate outcomes. Their hierarchy runs from globally competitive metropolitan innovation hubs, through diversified industrial regions, to structurally constrained and peripheral economies, reflecting differences in capabilities rather than simply income levels:

- **Frontier regions**, such as Île-de-France (Paris), Upper Bavaria (Munich), Stockholm, and Southern and Eastern regions of Ireland, combine strong innovation ecosystems, high R&D intensity, deep human-capital pools, and a concentration of headquarters and advanced services.

- **Near-frontier regions**, such as Lombardy, neighbouring regions of Bavaria, parts of Finland, and western Poland (for example, Wielkopolskie), have solid industrial bases and rising innovation capacity, but do not yet match the intensity and agglomeration advantages of the core hubs.

- **Constrained catch-up regions**, such as Andalusia, Central Portugal, Hungarian regions outside Budapest, and Southern Italy (for example, Campania), often have manufacturing or tourism bases but lack strong innovation systems and struggle to upgrade into higher-value activities.

- **Peripheral or trapped regions**, including parts of Greece (for example, Western Greece), rural Bulgaria, Romanian regions such as Nord-Est, and parts of Croatia, are characterised by low technological readiness, weak institutions, and limited integration into advanced sectors, making upward mobility particularly difficult.

Convergence to a common growth path within each group appears to be conditional on regions sharing similar structural characteristics, highlighting the importance of technological relatedness (Boschma and Frenken, 2011; Balland et al., 2019). Poorer regions do not automatically catch up but can escape low-growth traps when they cross critical thresholds in innovation, skills, and R&D investment. In this framework, technological readiness and innovation capacity emerge as key drivers of upward mobility between clubs.

Innovation activity in Europe is also becoming increasingly geographically concentrated, with a limited number of regions—typically major metropolitan areas and established science and technology hubs—hosting a disproportionate share of frontier firms and research-intensive activities. While agglomeration economies underpin this concentration, they can also reinforce regional disparities, as more advanced regions are better positioned to attract talent, investment, and high-complexity activities, while lagging regions remain less integrated into innovation networks (Pinheiro et al., 2025).

On the basis of this overview, the conclusion is that there is no simple one-to-one relationship between productivity performance and convergence across EU regions and countries. On the one hand, the existence of convergence clubs may reflect groups of structurally similar regions improving together because they share comparable innovation systems and production structures. On the other hand, it may indicate that the benefits of integration are unevenly distributed, with large differences between clubs preventing the EU from fully realising its potential. Long-term outcomes depend less on integration within the EU per se than on how regions and countries specialise within it. Where the free flow of capital, labour, and knowledge remains incomplete, these patterns may be reinforced, locking regions into existing specialisations. This issue is revisited in Section 5.3, which examines the role of innovation and diffusion in place-based productivity convergence.

### Box A: Has productivity measurement become more difficult?

A central question is the extent to which the measurement of productivity affects the analysis. International comparisons of productivity are complicated in at least three ways:

**The measure of output.** While most productivity studies rely on GDP from the national accounts as their measure of output, its suitability has been widely debated. Because GDP focuses on monetised transactions, it depends on reliable measures of prices and volumes to derive real output growth. These measures are becoming increasingly difficult to obtain in a digital economy characterised by intangible outputs such as data and digital services. Coyle (2025) argues that GDP has become difficult to measure for up to 80 percent of the economy because of failures to capture intangible value creation, quality change, and non-market activities adequately. GDP also includes a range of 'fictional' transactions, such as dwelling services for owner-occupiers and FISIM (Financial Intermediation Services Indirectly Measured), which complicate productivity measurement. To address these concerns, the GDP framework within the System of National Accounts (SNA) has been progressively expanded, most notably through the capitalisation of software in the 1993 SNA and R&D in the 2008 SNA. The forthcoming 2025 SNA revision extends this boundary further by recognising data as a produced asset (United Nations, 2025). In addition, work continues on incorporating marketing and branding assets, thereby improving the alignment between national accounts and the sources of value creation in modern, knowledge-based economies. A further limitation concerns the construction of price indices, which struggle to capture rapid quality improvements in digital goods and services, leading to a systematic understatement of real output and productivity growth (Nakamura, Samuels and Soloveichik, 2017; Goldin et al., 2024; Coyle, 2025). Brynjolfsson et al. (2019) propose an alternative measure, GDP-B ('B' for benefits), which incorporates consumer surplus from new and especially free goods, thereby providing a welfare-based measure of output that more fully reflects productivity gains in the digital economy.

**The measure of input.** Input-side measurement challenges mirror those on the output side. Extending the capital boundary to include intangible assets not yet capitalised in the national accounts, such as marketing, branding, and organisational capital, is essential for assessing the relative contributions of capital deepening and total factor productivity growth (Corrado, Hulten and Sichel, 2009, 2022). Section 4.2 discusses the role of intangible capital in technological change, knowledge diffusion, and business innovation in more detail. Measurement problems also affect other production inputs. Labour input, for example, remains difficult to measure accurately, especially working hours, which are often recorded inconsistently across sources and countries (Ward, Zinni and Marianna, 2018). Adjusting labour for human capital is equally challenging, since standard indicators based on educational attainment capture only part of the variation in skills, experience, and task composition in increasingly knowledge-intensive economies (Ward and Zinni, 2024). Similar issues arise for intermediate inputs, including energy, raw materials, and services, many of which are internationally sourced, where coverage, quality adjustment, and cross-country comparability can vary substantially. Taken together, these issues complicate the interpretation of productivity growth, especially TFP growth (see also Annex C).

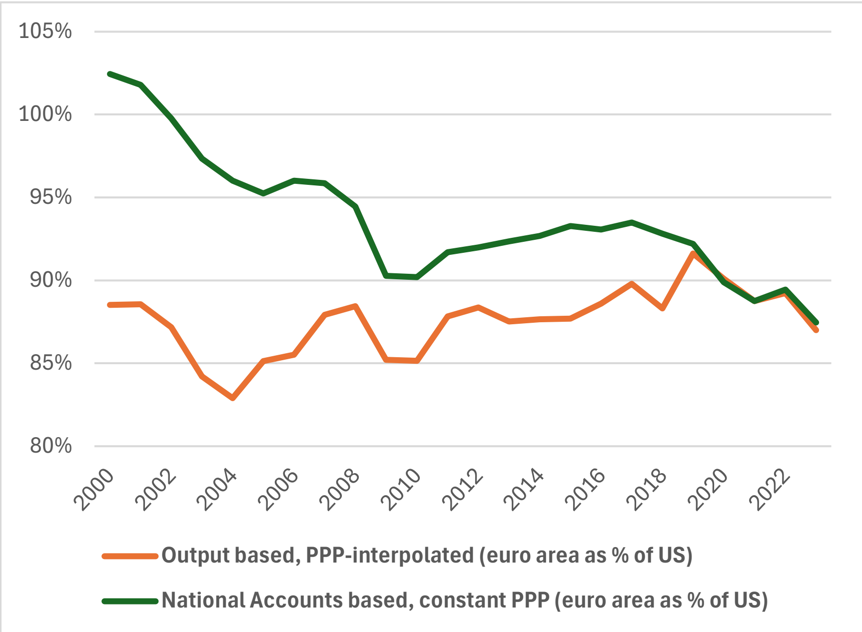
**The measure of comparative prices.** One of the most important, and often overlooked, issues in international productivity comparisons concerns the adjustment of output for differences in national price levels. This is typically done using purchasing power parities (PPPs) from the International Comparison Program (ICP), in which most UN member states participate (World Bank, 2024). For comparisons over time, analysts usually rely on constant-price PPPs, which benchmark GDP to a single year (most recently 2021) and preserve the consistency of national accounts growth rates.

However, for comparisons at a given point in time, current-price PPPs may provide a more accurate picture, as they avoid index-number problems associated with extrapolating benchmark data. Leaving quality differences, data limitations, and index-number issues aside (Deaton and Heston, 2010), constant- and current-price measures should yield similar results if price measurement across countries and over time is consistent. In practice, however, these methods often diverge, reflecting differences in how prices are measured across countries (for an accessible explanation of the concerns, see Ackerman, 2026). To address these issues, the Penn World Table provides an alternative measure of output, combining current-price PPP benchmarks from successive ICP rounds with national accounts data to interpolate and extrapolate across years (Inklaar and Rao, 2020; Inklaar, 2026). This measure suggests a more stable productivity gap between the euro area and the United States than implied by constant-price PPP measures, with euro area output per hour remaining at around 80–90 percent of the US level since the early 2000s. Unsurprisingly, the two measures have converged more closely since the late 2010s, as both now draw on the 2021 PPP benchmark for the most recent period.

**Chart A.1**

Comparative Measures of GDP per hour in the euro area as a percentage of the US, based on constant-price expenditure PPPs and interpolated output PPPs

Constant price National Accounts Expenditure PPP (2021) (green line) versus interpolated Output-adjusted PPPs between benchmark years (1993, 2005, 2011, 2017 and 2021) (orange line)




Sources: Penn World Table vs. 11.0; https://www.rug.nl/ggdc/productivity/pwt/?; Feenstra et al. (2015).

**Overall assessment.** The extent to which measurement issues affect comparative productivity performance between Europe and other major economies remains difficult to quantify. On the one hand, the gap may in fact be understated because the larger share of digital activities in the US economy may involve more unmeasured intangibles (Brynjolfsson, Rock and Syverson, 2021). Consistent with this view, Bounfour et al. (2026) find that the undermeasurement of productivity growth in Germany, France, Japan, and the United Kingdom may be smaller than in the US, because higher adjustment costs associated with intangible investment—especially organisational change—have been more pronounced in the US, while European firms have adopted such changes more slowly.

At the same time, the use of constant-price PPPs may have overstated the widening productivity gap between the United States and Europe. This reflects stronger measured price declines in US digital sectors, driven by the more extensive use of hedonic methods and the introduction of new software price indices (Lawless, 2006; Byrne, Fernald and Reinsdorf, 2016), which can distort comparisons of real output levels over time.

Overall, the prevailing view in the literature is that measurement issues, while relevant, are not large enough to explain the bulk of the transatlantic productivity divergence. Goldin et al. (2024) acknowledge that mismeasurement associated with intangible and digital activities affects productivity estimates but conclude that these effects account for only a limited share of observed differences between countries, which are primarily driven by structural and technological factors. Although measurement biases may have become more important in recent years, particularly given the larger digital footprint of the US economy, upward and downward effects are likely to offset each other at least in part.

This suggests that understanding the faster transformation of the digital economy in the United States is key to explaining the persistence of the productivity gap in Europe. A more granular, sector- and firm-level analysis is essential for understanding how technology and innovation shape the aggregate productivity gap.

# 3 Innovation, Diffusion and Adoption

While Section 2 has highlighted the risks of assuming a direct and unconditional relationship between innovation and productivity, Europe’s recent productivity slowdown is nonetheless often attributed to weaker innovation dynamics, particularly in the context of its declining competitiveness relative to major economic blocs such as China and the United States (European Commission, 2023; Draghi, 2024). This section examines that claim by reviewing the evidence on Europe’s innovation performance, including declining research productivity, weaker disruptive innovation, and growing productivity dispersion across firms.

The discussion shows that upstream innovation efforts are closely intertwined with downstream processes of diffusion and adoption, underscoring the need for an integrated approach that spans the full innovation and diffusion system, from frontier innovation to final use (see Box B for a description of this system).

It is important to stress from the outset that innovation-related factors should not be treated as separate from the broader set of explanations for Europe’s productivity slowdown. Declining business dynamism, lack of market contestability, regulatory fragmentation, incomplete Single Market integration, weaker capital deepening, and persistent scale-up gaps are all closely intertwined with the innovation and diffusion system. These issues are therefore addressed throughout this section as well as in Sections 4 and 5, which examine their implications for investment and policy, respectively.

Mission-related technologies are important to Europe’s security and resilience, notably those linked to the green transition and, more recently, defence and security. While these demand-pull areas fall largely outside this section’s discussion of the main trends in innovation and diffusion, the key policy issues they raise—particularly around direction-setting, demand creation, and coordination—are taken up in Sections 5 and 6.

Taken together, the evidence in this section does not support a simple view in which Europe suffers from an “innovation deficit” alone. Europe’s challenge lies increasingly in the uneven translation of innovation into broad-based productivity gains, reflecting weak diffusion, limited scale-up, and insufficient complementary investments in intangible assets, skills, and organisational capabilities. As discussed further in Sections 4 and 5, these constraints make the returns to innovation more uneven, more uncertain, and slower to materialise across firms and sectors.

Section 3.1 examines the main channels through which innovation and diffusion affect productivity. Section 3.2 addresses Europe’s challenges by reviewing the literature on innovation and diffusion from a longer-term perspective. Section 3.3 then turns to recent trends in the adoption of AI as a contemporary case study, highlighting the considerable uncertainty surrounding the pace of diffusion and its implications for productivity growth.

## 3.1 Why innovation does not automatically raise productivity

The link between innovation and productivity is well established in the literature (Fagerberg and Verspagen, 2020; Benhabib, Perla and Tonetti, 2021; Mairesse, Mohnen and Nolten, 2025). Those channels can be specified more explicitly to clarify how innovation affects productivity. For the purposes of this discussion, it is useful to distinguish between frontier innovation, dissemination, and absorption as key elements of the broader innovation and diffusion system (see Box B).

A recurring concern in the literature is that innovation has not always translated into productivity growth as strongly or as consistently as expected. One argument points to a decline in research productivity, implying slower effective innovation at the frontier (Bloom et al., 2020). As the generation of new ideas has become more complex, it increasingly requires larger and more specialised research efforts, resulting in falling research productivity despite rising R&D inputs. A second explanation emphasises that recent frontier technologies may be less transformative in character, generating more incremental improvements, reaching a narrower range of sectors, and producing weaker economy-wide spillovers, thereby contributing to the structural productivity slowdown (Gordon, 2016). Both arguments, however, need to be reconsidered in light of recent advances in AI (see Section 3.3), although the broader question is unlikely to be explained by AI alone. For example, recent firm-level evidence for the United States suggests that the link from research inputs to ideas may not have weakened as much as the aggregate evidence implies, and that the more important constraint may instead lie in the translation of ideas into wider productivity growth, including through spillovers and diffusion across firms (Fort et al., 2026).

Even if technological change has recently accelerated, particularly through advances in AI, productivity dynamics still vary markedly across industries, as discussed in Section 2.2. The increasingly uneven sectoral distribution of innovation may itself be an important reason for the productivity slowdown, insofar as it creates bottlenecks in production and supply-chain networks that prevent technological advances in leading sectors from translating into broad-based productivity gains across the wider economy (Acemoglu, Autor and Patterson, 2023).

Several of the key digital technologies that emerged during the 2010s reflected a broader transition towards mobile devices, ubiquitous broadband access, cloud computing, and advances in AI and robotics (Van Ark, 2016; Van Ark, De Vries and Erumban, 2021). Brynjolfsson, Rock and Syverson (2021) formalise the time-lag dimension of this process through the “productivity J-curve”, showing that initial investments in intangible assets, such as data, skills, management, and organisational change, are necessary precursors to future productivity gains (see Section 4.2). Because these investments divert resources and are only imperfectly measured in the short run, measured productivity may initially fall before rising once the new technology is effectively deployed and the complementary assets begin to generate returns.

A key, and often underemphasised, explanation for the productivity slowdown lies in staggered firm-level adoption decisions, even when new technologies are readily available. Firms' adoption choices reflect an assessment of expected benefits relative to costs, shaped by organisational and managerial capabilities, access to skills and finance, and internal incentive-related barriers (Hall and Khan, 2003; Comin and Hobijn, 2010; Atkin, Khandelwal and Osman, 2017; Svanberg et al, 2024). More recent evidence suggests that adoption has become particularly challenging in digital- and skill-intensive sectors, where constraints related to capabilities, skills, and finance remain especially pronounced in many European countries (Berlingieri et al., 2025; Roper, Jibril et al., 2025). There is also evidence that competitive barriers slow technology diffusion, particularly where complex software and proprietary information technologies allow large firms to strengthen their advantages over smaller competitors (Bessen, 2022). From a business-innovation perspective, the effective use of new digital technologies often requires substantial changes to organisational structures and business innovation models, which further complicates implementation (Velu, 2024).

Long diffusion lags may be further exacerbated by the high degree of uncertainty under which firms make adoption decisions. A substantial body of firm-level evidence points to the slow diffusion of frontier technologies from leading to lagging firms, highlighting the role of policy and market frictions in constraining adoption (Andrews Criscuolo and Gal, 2016; Nicoletti, von Rueden and Andrews, 2020). Periods of heightened demand and supply shocks—such as those following the global financial crisis and the COVID-19 pandemic—have been associated with greater economic policy uncertainty, which in turn dampens final demand and discourages investment (Baker, Bloom and Davis, 2016). At the same time, rising market concentration, insufficient regulatory adaptation, and short-termist policy frameworks may have reinforced these uncertainties, further reducing firms' willingness to undertake high-risk, high-return investments in innovation (see also Section 5.2).

Taken together, these factors help explain why, despite the rapid expansion in the availability and accessibility of new technologies, the "new innovation economy" has remained in a prolonged and uneven installation phase (Perez, 2002). Consistent with a general-purpose-technology framework, broad-based productivity gains are likely to materialise only once these technologies move into a fuller deployment phase, characterised by widespread adoption, complementary investments, and organisational transformation.

## 3.2 Does Europe have an innovation problem?

While the question of whether Europe has an innovation problem may appear straightforward, the previous discussion suggests the need for a more nuanced assessment of where the main bottlenecks lie in the innovation and diffusion process. Such an assessment can draw on a substantial empirical literature examining the relationship between innovation and productivity in Europe.

A useful starting point is the Crépon–Duguet–Mairesse (CDM) framework, which models the innovation and diffusion system as a two-stage process linking firms' R&D investment or other technological efforts to innovation outputs and, in turn, to productivity outcomes (Crépon, Duquet and Mairesse, 1998). This framework aligns closely with the upstream and downstream components of the innovation and diffusion system set out in Box B and helps distinguish between innovation productivity at the frontier and economic productivity in downstream adoption and use.

Owing to the widespread availability of harmonised firm-level data from the Community Innovation Survey (CIS), the CDM approach has been widely applied across European countries (Segarra-Blasco, Garcia-Quevedo and Teruel, 2022). This body of research points to a positive, though heterogeneous, relationship between innovation and productivity in Europe, with important differences across sectors, firm types, and modes of innovation. For example, process and organisational innovations often appear to have stronger productivity effects than product innovation, particularly in Europe's service-dominated economies, where non-technological innovation plays a relatively large role (Polder et al., 2010; Segarra-Blasco, Garcia-Quevedo and Teruel, 2022; Mairesse, Mohnen and Notten, 2025). Smaller firms, however, often lack the complementary capabilities, such as digital infrastructure, management practices, and skilled labour, needed to translate innovation into higher productivity (Hall, Lotti and Mairesse, 2013; Bartelsman, Van Leeuwen and Polder, 2019).

A specific European innovation challenge links to firms' limited ability to scale. Criscuolo, Gal and Menon (2014) show that, although start-up sizes are broadly similar across countries, firms in the United States grow much more after entry, resulting in significantly larger mature firms than in Europe. The average European firm that has been in operation for at least 25 years employs around 10 workers, compared with roughly 70 workers in a similarly aged firm in the United States (Cerdeiro, Danninger and Maneely, 2026, based on IMF firm-level analysis including Adilbish et al., 2025). Regulatory thresholds at specific firm sizes, market fragmentation within and across countries, incomplete Single Market integration, and constraints on access to growth finance all prevent European firms from expanding efficiently across borders (IMF, 2024a; Adilbish et al., 2025). These frictions contribute to persistently smaller average firm sizes and weaker resource reallocation, limiting diffusion and amplifying productivity dispersion (Bartelsman, Haltiwanger and Scarpetta, 2013; Andrews, Criscuolo and Gal, 2016). As digital technologies increasingly exhibit strong scale economies, network effects, and winner-takes-all dynamics, the costs of these constraints have risen over time, contributing to the deepening, of Europe's productivity slowdown (OECD, 2015a).

European firms also face a well-documented "scale-up finance gap", rooted in structural weaknesses in the region's financial system. Firm-level evidence indicates that limited access to market-based financing is a key bottleneck for frontier firms, restricting their ability to scale and diffuse innovation (Adilbish et al., 2025). The shortfall is particularly acute in the later stages of commercialisation, when inventions are ready for market but a lack of large-scale funds and limited participation by institutional investors constrain access to growth capital. European scale-ups raise around 50 percent less capital than their US peers after 10 years, reflecting the much smaller size of European venture capital (VC) markets, which are roughly one-sixth the size of those in the United States (EIB, 2025). At the aggregate level, VC investment totalled just €89 billion in the EU, compared with more than €1,000 billion in the United States between 2014 and 2023 (Collet et al., 2026).

These funding weaknesses are compounded by fragmented national financial systems, which impede the mobilisation of large pools of capital and contribute to Europe's declining share of global market capitalisation, now around 12 percent, down from 25 percent two decades ago (European Commission, 2025). At the same time, weaknesses in the European venture capital ecosystem often lead high-growth firms to seek financing abroad, implying a loss of domestic growth spillovers and reinforcing the scale-up gap (Martens, 2024).

Finally, labour market frictions can raise the cost of scaling up and, more broadly, of adopting technologies that require substantial restructuring. Where restructuring costs are high, the expected return on risky innovation falls, reducing both entry incentives and late-stage investment, especially for high-risk firms whose value depends on a small number of successful scale-ups (Coatanlem and Coste, 2024). Employment protection legislation also appears negatively associated with the adoption of AI and other technologies requiring significant workforce reorganisation, because restructuring costs raise the productivity threshold required for adoption (Canton, 2026; Cette, Nicoletti and Vernerey, 2026).

These findings reinforce the broader argument that Europe's innovation problem is not primarily a shortage of new ideas, but the institutional conditions that shape whether those ideas are commercialised, disseminated and adopted at scale. The policy challenge for Europe is therefore to lower the cost of productive reallocation while strengthening business dynamism.

## 3.3 How widespread is AI adoption?

In recent years, the emergence of AI as a transformative technology has attracted widespread attention for its potential to drive innovation and reshape productivity dynamics. Consistent with the upstream–downstream distinction in the innovation and diffusion system outlined in Box B, AI can be understood as a frontier invention that creates substantial opportunities for downstream innovation. In this sense, AI exhibits the characteristics of a general-purpose technology (GPT): it appears widely applicable across sectors, can stimulate complementary innovations, and is capable of generating continuous improvement over time. Moreover, AI may enhance the process of knowledge creation and frontier innovation itself by improving R&D productivity and idea generation, thereby functioning as an 'invention in the method of invention' (IMI) (Baily et al., 2026; Bontadini et al., 2026). The scope of this latter effect remains uncertain, but it may have important implications for long-term productivity growth, including for the productivity gap between the United States and Europe (see also Section 4.3).

This section focuses on the innovation and diffusion effects of AI, treating AI adoption as a real-time case study of the challenges Europe faces in diffusing and implementing new technologies. Assessing AI adoption requires distinguishing between two elements: the share of tasks or sectors exposed to AI that could potentially be automated, and the extent of effective adoption in practice (Lindenlaub et al, 2026). Task exposure has been widely studied (Autor, 2015; Gmyrek, Berg and Bescond, 2023; Pizzinelli et al., 2023; Eloundou et al., 2024). The remainder of this section therefore concentrates on the second element—effective adoption—with the aim to better understand the considerable heterogeneity in firm-level uptake. The productivity effects of AI are examined separately in Section 4.3.

**Survey issues.** Adoption measures are typically derived from surveys, but reported rates vary widely depending on methodology and survey design. Three main factors help explain these differences: who is surveyed, what is measured, and how questions are framed. First, respondent type matters. Surveys of senior executives and managers often yield higher adoption estimates than surveys of frontline workers, reflecting differences in expectations, awareness, or strategic intent rather than actual usage (Lovich, Meier and Taylor, 2025; Yotzov et al., 2026). At the same time, worker surveys often record higher rates of AI use than firm-level surveys, because they are more likely to capture informal, embedded, or task-level use that may not be reported as firm-wide adoption (Bick et al., 2026). Similarly, large firms consistently report higher AI adoption than small and medium-sized enterprises, reflecting greater resources, digital capabilities, and organisational readiness (OECD, 2025b; Eurostat, 2025).

Second, how AI is defined is equally important. Reported estimates differ depending on whether surveys focus only on generative or other advanced AI systems, or also include broader applications such as machine learning, automation tools, or data analytics. Studies using narrower, more clearly specified definitions tend to report lower adoption rates, whereas broader definitions, including tools used for text, image, or data processing, typically produce higher estimates (Brynjolfsson, Li and Raymond, 2023; Pizzinelli et al., 2023).

Third, question framing also matters. Surveys that capture any form of AI use, including indirect or “embedded” use through existing software (for example, search engines or navigation tools) or employee-driven ‘bring-your-own AI’ (BYO-AI) practices, tend to report much higher adoption rates than those that focus narrowly on deliberate firm-level implementation.

As a result, reported adoption rates vary widely. It is important to note that most available measures capture adoption on the extensive margin: whether firms, workers, or organisations report using AI at all. They say much less about the intensive margin: how frequently AI is used, how many workers or business functions are affected, how deeply it is integrated into workflows, or whether it leads to organisational change.

**AI adoption rates.** Official statistics, such as those from the US Census Bureau (2023) and Eurostat (2025), typically place current adoption rates at between 10 and 20 percent in representative samples of firms. By contrast, private-sector surveys, often based on broader definitions and responses from larger firms and senior executives, frequently report rates above 70 or even 80 percent. For example, McKinsey’s Global AI Survey finds that around 88 percent of large global organisations report using AI in at least one business function, based on surveys of senior leaders and executives (McKinsey, 2025). This wide dispersion highlights the importance of interpreting AI adoption statistics carefully and understanding the underlying measurement choices.

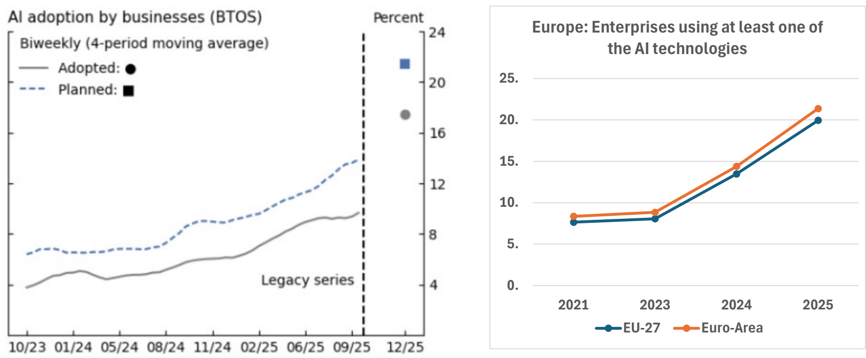
Given these caveats, where does Europe stand? Charts 8a and 8b report recent official survey-based adoption rates for the United States and Europe, respectively. The US Census Bureau's biweekly Business Trends and Outlook Survey (BTOS) captures recent and repeated AI use over two-week periods, but revised the survey question in November 2025 from "use of AI in producing goods or services" to "use of AI in any business functions" which substantially raised actual and planned adoption rates in the latest measures. European figures cover enterprises with 10 or more employees and self-employed persons using at least one AI application: text mining, speech recognition, natural language generation, audio-visual analysis, image processing, machine learning, or robotics.

### Chart 8

AI Adoption Rates according to Official Surveys, US and Europe

(8a) United States

(8b) European Union and euro area




Sources: U.S. Census Bureau, Business Trends and Outlook Survey, June 2026; Eurostat, Artificial intelligence by size class of enterprise, February 2026.
Note: In November 2025, the Census Bureau revised the AI questions in the BTOS to focus on firms' use of AI in "any of their business functions" rather than in "producing goods or services". Planned adoption refers to expected adoption over the following six months. European figures cover enterprises with 10 or more employees and self-employed persons using at least one of the following AI applications: text mining, speech recognition, natural language generation, audio-visual analysis, image processing, machine learning, or robotics.

Within Europe, variation is substantial, ranging from levels in the mid- to upper-30 percent range in several Nordic countries to just over 10 percent in parts of Southern and South-Eastern Europe. Despite differences in definitions and measurement, the charts highlight two main points: first, AI adoption has accelerated in recent years; and second, overall adoption levels remain low relative to the technology's perceived transformative potential.

As these measures are typically at the extensive margin of AI use, ECB SAFE survey data provide a stricter measure of use intensity: only around 7 percent of euro area firms report "intensive use of AI", defined as use "beyond infrequent or moderate levels and, in particular, use linked to innovation or the expansion of products and services" (Chaloupka, Lalinský and Lopez-Garcia, 2026).

Evidence from the United States, Europe, and the United Kingdom also points to a strong and systematic increase in AI adoption with firm size. Large firms are typically between 1.5 and 3 times more likely to adopt AI than small firms, with adoption rates often exceeding 40–50 percent among large enterprises in Europe and the UK, compared with roughly 15–25 percent among smaller firms. This concentration of adoption among larger firms implies that employment-weighted measures of AI use are substantially higher than simple firm-level averages (Crane, Green and Soto, 2025). It also suggests that effective AI use may be higher in the United States than in Europe, given the greater presence of large firms in the US economy.[3]

Based on a survey of around 6,000 senior executives (CEOs, CFOs, and senior managers) across the United States, the United Kingdom, Germany, and Australia, Yotzov et al. (2026) show that AI adoption is widespread, though with notable cross-country variation. On average, around 70 percent of firms report using AI, defined broadly as any current use of AI technologies within the firm, including applications such as generative AI (for example, text generation). The United States leads with 78 percent, followed by the United Kingdom at around 70 percent, Germany at roughly two-thirds of firms (65–70 percent), and Australia at 59 percent. Crucially, productivity effects remain limited so far, with around 90 percent of executives reporting no impact to date, despite more optimistic expectations for future gains. This apparent lag likely reflects the low intensity of use—averaging only around 1.5 hours per week—the early stage of deployment, and the need for complementary investments and organisational change, suggesting that widespread adoption has not yet translated into measurable productivity improvements.

Bick et al. (2026) show that measured AI adoption varies sharply with definition and survey design, with much higher rates reported in worker-level surveys of broad generative AI use (43 percent in the United States and 32 percent in Europe) than in firm-level surveys based on narrow “production” definitions (7 percent and 4 percent, respectively). The authors decompose the US–Europe adoption gap into compositional factors and management practices, finding that differences in worker and firm characteristics, such as demographics, occupations, industries, and firm size, account for about 55 percent of the gap, while variation in management practices plays an important additional role. In particular, once account is taken of whether employers actively encourage and support the use of AI, management-related factors can explain up to around 80 percent of the adoption gap, highlighting the central role of organisational policies and workplace practices in shaping cross-country differences in AI diffusion.

Using evidence from UK firm-level data, Poquiz et al. (2026) provide further support to the importance of managerial quality for AI adoption. After controlling for size, age, industry, and location, firms with higher baseline management scores in 2020 were significantly more likely to adopt AI by 2023. Importantly, this relationship appears to be specific to AI adoption, with no statistically meaningful link to the adoption of

[3] Interestingly, the ECB SAFE data suggest a different pattern for intensive use: small firms report intensive AI use more frequently than larger firms, and younger firms active for less than ten years report such use more often than older firms.(Chaloupka, Lalinský and Lopez-Garcia, 2026). This may indicate that intensive AI use is concentrated among a subset of more agile, scale-up firms, even if overall adoption remains higher among larger enterprises.

robotics, specialised software, or equipment, and only a much smaller effect for cloud computing, which was less than half as large as for AI. In particular, data-driven performance management and organisational coordination emerge as binding constraints on adoption. Overall, the evidence suggests that management is not merely complementary to AI diffusion, but a key differentiator to capturing productivity gains.

An EU-specific study by Cette, Nicoletti and Vernerey (2026) highlights that the diffusion of AI depends on a range of interrelated factors, among which adoption costs play a central role. Barriers to high adoption (that is, using at least 3 AI technologies) in the early period (2021-2024) were linked primarily to costs due to legal, ethical, and data protection concerns. However, as adoption broadened after 2024, the binding constraint shifted to whether firms have the expertise, data, and compatible systems to make productive use of AI. Limited human capabilities likewise emerge as a major structural barrier to broader AI deployment: firms with stronger ICT skills, training, and organisational capital are significantly more likely to adopt AI at scale. These issues are explored in more detail in Section 4.

The European Commission (2026) finds that AI adoption in Europe is expanding but remains uneven and largely incremental. While firms are increasingly using AI to improve efficiency and automate specific tasks, strategic integration into core business models is still limited. Sectoral differences are pronounced, with digitally advanced industries leading due to stronger capabilities, while others continue to face persistent structural barriers. Adoption is concentrated mainly in mature, lower-risk applications, with more transformative systems still seeing limited uptake. Across sectors, AI use tends to remain modular and task-specific, varying along the value chain and only rarely translating into broader organisational transformation, thereby reinforcing a two-speed pattern of diffusion.

Taken together, the evidence suggests that AI adoption has been rising quickly, especially since 2024, but remains relatively modest once the distinction is made between simple adoption on the extensive margin and deeper, productivity-relevant use on the intensive margin.

**Is European catch-up on AI still possible?** While results vary across studies, recent worker- and firm-level evidence consistently shows that AI adoption remains higher in the United States than in Europe (Bick et al., 2026). Despite this gap, AI remains a general-purpose technology that is still in its installation phase and, for many applications—particularly generative AI and advanced analytics—at an early stage of deployment. As will be further documented in Section 4.3, AI could still generate annual productivity gains in Europe of around 0.2–0.3 percent in TFP, and potentially twice or three times as much for labour productivity. For this, Europe will have to strategically invest in frontier layers of the AI stack, such as foundation models and compute infrastructure, although currently the economics of general-purpose technologies imply that much of the value creation may occur in downstream application layers. There, productivity gains depend on the sector-specific adaptation and integration of AI into business processes, which in turn require complementary investments in skills, organisational capital, and other intangible assets rather than frontier R&D alone (Brynjolfsson, Rock and Syverson, 2021; Acemoglu, 2025).

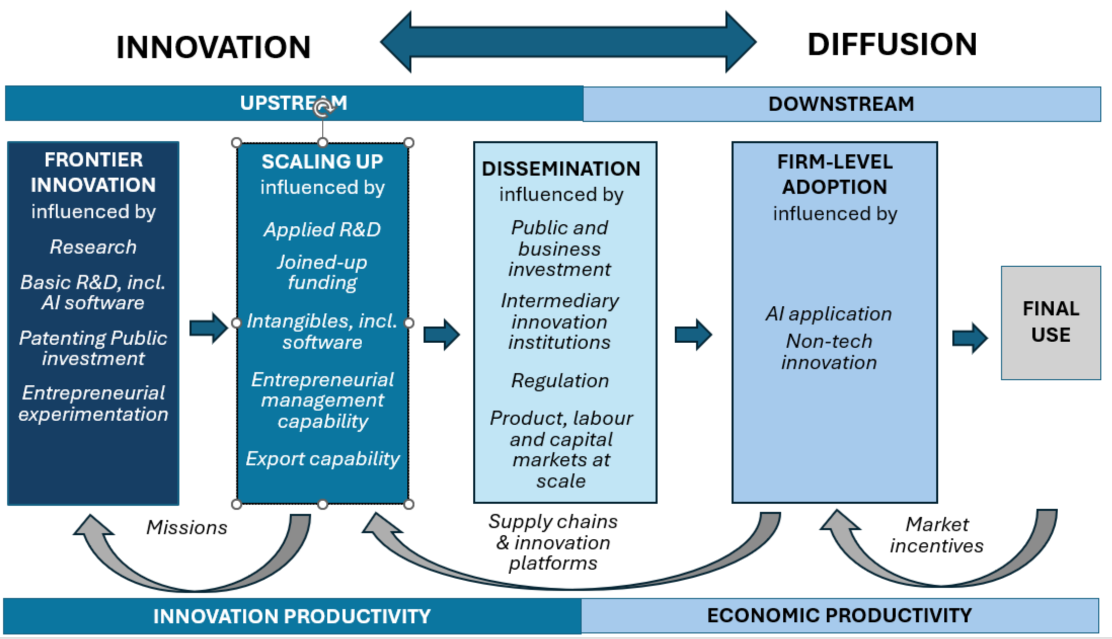
However, to fully exploit the opportunities, Europe will need to work on resolving a combination of structural constraints. First, weaker scaling dynamics and less developed capital markets, especially in venture capital, limit the ability of European firms to grow and deploy AI at scale, particularly in upstream segments, relative to their US counterparts. Second, fragmentation across national systems creates uneven regulatory and policy environments, resulting in smaller effective markets, higher coordination costs, and persistent barriers to cross-border expansion. Third, while effective AI regulation can enhance trust and reduce risks, it may also dampen incentives for experimentation and slow the pace of AI adoption and diffusion (OECD, 2022; Acemoglu, 2025; see also discussion in Section 3.2).

## Box B: The innovation and diffusion system

Because this paper focuses on the effects of innovation and diffusion on productivity, it is important to define the key terms clearly. Concepts such as 'technology', 'innovation', 'diffusion', and 'adoption' are often used interchangeably in the literature, obscuring important distinctions and complicating policy debate. Chart B.1 addresses this by presenting an integrated framework that maps the full innovation system from the creation of new knowledge and inventions, through their diffusion across firms and sectors, to their eventual effects on aggregate productivity and the wider economy.

A common distinction is between innovation and diffusion, which may also be understood as the upstream and downstream components of the system, respectively. In this framework, innovation refers primarily to radical advances that expand the frontier by generating new knowledge, inventions, and techniques.[4] Diffusion, by contrast, captures the downstream process through which these innovations spread across firms, sectors (or other clusters of economic activity), and regions and are put to use in the production of goods and services for final demand.

**Chart B.1**
The Innovation and Diffusion System




*Sources: based on Zahra and George (2002), Benhabib, Perla and Tonetti (2021), Corrado et al. (2022), Van Ark, De Vries and Pilat (2024).*

Innovation and diffusion play distinct but complementary roles in shaping productivity. Innovation raises the productivity frontier—whether at the global, national, or regional level—by transforming new knowledge, inventions, and techniques into commercially valuable outputs. Diffusion, in turn,

[4] This is not to suggest that all innovation takes the form of radical frontier advances. Incremental innovation—including new or improved products, services, and processes—can also make an important contribution to an economy's innovative capacity. This broader view is consistent with the OECD/Eurostat Oslo Manual (2018), which defines innovation as "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)". See also below and Section 3.2.

determines how widely and how rapidly these gains spread across the economy through firms' adoption and implementation decisions. This distinction matters because the incentives, risks, capabilities, and actors involved differ markedly across the two stages, shaping both the pace and the distribution of growth (Benhabib, Perla and Tonetti, 2021). Ultimately, productivity growth depends not on innovation or diffusion in isolation, but on the strength of their interaction and the balance between them.

**Frontier innovation and scaling up.** Focusing on the left-hand side of Chart B.1, the innovation and diffusion system can be broken down into two critical steps. The first is frontier innovation, involving the transformation of new knowledge, ideas, and inventions into advances at the technological or scientific frontier, typically undertaken by universities, public research organisations, corporate R&D laboratories or serial entrepreneurs. The second is scaling up: the process through which frontier innovations are scaled up and translated into commercially viable innovations in processes as well as products and services that can be brought to market. The transition from frontier innovation to scaling up is a critical stage in the innovation process, but one that is often hindered by barriers commonly referred to as "valleys of death". These barriers include not only funding gaps, but also weak knowledge transfer—especially of tacit knowledge—as well as scale-up challenges and insufficient demand. Together, these constraints create a wedge between research and successful innovation (Auerswald and Branscomb, 2003; Beard et al., 2009).

**Dissemination.** Turning to the right-hand side of Chart B.1, diffusion reflects the aggregate outcome of decisions by public and private sector organisations to adopt and implement innovations in production processes, organisational practices, and business models (Rogers, 2003). While market incentives play a central role in shaping these decisions, as firms weigh uncertain costs against expected benefits, diffusion is also influenced by institutional and governance-related factors beyond the control of individual adopters (Hall and Khan, 2003). On the positive side, these factors include spillovers—especially from R&D—as well as complementarities between innovation and institutions. But they can also create barriers, including imperfect product or labour market structures, insufficient complementary public investment, and regulatory or policy settings that limit access to, or weaken incentives for, adoption (see, for example, Van Ark, De Vries and Pilat, 2024; and Box D). These system-level conditions critically shape how widely productivity gains are disseminated across the economy, which is particularly important in the context of digitalisation (Nicoletti, Von Rueden and Andrews, 2020; Labhard, Lehtimäki and Baccianti, 2025).

**Firm-level adoption and absorptive capacity.** Adoption is strongly shaped by firms' absorptive capacity, which is a key mechanism linking diffusion to productivity outcomes in Chart B.1. Internal capabilities such as applied R&D enable firms to recognise the value of external knowledge, assimilate it, and exploit it commercially (Cohen and Levinthal, 1990). Zahra and George (2002) distinguish between potential absorptive capacity – defined as the ability to acquire and assimilate external knowledge –, and realised absorptive capacity – defined as the ability to transform and exploit that knowledge effectively in production, organisation, or market-facing activity –. This distinction is important because firms often learn about new technologies or innovations faster than they learn how to use them productively. Adoption on the extensive margin may therefore occur without substantial productivity gains if firms lack the organisational routines, managerial capabilities, and complementary investments needed to translate knowledge into effective use. Bridging the diffusion-productivity gap depends on coordination routines, knowledge-sharing mechanisms, and organisational capital—especially managerial quality—which enable firms to integrate, adapt, and operationalise new knowledge in ways that raise productivity (Bessen, 2015).

**Non-technological innovations.** Non-technological innovation, notably organisational and marketing innovation, plays a critical role in the broader innovation and diffusion system. These forms of innovation are often incremental in nature, but they are frequently essential to the adoption, adaptation, and effective use of other innovations (Hall and Khan, 2003). They are particularly prevalent in services sectors, where innovation often takes the form of new business models, pricing strategies, branding approaches, workplace practices, service concepts, client interaction models, organisational structures, and delivery systems (Den Hertog, Broersma and Van Ark, 2003; Den Hertog, Poot and Meinen, 2006). In many cases, the main innovation mechanism lies not in frontier technological invention itself, but in organisational redesign and new business models that reshape how labour is deployed, how services are delivered, and how firms interact with clients and suppliers. At the same time, access to technologies often remains an important enabling condition, especially in the current digital and AI era, where gains increasingly depend on combining technological tools with complementary changes in organisation, skills, and management (see also Section 3.3).

**System characteristics.** The stylised representation in Chart B.1 depicts the innovation and diffusion system as a sequence running from frontier research through scaling up to dissemination and adoption. This necessarily simplifies a much more complex reality. In practice, innovation and diffusion are not linear processes, but are characterised by multiple feedback loops and dynamic interactions across stages. Users and adopters, for example, provide critical market signals that shape both the direction of frontier innovation and the incentives for firms to adopt, adapt, and refine new products, processes, and services. Similarly, supply chains play a central role in business-to-business contexts, transmitting knowledge, demand signals, and innovation incentives both upstream and downstream, and thereby reinforcing complementarities between producers, suppliers, and users. Public policy also feeds into this system. Mission-oriented government initiatives—such as those aimed at climate change, security and resilience, or population ageing—can create powerful direction-setting and demand-pull incentives for frontier innovation, while also influencing the speed and pattern of downstream diffusion. More generally, systems-of-innovation approaches emphasise that outcomes depend on the alignment and interaction of complementary assets across the entire innovation and diffusion system, as well as on the quality of relationships among diverse actors and institutions operating at national and regional levels (Lundvall, 1992). Chart B.1 should therefore not be interpreted as a linear pipeline, but as a systemic framework in which interconnected processes jointly shape the pace, breadth, and distribution of productivity growth.

In Section 5 we discuss the policy implications of this more detailed analysis of the innovation and diffusion system.

# 4 An investment approach to innovation

Innovation depends on investment in both tangible and intangible assets, linking it directly to capital deepening. Investment matters not only because it expands the capital stock and productive capacity, but also because spending on digital assets, R&D, and data infrastructure is a key driver of technological progress and productivity growth. High-quality public investment, particularly in public R&D, education, and digital and green infrastructure, can crowd in private investment and support long-term growth. In addition, investment in human capital, including skills, and organisational capital, including managerial capabilities, can have lasting effects on firms' capacity to innovate and raise productivity, even if such expenditures are not formally treated as investment in current accounting frameworks.

Weak investment would therefore be a major constraint on productivity growth and innovation in Europe. The idea of an 'investment gap' has become central to recent European policy debates, including the influential reports by Draghi (2024) and Letta (2024). Section 4.1 compares recent trends in investment and capital deepening across Europe and other advanced countries, asking whether the recent weakness in capital deepening reflects a structural investment shortfall that has been contributing to slowing productivity growth. Building on the growing importance of intangible assets, Section 4.2 examines the roles of R&D, software, and data, alongside less well-measured forms such as organisational capital. These assets are critical not only for technological innovation, but also for business innovation, particularly by strengthening firms' absorptive capacity (see Box B). Finally, Section 4.3 considers how AI and broader digital transformation are reshaping productivity dynamics in Europe and the United States, and the extent to which they may strengthen both upstream innovation productivity and downstream economic productivity in both regions over time.

## 4.1 Does Europe have an investment problem?

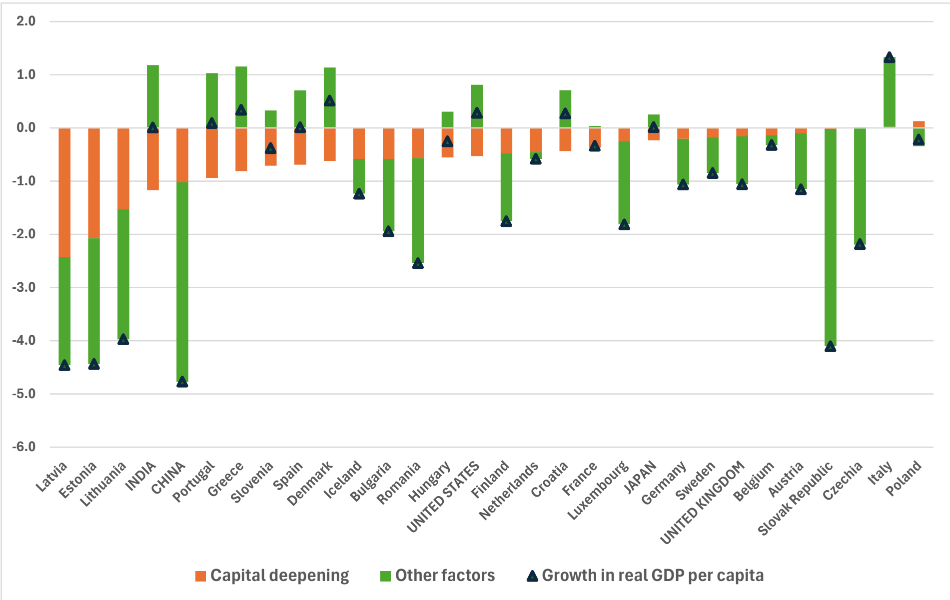
Subdued capital accumulation has significantly reduced potential output growth since the GFC, with weaker capital per worker accounting for a sizeable share of the growth slowdown across the OECD and other G20 economies (OECD, 2025a). OECD analysis argues that there is a growing disconnect between firms' investment decisions and traditional drivers such as the cost of capital, company valuations, and profitability. Instead, investment behaviour appears to be increasingly shaped by weaker demand, heightened uncertainty, and a range of structural pressures, including the digital transition, demographic change, and climate challenges.

To assess whether weak investment has a distinct European dimension, Chart 9 reproduces recent OECD data comparing the contributions of capital deepening and other factors to changes in potential output per capita growth between 2002–08 and 2024, with countries ranked by the contribution of capital deepening (OECD, 2025a).[5] The chart suggests that, in aggregate terms, capital deepening is not Europe's main comparative weakness. Although few countries recorded an increase in capital deepening over this period, around two-thirds of European economies, including France, Germany, and Italy, experienced smaller declines than the United States. By contrast, China and India saw larger declines than almost any European economy, reflecting a moderation in catch-up growth since the start of the century. Instead, "other factors", including changes in labour utilisation and TFP growth, appear to account for most of the slowdown in potential output per capita growth in Europe.

### Chart 9

Contribution of capital deepening to the change in the growth of potential output per capita, 2024 compared to 2002-08

(percent, potential GDP per capita growth)




Sources: OECD (2025a), OECD Economic Outlook 117 database; and OECD calculations.
Notes: Other factors include changes in labour utilisation and total factor productivity. Capital deepening is the rate of change in the capital stock per worker including tangible capital and some intangibles, as capitalised in the national accounts, including R&D, software and databases (see Section 4.2 and Chart 10).

Strikingly, the United States is one of the few countries in Chart 9 showing an increase in the contribution of 'other factors' to potential output growth, including higher labour utilisation and faster TFP growth. In the context of this analysis, TFP is a useful proxy for disembodied technological change and therefore captures an important part of the contribution of frontier innovation to growth. This suggests that Europe's slowdown may be particularly pronounced in innovation-intensive sectors, where TFP growth is typically strongest.

Another reason not to overstate the role of weak investment in slowing innovation and growth concerns the interpretation of standard growth-accounting

[5] For comparability, most countries outside the EU are not shown in the chart, with the exception of China, India, Japan, the United Kingdom and the United States (see OECD, 2025, Figure 2.1, for the full country set).

decompositions, which typically measure capital's contribution through capital deepening (capital per hour worked). Such decompositions are difficult to interpret because capital deepening and total factor productivity (TFP) are inherently endogenous, making cause and effect hard to disentangle. The standard Solow growth model can be reformulated to link capital accumulation to the capital-output ratio rather than the capital-labour ratio (Solow, 1956). In this representation, the capital-output ratio is determined by steady-state conditions, specifically savings, population growth, and depreciation. Deviations from that equilibrium reflect transitional dynamics, for example, changes in savings behaviour, structural change, or distortions such as financial frictions. In empirical decompositions, these deviations are typically reflected in investment dynamics, allowing them to be distinguished analytically from changes in TFP (Fernald et al., 2017). Viewed through the lens of the capital-output ratio, growth-accounting evidence suggests that Europe's slowdown in labour productivity growth primarily reflects weaker TFP growth rather than insufficient capital accumulation (Fernald, Inklaar and Ruzic, 2025; see Box C for further discussion and analysis).

Standard aggregate data and growth decompositions therefore do not suggest that investment weakness in Europe, while problematic in itself, is significantly greater than in other OECD economies. Döttling et al. (2018) argue that, since the beginning of the century, weak investment in Europe and the United States has reflected different underlying mechanisms. In Europe, investment used to be broadly consistent with fundamentals such as profitability and Tobin's q, suggesting that weakness was largely cyclical and driven by subdued demand and the legacy of the GFC and the euro crisis. In contrast, US investment remained persistently below the level implied by fundamentals, at least until the mid-2010s, pointing to a more structural shortfall linked to rising market concentration and weaker competition.

However, in recent years Europe's investment challenges may have become more structural in character. For example, Adilbish et al. (2025) links Europe's productivity gap to low innovation intensity, weak business dynamism, and insufficient investment in high-growth firms. The European Investment Bank (EIB) likewise identifies a persistent European investment gap not only in aggregate volume, but also in the capacity to finance innovation, scale firms, and diffuse technology across regions (EIB, 2025; see also Section 3.2). More recently, in launching the European Savings and Investments Union, the European Commission explicitly framed Europe's investment challenge as one of mobilising household savings for productive investment, particularly for SMEs and intangible assets.

Taken together, Europe's investment gap appears to be less of an aggregate shortfall but primarily a weakness in intangible investment. Gros, Mengel and Presidente (2025) and others highlight the need for greater investment in frontier innovation, notably R&D and high-tech sectors. Yet a more comprehensive approach must also recognise the role of investment in supporting the wider diffusion of technology and innovation across the economy (Andrews, Criscuolo and Gal, 2016; Berlingieri et al., 2025). The next section examines how investment has evolved across different categories of intangible capital and assesses where, and to what extent, Europe is lagging behind.

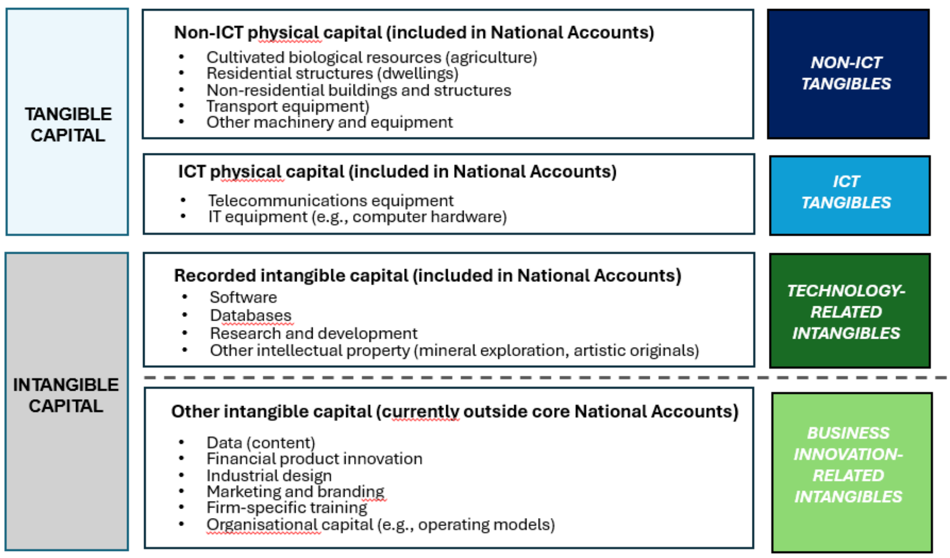
## 4.2 The role of intangible capital in growth and innovation

In recent decades, the concept of intangible assets has gained widespread recognition. While the term originated in the management literature (Stewart, 1997; Lev, 2001), it entered economic analysis in the early 2000s, most prominently through the work of Corrado, Sichel and Hulten (CHS, 2005). In their framework, intangible assets are defined as “expenditures that provide future benefits but are not embodied in physical capital”. Such expenditures should be treated as capital rather than intermediate costs, because they generate productive services over time, much like tangible assets.

The CHS framework captures the different ways firms invest in intangible capital by grouping such assets into three broad categories: digitised information (for example, software and databases), innovative property (such as R&D, design, and scientific knowledge), and economic competencies (including branding, firm-specific human capital, and organisational capital). Chart 10 distinguishes between those intangible assets from the perspective of whether or not they are being included as capital formation in the national accounts.[6]

**Chart 10**

Intangible Capital: Broad Categories and Types of Investment




Source: based on Corrado, Hulten and Sichel (2005) and Corrado et al. (2022)

Investments in the first group of intangibles, which are fully capitalised in the national accounts, include software, databases, and R&D, and are closely tied to the creation of technology. We refer to these as ‘technology-related’ intangibles, since they are central to the frontier innovation process discussed in Section 3 and contribute

[6] See Box A for further discussion. Other classifications of intangible assets have been proposed to better capture specific economic characteristics of intangibles. Coyle (2026), for example, proposes a distinction between knowledge capital, consisting of codified and potentially alienable assets, and organisational capital, comprising firm-specific, contextual, and relational assets. See also Van Ark (2004) for an early review of the literature on classifying intangibles.

directly to the innovation productivity of the economy. The second group of intangibles includes most forms of economic competencies, which play an important role in strengthening firms' innovation capabilities. These assets underpin the complementary investments firms must make to adopt new technologies and innovations and translate them into higher economic productivity. We refer to these as "business-innovation-related" intangibles.[7]

Recent estimates from the Global INTAN-Invest Database (Chart 11), covering 22 EU countries as well as Brazil, Canada, India, Japan, the Philippines, the UK, and the United States, show that software and databases have grown faster than any other category of intangible asset, likely reflecting the recent surge in AI-related software (Chart 11a). At the same time, organisational capital accounts for the largest share of total intangible investment, followed by R&D and then software and databases (Chart 11b). This pattern underscores the importance of complementarities across different forms of intangible capital, as discussed below (WIPO, 2026).

Using the 2023 release of the EUKLEMS-INTANProd industry-level database, Van Ark, De Vries and Erumban (2024) analyse trends in intangible investment and capital stocks for the market economy of nine EU countries (Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, and Sweden), the United Kingdom, and the United States over the period 1996–2019. Comparing the pre-GFC period (1996–2007) with the post-GFC period (2011–2019), they find a continued increase in intangible investment as a share of nominal GDP, but a moderate slowdown in the real growth of intangible capital stocks during the 2010s. This suggests that a change in the composition and accumulation of intangible investment. For example, a shift towards business-innovation-related intangibles, which typically depreciate faster than technology-related assets, translates a given level of investment into slower growth of net capital stocks. More recently, however, the United States appears to have entered a renewed phase of intangible deepening, with sharply rising investment once again feeding through into faster growth of the net intangible capital stock.[8]

Chart 12 decomposes labour productivity growth for the weighted average of the nine EU countries and the United States, comparing the pre-GFC period (1996–2007) with the post-GFC period (2011–2019).[9] It shows that the contribution of intangible capital deepening increased in both economies, reflecting the broader shift towards a more intangible economy. However, for the EU average, the contribution

[7] The distinction between technology-related and business-innovation-related intangibles can be analytically useful, but it does not map perfectly onto what is currently recognised as capital formation in the System of National Accounts, is not perfect. For example, artistic originals are capitalised in the national accounts, but are not necessarily technological assets. Conversely, financial product innovation is not currently capitalised, even though it may be more closely related to technological innovation; in practice, both categories are relatively small. More generally, the boundary between technology-related and business-innovation-related intangibles, and between measured and unmeasured capital formation, is likely to become less clear over time. This is especially the case with the recognition OF 'data as an asset' in the 2025 SNA and ongoing work to develop satellite accounts for marketing and branding linked to the core system (United Nations, 2025).

[8] With thanks to Filippo Bontadini for reviewing as yet unpublished estimates from EUKLEMS-INTANProd up to 2023..

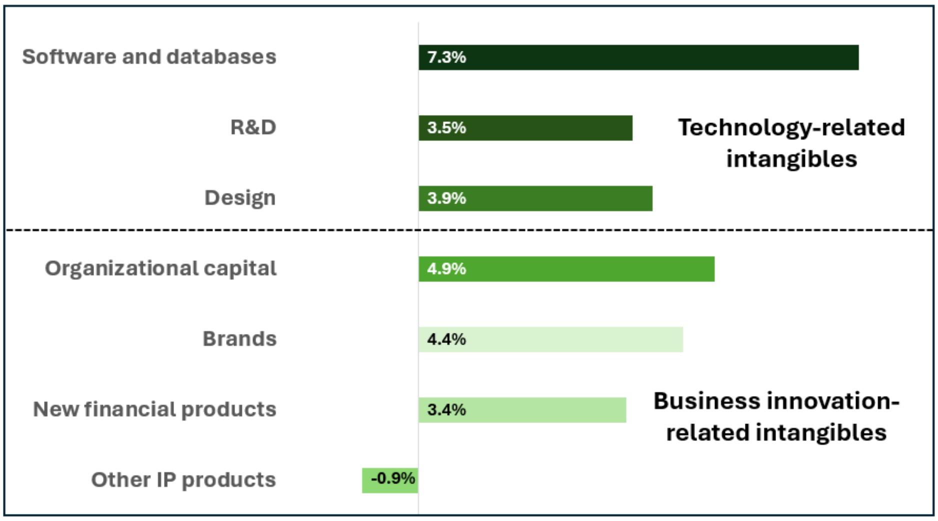
[9] The years 2008–2010 are excluded because the strong effects of the GFC on TFP estimates make comparisons between the pre- and post-GFC periods less reliable

of both technology-related and business-innovation-related intangibles remained substantially below that in the United States. Importantly, stronger intangible capital deepening was not sufficient to offset the marked decline in the contribution of tangible capital deepening following the GFC. This highlights a central challenge of an intangible-intensive growth model: because intangible assets typically depreciate more rapidly, they must sustain consistently high rates of investment to make a direct contribution to labour productivity growth comparable to that of tangible capital. As Van Ark, De Vries and Erumban (2024, p. 57) observe, 'given its higher rates of depreciation, intangible capital has "to work harder" than tangible capital to make a direct positive contribution to labour productivity growth.'

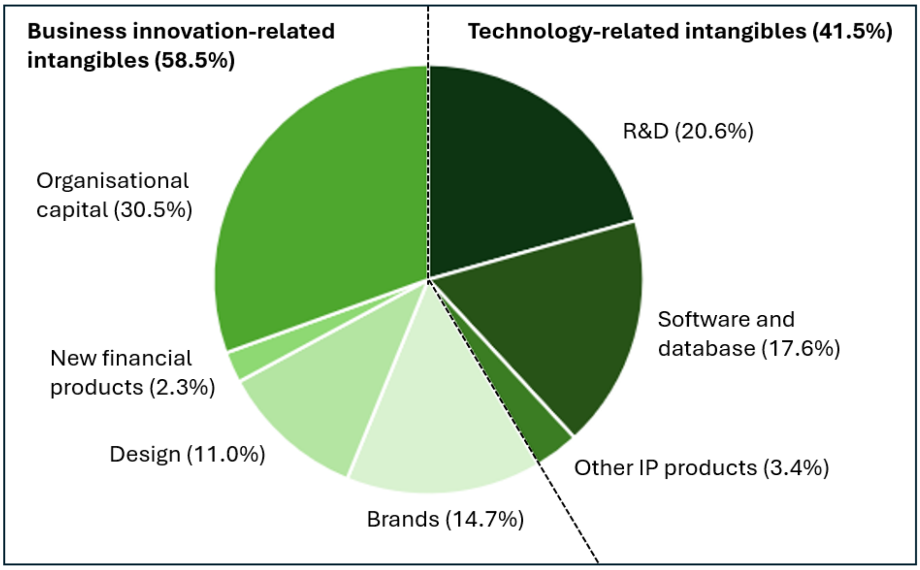
**Chart 11**

Growth and shares of intangible investment by asset category

(11a) Real compound growth rate by intangible asset category, 2013–2023, annual %




(11b) GDP share of intangible investment by category (2023), %




Sources: WIPO–LBS Global INTAN-Invest Database, July 2026.

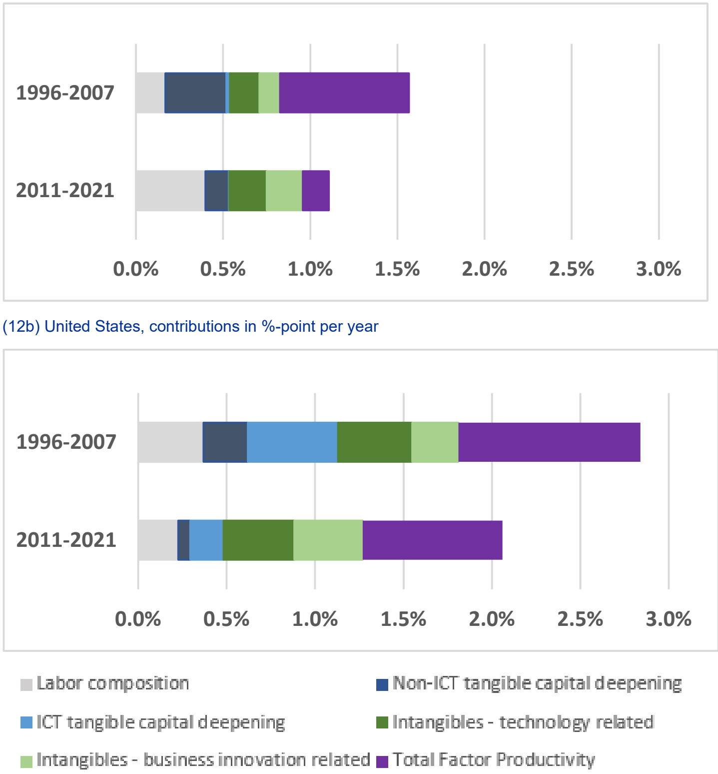
Note: Intangible investment by asset type has been aggregated over the sample countries: Brazil, Canada, EU-22, India, Japan, the Philippines, the UK and the US, weighted by shares of lagged nominal investment (in PPP terms);

### Chart 12

Decomposition of Labour Productivity Growth, including contributions of non-national accounts intangible capital, Market Economy. 1996-2021

(12a) European Union (9), contributions in %-point per year

(12b) United States, contributions in %-point per year




Note: EU (9) includes Austria, Germany, Denmark, Finland, France, Italy, Netherlands, Spain and Sweden..
Source: EUKLEMS & INTANProd (2025); Van Ark, De Vries and Erumban (2024) with series updated from 2019 to 2021.

Of course, intangible capital may also indirectly contribute to labour productivity through TFP effects from spillovers or complementarities between different types of assets. Recent work has revisited the extent to which intangible assets generate spillovers beyond the well-established external effects of R&D (Goodridge, Haskel and Wallace, 2016; Corrado, Haskel and Jona-Lasinio, 2017; Haskel and Westlake, 2017).[10] For many other forms of intangible capital, however, spillovers may be weaker, particularly in an environment of rising technological rents and increasing market concentration (Aghion et al., 2023; De Ridder, 2024). Business-innovation-related intangibles, such as organisational capabilities, are often highly firm-specific and can therefore generate durable strategic advantages, especially for large firms (Coyle, 2026). They also tend to exhibit a high degree of sunkenness, in the sense that investment in such assets is often irreversible and cannot easily be recovered or resold if the underlying project fails. More generally, the economic properties of intangible assets often lie somewhere between pure public-good characteristics and

[10] Haskel and Westlake (2017) mention sunkenness, spillovers, synergies and scaling at the four key economic properties of intangible assets—the “4S.”

deeply embedded, firm-specific capabilities, with important implications for both innovation and diffusion.

The critical role of synergies, or complementarities, between different types of intangible assets to generate TFP growth is consistent with firm-level analyses based on disaggregated asset classes, which provide substantial evidence of complementarities across particular bundles of intangibles, especially those combining technology-related assets (historically R&D and, more recently, software), workforce skills, and organisational change (Brynjolfsson and Hitt, 2000; Goodridge, Haskel and Wallace, 2016; Corrado, Haskel and Jona-Lasinio, 2017). It also aligns with the productivity J-curve literature (Brynjolfsson, Rock and Syverson, 2021; see also Section 3.1) and with the concept of absorptive capacity (Zahra and George, 2002; see also Box B).

Macro- and sector-level analysis suggests weaker or more mixed evidence on complementarities, because aggregation, measurement problems, and econometric constraints can obscure the firm-level relationships that underpin them. Thum-Thysen, Voigt and Weiss, 2021), for example, examine complementarities between tangible and intangible assets at the country level in Europe using translog production functions. They find some evidence of complementarities between tangible and intangible assets and between technology-related and business-innovation-related intangibles, with positive effects on labour productivity growth. However, the small sample size and high correlations across asset categories required some assets to be grouped together and quadratic terms (which may capture non-linearities) to be excluded. This limits interpretability and may bias the estimated complementarities.

Additional evidence on complementarities between assets at the sectoral level is provided by Van Ark, De Vries and Erumban (2024), who exploit both the industry and cross-country dimensions of the 2023 release of the EUKLEMS & INTANInvest database, covering nine EU countries, the United Kingdom, and the United States with data until 2019. Using a simple fixed-effects panel regression, they examine how four types of capital—ICT and non-ICT tangible capital, and technology-related and business-innovation-related intangible capital—are associated with TFP growth. Although this approach does not permit structural or causal identification of how individual or joint investments affect productivity, the results point to significant interaction effects in Europe, notably between business-innovation-related intangibles and ICT tangible capital, and between technology-related and business-innovation-related intangibles. These findings are consistent with the firm-level evidence discussed above and reinforce the view that complementarities across asset types matter for productivity growth.

An updated version of this analysis for five European countries (France, Germany, Italy, the Netherlands, and Spain), using data through 2021, suggests that tangible investment is strongly associated with productivity levels, but not with labour productivity growth. By contrast, in both the level and—more clearly—the growth specifications, the interaction effects between technology-related and business-innovation-related intangibles are generally statistically significant and economically meaningful (see Appendix Tables A.1 and A.2). This reinforces the argument made in

Section 4.1 that aggregate investment, including tangible capital formation, does not by itself explain the growth dynamics of the EU, or indeed of other advanced economies. Instead, the significant interaction between different types of intangible capital suggests that joint investment patterns matter for labour productivity growth, pointing to the need for a more nuanced and disaggregated approach to investment policy.

Whatever the role of spillovers and complementarities from intangible capital, these effects have not been strong enough to stop the weakening of TFP growth, which accounts for most of the slowdown in labour productivity growth. Chart 12a shows that TFP growth in the EU-9, dropped from 0.7 percent from 1996–2007 to just 0.2 percent from 2011–2021. Although the United States also experienced a post-GFC slowdown in TFP growth up to 2019, Chart 12b suggests that the deceleration was considerably less pronounced. While part of the recent EU–US TFP gap may reflect pandemic-related volatility, the latest estimates for the United States, based on the same broad intangible-asset coverage as in Chart 12, point to a renewed strengthening of U.S. TFP growth: it increased by 0.5 percentage points, from 0.4 per cent in 2012–2017 to 0.9 per cent in 2017–2024, returning to roughly its pre-GFC rate (Bontadini et al., 2026).

## 4.3 Is AI on track to deliver productivity in Europe?

How, then, can investment help accelerate the AI revolution and translate into gains in productivity and economic growth? As firms invest heavily in AI software and complementary intangible assets, why do the effects on measured productivity still appear relatively modest? A useful starting point is to distinguish between productivity gains at the level of tasks, firms, sectors, and the aggregate economy. While there is strong evidence that AI can generate substantial improvements in the performance of individual tasks, the evidence at the firm level remains more mixed (Filippucci et al., 2024; Chan and Shedania, 2026). Gains observed in specific use cases may dissipate at the firm or sector level because of organisational frictions, incomplete adoption, and the absence of the complementary capabilities needed to translate task-level improvements into firm-level productivity growth. This “leakage effect” is an important explanation for the wedge between rapid progress in AI innovation and still modest observed productivity growth (Allas and Goodman, 2026).

Firm-level evidence further supports the view that the limited aggregate productivity impact of AI reflects the importance of complementarities rather than the absence of technological gains. Using harmonised microdata across OECD countries, Calvino, Costa and Haerle. (2026) show that firms adopting advanced digital technologies tend to be more productive on average, but much of this productivity advantage disappears once human capital, digital capabilities, and other complementary assets are taken into account. In the case of AI, productivity premia are often small or statistically insignificant once these factors are controlled for. This suggests that AI adoption alone is not sufficient to generate productivity growth, and that observed productivity differences primarily reflect underlying organisational and capability-related factors. More broadly, it reinforces the view that productivity gains from AI are conditional on complementary investments and are unlikely to materialise at scale without deeper organisational transformation.

**AI productivity effects.** So far, most of the evidence on AI's macroeconomic productivity effects comes from the United States, but the estimates vary widely. Importantly, these differences do not simply reflect measurement or modelling choices. For example, Acemoglu (2025) projects annual TFP gains for the United States of only around 0.07 percentage points, reflecting the direct automation effects of a relatively limited set of tasks. This relatively modest estimate rests on assumptions of diminishing returns and weak spillovers to the wider economy, alongside the possibility that AI may increase rents and weaken incentives for broader innovation.

By contrast, larger productivity effects may arise if AI strengthens innovation more broadly by improving R&D productivity and accelerating idea generation, consistent with the IMI (invention in the method of invention) mechanism outlined in Section 3.3. Within a Schumpeterian framework, AI could stimulate the creation of new firms, technologies, and industries. It would also encourage complementary investments in skills, intangible assets, and organisational change, and raising efficiency beyond the direct automation of tasks. Consistent with this broader perspective, Aghion and Bunel (2024) estimate a much larger effect than Acemoglu, with AI raising US TFP growth by around 0.7 percentage points per year. In this view, AI is a dynamic force that not only automates existing tasks, but also fosters innovation, generates new activities, and creates strong economy-wide complementarities, thereby supporting larger and more sustained productivity gains.

Filippucci, Gal and Scheif (2024) offer a middle-ground estimate, suggesting that AI could raise U.S. TFP growth by between 0.25 and 0.6 percentage points per year, depending on the pace and breadth of adoption, the magnitude of productivity gains in affected tasks across sectors, and the strength of the complementary investments needed for firms to fully exploit the technology.[11]

Likewise, Bergeaud (2024) finds that AI has clear potential to raise TFP in the euro area, based on a simulation using exposure, adoption and task-level productivity gains. However, the estimated short- to medium-term effects for the euro area are more modest than in the US, at around 0.29 percentage points of annual TFP growth over the coming decade. These gains are driven mainly by the automation of a relatively limited set of tasks and therefore imply only modest year-by-year increases in TFP.

Misch et al. (2025) estimate that AI could raise Europe's TFP by around 0.2 percentage points per year over a five-year horizon, slightly below Bergeaud's estimate, although their analysis covers a broader sample of 31 countries, including several lower-productivity economies outside the euro area. They find substantial cross-country heterogeneity, with stronger gains in more advanced economies and

[11] Filippucci et al. (2026) project that AI could raise total factor productivity (TFP) growth across 65 US industries over the first ten years following the introduction of ChatGPT, with estimated annual effects ranging from 0.1 percentage points in manual-task-intensive activities to 2.8 percentage points in knowledge-intensive services, implying aggregate gains of 0.9 percentage points per year.

weaker effects where adoption remains limited. For example, estimated annual effects range from around 0.06 percentage points in parts of Eastern Europe to about 0.3 percentage points in more advanced economies such as France, Germany, and the Netherlands. These differences appear to reflect variation in capabilities, diffusion, and adoption. The authors also emphasise that regulation, particularly AI safety and data rules, could reduce productivity gains by more than 30 per cent, underscoring the importance of policy design (see Section 5).

Bontadini et al. (2026) show that AI affects labour productivity through the upstream innovation sector, where AI operates as an IMI, and the downstream production sector, where AI functions as a GPT (see Section 3.3). Productivity gains in the upstream sector stem primarily from the creation of new AI-related software, while downstream gains reflect firms' investment in that software and in the complementary intangible assets needed to translate it into productivity improvements. The authors' findings suggest that AI software production and use made a remarkably large contribution to US productivity growth, accounting for around half of the acceleration in labour productivity growth from 0.8 to 2.0 per cent between 2012–2017 and 2017–2024. Software-producing industries alone accounted for roughly 40 per cent of the acceleration in US TFP growth, which increased from 0.4 per cent in 2012–2017 to 0.9 per cent in 2017–2024.

For Europe, preliminary estimates from Bontadini et al. (2025) suggest that AI could raise annual labour productivity growth by around 0.3 percentage points, broadly consistent with recent TFP-based estimates, but well below their estimated effect of about 1 percentage point for the United States. A large part of the difference reflects Europe's weaker upstream base in AI software production, which limits its ability to capture productivity gains from the frontier layers of the AI stack, such as foundation models and compute infrastructure. However, Europe may still be able to capture productivity gains through sector-specific application layers, particularly in areas where it has relevant sectoral capabilities and domain expertise, such as parts of manufacturing, health, professional services, and other knowledge-intensive activities (see also Section 5.1). Realising these gains will require stronger investment not only in AI-related software, but also in the complementary intangible assets needed for effective deployment, notably skills, data, managerial capabilities and organisational capital.

## Box C: Growth Decomposition and the Problem of Endogeneity

Investment is a key driver of productivity, and understanding how it contributes to productivity growth is central to our analysis. However, traditional growth decompositions are complicated by the inherently endogenous relationship between capital accumulation and total factor productivity (TFP). In standard neoclassical decompositions, capital deepening is treated as an independent contributor to productivity growth. In practice, however, both the level and the growth rate of capital are strongly influenced by TFP, making it difficult to disentangle cause and effect.

This issue is particularly evident in low-productivity environments. Weak investment often reflects persistently low TFP, which depresses expected returns on capital and weakens incentives for firms to expand their capital stock. Firms operating under low efficiency, institutional constraints, or technological stagnation face limited investment opportunities, leading to subdued capital formation alongside weak productivity growth. In this sense, capital deepening is largely endogenous to TFP rather than an independent source of sustained growth.

The Solow model provides a useful lens for interpreting this relationship. While the contribution of capital to labour productivity is typically expressed in terms of capital deepening in standard growth accounting (Solow 1957), the model was originally emphasising the capital–output ratio (Solow, 1956):

$$\Delta ln\, Y_t - \Delta lnH_t = \frac{\alpha_t}{1-\alpha_t}\left(\Delta lnK_t - \Delta ln\, Y_t\right) + \Delta ln\mathrm{LC}_t + \frac{\Delta ln\mathrm{TFP}_t}{1-\alpha_t}.$$

The rationale is that, in steady state, capital formation is pinned down by savings behaviour, population growth, and depreciation (Solow, 1956). Deviations from this equilibrium ratio reflect transitional dynamics and can arise from changes in savings, structural shifts, or distortions such as financial frictions or macroeconomic uncertainty.

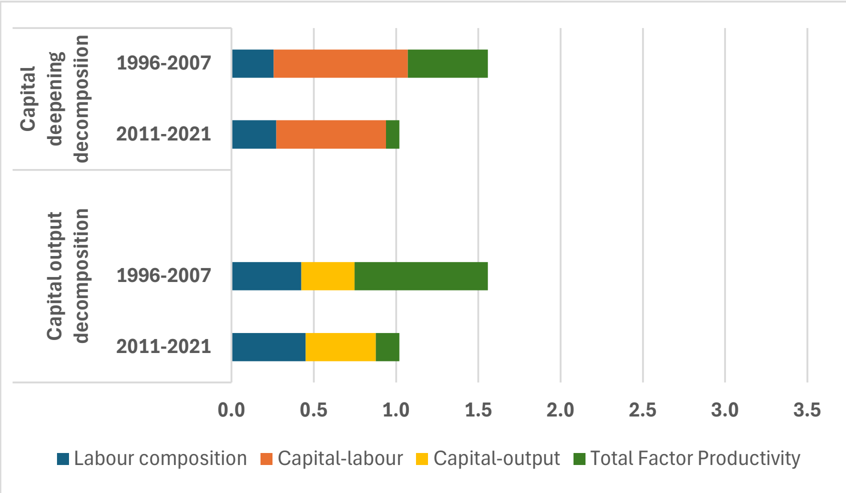
Interpreted in this way, examining the evolution of the capital–output ratio relative to its steady-state benchmark provides a useful way to distinguish investment behaviour driven by non-TFP factors, such as credit constraints, uncertainty, or cyclical shocks, from that driven by underlying productivity fundamentals (Fernald et al., 2017; Fernald, Inklaar and Ruzic, 2025).

Chart C.1 shows how using the capital–output ratio rather than the capital–labour ratio changes the respective contributions of capital and TFP to labour productivity growth between 1996–2007 and 2011–2021. Chart C.1a presents the results for a group of nine European economies (Austria, Denmark, Finland, France, Germany, Italy, the Netherlands, Spain, and Sweden), while Chart C.1b reports the corresponding decomposition for the United States. Capital in this decomposition includes all forms of intangible capital, including technology-related and business-innovation-related assets, as discussed in Section 4.2. In each chart, the upper and lower panels compare decompositions based on the capital–labour ratio and the capital–output ratio, respectively. The capital–output decomposition attributes a substantially larger share of labour productivity growth to TFP. Importantly, it suggests little or no slowdown in capital deepening over the period, and even a slight increase, especially in Europe.

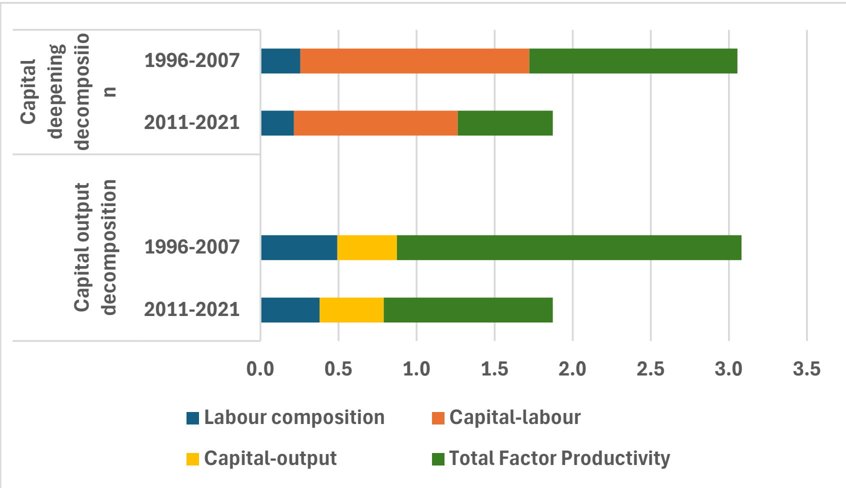
**Chart C.1**

Decomposition of Labour Productivity Growth Using Capital-Labour vs. Capital-Output Ratios

C.1a: European Union (9), contributions of labour quality, capital (tangibles and intangibles) and total factor productivity to growth in output per hour, annual (%):




C.1b: United States, contributions of labour quality, capital (tangibles and intangibles) and total factor productivity to growth in output per hour, annual (%):




*Note: EU(9) includes Austria, Germany, Denmark, Finland, France, Italy, Netherlands, Spain and Sweden. Capital includes all forms of intangible capital, including technology-related and business-innovation-related assets, as discussed in Section 4.2.*
*Source: EUKLEMS & INTANProd (2023);*

Yet even these adjustments only partly resolve the deeper conceptual challenge that arises when capital itself becomes a source of TFP growth. New growth theory emphasises that investment in innovation, particularly R&D, generates knowledge spillovers that directly raise TFP, thereby introducing a second channel of endogeneity running from capital to productivity (Romer, 1987; Aghion and Howitt, 1992). Whether other forms of intangible capital generate similar spillovers is less clear, since the returns to investments in, for example, organisational capital are more likely to be internalised by the investing firm (see Section 4.2).

Nevertheless, both sources of endogeneity can be addressed, at least partly, by extending growth decompositions to incorporate intangible assets. As firms invest in such assets, their capacity to adopt technologies, reorganise production, and scale knowledge may raise TFP in ways not fully captured by standard TFP measures. These effects may reflect either spillovers from intangible investment or complementarities across assets, whereby the productivity effect of one type of tangible or intangible capital depends on the presence of another, creating broader system-level synergies (see the discussion in Section 4.2).

Overall, recognising and addressing endogeneity in both directions—from TFP to capital and from capital to TFP—is essential to a more accurate analysis of how innovation affects productivity. Extending the framework to include intangible capital helps to clarify these intertwined relationships and supports more robust explanations of productivity, innovation, and diffusion dynamics across countries and sectors.

## 5 Rewiring the policy framework

What does the analysis of productivity, innovation and diffusion in this paper imply for making Europe's policy environment fit for purpose?

Two key insights from this paper so far shape the priorities for future policy. First, the euro area's productivity trend over 2018–2024 failed to return to its already weaker pre-pandemic trajectory, while the productivity growth gap with the United States widened further. This suggests that Europe's current policy framework has not been effective in closing the gap. The decomposition in Section 2 shows that the euro area's weaker productivity performance is overwhelmingly a within-industry story rather than a sector-composition story. In other words, the main problem lies less in Europe specialising in the "wrong" sectors than in frictions that weaken diffusion, adoption and resource reallocation within sectors.

Second, diffusion and adoption challenges are the binding constraint for transmitting technologies and innovations into broad-based productivity gains—particularly through barriers to scaling up, dissemination, and the development of absorptive capacity for new technologies. Europe's frontier R&D efforts often fail to translate into widespread productivity gains in the absence of complementary investments in digital capabilities, management quality, and other forms of intangible capital that support broad and rapid technological adoption. The challenges are likely to intensify in the AI era because these technologies exhibit strong scale economies and depend heavily on complementary intangible investment. Europe's scale-up gap and persistent financing constraints remain central bottlenecks in that process.

Much of the innovation policy debate has been framed too narrowly as a dichotomy between supporting frontier innovation and promoting diffusion and adoption. This is misleading, because the two are mutually dependent. Industrial policy has traditionally focused upstream on the innovation (often narrowly understood as the technological) frontier, reflecting concerns about Europe's narrow industrial base in key advanced sectors. By contrast, horizontal policies such as those related to skills, market functioning, and trade are primarily aimed at strengthening firms' absorptive capacity and improving the allocation of resources across the economy.

A key guiding principle in rewiring the policy framework is therefore not to treat innovation and diffusion as separate processes, but as tightly interconnected, both through the innovation system itself by better supporting diffusion and adoption (Section 3) and through complementary investment channels in technology-related and business-innovation intangible assets (Section 4). This section explores the implications of that interdependence for policy design.

Vertical (sector-specific) and horizontal (economy-wide) policies are also integral to the pro-productivity framework set out in Van Ark, De Vries and Pilat (2024). That framework encompasses policies that directly affect productivity, including those related to technological and structural change and factor accumulation; policies that affect productivity indirectly, such as market and resource-allocation policies and internationalisation policies; and foundational policies that create the conditions under which firms can innovate and invest, notably institutional quality and the macroeconomic framework (see Section 5.1 and Box D).

Detailed analysis across 17 economies shows that productivity outcomes depend critically on the interaction between those policy domains (Pilat and Van Ark, 2027).[12] For example, industrial policies without strong horizontal foundations, such as competition and trade openness, often deliver weak productivity outcomes. Similarly, horizontal reforms in product, labour or capital markets may fail to generate sustained productivity gains without strategic direction, capability building, and innovation support. The central policy challenge is therefore not to prioritise one approach over the other, but to align vertical and horizontal policies around the binding constraint: ensuring that innovations can be adopted and used productively across firms, sectors, and regions.

The remainder of this section reviews the current policy environment for investment, innovation, and diffusion, and identifies the main challenges involved in aligning them more effectively. Section 5.1 examines broad-based pro-productivity policies, highlighting how innovation and diffusion are embedded across multiple policy domains. Section 5.2 considers the role of monetary policy, moving beyond the traditional neutrality view to examine how monetary conditions affect productivity, frontier innovation, diffusion, and, more specifically, investment in intangible assets. Finally, Section 5.3 addresses how productivity-enhancing policies can support inclusive growth and the creation of good jobs, recognising that the benefits of productivity growth are often unevenly distributed and require coordinated policy responses across economic and social domains.

## 5.1 Connecting productivity policies to investment, innovation, and diffusion

Recent analysis of pro-productivity policies highlights that there is no single “silver bullet” for restoring Europe’s productivity trend (André and Gal, 2024; Van Ark, De Vries and Pilat, 2024). Sustained productivity gains depend on coherent policy packages rather than isolated interventions. Yet while much of the most visible policy debate has shifted towards strengthening frontier innovation, there is at least as much need in practice to focus on the barriers to, and opportunities for, improving diffusion, capability building, and system-wide policy coherence (André and Gal, 2024).

Van Ark, De Vries and Pilat (2024) have developed a system-wide typology of pro-productivity policies, grouping them into five complementary domains: factor accumulation, markets and resource allocation, technological and structural change, internationalisation, and a cross-cutting set of institutional and macroeconomic foundations (see Box D). Although the complementarities and effects of these policies vary with stage of development, they can be mapped reasonably well onto the innovation and diffusion system outlined in Box B:

[12] See https://www.productivity.ac.uk/policy/pro-productivity-policies/ for published country case studies.

- The upstream portion of the innovation and diffusion system, which supports frontier innovation and scaling up, is shaped primarily by policies for technological and structural change and factor accumulation, including R&D investment, industrial policy, and skills and research systems.

- The downstream portion, which covers diffusion, firm-level adoption, and non-technological innovation, depends more critically on markets and resource allocation, which shape incentives and patterns of reallocation.

- Internationalisation—including trade, FDI, and cross-border collaboration in science and technology—preserves openness as a channel of diffusion while also supporting upstream research and innovation collaboration. Institutional frameworks, government capabilities and macroeconomic policies underpin the entire innovation and diffusion system by coordinating policy complementarities, supporting implementation, and sustaining these feedback loops.

Persistent structural weaknesses continue to hamper Europe's innovation and diffusion system across all these levels, thereby slowing productivity growth. At the innovation frontier, these weaknesses include underinvestment in high-tech sectors, fragmented policy frameworks, small and fragmented markets, weak university–industry linkages, and the misallocation of R&D (Bergeaud, 2024; Gros, Mengel and Presidente, 2025). Yet an even larger policy challenge in Europe may lie in the weak diffusion of innovation across firms and sectors. Effective dissemination depends on efficient resource reallocation and business dynamism, whereas traditional policy levers such as competition policy, product market reform, and insolvency regimes have weakened or been applied less vigorously over time (André and Gal, 2024).

As a result, Europe's innovation weaknesses cannot be understood primarily as frontier underinvestment alone. They primarily reflect persistent barriers to scaling up, diffusion, and adoption. Many firms, concentrated in middle-technology activities, struggle to replicate the dynamism seen in the United States. In addition, some sectors—digital and AI industries in particular—are network industries that benefit strongly from scale effects, meaning that entrepreneurs seeking to scale in these markets are likely to favour the integrated US market over the more fragmented European one. Weak diffusion also reduces the broader impact of innovation on productivity and living standards, contributing not only to slower growth but also to rising inequality and labour-market polarisation (ECB, 2017).

Against this background, the strongest policy instruments remain unevenly distributed across the different stages of the innovation process.

**Frontier innovation**. For scientific upstream frontier innovation, the European Research Area (ERA) provides a single, borderless market for research, innovation, and technology in Europe. However, this well-established architecture has also attracted criticism, as participation in Horizon Europe continues to be concentrated in countries with stronger research systems, despite the expansion of widening instruments (Al-Ajlani et al., 2024).

For example, Europe has a relatively strong scientific research base in AI, which provides an important foundation for innovation. For example, Spain ranks among the leading countries in AI scientific output, maintaining a stable share of global publications and a position just below the top tier (Pérez et al., 2025). This suggests that the scientific capabilities required for frontier AI development are present and that Europe more broadly remains a significant contributor to global AI knowledge creation.

The key challenge, however, is that Europe lags in developing breakthrough technologies, pointing to weaknesses in commercialisation and scaling at the European level. For example, frontier innovation institutions beyond universities are also relatively well developed in several individual countries, including France's Crédit d'Impôt Recherche, Ireland's Knowledge Development Box, the Dutch TNO, and Germany's Fraunhofer system. Although they provide important anchoring in domestic priorities and can also support diffusion at the national level, these national institutions remain insufficiently connected at the European level to support Europe's industrial strategy (Draghi, 2024; Balland et al., 2025).

For example, national-level equivalents of the US Defense Advanced Research Projects Agency (DARPA), a mission-oriented agency that funds high-risk, breakthrough research, are unlikely to deliver as much frontier dynamism in Europe. This reflects the broader concern that Europe's innovation support remains fragmented and insufficiently agile at the scale required for breakthrough innovation (Draghi, 2024). Instead, what is most needed is a genuinely European instrument that pools resources and allocates them flexibly and non-discriminatorily across member states in support of the most promising opportunities. It also requires policies that improve the expected returns to innovation and entrepreneurship by expanding the scope for experimentation, reducing the cost of failure, and enabling successful firms to scale.

The DARPA model is most relevant to the European Defence Fund (EDF), which supports collaborative defence R&D and capability development across member states and offers clear potential for dual-use spillovers. By requiring cross-border consortia, the EDF directly addresses one of Europe's core weaknesses, namely fragmentation. However, realising a stronger defence-innovation agenda also requires institutional coordination capacity at EU level. The priority should therefore be to build explicit transfer mechanisms from EDF projects into Horizon Europe and EIC pipelines from the outset, and to adopt a DARPA-inspired model that links frontier defence research to civilian commercialisation pathways through clear milestones and performance-based accountability. It is equally important to ensure that greater defence spending crowds in, rather than crowds out, civilian R&D budgets if the dual-use spillovers underpinning the productivity case for defence investment are to materialise (Moretti, Steinwender and Van Reenen, 2025).

**Scaling up**. The upstream innovation potential of Europe's economy is significantly constrained by weaknesses in scaling. A persistent pattern is that strong academic research is translated only weakly into patents, private investment, and high-growth firms. This is reflected in fragmented patent bases with significant home bias (Bergeaud, 2024), limited private upstream investment, and insufficient financing for start-ups. Institutional barriers, including weak science–industry linkages and academic incentive structures that prioritise publications over commercial outcomes, further hinder the conversion of research into marketable innovation. At the same time, global AI development is becoming increasingly concentrated among large firms in the United States and China, reducing the scope for European firms to compete at the global AI innovation frontier. As a result, Europe retains important strengths in upstream research but remains relatively weak in converting them into scalable frontier AI innovation.

A key policy priority is to connect research more effectively through a coherent pipeline linking ERC frontier grants and other early-stage funding to the commercialisation and scaling up of breakthrough technologies. The EU AI Strategy explicitly aims to build such an ecosystem by connecting frontier research to scaling up and diffusion. For example, AI Factories provide shared compute infrastructure that can partly offset Europe's hardware disadvantage relative to US hyperscalers. The strategy's sector-specific application-layer approach also targets areas where Europe holds comparative strengths, notably manufacturing, health, and professional services. However, while the AI Act may create legal certainty and support a common European standard, it also imposes compliance costs that are likely to weigh disproportionately on SMEs, new entrants, and scale-ups, potentially deepening uneven AI adoption. A key takeaway is that a mission-oriented AI strategy must align incentives and capabilities to support innovation, adoption, and productivity growth, including the translation of technological breakthroughs into widespread scaling up and diffusion (André and Gal, 2024).

The European Innovation Council (EIC) and the European Institute of Innovation and Technology (EIT) together cover much of the pathway from frontier research to scaling up and, ultimately, diffusion. The EIC directly addresses Europe's scale-up gap through blended grant-plus-equity financing, but the rollout of its equity support has been slow and does not directly address the management capabilities and organisational redesign that firms often need to translate finance into productivity gains. By contrast, the EIT combines innovation support with entrepreneurship and capability-building programmes that strengthen managerial and absorptive capacity alongside technical knowledge, including through its higher education and regional innovation initiatives. However, much of this activity remains unevenly distributed across Europe, despite efforts to widen participation through the EIT Regional Innovation Scheme.

The "valley of death" is a critical failure point between frontier innovation and scaling up. European countries have repeatedly invested in research capacity without building the complementary equity finance, technology-transfer mechanisms, and scale-up support needed to carry inventions through to market. Ireland is a partial exception, as its R&D tax credit, Knowledge Development Box, and grant schemes were more deliberately sequenced to narrow this gap (Coates and Lawless, 2026). However, the problem is often framed too narrowly as a supply-side funding shortfall whereas, in practice, the more important weaknesses are often institutional and temporal mismatches, notably the failure to align public investment in research with the private investment decisions required at later stages of scaling up (Beard et al., 2009).

As discussed in Section 3, Europe's "scale-up finance gap" is a critical constraint for successful innovation. An important priority is to strengthen and scale Europe's venture capital ecosystem, particularly at later stages of firm growth. This includes large public–private financing instruments (such as the European Investment Fund, InvestEU, the European Tech Champions Initiative and the Scaleup Europe Fund) which aim to expand the supply and size of venture and growth capital funds and crowd in private investment. While these measures are expanding the supply of risk capital, their effectiveness ultimately depends on progress in reducing financial fragmentation and strengthening complementary elements such as exit markets and firm capabilities.

The Savings and Investments Union (SIU) aims to directly tackle the financial underpinnings of Europe's scale-up gap, particularly the shortage of growth capital and fragmentation of capital markets. By building on, deepening and extending the Capital Markets Union (CMU), embedding it in a wider framework that also includes banking integration and the mobilisation of household savings, it has significant potential to ease constraints on firm expansion. However, because the scale-up gap also reflects non-financial factors such as market integration, capabilities, and institutional quality, the SIU should be seen as a necessary but not sufficient condition for closing the gap. Policies that promote FDI openness, at least within Europe, and deeper Single Market integration are also key in helping firms to scale up and, hence, acquire better practices through management spillovers.

Despite those concerns, Europe is not without options. For example, there is meaningful scope to shape AI development in Europe, by focusing on building its own capabilities rather than remaining a passive adopter. The solid upstream research base can be combined with emerging firm-level innovation and start-up activity in AI. Given strong competition in core digital technologies, an effective strategy might be to focus on applications that leverage Europe's industrial strengths and to reinforce frontier innovation in mission-oriented areas such as green, bio, and security technologies through targeted industrial policies (World Economic Forum, 2025, 2026; European Commission, 2025; Perez et al., 2025).

**Dissemination**. The analysis in this paper highlights that downstream diffusion and adoption are the most critical bottlenecks preventing frontier innovation from spreading and be used productively. Non-technological innovations, such as organisational and business model change, play a key role in enabling firms to adopt new technologies effectively (Andrews, Criscuolo and Gal, 2016; André and Gal, 2024).

Main instruments at the European level, such as the European Structural and Investment Funds (ESIF) and the European Skills Agenda, were designed primarily around cohesion and labour-market objectives and have only secondarily become tools for technology diffusion and absorptive-capacity building. However, cohesion instruments are administratively complex and slow to deploy, making them poorly suited to the speed and heterogeneity of firm-level technology adoption decisions.

More generally, slow technology diffusion reflects structural weaknesses in both incentives and capabilities, in particular low managerial quality, weak ICT skills, and poor matching of workers to jobs (Nicoletti, Von Rueden and Andrews, 2020). Country-specific evidence also points to uneven diffusion performance in economies such as France, Italy, and Spain (Pilat and Van Ark, 2027). In addition, patchy vocational education and training systems continue to constrain firms' absorptive capacity, especially where links between training provision and changing skill needs remain weak.

At the European level, policy action in major areas such as digital technologies, AI, and green innovation has the potential to strengthen dissemination. For digital and AI, the Digital Single Market (DSM), together with the Digital Markets Act (DMA) and the Digital Services Act (DSA), is the EU's closest equivalent to a cross-cutting policy framework that can support dissemination across the wider innovation and diffusion system. However, the Single Market for digital services remains incomplete, as national licensing regimes and divergent consumer protection rules continue to slow cross-border diffusion. In addition, compliance costs associated with the DMA and DSA appear to fall disproportionately on SMEs. Evidence on the effects of the GDPR suggests that it raised the cost of data substantially, with EU firms reducing data storage by around 26 percent and data processing by 15 percent relative to comparable US firms, consistent with an increase in data costs of about 20–22 percent (Demirer et al., 2024). A more market-oriented reform of the GDPR could enhance data usage in European industry by making it more diffusion-friendly by reducing compliance asymmetries between large firms and platforms and SME adopters, and by ensuring that digital regulation does not inadvertently raise barriers to technology adoption by new entrants.

The European Green Deal similarly aims to connect upstream innovation with downstream diffusion and adoption. It is the EU's most strongly developed mission-oriented programme, combining the planned phase-out of internal combustion engines by 2035 with the 55 percent emissions reduction target and net-zero by 2050. Its strength lies in creating durable regulatory certainty that can de-risk long-term private investment in green technologies. However, the risk of member-state subsidy fragmentation remains substantial. Divergent national green industrial policies can undermine the Single Market diffusion channel, which is one of the Green Deal's main productivity levers. The priority, therefore, is to ensure that the Green Deal objectives are matched by EU-level funding instruments, including Horizon Europe missions and EIC deep-tech funding in clean technologies. It is equally important to guard against national subsidy races and to sequence the transition carefully so that short-term energy cost pressures do not crowd out the complementary intangible investment needed to make green innovation productive (Borowiecki et al., 2023; Hodge et al., 2024).

**Industrial policy**. Industrial policy is best understood not as a substitute for diffusion-oriented policy, but as a system-shaping complement that can strengthen the conditions under which frontier innovation is disseminated and translated into broader productivity gains. In the European context, that means less emphasis on picking isolated national champions and more on building cross-border ecosystems in which research, scale-up finance, standards, procurement, skills, and downstream adoption reinforce one another (Draghi, 2024). Importantly, industrial policy matters not only because Europe's frontier is too narrow, but because a thin frontier weakens diffusion itself by limiting managerial mobility, specialised suppliers, venture capital depth, and the density of learning networks. The policy test is therefore not simply whether a vertical intervention supports a strategic sector, but whether it strengthens the wider innovation and diffusion system (Juhász et al., 2024). Effective industrial policy should therefore be selective, experimental, and disciplined by trade openness and global competition (Cherif and Hasanov, 2026), and, in the European context, the Single Market. Without that broader systems discipline, mission-oriented industrial policy risks becoming subsidy competition or resilience policy without sustained productivity effects.

**Absorptive capacity.** Technologies can diffuse widely across the economy without generating productivity gains if firms lack the absorptive capacity to use them effectively. Firms often learn about new technologies faster than they learn how to use them, and this gap is rooted less in access to technology than in managerial and organisational capability. This is particularly evident in the current AI era, where widely available software still needs to be matched with opportunities to redesign processes, improve products and services, or adapt business models.

Non-technological innovation often becomes the decisive within-firm margin of adjustment. In particular, skills are often a binding constraint in translating technological adoption into productivity growth. This includes the quality of education, lifelong learning and reskilling, and better labour-market matching to address persistent shortages. These constraints give an important role to policies around vocational training, further education, and apprenticeship systems (OECD, 2015a; Nicoletti, Von Rueden and Andrews, 2020). Effective AI diffusion policy needs to target managerial capability formation, especially in SMEs, rather than focusing solely on technology access or cost reduction (Poquiz et al., 2026).

Although absorptive capacity is primarily something firms themselves must build, national applied research institutions can play a critical role, given their ability to support implementation in regional and local contexts through training, advisory services, and broader business support.

At the European level, the EIT Knowledge and Innovation Communities (KICs) come closest to addressing these needs through entrepreneurship education, although their geographic reach remains concentrated in north-west Europe. By contrast, the Skills Agenda and the Pact for Skills are oriented more towards worker skills but could usefully be broadened to include management capabilities and SME technology adoption.

More broadly, pro-productivity policies can help narrow the gap between potential and realised absorptive capacity (see Box B). For example, flexible labour-market policies that expand access to low-cost, low-productivity labour may weaken firms' incentives to invest in capability building and technology adoption, thereby slowing diffusion-stage productivity gains (Kleinknecht, Van Schaik and Zhou, 2014). Labour market institutions may also affect the costs of implementing new technologies by shaping firms' ability to reorganise production, reallocate tasks, retain workers and adjust workforce composition (Canton, 2026; Cette, Nicoletti and Vernerey, 2026). Similarly, weak governance, poor competition policy, and high entry and exit barriers can reduce business dynamism and lock resources into firms that have developed fewer capabilities to strengthen absorptive capacity (Andrews, Criscuolo and Gal, 2016; André and Gal, 2024).

**Fiscal policy.** The effectiveness of innovation and diffusion policies depends not only on addressing both upstream and downstream barriers, but also on the selectivity and design of fiscal interventions (Pilat and Van Ark, 2027). While public support is justified in the presence of market failures, targeted mission-oriented policies generate productivity gains only under specific conditions, notably when spillovers are large, targeting is accurate, and implementation capacity is strong. Where technologies are already relatively mature and the main bottlenecks lie in diffusion and adoption, broad-based fiscal measures may generate larger and more cost-effective productivity gains than highly selective frontier-oriented support, particularly in areas such as AI (IMF, 2024b).

**Policy coordination**. Innovation is not a linear pipeline but a system characterised by feedback loops in which users shape innovation, supply chains transmit incentives, and mission-oriented public policy helps set direction (see Box B). Because there is no single silver bullet, the most effective pro-productivity strategies combine policies across multiple domains and require strong coordination (Pilat and Van Ark, 2027). For Europe, this system perspective underscores the central role of institutions and policy frameworks capable of aligning industrial, innovation, and diffusion policies across levels of government (Draghi, 2024). The EU's mission-oriented instruments, including the Green Deal, the AI framework, and defence R&D, can provide direction-setting and demand-pull, but only if the EU can build the institutional capacity and leverage national innovation systems to coordinate horizontal and regional policies. For example, Smart Specialisation strategies help diffuse productivity gains rather than entrench existing disparities (see also Section 5.3). In addition, completion of the Single Market, deeper integration through the Capital Markets Union, and effective implementation of the Savings and Investments Union remain critical preconditions for the success of a frontier innovation agenda (Hodge et al., 2024).

## 5.2 The role of monetary policy in investment, innovation, and diffusion

Monetary policy plays a complementary role alongside fiscal and structural policies in supporting innovation, diffusion, and productivity growth. The impact of monetary policy on productivity, innovation and diffusion is increasingly recognised in the literature, moving beyond the traditional neutrality view (Jordà, Singh and Taylor, 2019). However, in particular the role of monetary policy in intangible-intensive economies deserves more attention (Haskel, 2021; 2022).

**Productivity.** Empirical evidence suggests that monetary tightening tends to exert a negative effect on total factor productivity (TFP), primarily through the investment channel (OECD, 2023). Contractionary shocks in particular reduce firm-level productivity growth by lowering demand, raising borrowing costs, and reducing capital utilisation. This underscores the close interaction between capital formation and productivity dynamics (see also Box C).

Beyond these direct effects from monetary policy on productivity, a complementary strand of literature emphasises the role of resource misallocation. Monetary tightening (especially when driven by exogenous policy shocks) can increase dispersion in firm markups, leading to less efficient capital allocation and a decline in aggregate TFP (Meier and Reinelt, 2024). These effects are likely to be most pronounced for financially constrained firms, especially SMEs which are often less able to adjust prices or absorb adverse shocks. By contrast, expansionary policy can improve allocative efficiency by inducing high-productivity firms to increase investment more strongly than low-productivity firms, thereby increasing business dynamism and raising aggregate TFP (González et al., 2023). However, accommodative conditions may also sustain low-productivity (“zombie”) firms, weakening allocative efficiency. As such, the net effect of monetary policy on productivity reflects a trade-off between within-firm improvements and between-firm allocation effects.

Inflation dynamics provide an additional channel linking monetary policy and productivity. Higher and more volatile inflation raises uncertainty and the hurdle rate for long-term, high-risk investments, particularly in the presence of financial frictions (Evers, 2006; Andersson, Bobasu and De Santis, 2024). At the same time, cost shocks, such as energy price increases, can trigger firm exit and sectoral reallocation. While this may increase average productivity through selection effects, it often comes at the cost of reduced entry and weaker business dynamism (Chafwehé, Colciago and Priftis, 2024). The second key policy trade-off, therefore, lies between stabilising inflation and preserving productive reallocation and long-term growth, as policies that limit short-term disruptions may also dampen creative destruction and diffusion.

**Frontier innovation and scaling up.** While monetary policy should not be seen as the primary instrument for driving innovation, it can influence firms’ incentives and financial capacity to innovate. The most direct channel operates through the cost and availability of finance for R&D. Empirical studies broadly confirm that tighter monetary policy dampens R&D, venture activity, and productivity growth, although the magnitude of these effects depends on financial development and institutional quality (Ma and Zimmermann, 2023; Yang et al., 2024). However, firm-level evidence also points to important heterogeneity, since tightening can raise the share of R&D in some firms, particularly when they are less dependent on external finance or benefit from public support. At the macro level, however, this channel should not be overstated, because intensive R&D investment remains concentrated in a relatively small group of firms and sectors, such as pharmaceuticals, advanced manufacturing, and AI-related software.

Frontier innovation also depends critically on venture capital, which helps address the “scale-up finance gap” and makes monetary transmission partly indirect through the cost of risk capital. Lower interest rates tend to increase the attractiveness of high-risk, long-duration VC investments by reducing required returns, as reflected in hurdle rates, although these typically adjust only gradually to changes in monetary conditions (Shah, Bunn and Melolinna, 2025). However, access to early-stage finance remains structurally constrained, as banks are often reluctant to lend to innovative firms, meaning that the development of venture capital is shaped as much by institutional conditions as by monetary policy (Palacin, 2008).

**Diffusion and intangibles.** The diffusion channel is where monetary transmission has become most attenuated, because the link has grown weaker and more complex in economies dominated by intangible assets. Intangible-intensive firms tend to respond less to monetary shocks because intangibles provide poor collateral, are difficult to value and redeploy, and often involve high uncertainty and sunk costs, limiting the effectiveness of both credit and user-cost channels (Haskel, 2020; Döttling and Ratnovski, 2023).

Monetary policy nonetheless continues to matter indirectly, as contractionary shocks reduce intangible investment and TFP, especially among financially constrained firms. Furthermore, standard monetary policy rules may generate greater financial volatility in intangible-intensive economies because intangibles are more sensitive to shifts in expectations, allowing changes in interest rates to translate into larger fluctuations in credit conditions (Baldi and Bodmer, 2020).

At a more structural level, the distinctive characteristics of intangible capital can lower investment demand at a given interest rate, exerting downward pressure on the equilibrium real interest rate (Haskel, 2020). However, this effect is not unambiguous. Improvements in expected productivity associated with digitalisation, innovation, AI adoption, and intangible investment may generate an offsetting force. If firms and households anticipate higher future growth, they may bring forward investment and consumption, raising current demand and increasing the equilibrium interest rate (Haskel, 2021).

The balance between these opposing forces depends critically on the effectiveness of diffusion and the realisation of complementary investments. Where diffusion remains weak and productivity gains are uncertain or delayed, the downward pressure on investment and equilibrium interest rates is likely to dominate, reinforcing low-growth, low-rate dynamics. By contrast, where diffusion is broad-based and productivity gains are credible, intangible-driven growth may strengthen current demand and tighten monetary conditions even as supply prospects improve.

More broadly, innovation and diffusion in intangible economies depend less on monetary conditions alone than on complementary institutions, such as venture capital markets, intellectual property regimes, competition policy, and organisational capabilities, which shape firms’ capacity to absorb and scale new technologies (Andrews and Criscuolo, 2013). The key implication is that monetary transmission and macroeconomic outcomes increasingly depend on whether structural and innovation policies succeed in turning frontier innovation into broad-based diffusion and productivity growth.

## 5.3 Productivity, innovation and diffusion for inclusive growth

**A broad-based productivity concept.** Throughout this paper, we have used the standard concept of productivity as improvements in the efficiency with which economies transform inputs into outputs (see also Section 2 and Box A). However, the analysis has also shown that, while innovation, diffusion, and productivity contribute to economic growth, their interaction can generate distributional tensions as disparities widen across sectors, firms, and regions. This section therefore adopts a broader perspective on productivity, innovation, and diffusion by examining how these forces can be aligned more closely with inclusive growth (Van Ark, O'Mahony and Pilat, 2025).

Productivity can be understood more broadly as the process through which scarce resources are combined in increasingly effective ways to generate improved outcomes for people, firms, and places (Van Ark and O'Mahony, 2023). This perspective moves beyond the traditional focus on output per unit of labour or capital by extending the concept of output beyond GDP to wider measures of welfare and well-being, as emphasised in recent work on economic performance beyond GDP (Heys, Martin and Mkandawire, 2019; Stiglitz, Fitoussi and Durand, 2018; United Nations, 2026). At the same time, it expands the notion of inputs beyond labour and physical capital to encompass a broader portfolio of productive assets, including human, intangible, social, community, and natural capital. Many of these broader inputs relate directly to the mechanisms through which innovation and diffusion shape economic performance, bringing them more explicitly within the productivity concept itself. This broader capital perspective also aligns with frameworks that conceptualise national wealth in terms of multiple capitals (Coyle, 2025) and with policy approaches such as the UK Levelling Up White Paper, which explicitly adopts a six-capitals framework to understand geographic disparities and long-term prosperity (HM Government, 2022).[13]

Taken together, this framing highlights that productivity growth is not only about efficiency, but also about how economic activity translates into inclusive, sustainable, and place-based prosperity. This broader concept of productivity is particularly relevant when analysing productivity in the public sector (Van Ark, 2022) or from a place-based perspective (The Productivity Institute, 2026).

**Innovation and productivity for inclusive growth.** A broader productivity perspective also makes it possible to draw a more explicit connection between innovation and inclusive growth. OECD (2015b) emphasises that innovation links productivity to well-being through three main channels: by raising efficiency and creating new economic opportunities, by enabling solutions to societal challenges, and by operating through systems of skills, diffusion, and institutions that shape how productivity gains translate into broader outcomes. OECD (2018) develops this

[13] This broader interpretation is consistent with recent work by The Productivity Institute, which emphasises productivity as a driver of inclusive and sustainable growth and a function of how economies mobilise and combine a wide range of tangible and intangible assets across people, firms, and places (Van Ark, 2021; Van Ark and O'Mahony, 2023).

relationship further, highlighting that the benefits of productivity growth depend on diffusion, capabilities, and institutional conditions across firms and places.

Pilat and Van Ark (2026) identify three dimensions through which productivity relates to inclusive growth: access to the sources of productivity growth, the transformation of inputs into outputs, and the distribution of productivity gains.

- First, pro-productivity policies can widen access to the main drivers of productivity growth for lagging social groups, firms, and regions. Inclusive productivity growth depends on investment in people (for example, skills), places (for example, infrastructure and housing), and firms (for example, management capabilities) that have fallen behind.

- Second, policies can make the transformation process itself fairer and more inclusive by shaping the mechanisms that drive productivity growth. This includes fair competition and business dynamism in product markets, including digital markets, as well as inclusive and efficient labour markets and equitable access to finance. However, this also requires mechanisms that help workers and communities manage these transitions through income support, retraining, job matching and mobility assistance, and ensure that insolvency and restructuring regimes allow non-viable firms to exit efficiently without unnecessarily destroying viable assets, skills or entrepreneurial capacity. Inclusive innovation policy also requires attention to who participates in the innovation process: who has the opportunity to become an inventor, scientist, or entrepreneur; how knowledge and technology are diffused across people, places, and firms; and the extent to which innovation efforts address the needs of those who have fallen behind.

- Third, policies can help secure fair and inclusive outcomes by ensuring that the gains from productivity growth are widely shared. This includes policies explicitly aimed at inclusion and fair income distribution, such as progressive tax and benefit systems, as well as measures that support people and regions in adjusting to structural change.

The concept of inclusive growth emphasises that not only the pace of growth matters, but also its pattern and reach. The ability to design inclusive policies also depends on who is involved in policy development and implementation. In practice, firm-related policy is often shaped disproportionately by large incumbent firms, including through lobbying, rather than by start-ups and emerging industries that may require a different policy mix.

**A place-based perspective.** The shift towards more inclusive growth parallels growing concern about widening regional disparities, which often reflect differing dynamics across regions and places. Section 2.3 has shown that European integration has delivered selective convergence rather than a cohesive catch-up process between regions. These differences are rooted in variations in regional agglomeration and sectoral composition, innovation capabilities and integration into knowledge networks. The gaps appear to have widened since the GFC and especially since the late 2010s, as digital technologies have reinforced agglomeration advantages through network effects, scale economies and the concentration of talent, data and complementary intangible assets. At the same time, where these advantages are protected by technological rents or market power, they may weaken knowledge spillovers and limit diffusion to lagging regions, thereby reinforcing lock-in dynamics within existing convergence clubs.

Beyond innovation capabilities, persistent regional disparities generate significant socio-economic and political consequences. Regions trapped in long-term stagnation in income, employment, and productivity increasingly experience a sense of relative decline, which can translate into political discontent. This is reflected in rising support for Eurosceptic and anti-system parties, with the intensity of this response tending to strengthen - the longer stagnation persists. Importantly, such dynamics are not confined to poorer regions, but also emerge in previously prosperous areas, posing risks to social cohesion and undermining the economic and political legitimacy of the European project (Rodríguez-Pose et al., 2024).

These observations carry important implications for EU cohesion policy, pointing to the limits of uniform approaches and the need for more targeted, place-based strategies. A growing literature has highlighted limitations in the effectiveness of EU cohesion policy in addressing regional disparities, particularly where underlying differences in capabilities, institutional quality, and innovation systems are not adequately recognised. Empirical evidence suggests that the impact of cohesion funding varies significantly across regions and depends crucially on local governance and absorptive capacity (Rodríguez-Pose and Garcilazo, 2015), while persistent inequalities reflect structural differences in human capital and innovation performance (Jagódka and Snarska, 2022). Cohesion policy has also often suffered from weak coordination with broader innovation and industrial strategies, limiting its ability to support diffusion-driven productivity growth (EPRS, 2024). Although the shift towards a place-based approach recognises the importance of local capabilities and institutional contexts, implementation has been uneven and frequently constrained by governance weaknesses (Barca, 2009; Keller and Virág, 2022). These critiques suggest that EU cohesion policy has yet to align fully with a broader productivity framework centred on innovation, diffusion, and capability building across places.

Relatedly, there has been a shift from traditional regional development strategies towards contemporary place-based policymaking, reflecting a transformation in both economic structure and policy logic at the local and regional levels (Anderson and Westwood, 2026). Whereas earlier regional policies typically relied on exogenous interventions, such as inward investment incentives, infrastructure provision, or firm attraction, place-based approaches emphasise endogenous capacity, focusing on local assets, institutional networks, and the co-creation of value through innovation, skills, and knowledge diffusion. This aligns closely with the transition to knowledge-intensive and innovation-led growth models discussed in this paper.

From the perspective of the broader productivity concept, introduced above, place-based investment becomes critical, highlighting the need to mobilise public and private capital in ways that strengthen local innovation ecosystems and absorptive capacity (The Productivity Institute, 2026). Ultimately, the evolution from regional policy to place-based policymaking is not simply about tailoring interventions, but about embedding investment, innovation, and institutional capacity within places in order to navigate a more uncertain and politically contested economic landscape.

Taken together, the broader perspective on productivity, innovation and diffusion developed in this section suggests that productivity policy cannot be judged solely by how much growth it generates, but also by how widely its sources and gains are shared across people, firms, and places. In the European context, this implies that innovation and diffusion policies need to be designed not only to raise efficiency, but also to strengthen capabilities, widen participation, and support place-based development. A productivity framework oriented towards inclusive growth therefore reinforces the case for more coordinated policies that connect investment, innovation, diffusion, and institutional capacity across multiple levels of governance. Such an approach would also be more consistent with Europe's social model and the principles of the European Pillar of Social Rights, rather than being in conflict with them.[14]

[14] https://employment-social-affairs.ec.europa.eu/policies-and-activities/european-pillar-social-rights-building-fairer-and-more-inclusive-european-union_en

## Box D: A framework for pro-productivity policies

To examine the relationship between productivity, innovation, and policy, this section draws on a recently developed typology of pro-productivity policies (Van Ark, De Vries and Pilat, 2024). The framework builds on earlier work by the OECD, the World Bank, and national productivity commissions, and encompasses a broad range of policy instruments commonly used by governments to influence productivity growth (Pilat, 2023; André and Gal, 2024).

Chart D.1 presents the policies included in this typology, which have long been recognised as supporting investment, innovation, and productivity. These are grouped into four main categories: (i) policies that promote factor accumulation, such as those that stimulate investment or strengthen education and skills; (ii) policies that support technological and structural change, such as innovation and industrial policies; (iii) policies governing markets and resource allocation, including measures to improve the functioning of product and labour markets; and (iv) policies related to internationalisation, aimed at enhancing openness to trade, foreign direct investment, and migration. Underpinning all four categories is a fifth, foundational layer of policies that establishes the institutional and macroeconomic frameworks necessary for productivity growth, including effective government capabilities and sound macroeconomic management.

Two of these categories—those focused on factor accumulation and on technological and structural change—primarily target the direct drivers of economic and productivity growth, including capital deepening and total factor productivity (TFP). By contrast, policies related to markets and resource allocation and to internationalisation influence productivity more indirectly. The former shape firms' incentives to improve performance, for example through competitive pressures, and affect the allocation of resources across the economy. The latter operate by reinforcing and amplifying the effects of other policy domains.

Policy priorities are also likely to evolve with a country's stage of development. For example, strategies for investment and factor accumulation tend to shift as economies become more advanced, with greater emphasis on intangible assets, equity finance, and more sophisticated public infrastructure. Similarly, human capital policies typically evolve from a focus on basic education and foundational skills, such as literacy and numeracy, towards secondary and tertiary education, the development of advanced capabilities, better skill matching, and lifelong learning.

Policies supporting technological and structural change likewise evolve over time. Innovation policy may initially focus on absorbing foreign knowledge and building domestic capabilities, before shifting towards stronger public and private investment in R&D, deeper national and international collaboration, and the development of more comprehensive innovation systems. Industrial policy may also change as economies move to more advanced stages of production, with greater emphasis on knowledge-intensive activities and services.

Policies related to markets and resource allocation also evolve as economies develop. As markets become more open, new and more complex barriers and regulatory challenges can emerge, while resource misallocation often becomes a more pressing concern. Policies for internationalisation likewise change over time. As countries deepen their openness to trade and foreign direct investment, attention increasingly shifts towards upgrading their position in global value chains and competing in more advanced, higher value-added segments, including services.

Chart D.1: A typology of pro-productivity policies

Source: Van Ark, De Vries and Pilat (2024).

Institutional and framework policies also evolve with economic complexity. New institutions may be required—such as data protection authorities or AI safety bodies—while governments adopt more advanced forms of public governance, including expanded digital government.

Although this framework covers a broad range of productivity-enhancing policies, a wider perspective may sometimes be needed (see Pilat and Van Ark, 2027). In the context of ageing populations, for example, pension systems play an important role in shaping labour market dynamics and long-term productivity. Tax policy is another critical factor influencing both productivity and innovation. The spatial dimension of productivity policy within countries has also become increasingly important, particularly in light of growing regional disparities.

## 6 Conclusions and Recommendations

This paper has examined Europe's productivity problem through a lens that connects investment, innovation, and diffusion. It began from the observation that Europe's broad-based productivity underperformance lies at the heart of current concerns about growth, competitiveness, and resilience. Yet the policy response is too often framed as a choice between strengthening frontier innovation and improving diffusion. By combining comparative evidence on productivity trends with a more detailed analysis of innovation, diffusion, and investment, the paper has shown that this 'either-or' framing is too narrow to capture the nature of Europe's productivity challenge. Section 2 documented the widening productivity gap between Europe and the United States, alongside growing divergence across sectors, firms, and regions within Europe. Section 3 showed that Europe's challenge lies not only in weaker frontier dynamism, but also in the barriers that prevent innovation from being scaled up, disseminated, and widely adopted. Section 4 demonstrated that these weaknesses are closely tied to an investment problem, particularly in intangible assets that support both innovation and diffusion. Section 5 translated these findings into a broader policy framework aimed at aligning productivity growth with inclusion and place-based development.

Taken together, the paper shows that Europe's productivity problem is not one of 'either-or' but of 'both-and'. Addressing only one side of this problem will not be sufficient. Europe suffers from weak frontier dynamism, especially through underperforming scaling-up mechanisms. However, the binding constraint on making the innovation system work for productivity growth lies in the systemic barriers that prevent innovations from spreading widely across the economy. These diffusion barriers include fragmented and often restrictive product-market regulation, weak business dynamism, limited market contestability, financing constraints for young and growing firms, and skills and capability mismatches that limit firms' absorptive capacity.

The central policy implication is the need to rewire Europe's productivity framework so that it gives greater weight to the dissemination of technologies and innovative practices, and to the absorptive capacity required to translate them into broad-based productivity growth. This would also prepare the ground for greater impacts from frontier innovation and scaling up. It requires recognising that the consequences of innovation and diffusion are increasingly distributional: productivity gaps have widened not only between Europe and the United States, but also across sectors, firms, and regions within Europe, raising the stakes for both efficiency and inclusion. In the European context, this calls for multi-level governance capable of aligning investment, innovation, and diffusion across the EU, national, and regional levels in support of productivity growth and more inclusive outcomes.

With this in mind, it is useful to distinguish between an EU-level industrial strategy and horizontal pro-productivity policies implemented primarily at national and regional levels. This distinction broadly mirrors the difference between vertical, sectoral or mission-oriented policies and horizontal economy-wide approaches described in Section 5. It also reflects differences in scale, spillovers, and institutional embeddedness: EU-level action is best suited to activities characterised by large fixed costs, cross-border externalities, or mission-oriented spillovers. National and regional policies, by contrast, are better placed to address country- and place-specific frictions, complementarities, and constraints on absorptive capacity.

The evidence from this paper suggests that the latter policies, which are primarily diffusion-oriented, should be the first-order priority. Europe needs stronger frontier innovation, and especially better scaling-up mechanisms, but the failure to disseminate technologies and innovations more widely points to the critical role of diffusion-oriented policies. Horizontal policies are institutionally easier to implement and directly address the measured within-industry productivity gaps. At national and regional levels, core policy domains – such as investment in human and organisational capital, support for SME innovation and diffusion, and the functioning of product and labour markets – remain central to stronger productivity performance and should, where possible, be embedded in place-sensitive policy frameworks. Openness and competition, domestically and globally, are another key diffusion mechanism.

Horizontal pro-productivity policies should be designed and implemented primarily by member states, while being coordinated at EU level. Existing National Productivity Boards (NPBs) should be strengthened to provide an institutional basis for such coordination, potentially reinforced by the creation of a European Productivity Board (EPB). Such a body could help address persistent coordination and information failures, strengthen cross-country learning, and improve the translation of evidence into policy design, while supporting longer-term productivity policymaking across the EU (Thomas and Reinstaller, 2026). Stronger regional institutions and policy mechanisms are also needed to address the spatial dimensions of productivity, innovation, and diffusion that are essential to fostering inclusive growth.

Strengthening horizontal policies is a prerequisite for successful vertical approaches. As discussed in Section 5.1, industrial policy – as one of the key instruments of vertical policy – is best understood not as a substitute for diffusion-oriented policy, but as a system-shaping complement that strengthens the conditions under which frontier innovation can be scaled up, disseminated and translated into broader productivity gains. Assigning primacy to industrial strategy at the EU level enables the scaling of key innovation missions, the pooling of funding, and the coordinated deployment of critical resources alongside the private sector. These include not only financial capital, but also intangible assets such as R&D, AI software development, and shared AI factories that support frontier compute infrastructure.

However, the EU will need to strengthen government capabilities to deliver more effective vertical action. Industrial policy has to be selective, experimental, and disciplined by performance criteria, while remaining aligned with openness, competition, and the Single Market. Crucially, this approach implies less emphasis on picking isolated national champions and more on building cross-border ecosystems in which research, scale-up finance, standards, procurement, skills, and downstream adoption reinforce one another (Draghi, 2024). Without such system-wide discipline, mission-oriented or sectoral industrial policy risks degenerating into subsidy competition or resilience policy without sustained productivity effects (Juhász et al., 2024).

An effective vertical strategy would ideally be guided by a public–private governance structure operating at some distance from the European Commission, but within clearly defined guardrails that ensure strategic alignment while preserving flexibility and agility. Its direction could be anchored in overarching instruments such as the Competitiveness Compass and complemented by a strategic roadmap for coordinated action on frontier innovation and investment in key industries.

While the vertical dimension should be anchored at EU level, national governments should play an active supporting role by contributing resources and capabilities to joint initiatives, including cross-border "DARPA-style" programmes that can help overcome the limitations of fragmented and small-scale national innovation efforts. Close coordination between EU-level industrial strategy and national and regional horizontal policies is essential to ensure coherence, exploit complementarities, and maximise the effectiveness of Europe's productivity agenda.

Once national and regional horizontal policies have unlocked the potential to accelerate and broaden diffusion and adoption across firms, sectors, and regions, a well-institutionalised EU-level industrial strategy can help create and scale frontier innovations. Europe's productivity strategy should therefore prioritise the national and regional anchoring of policies that enable diffusion, absorption and effective use, while ensuring that EU-led scaling of frontier innovation translates into broader productivity gains.

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# Appendix Tables

## Appendix Table 1

Regression Investment - dependent variable labour productivity levels, 1996-2021

| | (1) DE | (2) FR | (3) ES | (4) IT | (5) NL | (6) All 5 |
|---|---|---|---|---|---|---|
| Tangible | .507 | 1.04*** | .404* | .827*** | .643* | .643*** |
| | (.337) | (.211) | (.203) | (.234) | (.353) | (.139) |
| Intangible | .959* | -.422 | .171 | -.628** | -.292* | -.024 |
| | (.536) | (.275) | (.256) | (.297) | (.152) | (.16) |
| Intangible Business-related | .377 | .568* | .034 | 1.208** | 1.603** | .47* |
| | (.802) | (.298) | (.321) | (.533) | (.63) | (.276) |
| Tangible x Intangible tech | -.278** | .019 | -.049 | .094* | .02 | -.045 |
| | (.118) | (.034) | (.055) | (.054) | (.032) | (.032) |
| Tangible x Intangible Bus. | .011 | -.262*** | -.055 | -.336*** | -.245* | -.131* |
| | (.14) | (.086) | (.067) | (.083) | (.133) | (.067) |
| Intangible tech x Intangible | .109* | .188*** | .125*** | .157* | .047 | .131*** |
| | (.057) | (.038) | (.033) | (.086) | (.056) | (.035) |
| | (.057) | (.038) | (.033) | (.086) | (.056) | (.035) |
| _cons | .842 | .472 | 2*** | .386 | -.02 | 1.064** |
| Observations | 594 | 594 | 593 | 581 | 594 | 2956 |
| Within R2 | .384 | .756 | .401 | .338 | .657 | .362 |
| Adj R2 | .348 | .742 | .367 | .299 | .638 | .355 |

Sources: EUKLEMS & INTANProd (2023); Van Ark et al. (2024b) with series updated from 2019 to 2021.
Notes: Country-industry fixed effects (panel data) regressions including capital deepening for all tangible capital ("Tangible"), technology-related intangibles ("Intangible tech"), and business innovation-related intangibles ("Intangible Bus.).

**Appendix Table 2**

Regression Investment - dependent variable labour productivity growth, 1996-2021

| | (1)<br>DE | (2)<br>FR | (3)<br>ES | (4)<br>IT | (5)<br>NL | (6)<br>All 5 |
|---|---|---|---|---|---|---|
| **Tangible** | -1.222** | .1 | .025 | .069 | -.051 | -.156 |
| | (.437) | (.476) | (.149) | (.09) | (.306) | (.162) |
| **Intangible Technology-related** | .262 | -.099 | .272 | .131 | -.266*** | .002 |
| | (.287) | (.317) | (.219) | (.231) | (.091) | (.087) |
| **Intangible Business-related** | -.208 | -.222 | -.153 | .107 | .457 | 0 |
| | (1.116) | (.605) | (.268) | (.207) | (.44) | (.177) |
| **Tangible x Intangible tech** | -.02 | -.007 | -.083 | -.087 | .054** | -.01 |
| | (.109) | (.059) | (.052) | (.067) | (.026) | (.023) |
| **Tangible x Intangible Bus.** | .269*** | .003 | .044 | -.005 | -.048 | .05 |
| | (.086) | (.148) | (.064) | (.037) | (.096) | (.045) |
| **Intangible tech x Intangible Bus.** | -.043 | .126*** | .118*** | .109** | .035 | .05* |
| | (.104) | (.041) | (.029) | (.045) | (.045) | (.028) |
| **_cons** | -.001 | .017*** | -.005 | .012 | .001 | .01 |
| | (.013) | (.005) | (.01) | (.012) | (.012) | (.007) |
| **Observations** | 572 | 572 | 570 | 558 | 572 | 2844 |
| **R-squared** | .138 | .16 | .089 | .111 | .198 | .077 |
| **Adj R2** | .088 | .112 | .036 | .059 | .152 | .065 |

Sources: EUKLEMS & INTANProd (2023); Van Ark et al. (2024b) with series updated from 2019 to 2021.
Notes: Country-industry fixed effects (panel data) regressions including capital deepening for all tangible capital (“Tangible”), technology-related intangibles (“Intangible tech”), and business innovation-related intangibles (“Intangible Bus.).