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RESEARCH PAPER



EU's Past and Present Productivity

A SECTORAL VIEW



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Introduction

The productivity slowdown in the EU

The productivity slowdown in the EU is well documented. However, what it is less clear is why this is happening. This analysis explores the 'whys'. Using the most extended time span (1995-2024) for which all current 27 EU countries have available data on Eurostat for detailed sectoral breakdown (64 sectors) the approach to study EU productivity and EU productivity diffusion is based on the distinction between EU frontier countries (EU frontier) and EU follower countries (EU follower).

In each year EU frontier represents either the average of the productivities of the three member states with the highest annual productivity or these member states themselves. The productivity is measured by the annual gross value added (GVA) in 2019 prices per employed person. The EU follower represents either the average productivity of the rest of 24 member states not included in EU frontier, or these 24 member states themselves. To grasp the changes in the mix of labour-capital used by sectors the income breakdown of GVA is used.

OECD Context

Productivity is the ultimate growth driver of any economy. The OECD report on The Future of Productivity (2015) showed that the globally most productive firms has remained robust in the 21st century. However, the gap between those global leaders and the rest has increased over time, and especially so in the services sector. It was concluded that the future growth will largely depend on the revival of the diffusion machine, both within and across countries.

There are several possible explanations for the slowdown of productivity diffusion, one possibility is that patents and other intellectual property could be locked up in the frontier firms. Another possibility is that innovations are embedded in capital so one need new investment to diffuse innovation and business investment has been low for some time perhaps for 'cyclical' reasons. The OECD (2015) argues that this is consistent with: i) longer run evidence on the penetration rates of new technologies (e.g. Comin and Mestieri, 2013); ii) winner takes all dynamics (Gabaix and Landier, 2008); and iii) the rising importance of tacit knowledge. OECD (2021) shows that that rise in productivity dispersion after 2000 is more pronounced in intangible-intensive industries.

Methodology

EU frontier: Average of 3 EU countries with highest productivity (excluding outliers) in each year.

EU followers: Remaining 24 EU countries.

Productivity: GVA in 2019 prices per employed person.

Time span: 1995-2024 (most extended available data).

Data source: Eurostat National Accounts.

EU Frontier (3 Countries)	EU Followers (24 Countries)
<ul style="list-style-type: none"> - Highest productivity countries - Excludes outliers (Ireland, Luxembourg) - Benchmark for diffusion - Average of top 3 each year 	<ul style="list-style-type: none"> - Remaining EU member states - Includes CEE countries - Target for convergence - Measures diffusion success

01 Main Findings

Key insights from the productivity analysis

- The productivity evolution in the EU depends both on EU frontier and EU followers. The productivity in the EU followers depends on the extent the frontier productivity is diffused. The EU single market with free movement of labour, capital and products was supposed to contribute to the diffusion process and the productivity convergence between EU frontier and EU followers. But after 2019 the productivity convergence halted. The productivity in EU follower was 52% of the EU frontier in 2024 as it was in 2019.
- Although the force of the EU frontier strengthened after 2019 in terms of annual productivity growth and size (% of EU GVA) the productivity diffusion process among EU followers slowed down. During 2020-2024 the CAGR of productivity in EU follower was 1% just by 0.2pp higher than the CAGR in EU frontier. This is in sharp contrast with 1995-2019 when the CAGR of productivity in EU follower at 1.2% was the double of the EU frontier (0.6%).
- The main cause of the productivity slowdown in EU follower after 2019 was industry and agriculture. In both sectors the productivity growth in EU follower remained much behind the productivity growth in EU frontier. During 2020-2024 in agriculture the annual productivity growth in EU frontier was 3.6% annually, while in EU followers 1.3%. In industry, the productivity in EU frontier advanced by 3% annually, while in EU follower stayed unchanged.
- In manufacturing, the main subsector of industry, changes in both EU frontier and EU follower which could explain the slowdown of productivity diffusion occurred after 2019. The traction of EU frontier was undermined by two main evolutions: 1/ just a subset of manufacturing sectors grew and 2/ the size of only two sectors with increasing productivity expanded (basic pharma, textile and food).
- It seems that in EU follower the closeness to the EU frontier determines the productivity growth as though the average productivity gap of the economy vis-a-vis the EU frontier constraints the speed of the productivity diffusion in the sectors. After 2019 in EU followers the sectors closer to the EU frontier in 2019 lost productivity and sectors farther from the EU frontier in 2019 gained productivity.

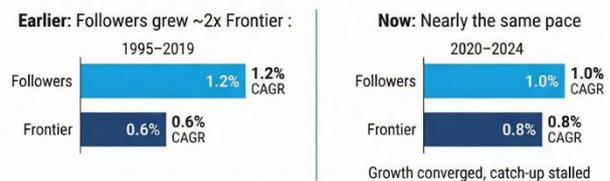
EU's Past and Present Productivity: The Stalled Convergence



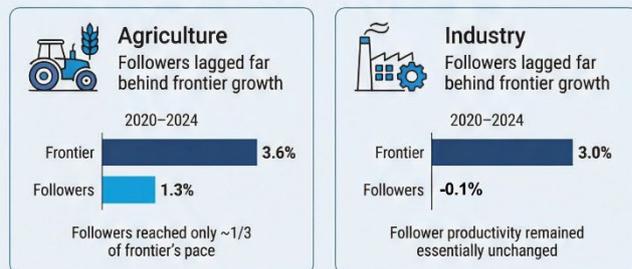
EU followers productivity = 52% of EU frontier

2019-2024: 52%-52%
Convergence has stalled: the gap remained unchanged.

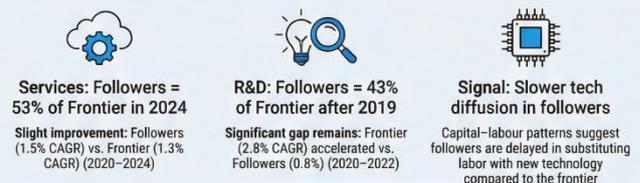
1. Diffusion Slowed After 2019



2. Sectoral Slowdown (Industry & Agriculture)



3. Technology Signals & Improvements



Frontier = 3 highest-productivity EU economies | Followers = the rest of EU economies

6. The changes in the income breakdown of GVA give evidence for the view that the delay in penetration rate of new technology was the reason why EU follower could not keep the pace with productivity growth in EU frontier.
7. After 2019 in EU frontier both industry and agriculture used more capital substituting labour (the share of consumption of fixed capital increased and the share of compensation of employees declined) than before 2019. In the same period, in EU follower, industry used the same capital with less labour and agriculture used more capital with more labour. In 2020-2024 both agriculture and industry were more capital intensive in EU frontier than in EU follower.
8. Productivity continued to advance after 2019 with higher rate than before 2019 in commercial services both in EU frontier (CAGR 1.3% in 2020-2024 vs. 0.8% in 1995-2019) and EU follower (CAGR 1.5% in 2020-2024 vs. 1% in 1995-2019). The productivity in commercial services in EU follower was 53% of EU frontier in 2024.
9. The composition of GVA in commercial services was relatively stable over time in both EU frontier and EU follower. In 2020-2024 the commercial services in EU follower were less capital and less labour intensive than in EU frontier.
10. Productivity in R&D accelerated after 2019 in EU frontier (CAGR 2.8% in 2020-2022 vs. 0.8% in 1995-2019) and grew with the same rate as before 2019 in EU follower (CAGR 0.8%). After 2019 productivity in R&D in EU follower was 43% of EU frontier, the sector being more capital and more labour intensive than in EU frontier.

Productivity Growth Comparison

Period	EU Frontier CAGR	EU Follower CAGR	Gap
1995-2019	0.6%	1.2%	+0.6pp
2020-2024	0.8%	1.0%	+0.2pp

02 EU Productivity Frontier

Analysis of the top-performing EU member states

Productivity is the ultimate growth driver of any economy. The OECD report on The Future of Productivity (2015) showed that the globally most productive firms has remained robust in the 21st century. However, the gap between those global leaders and the rest has increased over time, and especially so in the services sector. It was concluded that the future growth will largely depend on the revival of the diffusion machine, both within and across countries, while there is much scope to boost productivity and reduce inequality simply by more effectively allocating human talent to jobs.

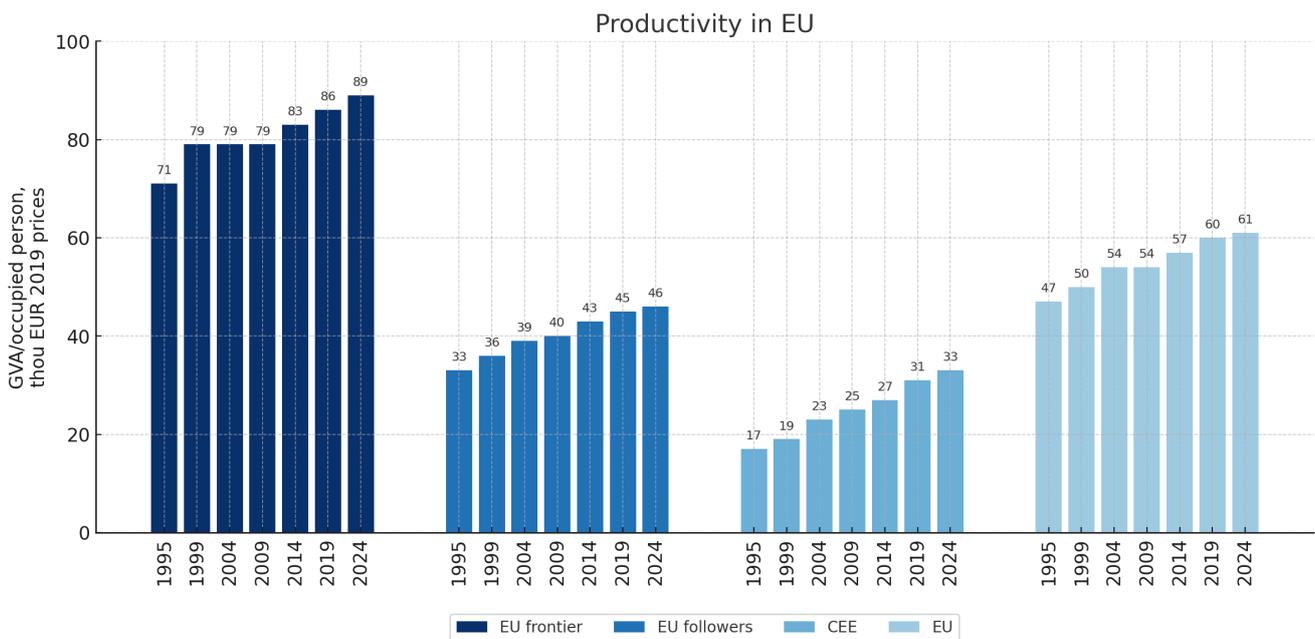
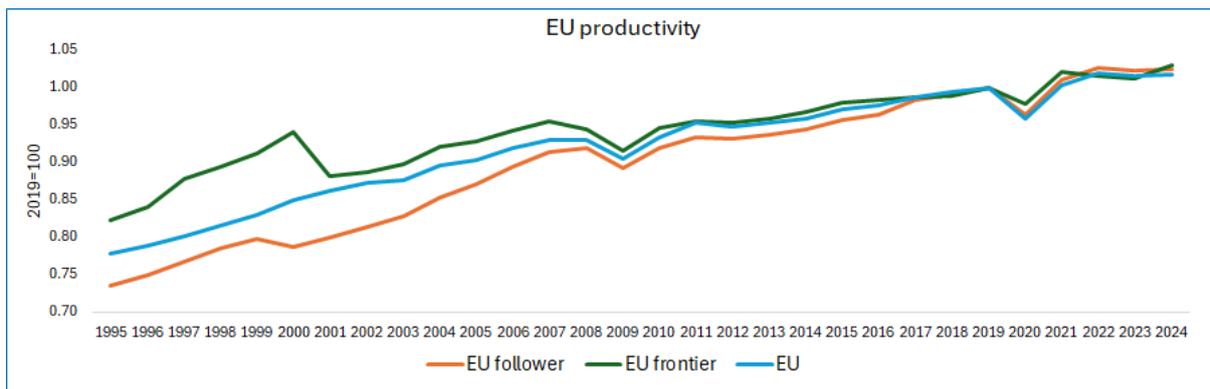
There are several possible explanations for the slowdown of productivity diffusion, one possibility is that patents and other intellectual property could be locked up in the frontier firms. Another possibility is that innovations are embedded in capital so one need new investment to diffuse innovation and business investment has been low for some time perhaps for 'cyclical' reasons.

This analysis using the most extended time span (1995-2024) for which all current 27 EU countries have available data proposes a novel approach to study EU productivity and EU productivity diffusion based on the distinction

between EU productivity frontier countries (EU frontier) and the follower countries (EU followers). The EU frontier consists of 3 EU countries with the highest productivity (excluding outliers) in each year.

The EU productivity frontier is computed as the average of the gross value added (GVA) in 2019 prices per person employed in the 3 best performing EU member states (excluding outliers) for the period 1995-2024 using Eurostat data for National accounts. The latest available data varies by sector. The decomposition into 10 industries is available up to 2024, while the decomposition into 64 industries is available up to either 2022 or 2023.

What happened in the EU? The productivity slowed down. The frontier productivity although advanced slightly faster after 2019 than before did not elicit a faster productivity growth among follower countries after 2019 as it did before. Since 2017 in follower countries the speed of productivity converged toward the frontier speed. After Covid-19 pandemic, when the frontier productivity contracted less than the followers, the follower productivity grew slower than the frontier productivity.



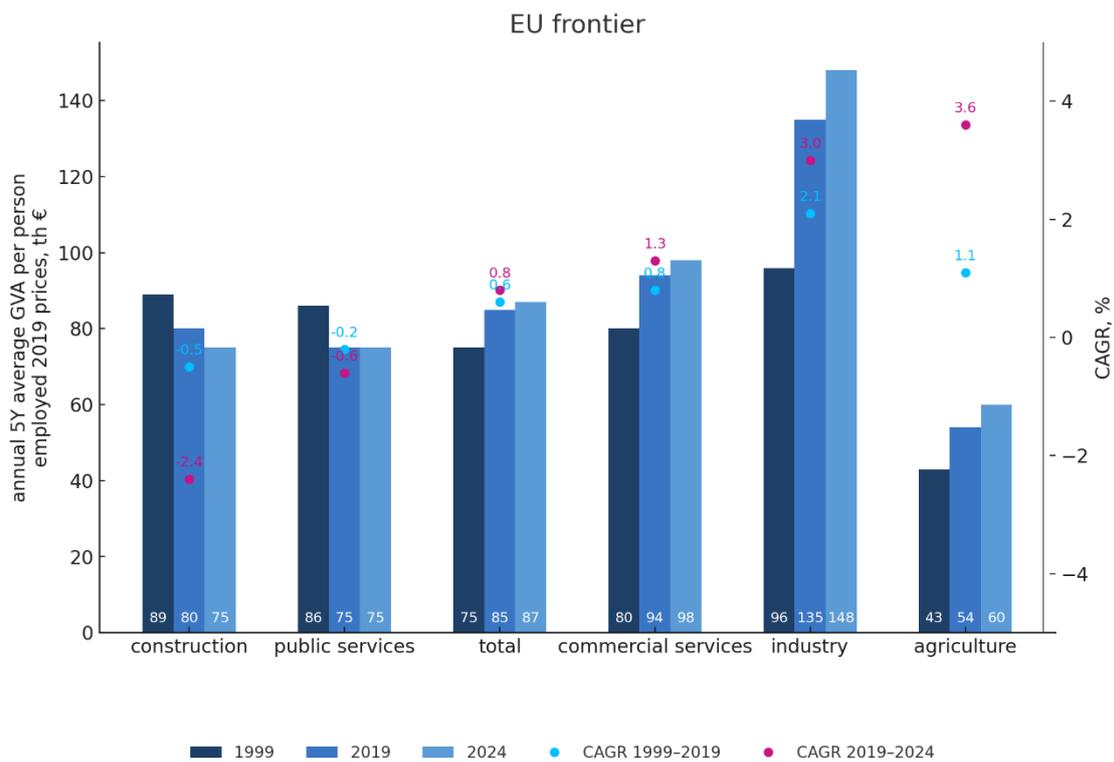
Note: CEE includes Romania, Czechia, Hungary and Poland

In 2024 the average productivity in EU frontier was higher by 48% compared to the average productivity in EU, by 52% than the average productivity in follower countries and by 2.7 times than the average productivity in CEE.

The 5Y annual average productivity increased in EU frontier by slightly higher annual rate after 2019 than before 2019 (0.6% before 2019 and 0.8% after 2019) reaching EUR 87K in 2024. The productivity increase in EU frontier was due to agriculture, industry and commercial services, whose productivity gain after 2019 more than compensated the productivity loss in construction and public services.

Productivity declined over the whole period in construction and public services; the contraction rates strengthened after 2019 in construction (-2.4% compared to -0.5%) and diminished in public services (-0.2% compared to -0.6%). After 2019 the productivity in commercial services, industry and agriculture increased faster than before 2019.

The growth leader was agriculture where productivity increased by 3.6% per year after 2019 reaching EUR 60K. Nevertheless, the productivity in the sector remained the smallest. The productivity leader is industry. The growth rate of the productivity almost doubled after 2019 (3% vs 1.7% before 2019) and reached EUR 148K in 2024. The same happened in commercial services but with lower growth rates (1.3% after 2019 and 0.8% before 2019) and the productivity reached EUR 98K.



Productivity Comparison 2024



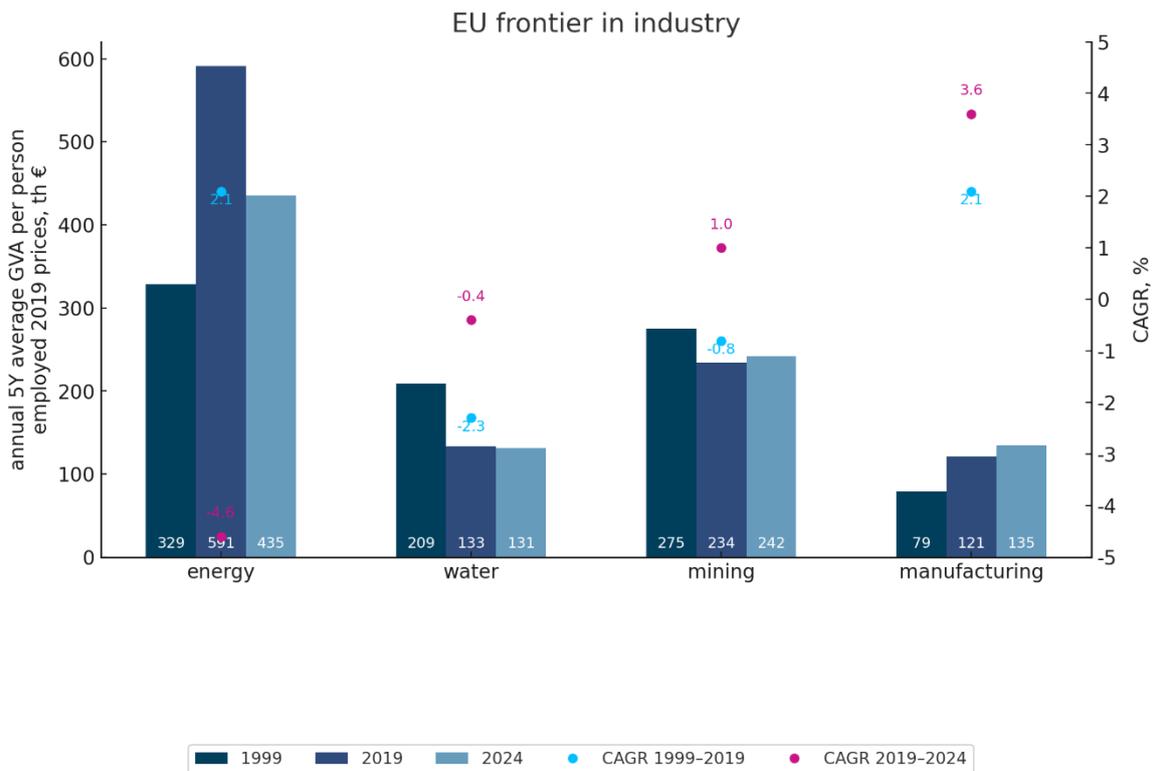
Sectoral Productivity Growth (CAGR)

Sector	Before 2019	After 2019	2024 Level
Agriculture	-	3.6%	EUR 60K
Industry	1.7%	3.0%	EUR 148K
Commercial Services	0.8%	1.3%	EUR 98K
Construction	-0.5%	-2.4%	-
Public Services	-0.6%	-0.2%	-

03 Industry Analysis

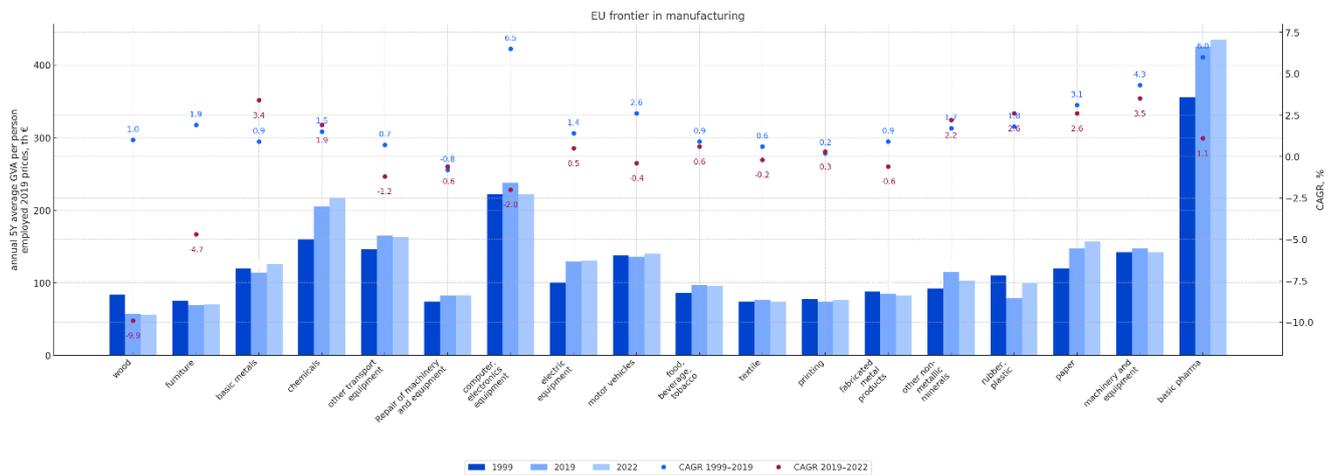
Productivity dynamics within industrial sectors

Within industry the evolution of productivity varies across sectors. In energy sector, the most productive sector, the productivity before 2019 increased at the same rate as in manufacturing (2.1%), but after 2019 the productivity in the sector declined by 4.6% yearly, while in manufacturing productivity continued to rise with a stronger rate (3.6%). In mining productivity declined before 2019 (-0.8%) and increased after 2019 (1%). In water sector the productivity continued to decline after 2019 too but with a lower contraction rate (-0.4% vs. -2.3% before 2019).



The productivity leader in industry was the manufacturing sector. The annual growth rate of productivity increased from 2.1% before 2019 to 3.6% after 2019. Productivity increased in all manufacturing subsectors before 2019. After 2019 some sectors - wood, furniture, chemicals, motor vehicles and other transport equipment, computer, electronics, electric equipment and repair of machinery - lost productivity. Nevertheless computer, electronics and chemicals remained the most productive sectors with EUR 218K and EUR 205K respectively. Wood and furniture stand out with the largest productivity decline after 2019 (-9.9% and -4.7% respectively).

The most productivity enhancing sectors after 2019 are basic pharma (6% growth), machinery and equipment (3.1% growth), paper (2.6% growth), rubber, plastic (2.2% growth). These sectors had the best productivity growth even before 2019. Basic pharma is the most productive sector with EUR 425K per year.



Manufacturing Leaders (After 2019)	Manufacturing Decliners (After 2019)
<ul style="list-style-type: none"> • Basic Pharma: 6% growth, EUR 425K productivity • Machinery & Equipment: 3.1% growth • Paper: 2.6% growth • Rubber & Plastic: 2.2% growth 	<ul style="list-style-type: none"> • Wood: -9.9% (largest decline) • Furniture: -4.7% • Motor Vehicles: -0.4% • Computer & Electronics: declining -0.6% but still EUR 218K

Industry Subsectors Productivity

Subsector	Before 2019	After 2019	Status
Manufacturing	2.1%	3.6%	UP
Energy	2.1%	-4.6%	DOWN
Mining	-0.8%	1.0%	UP
Water Supply	-2.3%	-0.4%	WARN

Key Insight: Manufacturing Asymmetries

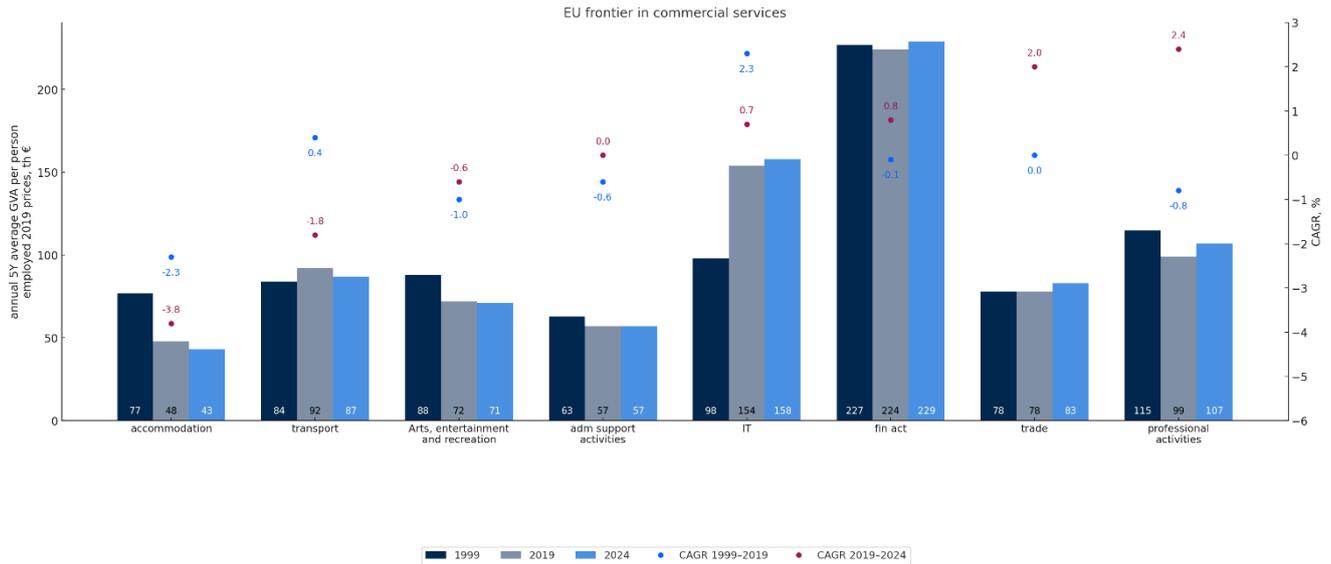
In EU follows the productivity diffusion showed asymmetries: the productivity growth tended to be speedier in sectors which had negative growth in EU frontier, but the productivity growth was slowest in sectors growing fastest in EU frontier (fabricated metal products, other non-metallic minerals, rubber and plastic, paper, machinery and equipment, basic pharma).

Compared to EU frontier the productivity in EU follower was 40% in agriculture and 36% in industry.

04 Commercial Services

IT, Financial Activities, Trade, and Transport

In commercial services before 2019 productivity declined in all sectors excepting IT and transport. After 2019 the productivity continued to increase in IT but slower with a comparable rate as in financial activities (0.8%) and declined in transport (-1.8%). The sectors with the fastest increasing productivity after 2019 are professional activities (2.4%) and trade (2%).



In commercial service the productivity growth in EU frontier strengthened after 2019 to CAGR 1.3% from CAGR 0.8% in 1999-2019. The reason was that while before 2019 only IT and transport registered productivity gains after 2019 financial activity and trade also improved their productivity.

The productivity in EU followers grew slightly faster than in EU frontier both before 2019 (CAGR 1%) and after 2019 (CAGR 1.5%). The growth gain and loss in EU follower mimicked the EU frontier, with the difference that the gains were higher (excepting professional activities after 2019) and the losses smaller (excepting real estate, transport and recreational activities after 2019). The influence of the size of the EU frontier is not conclusive.

Commercial Services Productivity Growth

<p>53%</p> <ul style="list-style-type: none"> • EU Follower vs EU Frontier • Commercial Services Productivity 2024 	<p>Stability in GVA Composition</p> <p>The composition of GVA in commercial services was relatively stable over time in both EU frontier and EU follower. In 2020-2024 the commercial services in EU follower were less capital and less labour intensive than in EU frontier.</p>
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05 EU Followers Analysis

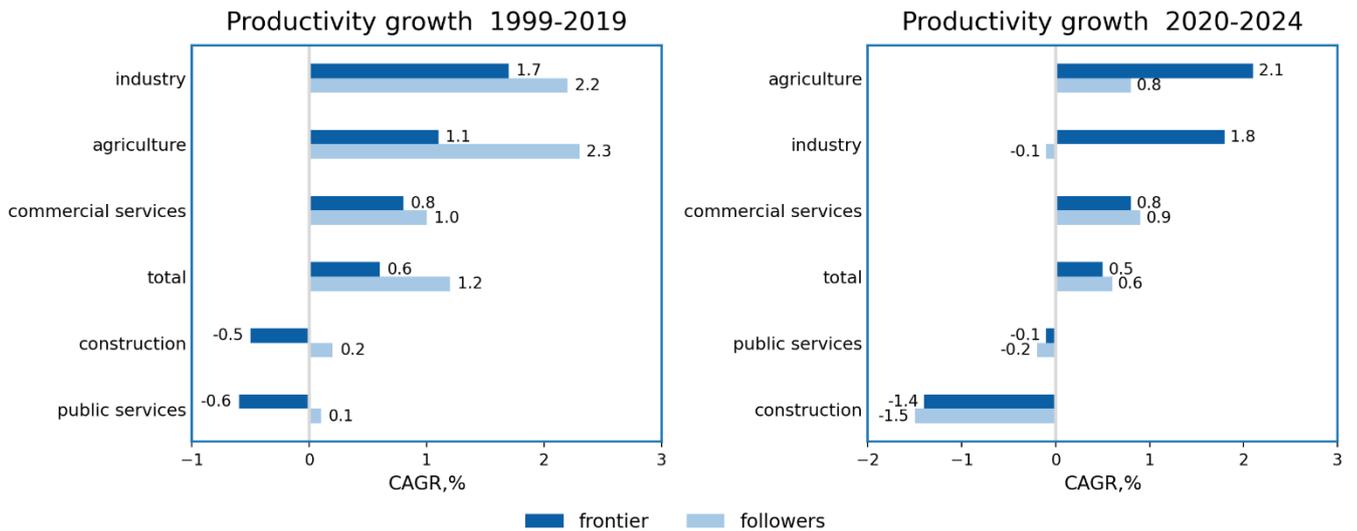
Productivity diffusion and convergence dynamics

The productivity evolution in EU depends not only on the frontier productivity but also on the degree the frontier productivity is diffused across follower countries. The EU single market with free movement of labour, capital and products is supposed to speed up the process. The expectation is that over time with strengthened integration of the EU countries in the EU single market the productivity diffusion strengthens as well. But it did not.

Convergence Halted

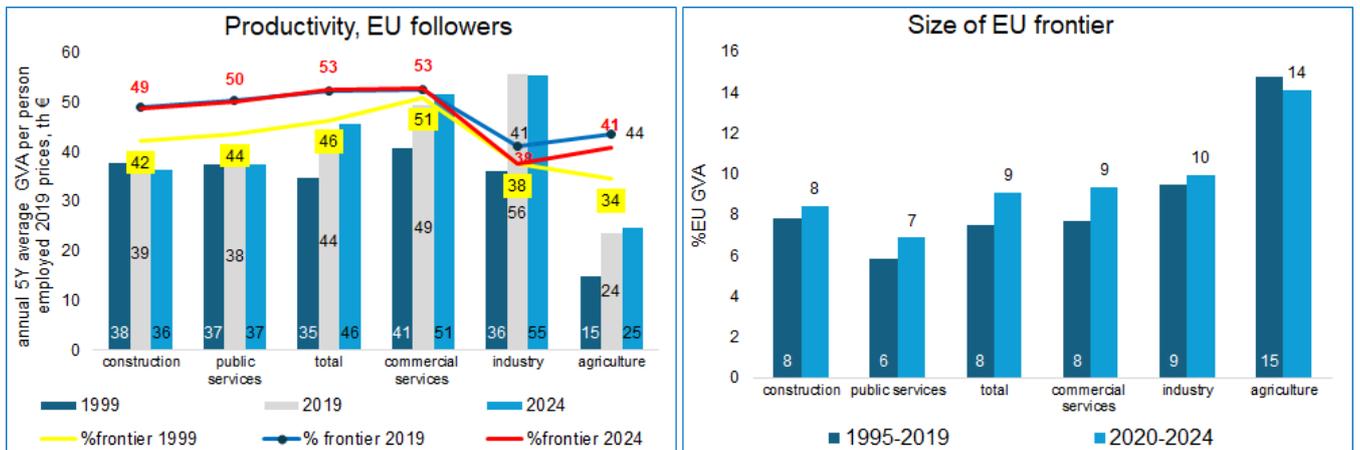
After 2019 the productivity in EU follower countries grew just slightly faster than the productivity in EU frontier, in contrast with the period before 2019 when the productivity growth in EU follower countries was double of the productivity growth in EU frontier.

The main cause of the slowdown was industry and agriculture. In both sectors the productivity growth in EU follower remained much behind the productivity growth in EU frontier. In agriculture the productivity growth in EU frontier was 2.1% annually, while in EU followers 0.8%. In industry, the productivity in EU frontier advanced by 1.8% annually, while in EU follower declined yearly by 0.1%.

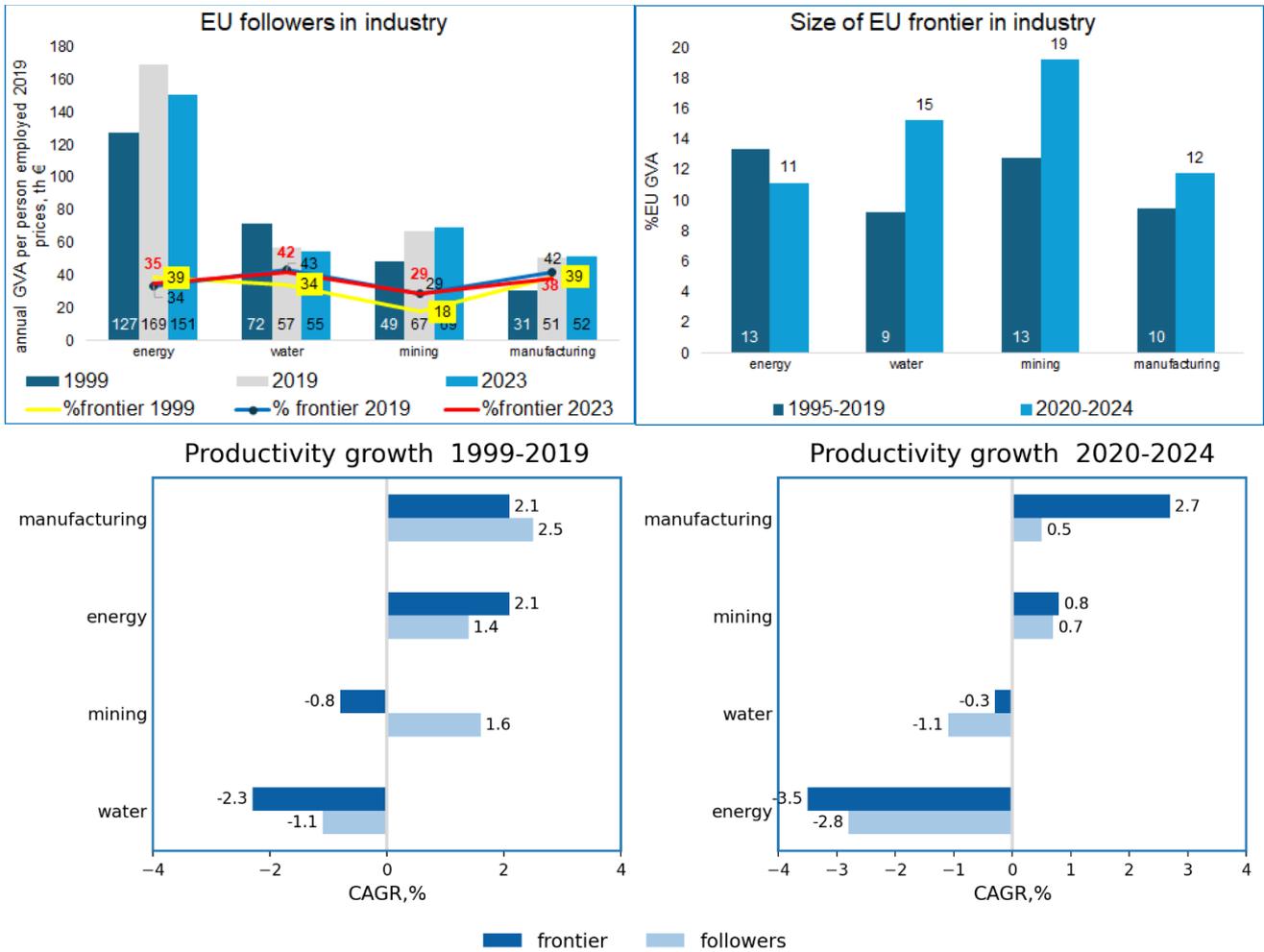


Note: CAGR of 5Y average productivity

The productivity in EU followers did not get closer to the EU frontier after 2019. The productivity in EU follower was 46% of EU frontier productivity in 1999 and increased to 53% in 2019 where it stayed in 2024 too. No sectors in EU follower achieved productivity gains vis a vis the EU frontier after 2019. Worse, in industry a loss in productivity compared to EU frontier occurred. The increased size of the EU frontier, as % of EU GVA, in most sectors, except agriculture, did not help the diffusion as expected.



The loss in productivity in industry in EU followers was mainly due to manufacturing, where the share of productivity in EU frontier fell from 42% in 2019 to 38% in 2023 as it was in 1999, even though the size of EU frontier increased. The productivity in manufacturing in EU follower increased by 0.5% annually, slower than in EU frontier (3.6%) after 2019. In the energy sector the productivity declined slower in EU follower than in EU frontier, which allowed some productivity convergence in 2024. In mining the productivity grew at par in EU followers and EU frontier, while in water supply the productivity growth declined more in follower than in EU frontier.

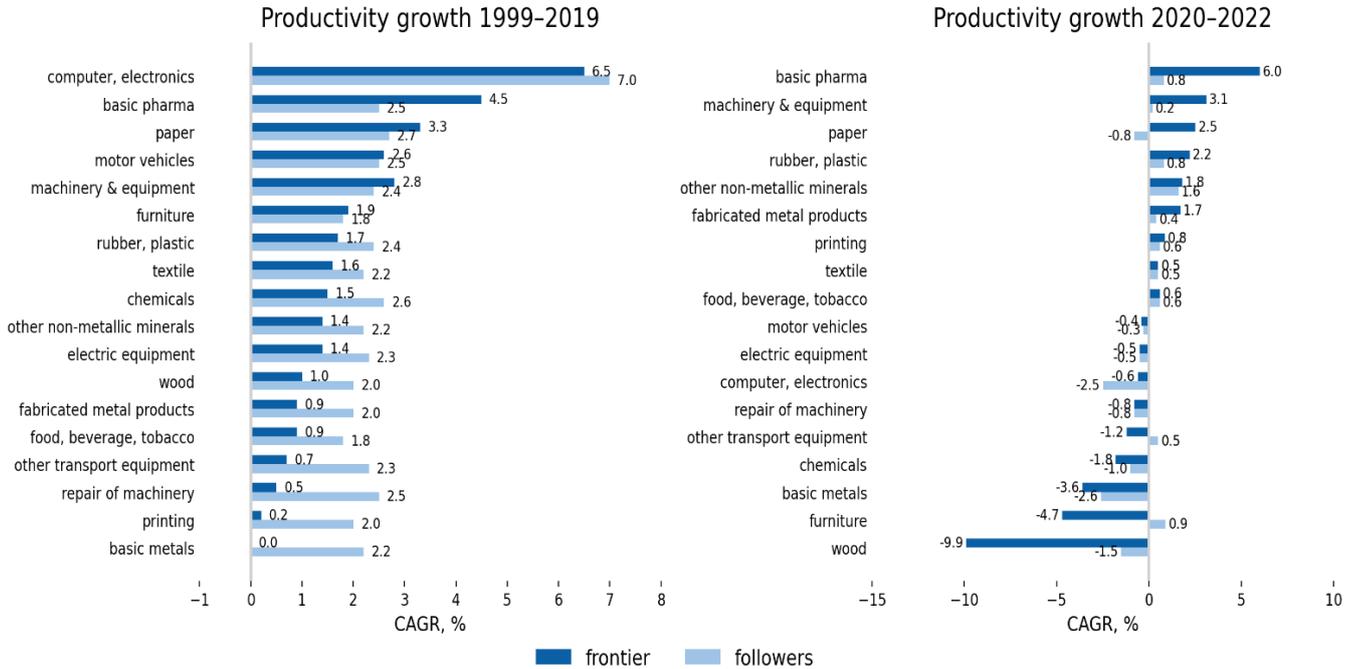


Note: CAGR of 5Y average productivity

For the manufacturing subsectors the latest data available are for 2022. Between 1999 and 2019 all sectors in EU frontier and EU follower countries had positive annual CAGR, and the CAGR rates in EU follower tended to be higher than in EU frontier (with notable exceptions like paper and basic pharma). That period was characterized by high-speed diffusion.

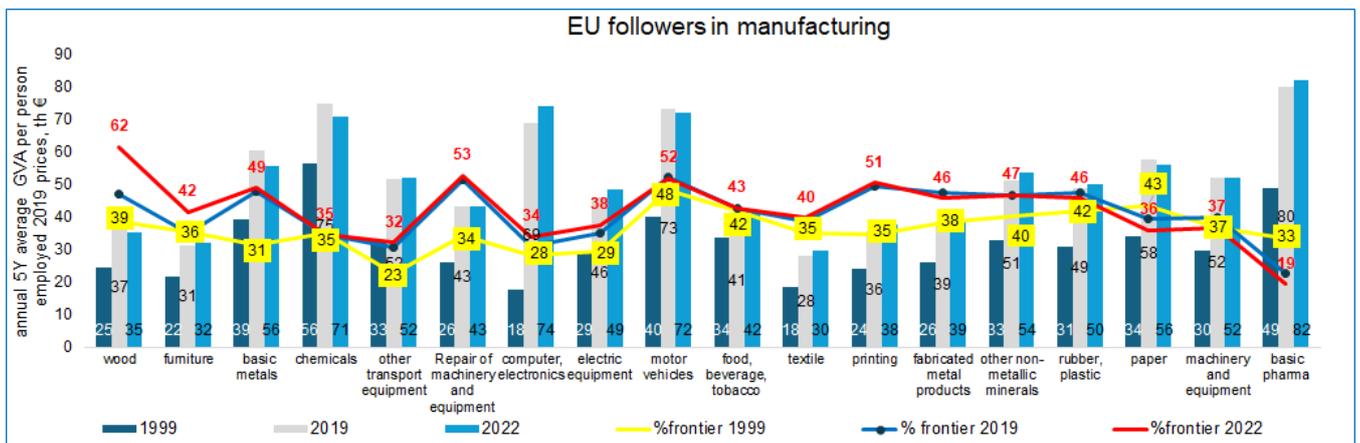
In 2019-2022 there were changes in both EU frontier and EU follower. The traction of EU frontier was undermined by two main evolutions: 1/ just a subset of manufacturing sectors had growth and 2/ out of the sectors with positive growth, the size increased in case of three (basic pharma, textile and food). In EU followers the productivity diffusion showed asymmetries: 1/ the productivity growth tended to be speedier in the sectors which had negative growth in EU frontier, but 2/ the productivity growth was the slowest (or even declined in paper) in the sectors which were growing the fastest in EU frontier (fabricated metal products, other non-metallic minerals, rubber and plastic, paper, machinery and equipment, basic pharma).

The productivity dynamics in EU follower comparative with EU frontier for a few sectors meant getting closer (wood, furniture, computer and electronics, printing) in 2022 compared to 2019, while for a few others meant getting apart (paper, basic pharma, machinery and equipment). For the majority of sectors, the gap vs. EU frontier remained in 2022 as it was in 2019.



Note: CAGR of 5Y average productivity

The size of the EU frontier does not seem influencing the diffusion process. It seems that in EU followers the closeness to the EU frontier determines the diffusion process as though the average productivity gap of the economy vis a vis the EU frontier constraints the speed of the productivity diffusion in the sectors. In EU followers the sectors closer to the EU frontier in 2019 lost productivity thereafter and sectors farther from the EU frontier in 2019 gained productivity.

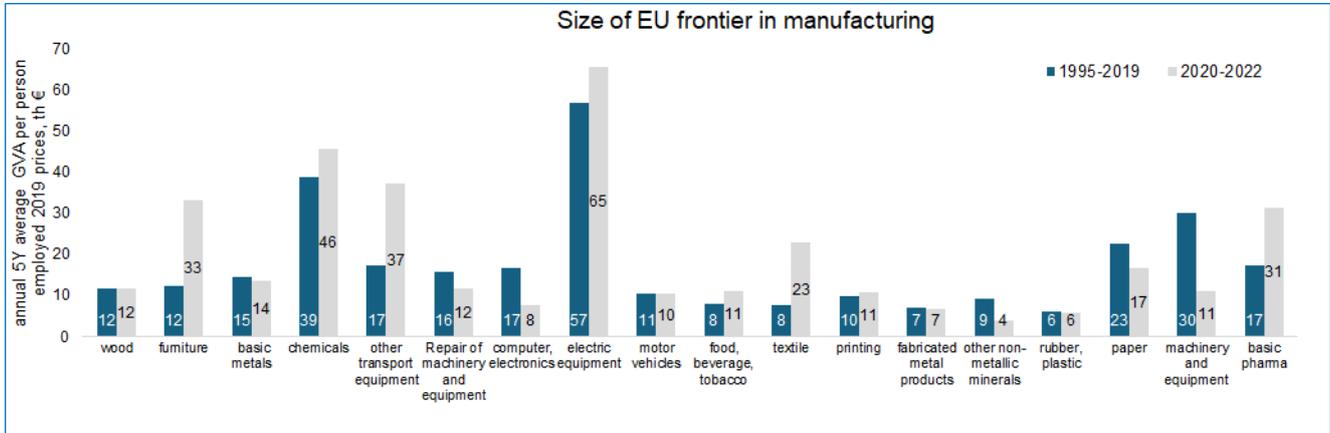


Industry: Loss in Productivity

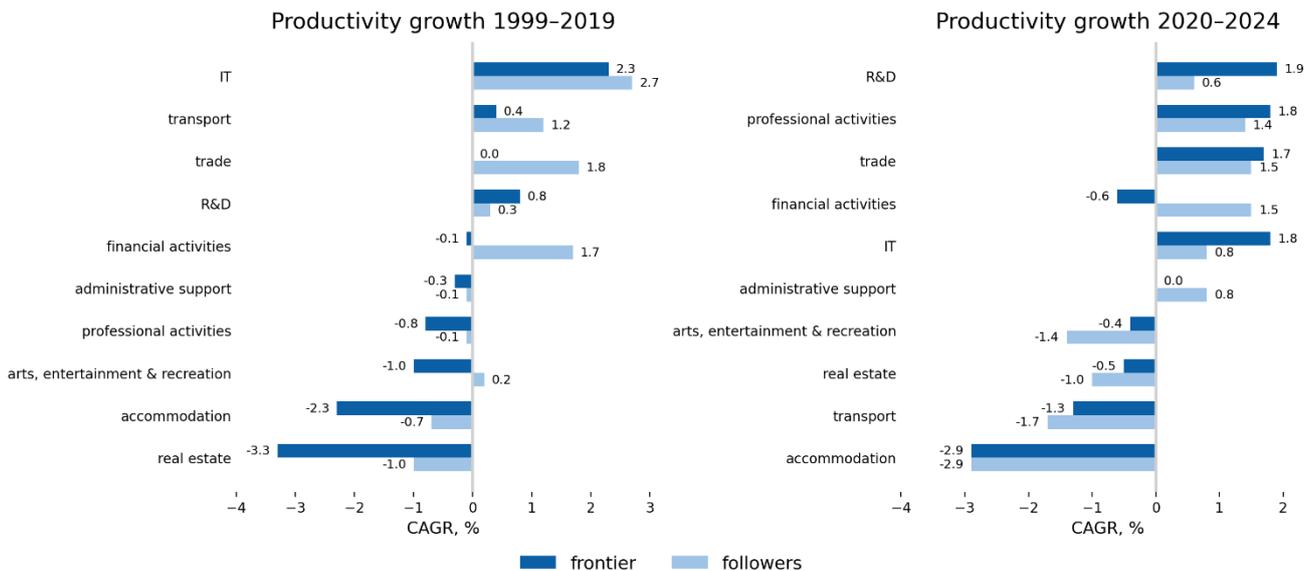
The loss in productivity in industry in EU followers was mainly due to manufacturing, where the share of productivity in EU frontier fell from 42% in 2019 to 38% in 2023, even though the size of EU frontier increased.

Closeness Paradox

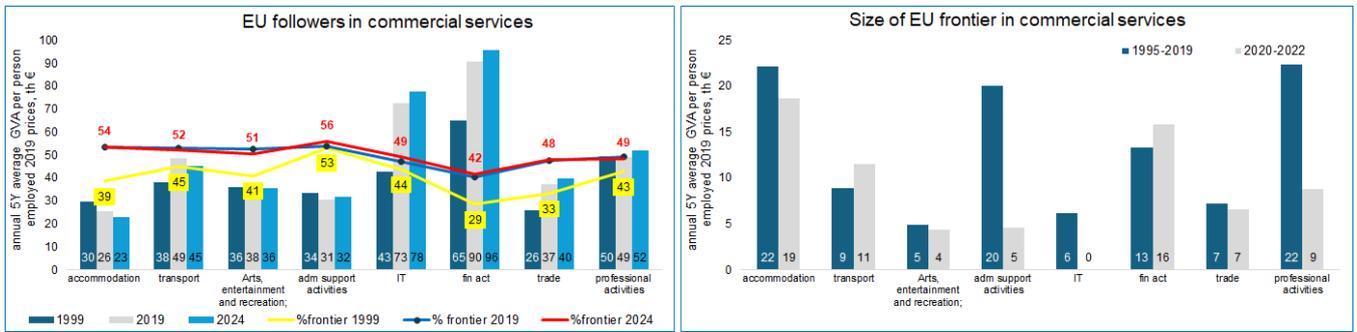
In EU followers the sectors closer to the EU frontier in 2019 lost productivity and sectors farther from the EU frontier in 2019 gained productivity.



In commercial service the productivity growth in EU frontier strengthened after 2019 to CAGR 1.3% from CAGR 0.8% in 1999-2019. The reason was that while before 2019 only IT and transport registered productivity gains after 2019 financial activity and trade also improved their productivity. The productivity in EU followers grew slightly faster than in EU frontier both before 2019 (CAGR 1%) and after 2019 (CAGR 1.5%). The growth gain and loss in EU follower mimicked the EU frontier, with the difference that the gains were higher (excepting professional activities after 2019) and the losses smaller (excepting real estate, transport and recreational activities after 2019). The influence of the size of the EU frontier is not conclusive.



Note: CAGR of 5Y average productivity, R&D data up to 2022, IT, fin act, real estate data up to 2024, for the other up to 2023.



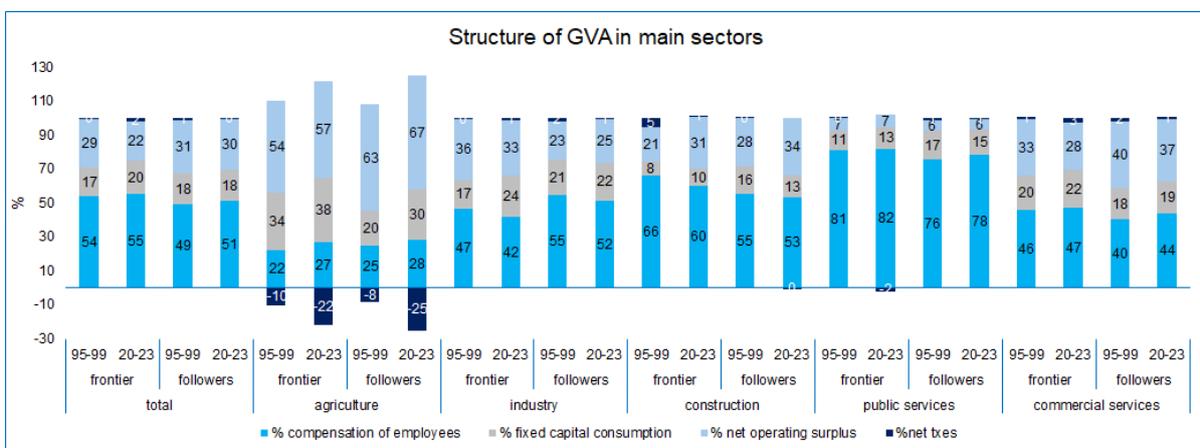
06 Structural Changes in GVA

Income breakdown analysis and technology adoption

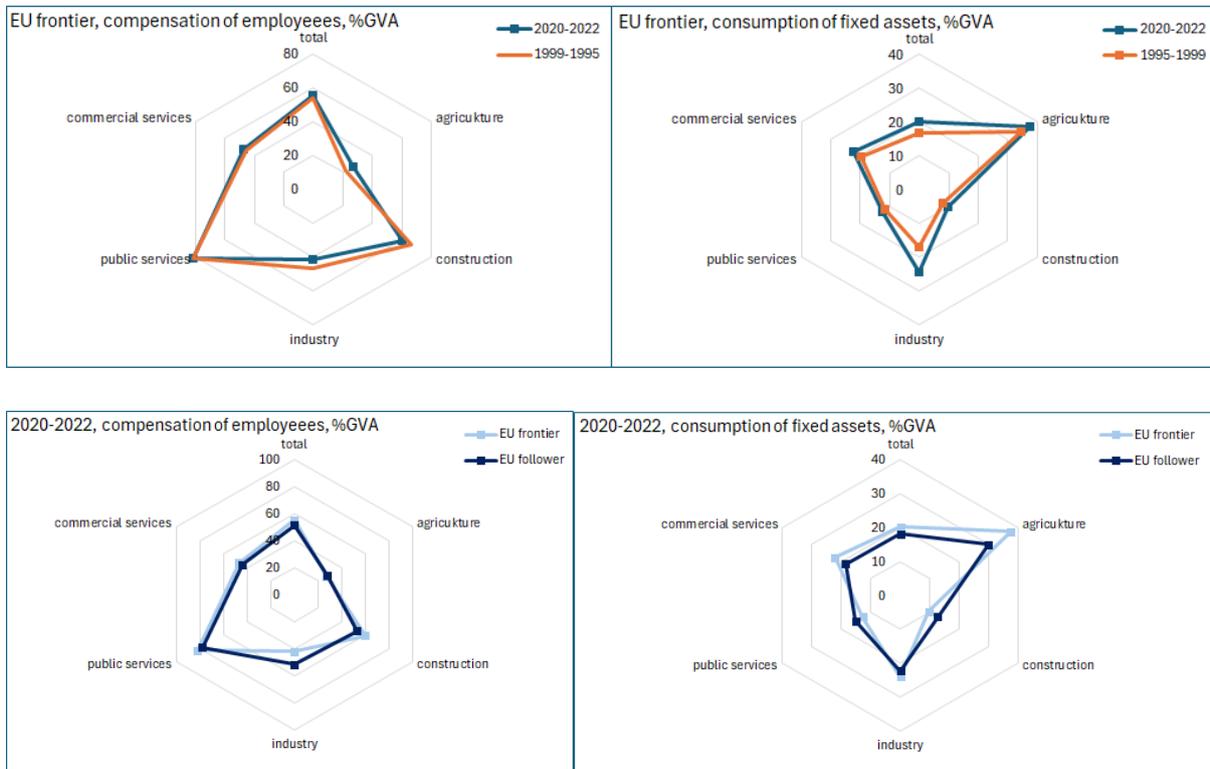
The reason why EU followers could not keep the pace with productivity growth in EU frontier might be the delay in adopting new technology. We analyse this possibility using the income breakdown of GVA before and after 2019 in EU followers and EU frontier.

The increase of the share of consumption of fixed assets after 2019 compared to before 2019 indicates more recent investments in fixed assets that is in new technology after 2019. The technology in turn could affect the need of labour. In case when labour and capital are complements both the share of consumption of fixed assets and the share of compensation of employees in GVA increases. The opposite can happen when capital and labor are substitutes.

Overall, in EU frontier the main change in 2020-2023 compared to 1995-1999 in the GVA structure was the increase of the share of consumption of fixed assets, while in EU followers the increased of the share of compensation of employees.



What happened in industry and agriculture, the sectors where the productivity grows lagged in EU followers compared to EU frontier after 2019? In EU frontier both industry and agriculture invested in more technology substituting labor, while in EU followers the same capital was used with less labor in industry and more capital with more labor in agriculture. In 2020-2023 both agriculture and industry are more capital intensive in EU frontier than in EU follower. The composition of GVA in services was relatively stable over time.



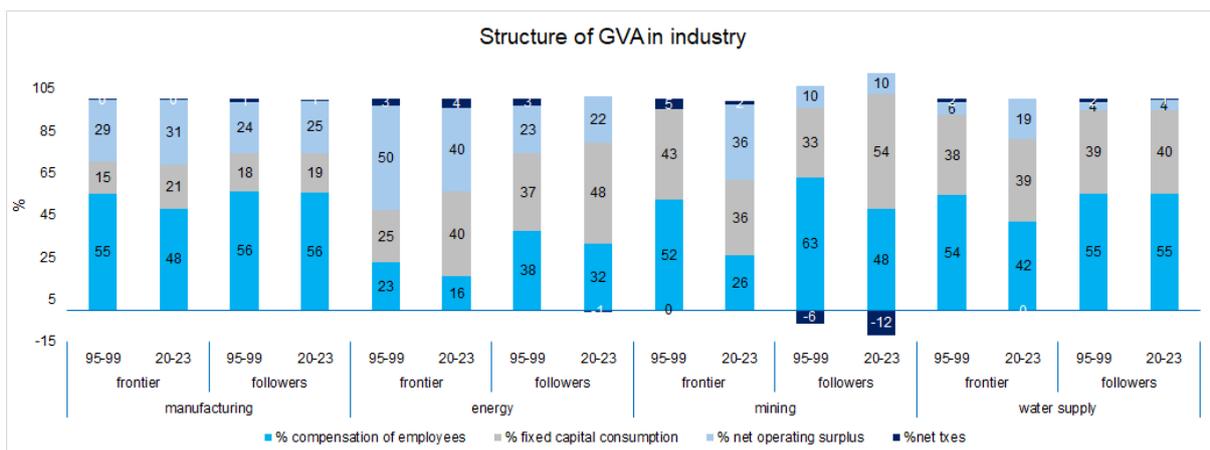
EU Frontier: Main Change

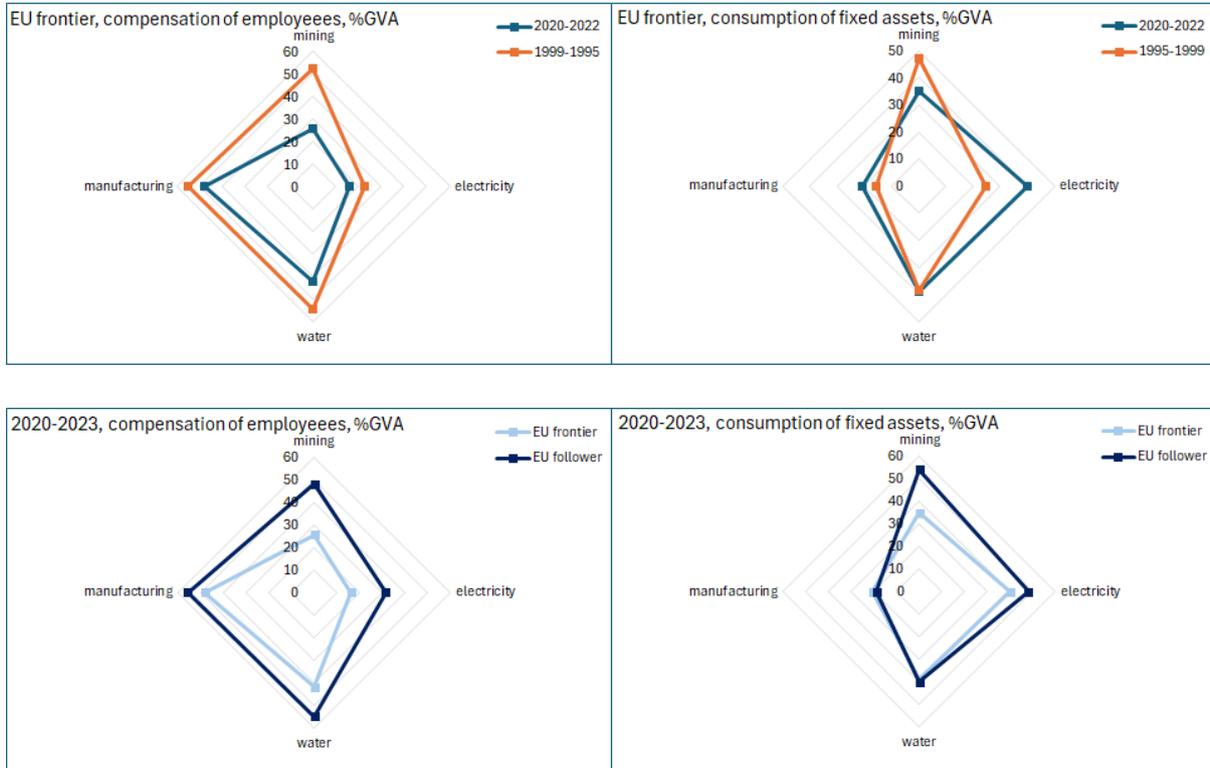
In 2020-2023 compared to 1995-1999: Increase in share of consumption of fixed assets - indicating investment in new technology.

EU Followers: Main Change

In 2020-2023 compared to 1995-1999: Increase in share of compensation of employees - indicating labour-intensive growth rather than technology adoption.

In all industrial subsectors the labor intensity declined, and the consumption of fixed assets increased in manufacturing and energy in EU frontier. In EU followers labor intensity declined and the consumption of fixed assets increased in mining and energy, while the structure of GVA was unchanged in manufacturing and water supply. After these changes the EU followers remained more labour intensive in all industrial sectors and more capital intensive in energy and mining than EU frontier in 2020-2023.



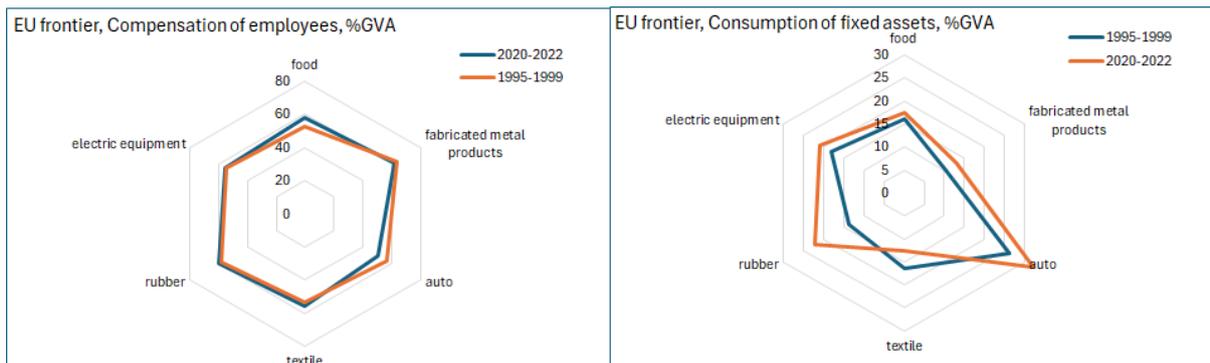


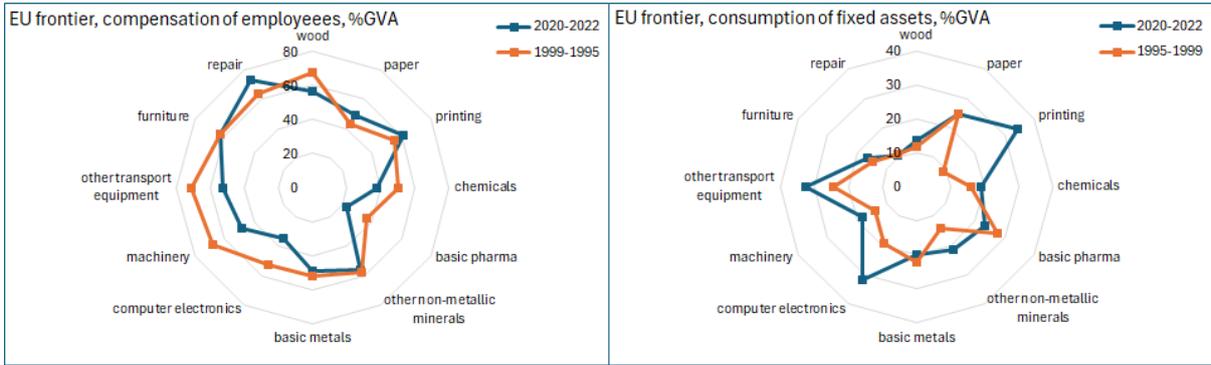
Key Insight

In EU frontier most manufacturing sectors invested in new technology substituting labor. In EU followers most manufacturing sectors were becoming less capital intensive and less labor intensive. The lower share of compensation and consumption of fixed assets in GVA extended the share of net operating surplus - meaning EU followers have financial means for future capital investment.

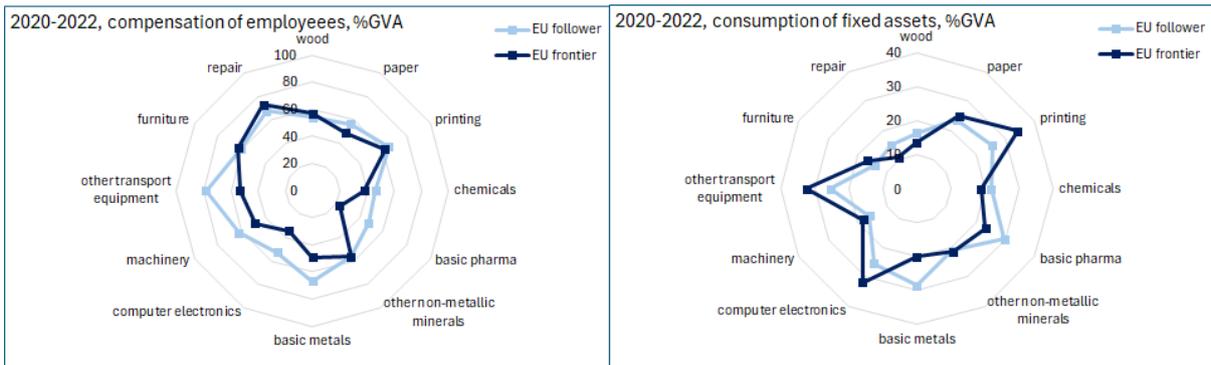
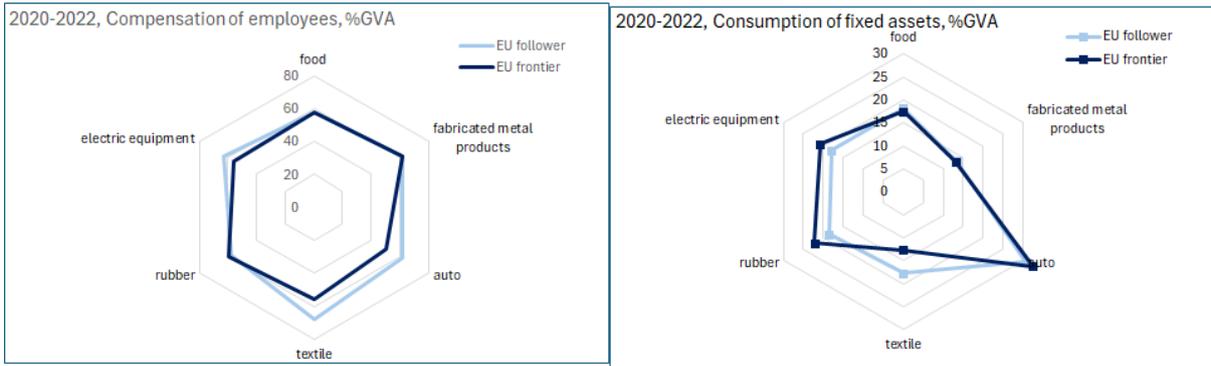
Summary of GVA Structure Changes in Manufacturing

Capital Intensity	Labour Intensity Increased		Labour Intensity Declined		Labour Intensity Unchanged	
	EU Frontier	EU Follower	EU Frontier	EU Follower	EU Frontier	EU Follower
Fixed Assets Increased	Printing	Basic pharma, Motor vehicles	Fabricated metal, Wood, Chemicals, Computer, Machinery	Wood, Furniture, Rubber, Electric equip	Other minerals	Furniture, Motor, Printing
Fixed Assets Declined	Textile	Basic metals, Rubber, Pharma	Basic metals, Machinery, Computer, Repair	-	Chemicals, Minerals, Transport	-
Fixed Assets Unchanged	Food, Paper, Repair	-	-	Textile, Fabricated metal	-	Food, Electric, Paper





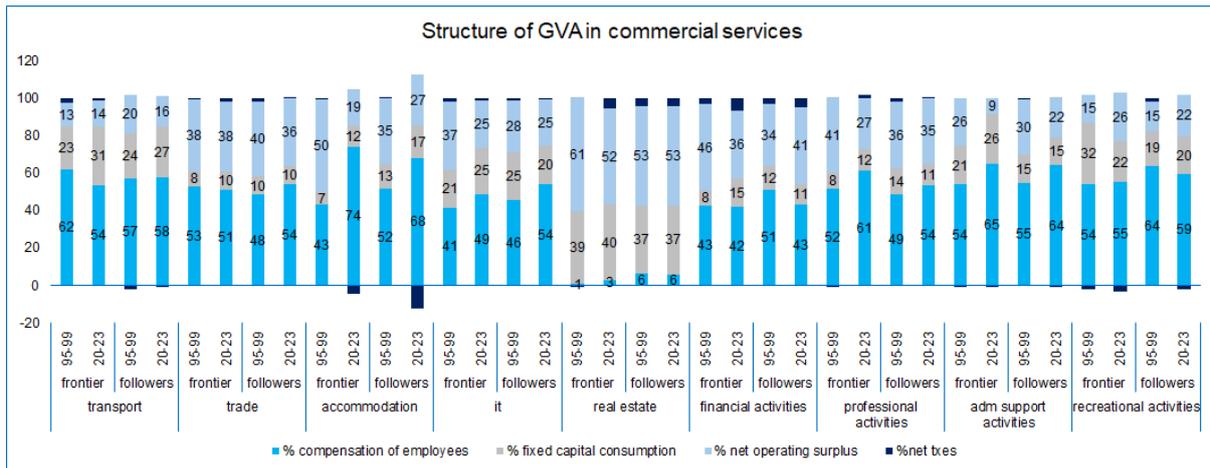
EU frontier and EU follower, differences in labor and capital intensity after 2019



07 Services Sector Changes

GVA structure evolution in service activities

The GVA structure in all kinds of service activities converged in EU frontier and EU followers, such that their GVA structure became more similar in 2020-2022 than it was in 1995-1999.



The main changes in the GVA structure were the following in EU frontier: 1/ in accommodation, IT, professional activities, administrative support activities both labour intensity and consumption of fixed assets increased (labour complementary technology), 2/ in transport labor intensity declined and consumption of fixed assets increased (labor substituting technology), 3/ in financial activities, real estate and trade labor intensity did not change but consumption of fixed assets increased (labour substituting technology), 4/ in recreational activities and R&D labor intensity did not change but consumption of fixed assets declined (labor substituting technology).

In EU follower the main changes were: 1/ labor intensity and consumption of fixed assets increased in accommodation and administrative activities (labor complementary technology), 2/ labor intensity declined and consumption of fixed assets maintained in financial activities, real estate and recreational activities (labour substitution technology), 3/ labor intensity increased and consumption of fixed capital maintained in trade, 4/ in transport labor intensity declined and consumption of fixed capital increased (labour substitution technology), 5/ in IT and professional activities labour intensity increased and consumption of fixed assets declined (labour substituting technology), 6/ labor intensity and capital intensity declined in R&D.

EU Frontier Changes

Labour Complementary Tech

Accommodation, IT, Professional activities, Administrative support - both labour intensity and consumption of fixed assets increased

Labour Substituting Tech (Type 1)

Transport - labour intensity declined, fixed assets increased

Labour Substituting Tech (Type 2)

Financial activities, Real estate, Trade - labour unchanged, fixed assets increased

Labour Substituting Tech (Type 3)

Recreational activities, R&D - labour unchanged, fixed assets declined

EU Follower Changes

Labour Complementary

Accommodation, Administrative activities - both increased

Labour Substitution (Maintained)

Financial activities, Real estate, Recreational activities - labour declined, fixed assets maintained

Labour Increase

Trade - labour increased, fixed assets maintained

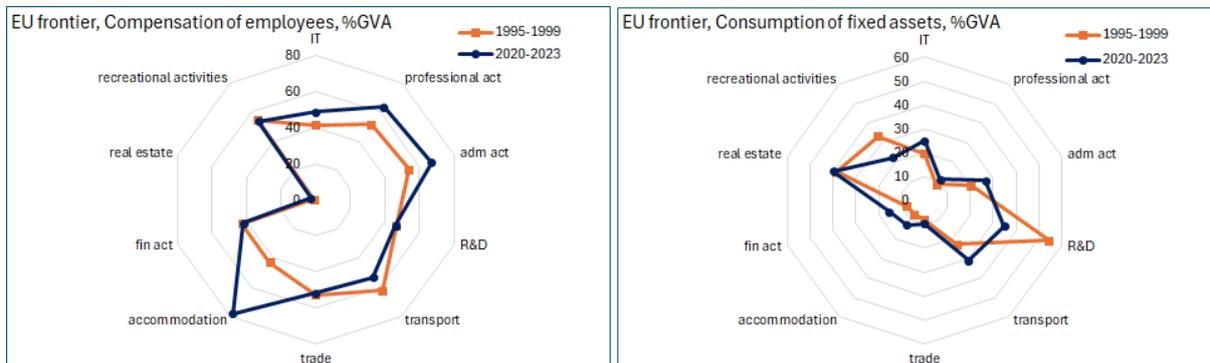
Mixed Changes

IT, Professional activities - labour increased, fixed assets declined

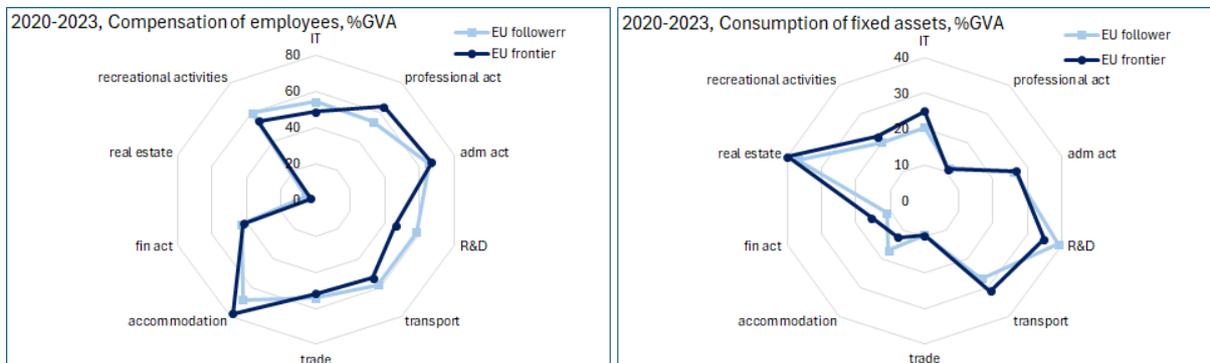
Both Declined

R&D - labour and capital intensity both declined

EU frontier: labor and capital intensity after and before 2019



EU frontier and EU follower, differences in labor and capital intensity after 2019



08 Manufacturing GVA Structure

Summary of changes in GVA structure

Summary changes in GVA structure in manufacturing show distinct patterns between EU frontier and EU follower countries:

Main GVA Changes in EU Frontier Services

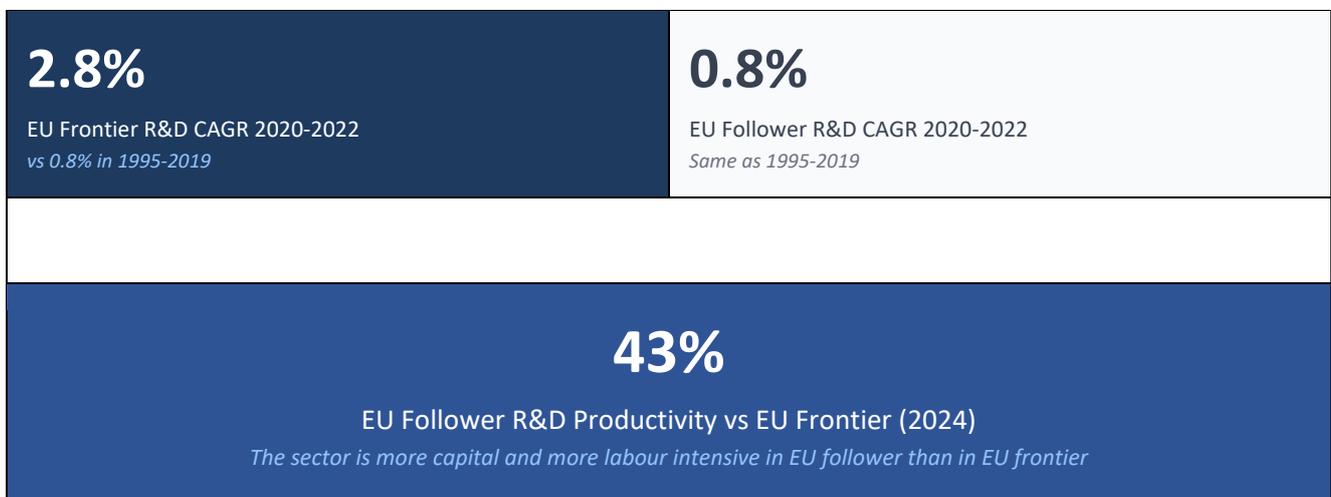
- In accommodation, IT, professional activities, administrative support activities both labour intensity and consumption of fixed assets increased (labour complementary technology)
- In transport labor intensity declined and consumption of fixed assets increased (labor substituting technology)
- In financial activities, real estate and trade labor intensity did not change but consumption of fixed assets increased (labour substituting technology)
- In recreational activities and R&D labor intensity did not change but consumption of fixed assets declined (labor substituting technology)

Main GVA Changes in EU Follower Services

- Labor intensity and consumption of fixed assets increased in accommodation and administrative activities (labor complementary technology)
- Labor intensity declined and consumption of fixed assets maintained in financial activities, real estate and recreational activities (labour substitution technology)
- Labor intensity increased and consumption of fixed capital maintained in trade
- In transport labor intensity declined and consumption of fixed capital increased (labour substitution technology)
- In IT and professional activities labour intensity increased and consumption of fixed assets declined (labour substituting technology)
- Labor intensity and capital intensity declined in R&D

09 R&D Sector Analysis

Research and Development productivity dynamics



Key Observations on R&D

- Productivity in R&D accelerated significantly after 2019 in EU frontier (CAGR 2.8% vs 0.8% before)
- EU follower R&D productivity grew at the same rate as before 2019 (0.8%)
- The widening gap suggests EU frontier is investing more heavily in R&D infrastructure and human capital
- EU followers being more labour and capital intensive yet less productive indicates efficiency challenges

Implications

For EU Frontier

Strong R&D productivity growth suggests successful adoption of advanced research technologies and efficient allocation of R&D resources.

For EU Followers

Stagnant R&D productivity despite higher resource intensity suggests need for better R&D management practices and technology diffusion mechanisms.

10 Conclusions

Summary and policy implications

The Productivity Diffusion Has Slowed

Main Causes

- Industry and agriculture productivity in EU followers lagged significantly behind EU frontier
- Delay in new technology adoption in EU followers
- EU frontier invested in capital-intensive, labour-substituting technologies
- Asymmetric diffusion patterns in manufacturing

Positive Signs

- Commercial services productivity continued to advance
- GVA structure in services converging between frontier and followers
- EU followers have accumulated financial means for future investment
- R&D showing potential in both regions

Policy Implications

- Need for accelerated technology diffusion mechanisms within the EU single market
- Focus on reducing barriers to capital investment in EU follower countries
- Targeted support for manufacturing sectors showing asymmetric diffusion patterns
- R&D efficiency improvements needed in EU follower countries
- Leverage the financial surplus in EU followers for technology investments

Annex 1 Frontier countries by sectors

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
Total	IE	Dk	Dk	Dk	Dk	Be	Fi	Se	Se	Se	Se	Se	Fi	Se																	
	Dk	Be	Be	Be	Be	Dk	Be	Be	Be	Be	Be	Be	Dk	Dk	Dk	Dk	Dk	Dk	Be	Dk	Dk	Be	Dk	Dk	Be						
	Be	IE	IE	IE	IE	IE	Dk	Dk	Dk	Dk	Dk	Dk	Be	Be	Be	Be	Be	Be	Dk	Be	Be	Dk	Be	Be	Dk						
Agriculture	Dk	Ge	Ge	Dk	Ge	Dk	Ge	Ge	Lu	Lu	Ge	Ge	Lu	Fr	Be	Ge	Fr	Ge	Ge	Ge	Fi	Ge	Ge	Fi	Dk	Be	Ge	Dk	Be	Fi	
	NI	NI	Lu	NI	NI	NI	NI	NI	Ge	NI	Se	Se	Se	Dk	Ge	Be	Dk	Be	Be	Be	Dk	Fi	Dk	Dk	Fi	Dk	Fi	Ge	Ge	Be	
	Lu	Lu	NI	Lu	Lu	Lu	Lu	Dk	NI	Dk	Dk	Dk	NI	Ge	Fr	Dk	Be	Dk	Dk	Dk	Be	Be	Be	Be	Be	Fi	Dk	Fi	Fi	NI	
Industry	IE	IE	NI	NI	NI	NI	Be	Be	Lu	Se	Se	Se	Se	Se	Be	Se	Se	Se	Se	Be	Se	Se	Se	Se	Se	Se	NI	NI	Se	Se	
	NI	NI	Dk	Dk	Dk	Dk	NI	NI	NI	NI	NI	NI	Dk	Dk	Dk	NI	Se	Se	NI	NI											
	Dk	Dk	IE	IE	IE	IE	Dk	Dk	Dk	Dk	Dk	Dk	NI	NI	NI	Dk	Dk														
Construction	Se	Fi	Se	IE	Be	Fi	Fi	At	At	At	At	At	Fi	Fi	Se	NI	Fi														
	Fi	At	At	At	Fi	Fi	MT	MT	Se	Fi	At	Fi	Be	At	Dk	Be	Be	Dk	Dk	Dk	Dk	Fi	Se	Se							
	At	Fi	Fi	Fi	At	Fi	At	At	Be	Be	Dk	Dk	Be	Be																	
Services	Dk	Dk	Fi	Fi	Fi	Dk	Dk	Fi	Fi	Fi	Fi	At	At	Fi	At	At	At	At	At	Se	Se	Se	Fi	Se							
	IE	Be	Be	Be	Be	Be	Fi	Dk	Be	Be	Be	Dk	Be	Be	Dk	Dk	Dk														
	Be	IE	IE	IE	IE	IE	Be	Dk	Dk	Dk	Be	Dk	Dk	Be	Be	Be															
Public services	At	Be	Be	At	At	At	At	Be	At	At	At	Be	Dk	Be	Dk	Be	Dk	Dk	At	At	At										
	IE	At	Be	Be	Be	Dk	Be	Dk	Be	Dk	Be	Be	Be	Be	Be																
	Lu	Lu																													
Commercial services	Fi	Fi	Dk	Dk	Dk	Be	Fi	Fi	Fi	Fi	Fi	Se	Fi	Fi	Se	Dk	Be	Be	Dk	Dk	Dk										
	Dk	Dk	Be	Be	Be	Dk	Be	Be	Be	Be	Be	Be	Dk	Dk	Dk	Be	Be	Dk	Be	Dk	Dk	Be	Be	Be	Se	Se	Se	Se	Se	Se	Se
	Be	Be	IE	IE	IE	IE	Dk	Dk	Dk	Dk	Dk	Dk	Be	Be	Be	Dk	Dk	Be	Dk	Be	Be	Dk	Dk	Dk	Be	Dk	Dk	Be	Be	Be	

Notes: 1995-2000 no data for Mt; total - Lu excluded since 2001, productivity higher than the next by 13-45%; agriculture – Mt excluded in 2024 when productivity 6 times higher than the next; industry – Ie excluded since 2001 when productivity higher by 30-360% than the next; Services-excluded Lu in 1995-2024, Ie in 2001-2024, commercial services - excluded Lu 1995-2024, Ie 2001-2024

Frontier countries in industry

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
mining	IE	IE	Fr	At	Lu	At	At	Lu	At	At	At	At	Es	Es	IE	IE														
	Lu	At	Lu	Lu	At	It	It	It	It	It	Se	Se	NI																	
	Se	It	Es	Se																										
manufacturing	Dk	Lu	Dk	Dk	Be	Lu	NI	NI	NI	Lu	NI	Fi	NI	Se	Dk	NI	NI	Se	Be	NI	NI	NI	Be	Be	Be	Be	NI	Se	Se	Be
	Lu	Be	Be	Be	Lu	Be	Dk	Lu	Be	Se	Se	NI	Se	Fi	NI	Be	Dk	NI	NI	Be	Be	Se	NI	NI	NI	NI	Se	NI	NI	NI
	IE	IE	IE	IE	IE	IE	Be	Be	Lu	Be	Be	Se	Fi	NI	Be	Se	Se	Dk												
energy	Be	Be	Dk	Be	Dk	Be	Dk	Dk	Be	pt	pt	Be	Be	Be	Be	Be	Be	Se	Se	Fi	Be	Be	Fi	Fi	Fi	pt	Se	Se	Es	
	Dk	Dk	Be	Es	Es	Es	Es	Se	Dk	Dk	Se	pt	Se	Es	pt	Se														
	Se	Es	pt	Fi	Fi																									
water	Lu	It	It	It	Be	Be	Fi	Fi	At	At	At	Be	Lu	Lu	Fi	Be	At	At	At	Be	NI	NI	NI	NI	Be	Ge	Be	Be	Be	
	It	Lu	Lu	Dk	Dk	Dk	Be	Be	Be	Dk	Be	Fi	Be	Be	At	At	Be	Fi	Fi	At	Fi	At								
	Dk	Dk	Dk	Lu	Lu	Lu	Dk	Dk	Dk	Be	Dk	Dk	Fi	Fi	Lu	Fi	Fi	Be	Be	Fi	At	Dk								

Notes: Mining-Dk, NI excluded their productivity higher 3 times the next; Manufacturing- Ie excluded since 2001 when productivity at least 2 times higher than the next;

Frontier countries in manufacturing

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	
food	IE	IE	IE	IE	IE	IE	Dk	Fi	Fi	Fi	Fi	Fi	Be	Fi	Fi	Se	Se	Se	Dk	Dk	Se	Se	Dk	Se	Dk	Se	Se	At	
	Be	Be	Be	Be	Be	Be	IE	Be	Be	Be	Be	Be	Fi	IE	Be	NI	Be	Dk	Dk	Dk									
	NI	NI	NI	NI	NI	NI	Be	IE	IE	IE	IE	IE	IE	Be	NI	Be	NI	NI											
textile	Dk	It	Be	Be	Be	NI	Be	Be	Dk	NI	Dk	Dk	Dk	Lu	Be	Be	Be	Be	Es	Be	Be	Be	Es	Be	Be	Es	Es	Se	
	It	Dk	Dk	Dk	Dk	Dk	NI	Dk	Be	Dk	Be	NI	Be	Dk	Lu	NI	Dk	Dk	NI										
	Lu	Lu	Lu	Lu	Lu	Lu	Dk	NI	NI	Be	NI	Be	NI	Be	NI	Dk	NI	NI	Dk	Dk									
wood	At	Dk	Ge	Se	NI	Be	NI	Dk	NI	Be	At	Be	At	At	At	NI	Dk	Dk	Se	Dk	Dk	Dk							
	Dk	At	Dk	Dk	Dk	Dk	Dk	Dk	NI	NI	Se	Se	Be	NI	Be	Dk	Dk	NI	NI	NI	Se	Dk	NI	NI	NI	NI	NI	NI	
	NI	Dk	Dk	Dk	Dk	Dk	Be	Se	Se	NI	Dk	Dk	Dk	NI	At	At													
paper	At	At	At	At	At	At	Se	At	At	Be	Be	Be	At	Be	Be	At	Ie	Ie	Ie	Fi									
	Es	Es	Se	Se	Se	Se	At	Se	Fi	Se	Se																		

	Fi	Se	Fi	le																									
printing	Dk	Dk	Dk	Dk	Dk	Dk	IE	IE	Dk	gr	Dk	IE	IE	Be	At	At	ro	At	NI	NI	Be	Be	NI	Dk	NI	NI	At	Se	
	gr	gr	gr	gr	gr	IE	Dk	Dk	IE	IE	gr	Dk	Dk	IE	IE	IE	IE	Dk	At	At	At	Dk	At	NI	At	ro	NI	At	
	IE	IE	IE	IE	IE	gr	gr	gr	gr	Dk	IE	gr	gr	Dk	Dk	Dk	Dk	IE	Dk	Dk	Dk	At	Dk	At	ro	At	Se	NI	
chemicals	Es	Es	Dk	Dk	It	Fi	NI	hu	hu	hu	Fi	hu	hu	Lu	Fi	Dk	Fi	Be	Dk	NI	NI	NI	NI	Be	NI	NI	Fi	Be	
	Be	Be	Be	Be	hu	hu	hu	NI	Be	Dk	Be	Dk	Dk	Be	Be	Dk	Be	Be	It	It									
	hu	hu	hu	hu	Be	Be	Be	Be	NI	Be	Be	Dk	Dk	NI	Fi	Fi	NI	NI											
basic pharma	Fi	ee	ee	Fi	Fr	Fr	Fr	Fi	Fr	Fi	Ge	Be	Ge	ee	Fi	Fi	Be	Be	Fi	Be	NI	NI	NI	NI	Be	NI	Be	Be	
	Be	Be	Dk	Be	Be	Be	Be	Be	Be	Dk	Dk	Fi	Dk	Fi	Dk	Dk	Fi	Fi	Be	Fi	Dk	Dk	Fi	Fi	NI	Be	NI	NI	
	PL	PL	Be	Dk	Dk	Dk	Dk	Dk	Dk	Be	Be	Dk	Be	Dk	Be	Be	Dk	Dk	Dk	Dk	Fi	Fi	Dk	Dk	Dk	Dk	Dk	Dk	
other non-metallic minerals	IE	IE	Be	NI	NI	Dk	At	Dk	Dk	Dk	Fi	NI	NI	Be	NI	NI	Be	NI	NI	Be	Dk								
	Be	Be	NI	Be	Dk	Dk	Be	NI	Be	Dk	NI																		
	NI	NI	IE																										
Basic metals	Se	Dk	Dk	Se	Cy	Se	Se	Cy	gr	gr	Se	Se	Se	ee	Dk	At	At	gr	gr	Be	At	Se	MT	At	MT	Fi	BE	Se	
	gr	Se	Se	Cy	Se	Cy	Cy	Se	Se	Se	gr	gr	At	gr	At	gr	MT	MT	MT	At	Be	Be	Be	Se	Be	Mt	NI	Fr	
	At	gr	At	gr	MT	gr	At	At	MT	MT	At	At	Gr	Se	Se	Se	Be												
Computer, electronic and optical products	Dk	Dk	Dk	NI	Fi	At	At	Dk	NI	Dk	At	Se	Se	Se	Se	Dk	At	At	Fi	Fi	Fi	Dk	Fi	Dk	Fi	NI	NI	Dk	
	It	It	It	It	NI	NI	NI	At	Dk	NI	Dk	NI	NI	NI	Fi	NI	NI	NI	Cy	Fi	Fi								
	At	At	At	At	At	Fi	NI	Cy	Cy	Cy	NI	Cy	Cy	Cy	Fi	Cy	NI												
Machinery and equipment n.e.c.	Fi	Be	Be	Fi	Fi	Se	Se	Ge	Ge	Ge	Ge	Ge	Fi	Be	NI	Be	Be	Be	Be	Be	Se	Se	Se	Se	Se	Dk	Dk	Be	
	Dk	Fi	Dk	Be	Ge	Ge	Ge	Be	Se	Be	Be	Be	Be	Fi	Be	Se	Se	NI	NI	NI	Be	Dk	Dk	Dk	Dk	Be	IE	Se	
	Ge	Ge	Ge	Ge	Be	Be	Be	Se	Be	Se	Se	Se	Se	Se	Fi	NI	NI	Se	Dk	Dk	NI	NI	NI	NI	NI	NI	Se	NI	
Other transport equipment	Se	It	It	It	Se	It	Se	Fr	Se	Fr	Dk	At	Se	Se	At	Se	Dk	Be	Es	Es	At	At	Be	At	Be	At	At	Ge	
	Fr	Fr	Se	Dk	Dk	Dk	Dk	Se	Fr	Dk	Se	Se	At	At	Se	At	At	Es	Se										
	Dk	Dk	Fr	Fr	Fr	Fr	Fr	Dk	Dk	Se	Fr																		
Furniture; other manufacturing	Ge	Ge	NI	NI	Fi	Fi	Fi	Fi	Fi	Fi	Se	NI	NI	Se	NI	NI	Fr	Fr	Fr	Be	Be	Be	NI	NI	Fr	Ge	Be	Be	
	Fi	Fi	Fi	Fi	NI	Se	Se	NI	Se	Be	Be	Ge	Ge																
	Dk	Se	Se	Se	Se																								
Repair and installation of	Fi	Fi	Fi	Fi	Se	Se	Se	Se	Se	Se	Ge	Ge	Ge	At	At	At	Fr	Fr	Fr	Fr	Be	NI	NI	At	Fr	NI	Se	Dk	
	NI	Se	Se	Se	gr	NI	gr	NI	NI	NI	Se	Se	Se	Se	Se	Se	At	At	At	At	NI	Be	Be	NI	Be	Fr	Fr	Fr	

machinery and equipment	Se	NI	NI	NI	NI	gr	NI	gr	gr	gr	NI	At	At	At	IE	At	At	At	At									
Motor vehicles	Fr	NI	Fr	Ge	Ge	At	Ge	At	Ge	Ge	At	Ge	Fr	At	Ge	Fr	Fr	At	At	At	NI	NI	Se	NI	NI	NI	At	At
	At	At	NI	Fr	Ge	Fr	Fr	Ge	Ge	Ge	NI	NI	Ge	Ge	NI	Se	Se	Se	Se	Se								
	Ge	Ge	Ge	NI	At	NI	NI	NI	Ge	Ge	Se	Se	Ge	Ge	Ge	Ge	Se	Se										
Rubber, plastic	IE	IE	NI	NI	IE	NI	IE	NI	At	IE	At	At	Be	Dk	Dk	Be	NI	NI	NI	NI	Be	NI	Be	Dk	Dk	Dk	Dk	NI
	NI	NI	At	At	At	At	At	At	IE	At	Be	IE	IE	IE	Be	Dk	Be	Be	Be	Dk	Dk	Dk	Dk	NI	Be	Be	NI	At
	Dk	Be	IE	Be	IE	IE	IE	IE	IE	IE																		
Fabricated metal products	Dk	NI	Se	Se	Fi	Fi	Fi	Fi	Fi	Fr	Fi	Fi	At	NI	Dk	Se	Se	Fr	Dk	Dk	Fr	Be	Se	Se	Be	Dk	NI	NI
	Se	Se	Fi	Fi	Se	Se	Se	Se	Se	Se	Dk	Dk	Fi	Se	Fi	Fi	Fi	At	At	At	NI	NI	NI	At	At	NI	Se	Se
	Fi	Fi	Dk	Se	Se	Se	Fi	NI	NI	NI	NI	NI	At	At	At	NI	NI	At	At	At								
Electric equipment	Ge	Ge	Ge	Ge	Ge	Be	Be	At	At	gr	NI	Be	Fi	At	NI	Fi	At	NI	Lu	At	At	NI	IE	Dk	At	Fi	At	IE
	Gr	Be	Gr	IE	Gr	NI	NI	NI	At	At	NI	At	At	NI	NI	At	At	At	NI	NI	NI	At						
	NI	IE	NI	NI	IE	IE																						

Notes: Mt no data 1995-2000, food-excluded NI 2001-2008, ie 2009-2013, Lu 1995-2922, textile excluded Lu 2001-2022, wood- no data 1995-2017, excluded ie, Lu 2017-2022, paper- no data Lu 1995-2018, Mt 2001-2022, printing – no data Mt 1996-2011, 2020-2022, Lu 1995-2022, chemicals- no data Mt 1995-2018, Se 1995-2022, ie 1995-2022, basic pharma- no data 199502922 Lt, Lu, ie, Se, Mt, rubber and plastic-no data Mt, Lu 1995-2022, other non-metallic minerals- no data Mt, Lu, basic metals – no data Mt 1995-2009, Lu 1995-2022, fabricated metal products- no data Mt 1995-2009, Lu 1995-2022, computer and electronics- no data Mt, Lu 1995-2022, electric equipment – no data Mt 1995-2013, Lu 1995-2022, machinery and equipment – no data Mt 1995-2017, Lu 1995-2022, excluded ie 2019, motor vehicles- no data Mt, Lu, ie; Other transport equipment - no data Mt, Lu, ie; furniture- no data Mt, Lu, excluded ie; Repair and installation of machinery and equipment -no data Mt 1995-2018, Lu 1995-2022;

Frontier countries in commercial services

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	
IT	At	Be	IE	Be	IE	IE	IE	IE	IE	IE	Be	Se	Se	Se	Se	Se	Lu	Be	Se	Cy	Cy										
	Be	At	At	IE	Be	Be	Be	Be	Be	Be	IE	IE	IE	IE	MT	MT	MT	MT	MT	MT	Be	Be	Be	Be	Be	Be	Lu	Be	Be	Be	
	Lu	IE	IE	IE	IE	IE	IE	Lu	Lu	Lu	Lu	Lu	Se	Se	Lu	Lu	Lu														
publishing	It	Es	Be	Be	Be	Be	It	MT	MT	MT	MT	Be	At	Be	At	Lu	Lu	It	It	Fi	Fi	Fi	Lu	Fi	Fi	Lu	Se	Be			
	Es	It	Es	Lu	It	Lu	MT	It	It	It	Lu	Lu	It	At	It	Be	It	Be	Be	Be	Be	Be	Fi	Lu	Be	Fi	Fi	Fi	Fi		
	Lu	Lu	It	It	Lu	It	Lu	Lu	Lu	Lu	It	It	Lu	It	Be	It	Be	Lu	Lu	Lu	Lu	Lu	Lu	Be	Be	Cy	Cy	Cy	Cy		
telecommunication	At	At	At	Lu	IE	IE	IE	IE	NI	NI	NI	gr	gr	gr	gr	NI	NI	NI	pt	Ge	NI	Fr	NI	Ge	Ge	Be	Be	Lu			
	IE	pt	pt	IE	pt	Lu	Lu	Lu	Lu	Lu	Lu	pt	Lu	pt	pt	pt	pt	pt	pt	NI	NI	Ge	Ge	Ge	NI	NI	NI	NI	Be		
	pt	IE	IE	pt	Lu	pt	pt	pt	pt	pt	pt	Lu	pt	Lu	NI																
computer programing	gr	Fr	Fr	Fi	Fr	Fi	At	At	Dk	Fr	At	Fr	Fi	Dk	Se	Dk	Cy	Dk	Dk	Dk	Dk	Dk									
	Fr	Be	gr	Fr	At	At	Fi	Fi	Fr	Dk	Fr	Se	Fr	Fr	Dk	Se	Se	Se	Se	Be	Be	Be	Se	Be	Be	Be	Be	Be	Be		
	Be	gr	Be	Se	Se	Se	Se	Be	Se	Se	Se	Se	Se																		
trade,transp, accommodation	At	Dk	Dk	IE	Dk	Se	At	Dk	Se	Lu	Lu																				
	Be	Lu	Lu	Se	Se																										
	Lu	Be	Be	Be	Be																										
transport	Dk	Se	Se	Be	Se	Se	Se	Se	Be	Lu	Be	Be	Be	Dk	At	Dk	Dk	At	At	At	NI	Lu	Se	Se	Lu	Se	Se	NI	At		
	Be	Dk	Dk	Se	Lu	Be	Be	Be	Se	Se	Se	Se	Lu	Se	Se	Se	Be	Dk	Be	Dk	Dk	Se	Be	Be	Be	At	Be	At	Be		
	Lu	Lu	Lu	Lu	Dk	MT	MT	Be	MT	MT	Se	Se	Se	Se	Se	Dk	Dk	Dk	Se	Be	Dk	Se	Dk								
trade	IE	IE	IE	Be	IE	IE	Dk	At	Dk	Dk	Dk	Dk	Dk	Se	Se	Dk	Dk	Se	IE	IE	Se	Se	Se	Se	Se	IE	Se	Se	Lu		
	Be	Be	Be	IE	Be	Be	IE	Se	Se	IE	IE	IE	IE	IE	Se	Lu	Lu	IE													
	Lu	Lu	Lu	Lu	Lu	Lu	Be	IE	IE	Be																					
accommodation	At	At	At	It	At	It	At	At	At	At	At	At	MT	Be	MT	Fi	At	Fi	Es	Es	Es	Es	Es	Lu	Es	Se	Lu	Se	Lu		
	Lu	Lu	Lu	Es	Es	Es	Es	Es	Es	Lu	Es	Fi	At	At	Fi	Be	Fi	At	At	At	At	At	Lu	Es	Lu	At	Se	Es	Es		
	Es	Es	Es	Lu	Lu	Lu	MT	MT	MT	Es	Lu	MT	Fi	Fi	At	At	Be	Be	Lu	Lu	Lu	Lu	At	At	At	Be	Es	Lu	Be		
fin act	NI	ee	ee	NI	Dk	MT	MT	Be	Be	Be	IE	IE	Dk	IE																	
	le	Mt	Mt	NI	NI	NI	NI	IE	IE	Be	NI	NI																			
	Lu	Mt	le	le	le	le	le	le	NI	Be	Be																				

Frontier countries in public services

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Public adm	NI	NI	NI	NI	NI	It	NI	le	It	Dk	Dk	le	le	le	le	le													
	Se	Se	Se	Se	Se	NI	MT	Dk	Dk	Dk	le	le	le	Dk	NI	Dk	It												
	Dk	le	le	le	Dk	Dk	Dk	le	Dk	NI																			
education	Be	Be	IE	NI	NI	NI	NI	NI	At	At	At	NI	At	At	Dk	Ge	NI	IE	IE	Fi	IE	Fi	Fi	Fi	Fi	NI	NI	At	Fi
	Ge	Ge	Be	Be	Be	Ge	At	Ge	Mt	Dk	Dk	NI	NI	NI	NI	NI	NI	Fi	Fi	Fi	Dk								
	IE	IE	Ge	Ge	Ge	Be	MT	NI	NI	NI	Dk	Dk	Dk	Dk	Dk	Be	Be	Dk	Be										
health	Fi	Fi	At	It	It	It	Fi	Se	Se	Se	Se	It	Es	Se	le	Se	Dk	Dk	Dk	Dk	le	le	At						
	It	At	Fi	Fi	Fi	Fi	It	Se	Se	Mt	Mt	IE	IE	IE	IE	At	Be	At	Be										
	At	It	It	At	IE	At	Be	Lu																					

Notes: public administration – LU excluded 1995-2024, le excluded 1995-2001, education -Mt, Lu excluded 1995-2022, health- Lu excluded 1995-2022, Mt excluded 1995-20

References

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