# Service Industries, Capital Intensity, and Labour Productivity

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# In this research …

- The purpose was to analyse productivity levels and development in service industries.
  - Industry-level analysis: trade (NACE Rev 2 code G), transport and storage (H), information and communication (J), financial and insurance activities (K), and professional, scientific and technical activities (M), with an emphasis on ICT and intangibles.
- Presenting data for European countries and partly the United States and Japan, at best for 1995-2023. Sources: Eurostat, EU Klems. National accounts statistics.
- At the industry level, it is not possible to examine, for example, the significance of artificial intelligence or digitalization due to lack of data. Otherwise, investments have been divided into four groups.
- Growth accounting, where the dependent variable is labour productivity (value added/hours worked) and the independent variables are capital intensity and the education level of the workforce. Both the level of productivity and its change are examined.


- Kaitila, V. (2025). Service industries, capital intensity, and labour productivity. ETLA Working Papers No 127. https://pub.etla.fi/ETLA-Working-Papers-127.pdf
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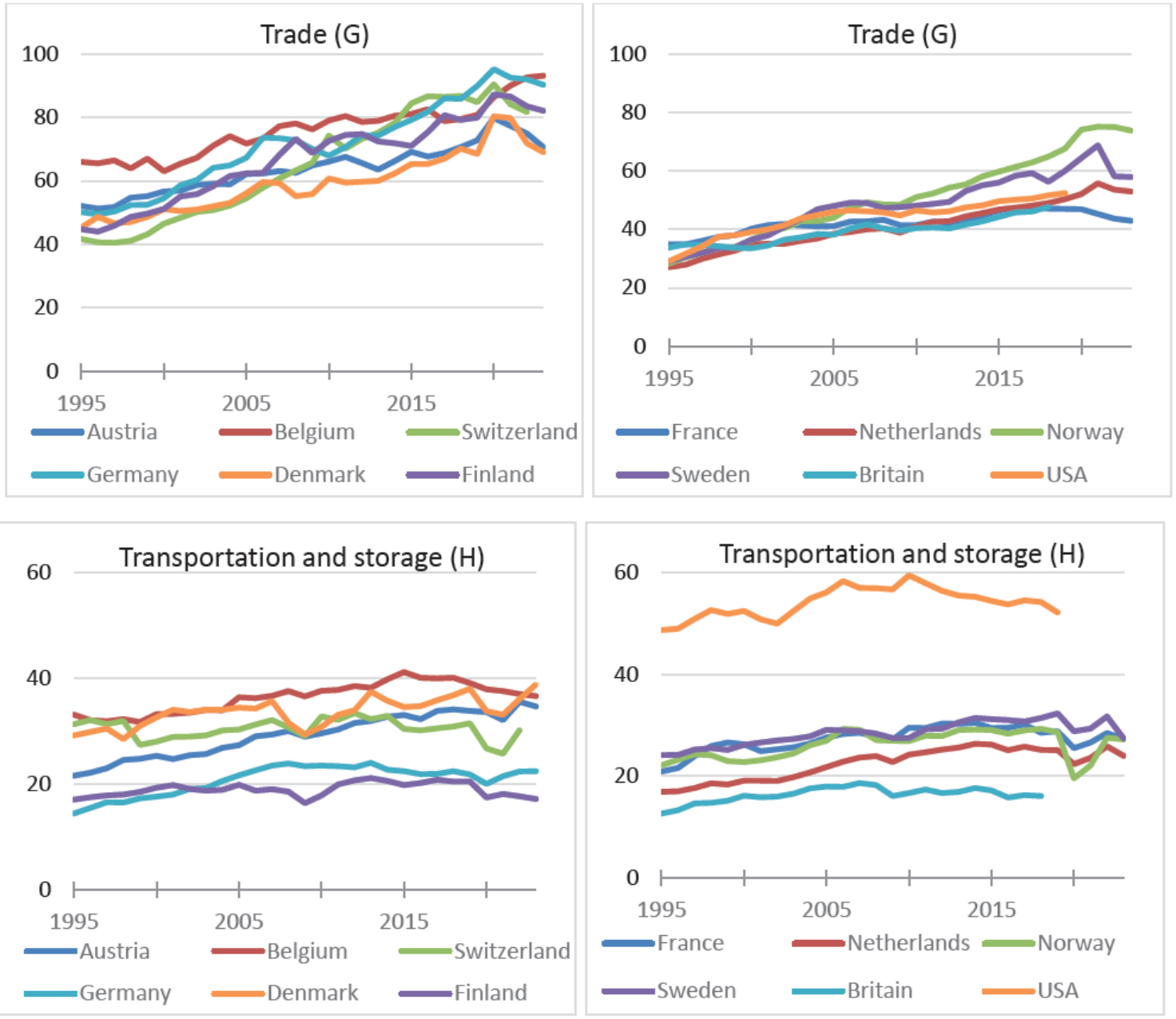
# General

- Without productivity growth, income levels and purchasing power will not increase.
- The share of service sectors in GDP and employment is large and has increased over time.

- In line with theory, empirical research has found that investments support the development of labour productivity. Studies have been conducted at the level of national economy, at the industry level, and at the company level.
- Machinery, equipment, and means of transportation have long supported productivity development in primary production and industry.
- How about service sectors?
- Same thing. Generally, according to literature, digital transition, intangible investments, and investments in information and communication technology (ICT) are positively related to productivity growth. Similar results have also been obtained for artificial intelligence.

- In addition, important background factors include the level of education of the workforce, the entry and exit of companies from the market (creative destruction), level of competition, the functioning of product and labour markets, and the efficient reallocation of capital and labour.
- However, excessive and/or misdirected investments do not help labour productivity and reduce capital productivity.

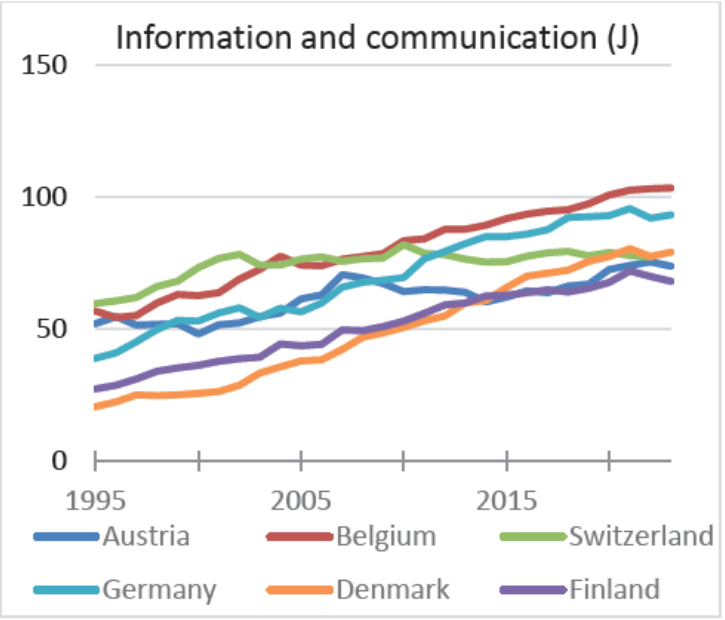
**Figure 3** **PPP-adjusted labour productivity (value added per hour) in selected countries, USD**

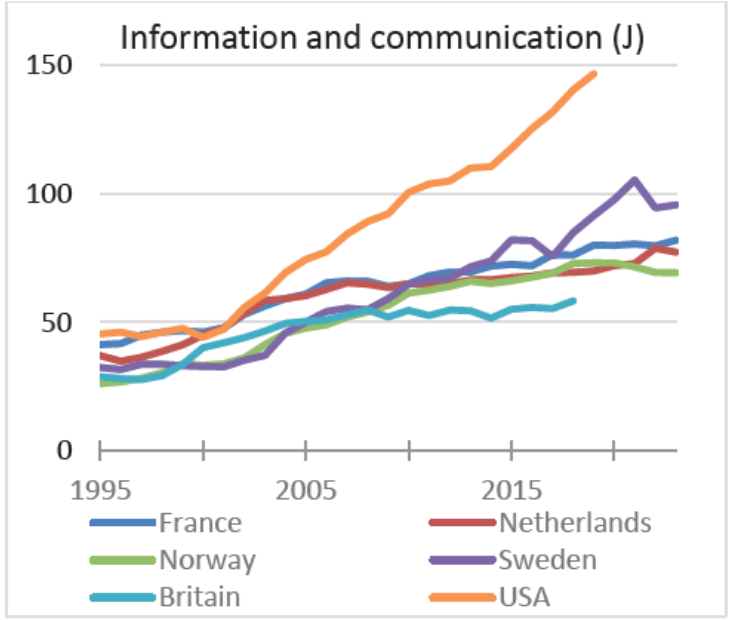


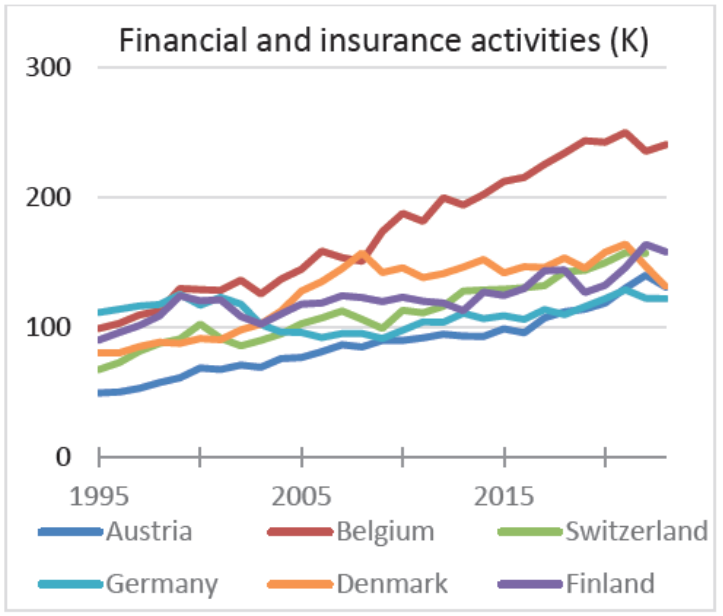

# Productivity, selected countries

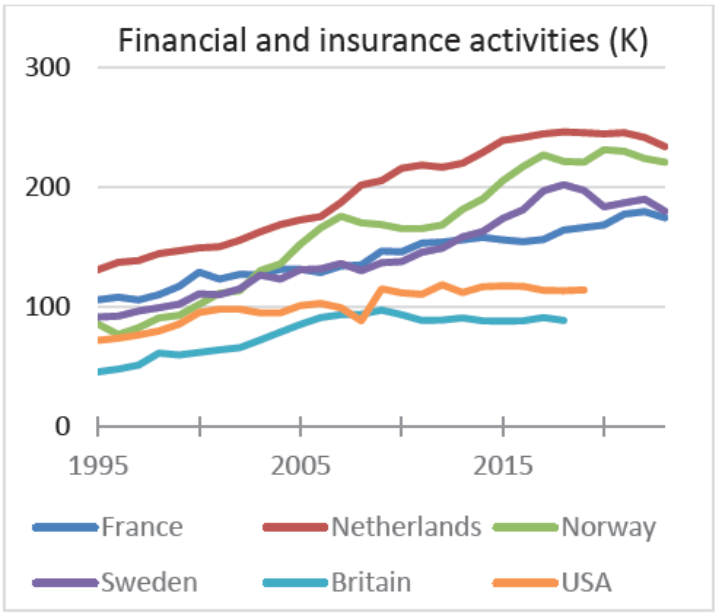
Sources: Eurostat, OECD, Inklaar et al. (2023), and own calculations.

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




# Productivity, selected countries

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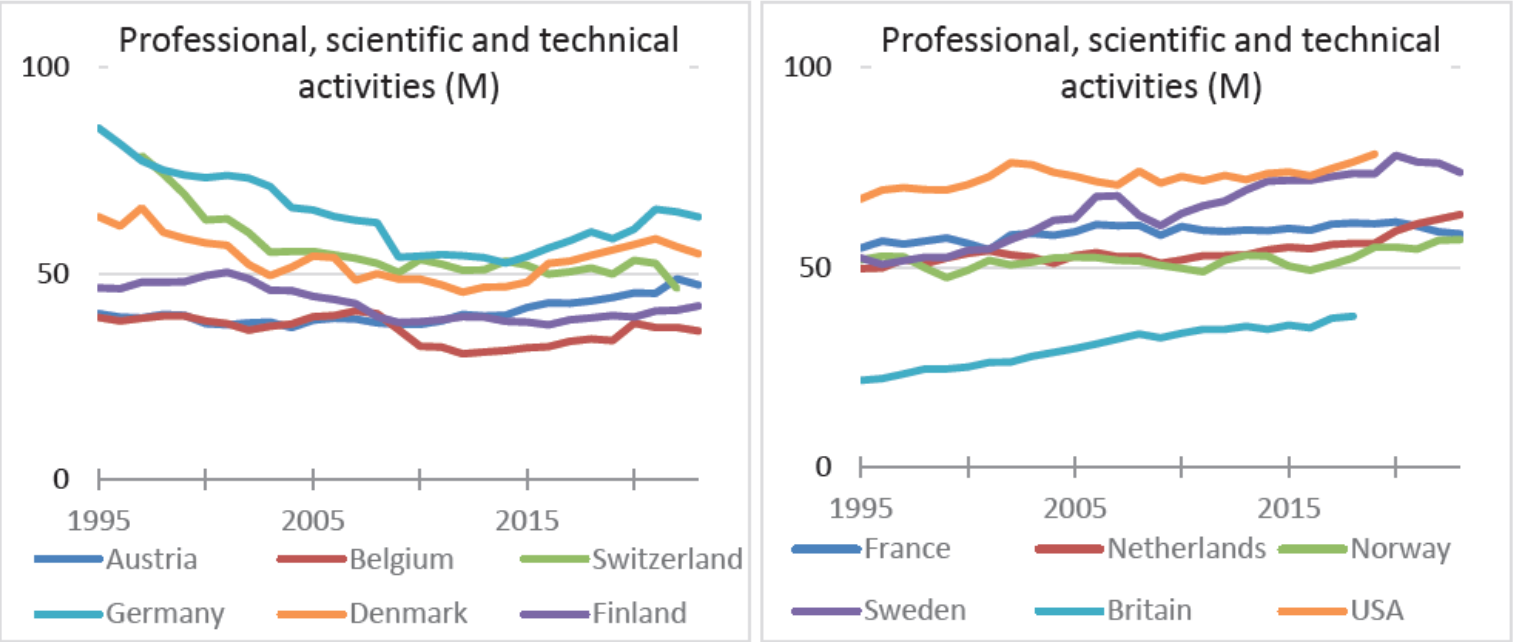
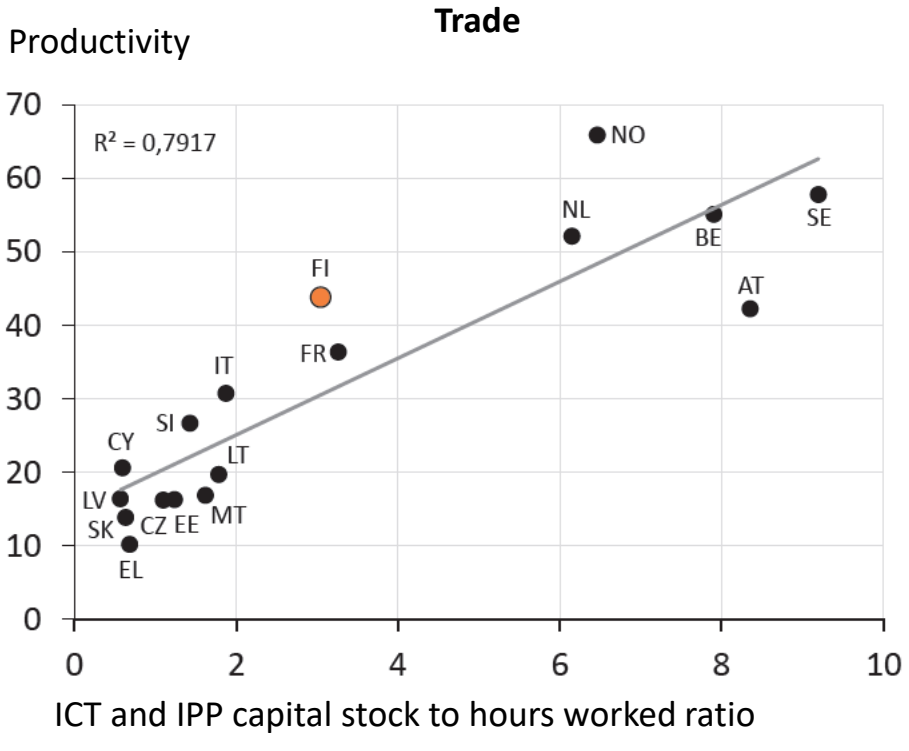
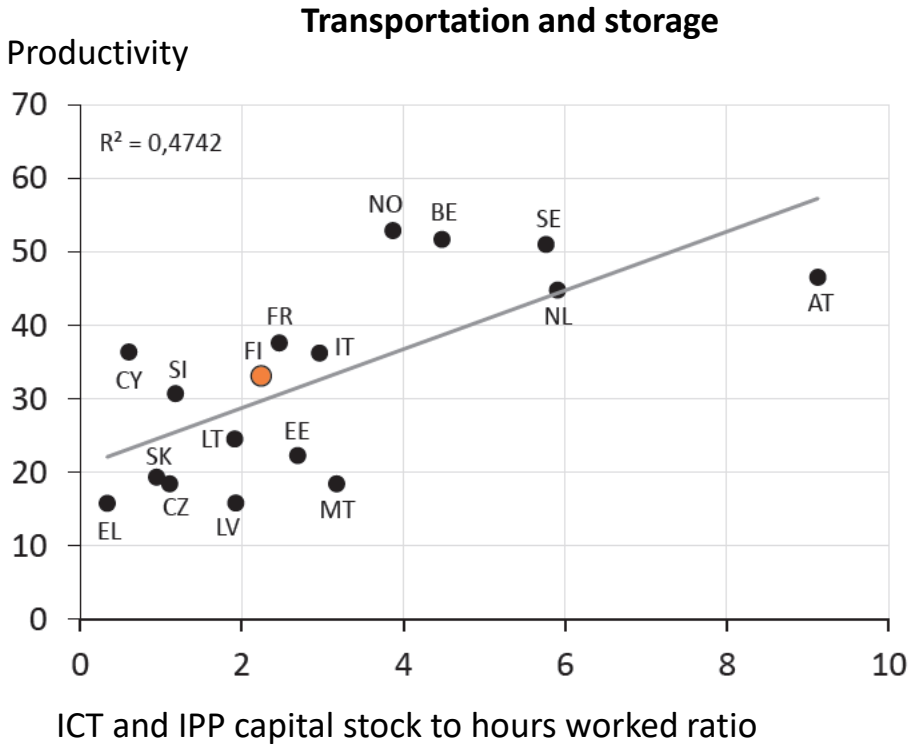



Sources: Eurostat, OECD, Inklaar et al. (2023), and own calculations.

# Productivity, selected countries

# ICT and intangible capital intensity vs. labour productivity level 2021



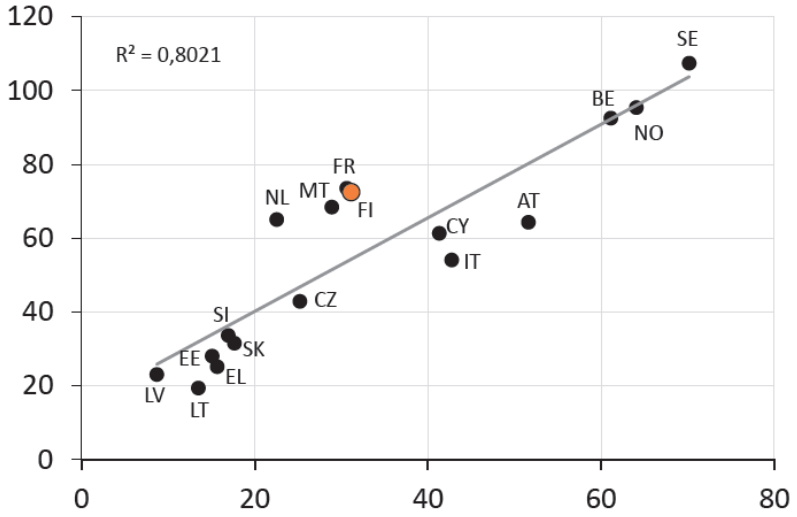

- Higher labour productivity is associated with higher capital intensity.
- ICT and IPP (intellectual property products: R&D + computer software and databases)
- The data are also affected by what firms (sub-industries) dominate within each industry.

Note: Labour productivity and net capital stock per hours worked in euros at 2015 prices.
Sources: Eurostat and own calculations.

# ICT and intangible capital intensity vs. labour productivity level 2021

Productivity

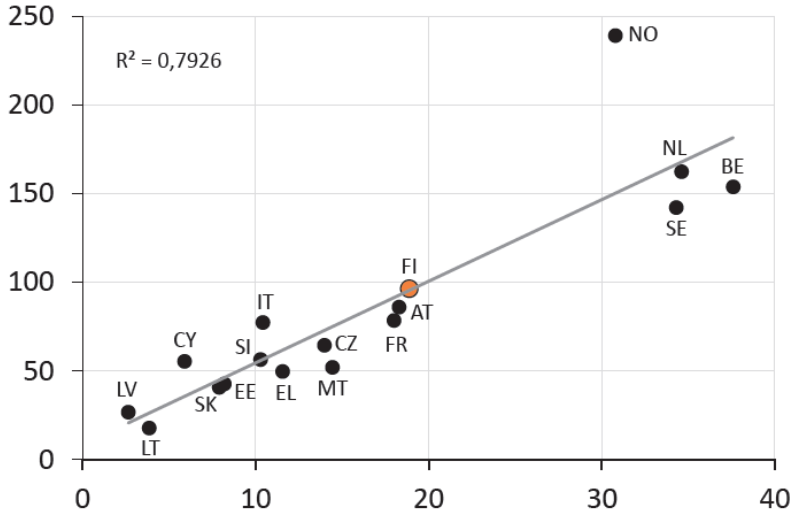
**Information and communication**




ICT and IPP capital stock to hours worked ratio

Productivity

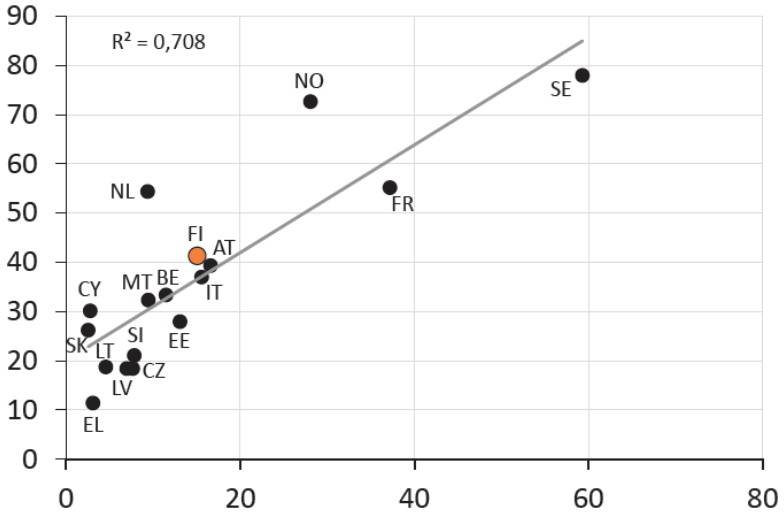
**Financial and insurance activities**




ICT and IPP capital stock to hours worked ratio

Productivity

**Professional, scientific and technical activities**




ICT and IPP capital stock to hours worked ratio

Note: Labour productivity and net capital stock per hours worked in euros at 2015 prices.
Sources: Eurostat and own calculations.

# Estimation

Following Timmer et al. (2010), the volume of value added *Y* in industry *i* is a function *f* of capital *K*, labour *L* (hours and labour composition or 'quality'), and technology *T:*

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

with a Cobb-Douglas production function. Jumping till the end, we have the change in labour productivity (*Y*/*H*) in log terms as

$$\Delta \ln y_i = \Delta \ln A_i^Y + \bar{v}_{ICT,i}^Y \Delta \ln k_i^{ICT} + \bar{v}_{RD,i}^Y \Delta \ln k_i^{RD} + \bar{v}_{SWDB,i}^Y \Delta \ln k_i^{SWDB} + \bar{v}_{other,i}^Y \Delta \ln k_i^{other} + \bar{v}_{L,i}^Y \Delta \ln LC_i$$

i.e. the sum of TFP growth, capital deepening (stock per labour input *H*), and changes in labour composition; and productivity levels accordingly.

ICT capital stock includes computer hardware and telecommunications equipment. RD is research and development. SWDB includes computer software and databases. Together, RD and SWDB are intellectual property products (IPP).

Other capital stock includes everything else, i.e. construction capital, machinery and equipment, and transport equipment.

Labour quality is determined as the share of the highly skilled in employment (hours worked). These data are from EU KLEMS.

EU + Norway

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

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

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

ICT and IPP

Also including OECD STRI data (Services trade restrictiveness index): higher productivity – higher restrictions.

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

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

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

Negative lagged productivity implies catching up.

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

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

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

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

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

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

# Pre vs. post-financial crisis: Some differences

# Results

- In the entire data set, productivity and capital intensity are positively associated. Also, all capital items separately.
- By industry (not shown above):
  - Traditional fixed capital and ICT intensity are always positively associated with the level of productivity.
  - This is also generally the case for R&D intensity.
  - Software and databases are also important in the information and communication sector (as well as the financial sector).
- Education level is positively associated with the level of productivity.

- Productivity growth and capital deepening are positively associated in the entire data set. Traditional fixed capital in general, and software and databases in almost all specifications.
- By industry, positive associations:
  - ICT deepening: especially trade and information and communication
  - Software and databases: information and communication (as well as the financial sector)
  - R&D deepening: professional, scientific and technical activities
- Catching up: productivity has grown faster when productivity levels have been lower, after capital deepening has been controlled for.

- Investments in education and, among other things, in the functioning of competition and markets are important at the national and EU levels.

THANK YOU FOR YOUR INTEREST !