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New Productivity Drivers:

Revisiting the Role of Digital Capital, FDI and Integration at Aggregate and Sectoral Levels

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Revisiting the Role of Digital Capital, FDI and Integration at Aggregate and Sectoral Levels

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Abstract

The paper studies the drivers of productivity at country and sectoral levels over the period 2000-2017 with the focus on the impact of capital accumulation and structure. The analysis confirms an especially important role of ICT and intangible digital capital for productivity growth, particularly in the manufacturing sectors. While backward global value chain participation and EU integration are also found to be instrumental for accelerating productivity growth, the impact of inward foreign direct investment is not robustly detected when the data is purged from the effects of special purpose entities and outlier countries.

Keywords: productivity, digitalisation, ICT, intangible capital, FDI, capital accumulation, global value chains

JEL classification: F14, F15, F21, E22, O47

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1. Introduction

Productivity is widely acknowledged to be an essential building block of competitiveness, economic growth and development. Productivity patterns nowadays are increasingly shaped by the new factors, including the rising role of information and communication technologies (ICT), intangible capital and broad-based digitalisation, along with the further progress in economic integration and globalisation reaching qualitatively new levels and giving rise to global value chains. The post-crisis growth malaise associated with both cyclical and structural factors prompts further research on these issues of high relevance to inform formulation and implementation of policies focusing on productivity improvements.

Examining the relevant empirical evidence delivered in the literature to date, the economic research of the 1980s and 1990s focusing on the impact of capital stock composition, mostly arguing over the effects of ICT versus non-ICT capital, was inconclusive, in part because of the challenges associated with the valuation of ICT capital stock. The latter also gave rise to the famous Solow productivity paradox (also known as the Solow computer paradox) — an observation that 'one can see the computer age everywhere but in the productivity statistics' — as the early data suggested that with more investment in ICT labour productivity empirically may decrease instead of increasing. As the statistical methodology improved over time and the data became more readily available, more evidence has emerged suggesting that capital structure matters for economic performance and ICT capital is particularly conducive for productivity (see, for example, Jorgenson and Stiroh, 2000; Oliner and Sichel, 2000; Stiroh 2002, 2005; Oliner et al. 2007; Strauss and Samkharadze, 2011; Spiezia, 2013; Wilson, 2009). Taking a comparative perspective, a number of scholars also attributed lower observed productivity in the EU in comparison with the USA to the lack of ICT investments (Timmer et al., 2010; Van Ark et al., 2002). The importance of intangible capital in driving productivity growth has been studied in Corrado et al. (2006) and Corrado et al. (2017). However, quantifying the role of intangible capital generally has been a challenge owing to the data constraints.

As a related matter, it is intuitive that capital coming from abroad via foreign direct investment (FDI) should also positively influence productivity in the host countries, perhaps even to a greater extent than domestic capital via the additional effects such as the transfer of technology, improvements in management efficiency, as well as increasing competitive pressures in the host economy. At the same time, some scholars argue that the effects of the investments made by multinational corporations (MNEs) may not necessarily be positive and significant per se, but rather are conditional on the absorptive capacity of the host countries and their industries. Borensztein, Gregorio and Lee (1998), for instance, report that FDI facilitates productivity only when the host country reaches a certain threshold level of human capital. Having surveyed 30 papers, Hale and Xu (2016), suggest that the effects of FDI differ in advanced and developing countries with the impact on productivity more profound in developing countries, while for the advanced countries it is mixed.

In this paper we contribute to the literature by revisiting the role of productivity drivers based on the sample of EU countries, Japan and the USA spanning the period 2000-2017, thereby also taking into account the post-crisis years characterised by a major productivity slowdown. Besides looking into the

role of FDI, global value chain (GVC) participation and EU integration, we also focus explicitly on the impact of digital capital, which hitherto has not been empirically assessed owing to data constraints with a few exceptions (e.g. Corrado et al., 2006, 2017). To this end we take advantage of the new EU KLEMS 2019 data (see Adarov and Stehrer, 2019a) and analyse the productivity impacts based on detailed tangible and intangible capital asset types (fourteen capital categories are distinguished), includes capital assets beyond the scope of the national accounts framework. This approach allows one to simultaneously distinguish between ICT vs non-ICT capital and intangible vs tangible capital assets, which is particularly instrumental for understanding the impact of digital capital. In addition to aggregate country-level analysis we also study the implications of FDI and capital formation at the sectoral level, which helps address the possible aggregation bias and investigate heterogeneous effects across industries. As a related matter, we analyse not only the manufacturing sectors, but also the primary and the services sectors, while the literature to date has focused largely on the manufacturing sector. Finally, when assessing the impact of FDI on productivity we net out the impact of special purpose entities (SPEs), tax offshore countries and control for the effects of capital disaggregated by asset types at the country- and sector-levels, which allows to reduce the biases associated with omitted variables and data measurement issues.

In summary, our analysis shows an important role of ICT capital accumulation in facilitating productivity with an especially robust superior effect found for digital capital (as measured by SoftDB under the EU KLEMS capital asset classification that we follow in the paper). Digital capital in fact appears to be the only capital asset type among the fourteen capital asset types examined that manifests strongly as a driver of productivity across multiple empirical exercises at the sectoral and aggregate levels. Aggregate country-level estimates suggest that a 1-percentage point (pp) increase in the growth of real capital stock induces an increase in the growth of real labour productivity by about 0.06 pp in the case of the tangible ICT capital and 0.09 pp in the case of the intangible ICT capital (SoftDB). Upon a closer sector-level examination we find a relatively stronger impact of ICT on the manufacturing sectors, particularly for the textile and clothing, coke/refined petroleum and machinery manufacturing sectors in the case of intangible ICT and for the food processing and transport equipment sectors in the case of tangible ICT capital. Besides this, the estimates suggest that backward global value chain (GVC) participation also fosters labour productivity, as well as the EU integration with the progressively increasing cumulative post-accession effect. However, in contrast to much of the literature, we do not find strong evidence of FDI impact on labour productivity after netting out the impact of SPEs and outliers and controlling for labour services, capital composition and convergence effects.

Inter alia, thus, our results in line with the most recent literature refuting the Solow's computer paradox. On the contrary, we highlight an important role that ICT capital and especially intangible ICT play in boosting productivity. The lack of visible productivity accelerations in Europe may thus in part be attributed to underinvestment in digital capital. In this regard, the paper provides further empirical support for the necessity of extra policy efforts targeted at the efficient adoption of ICT capital, both tangible and intangible, fostering technology absorption and broad-based digitalisation, especially vital for the EU in light of its weak post-crisis growth performance aggravated further by the new challenges posed by the deep lasting negative impacts of the coronavirus disease. As regards the latter, digitalization proved to be instrumental for keeping much of the economic activities, both public and private, running still under the quarantine regimes and thereby alleviating the economic slack.

The issue is yet of greater importance looking further into the future as the EU, with the exception of its several frontier economies, is falling behind not only the global leaders in digital innovation – the USA and Japan, but also the rapidly developing new competitors from Asia, particularly, China and South Korea. Gaining momentum in digital transformation via ICT capital investment may further aid the catching up of the lagging EU Member States, especially in light of the general purpose technology nature of ICT, and thereby improve its internal cohesion and resilience, as well as, more generally, strengthen the trust in the transformative power and net benefits the bloc may bring to its members, which has lost much steam in the aftermath of the global crisis.

The rest of the paper is structured as follows. Section 2 reviews the data, country sample and introduces the industrial classification used in the paper. Sections 3 and 4 review the position of European countries relative to peers in terms productivity patterns, FDI, capital dynamics and structure. Sections 5 and 6 report the results of the econometric analysis at the aggregate and sectoral levels, respectively. Section 7 reviews policy implications and concludes.

2. Data and sample

For the purposes of econometric analysis we assemble a panel dataset that includes aggregate country- and sector-level variables of labour productivity, hours worked, labour composition, FDI, capital stocks and composition by asset types and other variables employed in the econometric analysis. The sample country composition and time coverage is largely determined by the availability of the data in the key data sources, particularly the EU KLEMS database, which covers EU countries and, among non-EU countries, only the USA and Japan.

We deliberately drop Cyprus, Luxembourg, Malta, Ireland and the Netherlands from the sample as these are the recognised as the "tax offshore" countries (see, e.g. Hines, 2010 for a list of tax havens), as well as countries for which the data for the key variables of interest is missing or too short.[1] The resulting panel dataset covers 20 countries over the period 2000-2017 (Table 2.1). For regressions that use global value chain participation measures the effective sample shrinks to the period 2000-2014 – the coverage of the WIOD data that is used to construct our GVC measures.

Table 2.1 / Sample of countries

Country	ISO3 code	Country	ISO3 code
Austria	AUT	Greece	GRC
Belgium	BEL	Italy	ITA
Czech Republic	CZE	Lithuania	LTU
Germany	DEU	Latvia	LVA
Denmark	DNK	Portugal	PRT
Spain	ESP	Slovak Republic	SVK
Estonia	EST	Slovenia	SVN
Finland	FIN	Sweden	SWE
France	FRA	United States	USA
United Kingdom	GBR	Japan	JPN

The FDI data is compiled using the Eurostat and the OECD data, depending on which source offers longer series for a given country and bridging to the extent possible the gaps in the data. The OECD and the Eurostat use a common framework for reporting FDI statistics and thus the resulting data are internally consistent across the country-sector and time dimensions. In general, we follow the conventions and methods used by the Eurostat/OECD framework described in the 4th edition of the OECD Benchmark Definition of Foreign Direct Investment, BMD4. Importantly, our dataset excludes special purpose entities (SPEs) from the FDI data. SPEs are entities that primarily engage in holding activities and facilitate internal financing of multinational enterprises, but have little or no physical presence in the host economy, which severely distorts the FDI data and adversely affects economic inference in formal analysis, particularly, for countries hosting financial centres. Together with dropping tax haven countries this approach allows to focus only on the FDI dynamics with real economic relevance in the context of the productivity analysis.

[1] This mostly occurs when the capital asset data for certain asset types is not available.

Table 2.2 / Classification of sectors

SEC	NACE Rev.2 codes	Sector description (based on NACE 2 classification)	Label
1	A	Agriculture, forestry and fishing	1_AGRI
2	B	Mining and quarrying	2_MING
3	10-12	Food products, beverages and tobacco	3_FOOD
4	13-15	Textiles, wearing apparel, leather and related products	4_TXTL
5	16-18	Wood and paper products; printing and reproduction of recorded media	5_WOOD
6	19	Coke and refined petroleum products	6_COKE
7	20-21	Chemicals and chemical products	7_CHEM
8	22-23	Rubber and plastics products, and other non-metallic mineral products	8_RUBB
9	24-25	Basic metals and fabricated metal products, except machinery and equipment	9_METL
10	26-27	Electrical and optical equipment	10_ELEC
11	28	Machinery and equipment n.e.c.	11_MACH
12	29-30	Transport equipment	12_TRAN
13	31-33	Other manufacturing; repair and installation of machinery and equipment	13_OMAN
14	D-E	Electricity, gas and water supply	14_GASW
15	F	Construction	15_CONS
16	45	Wholesale and retail trade and repair of motor vehicles and motorcycles	16_TRMO
17	46	Wholesale trade, except of motor vehicles and motorcycles	17_WHTR
18	47	Retail trade, except of motor vehicles and motorcycles	18_RETR
19	49-52	Transport and storage	19_TRSR
20	53	Postal and courier activities	20_POST
21	I	Accommodation and food service activities	21_ACCO
22	J	Information and communication	22_INFO
23	K	Financial and insurance activities	23_FINA
24	L	Real estate activities	24_REAL
25	M-N	Professional, scientific, technical, administrative and support service activities	25_PROF
26	O-U	Community social and personal services	26_SOCI
100	TOT	Country total	100_TOTL

Note: the table shows the classification of sectors used in the paper with the numerical codes (SEC), corresponding NACE Rev. 2 codes, sector full name (based on NACE Rev.2) and short labels used for the brevity of exposition when discussing sectoral estimation results.
Source: own elaboration.

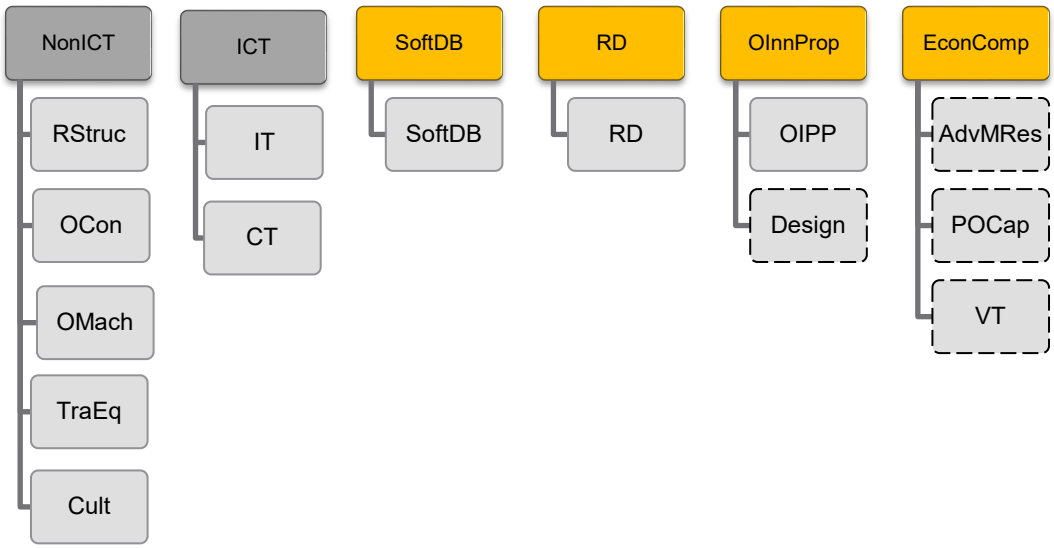
In addition, given the change in the NACE classification during the period 2000-2017 in order to compile a dataset internally consistent across countries and sectors for the entire time period, we devised a sectoral classification (based on NACE Rev.2). More specifically, in the original Eurostat database the sectoral FDI data for the period 2000-2007 (for some countries 2009) are available according to BPM5 in NACE Rev.1; from 2008-2012 the data are available in BPM5 and according to NACE Rev.2; from 2013-2016 these data are according to BPM6 and NACE Rev.2. The resulting classification is reported in Table 2.2, listing the corresponding NACE Rev.2 codes and labelling conventions used in the paper.[2]

The data for capital stocks, their composition by asset types, labour productivity, total factor productivity (TFP), hours worked and labour composition variables are obtained from the new EU KLEMS 2019 Release (see Adarov and Stehrer, 2019a for additional details about the database). The new EU KLEMS release, besides additional time coverage, in contrast to the earlier vintages of the EU KLEMS database, introduces an expanded capital asset type classification. It includes the ten asset types available from the national accounts capital data, which have already been included in the previous EU KLEMS data (the taxonomy is presented in the Appendix Figure A1): Cultivated assets (Cult), Dwellings (RStruc),

[2] The detailed mapping of sectors from different NACE versions is available from the authors on request.

Other buildings and structures (OCon), Transport equipment (TraEq), Other machinery equipment (OMach), Computer hardware (IT), Telecommunications equipment (CT), Computer software and databases (SoftDB), Research and development (RD), Other intellectual property products (OIPP). In addition, the database introduces four new 'supplementary' intangible asset types, including Advertising and Market Research (AdvMRes), Design (Design), Purchased Organisational Capital (POCap) and Vocational Training (VT).

Figure 2.1 / Capital asset aggregates



Note: Dashed lines indicate asset types outside the boundaries of National Accounts.
Source: own elaboration based on Haskel and Westlake (2018).

Therefore we distinguish fourteen capital asset types. For the purposes of econometric analysis in order to make the list of asset types more manageable and focused on the role of tangibles/intangibles and ICT/non-ICT capital, as well as gain greater efficiency in the estimations given a relatively small sample size, in the baseline analysis we follow Haskel and Westlake (2018) and group the 14 asset types into 6 broader aggregates, as outlined in Figure 2.1.

The data for GDP, institutional development and educational attainment are obtained from the World Bank's World Development Indicators and Penn World Tables 9.1. In some empirical exercises we also employ measures for backward and forward global value chain participation, which are computed deriving backward and forward linkages in line with the Koopman et al. (2014) approach using the WIOD database. In brief, in line with this framework, gross exports are decomposed into domestic value added, foreign value added and pure double counting terms. Backward GVC participation is then computed as the share of the imported value added from foreign suppliers upstream in the country's exports: $GVC_{ct}^{BWI} = \frac{FV_{ckt}}{X_{ct}}$. Forward GVC participation is measured as the domestic value added entering the exports of other countries: $GVC_{ct}^{FWI} = \frac{IV_{ct}}{X_{ct}}$. Additional technical details on the computation of the GVC measures are reported in Adarov and Stehrer, 2019b.

3. Productivity dynamics in Europe: a comparative perspective

This section reviews the productivity dynamics in Europe over time and relative to peer economies. As a measure of labour productivity we use real output *per hour worked* (at the annual frequency), which better reflects the productivity concept in comparison with the alternative measure of labour productivity *per person employed*, as it is not prone to the bias associated with the full-time versus part-time workers. In addition, we also review total factor productivity (TFP) dynamics based on the EU KLEMS and PWT 9.1 data. TFP conveys the combined productivity of labour and capital inputs and is estimated as a residual term of the production function. The econometric analysis however focuses only on the labour productivity per hour worked given the particular importance of this measure as a driver of economic development, real incomes and competitiveness.[3]

As reported in the literature, sluggish productivity growth has been a major challenge for many economies worldwide, particularly in the post-crisis period. As can be seen in Figure 3.1, most of the European countries suffered a major slowdown in labour productivity and TFP growth in the aftermath of the Great Recession, followed by a double-dip recession. The lacklustre productivity dynamics did not improve in the post-2013 period either, but, quite on the contrary, for most countries the slowdown persisted and productivity is still hardly seen to be on the recovery path. With the exception of Ireland, Spain, Italy and Denmark, labour productivity has further decelerated in the post-crisis period. Especially strong productivity losses were incurred by the Baltic countries and Romania, e.g. the average productivity growth declined by more than 3 percentage points after the crisis.

While the recent years were characterised by particularly lasting and sizeable productivity losses, it should also be noted that the productivity slowdown is not a phenomenon observed in the recent post-crisis years only; rather, many countries of Europe, both advanced and developing, suffered from productivity decelerations also in the pre-crisis period. For instance, in Germany both labour productivity and TFP growth endured a drop in the years 2002-2003 amid a generally downward long-run trend (Figure 3.3).

Besides the common cyclical and structural issues underlying the productivity slowdown, the productivity dynamics are driven by economic convergence processes accelerated by economic integration as countries with lower absolute productivity levels generally tend to enjoy a faster productivity growth rate relative to high-productivity economies (Figure 3.4). This has been a particularly important factor for Europe as multi-speed EU integration facilitates institutional and infrastructural upgrading of the countries lagging behind — the transition economies and the Western Balkan countries. At the same time, a group of countries comprising Portugal, Greece, Croatia, Cyprus, and, to a lesser extent, Italy and Spain, nevertheless lag behind the comparable peer European economies and exhibit lower

[3] In addition, as regards the TFP measure, it is estimated as a residual in a production function involving capital and labour inputs and thus using it as a regress and for our purposes, i.e. estimating the impact of capital) is technically problematic.

productivity dynamics than expected based on the general statistical association between the productivity levels and productivity growth rates as could be inferred from the scatterplots in Figure 3.4.

As a related matter, given the high heterogeneity of European countries in terms of productivity levels and productivity growth rates, the average productivity (for instance, the EU-28 average plotted also for reference in Figure 3.1 for the pre-crisis, post-crisis and the full sample period) may be misleading as a characteristic of a general stance of the EU, particularly in comparison with the peer non-European economies, e.g. the USA or Japan. However, in general, most countries of Europe tend to lag behind the USA in terms of both labour productivity and TFP levels (particularly in the post-crisis period) and in many cases also in terms of productivity growth rates. There are only a few EU countries that are at or close to the global 'productivity frontier' — the advanced countries like Germany, France, Austria, Belgium, Denmark. These countries, as noted, are naturally also characterised by lower productivity growth rates. The notable exception is Ireland, which has demonstrated an especially high level of productivity (both labour productivity and TFP) coupled with high productivity growth rates, which also proved to be resilient to the post-crisis growth malaise (the average post-crisis growth rate has increased relative to the pre-crisis period by 4.3 pp and 2.7 pp for labour productivity and TFP, respectively). In fact, Ireland recently has been the most productive country in the world. Its especially high productivity levels are attributed to the heavy presence of multinational corporations in the economy.[4]

With the exception of selected high-performance economies, it is clear, however, that many EU countries tend to fall behind the USA in terms of aggregate labour and TFP productivity, and in many cases are also below the productivity levels of Japan. As a result of the combined effect of a broad-based slowdown in productivity across Europe as well as the lasting structural productivity issues faced by certain EU countries (particularly, protracted productivity convergence of the lagging economies of Central, Eastern and Southeastern Europe and macroeconomic issues associated with Italy, Portugal, Greece and Spain), the EU has fallen behind both the USA and Japan. The USA labour productivity *level* is almost twice higher that of the EU average — a trend that persisted both before and after the recent crisis (see Figure 3.1). The EU suffered a major setback in the productivity growth rate as a result of the crisis and, although it still enjoys the productivity *growth rate* moderately above that of the USA in the post-crisis period, bridging this gap appears to be an uphill battle in light of the ongoing challenges faced by the EU.

A comparative overview of sectoral labour productivity dynamics reported in Figure 3.5 for each of the 26 sectors as outlined in Section 2 (for reference, real labour productivity growth rates are also reported the Appendix Figure A3) reveals similar meagre patterns with most EU countries lagging behind the USA with the exception of selected frontier economies — Austria, Germany, Finland, Belgium, Denmark and other advanced industrialised economies (the relative standing of countries yet differs across sectors). Inter alia, the productivity hold-up is visible in the high-tech manufacturing cluster (sectors 10_ELEC, 11_MACH, 12_TRAN): both Japan and the USA significantly surpass the average EU productivity in these sectors with the gap widening in the post-crisis period as the EU suffered major losses in the productivity growth dynamics in these sectors, especially in 10_ELEC and 11_MACH,

[4] Notably, while the multinational companies in Ireland are highly productive, the productivity of domestic enterprises is much lower (also below the OECD average). High productivity is associated with the relatively small number of frontier multinational companies operating in several foreign-dominated sectors, particularly, pharmaceuticals, ICT and food sectors as argued in the analytical report by the Irish National Competitiveness Council (2019).

which were the leaders in terms of productivity growth dynamics in the EU before the crisis (see Figure 3.6 for a comparative review of the average EU productivity by sectors before and after the crisis). In light of the observed concurrent weakening of productivity across multiple sectors, it is important to note that the decline in the *aggregate national* productivity therefore appears to be associated to a greater extent with common nation-wide structural and cyclical challenges, rather than with the shift of the economic structure of European countries towards sectors with lower productivity growth rates (although the latter might still contribute to aggregate productivity slowdown).

The sluggish performance of the EU by both the international standards and relative to the historical trends gave a renewed impulse to the debate on the drivers of productivity. While no consensus has been reached as regards the relative importance of specific factors driving the productivity slowdown, a number of factors are frequently outlined as being highly relevant in the economic literature and policy discussions. As already mentioned, the EU has suffered from structural impediments faced by the periphery European economies resulting in the slow convergence and catch-up to the EU 'frontier' economies, which also reflected in the overall average productivity dynamics for the EU aggregate. In this respect, among the bottlenecks inhibiting broad-based technological diffusion and resulting productivity gains is the complex interplay between such factors as the overregulation and low business dynamism in some sectors, challenges in the regulatory convergence of the periphery EU countries, other impediments for efficient reallocation of capital and labour, along with the lack of absorptive capacity by the 'follower' firms unable to take advantage of ICT investments, digitalisation and technological advances made by the 'leader' firms in the same industry.

These lasting structural issues have been further aggravated by the recent crisis, in particular, the much deeper adverse impact of the Global Financial Crisis and the following recession on Europe in comparison with the USA. While the USA recovered relatively quickly, Europe has suffered a much more prolonged crisis — in fact, a double-dip recession followed by continued stagnant economic growth. The latter resulted in the greater damage to the EU economy via the hysteresis effects and the lasting losses of production capacity (i.e., the decline in the potential GDP rather than the transitory business cycle shock associated with a 'normal' V-shaped economic crisis).

The weak macroeconomic stance had a profound negative impact on capital deepening, which is a critical aspect of productivity typically measured by capital-to-labour ratio (see also next section for a recap of the capital dynamics and composition). The protracted crisis was accompanied by a major investment slowdown and, as a result, unsatisfactory capital deepening across European economies. The decline in the credit supply on account of the crisis was also aggravated by less efficient in comparison with the USA financial markets, in particular, the 'bank bias' in Europe (the dominance of the banking sector in financial intermediation, while the capital markets remain less developed).

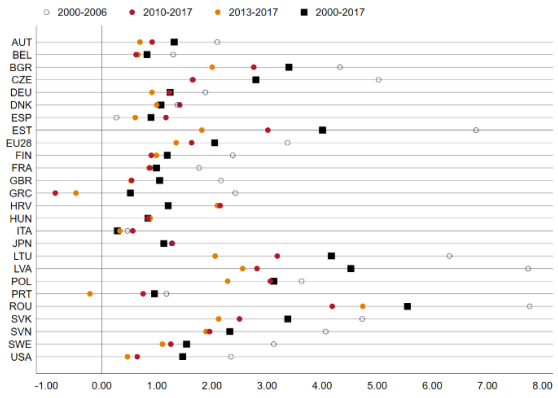
The crisis gave rise to the political and institutional challenges as the EU has been facing new challenges as regards the rise of anti-integration sentiment, including Brexit, and the resulting uncertainties reflecting negatively on the forward-looking investment sentiment. Among other disputed factors behind the observed productivity slowdown, which, however are not EU-specific, is the possibility that the 'low hanging fruit' associated with the technological progress has been picked up already, which has naturally resulted in the productivity decelerations across the frontier economies (see, for instance, Gordon, 2016). Finally, some scholars debate over the extent of the bias in the available statistical data on account of the mismeasurements of productivity and, more generally, GDP and economic growth

stemming from the new challenges associated with the valuation of intangible investments in national accounts (see also Corrado et al, 2006).

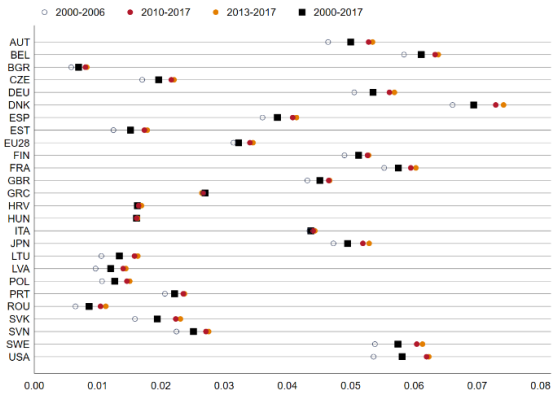
In this paper we thus attempt to bridge the gap in the analysis by focusing on the role of the new drivers, particularly, digital capital and, more generally, ICT capital, and FDI, taking advantage of the detailed capital asset data including intangible assets made available only recently, which we explore in more detail further.

Figure 3.1 / Productivity dynamics

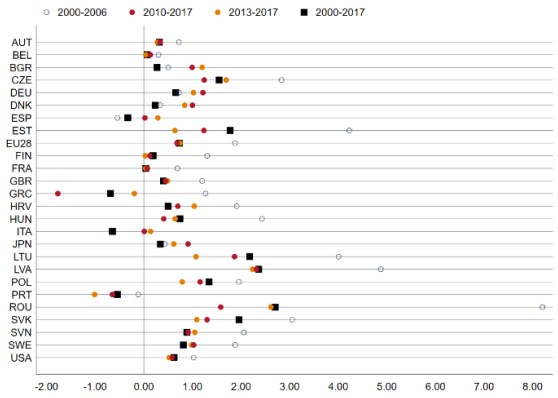
Labour productivity growth, year-on-year % change



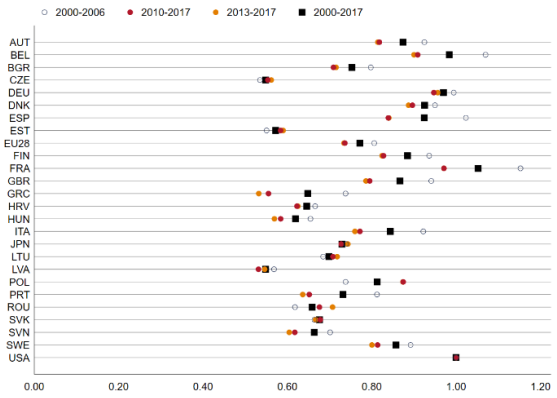
Labour productivity level (mn 2010 USD)



TFP growth, year-on-year % change

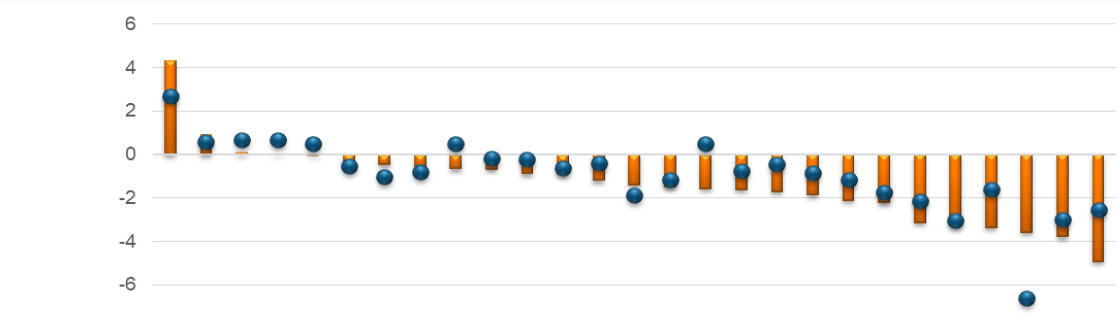


TFP level (USA = 1)



Note: The figure shows real labour productivity (per hour worked) growth and real labour productivity level (in mn 2010 USD), as well as TFP growth and TFP level (relative to the USA). The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates EU-28 average values.
Source: own computations based on the EU KLEMS 2019 and PWT 9.1 data.

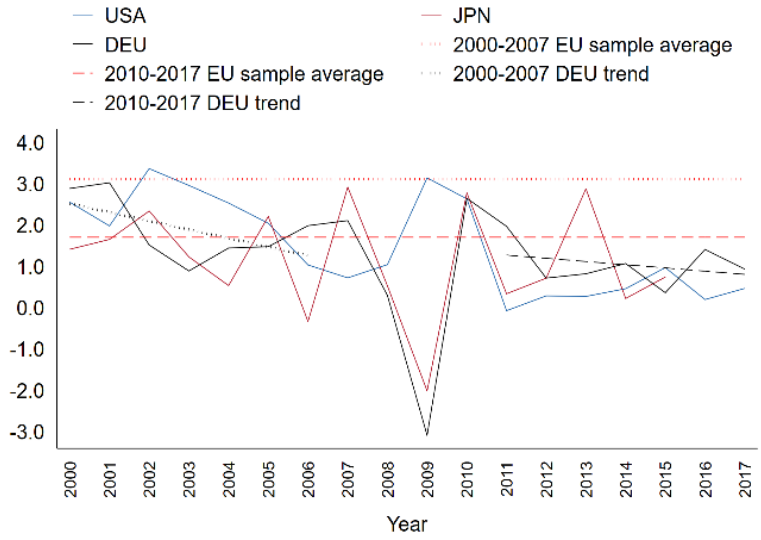
Figure 3.2 / Pre-crisis and post-crisis labour productivity growth differential



	IRL	ESP	ITA	DNK	JPN	PRT	LUX	POL	DEU	BEL	NLD	FRA	AUT	CYP	FIN	BGR	GBR	USA	SWE	SVN	SVK	LTU	GRC	CZE	ROU	EST	LVA
Labour productivity	4.3	0.9	0.1	0.0	0.0	-0.4	-0.5	-0.6	-0.6	-0.7	-0.9	-0.9	-1.2	-1.4	-1.5	-1.6	-1.6	-1.7	-1.9	-2.1	-2.2	-3.1	-3.3	-3.4	-3.6	-3.8	-4.9
TFP	2.7	0.6	0.7	0.7	0.5	-0.5	-1.0	-0.8	0.5	-0.2	-0.2	-0.6	-0.4	-1.9	-1.2	0.5	-0.8	-0.4	-0.9	-1.1	-1.8	-2.1	-3.0	-1.6	-6.6	-3.0	-2.6

Note: the figure shows the percentage-point difference between the average 2010-2017 and the average 2000-2006 growth rates of real labour productivity. The countries are sorted by the labour productivity growth differential.
Source: own calculations based on the EU KLEMS 2019.

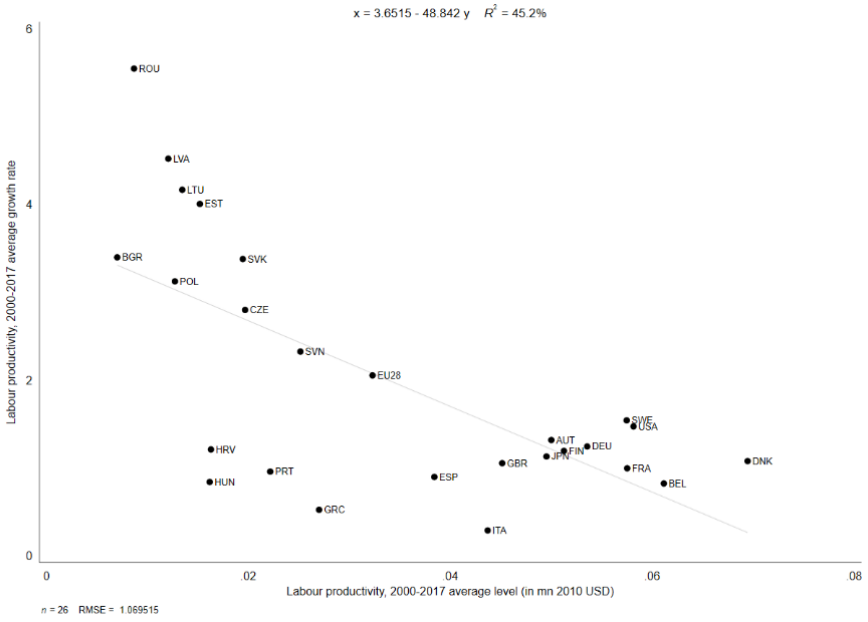
Figure 3.3 / Labour productivity trends, selected countries, 2000-2017



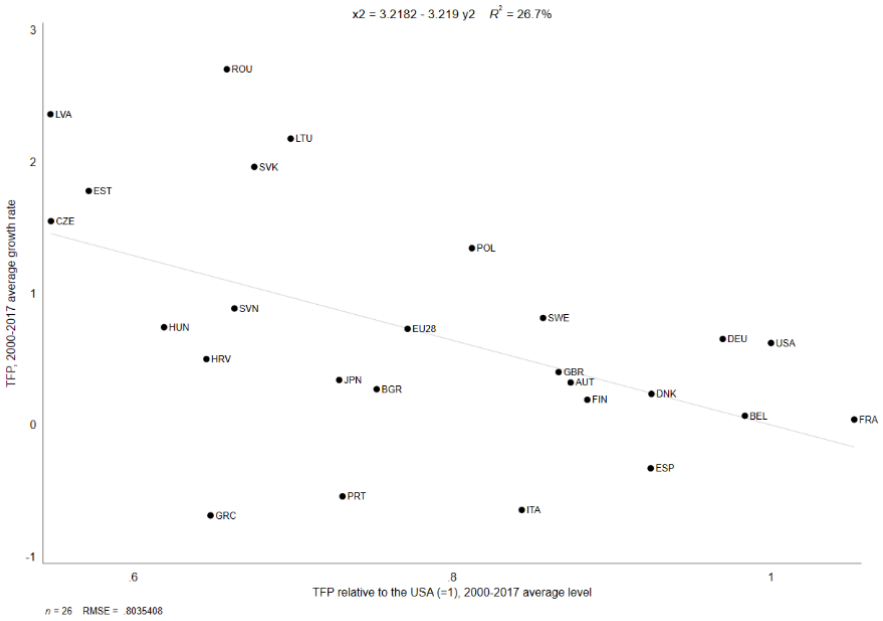
Note: the figure shows labour productivity growth over the period 2010-2017 of selected economies along with the pre- and post-crisis linear trend for Germany and sample pre- and post-crisis (simple) average growth rates.
Source: own calculations.

Figure 3.4 / Long-run productivity convergence

Labour productivity



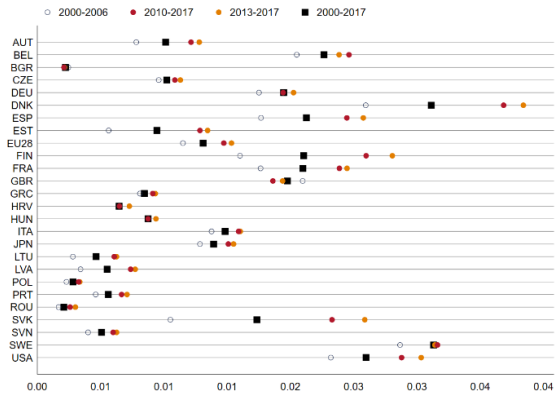
TFP



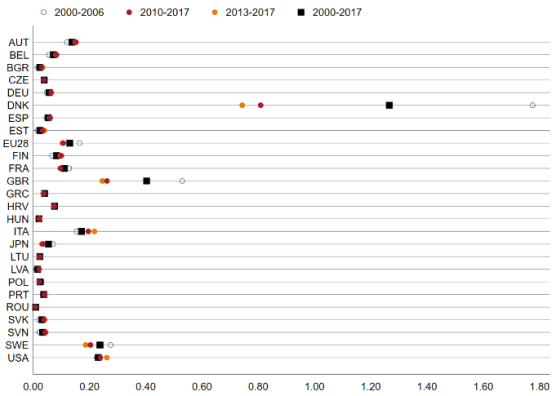
Note: The figure shows the scatterplot of long-run productivity levels and growth rates along with the fitted linear regression line. EU28 indicates the EU sample average.
Source: own calculations.

Figure 3.5 / Productivity dynamics by sectors (levels)

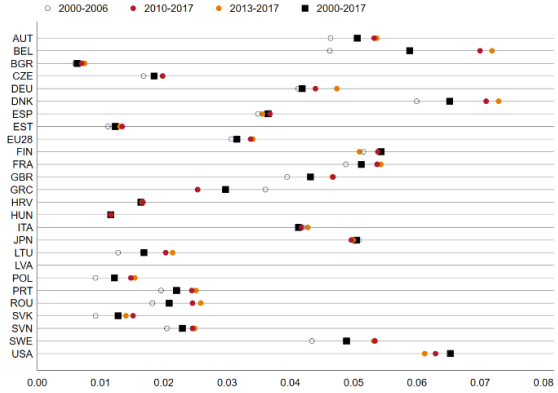
1_AGRI



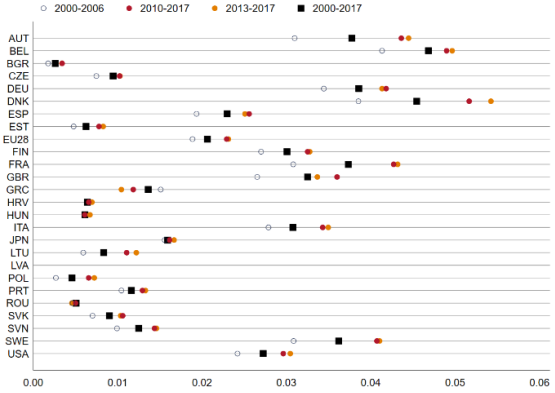
2_MING



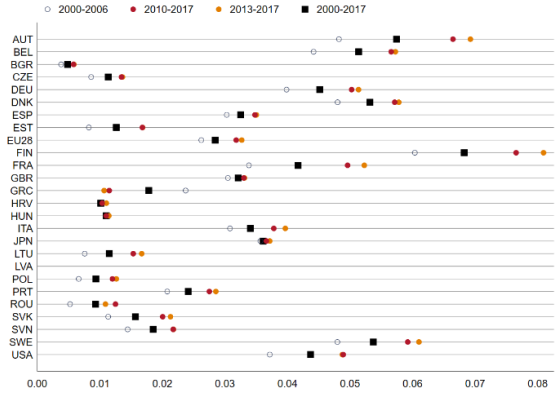
3_FOOD



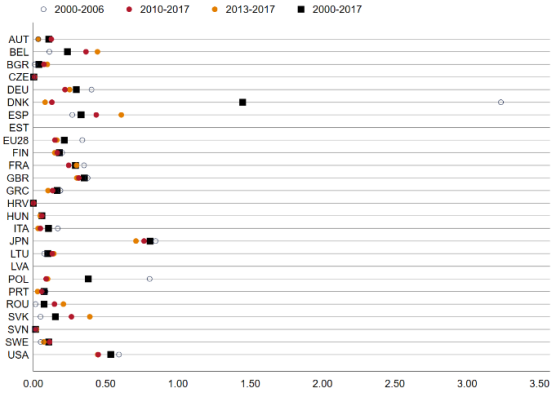
4_TXTL



5_WOOD



6_COKE

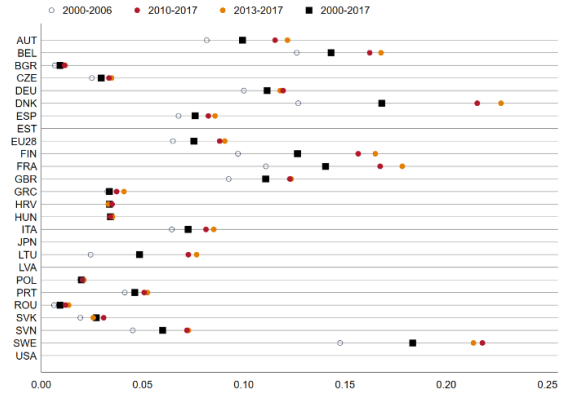


Note: The figure shows real labour productivity levels in mn 2010 USD for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

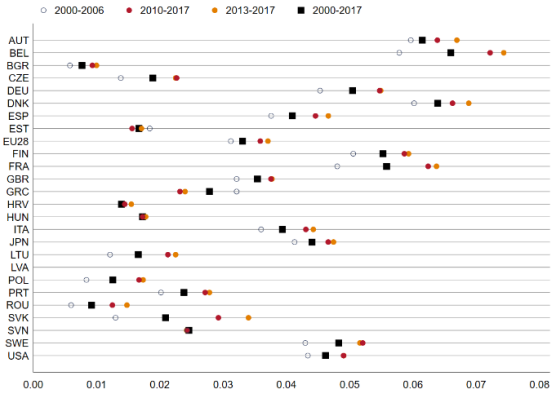
ctd.

Figure 3.5 / (cont.)

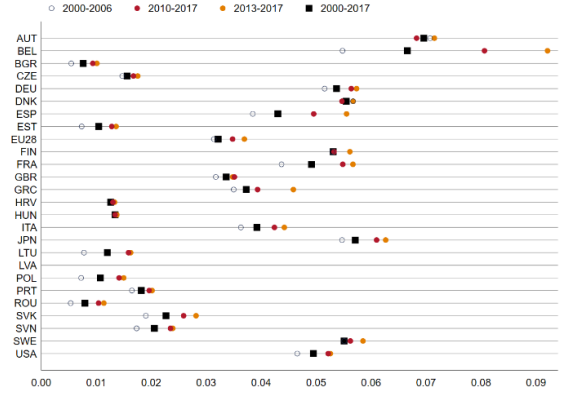
7_CHEM



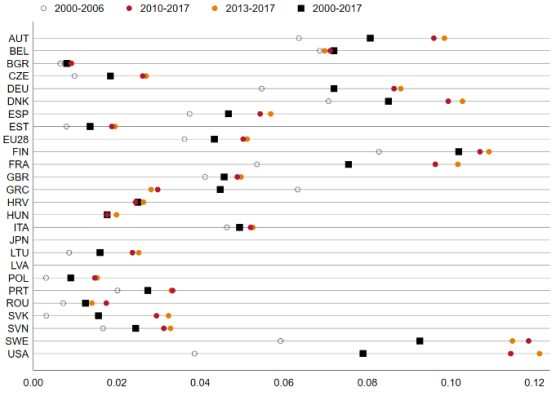
8_RUBB



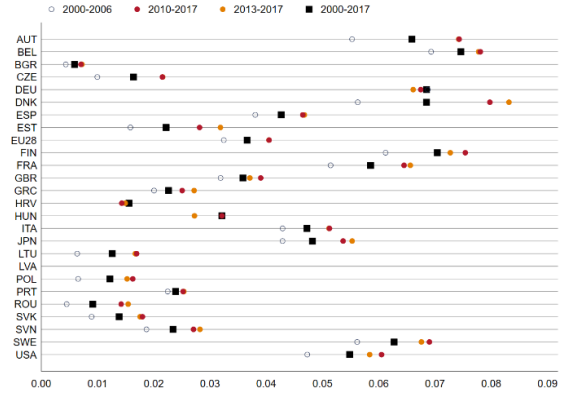
9_METL



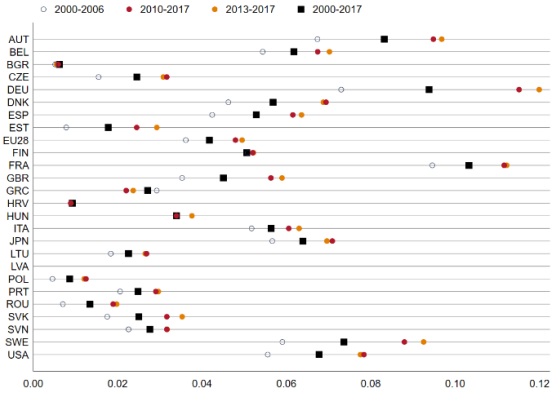
10_ELEC



11_MACH



12_TRAN

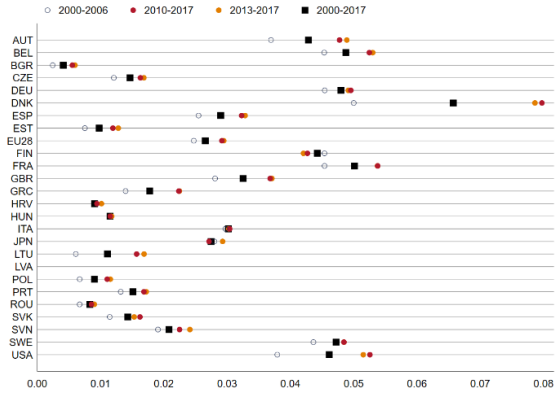


Note: The figure shows real labour productivity levels in mn 2010 USD for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

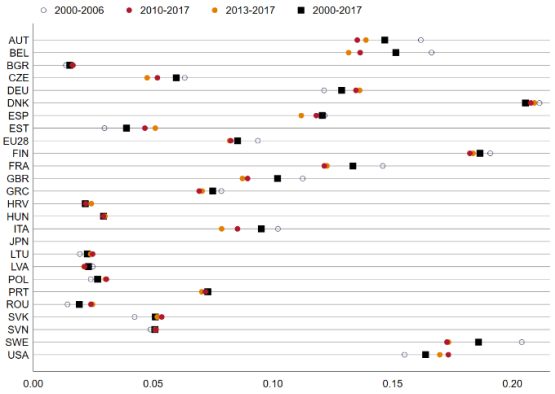
ctd.

Figure 3.5 / (cont.)

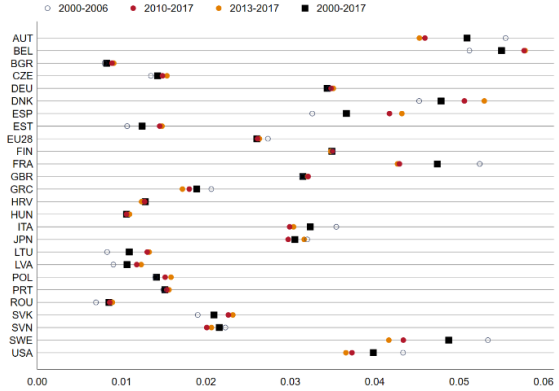
13_OMAN



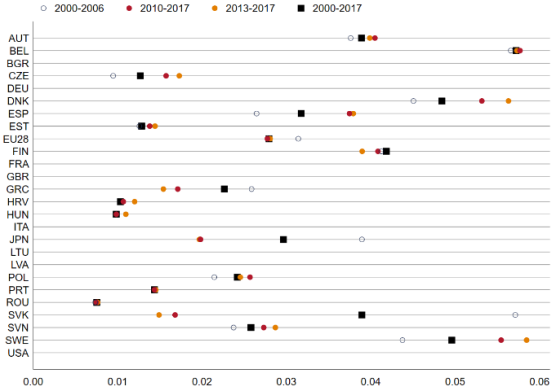
14_GASW



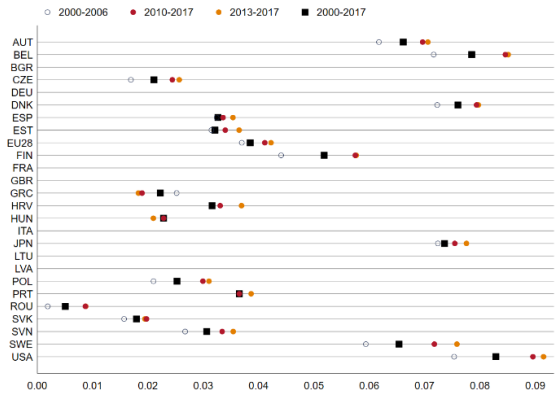
15_CONS



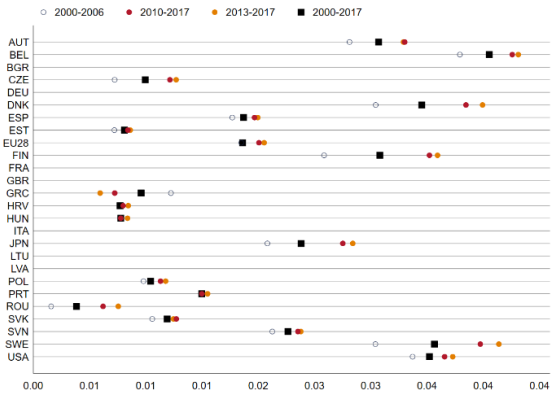
16_TRMO



17_WHTR



18_RETR

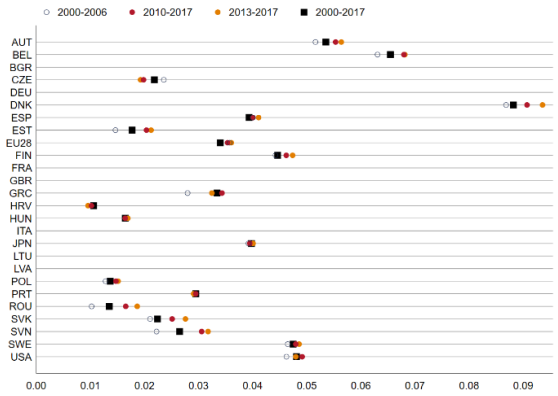


Note: The figure shows real labour productivity levels in mn 2010 USD for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

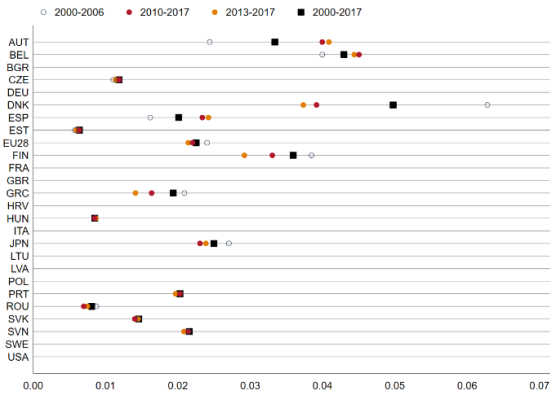
ctd.

Figure 3.5 / (cont.)

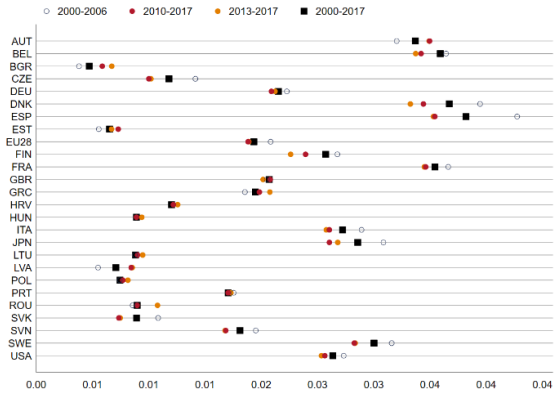
19_TRSR



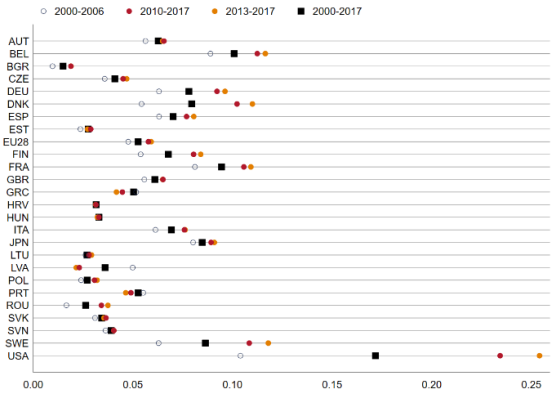
20_POST



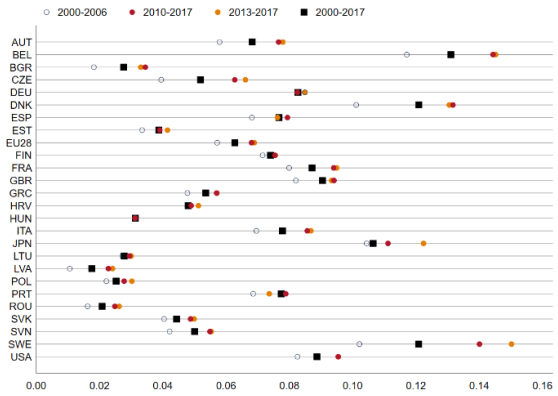
21_ACCO



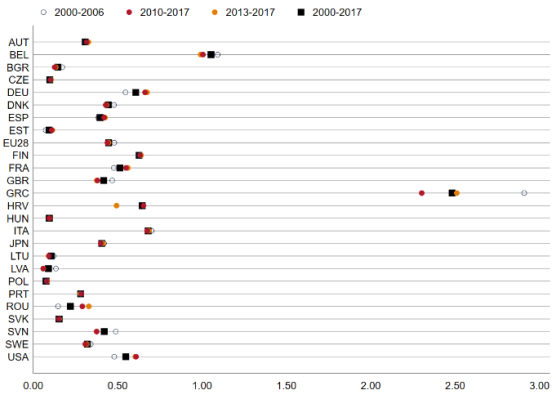
22_INFO



23_FINA



24_REAL

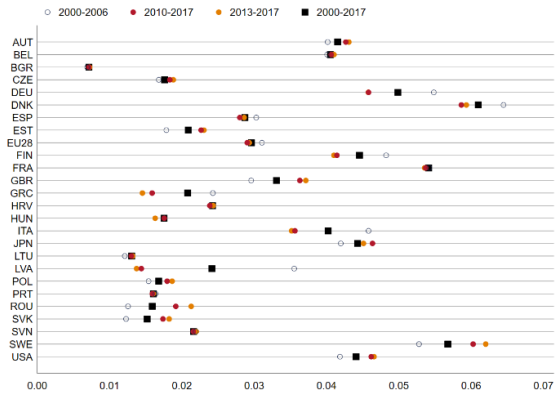


Note: The figure shows real labour productivity levels in mn 2010 USD for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

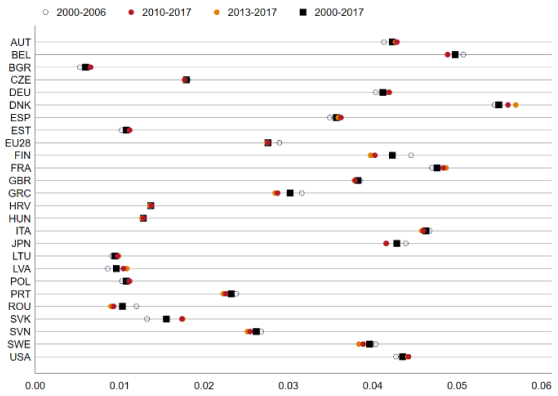
ctd.

Figure 3.5 / (cont.)

25_PROF

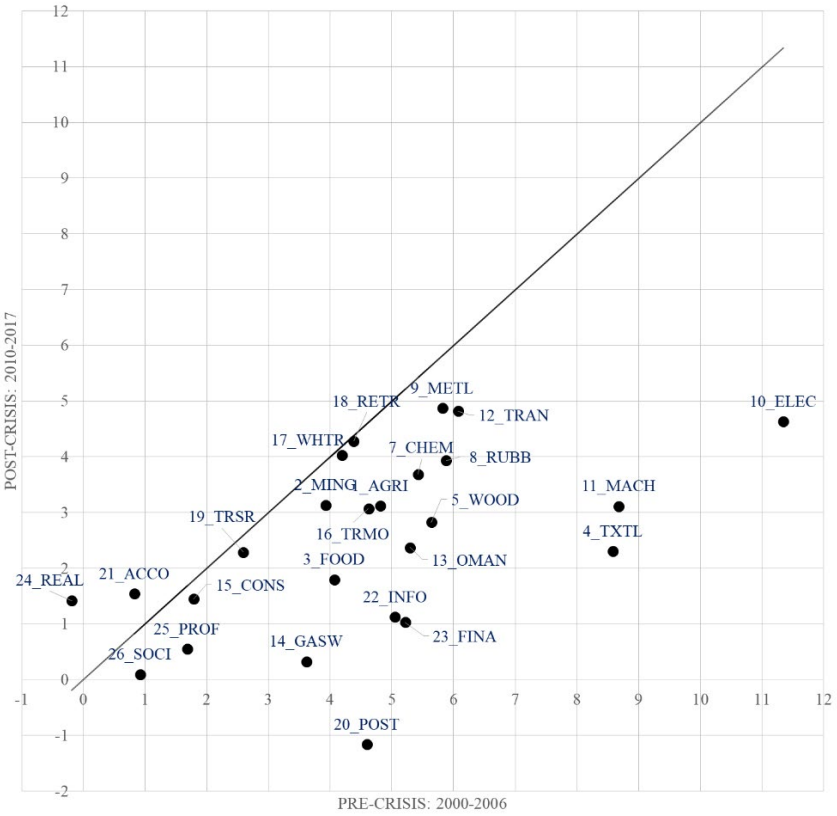


26_SOCI



Note: The figure shows real labour productivity levels in mn 2010 USD for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

Figure 3.6 / Labour productivity by sectors: EU-28 average before and after crisis



Note: The figure shows real labour productivity growth rates before and after the crisis along with the 45-degree line. Sector 6_COKE is omitted for clarity.
Source: own computations based on the EU KLEMS 2019 data.

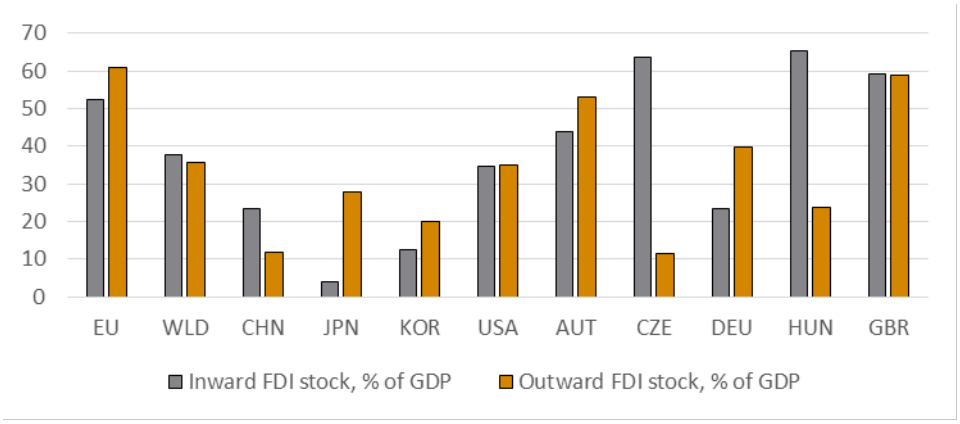
4. FDI and capital dynamics

As discussed in the data section, our analysis employs the FDI data compiled using the Eurostat and OECD datasets netting out investment associated with SPEs. We also exclude countries that are commonly acknowledged by experts as 'tax havens'. This allows to focus on the real economic implications pertinent to FDI conveying a lasting interest by an investor in one economy in an enterprise resident in another economy.

Figure 4.1 shows the dynamics of FDI for the EU in comparison with the global FDI intensity and selected economies. The EU is characterised by a much higher FDI intensity relative to its peer economies — the USA, China, Japan, South Korea in terms of both inward and outward FDI-to-GDP ratios. Despite a decline in the volume of FDI in the EU relative to 2017 (inward FDI stock decreased by 0.2% and outward FDI stock – by 5.3%), FDI intensity in 2018 stands high at 54.8 percent of GDP for inward FDI stock and 60.3 percent of GDP in the case of outward FDI stock. Overall, the post-crisis period has been characterised by a decline in FDI inflows for European countries (Figure 4.2).

While aggregate capital intensities vary significantly across European countries (Figure 4.2), in terms of the absolute levels of real capital stock and capita-to-labour ratios European countries generally lag behind the peers (e.g. USA and Japan).

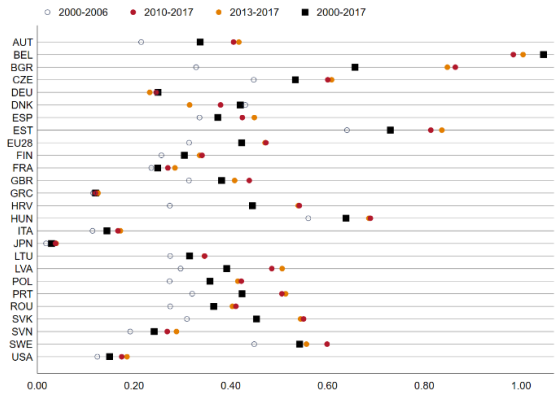
Figure 4.1 / Inward and outward FDI stocks, 2014-2018 average



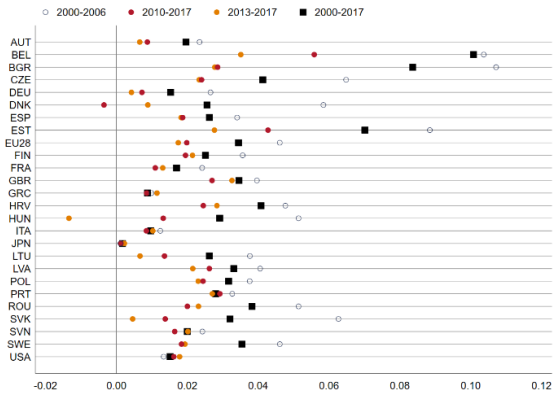
Note: the figure shows 2014-2018 average inward and outward FDI stocks as a percentage of GDP for the EU, the world economy (WLD) and selected economies. 2014-2017 average for South Korea.
Source: computations based on OECD FDI database, 2019.

Figure 4.2 / FDI and capital accumulation before and after the Great Recession

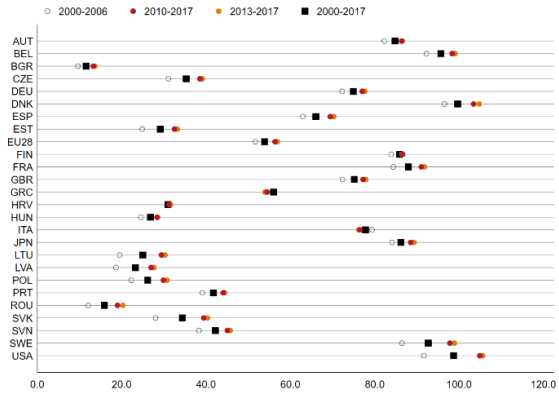
Inward FDI stock, share of GDP (ex. tax havens)



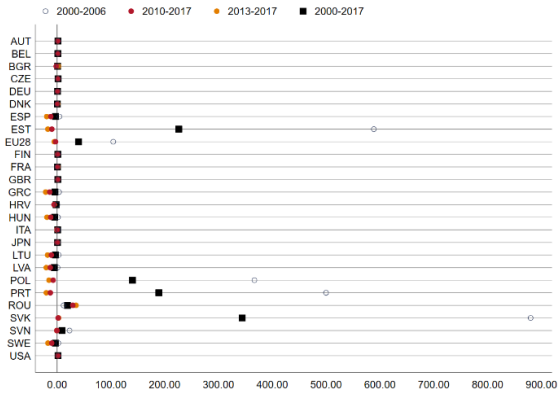
FDI inflow, share of GDP (ex. tax havens)



Real capital stock, thousand USD per person employed



Real capital stock, year-on-year growth



Note: The figure shows inward FDI stocks and flows, real capital stock growth and real capital-to-labour ratios. 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order.
Source: own computations based on Eurostat, OECD and EU KLEMS 2019 data

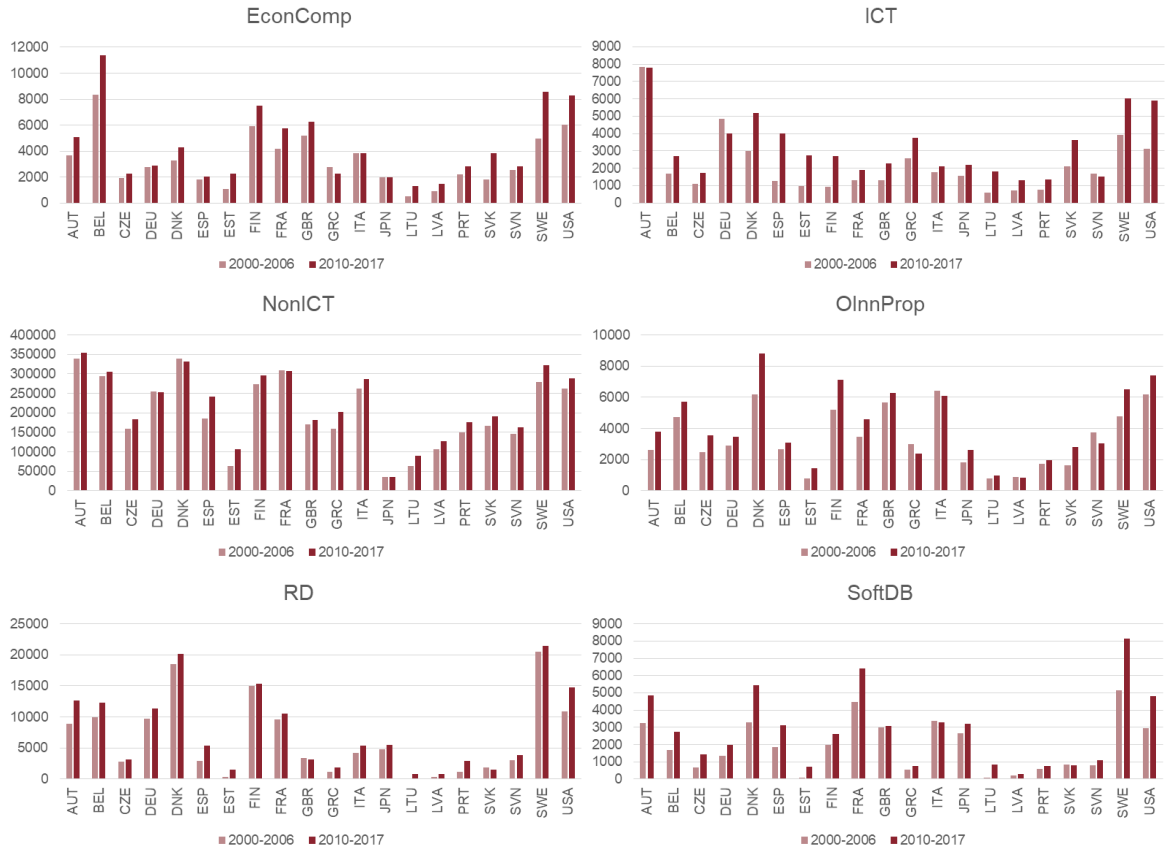
Of equal importance is the composition of capital stocks, in particular, the share of ICT capital and intangible assets, which are seen recently as important new factors of economic growth and productivity. Based on the capital asset taxonomy introduced in Section 2, in Figures 4.3 and 4.4 we outline the share of individual capital asset aggregates in total capital stocks and intensities with respect to the labour employed, also examining the changes between the pre- and post-crisis periods (for the countries for which the detailed capital asset composition is available in the EU KLEMS 2019). Most of the capital stock value (about 90%) is attributed nonICT capital. In this regard Japan prominently stands out from the rest of the sample with a smaller share of nonICT capital and particularly high shares of ICT, SoftDB and RD capital in the total capital stock; however, as a share of employed these capital asset aggregates are in line with other countries. European countries exhibit significant heterogeneity in terms of capital composition. While no significant changes are observed in the shares of tangible and intangible ICT capital in total capital stocks (there is a marginal increase in share of SoftDB along with a slight decrease in the share of tangible ICT in total capital stock), their per-employed intensities have increased notably despite the decline in the real capital stock growth (Figure 4.5). Among the European

countries, Austria, Sweden and Denmark appear to be the leaders at the digital capital frontier as measured by the importance of ICT and SoftDB relative to both total capital stock and the persons employed (also France for SoftDB, but not tangible ICT).

Figure 4.3 / Composition of capital stocks by asset groups

Note: the figure shows the share of an asset group in the total capital stock, averages over the period 2000-2006 and 2010-2016. Countries are listed by ISO3 in alphabetic order.
Source: own computations based on EU KLEMS 2019.

Figure 4.4 / Capital stocks per person employed by asset groups, mn USD

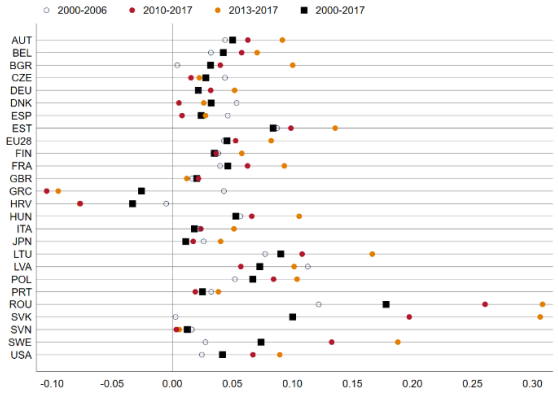


Note: the figure shows real capital stock per person employed (in mn USD) by asset group, averages over the period 2000-2006 and 2010-2017. Countries are listed by ISO3 in alphabetic order.
Source: own computations based on EU KLEMS 2019 data

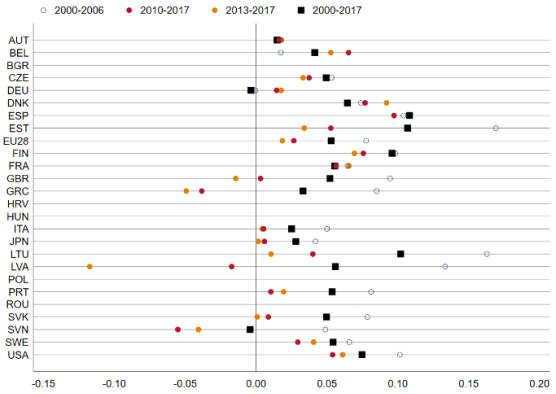
As a rough assessment of the relationship between capital structure and labour productivity, Figure 4.6 shows the scatterplots based on the full panel data (country aggregates). Although for all capital asset the relationship appears to be positive, it is clear that at least to some extent the results are clearly influenced by outlier points which prompts a careful control for outliers in addition to controlling for other factors influencing productivity via a robust econometric analysis — discussed in the next section.

Figure 4.5 / Capital dynamics by broad asset groups (real capital stocks in log-differences)

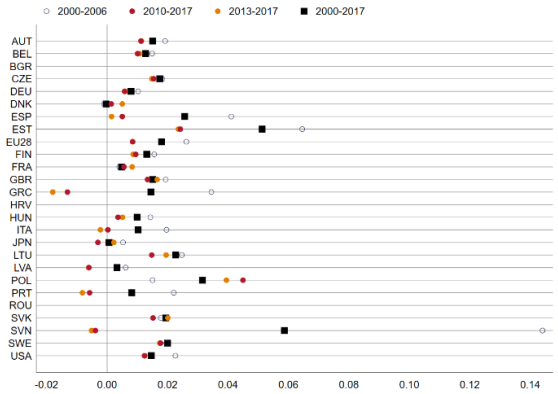
EconComp



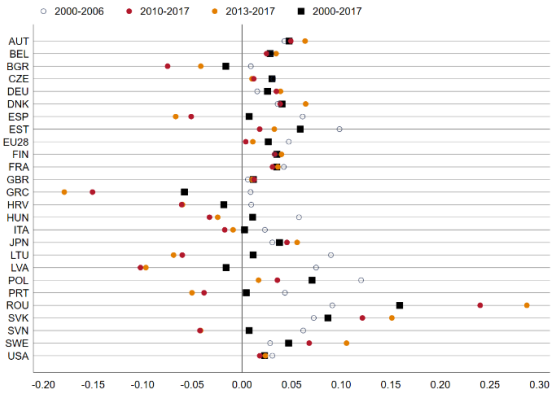
ICT



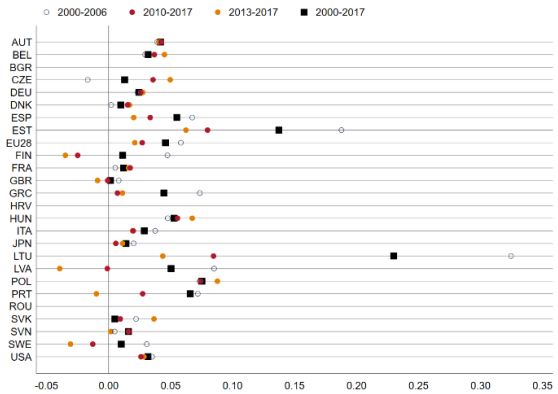
NonICT



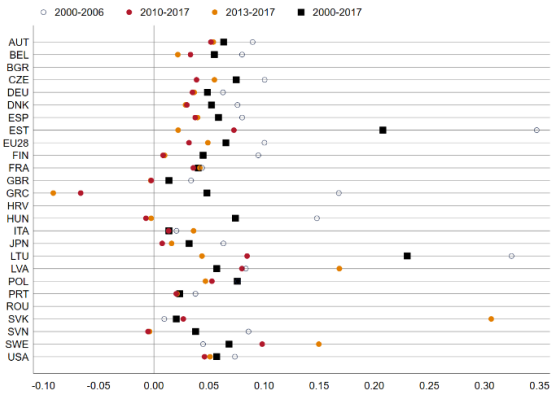
OInnProp



RD

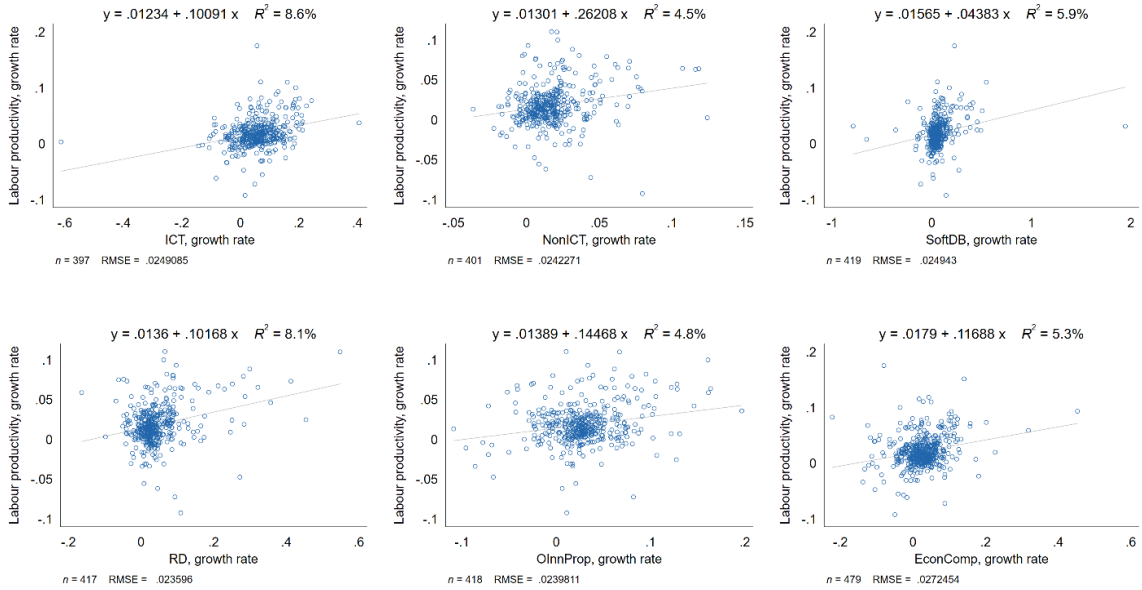


SoftDB



Source: own computations based on EU KLEMS 2019 data

Figure 4.6 / Scatterplots: labour productivity growth vs growth of capital asset aggregates



Source: own elaboration based on EU KLEMS 2019 data.

5. Evidence from the aggregate country analysis

5.1. MODEL SETUP

In this section we first estimate the effects of FDI and capital composition on labour productivity. The descriptive statistics for the effective sample used in the econometric analysis are reported in Appendix A. Consistent with the standard Cobb-Douglas production function explaining output as a function of capital and labour inputs, as well as total factor productivity, we use the following specification expressed in log-differences (approximation to growth rates), which allows its estimation as a stationary model:

$$\Delta \ln \mathrm{PROD}_{ct} = \alpha_1 \ln \mathrm{PROD}_{ct-1} + \alpha_2 \ln \mathrm{L}_{ct} + \sum_{q \in Q} \beta_q \, \Delta \ln \mathrm{K}_{qct} + \sigma \Delta \ln \mathrm{FDI}_{ct-1} + \boldsymbol{\xi} \mathbf{X}_{ct} + \boldsymbol{\mu}_c + \varepsilon_{ct}$$

where $\Delta \ln \mathrm{PROD}_{ct}$ is the measure of productivity in country c (real value added per hour worked), in log-differenced form (thus conveying its growth rate). The term $\ln \mathrm{PROD}_{ct-1}$ is the lagged level of real labour productivity capturing the convergence effect. $\Delta \ln \mathrm{L}_{ct}$ is the labour input: the growth of the labour services, which is used for baseline estimations, or a combination of the hours worked and the change in the labour composition, i.e. $\Delta \ln \mathrm{L}_{ct} = \Delta \ln \mathrm{LC}_{ct} + \Delta \ln \mathrm{H}_{ct}$.

The term $\Delta \ln \mathrm{K}_{qct}$ denotes the measure of capital inputs. The baseline model uses real capital stocks in log-differences distinguishing between several capital asset types (alternative specifications include capital services growth and the change in real capital stocks as a share of employed persons). In the baseline analysis we distinguish the six broader capital asset groups as defined in Section 2, i.e. the set Q = {SoftDB; NonICT; ICT; RD; OInnProp; EconComp}. In additional empirical exercises the fourteen detailed capital asset types are included instead of the aggregate groups.

The variable $\Delta \ln \mathrm{FDI}_{ct-1}$ denotes a measure of foreign direct investment; the baseline model employs inward FDI growth (real inward FDI stock in log-differences[5]). Alternative specifications use the change in the inward FDI stock as a share of GDP and the ratio of (real) inward FDI stock to the persons employed in log-differences. In order to address possible endogeneity issues the FDI variable is lagged by one (in the baseline specification) or more years (in alternative specifications estimated for robustness).[6] In additional empirical exercises the model is further augmented by other explanatory variables of interest comprising constituting the vector $\mathbf{X}_{ct}$, including interaction terms of FDI with various variables conveying 'absorptive capacity' — institutional variables (World Bank's Worldwide Governance Indicators measuring government effectiveness and control of corruption), educational attainment, quality of infrastructure, financial development measured as private credit-to-GDP ratio and others. Other exercises also incorporate GVC participation measures and EU integration variables — discussed in more detail in Section 5.3. Finally, $\boldsymbol{\mu}_c$ denotes the vector of country and year fixed effects, capturing unobserved country heterogeneity and common year-specific shocks.

5 GDP deflators are used to compute FDI in constant prices.

6 In additional robustness exercises we also explore deeper lags of capital and FDI variables.

5.2. THE IMPACT OF DIGITAL CAPITAL AND OTHER CAPITAL ASSETS TYPES

In this section we assess the effects of capital structure and FDI on labour productivity. The model is estimated first via fixed effects with standard errors clustered by country ("FE") as the baseline estimator — the results are reported in Table 5.1 with the benchmark specification listed in column 1. We also report pooled OLS ("POLS") and the Arellano-Bover / Blundell-Bond system GMM ("System GMM") estimates for comparison. The latter model is reported merely for reference as it is based on 3-year non-overlapping averages, which ensures that N > T (in this case N=20 and T=6), which significantly reduces the sample size. Nevertheless, the results are consistent across all specifications and estimators in terms of statistical significance and magnitudes.

Although we remove the effects of SPEs from the FDI data and drop tax haven countries as described in Section 2 describing the data and sample issues, the panel dataset still suffers from outliers associated with some countries (the issue is worse for the sector-level analysis) that may notably bias the results. The main results are thus based on the threshold of 2 standard deviations from the mean imposed on the key variables of interest (labour productivity growth, real capital stock growth by asset types and real FDI stock growth), which allows to focus on the robust average marginal effects (effectively, based on the 87-90% of the data). The use of the cut-off thresholds to control for outliers was motivated by a battery of additional specification tests, including partial-regression leverage plots, added-variable plots and the Cook's distance measures. Estimation results with alternative outlier thresholds, along with the estimates without any outlier control, are reported in the Appendix Table B3 accompanied by a table with related summary statistics per each exercise.

The analysis strongly suggests that investment in ICT capital is associated with the increase in labour productivity, consistent with the idea that advanced technology embodied in ICT effectively complements workers' skills leading to productive efficiency gains. More generally, ICT capital, being a general-purpose technology, has multiple channels via which it may influence broad-based productivity at the country level, including faster and more efficient communication, better data management practices and enhanced data flow, thereby also reducing information inefficiencies and fostering knowledge creation and transfer. Notably, both tangible ICT (ICT) and intangible ICT (SoftDB) variables are statistically significant and imply sizeable economic effects: a 1-percentage point increase in the growth of real capital stock induces an increase in real labour productivity growth of about 0.06 pp. in the case of the tangible ICT capital and 0.09 pp. in the case of the intangible SoftDB capital. In fact, the impact of SoftDB is more profound relative to the ICT aggregate in terms of the magnitude and manifests itself more strongly across multiple specification and robustness checks, including alternative samples and models.

Contrary to expectations, no impact of FDI on productivity is found. In fact, the effect does not manifest at deeper lags of the FDI variable and after adjusting for the country's absorption capacity as proxied by institutional development, human capital and financial development measures (discussed in the next section). This implies that, after imposing a strict control over the sample, that is, removing the impact of strong outliers like Ireland, removing the bias associated with SPEs and controlling for other factors, the role of FDI as a booster of labour productivity may not be significant at least in the relatively short time spans of several years. This is however consistent with the idea that FDI is targeted at countries (or sectors) with already high levels of productivity (which is captured in the specification by the lagged labour productivity variable), but does not robustly contribute much per se to further productivity growth.

As expected and in line with the results from the descriptive analysis, lagged labour productivity level is negative and significant throughout specifications, indicating strong convergence effects as countries with lower productivity levels generally enjoy a faster catch-up productivity growth. Introducing deeper lags of the real labour productivity variable as a robustness check yields very similar results. The growth of labour services is overwhelmingly associated with the decline in labour productivity. Decomposition of the labour services variable into its components – the hours worked and the labour composition (Column 2) reveals that this effect is entirely attributed to the negative impact of the growth in the hours worked, which confirms the conjecture of diminishing marginal returns to labour inputs.

Table 5.1 / Aggregate country-level estimation results

	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) POLS	(7) GMM
Ln (Labour productivity), lag	-0.122***	-0.119***		-0.135***	-0.106***	-0.010***	-0.117**
	(0.021)	(0.019)		(0.022)	(0.020)	(0.002)	(0.047)
ΔLn (Labour services)	-0.333***		-0.397***	-0.327***	-0.356***	-0.325***	-0.282*
	(0.073)		(0.079)	(0.079)	(0.068)	(0.059)	(0.166)
Labour composition growth		-0.028					
		(0.151)					
ΔLn (Hours worked)		-0.378***					
		(0.072)					
ΔLn (Inward FDI stock), lag	-0.012	-0.011	-0.012	-0.013		-0.004	-0.011
	(0.007)	(0.008)	(0.008)	(0.008)		(0.007)	(0.035)
ΔLn (EconComp, real capital stock)	-0.039*	-0.031	-0.040		-0.029	-0.012	-0.099
	(0.020)	(0.021)	(0.024)		(0.020)	(0.025)	(0.073)
ΔLn (ICT, real capital stock)	0.055**	0.061***	0.045**		0.040**	0.031**	0.030
	(0.021)	(0.021)	(0.021)		(0.017)	(0.013)	(0.059)
ΔLn (NonICT, real capital stock)	-0.037	0.018	-0.063		-0.006	-0.002	0.119
	(0.122)	(0.103)	(0.120)		(0.114)	(0.096)	(0.323)
ΔLn (OInnProp, real capital stock)	-0.002	-0.003	-0.021		0.013	0.008	0.026
	(0.050)	(0.047)	(0.054)		(0.049)	(0.054)	(0.098)
ΔLn (RD, real capital stock)	0.046	0.041	0.057		0.041	0.020	0.014
	(0.039)	(0.039)	(0.044)		(0.033)	(0.035)	(0.084)
ΔLn (SoftDB, real capital stock)	0.085**	0.085***	0.091**		0.083***	0.091**	0.105*
	(0.031)	(0.029)	(0.035)		(0.027)	(0.036)	(0.060)
ΔLn (Labour productivity), lag							-0.043
							(0.185)
Constant	-0.370***	-0.362***	0.016***	-0.425***	-0.326***	-0.018*	-0.347**
	(0.066)	(0.061)	(0.004)	(0.074)	(0.068)	(0.009)	(0.145)
Country FE	Yes	Yes	Yes	Yes	Yes	No	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	216	216	216	248	262	216	76
Adj. R-squared	0.581	0.593	0.521	0.495	0.589	0.468	

Note: The table shows the estimation results using fixed effects ('FE') with standard errors clustered by country (in parentheses), as well as pooled OLS ('POLS') and system GMM ('GMM') based on 3-year non-c averages. The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels, respectively.

We also run estimations separately for the pre-crisis and post-crisis periods, as well as the full period, excluding the crisis years (for the purposes of the analysis the crisis years are defined as the period of 2007-2009, which covers the periods of real economic growth decline and post-crisis recovery). The

results are reported in Table 5.2. The exclusion of the crisis years has virtually no effect on the estimates. At the same time, examining separately the pre-crisis and the post-crisis periods, while the tangible ICT capital variable does not enter statistically significantly in both periods, the impact of intangible ICT (SoftDB) still manifests with the estimated marginal effect somewhat lower after the crisis (0.06, as opposed to 0.11 for the pre-crisis period). One should however note that the number of observations available for the pre-crisis period is not high at 59 and thus the results are not robust.

Complementing the results with aggregate capital asset groups, we also estimate the model using the fourteen detailed capital asset types (the classification in line with the EU KLEMS 2019 release in the Appendix Figure B1). The results are reported in the Appendix B Table B6. Consistent with the baseline results using broad capital groups, the estimates suggest that the CT and SoftDB capital facilitate labour productivity (IT capital is however not significant). The marginal effects are also similar: a 1 pp increase in the growth of real capital stock induces an increase in real labour productivity growth of 0.05 pp. in the case of IT capital and 0.06 pp. in the case of SoftDB capital.

Table 5.2 / Pre-crisis and the post-crisis periods

	(1) all years	(2) pre-crisis	(3) post-crisis	(4) all years, excl. crisis
Ln (Labour productivity), lag	-0.122***	-0.082	-0.198***	-0.112***
	(0.021)	(0.092)	(0.056)	(0.021)
ΔLn (Labour services)	-0.333***	-0.433**	-0.354***	-0.338***
	(0.073)	(0.176)	(0.115)	(0.078)
ΔLn (EconComp, real capital stock)	-0.039*	-0.064	-0.031	-0.082**
	(0.020)	(0.088)	(0.034)	(0.034)
ΔLn (ICT, real capital stock)	0.055**	0.004	0.073	0.058***
	(0.021)	(0.015)	(0.043)	(0.020)
ΔLn (NonICT, real capital stock)	-0.037	0.108	0.107	-0.108
	(0.122)	(0.155)	(0.165)	(0.107)
ΔLn (OInnProp, real capital stock)	-0.002	-0.084	-0.073	0.002
	(0.050)	(0.150)	(0.061)	(0.060)
ΔLn (RD, real capital stock)	0.046	0.030	-0.018	0.018
	(0.039)	(0.094)	(0.040)	(0.034)
ΔLn (SoftDB, real capital stock)	0.085**	0.108*	0.060**	0.098***
	(0.031)	(0.057)	(0.024)	(0.025)
ΔLn (Inward FDI stock), lag	-0.012	-0.010	0.003	-0.008
	(0.007)	(0.008)	(0.007)	(0.007)
Constant	-0.370***	-0.232	-0.626***	-0.337***
	(0.066)	(0.293)	(0.187)	(0.067)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	216	59	117	176
Adj. R-squared	0.581	0.368	0.594	0.574

Note: The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels, respectively. Baseline specification is estimated for the full sample including all years, i.e. 2000-2017 (column 1), the period 2000-2006 (pre-crisis), the period 2010-2017 (post-crisis) and the full sample excluding the crisis years, including the post-crisis recovery period (2007-2009).

5.3. ESTIMATION RESULTS: FURTHER INQUIRY INTO THE INTEGRATION EFFECTS

In this section we present additional results focusing on the effects of GVC participation, European economic integration, as well as exploring in more detail the implications of FDI for labour productivity as the baseline estimation results did not reveal any significant impact despite expectations. The results are reported in Table 5.3 and additional regressions with alternative FDI measures and interaction terms are reported in the Appendix Table B5.

Table 5.3 / The impact of GVC participation and EU membership

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Ln (Labour productivity), lag	-0.120***	-0.120***	-0.129***	-0.121***	-0.121***	-0.148***	-0.148***
	(0.025)	(0.026)	(0.026)	(0.027)	(0.021)	(0.029)	(0.029)
ΔLn (Labour services)	-0.339***	-0.339***	-0.336***	-0.347***	-0.334***	-0.342***	-0.342***
	(0.076)	(0.075)	(0.080)	(0.075)	(0.077)	(0.076)	(0.076)
ΔLn (EconComp, real capital stock)	-0.042	-0.042	-0.042	-0.044	-0.039*	-0.027	-0.027
	(0.028)	(0.028)	(0.026)	(0.028)	(0.020)	(0.022)	(0.022)
ΔLn (ICT, real capital stock)	0.043**	0.043**	0.043**	0.039*	0.055**	0.060**	0.060**
	(0.019)	(0.019)	(0.019)	(0.019)	(0.021)	(0.021)	(0.021)
ΔLn (NonICT, real capital stock)	0.036	0.036	0.015	0.048	-0.034	-0.050	-0.050
	(0.131)	(0.131)	(0.128)	(0.123)	(0.124)	(0.126)	(0.126)
ΔLn (OInnProp, real capital stock)	-0.003	-0.002	-0.005	-0.005	-0.002	-0.002	-0.002
	(0.044)	(0.043)	(0.046)	(0.044)	(0.049)	(0.049)	(0.049)
ΔLn (RD, real capital stock)	0.056	0.056	0.054	0.053	0.046	0.036	0.036
	(0.040)	(0.040)	(0.039)	(0.041)	(0.040)	(0.037)	(0.037)
ΔLn (SoftDB, real capital stock)	0.075**	0.075**	0.082**	0.070**	0.085**	0.081**	0.081**
	(0.032)	(0.033)	(0.032)	(0.033)	(0.032)	(0.029)	(0.029)
FDI = ΔLn (Inward FDI stock), lag	-0.014*	-0.014*	-0.013	-0.009	-0.012	-0.012	-0.012
	(0.008)	(0.008)	(0.008)	(0.009)	(0.007)	(0.007)	(0.007)
Δ Backward GVC, lag	0.200**	0.204**		0.237**			
	(0.085)	(0.076)		(0.091)			
Δ Forward GVC, lag	-0.017		-0.139	-0.108			
	(0.155)		(0.146)	(0.179)			
FDI × Δ Backward GVC , lag				-0.083			
				(0.461)			
FDI × Δ Forward GVC, lag				1.664			
				(1.001)			
FDI × Transition economy DV, lag					0.003		
					(0.016)		
EU membership DV						0.015**	0.015**
						(0.006)	(0.006)
Years in the EU							0.006*
							(0.003)
Constant	-0.366***	-0.365***	-0.395***	-0.368***	-0.367***	-0.468***	-0.664***
	(0.079)	(0.081)	(0.080)	(0.083)	(0.067)	(0.096)	(0.163)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	193	193	193	193	216	216	216
Adj. R-squared	0.601	0.603	0.594	0.604	0.579	0.585	0.585

Note: The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels, respectively. 'FDI' in the interaction terms refers to real inward FDI stock in log-differences, i.e. ΔLn (Inward FDI stock).

Across all specifications the marginal effect of ICT and SoftDB remains significant. We first examine the impact of backward and forward GVC participation on productivity. While forward GVC integration does not reveal any impact, backward GVC participation enters significantly with the marginal impact of 0.2, which implies that an increase in the growth of backward GVC participation by 0.1 induces a 2 percentage point increase in the growth of aggregate labour productivity.[7] It is intuitive that participation in global value chains provides an opportunity for productivity gains due to knowledge spillovers from MNEs and efficiency gains associated with greater specialisation in certain tasks. In this respect the results highlight the important difference in the relative gains associated with the mode of GVC participation, i.e. specialisation in relatively more downstream industries as picked up by the backward GVC participation measure, as firms are able to take advantage of imported inputs of superior quality and at lower costs, and, in general, greater available variety of foreign inputs.

GVC integration is closely related to FDI as both are coordinated by MNEs. Therefore, we also assess the possible interaction between FDI and GVC participation. The impact of FDI is nevertheless not found to be significant, consistent with the baseline model results. A battery of additional checks (selected results are reported in the Appendix Table B5) does not reveal FDI effects at statistically significant levels. In particular, we check alternative measures of FDI, including inward FDI stocks and flows taken as a share of GDP and using deeper lags to pick up a possibly delayed effect of FDI on the real economy along and further alleviating possible endogeneity issues. Although the literature suggests that the impact of FDI may be conditional on the absorptive capacity of the host country, we also do not find support for this conjecture as the inclusion of interaction terms (education attainment variables, human capital, control of corruption, government effectiveness, financial development variables) does not yield statistically significant results.[8]

Finally, we augment the model with the EU dummy variable that takes the value of unity if the country is an EU member in year t and is zero otherwise. Additionally, the variable measuring the total number of years in the EU of a given country is introduced to gauge the possible non-linear effects associated with the intensity of integration.[9] Notably, both variables enter statistically significantly implying that the EU membership boosts labour productivity growth by 1.5 percentage points, with each year in the bloc bringing an additional increase of 0.6 pp, ceteris paribus, i.e. in addition to the general convergence effects.

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7 For reference, backward GVC participation measure by construction is contained in the (0; 1) interval. In this respect a change in the backward GVC participation of the magnitude of 0.1 is a significant increase: de facto backward GVC participation for the sample under consideration varies from 0.09 (USA) to 0.52 (Hungary); the sample year-on-year change in the backward GVC participation varies from -0.05 to +0.04 with the mean of 0.005.

8 Estimating a model separately for the subsample of Central, Eastern and Southeastern European countries yields a positive impact of FDI when using FDI as a share of GDP and not controlling for the capital asset types. This result, however, is not robust given that FDI-to-GDP share is a trending variable and omission of capital variables introduces an omitted variable bias.

9 To this end we use the years of entry per each country starting from the Treaties of Rome (i.e. the year 1958) as listed by the European Commission on the EU portal: https://europa.eu/european-union/about-eu/countries_en#tab-0-1.

6. Evidence from the sectoral analysis

6.1. MODEL SETUP

In order to address the possible aggregation bias and investigate heterogeneous effects of digital capital and other variables of interest across sectors, we perform separate estimations for each of the twenty five sectors as outlined in Section 2 (sector 20_POST lacks sufficient capital asset data and is therefore omitted in the sectoral analysis), as well as run pooled estimations with the primary, the manufacturing and the services sector groups.

For sector-specific analysis we use a specification similar to the baseline aggregate country-level model with the following adjustments made:

$$\Delta \ln PROD_{cjt} = \alpha_1 \ln PROD_{cjt-1} + \alpha_2 \ln L_{cjt} + \sum_{q \in Q} \beta_q \Delta \ln K_{qcjt} + \sigma \Delta \ln FDI_{cjt-1} + \boldsymbol{\xi} \mathbf{X_{cjt}} + \boldsymbol{\mu_{cj}} + \varepsilon_{cjt}$$

where $\Delta \ln PROD_{cjt}$ is the measure of labour productivity in country c, sector j (real value added per hour worked), in log-differenced form; $\ln PROD_{cjt-1}$ is lagged real labour productivity; $\Delta \ln L_{cjt}$ is the growth of labour services (alternatively, the growth of the hours worked and the change in the labour composition). $\Delta \ln K_{qcjt}$ denotes the measure of capital inputs: real capital stocks in log-differences (i.e. real growth rates of capital by asset types), in alternative specifications — real capital stocks as a share of employed (in log-differences), capital services growth rates, capital-to-sector value added ratios. $\Delta \ln FDI_{cjt-1}$ is the FDI variable: real inward FDI stock in log-differences in the baseline specification; in alternative specifications — inward FDI stock as a share of employed (in log-differences) or inward FDI as a share of value added. $\mathbf{X_{cjt}}$ and $\boldsymbol{\mu_{cj}}$ are the vectors of control variables and the fixed effects, respectively. For the pooled estimations for the primary sectors (SEC 1-2), the manufacturing sectors (SEC 3-13) and the services sectors (SEC 14-26), as well as the all-sector pooled sample the model is estimated with several alternative vectors of fixed effects for robustness, including country-sector and year effects, country-sector and sector-year fixed effects, country-sector and country-year fixed effects. In pooled sectoral estimations standard errors are clustered at the country-sector level.

Similarly to the aggregate country-level regression analysis, in the baseline analysis we drop observations that are outside of the two-standard deviation interval from the sector-specific sample mean for the main variables of interest (labour productivity, FDI and capital growth rates) as the marginal impact of outlier values is even greater at the sectoral level biasing the estimates.

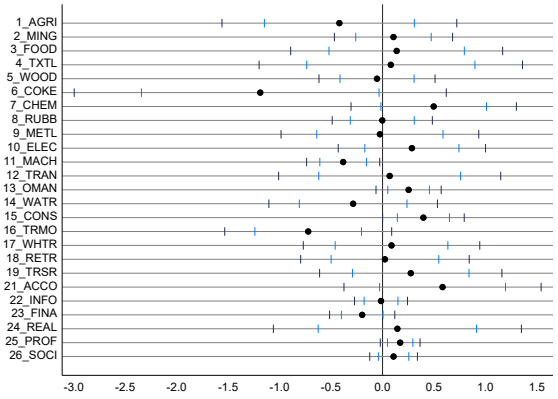
6.2. ESTIMATION RESULTS

We first run individual estimations for each sector in the analysis using the baseline fixed effects model regressing real labour productivity growth on real inward FDI stock growth lagged by one year, real capital stock growth (by capital asset aggregates) and control variables as described in the previous subsection.

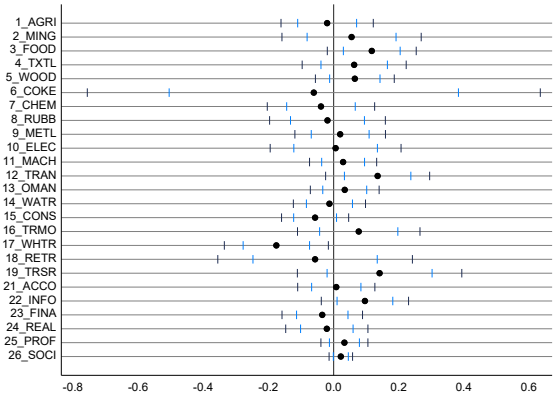
For convenience, the marginal effects for each capital asset aggregate and the FDI variable are reported in Figure 6.1 for each sector considered (as noted above, the analysis excludes sector 20, for which the available capital asset data is not sufficient for econometric analysis). In addition, the 99% and 90% confidence intervals computed from the robust standard errors are plotted along with the marginal effects to gauge both the statistical and the economic significance of the estimates. The corresponding regression results are reported in Table 6.1. In order to allow for the possibility of a delayed impact on productivity, we additionally explore deeper lags of the FDI variable: the results with the 3-year lags are also included in Figure 6.1. Using capital services growth rates instead of real capital stock growth yields largely identical results, as well as specifications with real inward FDI and real capital stocks by asset groups taken as a share of employed. The latter results exhibit a few differences in comparison with the baseline model and are thus reported in the Appendix Tables C2 and C3 with the FDI variable lagged by 1 and 3 years, 'respectively'.

Figure 6.1 / Marginal impact of FDI, ICT and non-ICT capital on labour productivity by sector

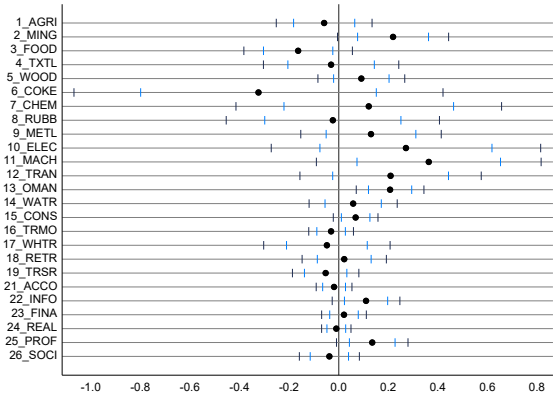
NonICT



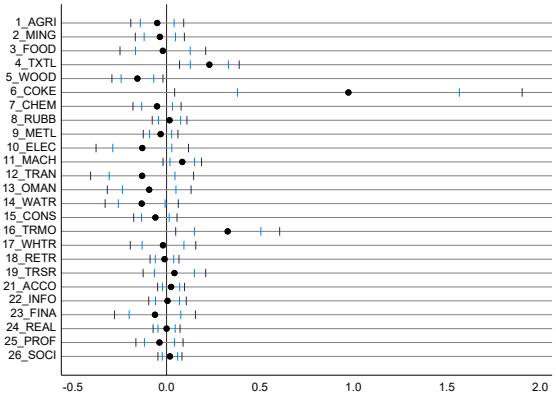
ICT



RD



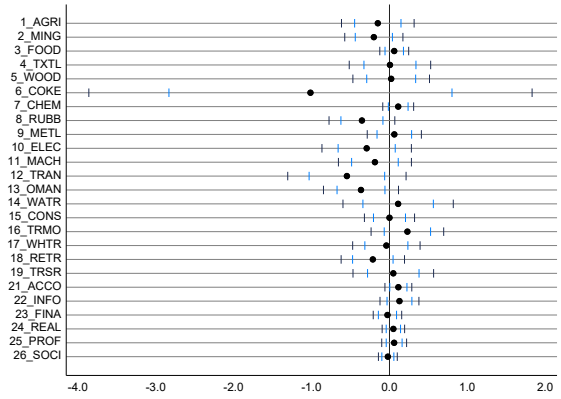
SoftDB



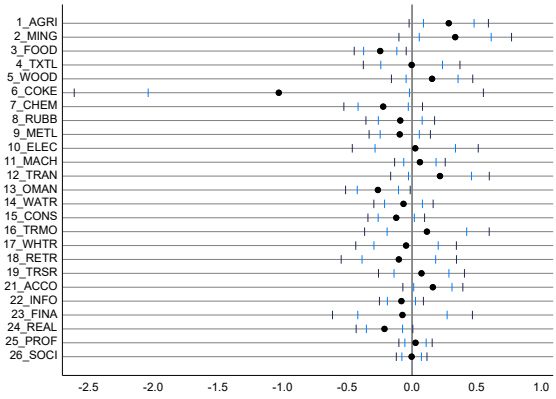
ctd.

Figure 6.1 / (cont.)

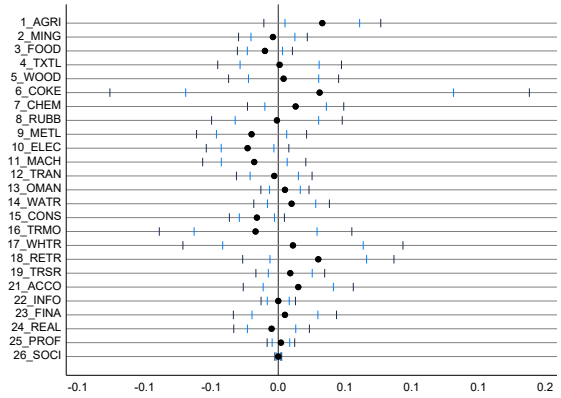
OInnProp



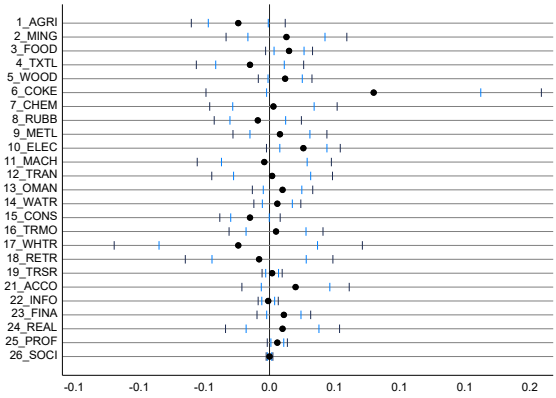
EconComp



Inward FDI stock (1-year lag)



Inward FDI stock (3-year lag)



Note: The figure shows the average estimated marginal impact of capital (by aggregate capital asset groups) and inward FDI stock on real labour productivity growth, along with the 90% and 99% confidence intervals (indicated light and dark blue bars, respectively). Capital and FDI variables are real stocks (2010 USD) in log-differences. The regression results associated with the estimates are reported in Appendix Table B1 (Panel B1-A for the six capital asset and FDI 3-year lag estimates and Panel B1-B for the FDI 1-year lag estimates). Sector 20_POST lacks sufficient observations for robust estimations (omitted).
Source: own calculations.

Summarising the estimation results across various empirical exercises, consistent with aggregate country results, labour services growth is associated with lower labour productivity on account of the hours worked component embedded in the labour services variable. Across all sectors the convergence effects can also be observed as picked up by the negative and in most cases statistically significant coefficients of the lagged real labour productivity level variable.[10]

We generally do not find a strong impact of inward FDI on labour productivity. The positive effects manifest themselves only for some sectors at deeper lags. At the 1-year lag, the weakly statistically significant — at the 10-percent level of statistical significance — impact of FDI is observed only for

[10] In both aggregate country analysis and sector estimations deeper lags of the productivity level variables were also checked for robustness, yielding very similar results.

sector 1_AGRI (positive effect), and for sectors 10_ELEC and 15_CONS (negative effects). Estimations with alternative FDI measures yield similar results (see Table C2). A more robust positive impact of FDI, however, can be detected at the 3-year lag for sectors 3_FOOD, 10_ELEC and 25_PROF. In all cases, however, the magnitudes of the effects are small: the highest marginal effect of 0.03 is found for sectors 1_AGRO (at the 1-year lag) and 10_ELEC (at the 3-year lag), which implies that a 1 percentage point increase in the growth of real inward FDI stock leads to a 0.03 pp increase in real labour productivity growth.

By contrast, the impact of capital accumulation on labour productivity is much more profound, although the impact varies significantly both across sectors and capital asset types. Examining first the impacts of non-ICT capital asset types, notably, in the case of the primary sectors, 1_AGRI and 2_MING, investment in EconComp facilitates labour productivity with the estimated magnitude of about 0.3 statistically significant at the 5-10% level.[11] For a number of manufacturing and services sectors the impact of EconComp however is negative with the magnitudes in the 0.2-0.3 range (especially for sectors 3_FOOD and 13_OMAN, as well as 7_CHEM and 24_REAL). NonICT capital enters significantly with a positive sign for 13_OMAN, 15_CONS and 25_PROF sectors.

RD capital, besides the mining sector 2_MING, is found to be conducive to labour productivity growth in technologically advanced manufacturing and services sectors: 11_MACH, 13_OMAN, 22_INFO and 25_PROF. The results are particularly noteworthy for sectors 11_MACH and 25_PROF, which are characterised by relatively high average intensity of RD capital in total capital stock of the sector.[12]

Turning attention to ICT capital, the positive impact of tangible ICT capital accumulation (ICT capital asset group) is found for sectors 3_FOOD and 12_TRAN. Among the services sectors, the significant effect (although only at the 10% level) is found for the sector 22_INFO, which is in line with expectations as the provision of information and communication services heavily relies on tangible and intangible ICT capital. In all three cases the magnitude of the effect is about 0.1. At the same time, notably, the impact of intangible ICT capital (SoftDB capital asset group) is much more profound, with especially strong positive effects in terms of both statistical and economic significance observed in sectors 4_TXTL, 16_TRMO and 6_COKE. In the latter case the magnitude is particularly high, implying almost a 1-to-1 increase in labour productivity growth associated with the growth in the SoftDB capital. SoftDB capital also enters positively for the sector 11_MACH, but the effect is less significant statistically and in terms of economic significance (the estimate varies in the range of 0.08-0.1 across specifications). Surprisingly, intangible ICT also has a negative impact on sector 5_WOOD. Overall, the results observed across all specifications do not reveal strong systematic patterns across sectoral groups; while the high-tech sectors and sectors involved in the provision of information and communication services tend to exhibit more consistent positive response of productivity growth to ICT and RD capital, the impact of capital composition varies significantly and is specific to each sector.

Nevertheless, as a final exercise, we also run pooled sectoral estimations with appropriate fixed effects included to control for year, country and sector effects, pooling across all sectors, as well as separately

[11] This holds for specifications involving the real capital stock and the alternative capital-to-labour ratio variable.

[12] More generally, the RD-capital intensive sectors with the average share of RD capital in total capital stock of at least 10% are the high-tech manufacturing sectors involved in the production of machinery and electronics (SEC10, SEC11, SEC 12) and chemical/pharmaceutical products (7_CHEM), as well as SEC25 (professional services). See Table A2 in the Appendix for a review of capital composition by sectors.

for the primary, manufacturing and services sectors (Table 6.2). In the case of the all-sector pooled estimation results SoftDB is positive, but only marginally significant (up to 5% level of statistical significance) with the marginal effect low at 0.03. For other capital assets the impacts are small in magnitude and/or statistically weakly significant or insignificant. Splitting the sample into sector groups however yields more interesting outcomes. The primary sector reveals a positive effect of RD and EconComp capital asset groups on labour productivity with the marginal effects of 0.1 and 0.3, respectively. In the manufacturing sector group both EconComp and OInnProp capital growth have a negative productivity impact, while, notably, RD and SoftDB capital asset groups enter positively with the statistical significance of 1-5%. Estimates suggest that a 1-pp increase in real capital growth boosts labour productivity growth by about 0.1 pp in the case of SoftDB and 0.2 pp. in the case of RD. Finally, the pooled services sector group does not reveal any significant effects associated with capital accumulation. Consistent with the aggregate country-level and sector-specific results, in all cases the FDI variable is not significant.

Table 6.1 / Drivers of labour productivity: regressions with real capital and real inward FDI stock (1-year lag) growth rates

	1_AGRI	2_MING	3_FOOD	4_TXTL	5_WOOD	6_COKE	7_CHEM	8_RUBB	9_METL	10_ELEC	11_MACH	12_TRAN	13_OMAN
Ln (Labour productivity), lag	-0.211***	-0.099***	-0.163*	-0.404***	-0.092**	-0.222*	-0.231*	-0.370***	-0.163**	-0.108*	-0.195***	-0.432***	-0.165**
	(0.050)	(0.031)	(0.085)	(0.060)	(0.040)	(0.108)	(0.115)	(0.057)	(0.061)	(0.061)	(0.039)	(0.071)	(0.060)
ΔLn (Labour services)	-0.478	-0.299***	-0.413*	-0.873***	-0.350*	0.536	-0.349*	-0.113	-0.325	-0.168	-0.386*	0.261*	-0.512***
	(0.273)	(0.060)	(0.209)	(0.194)	(0.163)	(0.744)	(0.186)	(0.155)	(0.186)	(0.189)	(0.201)	(0.133)	(0.143)
ΔLn (EconComp, real capital stock)	0.284**	0.334*	-0.246***	-0.003	0.155	-1.030	-0.223*	-0.091	-0.095	0.025	0.061	0.216	-0.264**
	(0.119)	(0.169)	(0.078)	(0.145)	(0.122)	(0.614)	(0.118)	(0.103)	(0.092)	(0.189)	(0.076)	(0.148)	(0.097)
ΔLn (ICT, real capital stock)	-0.020	0.055	0.117**	0.063	0.065	-0.061	-0.039	-0.019	0.020	0.006	0.029	0.135**	0.034
	(0.055)	(0.083)	(0.053)	(0.062)	(0.047)	(0.270)	(0.064)	(0.069)	(0.054)	(0.078)	(0.040)	(0.062)	(0.041)
ΔLn (NonICT, real capital stock)	-0.420	0.106	0.137	0.080	-0.054	-1.189	0.497	-0.003	-0.026	0.285	-0.383**	0.069	0.253*
	(0.443)	(0.223)	(0.400)	(0.497)	(0.219)	(0.702)	(0.312)	(0.189)	(0.373)	(0.278)	(0.138)	(0.419)	(0.123)
ΔLn (OInnProp, real capital stock)	-0.150	-0.201	0.061	0.006	0.022	-1.015	0.112	-0.354*	0.062	-0.293	-0.187	-0.547*	-0.366*
	(0.181)	(0.145)	(0.072)	(0.203)	(0.191)	(1.105)	(0.077)	(0.164)	(0.135)	(0.223)	(0.182)	(0.295)	(0.187)
ΔLn (RD, real capital stock)	-0.059	0.219**	-0.164*	-0.031	0.091	-0.324	0.121	-0.024	0.130	0.271	0.363*	0.209	0.207***
	(0.075)	(0.087)	(0.085)	(0.106)	(0.068)	(0.289)	(0.208)	(0.167)	(0.110)	(0.211)	(0.176)	(0.142)	(0.053)
ΔLn (SoftDB, real capital stock)	-0.050	-0.036	-0.020	0.229***	-0.156**	0.973**	-0.051	0.016	-0.032	-0.130	0.084*	-0.131	-0.093
	(0.055)	(0.051)	(0.089)	(0.062)	(0.053)	(0.361)	(0.050)	(0.036)	(0.036)	(0.096)	(0.040)	(0.107)	(0.087)
ΔLn (Inward FDI, real stock), lag	0.033*	-0.004	-0.010	0.001	0.004	0.031	0.013	-0.001	-0.020	-0.023*	-0.018	-0.003	0.005
	(0.017)	(0.010)	(0.008)	(0.018)	(0.016)	(0.061)	(0.014)	(0.019)	(0.016)	(0.012)	(0.015)	(0.011)	(0.007)
Constant	-0.858***	-0.305***	-0.460	-1.399***	-0.284*	-0.426*	-0.463*	-1.070***	-0.455**	-0.222	-0.552***	-1.103***	-0.492**
	(0.201)	(0.085)	(0.262)	(0.209)	(0.135)	(0.226)	(0.253)	(0.166)	(0.200)	(0.175)	(0.124)	(0.169)	(0.199)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	100	153	132	106	104	76	122	109	138	120	136	113	109
Adj. R-squared	0.268	0.270	0.308	0.517	0.222	0.347	0.130	0.464	0.350	0.389	0.567	0.565	0.642

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table 6.1 / (cont.)

	14_WATR	15_CONS	16_TRMO	17_WHTR	18_RETR	19_TRSR	21_ACCO	22_INFO	23_FINA	24_REAL	25_PROF	26_SOCI
Ln (Labour productivity), lag	-0.198***	-0.144**	-0.189**	-0.124	-0.358**	-0.440***	-0.266***	-0.071*	-0.188**	-0.268**	-0.106***	-0.140**
	(0.061)	(0.052)	(0.073)	(0.101)	(0.096)	(0.097)	(0.065)	(0.034)	(0.073)	(0.092)	(0.030)	(0.057)
ΔLn (Labour services)	-0.506***	-0.321**	-0.253	0.178	-0.531**	-0.178	-0.215	-0.400***	-0.207**	-0.199	-0.398***	-0.318**
	(0.103)	(0.139)	(0.146)	(0.441)	(0.180)	(0.154)	(0.238)	(0.112)	(0.094)	(0.125)	(0.092)	(0.125)
ΔLn (EconComp, real capital stock)	-0.066	-0.122	0.115	-0.046	-0.102	0.073	0.161*	-0.082	-0.074	-0.213**	0.027	-0.003
	(0.089)	(0.085)	(0.187)	(0.151)	(0.173)	(0.129)	(0.090)	(0.066)	(0.210)	(0.085)	(0.050)	(0.046)
ΔLn (ICT, real capital stock)	-0.013	-0.057	0.077	-0.176**	-0.057	0.141	0.008	0.096*	-0.035	-0.021	0.033	0.022
	(0.043)	(0.040)	(0.073)	(0.062)	(0.116)	(0.098)	(0.046)	(0.052)	(0.048)	(0.049)	(0.028)	(0.014)
ΔLn (NonICT, real capital stock)	-0.286	0.397**	-0.723*	0.087	0.023	0.274	0.583	-0.015	-0.198	0.144	0.171**	0.107
	(0.318)	(0.154)	(0.315)	(0.333)	(0.318)	(0.344)	(0.372)	(0.100)	(0.123)	(0.468)	(0.075)	(0.090)
ΔLn (OInnProp, real capital stock)	0.111	-0.000	0.230	-0.040	-0.214	0.049	0.114	0.128	-0.026	0.050	0.060	-0.021
	(0.275)	(0.125)	(0.181)	(0.168)	(0.158)	(0.201)	(0.067)	(0.097)	(0.071)	(0.056)	(0.062)	(0.047)
ΔLn (RD, real capital stock)	0.058	0.068*	-0.031	-0.048	0.022	-0.053	-0.019	0.110*	0.021	-0.010	0.135**	-0.038
	(0.069)	(0.035)	(0.035)	(0.099)	(0.066)	(0.052)	(0.028)	(0.053)	(0.035)	(0.023)	(0.056)	(0.047)
ΔLn (SoftDB, real capital stock)	-0.133	-0.060	0.327**	-0.019	-0.011	0.042	0.024	0.005	-0.062	0.000	-0.038	0.018
	(0.076)	(0.045)	(0.108)	(0.068)	(0.030)	(0.065)	(0.028)	(0.039)	(0.084)	(0.028)	(0.049)	(0.025)
ΔLn (Inward FDI, real stock), lag	0.010	-0.016*	-0.017	0.011	0.030	0.009	0.015	-0.000	0.005	-0.005	0.002	0.000
	(0.011)	(0.008)	(0.028)	(0.032)	(0.022)	(0.010)	(0.016)	(0.005)	(0.015)	(0.011)	(0.004)	(0.001)
Constant	-0.487***	-0.469**	-0.563*	-0.313	-1.211**	-1.362***	-1.064***	-0.164*	-0.434**	-0.290***	-0.341***	-0.483**
	(0.150)	(0.175)	(0.225)	(0.293)	(0.329)	(0.311)	(0.241)	(0.089)	(0.190)	(0.095)	(0.109)	(0.198)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	152	151	47	68	54	72	106	163	158	112	162	152
Adj. R-squared	0.304	0.362	0.713	0.292	0.557	0.461	0.283	0.450	0.0943	0.446	0.477	0.283

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table 6.2 / Regressions with pooled sectors

	Primary sectors SEC 1-2		Manufacturing sectors SEC 3-13		Services sectors SEC 14-26		All sectors SEC 1-26	
Ln (Labour productivity), lag	-0.106***	-0.111***	-0.113	-0.095	-0.127***	-0.148***	-0.104*	-0.098*
	(0.029)	(0.030)	(0.074)	(0.070)	(0.024)	(0.022)	(0.054)	(0.051)
ΔLn (Inward FDI stock)	0.004	0.003	-0.000	-0.005	-0.003	-0.001	-0.002	-0.001
	(0.007)	(0.010)	(0.012)	(0.011)	(0.002)	(0.002)	(0.004)	(0.004)
ΔLn (EconComp, real capital stock)	0.311**	0.315**	-0.292**	-0.216***	-0.054	-0.060	-0.124*	-0.084
	(0.133)	(0.142)	(0.114)	(0.071)	(0.039)	(0.044)	(0.068)	(0.058)
ΔLn (ICT, real capital stock)	0.028	0.037	0.016	0.020	-0.010	-0.005	0.015	0.013
	(0.047)	(0.063)	(0.038)	(0.034)	(0.015)	(0.013)	(0.014)	(0.012)
ΔLn (NonICT, real capital stock)	-0.002	0.005	-0.181	-0.223	0.006	-0.008	-0.069	-0.114
	(0.204)	(0.221)	(0.178)	(0.229)	(0.052)	(0.056)	(0.094)	(0.133)
ΔLn (OInnProp, real capital stock)	-0.193	-0.201	-0.332*	-0.251**	0.048	0.062	-0.148*	-0.091
	(0.142)	(0.139)	(0.163)	(0.115)	(0.036)	(0.038)	(0.078)	(0.063)
ΔLn (RD, real capital stock)	0.121*	0.148**	0.233**	0.185***	-0.013	-0.004	0.035	0.037**
	(0.062)	(0.067)	(0.088)	(0.058)	(0.009)	(0.014)	(0.021)	(0.015)
ΔLn (Soft_DB, real capital stock)	-0.038	-0.031	0.097**	0.119***	0.006	-0.005	0.030	0.034**
	(0.049)	(0.046)	(0.035)	(0.039)	(0.023)	(0.014)	(0.018)	(0.013)
ΔLn (Labour services)	-0.291***	-0.309***	-0.143	-0.287*	-0.271***	-0.330***	-0.201***	-0.310***
	(0.075)	(0.067)	(0.155)	(0.144)	(0.070)	(0.079)	(0.056)	(0.062)
Constant	-0.285**	-0.306***	-0.319	-0.262	-0.356***	-0.417***	-0.302*	-0.268
	(0.099)	(0.087)	(0.231)	(0.200)	(0.073)	(0.064)	(0.169)	(0.159)
Country-sector FE	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes		yes		yes		yes	
Sector-year FE		yes		yes		yes		yes
Observations	253	253	1,265	1,265	1,414	1,414	2,932	2,932
Adj. R-squared	0.313	0.376	0.214	0.397	0.219	0.417	0.141	0.367

Note: The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). The dependent variable is real labour productivity (per hour worked) in log-differences. *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

7. Policy implications and concluding remarks

Accelerating productivity growth has been a major challenge in the post-crisis period. It is an especially important issue in the context of feeble economic growth in the EU and is increasingly seen by policymakers as a means to foster sustainable long-run economic development. The double-dip recession indeed resulted in a deep structural slowdown in the growth dynamics coupled with weak macroeconomic outlook at least in the medium run.

In this regard, given the paramount importance of productivity as a source of competitiveness and ultimately a vehicle for sustained development, it is critical to revisit its drivers in light of the recent developments, including trade and investment integration, also manifesting itself in the rise of global value chains, the growing importance of ICT technologies and rapid broad-based digitalisation. Our analysis shows an especially important role of ICT capital accumulation, and, hitherto not quantified empirically, a robust superior role of digital capital as measured by the intangible capital comprising the SoftDB asset class. In fact, it is the only capital asset type that manifests strongly as a driver of productivity across multiple empirical exercises at the sectoral and aggregate levels. Therefore, fostering infrastructure necessary to facilitate a more efficient allocation of investment with an emphasis on ICT capital, both tangible and intangible, facilitating technology absorption and digitalisation by the real economy seems to be a pragmatic way forward in the efforts to improve structural conditions, which applies not only to the EU, but more generally to economies both advanced and developing. This is yet more important given that ICT capital affects the entire economy, i.e. constitutes a general purpose technology.

As regards the latter, the paper finds that integration in value chains and more specifically, backward GVC integration, is another avenue to accelerate productivity. The causality in this respect goes in both directions with likely spillovers to other sectors along the distributed production chain. The analysis also supports the important transformational impact of EU integration for productivity growth, which may work through multiple channels, including regulatory convergence and upgrading of institutions, co-funding of infrastructure, efficiency gains due to a more efficient cross-border reallocation of productive resources. This underscores the importance of tackling the bottlenecks that still exist in Europe concerning regulatory inefficiencies along with high cross-country heterogeneity in the capacity to improve the necessary ‘framework conditions’ preventing effective generation of innovation and adoption of new technologies. Digitalisation represents a significant opportunity for the EU to accelerate the lacklustre productivity growth and thereby potential (structural) economic growth. At the same time, it is clear that it also represents a challenge given the global nature of competition nowadays and the rise of highly competitive peer economies. Nowadays the EU faces multiple challenges associated with geopolitical tensions, unresolved macroeconomic issues and has been already lagging in terms of innovation and digitalisation technology behind not only the US and Japan, but also the rapidly developing new competitors from Asia – China and South Korea. While Europe seems to have all the necessary ingredients to boost innovation and innovation-driven productivity, including skilled workforce, strong institutions and research infrastructure, more efforts are clearly needed to mobilise them and channel to the real economy in order not to fall behind the peers in the new era of Industry 4.0.

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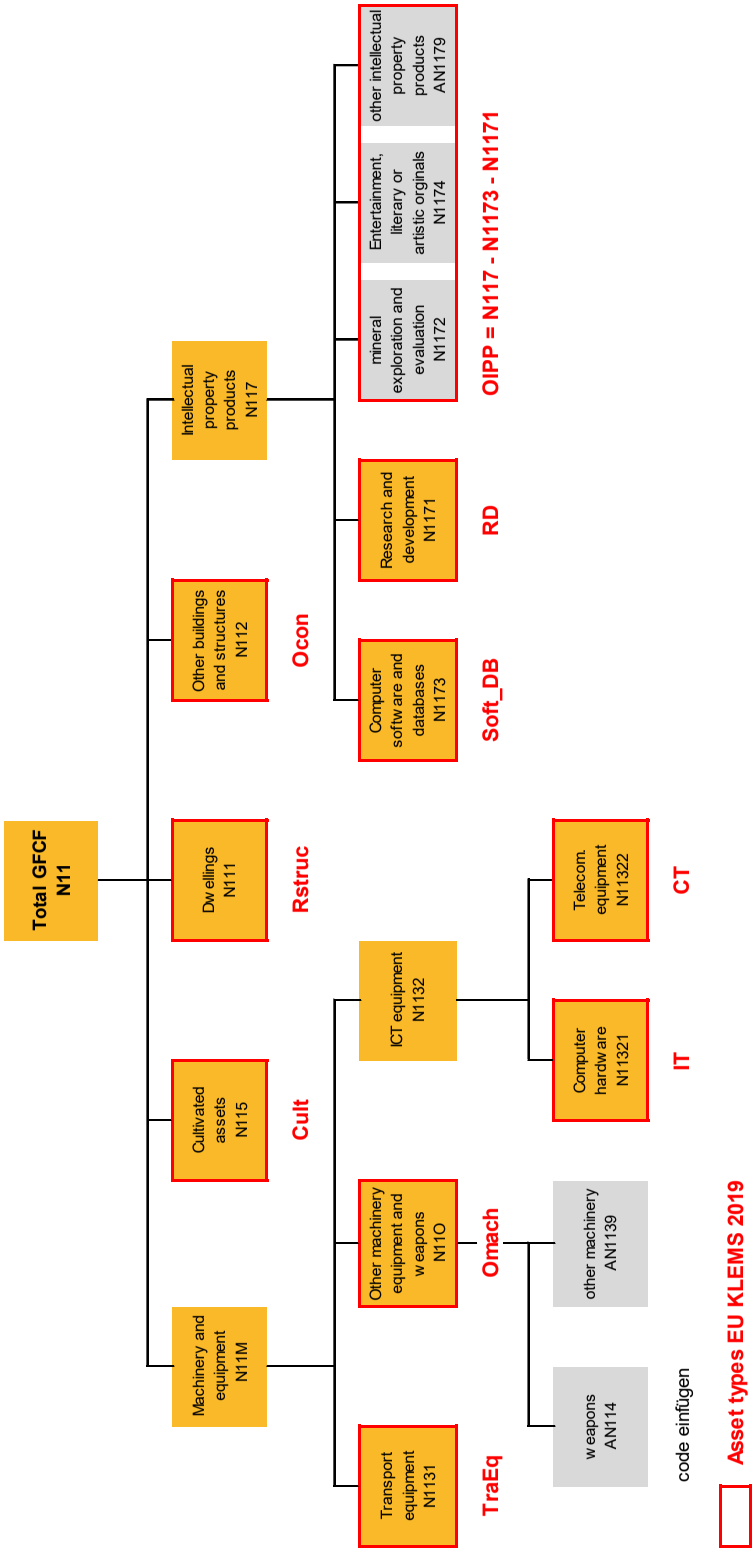
Appendix A: Summary statistics

Table A1 / Summary statistics for aggregate country-level variables

Variable	Variable description	N	mean	median	std. dev.	min	max
ΔLn (Labour productivity)	Growth of value added per hour worked, chain-linked 2010 USD	216	0.012	0.010	0.017	-0.032	0.068
Ln (Labour productivity)	Value added per hour worked, chain-linked 2010 USD	216	-3.215	-3.033	0.461	-4.438	-2.625
ΔLn (Inward FDI stock)	Growth of inward FDI stock, chain-linked 2010 USD	211	0.051	0.046	0.121	-0.272	0.319
ΔLn (Labour services)	Growth of labour services	216	0.008	0.010	0.022	-0.182	0.062
ΔLn (EconComp, real capital stock)	EconComp, chain-linked 2010 USD	216	0.030	0.026	0.047	-0.111	0.206
ΔLn (ICT, real capital stock)	ICT, chain-linked 2010 USD	216	0.041	0.042	0.056	-0.107	0.186
ΔLn (NonICT, real capital stock)	NonICT, chain-linked 2010 USD	216	0.011	0.010	0.013	-0.018	0.048
ΔLn (OInnProp, real capital stock)	OInnProp, chain-linked 2010 USD	216	0.020	0.027	0.035	-0.106	0.133
ΔLn (RD, real capital stock)	RD, chain-linked 2010 USD	216	0.025	0.022	0.032	-0.069	0.148
ΔLn (SoftDB, real capital stock)	SoftDB, chain-linked 2010 USD	216	0.037	0.036	0.045	-0.141	0.199
Labour composition growth	Labour composition growth	216	0.006	0.005	0.007	-0.021	0.032
ΔLn (Hours worked)	Growth of hours worked	216	0.002	0.005	0.022	-0.180	0.035
ΔLn (Inward FDI stock, share of employed)	Growth of inward FDI stock, chain-linked 2010 USD, as a share of employed	211	0.070	0.055	0.132	-0.263	0.414
Δ GVC_BWI	Change in backward GVC participation	179	0.005	0.003	0.016	-0.049	0.044
Δ GVC_FWI	Change in forward GVC participation	179	0.002	0.002	0.008	-0.030	0.022
Δ Control of corruption	Change in the WB WGI Control of corruption estimate	204	-0.008	-0.002	0.086	-0.287	0.242
Δ Governement effectiveness	Change in the WB WGI Government effectiveness estimate	204	-0.011	-0.007	0.120	-0.670	0.299
Labour force with advanced education	Labor force with advanced educ. (% of working-age population with adv. educ.)	207	79.038	78.243	3.791	73.250	89.974
Labour force with basic education	Labor force with basic educ. (% of total working-age population with basic ed.)	205	38.729	37.631	11.679	13.960	68.337
Δ Private credit-to-GDP	Change in private credit by deposit money banks, % of GDP	205	0.480	0.135	6.525	-18.350	26.370
Δ Human capital index	Change in the human capital index	216	0.015	0.016	0.007	0.002	0.050

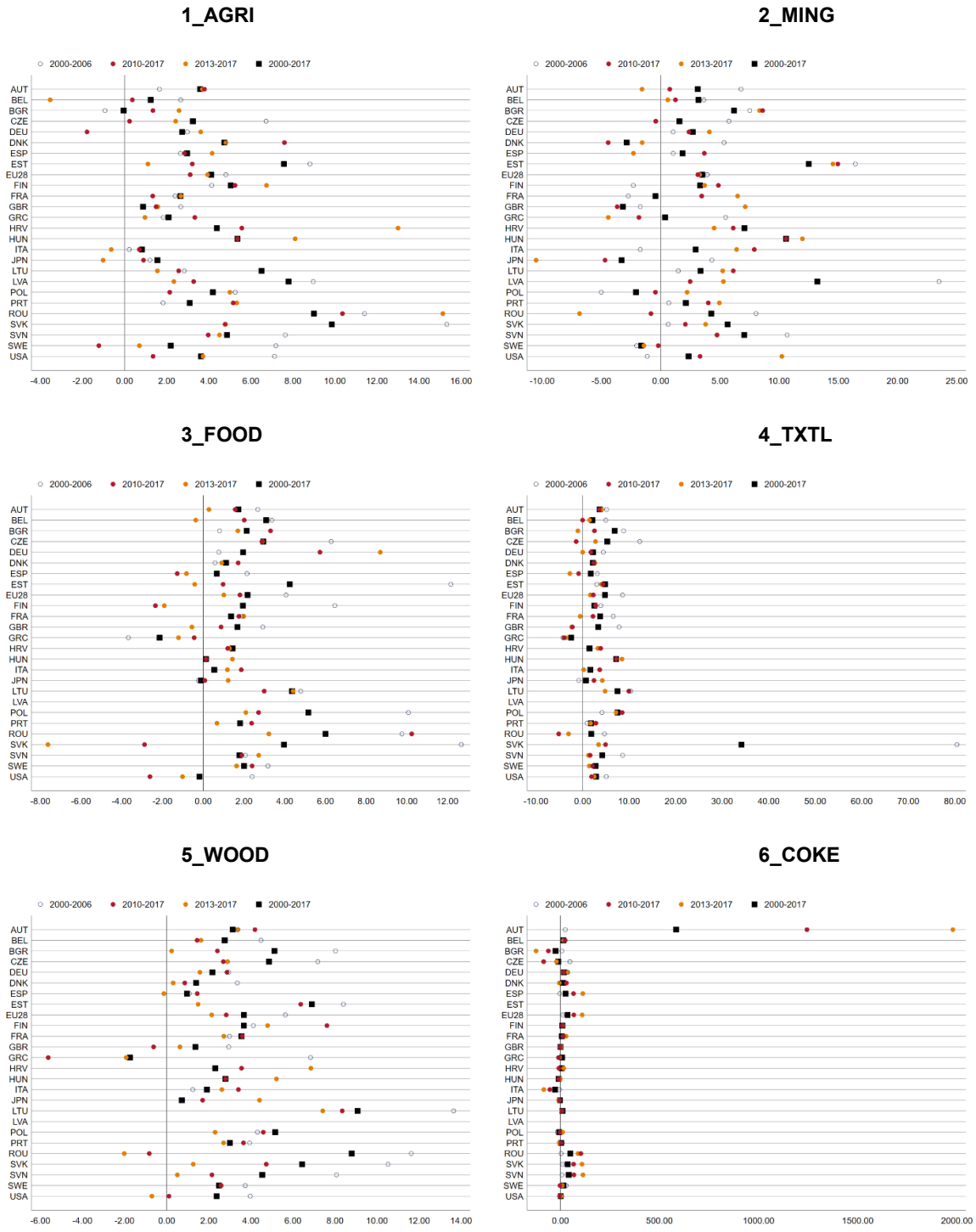
Source: own computations.

Figure A1 / National Accounts asset breakdown



Note: Asset types are based on ESA'2010 definition. Those with a code are available at Eurostat (yellow/orange), others not (grey).
Source: Adarov and Stehrer (2019a).

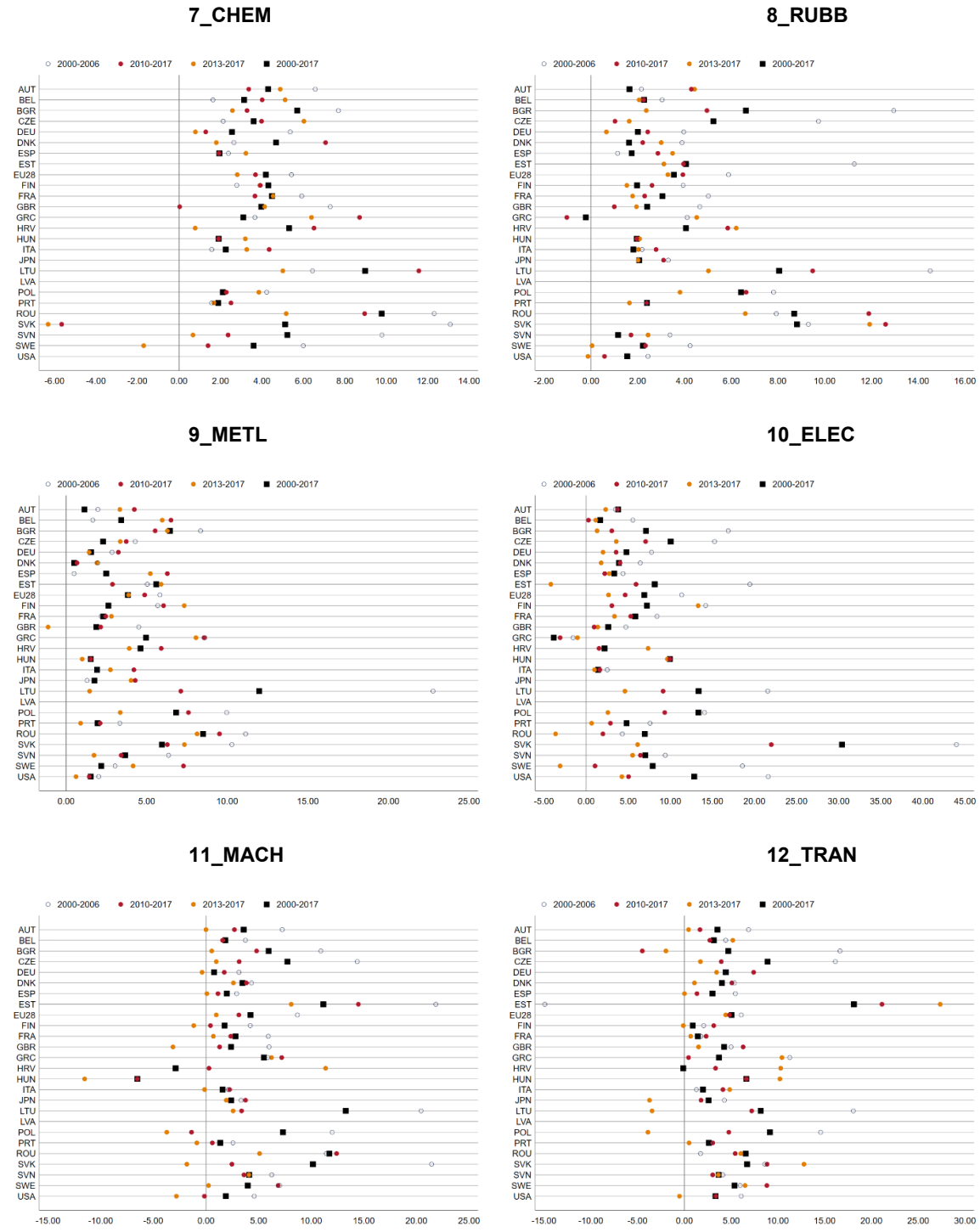
Figure A2 / Productivity dynamics by sectors (growth rates)



Note: The figure shows real labour productivity growth rates for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

ctd.

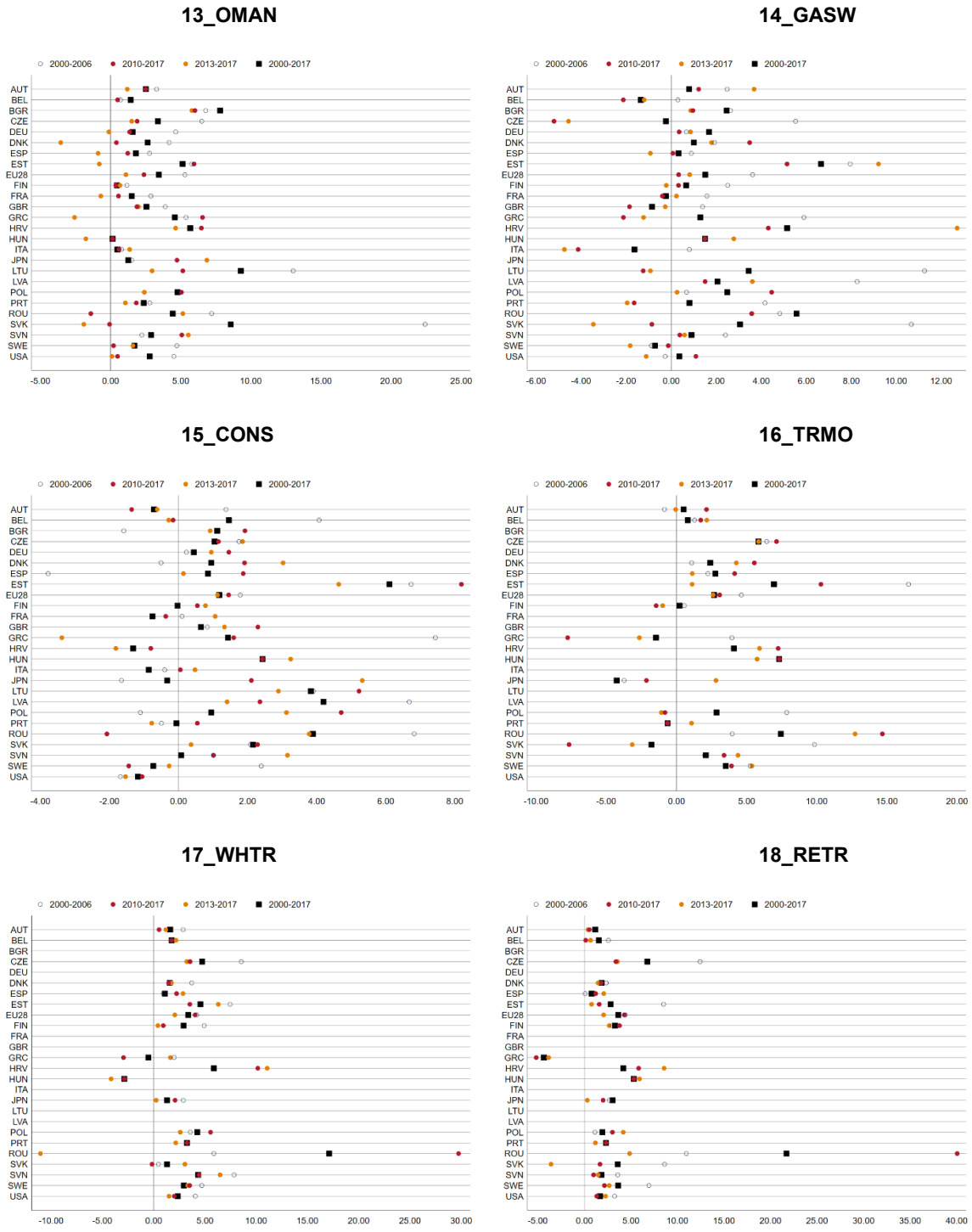
Figure A2 / (cont.)



Note: The figure shows real labour productivity growth rates for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

ctd.

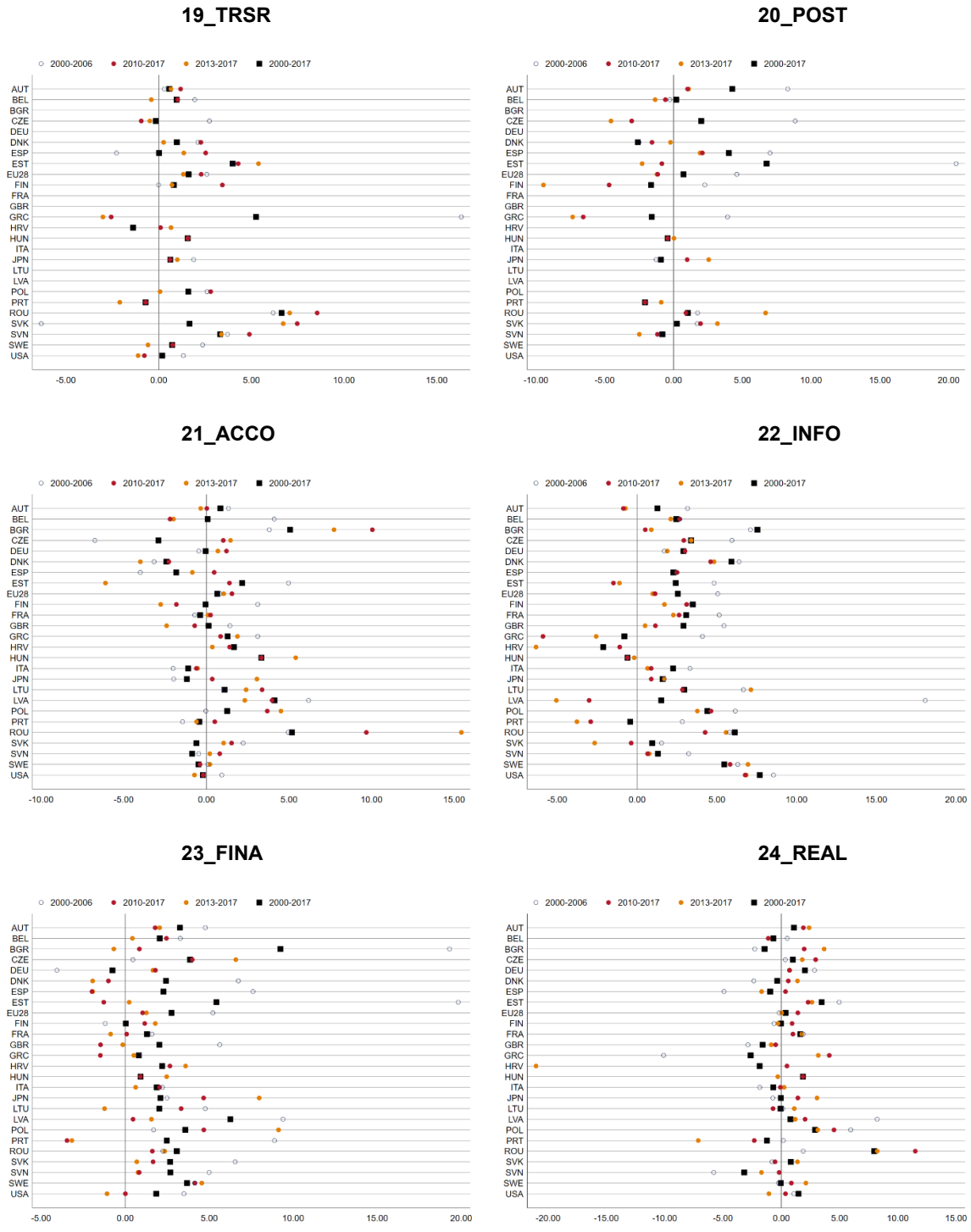
Figure A2 / (cont.)



Note: The figure shows real labour productivity growth rates for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

ctd.

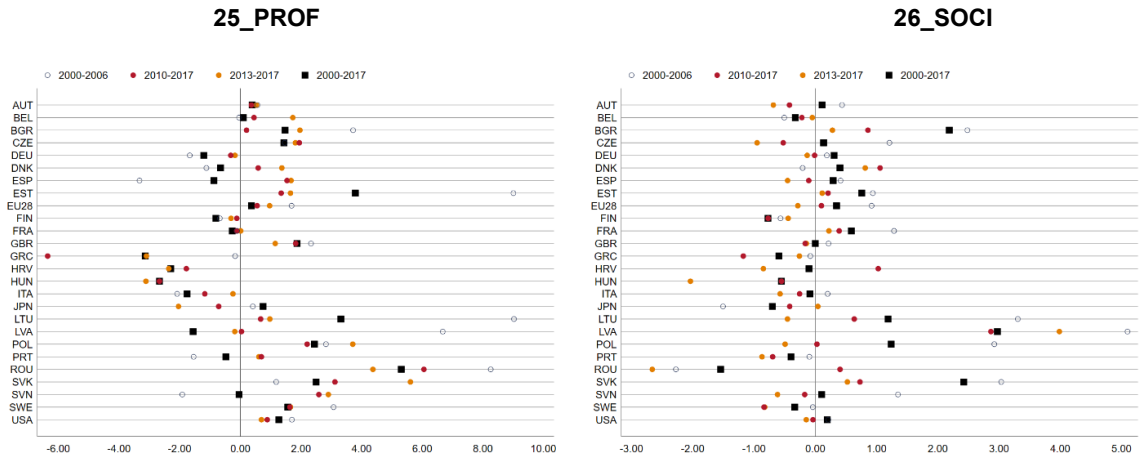
Figure A2 / (cont.)



Note: The figure shows real labour productivity growth rates for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

ctd.

Figure A2 / (cont.)



Note: The figure shows real labour productivity growth rates for the 26 sectors as outlined in Table 2.2. The figures indicate 2000-2017 averages along with the pre-crisis and post-crisis period averages (with and without the double-dip recession period). Countries are sorted by ISO3 in alphabetic order. EU28 indicates average EU-28 values.
Source: own computations based on the EU KLEMS 2019 data.

Table A2 / Capital asset composition by sectors (average across countries and years 2000-2017)

SEC	EconComp	ICT	NonICT	OInnProp	RD	Soft_DB
1_AGRI	0.22%	0.48%	98.42%	0.44%	0.29%	0.14%
2_MING	0.79%	0.84%	89.66%	6.70%	1.60%	0.41%
3_FOOD	5.37%	1.25%	87.17%	1.31%	3.58%	1.32%
4_TXTL	3.31%	1.04%	86.83%	1.26%	5.65%	1.91%
5_WOOD	2.11%	2.65%	89.05%	1.31%	3.14%	1.73%
6_COKE	2.23%	1.42%	88.75%	2.09%	4.29%	1.23%
7_CHEM	2.78%	1.24%	61.70%	1.22%	31.42%	1.64%
8_RUBB	2.60%	1.44%	85.72%	1.52%	7.23%	1.50%
9_METL	2.41%	1.71%	86.15%	1.66%	6.43%	1.63%
10_ELEC	2.92%	2.58%	41.68%	1.67%	46.04%	5.11%
11_MACH	3.58%	1.59%	65.69%	3.03%	22.65%	3.46%
12_TRAN	2.64%	1.70%	62.00%	2.34%	28.69%	2.62%
13_OMAN	3.99%	1.70%	73.58%	2.49%	14.79%	3.46%
14_GASW	0.62%	1.30%	95.88%	0.86%	0.75%	0.59%
15_CONS	2.03%	0.76%	84.35%	11.75%	0.49%	0.61%
16_TRMO	7.45%	1.77%	86.34%	1.72%	0.70%	2.01%
17_WHTR	9.88%	3.39%	74.63%	3.52%	3.55%	5.02%
18_RETR	6.18%	3.02%	86.10%	1.23%	0.41%	3.05%
19_TRSR	0.99%	1.45%	95.89%	0.77%	0.23%	0.67%
20_POST	3.37%	6.82%	77.76%	2.40%	2.08%	7.56%
21_ACCO	2.78%	1.71%	94.13%	0.78%	0.06%	0.54%
22_INFO	4.26%	14.90%	60.20%	7.18%	5.03%	8.43%
23_FINA	6.31%	3.66%	77.11%	1.65%	1.81%	9.46%
24_REAL	0.07%	0.05%	99.61%	0.25%	0.00%	0.02%
25_PROF	9.15%	4.48%	61.09%	8.36%	13.35%	3.56%
26_SOCI	0.75%	1.21%	91.64%	0.96%	4.56%	0.88%

Source: own computations based on the EU KLEMS 2019 data.

Appendix B: Additional country-level regression results

Table B1 / Regression results with FDI and capital adjusted for the persons employed

	(1) FE	(2) FE	(3) FE	(4) FE	(5) FE	(6) POLS	(7) GMM
Ln (Labour productivity), lag	-0.121***	-0.118***		-0.137***	-0.102***	-0.009***	-0.115**
	(0.020)	(0.019)		(0.022)	(0.020)	(0.003)	(0.050)
ΔLn (Labour services)	-0.271**		-0.330***	-0.327***	-0.298***	-0.206**	-0.204
	(0.100)		(0.109)	(0.078)	(0.091)	(0.087)	(0.230)
Labour composition growth		-0.060					
		(0.158)					
ΔLn (Hours worked)		-0.321***					
		(0.104)					
ΔLn (Inward FDI stock, share of employed), lag	-0.014**	-0.014**	-0.011	-0.014*		-0.005	-0.004
	(0.006)	(0.006)	(0.006)	(0.007)		(0.006)	(0.036)
ΔLn (EconComp, real capital stock, share of employed)	-0.035	-0.030	-0.037		-0.029	-0.012	-0.106
	(0.021)	(0.022)	(0.024)		(0.022)	(0.025)	(0.076)
ΔLn (ICT, real capital stock, share of employed)	0.058**	0.061***	0.048**		0.042**	0.031**	0.036
	(0.021)	(0.020)	(0.020)		(0.017)	(0.014)	(0.060)
ΔLn (NonICT, real capital stock, share of employed)	-0.054	-0.090	-0.033		-0.057	0.061	0.007
	(0.105)	(0.108)	(0.119)		(0.094)	(0.099)	(0.273)
ΔLn (OInnProp, real capital stock, share of employed)	-0.005	-0.011	-0.019		0.014	0.015	0.026
	(0.049)	(0.048)	(0.056)		(0.050)	(0.057)	(0.098)
ΔLn (RD, real capital stock, share of employed)	0.047	0.042	0.059		0.039	0.019	0.009
	(0.040)	(0.040)	(0.046)		(0.034)	(0.035)	(0.086)
ΔLn (SoftDB, real capital stock, share of employed)	0.086**	0.083***	0.094**		0.083***	0.096**	0.113*
	(0.030)	(0.029)	(0.034)		(0.026)	(0.035)	(0.061)
ΔLn (Labour productivity), lag							-0.099
							(0.176)
Constant	-0.368***	-0.360***	0.015***	-0.431***	-0.311***	-0.016*	0.000
	(0.063)	(0.061)	(0.005)	(0.072)	(0.066)	(0.009)	(0.000)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	217	217	217	249	263	217	76
Adj. R-squared	0.585	0.590	0.525	0.497	0.589	0.484	

Note: The table shows the estimation results using fixed effects (FE) with standard errors clustered by country (in parentheses), as well as pooled OLS (POLS) and system GMM based on 3-year non-overlapping averages (GMM). The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels.

Table B2 / Regression results with alternative capital measures

	(1) RK	(2) RK	(3) RK	(4) RK	(5) RK	(6) RK	(7) RK	(8) ERAT	(9) KS	(10) L	(11) L2
Ln (Labour productivity), lag	-0.122***	-0.133***	-0.135***	-0.143***	-0.134***	-0.140***	-0.135***	-0.119***	-0.130***	-0.119***	-0.115***
	(0.021)	(0.022)	(0.021)	(0.025)	(0.021)	(0.027)	(0.026)	(0.020)	(0.020)	(0.021)	(0.023)
ΔLn (Labour services)	-0.333***	-0.316***	-0.337***	-0.303***	-0.323***	-0.294***	-0.332***	-0.270**	-0.334***	-0.363***	-0.347***
	(0.073)	(0.080)	(0.071)	(0.079)	(0.080)	(0.085)	(0.078)	(0.101)	(0.074)	(0.073)	(0.081)
ΔLn (Inward FDI stock), lag	-0.012	-0.013*	-0.014*	-0.012	-0.013*	-0.012	-0.009	-0.013*	-0.011	-0.016*	-0.016*
	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.008)	(0.007)	(0.007)	(0.007)	(0.008)	(0.008)
EconComp	-0.039*	-0.018						-0.037*	-0.027	-0.008	-0.062
	(0.020)	(0.030)						(0.020)	(0.034)	(0.036)	(0.040)
ICT	0.055**		0.063**					0.058**	0.049**	0.004	-0.007
	(0.021)		(0.024)					(0.021)	(0.020)	(0.008)	(0.007)
NonICT	-0.037			0.052				-0.053	-0.072	-0.081	0.109
	(0.122)			(0.123)				(0.105)	(0.142)	(0.092)	(0.100)
OInnProp	-0.002				-0.016			-0.004	0.039	-0.073	-0.037
	(0.050)				(0.050)			(0.050)	(0.071)	(0.045)	(0.042)
RD	0.046					0.070		0.047	0.047	0.064*	0.005
	(0.039)					(0.045)		(0.040)	(0.039)	(0.036)	(0.048)
SoftDB	0.085**						0.088***	0.086**	0.079**	0.043**	0.014
	(0.031)						(0.029)	(0.031)	(0.031)	(0.018)	(0.028)
Constant	-0.370***	-0.418***	-0.412***	-0.441***	-0.421***	-0.433***	-0.419***	-0.361***	-0.408***	-0.356***	-0.340***
	(0.066)	(0.071)	(0.068)	(0.082)	(0.070)	(0.087)	(0.083)	(0.064)	(0.066)	(0.069)	(0.074)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	216	248	216	230	248	230	230	216	224	218	217
Adj. R-squared	0.581	0.494	0.534	0.517	0.493	0.528	0.562	0.581	0.554	0.544	0.501

Note: The table shows the estimation results using fixed effects (FE) with standard errors clustered by country (in parentheses). The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Capital asset variables (EconComp, ICT, NonICT, OInnProp, RD, SoftDB) are included in each specification as follows: columns denoted 'RK' include real capital stocks in log-differences; 'ERAT' – real capital stocks as a share of employed, in log-differences; 'KS' – growth rate of capital services; 'L' and 'L2'— 1-year and 2-year lags of real capital stocks in log-differences, respectively.

Table B3 / Regression results with alternative outlier thresholds

	μ ± 2σ	μ ± 3σ	μ ± 4σ	no outlier cutoff
Ln (Labour productivity), lag	-0.122***	-0.132***	-0.143***	-0.151***
	(0.021)	(0.019)	(0.027)	(0.023)
ΔLn (Labour services)	-0.333***	-0.293***	-0.246**	-0.155
	(0.073)	(0.091)	(0.093)	(0.101)
ΔLn (Inward FDI stock)	-0.012	-0.015*	-0.011	-0.009
	(0.007)	(0.007)	(0.009)	(0.009)
ΔLn (EconComp, real capital stock)	-0.039*	0.004	0.009	0.029
	(0.020)	(0.025)	(0.030)	(0.022)
ΔLn (ICT, real capital stock)	0.055**	0.036**	0.029*	0.015
	(0.021)	(0.014)	(0.016)	(0.010)
ΔLn (NonICT, real capital stock)	-0.037	0.013	0.058	-0.295
	(0.122)	(0.115)	(0.132)	(0.263)
ΔLn (OInnProp, real capital stock)	-0.002	-0.035	-0.002	0.005
	(0.050)	(0.034)	(0.029)	(0.028)
ΔLn (RD, real capital stock)	0.046	0.045	-0.022	0.016
	(0.039)	(0.040)	(0.053)	(0.051)
ΔLn (SoftDB, real capital stock)	0.085**	0.033**	0.015	0.004**
	(0.031)	(0.014)	(0.017)	(0.002)
Constant	-0.370***	-0.404***	-0.441***	-0.468***
	(0.066)	(0.063)	(0.087)	(0.076)
Country FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	216	233	238	248
Adj. R-squared	0.581	0.554	0.508	0.494

Note: The table shows the estimation results using fixed effects (FE) with standard errors clustered by country (in parentheses). The dependent variable is ΔLn (Labour productivity). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. The estimates reported in columns correspond to the baseline specification with different levels of outlier threshold imposed on the key variables (labour productivity, FDI and capital asset growth rates): 'μ ± 2σ', 'μ ± 3σ', 'μ ± 4σ' denote threshold levels at 2, 3 and 4 standard deviations from the sample mean. The former corresponds to the benchmark model. Column 'no outlier cutoff' lists results with all observations (no outlier control).

Table B4 / Summary statistics with alternative outlier thresholds

	ΔLn (Labour productivity)	Ln (Labour productivity)	ΔLn (Labour services)	ΔLn (Inward FDI stock)	ΔLn (EconComp, real capital stock)	ΔLn (ICT, real capital stock)	ΔLn (NonICT, real capital stock)	ΔLn (OInnProp, real capital stock)	ΔLn (RD, real capital stock)	ΔLn (SoftDB, real capital stock)
μ ± 2σ										
N	216	216	216	216	216	216	216	216	216	216
mean	0.012	-3.215	0.008	0.043	0.030	0.041	0.011	0.020	0.025	0.037
sd	0.017	0.461	0.022	0.147	0.047	0.056	0.013	0.035	0.032	0.045
min	-0.032	-4.438	-0.182	-0.597	-0.111	-0.107	-0.018	-0.106	-0.069	-0.141
max	0.068	-2.625	0.062	0.483	0.206	0.186	0.048	0.133	0.148	0.199
μ ± 3σ										
N	233	233	233	233	233	233	233	233	233	233
mean	0.013	-3.248	0.007	0.043	0.030	0.037	0.011	0.019	0.025	0.036
sd	0.019	0.483	0.022	0.148	0.055	0.060	0.013	0.044	0.034	0.066
min	-0.054	-4.438	-0.182	-0.597	-0.144	-0.238	-0.018	-0.158	-0.069	-0.363
max	0.079	-2.625	0.062	0.483	0.289	0.186	0.048	0.223	0.186	0.493
μ ± 4σ										
N	238	238	238	238	238	238	238	238	238	238
mean	0.012	-3.251	0.006	0.041	0.030	0.039	0.011	0.019	0.025	0.039
sd	0.020	0.484	0.023	0.150	0.060	0.066	0.012	0.045	0.040	0.074
min	-0.061	-4.438	-0.182	-0.597	-0.144	-0.238	-0.018	-0.158	-0.164	-0.363
max	0.079	-2.625	0.062	0.483	0.372	0.445	0.048	0.223	0.272	0.507
no outlier cutoff										
N	248	248	248	248	248	248	248	248	248	248
mean	0.012	-3.271	0.006	0.038	0.034	0.037	0.011	0.020	0.025	0.040
sd	0.021	0.495	0.023	0.153	0.075	0.116	0.013	0.052	0.040	0.158
min	-0.092	-4.438	-0.182	-0.597	-0.144	-0.818	-0.018	-0.181	-0.164	-0.790
max	0.079	-2.625	0.062	0.483	0.598	1.005	0.090	0.303	0.272	1.942

Note: The table shows summary statistics for the regression variables with different levels of outlier threshold imposed on the key variables (labour productivity, FDI and capital asset growth rates): 'μ ± 2σ', 'μ ± 3σ', 'μ ± 4σ' denote threshold levels at 2, 3 and 4 standard deviations from the sample mean; 'no outlier cutoff' lists results with all observations (no outlier control).

Table B5 / Regression results with alternative FDI measures

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
Ln (Labour productivity), lag	-0.122***	-0.149***	-0.137***	-0.135***	-0.124***	-0.113***	-0.125***	-0.113***	-0.118***	-0.128***	-0.148***	-0.147***	-0.121***
	(0.021)	(0.031)	(0.027)	(0.037)	(0.021)	(0.025)	(0.020)	(0.023)	(0.019)	(0.020)	(0.029)	(0.030)	(0.020)
ΔLn (Labour services)	-0.333***	-0.348***	-0.364***	-0.351***	-0.335***	-0.361***	-0.373***	-0.346***	-0.334***	-0.331***	-0.330***	-0.330***	-0.333***
	(0.073)	(0.080)	(0.072)	(0.077)	(0.073)	(0.068)	(0.071)	(0.085)	(0.078)	(0.071)	(0.074)	(0.075)	(0.075)
ΔLn (EconComp, real capital stock)	-0.039*	-0.037	-0.021	-0.030	-0.035	-0.026	-0.032	-0.039*	-0.037	-0.041*	-0.035	-0.034	-0.037*
	(0.020)	(0.023)	(0.023)	(0.023)	(0.022)	(0.021)	(0.020)	(0.020)	(0.022)	(0.020)	(0.022)	(0.022)	(0.020)
ΔLn (ICT, real capital stock)	0.055**	0.055**	0.050**	0.059**	0.056**	0.048**	0.046**	0.063**	0.066**	0.058**	0.055**	0.055**	0.046**
	(0.021)	(0.022)	(0.022)	(0.025)	(0.021)	(0.020)	(0.019)	(0.024)	(0.024)	(0.021)	(0.022)	(0.022)	(0.020)
ΔLn (NonICT, real capital stock)	-0.037	-0.036	-0.016	-0.056	-0.024	0.024	-0.001	-0.041	-0.069	-0.057	-0.074	-0.074	-0.049
	(0.122)	(0.135)	(0.129)	(0.142)	(0.118)	(0.118)	(0.115)	(0.126)	(0.123)	(0.124)	(0.127)	(0.126)	(0.134)
ΔLn (OInnProp, real capital stock)	-0.002	0.015	0.015	0.013	0.004	0.004	0.028	-0.005	-0.011	-0.008	-0.000	-0.003	0.021
	(0.050)	(0.050)	(0.048)	(0.049)	(0.051)	(0.053)	(0.048)	(0.053)	(0.054)	(0.049)	(0.049)	(0.049)	(0.050)
ΔLn (RD, real capital stock)	0.046	0.033	0.024	0.037	0.044	0.031	0.026	0.047	0.051	0.050	0.039	0.039	0.050
	(0.039)	(0.043)	(0.042)	(0.047)	(0.040)	(0.034)	(0.033)	(0.040)	(0.039)	(0.039)	(0.039)	(0.039)	(0.041)
ΔLn (SoftDB, real capital stock)	0.085**	0.085**	0.095***	0.092***	0.086**	0.083***	0.087***	0.084**	0.080**	0.080**	0.082**	0.082**	0.075**
	(0.031)	(0.031)	(0.027)	(0.028)	(0.031)	(0.029)	(0.029)	(0.033)	(0.031)	(0.031)	(0.030)	(0.030)	(0.031)
FDI = ΔLn (Inward FDI stock), lag	-0.012			-0.013				0.020	0.193	0.005	-0.027	-0.032	-0.011
	(0.007)			(0.010)				(0.023)	(0.123)	(0.015)	(0.020)	(0.026)	(0.007)
ΔLn (Inward FDI stock), 2-year lag		0.009		0.003									
		(0.005)		(0.006)									
ΔLn (Inward FDI stock), 3-year lag			-0.007	-0.009									
			(0.006)	(0.007)									
Δ Inward FDI stock / GDP, lag					-0.021								
					(0.020)								
Inward FDI stock / GDP, lag						-0.004							
						(0.015)							
Inward FDI flow, lag							-0.000						
							(0.000)						
FDI × Share of labour force with basic education, lag								-0.001					
								(0.000)					
FDI × Share of labour force with advanced education, lag									-0.003				
									(0.002)				
FDI × Change in human capital index, lag										-1.073			
										(0.790)			
FDI × Change in Control of Corruption index, lag											0.011		
											(0.012)		
FDI × Change in Government Effectiveness index, lag												0.014	
												(0.016)	
FDI × Private credit-to-GDP, lag													0.000
													(0.001)
Constant	-0.370***	-0.458***	-0.420***	-0.416***	-0.378***	-0.338***	-0.375***	-0.343***	-0.360***	-0.391***	-0.453***	-0.450***	-0.366***
	(0.066)	(0.096)	(0.086)	(0.118)	(0.066)	(0.082)	(0.062)	(0.075)	(0.062)	(0.063)	(0.092)	(0.093)	(0.065)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	216	207	200	189	216	235	238	205	206	216	204	204	214
Adj. R-squared	0.581	0.568	0.571	0.575	0.576	0.576	0.564	0.583	0.586	0.581	0.574	0.573	0.568

Note: The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels, respectively. The dependent variable is ΔLn (Labour productivity).

Table B6 / Country-level regressions with detailed capital asset types

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Ln (Labour productivity), lag	-0.138***	-0.135***	-0.129***	-0.141***	-0.134***	-0.139***	-0.143***	-0.143***	-0.129***	-0.128***	-0.140***	-0.145***	-0.135***	-0.140***	-0.133***
	(0.036)	(0.022)	(0.023)	(0.027)	(0.022)	(0.022)	(0.025)	(0.025)	(0.021)	(0.022)	(0.027)	(0.026)	(0.026)	(0.026)	(0.023)
ΔLn (Labour services)	-0.302**	-0.324***	-0.352***	-0.297***	-0.320***	-0.277***	-0.303***	-0.299***	-0.295***	-0.323***	-0.294***	-0.299***	-0.332***	-0.310***	-0.335***
	(0.107)	(0.077)	(0.073)	(0.085)	(0.075)	(0.067)	(0.081)	(0.080)	(0.078)	(0.085)	(0.085)	(0.083)	(0.078)	(0.087)	(0.088)
ΔLn (Inward FDI stock), lag	-0.013	-0.013*	-0.014*	-0.014*	-0.014*	-0.013*	-0.012	-0.012	-0.015*	-0.008	-0.012	-0.012	-0.009	-0.012	-0.011
	(0.009)	(0.007)	(0.007)	(0.008)	(0.008)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.007)	(0.007)	(0.009)
AdvMRes	-0.018	-0.005													
	(0.023)	(0.036)													
CT	0.053**		0.061**												
	(0.024)		(0.022)												
Cult	0.003			0.002											
	(0.007)			(0.004)											
Design	0.026				-0.035										
	(0.068)				(0.049)										
IT	0.000					0.030									
	(0.027)					(0.019)									
OCon	0.100						0.047								
	(0.120)						(0.099)								
OIPP	0.007							0.011							
	(0.027)							(0.021)							
OMach	-0.070								-0.096						
	(0.084)								(0.068)						
POCap	-0.031									-0.024					
	(0.023)									(0.027)					
RD	0.062										0.070				
	(0.045)										(0.045)				
RStruc	0.148											0.047			
	(0.099)											(0.087)			
SoftDB	0.060*												0.088***		
	(0.033)												(0.029)		
TraEq	0.021													0.018	
	(0.036)													(0.034)	
VT	0.011														0.005
	(0.016)														(0.010)
Constant	-0.426***	-0.423***	-0.390***	-0.438***	-0.418***	-0.423***	-0.440***	-0.442***	-0.391***	-0.402***	-0.433***	-0.448***	-0.419***	-0.433***	-0.424***
	(0.120)	(0.072)	(0.073)	(0.089)	(0.074)	(0.071)	(0.081)	(0.080)	(0.067)	(0.073)	(0.087)	(0.085)	(0.083)	(0.084)	(0.078)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	172	248	216	214	248	199	230	230	222	237	230	230	230	230	221
Adj. R-squared	0.631	0.493	0.533	0.535	0.495	0.536	0.517	0.518	0.513	0.493	0.528	0.517	0.562	0.517	0.506

Note: The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. The dependent variable is real labour productivity (per hour worked) in log-differences. Capital asset variables are included as real capital stocks in log-differences.

Appendix C: Additional sector-level regression results

Table C1 / Drivers of labour productivity: regressions with real capital stocks and real inward FDI stock (3-year lag), growth rates

	1_AGRI	2_MING	3_FOOD	4_TXTL	5_WOOD	6_COKE	7_CHEM	8_RUBB	9_METL	10_ELEC	11_MACH	12_TRAN
Ln (Labour productivity), lag	-0.254***	-0.121***	-0.143	-0.539***	-0.076*	-0.430***	-0.290**	-0.246**	-0.232**	-0.121*	-0.266***	-0.589***
	(0.061)	(0.037)	(0.085)	(0.093)	(0.037)	(0.108)	(0.127)	(0.087)	(0.087)	(0.064)	(0.042)	(0.110)
ΔLn (Labour services)	-0.527*	-0.328***	-0.682**	-0.845***	-0.024	0.904	-0.224	-0.089	-0.245	-0.202	-0.490**	0.165
	(0.247)	(0.083)	(0.224)	(0.233)	(0.137)	(0.733)	(0.337)	(0.144)	(0.244)	(0.203)	(0.185)	(0.176)
ΔLn (EconComp, real capital stock)	0.589*	0.294	-0.220***	0.109	-0.051	-0.444	-0.076	0.024	-0.181*	0.051	0.161*	0.380*
	(0.297)	(0.212)	(0.066)	(0.110)	(0.091)	(0.444)	(0.147)	(0.177)	(0.086)	(0.256)	(0.089)	(0.186)
ΔLn (ICT, real capital stock)	-0.046	0.128	0.050	-0.053	0.079**	-0.163	-0.010	-0.177***	0.088	0.039	0.036	0.168*
	(0.061)	(0.098)	(0.055)	(0.048)	(0.030)	(0.298)	(0.065)	(0.035)	(0.054)	(0.083)	(0.077)	(0.092)
ΔLn (NonICT, real capital stock)	-0.231	-0.292	0.018	0.235	-0.382*	-1.341	0.470	0.247	0.042	0.279	-0.029	0.337
	(0.368)	(0.305)	(0.403)	(0.404)	(0.213)	(0.821)	(0.388)	(0.330)	(0.326)	(0.303)	(0.337)	(0.240)
ΔLn (OInnProp, real capital stock)	-0.273	-0.163	0.046	0.065	0.019	1.012	-0.154	0.087	0.153	-0.254	-0.183	-0.785**
	(0.251)	(0.135)	(0.123)	(0.241)	(0.112)	(1.073)	(0.106)	(0.240)	(0.148)	(0.251)	(0.169)	(0.311)
ΔLn (RD, real capital stock)	-0.113	0.167	-0.108	-0.334*	0.168	0.390	-0.084	-0.243	0.153	0.230	0.238	-0.025
	(0.081)	(0.131)	(0.122)	(0.162)	(0.102)	(0.537)	(0.138)	(0.149)	(0.134)	(0.269)	(0.200)	(0.163)
ΔLn (SoftDB, real capital stock)	-0.046	-0.012	-0.067	0.211***	-0.083**	-0.089	0.030	0.051	-0.007	-0.268	0.009	-0.153*
	(0.058)	(0.066)	(0.061)	(0.056)	(0.032)	(0.340)	(0.038)	(0.051)	(0.042)	(0.159)	(0.052)	(0.080)
ΔLn (Inward FDI, real stock), 3-year lag	-0.024	0.013	0.015*	-0.015	0.012	0.080	0.003	-0.009	0.008	0.026**	-0.004	0.002
	(0.014)	(0.018)	(0.007)	(0.016)	(0.008)	(0.050)	(0.019)	(0.013)	(0.014)	(0.011)	(0.020)	(0.018)
Constant	-1.075***	-0.397***	-0.384	-1.886***	-0.230*	-0.685***	-0.597*	-0.728**	-0.678**	-0.281	-0.753***	-1.492***
	(0.250)	(0.076)	(0.263)	(0.332)	(0.119)	(0.188)	(0.279)	(0.255)	(0.266)	(0.180)	(0.133)	(0.264)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	87	136	118	89	89	58	110	96	120	106	116	99
Adj. R-squared	0.233	0.197	0.293	0.539	0.159	0.363	0.142	0.386	0.373	0.432	0.637	0.688

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table C1 / (cont.)

	13_OMAN	14_WATR	15_CONS	16_TRMO	17_WHTR	18_RETR	19_TRSR	21_ACCO	22_INFO	23_FINA	24_REAL	25_PROF	26_SOCI
Ln (Labour productivity), lag	-0.263***	-0.201***	-0.221***	-0.200*	-0.188	-0.489*	-0.488***	-0.064	-0.042	-0.200*	-0.274***	-0.116***	-0.129*
	(0.064)	(0.052)	(0.070)	(0.097)	(0.118)	(0.198)	(0.107)	(0.114)	(0.040)	(0.105)	(0.070)	(0.038)	(0.073)
ΔLn (Labour services)	-0.620***	-0.475***	-0.407***	-0.299	-0.027	-0.705*	-0.472*	-0.261	-0.414***	-0.290**	-0.191	-0.420***	-0.340**
	(0.201)	(0.104)	(0.104)	(0.343)	(0.430)	(0.318)	(0.219)	(0.178)	(0.123)	(0.100)	(0.116)	(0.097)	(0.126)
ΔLn (EconComp, real capital stock)	-0.307**	-0.065	-0.047	0.173	-0.209	-0.219	-0.317**	0.194**	-0.027	-0.182	-0.204	0.056	-0.026
	(0.128)	(0.106)	(0.100)	(0.182)	(0.178)	(0.135)	(0.126)	(0.090)	(0.078)	(0.180)	(0.122)	(0.081)	(0.037)
ΔLn (ICT, real capital stock)	0.051	-0.064	-0.115**	0.127	-0.172	0.033	0.168	0.032	0.082*	-0.023	-0.013	0.025	-0.002
	(0.042)	(0.067)	(0.048)	(0.085)	(0.111)	(0.097)	(0.103)	(0.037)	(0.044)	(0.052)	(0.050)	(0.024)	(0.014)
ΔLn (NonICT, real capital stock)	-0.091	-0.287	0.361*	-0.581	0.700	-0.205	0.056	0.257	-0.164	-0.125	0.031	0.127	-0.046
	(0.250)	(0.260)	(0.177)	(0.925)	(0.509)	(0.458)	(0.317)	(0.387)	(0.119)	(0.166)	(0.468)	(0.081)	(0.067)
ΔLn (OInnProp, real capital stock)	-0.270	0.167	0.048	0.312	0.067	-0.215	0.291**	0.048	0.092	0.034	0.016	0.053	-0.036
	(0.197)	(0.301)	(0.139)	(0.286)	(0.182)	(0.215)	(0.122)	(0.062)	(0.087)	(0.039)	(0.071)	(0.112)	(0.041)
ΔLn (RD, real capital stock)	0.237**	0.039	0.109**	0.017	-0.125	-0.005	-0.144*	-0.020	0.114**	-0.003	-0.014	0.157**	0.002
	(0.098)	(0.067)	(0.038)	(0.057)	(0.101)	(0.058)	(0.065)	(0.024)	(0.052)	(0.037)	(0.021)	(0.056)	(0.050)
ΔLn (SoftDB, real capital stock)	-0.126	-0.145***	-0.086*	0.249	-0.066	-0.033	-0.024	-0.015	-0.062	-0.077	0.012	-0.009	0.047
	(0.075)	(0.042)	(0.044)	(0.145)	(0.075)	(0.030)	(0.110)	(0.039)	(0.062)	(0.092)	(0.028)	(0.045)	(0.031)
ΔLn (Inward FDI, real stock), 3-year lag	0.010	0.006	-0.015	0.005	-0.024	-0.008	0.002	0.020	-0.001	0.011	0.010	0.006**	-0.000
	(0.009)	(0.007)	(0.009)	(0.014)	(0.037)	(0.022)	(0.003)	(0.016)	(0.003)	(0.008)	(0.017)	(0.003)	(0.001)
Constant	-0.809***	-0.491***	-0.745***	-0.619	-0.504	-1.665*	-1.517***	-0.271	-0.094	-0.466	-0.308***	-0.379**	-0.444*
	(0.209)	(0.124)	(0.240)	(0.335)	(0.341)	(0.677)	(0.346)	(0.444)	(0.101)	(0.271)	(0.066)	(0.132)	(0.253)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	93	134	132	39	58	46	66	98	150	142	100	142	136
Adj. R-squared	0.540	0.361	0.415	0.714	0.135	0.518	0.483	0.205	0.372	0.0802	0.443	0.551	0.349

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table C2 / Regressions with real capital stocks and real inward FDI stock (1-year lag), share of employed

	1_AGRI	2_MING	3_FOOD	4_TXTL	5_WOOD	6_COKE	7_CHEM	8_RUBB	9_METL	10_ELEC	11_MACH	12_TRAN	13_OMAN
Ln (Labour productivity), lag	-0.215***	-0.091***	-0.153	-0.403***	-0.107**	-0.109	-0.221**	-0.335***	-0.162**	-0.107*	-0.201***	-0.424***	-0.173***
	(0.055)	(0.027)	(0.087)	(0.072)	(0.039)	(0.068)	(0.099)	(0.054)	(0.062)	(0.059)	(0.040)	(0.063)	(0.057)
ΔLn (Labour services)	-0.580**	-0.175***	-0.193	-0.642**	-0.163	-0.160	-0.090	-0.147	-0.236	-0.012	-0.216	0.298*	-0.506**
	(0.251)	(0.055)	(0.184)	(0.278)	(0.173)	(0.440)	(0.288)	(0.225)	(0.250)	(0.196)	(0.249)	(0.163)	(0.210)
ΔLn (EconComp, real capital stock, share of employed)	0.327**	0.341**	-0.197**	-0.081	0.208	-0.935	-0.247*	-0.001	-0.076	0.036	0.088	0.224	-0.246**
	(0.140)	(0.143)	(0.083)	(0.185)	(0.125)	(0.677)	(0.132)	(0.159)	(0.103)	(0.193)	(0.067)	(0.155)	(0.098)
ΔLn (ICT, real capital stock, share of employed)	-0.026	0.048	0.121*	0.081	0.065	-0.182	-0.035	-0.028	0.017	0.005	0.004	0.129*	0.031
	(0.056)	(0.063)	(0.060)	(0.060)	(0.045)	(0.269)	(0.067)	(0.069)	(0.051)	(0.074)	(0.036)	(0.070)	(0.038)
ΔLn (NonICT, real capital stock, share of employed)	-0.378	0.039	0.495	0.081	-0.020	-0.243	0.473*	0.303	0.008	0.349	-0.124	0.128	0.408**
	(0.397)	(0.135)	(0.285)	(0.256)	(0.200)	(0.602)	(0.256)	(0.346)	(0.284)	(0.252)	(0.203)	(0.389)	(0.167)
ΔLn (OInnProp, real capital stock, share of employed)	-0.056	-0.160	0.048	0.035	0.106	-0.289	0.125	-0.242	0.073	-0.274	-0.132	-0.531*	-0.295
	(0.238)	(0.143)	(0.083)	(0.205)	(0.160)	(0.933)	(0.110)	(0.154)	(0.127)	(0.264)	(0.148)	(0.273)	(0.170)
ΔLn (RD, real capital stock, share of employed)	-0.062	0.200**	-0.134	-0.042	0.141**	0.267	0.129	-0.021	0.131	0.261	0.408**	0.258*	0.206***
	(0.071)	(0.082)	(0.092)	(0.075)	(0.057)	(0.365)	(0.190)	(0.183)	(0.104)	(0.190)	(0.151)	(0.120)	(0.050)
ΔLn (SoftDB, real capital stock, share of employed)	-0.048	-0.033	-0.003	0.239***	-0.131**	0.959**	-0.041	0.019	-0.027	-0.114	0.099**	-0.126	-0.055
	(0.052)	(0.048)	(0.101)	(0.064)	(0.052)	(0.315)	(0.050)	(0.046)	(0.034)	(0.086)	(0.038)	(0.111)	(0.072)
ΔLn (Inward FDI, real stock, share of employed), lag	0.042*	-0.003	-0.014*	-0.011	0.001	0.061	0.016	0.003	-0.019	-0.022*	-0.027	-0.005	0.005
	(0.020)	(0.009)	(0.008)	(0.014)	(0.014)	(0.071)	(0.014)	(0.019)	(0.015)	(0.012)	(0.018)	(0.014)	(0.007)
Constant	-0.887***	-0.267***	-0.439	-1.386***	-0.337**	-0.166	-0.439*	-0.981***	-0.454**	-0.221	-0.576***	-1.084***	-0.524**
	(0.222)	(0.078)	(0.268)	(0.259)	(0.130)	(0.154)	(0.222)	(0.162)	(0.201)	(0.170)	(0.126)	(0.154)	(0.189)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	100	153	131	104	104	75	122	108	139	119	136	113	111
Adj. R-squared	0.283	0.330	0.324	0.528	0.268	0.321	0.149	0.446	0.355	0.392	0.589	0.566	0.546

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table C2 / (cont.)

	14_WATR	15_CONS	16_TRMO	17_WHTR	18_RETR	19_TRSR	21_ACCO	22_INFO	23_FINA	24_REAL	25_PROF	26_SOCI
Ln (Labour productivity), lag	-0.181***	-0.148**	-0.264*	-0.115	-0.340**	-0.448***	-0.236***	-0.066*	-0.188**	-0.243**	-0.078**	-0.145**
	(0.056)	(0.052)	(0.114)	(0.092)	(0.114)	(0.069)	(0.066)	(0.034)	(0.075)	(0.094)	(0.029)	(0.055)
ΔLn (Labour services)	-0.502***	-0.166	-0.342*	0.083	-0.615**	0.157	0.025	-0.265**	-0.209*	-0.164	-0.308**	-0.298**
	(0.111)	(0.178)	(0.157)	(0.515)	(0.237)	(0.262)	(0.265)	(0.105)	(0.112)	(0.101)	(0.108)	(0.124)
ΔLn (EconComp, real capital stock, share of employed)	-0.038	-0.112	-0.054	-0.049	-0.079	0.086	0.144	-0.050	0.016	-0.201**	0.007	0.003
	(0.099)	(0.079)	(0.221)	(0.153)	(0.168)	(0.135)	(0.106)	(0.067)	(0.198)	(0.071)	(0.064)	(0.045)
ΔLn (ICT, real capital stock, share of employed)	0.002	-0.058	0.109	-0.173**	-0.075	0.137	0.003	0.091*	-0.040	-0.026	0.044	0.022
	(0.036)	(0.043)	(0.090)	(0.069)	(0.090)	(0.085)	(0.047)	(0.049)	(0.047)	(0.034)	(0.029)	(0.014)
ΔLn (NonICT, real capital stock, share of employed)	-0.013	0.362*	-0.782**	0.213	0.236	0.261	0.210	0.008	-0.004	0.737***	0.119	0.112
	(0.189)	(0.172)	(0.264)	(0.369)	(0.317)	(0.258)	(0.258)	(0.078)	(0.126)	(0.133)	(0.083)	(0.107)
ΔLn (OInnProp, real capital stock, share of employed)	0.249	-0.007	0.040	-0.021	-0.218	0.087	0.107*	0.151*	-0.017	0.063	0.031	-0.012
	(0.164)	(0.116)	(0.103)	(0.184)	(0.147)	(0.206)	(0.055)	(0.082)	(0.063)	(0.070)	(0.067)	(0.046)
ΔLn (RD, real capital stock, share of employed)	0.055	0.063*	-0.014	-0.047	0.020	-0.063	-0.020	0.127**	0.013	-0.008	0.092	-0.036
	(0.069)	(0.035)	(0.049)	(0.095)	(0.068)	(0.059)	(0.025)	(0.049)	(0.039)	(0.019)	(0.065)	(0.046)
ΔLn (SoftDB, real capital stock, share of employed)	-0.107	-0.066	0.327**	-0.020	-0.017	0.013	0.030	-0.001	-0.008	-0.014	-0.055	0.017
	(0.077)	(0.045)	(0.098)	(0.079)	(0.030)	(0.045)	(0.029)	(0.035)	(0.090)	(0.030)	(0.049)	(0.026)
ΔLn (Inward FDI, real stock, share of employed), lag	0.014	-0.013	-0.035	0.012	0.037	0.007	0.020	0.002	-0.006	-0.006	-0.000	0.001
	(0.011)	(0.008)	(0.031)	(0.032)	(0.023)	(0.008)	(0.016)	(0.005)	(0.015)	(0.008)	(0.004)	(0.001)
Constant	-0.459***	-0.483**	-0.771*	-0.292	-1.153**	-1.374***	-0.919***	-0.146	-0.444**	-0.252**	-0.235**	-0.501**
	(0.126)	(0.178)	(0.342)	(0.272)	(0.387)	(0.216)	(0.245)	(0.088)	(0.196)	(0.094)	(0.103)	(0.191)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	152	149	48	67	54	73	106	163	158	113	162	153
Adj. R-squared	0.304	0.363	0.670	0.282	0.557	0.497	0.291	0.479	0.0658	0.624	0.464	0.281

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table C3 / Regressions with real capital stocks and real inward FDI stock (3-year lag), share of employed

	1_AGRI	2_MING	3_FOOD	4_TXTL	5_WOOD	6_COKE	7_CHEM	8_RUBB	9_METL	10_ELEC	11_MACH	12_TRAN	13_OMAN
Ln (Labour productivity), lag	-0.256***	-0.099***	-0.144	-0.531***	-0.112***	-0.327**	-0.258**	-0.247***	-0.228**	-0.121*	-0.262***	-0.582***	-0.259***
	(0.071)	(0.033)	(0.085)	(0.093)	(0.036)	(0.109)	(0.113)	(0.072)	(0.086)	(0.065)	(0.035)	(0.102)	(0.073)
ΔLn (Labour services)	-0.522	-0.194**	-0.499*	-0.675**	0.053	0.988	0.088	-0.091	-0.132	-0.077	-0.231	0.148	-0.840**
	(0.334)	(0.080)	(0.253)	(0.299)	(0.130)	(0.698)	(0.373)	(0.339)	(0.308)	(0.210)	(0.175)	(0.182)	(0.296)
ΔLn (EconComp, real capital stock, share of employed)	0.600*	0.357**	-0.193**	0.071	0.023	-0.235	-0.099	0.025	-0.178*	0.055	0.152*	0.396*	-0.272*
	(0.293)	(0.144)	(0.075)	(0.123)	(0.104)	(0.818)	(0.148)	(0.179)	(0.096)	(0.269)	(0.079)	(0.211)	(0.127)
ΔLn (ICT, real capital stock, share of employed)	-0.047	0.114	0.074	-0.039	0.083**	-0.249	0.011	-0.177***	0.094*	0.036	0.011	0.163	0.051
	(0.063)	(0.077)	(0.057)	(0.051)	(0.033)	(0.233)	(0.072)	(0.034)	(0.052)	(0.080)	(0.066)	(0.095)	(0.044)
ΔLn (NonICT, real capital stock, share of employed)	-0.130	-0.128	0.439	0.250	-0.187	-1.077	0.675**	0.250	-0.030	0.334	0.142	0.368	0.062
	(0.464)	(0.136)	(0.293)	(0.254)	(0.176)	(0.682)	(0.237)	(0.263)	(0.298)	(0.254)	(0.340)	(0.285)	(0.267)
ΔLn (OInnProp, real capital stock, share of employed)	-0.240	-0.068	0.067	0.063	0.107	1.423	-0.085	0.089	0.132	-0.235	-0.159	-0.782**	-0.195
	(0.224)	(0.151)	(0.108)	(0.229)	(0.104)	(1.102)	(0.117)	(0.216)	(0.141)	(0.295)	(0.146)	(0.318)	(0.181)
ΔLn (RD, real capital stock, share of employed)	-0.111	0.200	-0.042	-0.336**	0.283**	0.572	0.048	-0.242	0.139	0.255	0.228	-0.012	0.243**
	(0.080)	(0.121)	(0.108)	(0.137)	(0.100)	(0.430)	(0.118)	(0.146)	(0.125)	(0.222)	(0.160)	(0.122)	(0.082)
ΔLn (SoftDB, real capital stock, share of employed)	-0.045	-0.002	-0.062	0.226***	-0.044	0.013	0.050	0.049	-0.010	-0.254*	0.023	-0.149*	-0.088
	(0.058)	(0.056)	(0.066)	(0.057)	(0.032)	(0.349)	(0.036)	(0.064)	(0.043)	(0.139)	(0.043)	(0.076)	(0.067)
ΔLn (Inward FDI, real stock / employed), 3-year lag	-0.025	0.011	0.013*	-0.021	0.013*	0.055	0.016	-0.008	0.005	0.025**	-0.007	-0.004	0.009
	(0.016)	(0.017)	(0.007)	(0.017)	(0.007)	(0.071)	(0.015)	(0.010)	(0.013)	(0.010)	(0.017)	(0.018)	(0.007)
Constant	-1.087***	-0.323***	-0.398	-1.866***	-0.346**	-0.540**	-0.528*	-0.729***	-0.664**	-0.283	-0.742***	-1.474***	-0.798***
	(0.286)	(0.073)	(0.263)	(0.339)	(0.116)	(0.208)	(0.249)	(0.214)	(0.265)	(0.181)	(0.113)	(0.249)	(0.239)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	87	136	119	88	89	59	110	96	121	106	116	99	94
Adj. R-squared	0.232	0.284	0.291	0.545	0.184	0.374	0.192	0.385	0.373	0.436	0.655	0.688	0.533

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

Table C3 / (cont.)

	14_WATR	15_CONS	16_TRMO	17_WHTR	18_RETR	19_TRSR	21_ACCO	22_INFO	23_FINA	24_REAL	25_PROF	26_SOCI
Ln (Labour productivity), lag	-0.189***	-0.242***	-0.064	-0.185	-0.427	-0.488***	-0.053	-0.049	-0.184	-0.276***	-0.081*	-0.138*
	(0.051)	(0.070)	(0.076)	(0.111)	(0.229)	(0.096)	(0.109)	(0.039)	(0.117)	(0.090)	(0.040)	(0.074)
ΔLn (Labour services)	-0.506***	-0.177	-0.641**	-0.300	-0.829*	-0.465	-0.162	-0.303***	-0.296**	-0.161	-0.334***	-0.346**
	(0.128)	(0.160)	(0.203)	(0.490)	(0.342)	(0.262)	(0.222)	(0.090)	(0.105)	(0.095)	(0.112)	(0.126)
ΔLn (EconComp, real capital stock, share of employed)	-0.032	-0.042	0.057	-0.286	-0.200	-0.318*	0.201*	0.019	-0.089	-0.201*	0.037	-0.019
	(0.113)	(0.096)	(0.202)	(0.205)	(0.181)	(0.142)	(0.096)	(0.084)	(0.157)	(0.099)	(0.086)	(0.036)
ΔLn (ICT, real capital stock, share of employed)	-0.051	-0.113**	0.163*	-0.190*	-0.009	0.169	0.030	0.087*	-0.026	-0.036	0.035	-0.001
	(0.060)	(0.047)	(0.067)	(0.098)	(0.057)	(0.107)	(0.034)	(0.042)	(0.054)	(0.033)	(0.026)	(0.014)
ΔLn (NonICT, real capital stock, share of employed)	-0.096	0.382*	-0.958**	0.261	0.245	0.040	0.011	0.015	0.038	0.788***	0.072	-0.001
	(0.182)	(0.182)	(0.311)	(0.353)	(0.453)	(0.211)	(0.255)	(0.108)	(0.156)	(0.158)	(0.087)	(0.084)
ΔLn (OInnProp, real capital stock, share of employed)	0.290	0.049	0.078	0.069	-0.172	0.291*	0.046	0.157	0.047	0.043	0.021	-0.028
	(0.205)	(0.134)	(0.167)	(0.177)	(0.211)	(0.136)	(0.059)	(0.104)	(0.050)	(0.074)	(0.110)	(0.042)
ΔLn (RD, real capital stock, share of employed)	0.033	0.108***	0.037	-0.138	0.001	-0.145*	-0.020	0.135**	-0.007	-0.002	0.105*	0.004
	(0.067)	(0.036)	(0.035)	(0.114)	(0.066)	(0.067)	(0.026)	(0.054)	(0.040)	(0.015)	(0.057)	(0.049)
ΔLn (SoftDB, real capital stock, share of employed)	-0.120**	-0.089**	0.039	-0.109*	-0.041	-0.025	-0.006	-0.054	-0.026	-0.018	-0.017	0.047
	(0.053)	(0.040)	(0.152)	(0.057)	(0.046)	(0.089)	(0.040)	(0.056)	(0.096)	(0.034)	(0.042)	(0.034)
ΔLn (Inward FDI, real stock / employed), 3-year lag	0.002	-0.015	-0.024	-0.017	-0.000	0.002	0.017	-0.001	0.005	0.007	0.007**	-0.001
	(0.009)	(0.009)	(0.031)	(0.041)	(0.020)	(0.003)	(0.014)	(0.003)	(0.012)	(0.012)	(0.003)	(0.001)
Constant	-0.478***	-0.818***	-0.173	-0.480	-1.460	-1.517***	-0.214	-0.110	-0.440	-0.298***	-0.249*	-0.478*
	(0.118)	(0.240)	(0.257)	(0.321)	(0.782)	(0.306)	(0.422)	(0.098)	(0.297)	(0.090)	(0.138)	(0.254)
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Observations	134	131	40	58	46	66	98	150	142	100	142	136
Adj. R-squared	0.352	0.433	0.721	0.166	0.489	0.484	0.197	0.409	0.0461	0.614	0.537	0.347

Note: The dependent variable is real labour productivity (per hour worked) in log-differences. The table shows the estimation results using fixed effects with standard errors clustered by country (in parentheses). *, **, *** indicate statistical significance at the 10, 5 and 1% levels. Sector 20_POST has insufficient number of observations and therefore is omitted from the analysis.

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