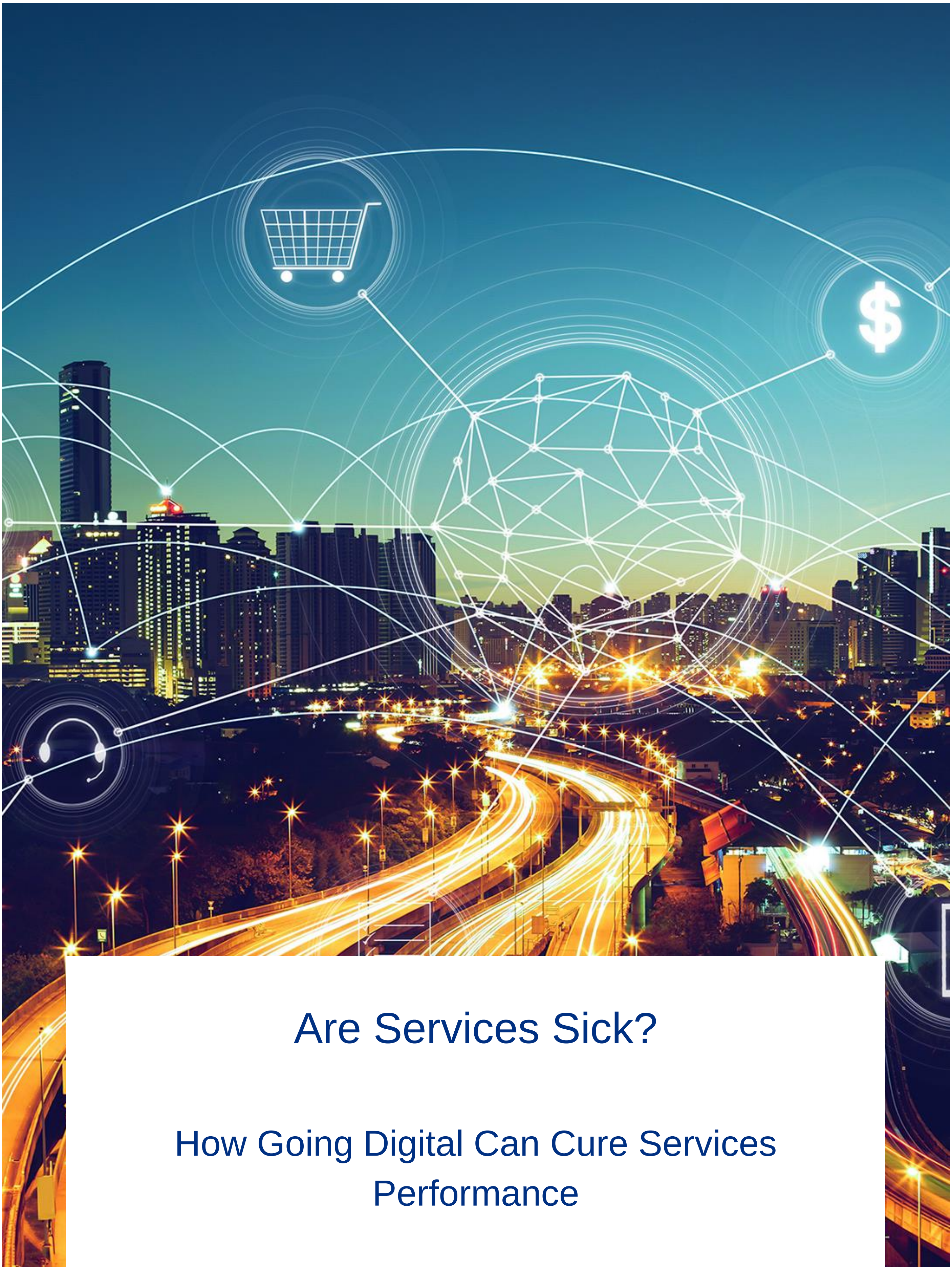

Are Services Sick?

How Going Digital Can Cure Services Performance

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Content

Executive Summary

- Services are important nowadays. In many OECD countries, more than 70 percent of GDP is comprised of services – and, in the EU, services represent 66 percent of output.
- As overall productivity growth is declining, no in-depth study to date has actually zoomed in on the services economy and analysed productivity patterns of the markets of services.
- While services show different productivity patterns, poor performance of many services can be traced back to low absorption rates of digital technologies, driving down overall productivity
- This report shows that the low digital absorption is linked to trade performance in services: as trade restrictions are still high in services it prevents them from picking up these technologies.
- Yet given that many services nowadays are produced with digital technologies, and that many services are traded with the help of the internet, restrictions on digital technologies matter too
- Indeed, differences in services productivity performance between sectors and countries can also be explained by policy factors holding back the digitalisation of services production and trade
- However, not only regulatory restrictions and digital trade barriers prevent services from picking up digital technologies. This report also shows that other factors like market structure matter too.
- Market structure of some services sectors prevents the sectors from the ability to reap greater productivity gains – even if firms invest in digital technologies – due to market concentration.
- In other cases, however, distorted market structures may exist due to cartel-like agreements between service providers failing to create incentives for them to pick up digital technologies.
- If markets suffer from low levels of competition, and if revenues are captured by only a handful of firms, the benefits of digital technologies are entirely offset by a distorted market structure
- In short, our findings show that the widely held view of the adverse relationship between an expanding services market and the slowing down of overall productivity growth is avoidable.

Why Digital Services Matter for Future Proofing Developed Economies

Why should we care about the digitalisation of services? This is not a niche subject. In developed economies, the tertiary or services sector contributes up to 70 percent to GDP, for example in France, the United Kingdom or the United States. Even for Germany, a country with a relatively large and strong manufacturing sector, services make up for 60 percent of GDP, making it much more important than any other type of economic activity.

From an historical perspective, the importance of the services sector has been continuously increasing. While in pre-industrial times the lion share of economic activity was dedicated to the production of raw materials (primary sector), the secondary sector (industrial manufacturing) became dominant after the industrial revolution. For a long time, we have been witnessing a services revolution. The service sector tends to grow faster than most industrial sectors making it even more important for most economies, not only highly developed ones. While trade in goods has been stagnating since the financial crisis, trade in services has continued to expand.

The size and growth of the service sector is not the only reason why we should care about this sector. Technology is already transforming the services sector and will continue to do so in the future. Technological developments make the services sector more productive but also increasingly internationally tradable. The emphasis of this study is on the increases in productivity that a digitalisation of the services sector can bring about. However, technology changes the nature of the services sector as it makes services more internationally tradable.

Examples for this trend are plenty: For the maintenance of a machine, it used to be necessary that some mechanics visit the site of the machine. Today, it’s possible to monitor the performance of the machine remotely, predictive maintenance allows to send replacement parts before the machine breaks down. Consulting services were restricted to being provided by a local consulting team, now video conferencing and data transmission enable consultants to service clients all over the world. While services already constitute a large share of activities in developed economies, the increasing opportunity to trade services worldwide makes it likely that they will continue to expand in the future. In order to be able to compete with other providers of services worldwide, productivity is key, hence the motivation of this study to look deeper into what drives productivity developments in the services sector.

For developed economies especially, it is crucial to harness the potential inherent in more productive and more internationally tradable services. Making sure services are competitive is a good way to future-proof many economies. This study looks into productivity developments in the services industry and which factors contributed to them. We hope that we can make a contribution to improving competitiveness of the services industry.

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Introduction

A puzzling conclusion in many studies of economic modernisation is that the growth of productivity tends to decline when economies become post-industrial and raise the share of the services sector in the economy. In many OECD countries, more than 70 percent of GDP is comprised of services – and, in the EU, services represent 66 percent of the output. For Germany, this figure stands at 61 percent. It is true that these numbers mask great differences among European countries (for instance, in Romania and the Czech Republic the share is only around 50 percent), but a majority of economic activities in all countries are nonetheless based on services. Even emerging economies like South Africa and Brazil record a services-share of GDP that is more than half.

It is in several ways a desirable development, but one consequence of the "servicification" of the economy is that there is a loss of underlying economic dynamism, at least when measured as productivity growth. Figure 1.1 outlines the aggregate development with the two lines indicating a conflicting trend: as the size of services in GDP expands, productivity goes in opposite direction. The trend has accelerated since the financial crisis in 2008. Given that productivity is a key factor for economic growth in the long run, the end result of an expanding services sector is that people get deprived of new economic prosperity.

Why is productivity growth declining on the heels of service-sector growth? Scholars have struggled to get to the bottom of the crawling services economy and identified some causes. Most analyses have pointed to explanations that are general to the entire economy – and not specifically about services. For instance, Gordon (2015) notes that many important innovations have already taken place, and that recent technological change has underwhelmed. Innovation today, quips Paul Krugman, is "more fun than fundamental" and, as a consequence, its contribution to productivity growth has declined.[1] Others have suggested that growth in research productivity has been falling (Bloom et al., 2017) or that ICT and other digital technologies have not boosted the wider economy much, at least not since the ICT boom (van Ark, 2018).

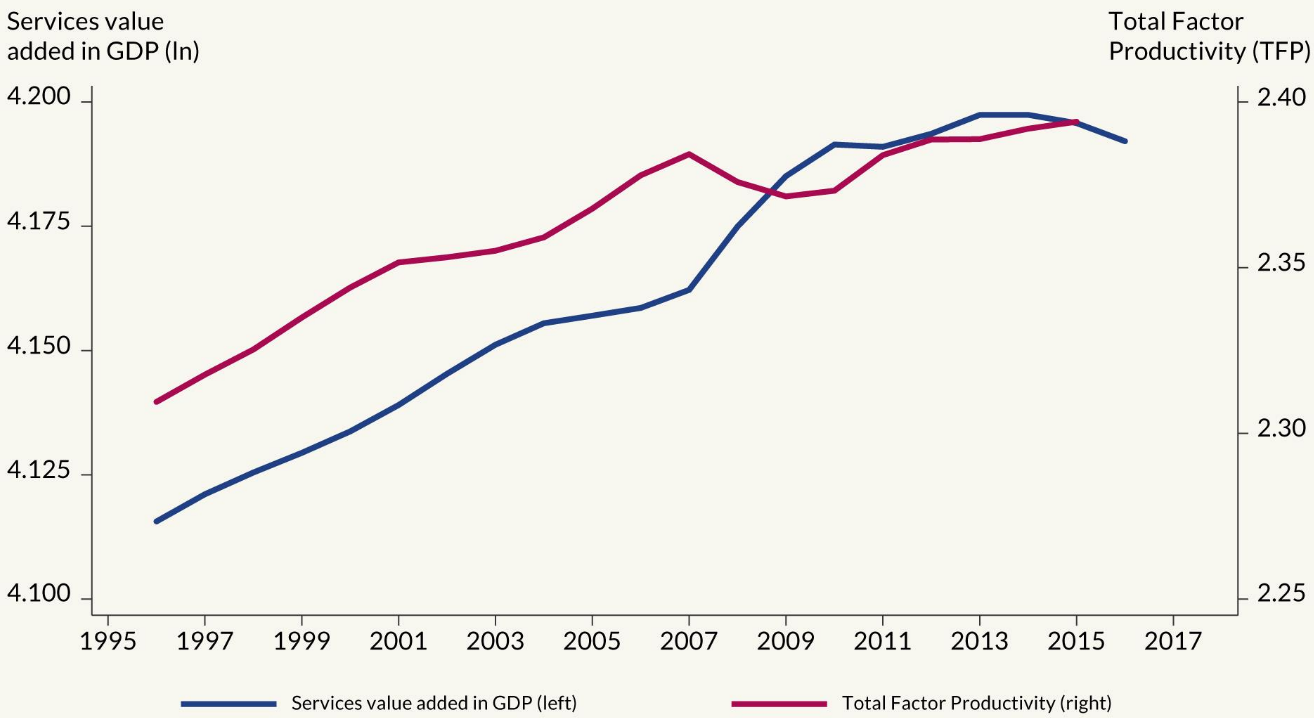
However, none of these studies have actually zoomed in on the services economy. It is the purpose of this study to put new light on the productivity dynamics in the service sector and identify key factors holding down the performance of this sector, especially in trade. It is our thesis that, while the sector will show productivity variations, poor performance can be explained by low absorptions of digital technologies. More specifically, this report intends to analyse how the low digital absorption is linked to services trade performance. It investigates, firstly, if variations in services productivity performance – between sectors and countries – can be explained by policy factors holding back the digitalisation of services production and trade. Secondly, it examines if other factors like market structure and internationalisation experiences explain why some sectors and countries perform well, but not others.

Importantly, our findings show that the adverse relationship between an expanding services market and the slowing down of productivity growth is avoidable. We use econometric analyses to back up the conclusion, but even basic observations provide support for our optimistic view. For instance, some services in Europe and the United States are comparable with the manufacturing sectors in productivity performance,

[1] Both Fernald (2014) and the OECD (2015) confirm the notion that the recent productivity slowdown has been caused by mainly two factors: the decreased growth levels of capital deepening and TFP. The slow pace of new innovations and inventions can be seen as the most important factor for this as Gordon (2015) notes.

proving that some services aren't trailing behind industrial firms. There are also sectoral variations between countries, and the sheer observation that some services perform well in some countries but not in others suggests that poor productivity growth is not indigenous to services. And that takes us to a critical conclusion: the productivity performance in services depends on whether services markets are open or closed, and the extent to which the structure of the services market invites the adoption of digital technologies.

FIGURE 1.1: **Services Value-added in GDP and Total Factor Productivity (TFP) in the Euro Area**



Source: World Bank WDI; Bergeaud et al. (2016); Eurostat; authors' own calculations. Note: Services value-added and GDP in current USD are both deflated using appropriate deflators from Eurostat.

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Crucially, the performance of services sectors depends on the restrictiveness and quality of regulation. The modernization of services-sector regulation has not advanced as much as the regulation of manufacturing. Obviously, regulatory motivations differ: many services are regulated for historical reasons or because they have aspects of market failure. But many regulations are unnecessarily burdensome, preventing services from being traded and thereby contributing to the low productivity levels in services in many economies. Moreover, given that many services nowadays have been produced with the help of digital technologies, and that many services are traded with the help of the internet, restrictions on digital technologies matter too.

Consequently, this report looks at the combinatorial effect of restrictive services-trade policies *and* prohibitive policies in digital trade. The combined effect of distortive digital and non-digital policies in services is one factor explaining the varying degrees of the "digital-intensity" of services, i.e. the extent to which services absorb digital technologies as part of their production process. Put differently, restrictive policies in services and digital trade appear to slow down the pace of digital technologies rippling through services sectors, leading to poor productivity performance in many services, particularly in those services that could and should be reliant on digital technologies.

But it is just not policy that explains poor services performance. The market structure of services themselves (as opposed to the environment in which they operate) matters equally. The last part of this report shows that the market structure of some services sectors prevents the sector from reaping greater productivity gains – even if firms invest in digital technologies. In fact, our research shows that firm benefits of absorbing digital technologies can entirely be nullified if the services sector has high market concentration. In other words, if markets suffer from low levels of competition, and if revenues are captured by only a handful of firms, the benefits of digital technologies are entirely offset by this distorted structure of the market.

1 Services Productivity Developments in Developed Economies

This chapter makes the point that, at first sight, services may be considered “sick” as they suffer from poor productivity developments that ultimately impact negatively on the total economy. However, this is a misguided view, not least because digital technologies have managed to improve the performance of various services. Even if there are reasons to expect some services to suffer from the “cost disease” – the supposition, first made by William Baumol, that productivity in services inevitably will suffer because of their inability to raise productivity on the back of new technology – the reality is that some services clearly are healthy and that digitally-intense sectors tend to perform comparably to the manufacturing sector, which traditionally shows a higher level of productivity growth.

1.1 Are Services Sick?

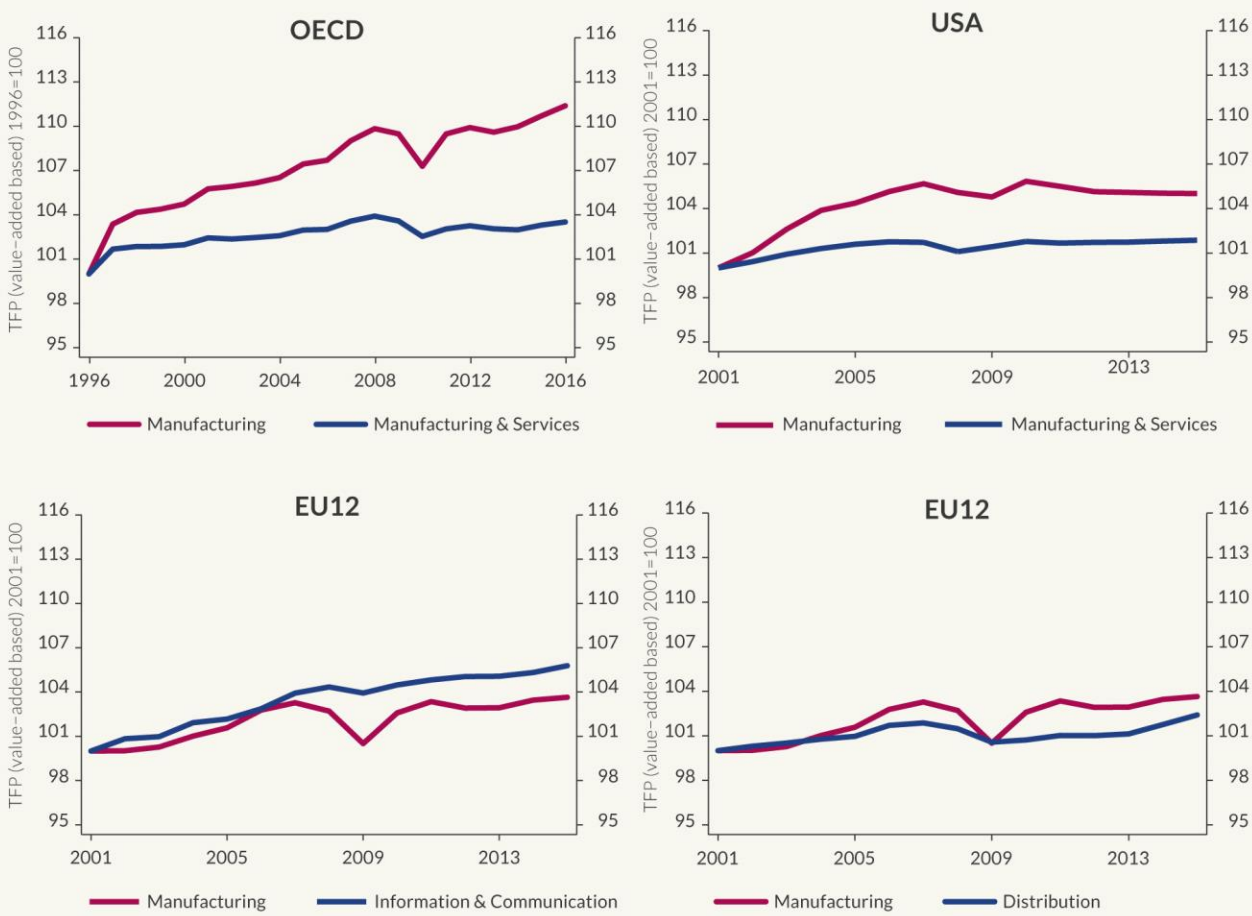
Economists have for long had a concern about the services sector: services tend to be a long-term drag on the economy, and the more an economy gets dependent on services, the worse it performs in classic indicators of economic dynamism, like productivity growth. The expansion of the services sector is part of economic modernisation. The richer countries become, the more likely they are to move their dominant share of economic activity from manufacturing to services. This can also be seen in Figure 1.1 in the introduction. Even though the services share in the EU19 has flattened out in recent years, formal analysis using regressions-as-correlations (Table A1 in Annex A) show the existence of a close association between an expanding services sector and reduced productivity across OECD countries.

The negative relationship between the share of services and productivity is more commonly known among economists as “Baumol’s cost disease” (Baumol, 1963; Baumol and Bowen, 1964). The Baumol disease states that some services such as personal services are less susceptible to labour productivity improvements because labour is not easily substitutable by other more productive means. Moreover, many services are intangible, non-storable and non-tradable, which make them less receptive to technology changes that could boost productivity. Hence, there is an irrepressible logic of the effect on the total economy: as the services share of the economy grows faster over time, low-productive sectors will take over from high-productive sectors and eventually stagnate the general economic growth of a country. Considering the services sector in the aggregate, evidence supports this claim (see Annex A).

Moreover, Figure 1.2 plots the simple trend of TFP growth for manufacturing and services together for OECD countries as a group and the US separately (top panels). The two charts show the TFP developments for the manufacturing sector and the entire market economy (which includes the services economy), and for both country groups, the trend clearly shows a slower productivity growth development for services. Therefore, the two panels support the view that, in the aggregate, the growth of services indeed tends to weigh down the overall productivity development of economies as the manufacturing sector alone records faster productivity rates.

However, all services sectors need not necessarily be less productive than the manufacturing sector. Delving deeper into some specific sectors, patterns reveal that some services sectors are close to the productivity of manufacturing and some have recorded higher growth patterns of productivity. The bottom panel of Figure 1.2 shows, for instance, that the information and communication sector in the EU12 has surpassed the productivity development in the manufacturing economy. Productivity trends in the EU also show that, for instance, the distribution sector (which covers retail and wholesale together) isn’t far away

FIGURE 1.2: **TFP in Manufacturing and Services in OECD, US and EU12 (1996-2015)**



Source: author's calculations using EUKLEMS.

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from productivity growth in manufacturing. It would therefore be wrong to dismiss the entire services sector as unproductive or being a drag on the entire economy.

Clearly, there are important nuances that defy the Baumol logic of a services cost disease and they can only be identified when the services sector is disentangled.[2]

Further proof can be found in Figure 1.3, plotting the distribution pattern of manufacturing productivity and the productivity of selected services for EU countries and the US. In this figure, the bell-shaped curve for each sector indicates where the countries (over time) find their most commonly measured productivity level – indicated by the "bell". If a curve is shifted out more to the right (left), it indicates that this sector is more (less) productive compared to the other curves shown. The fact that the bell-shaped curve of the

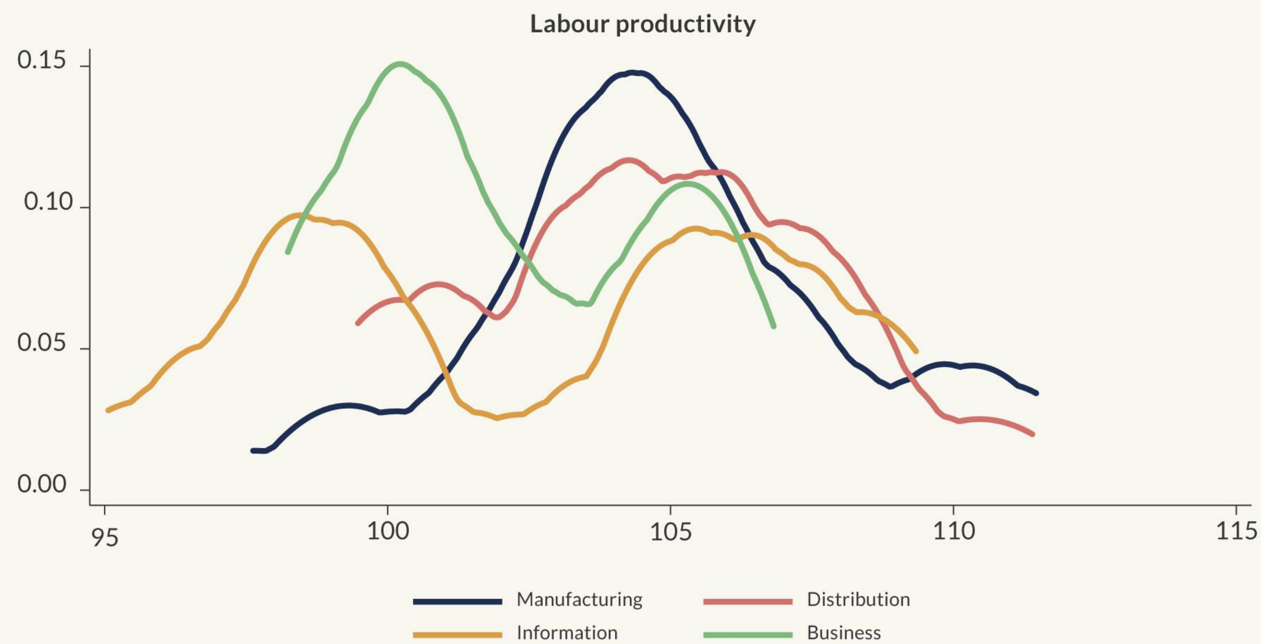
[2] Measurement issues have been also discussed in the literature as an explanation for the slowdown in the productivity growth in services. See for instance Hulten and Nakamura (2017). See for further discussion Box 1.2.

manufacturing sector and the distribution sector are more shifted to the right indicates that these two sectors have been most productive over the years. The distribution sector has a productivity level on par with many manufacturing sub-sectors. Moreover, the “shape” of the bell for the distribution sector also indicates that this sector’s entire productivity distribution is similar to manufacturing: countries show a productivity level towards a central point that is optimal across countries.

However, this is not the case for several other services sectors. For instance, Figure 1.3 also shows that the curves for the business services sector and the information services sector (which covers, publishing, telecom, and IT and other information services together), follow an abnormal distribution of productivity trends. This conclusion can be drawn from the fact that the curve for the respective services sectors illustrate two bell-shaped curves. This means that, over time, there is one group of countries with a lower productivity rate whereas another group with a much higher rate. In effect, this points to a diverging pattern of productivity in these two sectors. Yet, the group of countries with higher productivity levels in information and business services probably means that their sector is on par with manufacturing.

Annex B shows that this conclusion is also true to some extent regarding the financial sector and to a great extent also holds when using TFP instead.[3]

FIGURE 1.3: **Distribution of Labour Productivity in the EU and US in Services and Manufacturing (1990-2015)**



Source: EUKLEMS; authors’ own calculations. The vertical axis indicates the density function of labour productivity across EU countries and the US, which represents the (unit) probability of getting the value denoted by labour productivity i.e. it displays the distribution of the data. Data points are plotted by country-year between 1990-2015.

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[3] Note that these patterns represent productivity levels of growth and not yet the rate of growth itself, which otherwise follows a natural normal log-linear distribution when using in a distribution plot.

1.2 Curing Services with ICT and Digital Technologies

We need a subtler view of services-sector performance. Since some services sectors do not show a consistently lower level of productivity or in all countries, the Baumol disease simply cannot apply unconditionally. The fact that services does not necessarily need to be less productive than manufacturing has also been theorized and emphasized by other scholars (Young, 2014; IMF, 2018). After all, a healthy pattern of economic growth has been recorded in the past two centuries despite a growing share of the services economy. Even though expanding services sectors may attract more resources that are less efficient, services and goods do not necessarily need to diverge in productivity growth.

Moreover, Blanchard (2004) have pointed out that US services sectors that use IT intensively have had much higher growth rates compared to Europe, when measured against manufacturing. Again, this suggests that there are technology factors at play. Critically, analysis in the US have also demonstrated that, in the distribution sector, the use of digital tools and technologies enabled this sector to “cure” the Baumol disease (Triplett and Bosworth, 2004). These observations beg the question: what kind of services then show similar productivity developments as manufacturing, and what make them different from other services sectors? Furthermore, in what way does technology make services more productive?

There is one commonality between the services sectors that show (at least in part) a productivity trend similar to manufacturing: they appear to use ICT and digital technologies extensively (see Box 1.1 for a definition of digital technologies). For instance, the distribution sector uses many digital technologies to monitor the flow of retail and wholesale goods in the supply chain – from producer to consumer. Financial services are commonly known for being a heavy user of ICT; in fact, the sector can actually be considered as a producer of ICT. Generally, many of the more productive services sectors have used ICT and other digital technologies to allow for greater tradability and storability of services, raising their productivity potential. [4]

These results are not surprising. They rather conform to conclusions drawn from the analysis of entire economies. The positive contribution of ICT to the economy has been well documented, for instance, in firm-level analysis by Bloom et al. (2012) and Basker (2012) and in industry-level analysis by Stiroh (2002) and O’Mahony and Timmer (2009). Moreover, Van Ark et al. (2008) have pointed out that growth differences between the EU and the US can be mainly traced back to the lower growth contributions of ICT technology in Europe and the bigger size of ICT technology-producing industries in the US. The latter authors also showed that these differences are in large part caused by differences in the performance of services (Inklaar, et al., 2007). More recently, studies for the US reveal that productivity gains have been concentrated in the ICT industry and not so much in the downstream sectors that are using ICT and digital technologies (Acemuglu et al., 2014).

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[4] A further notion to reflect on regarding services and productivity is that the use of the former by many industries has greatly improved the productivity of producing goods in terms of their quality (another determinant of productivity growth). For instance, the use of design, customization and after-sales services or even the use and trade of goods through online platform services have greatly improved the quality of many downstream goods in the economy. The use of digital technologies plays a critical role in this process.

Box 1.1: What are ICTs, Digital Goods, Services and Technologies?

Digital goods are goods provided in the digital economy such as semi-conductors, fibre optic cables, and internet-connected devices.

Digital services can be split into two categories, namely digital services and digital-enabled services. The former cover telecom services, computer and other internet services.

The latter come into existence and are delivered through digital technologies such as the internet but are not a digital services *per se*. They include all intangible items such as cloud computing, digital content services (for instance provided by Netflix), and online search engines. They also cover financial services in the form of digital payments (either through an online platform or not).

In this framework, the cross-border flow of data is underpinning the production and trade of digitally delivered and enabled goods and services. With the help of internet technologies, cross-border data support digital trade to happen. In other words, internet and other digital technologies create production and trade opportunities in many sectors.[5]

These digital technologies cut across sectors and traditional business functions in many supply chains. For instance, R&D services use 3D printing (robotics and automation), management services use supply chain monitoring systems (IoT) and marketing services use automatic customer services (data analytics).

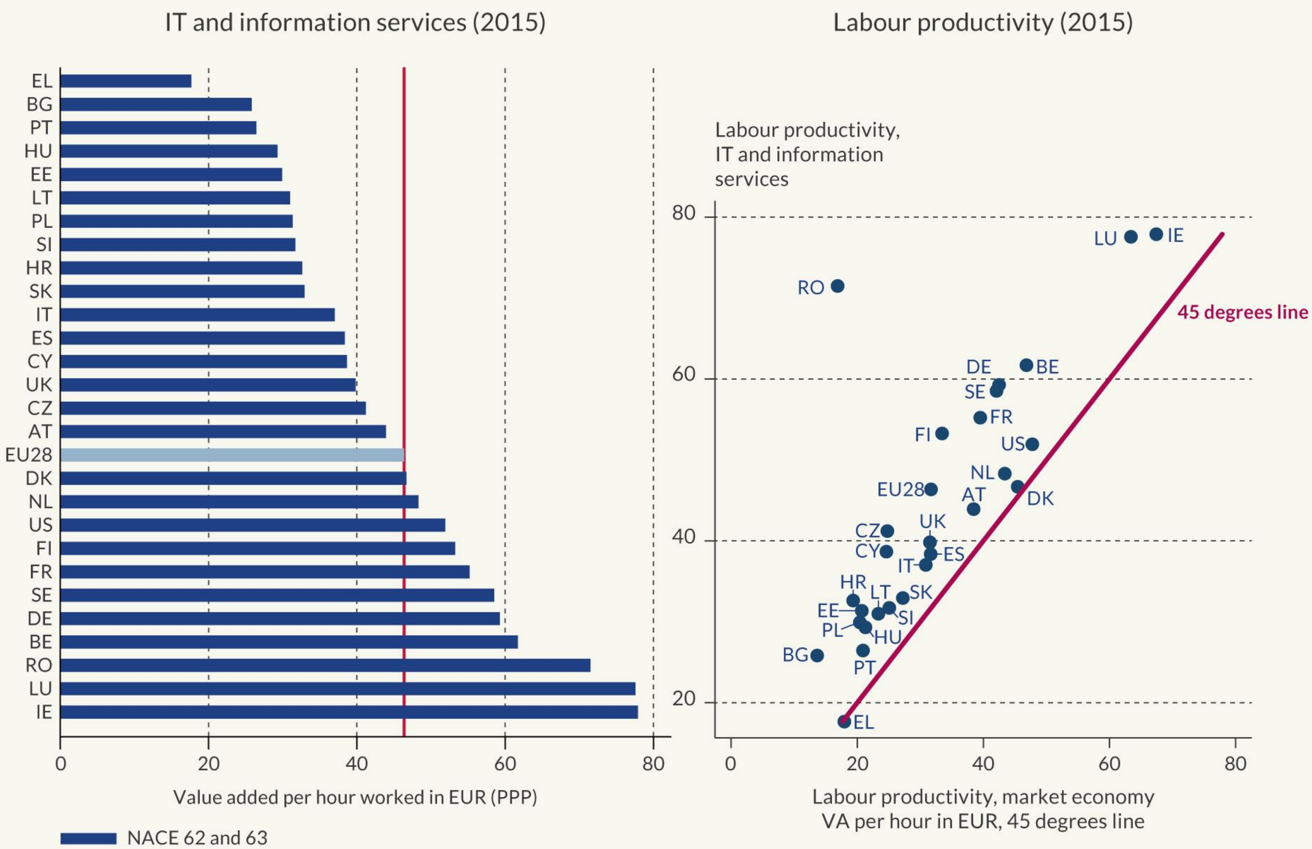
E-commerce is also widely used nowadays. The distribution sector for instance uses Unmanned Aerial Vehicles (UAV) for packages delivery – in addition to remote monitoring, update and maintenance systems that are all digital. All these internet technologies help establishing sectors that make use of e-commerce platforms to expand digital trade and become more productive. Furthermore, many e-commerce platforms use internet technologies such as warehouse robotics (automation).

1.3 Downstream Effects of Digital Developments

Why isn't there better downstream effects? The successful absorption in downstream sectors of digital technologies is to some extent linked to the productivity developments of the IT sector itself. Generally, digital-services sectors can be split into so-called ICT "producing" and ICT "using" sectors on the basis of work by Jorgenson et al. (2011). ICT producing industries and sectors bring forward the ICT goods, digital technologies and services that are in turn used by the ICT using sectors, i.e. downstream. Interestingly, in the ICT producing industry in Figure 1.4 (left-hand panel), there is substantial variation in productivity among EU countries and the US. Countries such as Hungary, Poland, Estonia, Italy and Spain suffer from low productivity in this sector, whereas Luxembourg, Romania, Belgium, Sweden and Germany appear to have a much more thriving ICT producing sectors, even more so than the US.

[5] Examples of internet technologies are cloud-based data processing and data analytics, digital content, e-commerce, the Internet of Things (IoT), and robotics as well as automation processes enabled by Artificial Intelligence (IA) (see USITC, 2017).

FIGURE 1.4: **Varying Productivity Levels in the ICT Sector (2015)**



Source: EUKLEMS; Eurostat; authors' own calculations.

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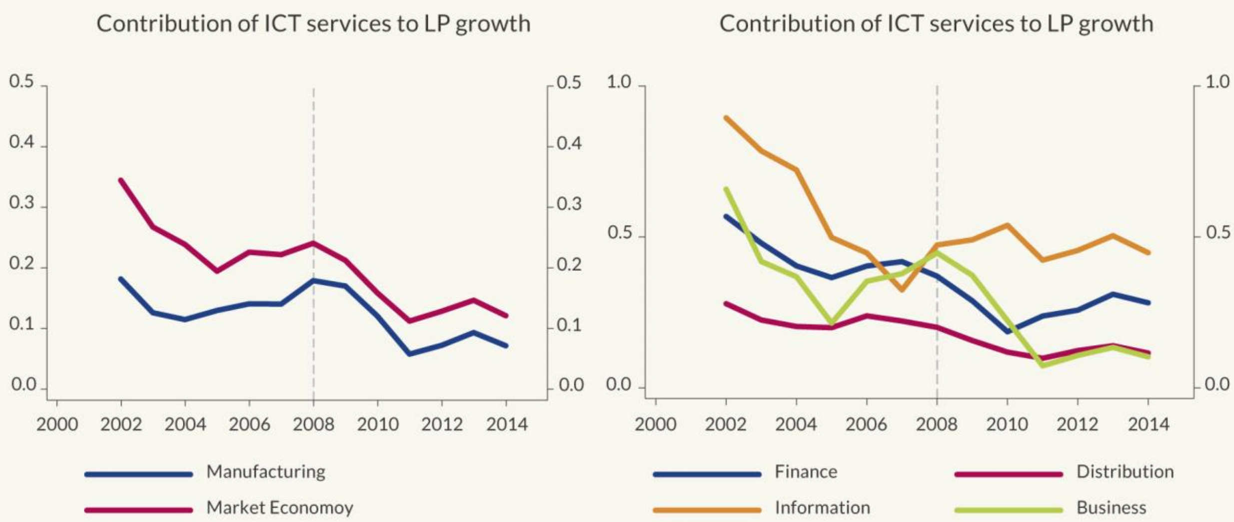
Ultimately, the productive digital services and technologies from the ICT producing (services) sector should have positive effects on the wider downstream economy. That also seems to be the case. Figure 1.4 (right-hand panel) shows that countries with a thriving IT and information services sector have better productivity developments in the wider market economy (covering both goods and services). The figure shows that there is a close connection between the productivity of ICT producing and all other ICT using sectors and industries. Incidentally, the general pattern also shows that the IT and information sector is more productive than that of the market economy overall in all countries (most dots are placed above the 45-degrees line). The striking result is that a thriving digital market has positive knock-on effects on the sectors using digital technologies. Conversely, countries with lower productivity in the digital producing sector have a much lower performance in the total economy.

True, a successful ICT sector does not guarantee that services sectors using digital technologies will also become more economically productive. Much depends on the willingness and ability of the non-digital services sector to absorb new technologies – and, naturally, there is variation between these sectors. In the US, for instance, the ICT sector has greatly contributed to enhancing productivity growth in the distribution sector (Triplett and Bosworth, 2003), partly by enabling new management models. However, recent studies such as van Ark (2018) find that ICT technologies and data services still need to be further "infused" in many economies before there can be larger productivity payoffs. Worryingly, the contribution of ICT to downstream productivity growth has been waning despite the emergence of new ICT technologies. Figure

1.5 (left-hand panel) shows that downstream productivity growth has been declining in the EU, even if services sectors profit the most from the ICT contribution to the overall productivity level.

FIGURE 1.5: **Contribution of ICT to Productivity in Downstream Sectors in the EU12 (2000-2015)**



Source: EUKLEMS; authors' own calculations. Each line represents the 3-years moving averages so as to smoothen out the trend and reduce the influence of outliers.

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Moreover, some sectors have been more successful than others in translating ICT technologies and services into productive activities. In Europe, the information sectors (which include publishing and broadcasting) are naturally placed to profit from the use of digital technologies, and their usage of ICT has had a positive impact on their labour productivity. Similarly, financial services have also had a positive productivity development on the back of ICT, at least in recent times. Although being more or less stable, the distribution sector shows a lower productivity level that can be traced back to its relatively low levels of digital penetration compared to the amount of labour it uses. Other services sectors, such as business services, have moved in a negative direction: they have declined their profits from using ICT technologies. After 2008, the reduced impact of ICT usage that contributes to productivity growth in business services have been stronger than in all other sectors.

1.4 Concluding Comments

Our conclusion from this chapter is that services do not necessarily need to be unproductive to the economy and that much of the variation in productivity growth in services sectors are in part explained by variations in the use of digital technologies.

In other words, if services firms are better at deploying digital and ICT technologies there would be a positive effect on their productivity levels. Firms can become more productive by using new technologies to produce services and improve their production, quality and delivery. Digital technologies and services can also create entirely new services downstream. For instance, the internet has greatly expanded the scope and quality of broadcasting and sound recording services, but also for R&D and distribution services (see Box 1.2).

However, there are important market conditions that also determine the employment of digital technologies – and its effect on productivity. Therefore, the theme of the next chapter is the role of regulatory policies in services, and how regulations are strongly associated with levels of digital deployment by firms active in services sectors and, subsequently, the productivity of services.

2 Service Sector use of Digital Technologies in the EU

This chapter will examine if variations in services productivity can be traced back to (a) the absorption of digital technologies, and (b) if the capacity for absorption depends on a favourable regulatory framework in (digital) services. Our analysis will show that sectoral receptiveness to digital technologies is partly explained by their general openness to trade. In fact, the results show that the combination of digital and non-digital policy restrictions has a direct and significant impact on productivity development in services. In sum, restrictive policies in services generally lead to a misallocation of factor resources such as labour and capital (Hsieh and Klenow, 2014; 2009); in our case, they also prevent the diffusion of digital technologies that would make sectors more productive.

2.1 Digital Intensities: The Use of Digital Technologies by European Firms

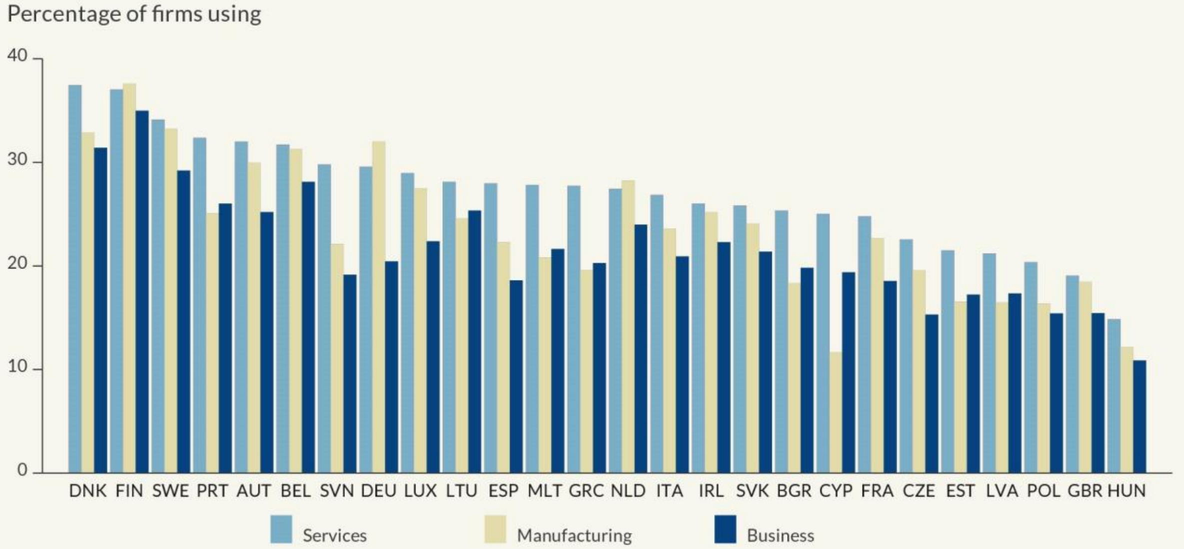
What does digital absorption look like in Europe? Using Eurostat's Comprehensive Dataset on the Digital Economy and Society, we have computed the percentage of firms using digital and ICT technologies that are useful for businesses (digital technologies specifically utilized by households are excluded). More precisely, using the large firm-level survey from Eurostat's database we calculate the percentage of firms using (a) big data, (b) cloud computing, (c) advanced software for Customer Relationship Management (CRM), (d) Enterprise Resource Planning (ERP) software package, (e) automated e-invoicing, (f) Radio Frequency Identification (RFID) technologies to automatically identify and trade tagged objects, and (g) finally automated business process between suppliers (see Annex C for more details).

The results are shown in Figure 2.1 where European countries are ranked by digital usage in the entire services sector (left-bar for each country). It is in the Nordics and Portugal where services firms most absorb digital technologies. Next in line are Austria, Belgium, Germany and Luxembourg. The countries that show lowest use of digital technologies are Hungary, UK, Estonia, and Poland. One interesting result is that both the UK and Latvia appear to have low penetration rates by firms despite having sectors that are usually digitally intense. For instance, the UK has a large financial sector that is generally measured as digitally intensive (see below), and Estonia has had some successes with digital unicorns such as Skype whilst also having developed a strong e-government framework.[6]

Figure 2.1 benchmarks digital usage in services against manufacturing and the sub-sector of business and professional services, which include wide-ranging type of services such as value-chain services (i.e. marketing, consultancy services) and professional services (i.e. accountancy and legal services). Except for Finland, Germany and the Netherlands, the absorption rate of digital technologies is higher in services than manufacturing. The general pattern that digital technologies are mostly present in services has been pointed out before (see WTO, 2018). Germany's level of digital technologies in manufacturing is no surprise since the country has a strong industrial base. The fact that two services-oriented economies like Finland and the Netherlands have lower digital penetration rates in services is notable.

[6] Note, however, that the Eurostat database measured firm's digital technology usage of all categories of companies starting from small companies with 10 or more employees. As a result, the figures in this section shows the percentage of firms' digital technology usage for small and medium sized firms as well as the largest firms.

FIGURE 2.1: **Percentage Usage of Digital Technologies by Firms (e-business) in EU (2009-2016)**



Source: Eurostat; ECIPE; authors' own calculations.
Note: The long time span is taken because of missing intermittant years for several indicators of ICT technology.
See Annex C for more details..

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Box 2.1: Services and Digital Technologies: Missing Growth in in the US?

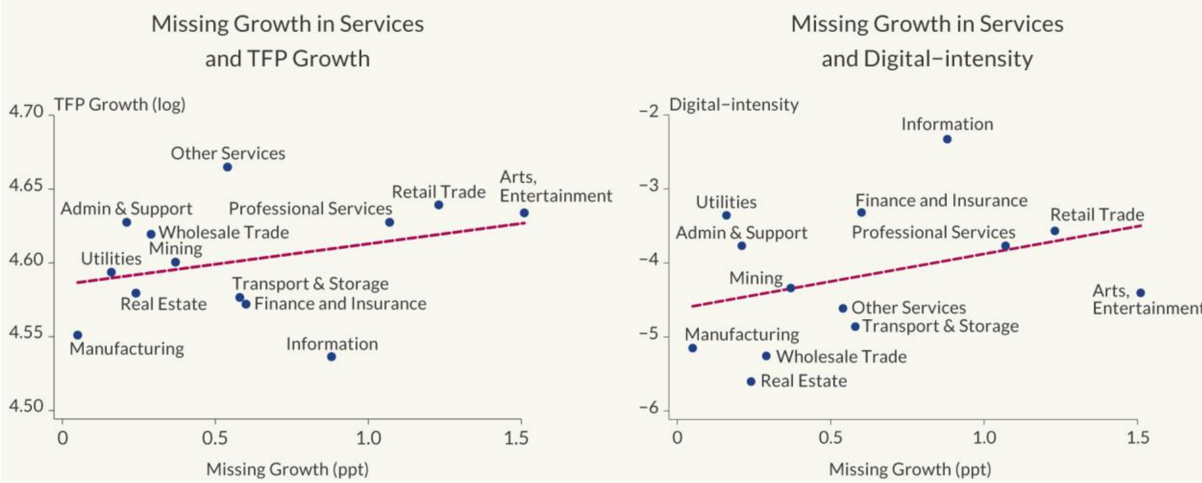
Further evidence showing that digital technologies are an important factor in creating growth is provided with some results from a recent study by Aghion et al. (2018). As the authors argue, many services suffer from "missing growth" – growth not properly recorded by statistical agencies. And that missing growth is realized through the Schumpeterian force of creative destruction.

Whether the contribution of services is truly under-estimated remains to be seen. Other reports have pointed out that the understatement of growth is negligible – see for instance by Bean (2016), Syverson (2017) and Byrne et al. (2016). The point here is rather that there is a revealing sector variation supporting our analysis. In our case, when plotting Aghion's missing growth against our TFP measure in services, the interesting result is that missing growth is precisely reported in already high productivity sectors.[7]

That can be seen in the left-hand panel below of Figure B1. The horizontal axis reports the percentage point missing growth for each 2-digit services sector whereas US TFP growth over the same period is plotted on the vertical axis. Missing growth which would be caused by under-reported Schumpeterian forces is actually seen in the most productive services sectors over a time span of three decades.

[7] One element to keep in mind regarding the digital services and productivity is that the digital economy has brought forward many "free" digital services which may modify as well as complicate the measurement of services productivity.

FIGURE B1: **Missing Growth and TFP Growth and Digital Intensity (1983-2013)**



Source: EUKLEMS; Aghion et al. (2018); US Census. Note that Hotels and Restaurants are excluded because of being an extreme outlier. However, that does not alter the patterns described. Applying productivity weighs neither affect the results found in the two panels.

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What is more interesting for our analysis, however, is that supposedly missing growth in the US is observed in services that are very digital intense (measured by usage of advanced software). In the right-hand panel of Figure B1, sectors such as arts, entertainment, retail trade and professional services are more intensive users of digital technologies such as computer software. If anything, digital absorption is likely to allow for new services entering the market which in turn makes services more dynamic in the economy, contributing to growth – regardless of whether it is under-reported or not.

Further analysis reveals that it is particularly the small and medium size firms in the UK, Estonia and Poland that have extremely low digital penetration rates. In the Netherlands and Belgium, this rate for SMEs is much higher.[8] A final message from Figure 2.1 is that the business services sector shows the lowest usage level of digital technologies by firms despite being one of the most dynamic parts of the entire services economy. The digital absorption rate is very low particularly in Hungary, the UK, Slovenia and some other Eastern European countries. In the Nordic countries, Belgium, the Netherlands, and Lithuania, this percentage is much higher.

2.2 Digital Intensities and Digital Trade Regulation

What explains the variation in firm usage of digital technologies? One potential factor is regulation, or how regulatory policies are set in the digital economy. There are good reasons to believe that there is substantial variation between how countries design regulations relevant for digital absorption – and, in the first

[8] Note that this is based on the percentage of firms that use digital technologies across the entire range of services covering both manufacturing and services as no detailed data is available for SMEs by services sector. Moreover, when using this metric, Belgium accounts for the highest percentage of firm usage of digital technologies.

place, that regulation matters. Moreover, emerging digital technologies and changing patterns of globalization alter competition in many sectors, and that provides reasons or incentives for governments to respond with new regulatory policies.

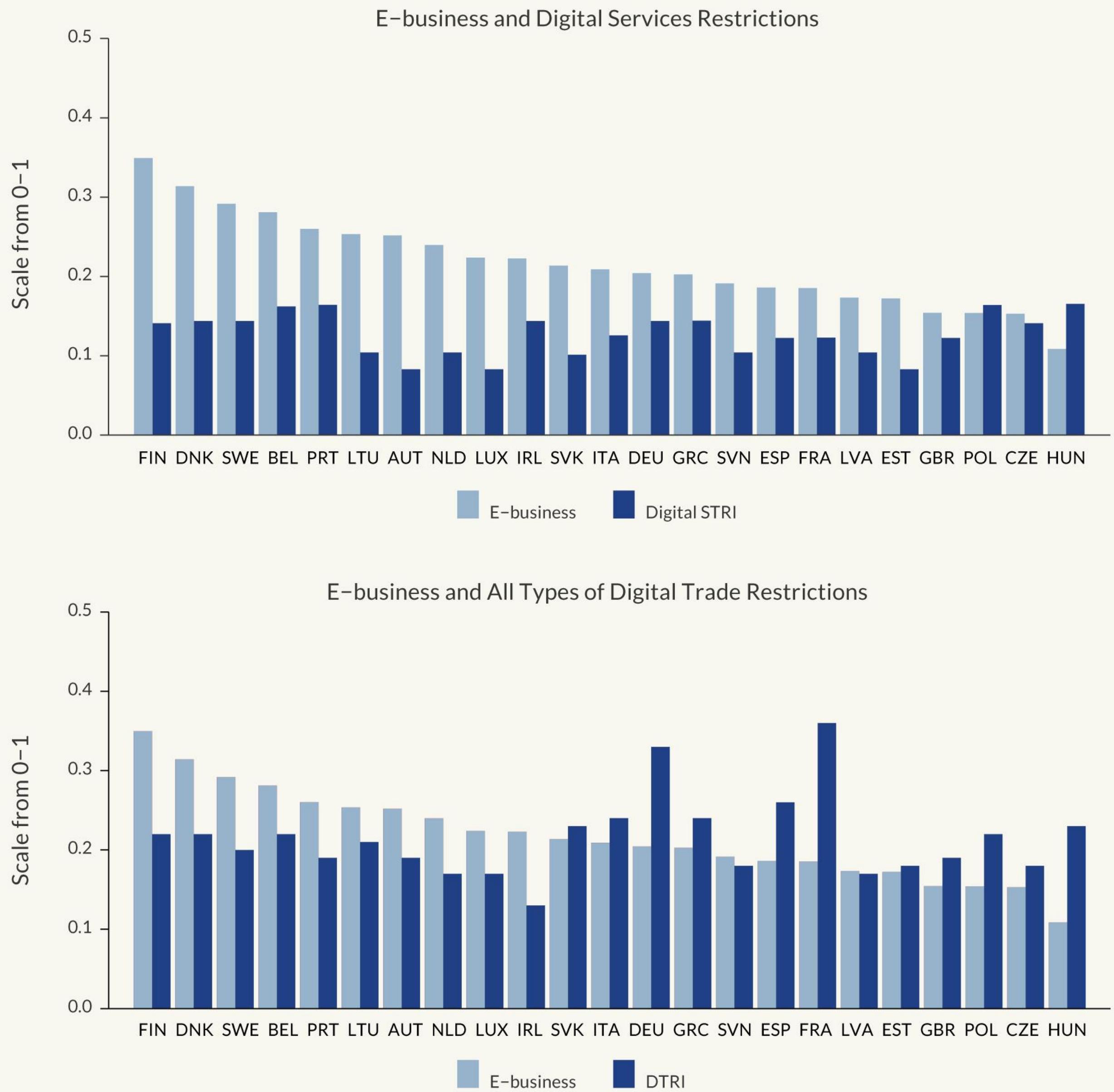
Evidence supports this supposition. The general openness of markets is strongly associated with positive productivity developments, not least because of the “spill-over effects” that trade has on the economy. The same conclusion holds for openness to digital trade and the digital and non-digital economy at large. Markets that are characterized with open regulatory policies in trade and digital technologies are likely to bring in the best available technologies and digital services. Barring policies to address market failures, burdensome restrictions in digital services trade are likely to frustrate the absorption of digital technologies by firms in all sorts of sectors in the economy.

Figure 2.2 illustrates this relationship between too restrictive policies in digital (services) trade and the take-up of digital technologies by firms in the EU services economy. The top panel of the figure shows the indicator measuring the extent to which firms in EU countries take up digital technologies (i.e. our e-business indicator) and the OECD Digital Services Trade Restrictiveness Index (Digital STRI). Both indicators vary between 0 (no usage of digital technologies by any firms and complete openness, respectively) and 1 (all firms show usage of digital technologies and completely closed markets, respectively). Even if no strong pattern can be observed at first sight, it is notable that some countries with low digital absorption rates have *relatively* higher restrictions in digital services markets compared to some countries where firms show a higher amount of digital technologies.

This result is reinforced when we are using ECIPE’s Digital Trade Restrictiveness Index (DTRI), an index measuring digital trade restrictiveness in the entire (digital) economy (including areas such as digital goods, internet technologies and public procurement). For example, the DTRI also covers restrictions on platforms (e.g. intermediate liability regimes), e-commerce activities (e.g. online sales and transaction regulations) and an extensive set of restrictive data policies such as data localization. The bottom panel of Figure 2.2, showing the DTRI together with the e-business indicator, illustrates that some countries with the lowest digital penetration rates by firms also have substantially higher restrictions than others in digital trade. In short, firms are likely to make much less use of digital technologies in countries with burdensome restrictions in digital trade.

A last point is that the fact that our wider DTRI index appears to have a somewhat stronger result likely means that it’s not only digital restrictions in services that matter, but that the entire range of restrictions in the digital economy (including non-services) prevent spill-over effects running from the digital sector to other downstream services sectors.

FIGURE 2.2: **E-business and Digital (Services) Trade Restrictiveness (2014-2015)**



Source: Eurostat, OECD, ECIPE; authors' own calculations. Note: See Annex C for further details. E-business denotes the percentage usage of digital technologies by firms in each services sector. For the e-business indicator, the sector of business services is chosen.

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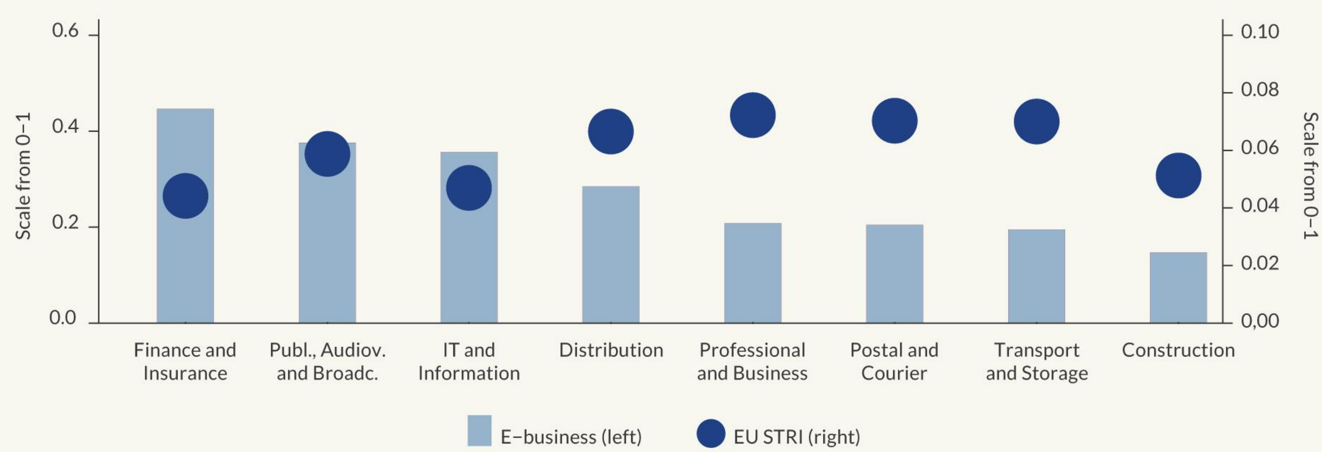
2.3 Digital Intensities and Services Trade Regulation

Let us now turn to general and non-digital services restrictions as they surely also play a role in explaining varying rates of digital absorption – not least because they cover a wider scope of policies. Services trade is different from trade in goods in that it can happen in different ways: services trade has more modes of supply. For instance, services can be exported in the classic way – from one country to another (e.g. traded over the internet), but trade can also happen through a foreign subsidiary and the actual services provider crossing a border to perform the exported or imported service. Services regulations therefore span a wide set of policies such as investment restrictions and restrictions on the movement of natural persons across borders.

Moreover, there are many *indirect* regulatory policies that have a restrictive impact on services trade, e.g. general barriers to competition in services markets or non-transparent administrative rules and procedures that burden the business operations for services providers. The OECD's Services Trade Restrictiveness Index (STRI) include all these restrictive measures – for many services – and allow for an assessment of their effect on services across sectors. Furthermore, a new index by the OECD (the EU STRI) measures restrictions to services trade for 25 EU countries within the European Economic Area (EEA).[9] Similar to the Digital STRI and e-business index, the EU STRI is measured between 0 and 1.

As shown in Figure 2.3, the structure of restrictiveness within each services sector is similar to the index of digital restrictions across countries. When all countries are taken into account, the figure shows that some services are less digital-intense than others while also facing higher non-digital services trade restrictions. This pattern support previous findings. Although the level of restrictiveness within the EEA is relatively low (see right-hand side axis), it is nonetheless clear that firms active in, for example, construction and transport and storage, courier services and business services are less digitally intense. It is equally clear that these services face higher levels of non-digital restrictions (as shown by the dots) compared to financial services and various information services. The latter two services show a greater usage of digital technologies by firms.

FIGURE 2.3: **E-business and (Internal) EU Services Restrictions within the EEA (2014-2015)**



Source: Eurostat, OECD, ECIPE; authors' own calculations. Note: See Annex C for further details. E-business denotes the percentage usage of digital technologies by firms in each services sector.

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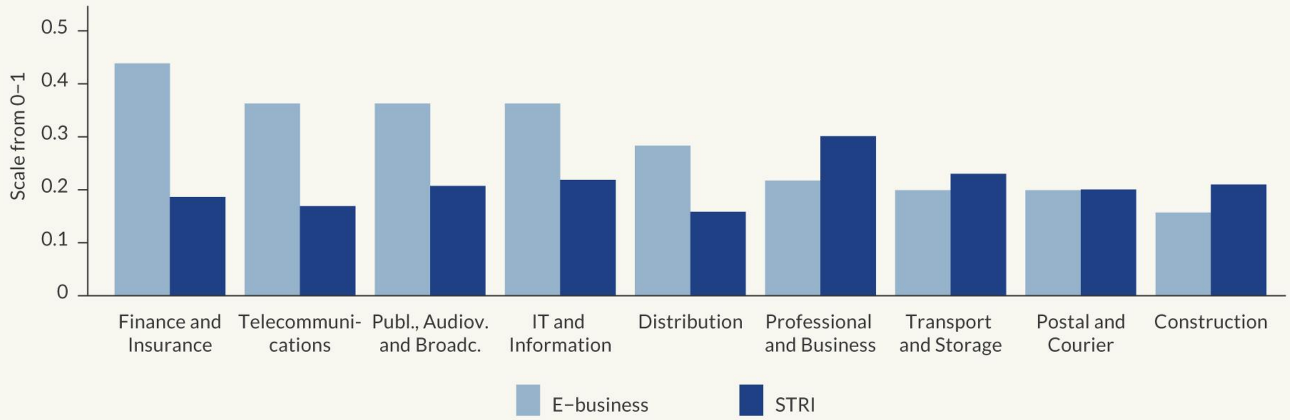
These results are confirmed when we use the OECD's general STRI, which measures the multilateral services trade restrictiveness of EU countries', i.e. vis-à-vis third countries outside the EEA. Figure 2.4 shows in similar manner the ranking of services-sector digital intensity as measured by our e-business indicator. As before, the level of restrictiveness (indicated by the right-side, dark blue bar) are relatively higher for

[9] The Intra-EEA STRI complements the OECD's general STRI. The latter quantifies the multilateral services trade restrictiveness, in which case for the 25 EU countries it covers their *external* services trade restrictiveness vis-à-vis third countries outside the EEA.

professional services, transport and storage, postal and courier services, and construction services compared to finance and insurance, information services and distribution services. Interestingly, using the same scale, it is clear that the inverse relation between the level of the STRI and our e-business indicator is similar across these two group of services, just as in Figure 2.3.

FIGURE 2.4: **E-business and (Internal) EU Services Restrictions external of EEA (2014-2015)**



Source: Eurostat, OECD, ECIPE; authors' own calculations. Note: See Annex C for further details.
E-business denotes the percentage usage of digital technologies by firms in each services sector.

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Admittedly, it is easier for some services than others to adopt digital technologies. For instance, telecommunication services, audiovisuals and IT services have over the last 10 to 15 years gone through tremendous technological change. Similarly, the financial sector has integrated a lot of digital technologies, partly because many financial services can be traded electronically. The susceptiveness of these services to digital technologies often do not exist in more labour-intensive services. An example is construction: it's difficult to substantially substitute labour with technology when you are building a house! Likewise, professional services like legal services may also be difficult to boost digitally as they need to be client tailored with legal expertise which can be hard to provide using technology only.

However, that excuse won't take us far. Many services such as transport are generally known for being able to integrate many ICT tools. Similarly, even if all business services cannot be digitally operated, the reality is that business services in the US have a much higher rate of digital penetration by way of software usage (see Box 1.2). Considering Figure 2.4, the relevant takeaway point should be that improved services and digital trade regulation would spur the absorption of digital technologies by EU firms in business services.[10]

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[10] The premise of Sections 2.1 and Section 2.2 is that both services trade restrictions and restrictions in digital trade have a negative and significant associations with firm usage of digital technologies as measured by our e-business indicator. Although set out separately in the corresponding figures, econometric analysis also support that there is a negative and significant correlation between the combined sets of restrictions and digital absorption, depending on the selection of indexes. Although these results are not shown in the Annex D, they can be obtained upon request.

2.4 The Combined Impact of Digital and Services Trade Regulation

Ultimately, restrictive policies will impact on the productivity patterns in services. Given that both countries and sectors with lower digital penetration rates have greater levels of both digital restrictions and sector-specific services restrictions, it seems likely that the groups of policies are mutually reinforcing their negative effect on productivity performance. For example, sectors that are still protected by services trade regulations are the sectors where digital penetration is least likely to take place, probably for the reason that the best available digital technologies and services are prevented from flowing in. Hence, productivity growth in these sectors are inhibited.

Our analysis supports this view. The *combined* impact of high digital and non-digital services restrictions on productivity in different countries is shown in Figure 2.5. In there, the combined level of digital services and non-digital sector specific restrictions are plotted on the horizontal axis. The vertical axis shows TFP. Clearly, the negative trend supports our thesis: countries with both high digital and services trade restrictions also have lower TFP growth rates. Examples include Belgium, Italy, Czech Republic and to some extent also Germany. Conversely, countries such as Latvia, the Netherlands, Luxembourg and the UK show lower levels of restrictions in digital services and non-digital services and higher levels of TFP growth.[11]

[11] Note that there is some overlap between the two regulatory indicators. The OECD STRI picks up some digital barriers which are partly reflected in ECIPE's DTRI. However, the latter picks up much more digital trade restrictions beyond services and therefore has a wider coverage.

FIGURE 2.5: **Combined Impact of Digital and Services Restriction on Productivity in Services (2014-2015)**

Source: OECD, ECIPE, EUKLEMS; authors' own calculations. Note: Digital Trade Restrictions is proxied by ECIPE's DTRI and Services Trade Restrictions by the OECD STRI.

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Formal analysis supports this result (see Annex D). Using econometric techniques with appropriate fixed effect, controlling for anything else that may be associated with productivity growth, the analysis reveals a significant negative relationship between the extent to which both services trade restrictions as well as non-digital trade restrictions exist in countries and observed productivity growth. In essence, countries with higher levels of digital trade restrictions in the entire economy and which are still protected by non-digital regulations in services exhibit lower productivity levels. Equally, countries with lower digital trade restrictions that are less protected by non-digital restrictions in services markets show higher levels of productivity. Clearly, it matters if a service sector is open for foreign competition, but this impact is greater when countries have less restrictive digital trade restrictions.[12]

Moreover, this observed pattern is particularly strong in sectors with higher digital penetration rates. Although the negative impact of the combined restrictions on productivity will be felt in the entire services economy, this is particularly strong in sectors with relatively higher digital penetration rates. Interestingly, the results mean that productivity is negatively impacted in two ways. First, the combined sets of restrictions thwarts digital technology adoption to happen in the first place. Second, firms already using

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[12] Note again that there is some overlap between the two regulatory indicators as explained in the footnote of Figure 2.5. However, given that the OECD's STRI in combination with our e-business indicator in Annex D also gives significant results, it's safe to say that the combined set of digital and non-digital regulatory policies correlates strongly with lower productivity growth in services sectors, particularly those that use more digital technologies.

digital technologies are prevented from employing them more effectively to create further productivity effects. The latter evidence is also provided in Annex D in which the combined impact of services regulations and digital services regulations as measured by the OECD's STRI are interacted with the digital intensity measure as defined with our e-business indicator.[13]

Because of these results, it is of interest to understand how regulations can affect the absorption of digital technologies by firms in different sectors. Box 2.1 provides some specific "on-the-ground" examples to illustrate how restrictive policies can affect the infusion of digital technologies in practice. These examples include the professional services sector in Germany and banking services in Belgium.

Box 2.2: Examples of Restrictive Regulations in EU countries

Professional services in Germany

In Germany, 68% of companies see enhanced opportunities in adopting more digital business models. However, 84% of them feel that regulations restrict their ability to digitalise. According to the German Ministry of Economic Affairs, a particular concern in recent years has been forced localisation of information (Federal Ministry for Economic Affairs and Energy, 2017). According to McKinsey, legal obstacles include contract law, liability issues, tax regulations, copyright law, cyber security and working hour regulations (Windhagen et al., 2017).

Due to amendments in 2008 to the German Commercial Code - Section 257 No. 1 and 4 (Handelsgesetzbuch § 257), all accounting documents and business letters must be stored in Germany. The breadth of the regulation was extended in 2012 through amendments to Tax Code - Section 146(2) 1 (Abgabenordnung, AO), which now requires all companies liable to pay taxes in Germany to keep all books and records domestically. While affecting all companies with operational presence in Germany, these rules particularly impact professional services, such as auditors, accountants and lawyers.

Banking services in Belgium

Fintech companies such as N26, Tandem bank, Transferwise, Atom bank, Mintos, Monzo and Starling have changed commercial banking. They have introduced digital-only platforms, crowdfunding, sophisticated peer-to-peer (p2p) lending, transparent competitive pricing and centralised personal finance. Moreover, they have compelled established commercial banks to adopt new technologies such as digital wallets and blockchain applications in order to stay competitive.

However, there are still many barriers to entry and growth (Megaw, 2019). One such example is p2p lending, where there is no EU framework but rather significant divergence at national level. Some countries

[13] Note that in this case the potential overlap that exists between ECIPE's DTRI and the OECD's STRI is removed.

apply very restrictive regulations – and Belgium is a case in point. The country's regulator does not yet allow for consumer-to-consumer lending.

2.5 Concluding Comments

It has already been evidenced that restrictions on specific digital technologies can lower productivity (Ferracane et al., 2018b) and services trade (Ferracane and van der Marel, 2018). In this chapter, we have shown that restrictions on all sorts of digital technologies and services trade damage the absorption and productivity in services, and that this negative association is even stronger when digital restrictions are combined with high non-digital restrictions in services sectors.

This result helps to explain why the EU suffers from low productivity in various services sectors. One sector that particularly stands out is business services. Generally, this sector is now more exposed to trade than before, and the sector has substantially expanded over the last two decades (Berlingieri, 2014). And yet, business services are in large parts non-affected by digital technologies. Unsurprisingly, this sector faces relatively high services regulations and digital trade restrictions. In other words, business services are developing below their potential.

3 Market Structure of Services and Use of Digital Technologies

Inevitably, there are productivity differences between firms in a market economy. Everyone can't be at the top and there will always be a group of firms that trails the general level of productivity. If this group of laggard firms is getting relatively big, aggregate productivity of the market will be severely hampered. Similarly, if the front-line of firms are becoming too productive compared to the rest, aggregate productivity may be inhibited because productivity isn't "spilling-over" to other firms (OECD, 2015). In both cases, a better result could be achieved if the productivity distribution among all firms in the market was less dispersed.

This section will go deeper into the market structure of each services sector. It assesses how the use of digital technologies has a positive impact on this "spill-over" of firm productivity, and what role that the market structure plays to determine the effect of digital absorption. Importantly, we will show that the effect of digital absorption can be entirely nullified if the structure of the market is not conducive to competition. Oftentimes, market structures are determined by the applied regulatory policies. As a result, this chapter illustrates that some countries are ahead of others in creating supportive market structures in services. It finally lays out that less distortive regulatory policies in services as well as digital services technologies can help diffuse positive productivity effects in the economy.

3.1 Dispersion of Firm Productivity

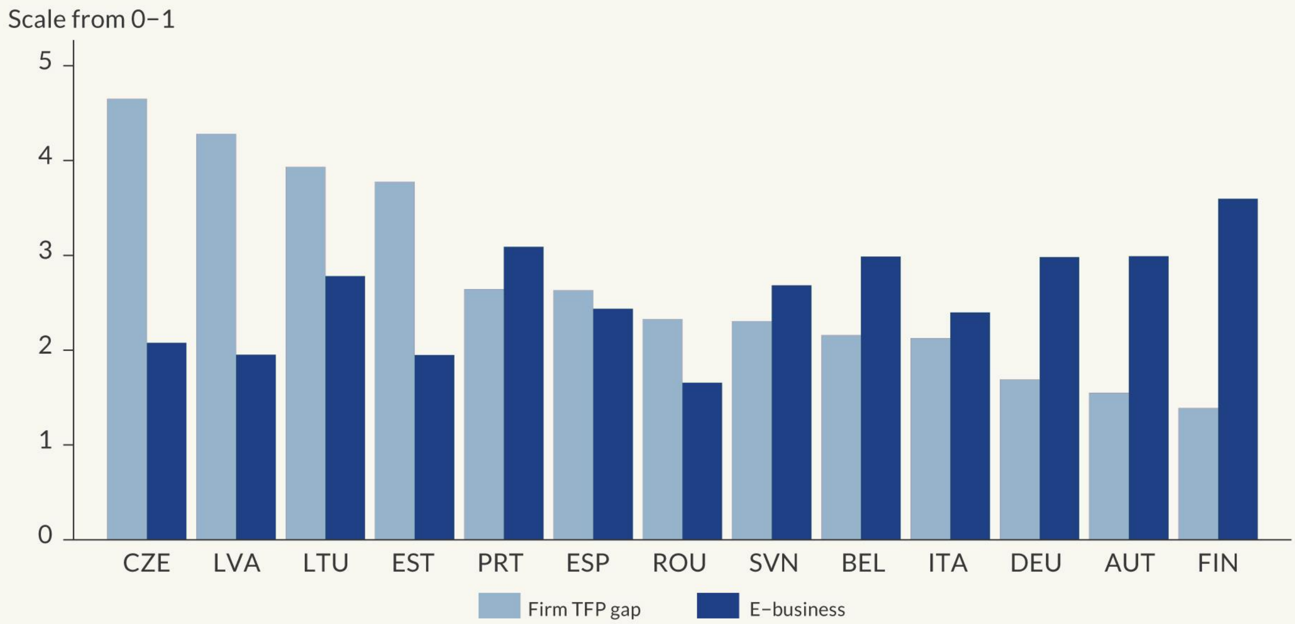
The productivity pattern shown in Section 1 is in great part a result of the distribution of firm productivity *within a sector*. Most often, distribution is spread out because there is a large variation between firms that show low productivity performance and firms that show high productivity performance. The greater this gap, or dispersion, of productivity performance between the top and bottom firms, the more likely it is that a market has an aggregate productivity problem. This means, in other words, that there is a sub-optimal organization of firms inside the structure of the (services) market. The narrower this gap between high and low performing firms, the better the organization of firms within the market, and the more likely it is that higher productivity performance can be reached across the entire sector as the bar becomes higher for firms to enter and stay in the market.[14]

One way in which this dispersion of productivity performance across firms can be reduced is through the use of digital technologies. Figure 3.1 below sets out the averaged aggregated results of our e-business indicator (firm usage of digital technologies) and the dispersion gap between high and low firm productivity. The figure shows an almost perfectly inverse relationship between the productivity dispersion gap of high and low performing firms over all services sectors and the use of digital technologies by firms. It indicates that countries where firms use more digital technologies have a lower dispersion gap of productivity.

[14] There is one caveat however in this pattern of productivity dispersion. If the market demonstrates a high rate of churning, i.e. when firms enter the market at low initial productivity levels but then quickly catch up or even exit the market, the productivity dispersion gap may in fact not be a problem. If on the other hand a high rate of dispersion reflects firms stuck in low productivity levels whilst frontrunners stay ahead, then there is an aggregate productivity gap which forms a problem. In our empirical analysis we are unable to control for this churning rate as no appropriate variable is available. However, to the extent that barriers to entry and conduct still exists in services markets, be it through digital or non-digital (services) trade regulations, as we claim in this report, churning is less likely to take place.

It points to the fact that productivity in the services sector is becoming better organized as the gap between the high and low performing firms is closing. This relationship is more thoroughly analysed using a regression-as-correlation analysis with various alternative proxies for the firm productivity gap in Annex E.[15]

FIGURE 3.1: **Firm Productivity Dispersion (Gap) and E-business (2011-2012)**



Note: firm productivity dispersion gap stands for the TFP dispersion of firm productivity between high and low performing firms and is computed as the difference between 75th and 25th percentiles of firm productivity, or between upper and lower quartiles. The inter-quartile range (IQR) is used to compute this as provided by COMPNET. Alternative dispersion measures show similar results as can be seen in Annex E. Averages over 2011-2012 are used for the IQR. The e-business indicator is divided by 10 to align with in levels with the IQR but does not change the significance of this relationship as regression results in Annex E show.
Source: COMPNET and Eurostat; authors' calculations.

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The fact that greater use of digital technologies by firms is associated with the level of productivity dispersion is not entirely new and has been verified for the manufacturing sector in more detail by Keiko and Lechevalier (2008) and Faggio et al. (2007) although with opposing results.[16] In our case, what is new is that digital technology adoption is meaningful for services sectors. Figure 3.2 shows that, for a number of services, the productivity gap is substantially higher compared to manufacturing. For instance, for the distribution, transportation, broadcasting and audio-visual sectors, the dispersion gap of firm productivity is substantial. In other cases, such as in business services and the IT and information services, the gap is

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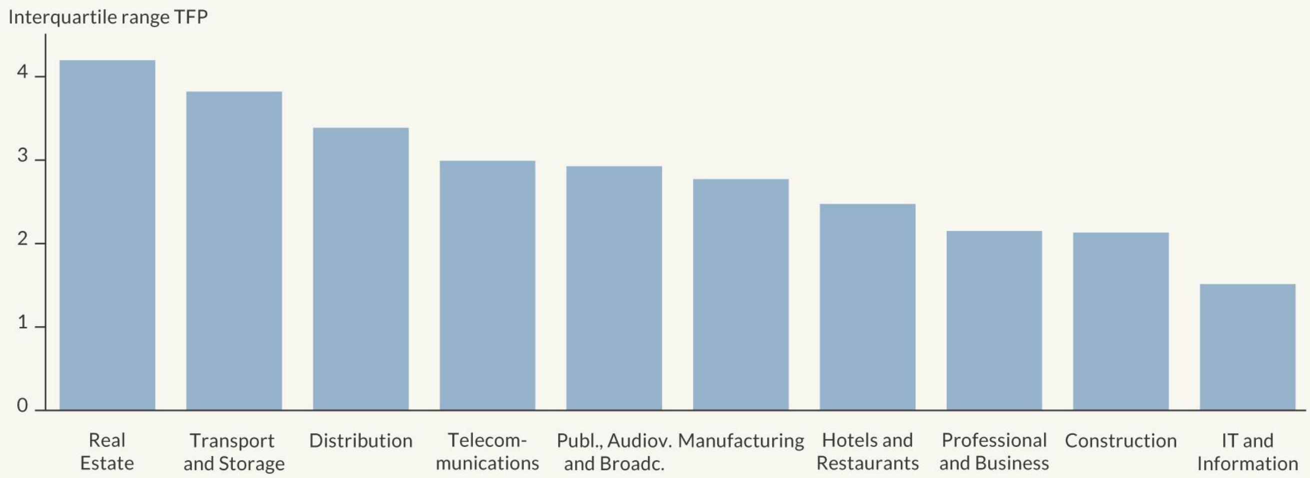
[15] Note that in this section the following countries were used in the calculation of the figures: Austria, Belgium, Czech Republic, Germany, Estonia, Finland, Italy, Lithuania, Latvia, Portugal, Romania, Slovenia and Spain. Admittedly, this leaves out other bigger countries such as France, but this selection of countries is constraint by our use of the COMPNET database which does not provide more countries.
[16] Both papers use ICT investments by sector as a proxy for digital technologies usage. This paper uses a more sophisticated measure by our e-business indicator which is defined through firm-level surveys for all countries by 2-digit manufacturing and service sectors. Annex C explains that the e-business indicator measures the extent to which firms use nine different digital technologies which is much narrower defined than ICT investments.

much lower, in fact lower than manufacturing. Note here that the business services sector covers a broader variety of sectors, of which some sub-sectors have been exposed to high levels of (digital) competition in recent years, whereas others such as professional services haven't.

FIGURE 3.2: **Average Firm Productivity Dispersion (Gap) by Sector (2011-2012)**



Note: firm productivity gap stands for the TFP dispersion of firm productivity between high and low performing firms and is computed as the difference between 75th and 25th percentiles of firm productivity, or between upper and lower quartiles. The inter-quartile range (IQR) is used to compute this as provided by COMPNET and averaged over all countries available.
Source: COMPNET; authors' calculations.

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The results in both Figure 3.1 and Figure 3.2 mask country-sector differences as they are averaged numbers. In a similar manner, aggregating the relationship between firm-level dispersion of productivity and digital technologies potentially simplifies the link by leaving out other forces that are at play and determine the distribution of productivity performance within sectors. Indeed, the economic literature puts forward various factors that are also important to take into account. One is the level of market concentration, which traditionally has characterized various services sectors. Another important factor to take stock is the extent to which services sectors are exposed to international forces. Works by Melitz (2003) and Helpman (2006) have clearly shown that international trade leads to a selection mechanism in which only the most productivity firms stay in the market, reinforcing the decrease in dispersion among firms whilst increasing aggregate productivity. We discuss both factors in turn.

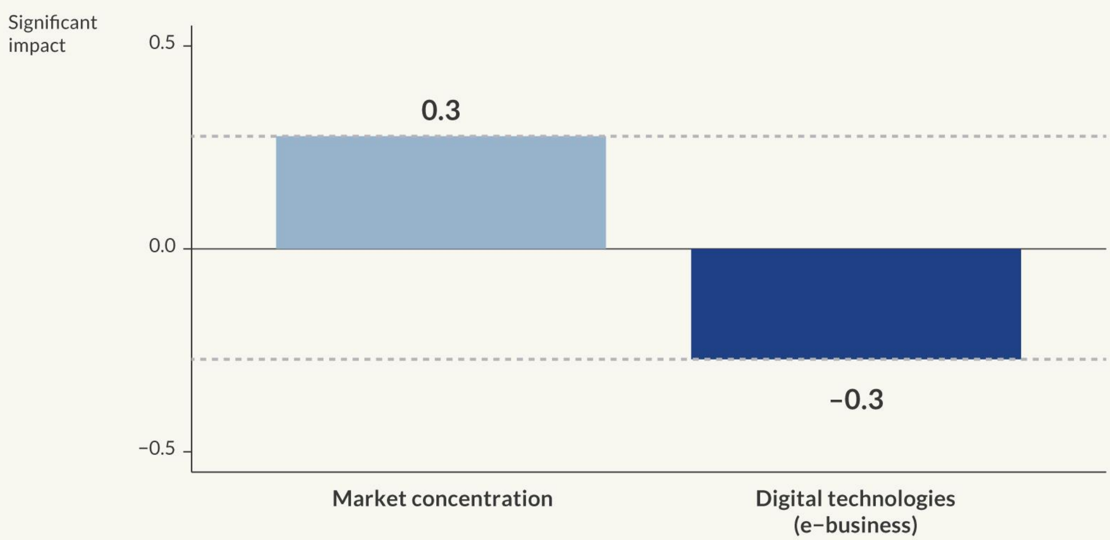
3.2 Market Concentration

The services economy has long been sheltered from competition. Because of its history, incumbents in services markets have enjoyed less competition than their counterparts in manufacturing. Traditional properties of services such as its indivisibility and non-storability have long prevented policy makers from imagining this sector as being tradable. Moreover, many services have long been state-supplied, meaning that private forces of competition were lacking. In part, this is changing as countries have made a concerted effort to liberalise and increase competition in services. Only a few decades ago, many services where faced with burdensome regulatory policies, if they weren't outright monopolies. Various studies have shown that the removal of restrictive policies have had a positive impact on the productivity of services themselves (van der Marel, 2012), and that there have been significant knock-on effects on downstream industries using many services as inputs in their production (Arnold et al, 2015; 2011) and the wider economy (Eschenbach and Hoekman, 2005).

On top of that, digital technologies have radically altered the nature of services. Internet technologies have made services digitalised, enabling easy exchange of services between parties and across borders to an ever-finer degree. In fact, services no longer need to be supplied and demanded at the very same time. Thanks to digital technologies, services have in some instances become more competitive and more productive. Still, competition and digitalisation in services are limited by traditional regulatory barriers and by new barriers imposed to the digital economy as argued in the previous section, which have a detrimental impact on how firms adopt digital technologies. Even though digital technologies increase productivity across the board, narrowing the gap between high-and low performing firms, a lack of competition inhibits a renewal of the ecosystem of firms in a given sector, preventing low productivity firms to exit the market and leave more space for successful and efficient companies to thrive.

This adverse impact can be seen in Figure 3.3. The figure shows the results from our econometric regressions in which we analyse (a) whether both market concentration and digital absorption significantly impact the firm productivity gap, and (b) the magnitude of both forces. Our assessment in Annex E shows that both forces have a separate impact in different directions and are both significant to how productivity is dispersed in each service sector. On the one hand, rising market concentration in services, where only a handful of firms have the majority of the market, leads to a widening of the firm productivity gap: a market structure where market shares by firms are more concentrated increases the gap between the higher performers and low performers of firms. On the other hand, the increase in productivity dispersion can be offset by the extent to which firms are using digital technologies, as measured by our e-business indicator. The more firms use digital technologies, the lower the productivity dispersion gap between the most and the least productive firms.

FIGURE 3.3: **Significant impact on firm productivity gap**



Note: firm productivity gap stands for the TFP dispersion of firm productivity between high and low performing firms and is computed as the difference between 75th and 25th percentiles of firm productivity, or between upper and lower quartiles. The inter-quartile range (IQR) is used to compute this as provided by COMPNET and averaged over all countries available. Results are obtained from using standardized variables in equation (E2) in Annex E.
Source: COMPNET and Eurostat; authors' calculations.

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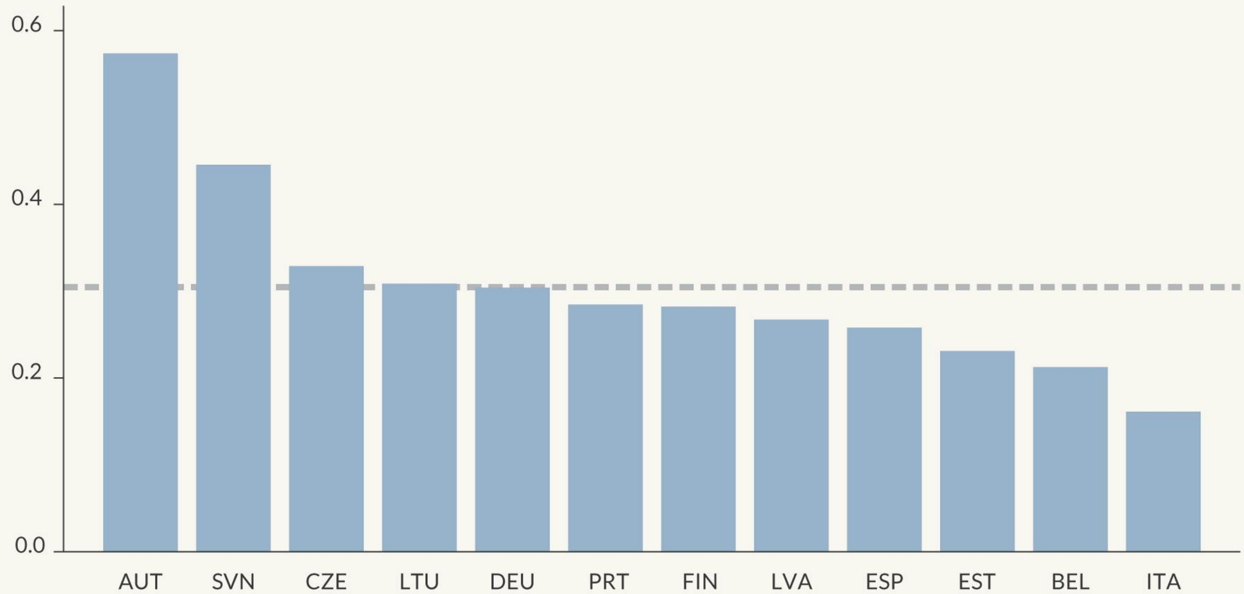
However, what is more interesting is that the two factors influence the productivity gap to the same degree. That is, a one unit of increase of market concentration is correlated with a 0.3 increase of the measured productivity gap, whereas a similar one unit increase of digital technologies firm use in services is associated with a 0.3 decrease of the high performing and low performing firms, as can be seen in Figure 3.3. In other words, the positive impact of using digital technologies is entirely offset in cases where services markets exhibit high market concentration by a small group of firms that own the majority of the market. This result suggests that the positive spill-over effects from using digital technologies are entirely nullified as they cannot flow to other firms in the market because a substantial share of the market is captured by a small group of firms. Hence, a concentrated market structure prevents digital technologies from what they are supposed to do: increasing the productivity level for everyone.

Bearing in mind the significant digital differences across the services, market concentration does also vary substantially among countries, as illustrated in Figure 3.4. For instance, Austria and Slovenia show the highest level of market concentration in services, and it is considerably larger there than in Estonia or Belgium, where market concentration is the lowest. The middle range of countries is occupied by Germany, Portugal, Finland, Latvia and Spain. Austria shows high levels of market concentration in almost all services except the distribution sector. Germany shows higher concentration ratios in telecoms and to some extent the transport services sector, and low levels of market concentration in the distribution sector. A similar picture emerges for Finland where the telecom sector is highly concentrated, and where audio-visuals and business services have notable levels of market concentration. In Italy, the telecom sector is also very concentrated together with the audio-visuals and the IT and computer sector. All other sectors are relatively less concentrated.

In fact, the telecom sector is highly concentrated in all the countries. This can partly be explained by the nature of the market. Firms operating in the telecommunication sector require high sunk costs which results in a fewer number of companies as their activities are subject to significant economies of scale. Similarly, it should be noted that for some services markets in which the role of data is an important input (for example for targeted advertising, the Internet-of-Things, or Artificial Intelligence, etc.), such as in information services or even retail and distribution services, economies of scale may justify a somewhat higher local market concentration while international competition may still ensure competitive pressure. The latter is not a given however, as we have shown in this report. Therefore, restrictive regulations may eventually induce too high market concentrations in services markets.

FIGURE 3.4: **Market Concentration in Services by Country (2011-2012)**

Share Top 10 firms in revenue



Note: Market concentration is measured as the turnover share of each sector from the ten largest firms (by turnover) within each services sector and is an average by country over all services sectors using amount of labour employed as weights.
Source: COMPNET; authors' calculations.

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Nonetheless, there are still variations between the countries, and other digital-intense services such as IT and computer services are also fairly concentrated in a number of countries, particularly in Austria and Latvia. Likewise, audio-visual and publishing services are also substantially concentrated in a variety of countries.

The fact that some of the digital services sectors show high levels of market concentration may therefore indicate that there is a lack of competition. This outcome is likely to be linked to the under-usage of digital technologies by firms in other sectors. For instance, uncompetitive digital markets can, on the one hand, result in failing supply of state-of-the-art technologies at competitive prices available for downstream firms. On the other hand, downstream firms are more likely to pick up digital technologies when competition give stronger incentives to become more productive. When downstream services markets are non-competitive because of their high levels of concentration, firms aren't adequately pressured to use productivity-enhancing technologies in the first place.

The business services sector is overall a fairly concentrated sector, although the level of market concentration varies across countries, being higher in Austria than in Portugal and Italy. Most other countries show a moderate or a relatively high level of market concentration in business services. Note that unlike digital sectors that in some cases may naturally show a somewhat higher market concentration, some business services sectors such as the regulated professions tend to have an opposite pattern. For example, legal services, architects and other professional activities may have many firms in the market and therefore a low concentration rate. This does not mean however that these services markets are not regulated with restrictive policies. On the contrary, as the previous section has shown some professional services regulations are still very restricted.

3.3 Closing the Circle: Services Productivity and Digital Trade Regulation

Market concentration is in large part determined by how much services sector are protected. Moreover, the extent to which a sector shows a healthy productivity distribution is also impacted by the extent to which it is exposed to competitive forces from abroad. The contestability of the market by domestic and foreign competitors drives each firm to a less distorted performance of productivity within the market, eventually increasing the entire productivity range of all firms as only the best performing firms can survive. Therefore, reducing restrictive trade policies in services is likely to cut the firm productivity gap and eventually increase the overall level of the productivity.

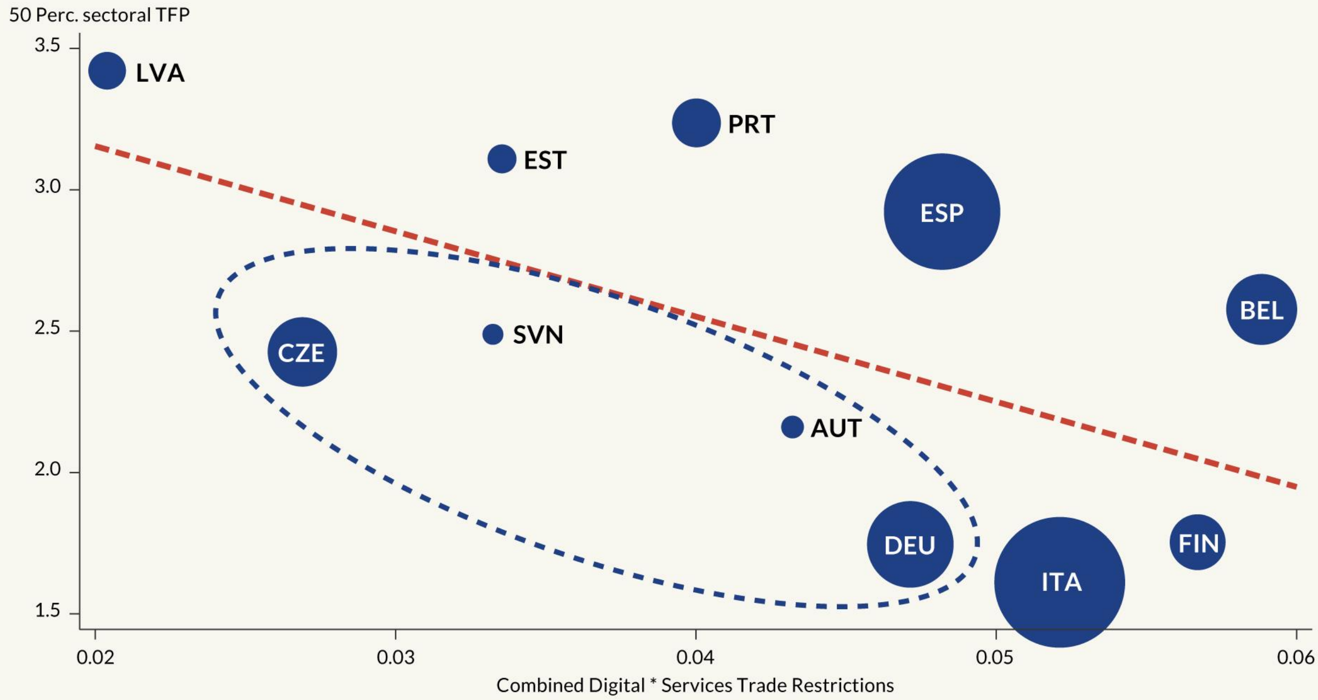
Figure 3.5 illustrates this latter market dynamic. The figure uses the median value of productivity, which is an appropriate measure. It represents the productivity value of a typical firm in a country: a higher median value means that the productivity for the entire range of firms is higher.[17] The median may be thought of as the "middle" value of the productivity distribution of all services firms. It shows what a “typical” value of firm-level productivity is in the services sector. Figure 3.5 shows this middle value for productivity in services for all services sectors by each country using an average that is weighted by the size of each services sector using labour.[18]

The result is clear. There is a downward sloping relationship between, on the one hand, the productivity value for a typical firm in services and, on the other hand, the level of the combined digital and non-digital services trade restrictiveness in each country. In other words, countries with a higher level of combined restrictiveness in services (e.g. Italy, Finland and Germany) also have lower median values of firm productivity. Conversely, countries such as Latvia, Estonia and Portugal have much higher levels of firm productivity values in each service whilst also having much lower digital and non-digital restrictions in services.

[17] The median is the value separating the higher half from the lower half of a data sample – in our case the firm-level productivity distribution The median value has some advantages over the mean as (i) the median is less sensitive to a situation in which a few outliers determine a skewed distribution of the data, in our case productivity, and tells us something about where the central tendency of the distribution is placed; and (ii) aggregating firm-level data by way of using an average has its problems since it’s not clear how weights have been used at the firm-level.

[18] Unfortunately, data on the distribution of productivity from COMPNET with good coverage only goes up to 2012 whilst the STRI, DTRI as well as DGSTRI are starting in 2014. Therefore, we can only present a correlation as done in Figure 3.5 that needs to be taken with extreme care as years do not overlap. Still, patterns may be indicative of a sense of direction where the relationship between productivity and policy regulation in services is going.

FIGURE 3.5: **Middle Value of Productivity Distribution in Services and Restrictions (2012 & 2014)**



Note: Digital Trade Restrictions is proxied by ECIPE's DTRI and Services Trade Restrictions by the OECD STRI. The median (i.e. 50th percentile) is an average that is weighted by the size of each services sector using labour. Services restrictions are from 2014 (earliest year possible) whereas the median is from 2012 (latest years possible) and therefore do not overlap.
Source: ECIPE, OECD, COMPNET; authors' calculations.

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It is equally telling that some countries with high market concentration values are also below the downward sloping fitted values line. These countries have a much lower level of typical firm productivity based on what their level or restrictiveness predicts. Put differently, given their level of combined restrictiveness, they should have a higher level of median value of productivity in services. However, they don't have that. These countries are within the dash-circled line. Italy is an outlier in the sense that it actually shows an extremely low market concentration in services, and yet it appears to have one of the lowest productivity numbers in services. It may be because other forces are at play. For instance, Italy's unit labour costs are very high, and labour costs are important for labour intensive services. Italy also has one of the most protected labour markets, which may further prevent digital technologies from being introduced by firms in many services sectors.

3.4 Concluding Comments

Previous chapters showed that the combination of restrictive non-digital and digital policies can have pernicious effects on productivity. High levels of restrictions in these areas of regulation are likely to cause under-performance in productivity in the EU. In this section, we have brought market structure and market concentration into the analysis.

Interestingly, the result is that when markets structures are too concentrated in services, the introduction of digital technologies won't have a lasting impact. Indeed, our analysis suggests that the benefits of firms absorbing and using digital technologies is entirely nullified when markets are too concentrated. In that case, the market structure prevents firms from creating higher productivity levels through the use of digital technologies as firms are limited in their capacity. Admittedly, a host of factors may determine why market structure are too concentrated, but this report also shows that restrictive services regulation in combination with restrictive digital regulations in services weighs down the productivity levels across the entire range of firms.

However, the extent to which restrictive regulations have an impact on firms' capacity to absorb digital technologies is not only a question of inability. In our view it's equally important to point out that restrictive regulations can reduce the motivation for firms to integrate digital technologies. For instance, this section shows that the business services represent a fairly concentrated sector. Many services that fall into this category of services are reserved professional activities protected by licencing agreements, which in effect can result in a cartel-like market structure (Edlin and Haw, 2014). The lack of competition in these professional markets due to restrictive non-digital regulations causes firms to not have any impulse to innovate by using digital technologies. Therefore, besides capacity the lack of incentives also plays an important role.

Conclusion

We started our analysis by asking if services are "sick" – if the services sector suffers from poor productivity developments, thereby being a drag on the overall economy? The short answer is no. Services such as information services and distribution services show a healthy pattern where they can be as productive as the manufacturing, a sector that traditionally has experienced high productivity levels. Crucially, this report shows that the adverse relationship between an expanding services sector in OECD countries and a slowdown of productivity growth does not always hold true and can in fact be avoided, or at least partially reversed.

Digital technologies play an important role in this story. In fact, emerging digital technologies and changing patterns of globalization have altered competition in many services sectors, which render them more productive than before. However, digital technologies are also becoming increasingly regulated with unnecessary burdensome restrictions. Examples include restrictions on the cross-border movement of data, remaining restrictions in telecom markets and digital payment regulations which have been introduced by governments while digital technologies came into existence. This report has shown that the varying degrees of productivity in services is highly connected by the extent to which governments have applied these regulations in digital trade. Some countries have greater levels of digital restrictions and in effect suffer from lower levels of productivity growth.

However, digital restrictions are only part of the story. The general market openness of services also explains how firms are able to use digital technologies to become more productive. In fact, this report shows that precisely the combined impact of digital and non-digital services regulations hampers positive productivity developments in services, and therefore negatively contributes to defying the so-called "cost disease" in services. Lower restrictions allow firms to pick up digital technologies. While some services are naturally more receptive in absorbing digital technologies, e.g. finance or distribution, a stronger absorption of digital and ICT technologies in the quality and delivery of services would result in an increase of productivity for firms. Restrictions in digital trade and services prevent this from happening as they inhibit digital technologies from flowing to the wider economy.

Which regulatory policies are we talking about? Further analysis in Annex F reveals that in particular foreign entry restrictions (covering establishment restrictions, equity restrictions, restrictions on the board of directors and managers when foreign firms invest in the partner country and other investment restrictions) in combination with digital restrictions have negative consequences for reaping higher productivity growth in services. Digital restrictions also have a negative impact in combination with restrictions on the cross-border mobility of foreign services providers, such as labor market quotas, residency requirements. Digital restrictions that are found to be holding back productivity effects in services are related to restrictions on electronic transactions, payments systems and restrictions related to the cross-border movement and domestic usage of data.

This combination of restrictions can be so pernicious in services that they can prevent services productivity to happen for all firms in the market, depending on the structure of the market. Indeed, this report also finds that if services markets are too concentrated, i.e. if revenue is too much owned by a small group of firms controlling the bulk of the sector, the benefits of absorbing digital technologies can be entirely wiped out. Abolishing restrictive policies in services and digital trade could help avoid markets from becoming too concentrated in the first place. It would induce companies to become more competitive with the help of digital technologies. Unproductive firms to forced to leave the market while good firms are enabled to increase their productivity, so that overall productivity is improved.

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Annex A: Baumol's Disease at Aggregate Level

Using aggregate data, parametric regression in the form of regression-as-correlations shows there is a close connection between the extent to which countries have a sizable services sector (as part of their Gross Domestic Product, i.e. GDP) and productivity. In order to perform our correlations (over time) we draw on data from various sources and apply the following regression:

$$Productivity_{ct} = \ln(Services\ value\ added\ in\ GDP)_{ct} + \delta_c + \theta_t + \varepsilon_{ct} \quad \text{(A1)}$$

where services value added in GDP is computed in current and constant terms for country *c* in year *t* between 1990 and 2018. Productivity is similarly taken for country c and year t and denotes different types of productivity, namely labour productivity as well as Total Factor Productivity (TFP). Generally, labour productivity is the (real/constant) value added per worker whereas TFP represents a residual of productivity terms after accounting for the contribution of all factors of production used in the economy to generate productivity. It's commonly accepted that TFP represents that part of productivity stemming from technological change. In addition, in equation (A1) the terms δ_c and θ_t denote the fixed effect by sector and year respectively to control for any other influence that may be correlated with productivity within a country and year. Finally, the term ε_{ct} is the error term.

Table A1: Regression-as-Correlation between Services and Productivity (1990-2018), OECD countries

	(1) ln(LP)	(3) ln(TFP)	(4) ln(CTFP)	(5) ln(CWTFP)
ln(services value added in GDP) current	-0.139**		-1.703***	
	(0.022)		(0.000)	
ln(services value added in GDP) constant		-0.727***		-0.508***
		(0.000)		(0.000)
FE Country		Yes		
FE Year		Yes		
Observations	465	442	406	406
R2A	0.982	0.972	0.899	0.813
RMSE	0.032	0.030	0.049	0.047

Note: p-values (and not standard deviations) in parentheses * p<0.10; ** p<0.05; *** p<0.01. All productivity measures are put into logs (ln). LP and TFP stand for labour productivity and Total Factor Productivity respectively and are taken from Bergeaud et al. (2016). CTFP and CWTFP stand for TFP and welfare relevant TFP level, computed with output-side real GDP, using prices for final goods, exports, and imports that are constant across countries and are taken from the Penn World Table 9.0. Both services value-added in GDP at current and constant rate are taken from the World Bank World Development Indicators. Countries include AUT, BEL, CAN, CHE, DEU, DNK, ESP, FIN, FRA, GBR, ITA, JPN, NLD, NOR, NZL, PRT, SWE, USA. Robust clustering applied at country-year.

The results of the regressions are shown in Table A1 above. The footnote to the table provides additional information on the variables chosen and other technical details. In all specifications, i.e. from column 1 through column 4, the coefficient results are significant with a negative sign. This means that one unit increase of services in GDP among OECD countries is significantly associated with a one unit reduction in productivity, being labour productivity or TFP. Although many other factors influence the productivity level of a country, to the extent that we control for them by applying the appropriate fixed effects, a strong adverse relationship exists between the size of the services market of countries' economies and the level of productivity.

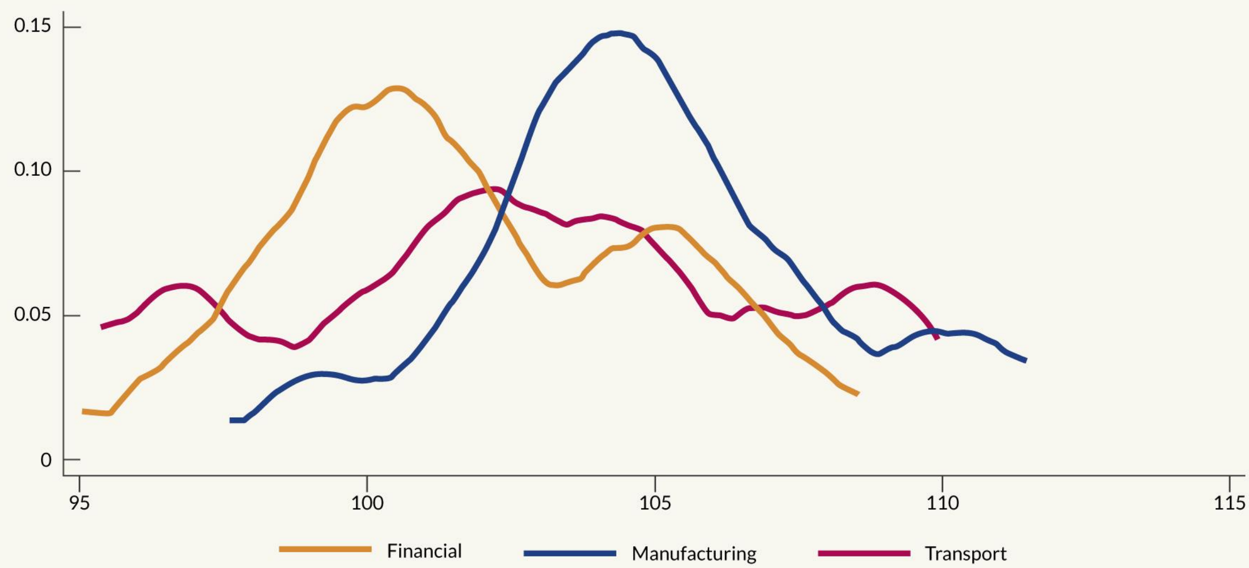
However, as this report outlines, this relationship holds at aggregate level and a more nuanced picture arises when looking into each services sector specifically. That is, across EU countries and the US, for which data is available only, it becomes clear that some services have seen high productivity growth compared to others. This is related to the extent to which services sectors are able and incentivised to absorb digital and ICT technologies, which in turn relates to how much these services sectors and digital technologies are rippled with burdensome regulatory policies.

Annex B: Productivity Distribution in the EU and the US

Distribution plots provide a convenient overview to verify the "spread" of a certain variable (or more appropriately the frequency of observations of a variable) across units and possibly time. In our case, we show the distribution pattern of productivity across as many countries as possible being EU countries and the US as shown in Figure 1.2 in the report for distribution, information services as well as business services with the manufacturing sector as a benchmark.

Figure B1 plots a similar distribution chart for other services sectors, namely for transport and the financial service sector with again the manufacturing sector as a benchmark. If productivity is normally distributed around across countries and time, the curve would show a nicely bell-shaped trend, as can be seen for the manufacturing sector. This means that most of the productivity that one can observe in all countries in the analysis, in this case for manufacturing, is mostly clustered around its median, i.e. the level of productivity that occurs the most – because observations for this sector is normally distributed. The more we deviate from this median, the lower the frequency, hence the more we slide off the peak along the vertical axis in both directions as visible in Figure 1.2 and Figure B1 below. Eventually, as more extreme productivity levels are measured in fewer instances, the figure eventually obtains the bell-shaped curve.

FIGURE B1: **Distribution of Labour Productivity in the EU and US (1990-2015)**



Source: EUKLEMS; authors' own calculations.
The vertical axis indicates the density function of labour productivity across EU countries and the US, which represents the (unit) probability of getting the value denoted by labour productivity i.e. it displays the distribution of the data.

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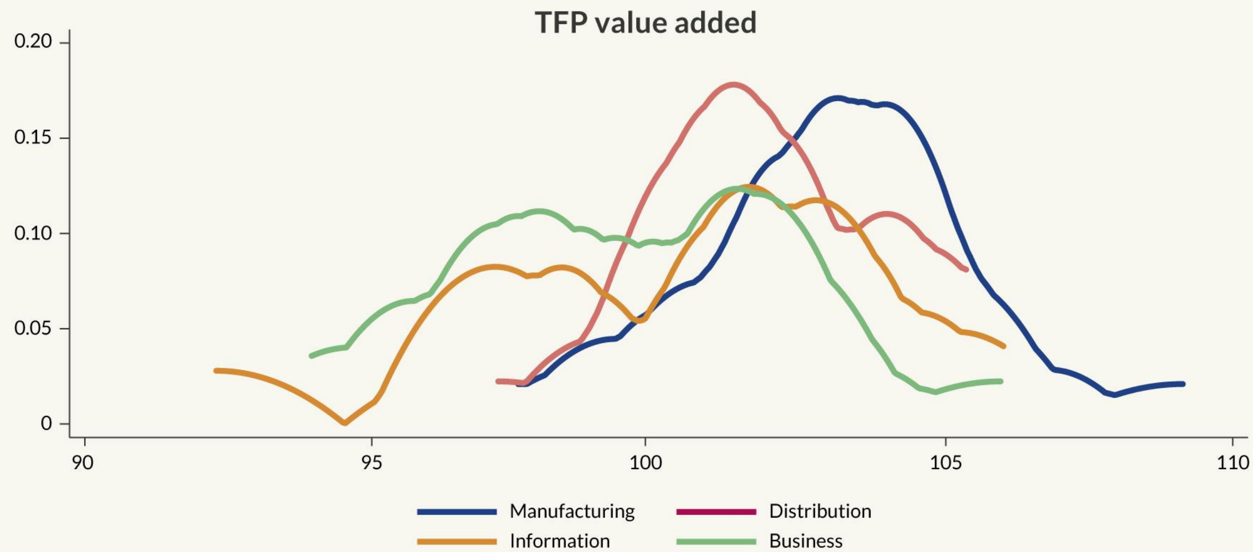
As discussed in the report, some services sectors show extreme deviations around this median or show a pattern in that there are two medians or peaks. The business services sector is one example, but Figure B1 also shows that the two peaks pattern is to some extent also present for financial services. In any event, the large majority of countries appear to be much less productive than the manufacturing sector as the bell is shifted much more to the left compared to the latter sector. This message also comes through when using TFP measures instead of overall labour productivity. Figure B2 replicates Figure 1.2 from the report but now using TFP based on value-added as provided by EUKLEMS. Many services, if not all, again show a much lower productivity level than manufacturing. More importantly, however, is that the business services sector is again greatly distorted with one group being much more advanced.

Naturally, some countries contribute a lot more as a group than others to a group of countries together and so accounting for their market size may result in the fact that when discounting smaller economies, the results would not provide an alarming picture of distorted productivity trends in services. However, even adjusting for weighted share of value added or output for each services sector shows that some services are still less productive than others, such as financial services and that the business services sector and to some extent also the distribution services sector. These services show distorted trends of productivity across the EU and the US of a kind that is almost similar to the ones presented in the figures above.

FIGURE B2: **Distribution of Labour Productivity in the EU and US (1990-2015)**



Source: EUKLEMS; authors' own calculations.
The vertical axis indicates the density function of labour productivity across EU countries and the US, which represents the (unit) probability of getting the value denoted by labour productivity i.e. it displays the distribution of the data.

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Annex C: E-Business Indicator

The e-business indicator measures the extent to which firms in every EU country and sector uses digital technologies as part of their production process. The data comes from the Eurostat's Comprehensive Database on the Digital Economy and Society. The database provides information based on household and firm-level surveys on the usage of information and communication (ICT) technologies in enterprises and households/by individuals. The data has been updated in January 2019.

For this paper, data is taken that specifically measures ICT usage in enterprises. Within this category of the Digital Economy and Society database, various sub-categories are available that each measures a particular dimension of the usage of ICT by businesses, which are: e-commerce activities, enterprises connection to the internet, website and social media usage by firms, e-business, and finally, ICT security. The purpose of this paper is to investigate the extent to which each firm's absorbs ICT technologies and so therefore we take the sub-category of e-businesses to construct our intensity measure.

The sub-category of e-business measures the absorption and integration of ICT technologies by firms on the basis of various dimensions, which are:

(a) Integration of internal processes
(b) Integration with customers/suppliers, supply chain management
(c) Cloud computing services
(d) Big data analysis
(e) 3D printing and robotics

For our analysis, we select the first four dimensions (i.e. a-d) of the e-business category in this database excluding 3D printing and robotics. The main reasons for excluding the latter dimension is that this paper is concerned with the digital infusion of ICT technologies in services sector and not the manufacturing sector for which this category is almost only available. Also, previous literature that analysis the extent to which for instance robotics takes place across sectors concludes that the usage of robotics in services sectors is still in its infancy and therefore to use this category seems not relevant. See for instance Graetz and Michaels (2018) and Artuc et al. (2019) on the industry usage or robots.

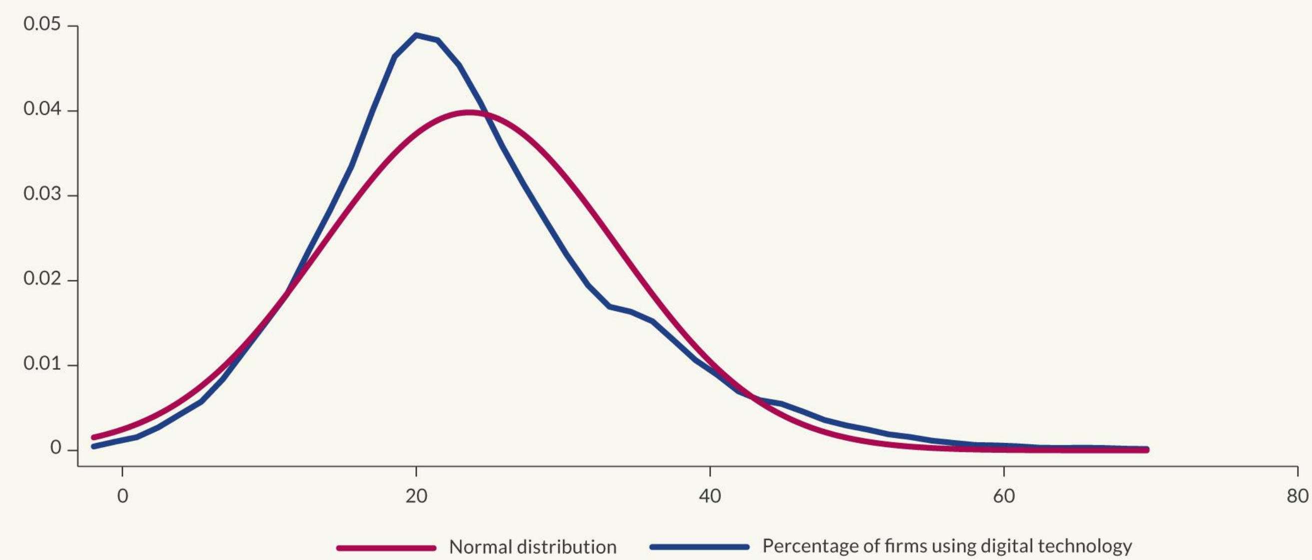
For each of the four dimensions the database records many survey questions of which quite a few at extremely detailed level. For our purposes, we only select those survey questions (i.e. variables) that remains somewhat generic about the usage of ICT by enterprises. In total, nine survey questions are chosen, which are listed in Table C1 including their indicator name as labels in the database:

Table C1: Survey Questions (i.e. Variables) on Percentage Usage of ICT Technology by Firms

Indicator	Variable
E_BD	Enterprises analysing big data from any data source
E_CC	Buy cloud computing services used over the internet
E_CRM	Enterprises using software solutions like Customer Relationship Management (CRM)
E_ERP1	Enterprises having ERP software package to share information between different functional areas
E_INV3_AP	Enterprises sending or receiving e-Invoices, suitable for automated processing
E_RFAC1	Enterprises using RFID technologies for person identification or access control (as of 2014)
E_RFASPRI1	Enterprises using RFID technologies for after sales product identification (as of 2014)
E_RFID1	Enterprises using Radio Frequency identification (RFID) technologies (as of 2014)
E_SISC	Enterprises whose business processes are automatically linked to suppliers and/or customers

Each of the survey question measures the percentage usage of firms of a particular technology as outlined by each variable indicator based on a 2-digit NACE sector classification. We select all available services sectors and also the manufacturing sector to benchmark our results. Then, we average values (i.e. percentage use by firms using the particular digital technology) by sector and country over the years 2009-2016 obtain an unweighted average over each survey question. The reason for applying an unweighted average is that we lack any information on how much each of the digital technologies are used within each sector. After averaging we nonetheless get an almost perfect distribution of the data, as shown in Figure C1.

FIGURE C1: **Frequency Distribution of the E-business Indicator**



kernel = epanechnikov, bandwidth = 2.0426

Source: Eurostat; authors' own calculations.

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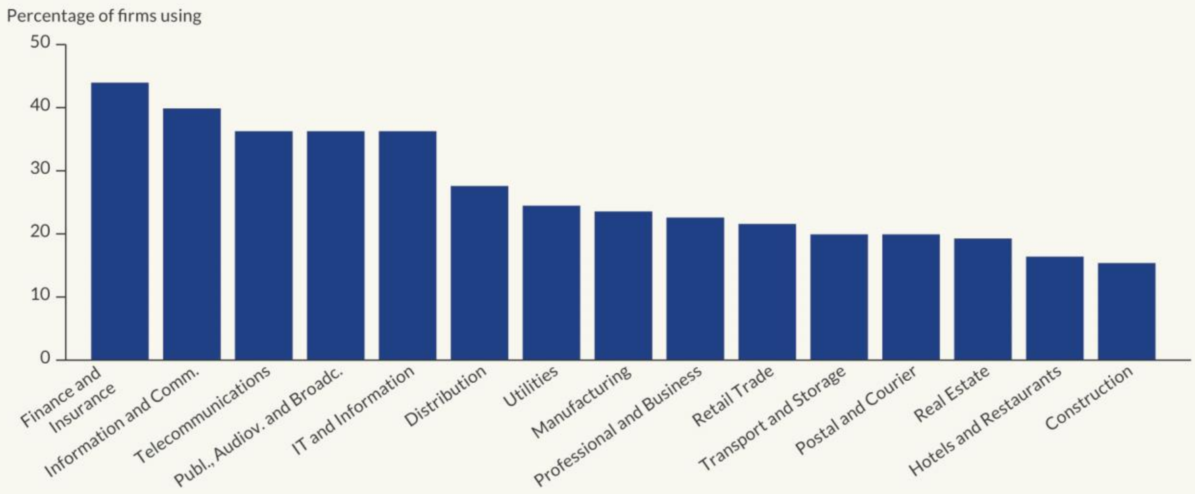
As a final step, we concord our sector classification of the Eurostat database into our classification system which is based on the one from EUKLEMS as our variable of interest for the econometric analysis is from the latter data source. The two classification systems neatly fit into each other as both are based on the NACE Rev. 2.

However, for some sectors EUKLEMS provide a higher level of disaggregation with sub-sectors for which the Eurostat database does not provide any information. In our case, Postal and Courier activities are put under the aggregated sector of Transport and Storage and all sub-sectors of the Information and Communication sector are put together (i.e. Publishing, audio-visual and broadcasting; Telecommunications; and IT and other services). The ranking of the final e-business indicator by services sector and the manufacturing sector is provided in Figure C2.

FIGURE C2: **Ranking of E-business Indicator by Service Sector and Manufacturing (2009-2016)**



Source: Eurostat; authors' own calculations.

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Annex D: Combined Services and Trade Restrictions and Productivity

In order to assess the impact of the combined occurrence of digital and non-digital (services) trade restrictions on productivity, we effectively employ a regression-as-correlations as we have limited times series. In fact, we only have 2014-2015 as a panel series which only gives us a near cross-country setting. Keeping this in mind, the empirical estimation strategy is as follows:

$$Productivity_{cst} = STRI_{cst} * EB_{cs} + C_{cst} + \delta_{ct} + \theta_{st} + \gamma_{cs} + \varepsilon_{cst} \qquad \text{(D1)}$$

$$Productivity_{cst} = DTRI_{ct} * STRI_{cst} * EB_{cs} + C_{cst} + \delta_{ct} + \theta_{st} + \gamma_{cs} + \varepsilon_{cst} \qquad \text{(D2)}$$

where in both equations (D1) and (D2) $Productivity_{cst}$ stands for the various productivity measures we apply, namely labour productivity as well as two variations of Total Factor Productivity (TFP): one computed on the basis of simple value added, and one on the basis of value added per hour worked. Labour productivity is defined as gross value added per hour worked. All three productivity measures vary by country-sector-year and are put in logs. Data is taken from EUKLEMS.

The combined effect of digital and non-digital services trade restrictions is represented in two ways in equations (D1) and (D2) separately. One is by interacting the OECD STRI, which contains digital and non-digital regulations in services markets, with our e-business indicator (i.e. EB) in equation (D1); and second by interacting the OECD Services Trade Restrictiveness Index (STRI) with ECIPE's Digital Trade Restrictiveness Index (DTRI) which gives the $DTRI_{ct} * STRI_{cst}$ in equation (D2) whilst keeping in mind the potential overlap between the two proxies. Note, in this case, that we don't interact the OECD STRI and with the OECD Digital Services Trade Restrictiveness Index (i.e. DGDTRI) as the latter index takes out the horizontal measures of digital services trade restrictions that are covered by the former. ECIPE's DTRI goes beyond services markets and therefore takes into account digital restrictions of the entire economy and not only in services. The $DTRI_{ct} * STRI_{cst}$ term is also interacted with our e-business indicator.[19]

The STRI covers non-digital trade restrictions in each services sector selected (see Geloso Grosso et al., 2015). It's the widely used STRI from the OECD that has been developed since 2014 up to 2018 for all OECD and some non-OECD countries and measures the applied MFN regimes of regulatory services

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[19] See for a comparison between the OECD DGSTRI and ECIPE's DTRI Ferencz (2019) and Ferracane et al. (2018) respectively. The DTRI goes beyond mere trade restrictions in digital services compared to the OECD DGSTRI as it also covers all sorts of other trade restrictions such as restrictions in digital public procurement, IPR measures and tariffs on digital goods and commodities as well as restrictive content access and intermediate liability measures. Both the DTRI and DGSTRI are country-specific.

trade restrictions. The STRI has recently been complemented by the EEASTRI which measures services trade restrictions within the European Economic Area (EEA), which we use as a robustness check and call EUSTRI. It includes 25 EEA countries and is sector-specific covering similar years as the overall STRI. This index follows the methodology of the general STRI and as such are comparable (see Benz and Gonzales, 2019). Of note, although all indexes presented here are specifically targeting trade barriers, one should also know that in various occasions they measure domestic regulatory measures that have an indirect effect on trade due to the nature of services. This is also true for the DTRI.

The reason we employ the e-business indicator in both equations is that we suspect that the combined impact of digital and non-digital trade barriers has a more pronounced impact in sectors with a higher share of firms using digital technologies such as big data and cloud computing. In other words, the combined impact of regulations should be proportionately more felt in terms of productivity in sectors in which firms are more reliant on digital technologies. This identification strategy follows the one pioneered by Arnold *et al*. (2015; 2011) and recently also applied by Ferracane et al. (2018) in a digital economy setting. Full details of how we develop this indicator is provided in Annex C. This index measures digital technology use through firm-level surveys and is country-sector specific. However, due to the fact that not all digital technologies and their usage use are measured in the survey for every year (only digital data is missing with one year), we average this measure across the two years.

Furthermore, because we apply a productivity growth model at sector-level, we ought to introduce various standard control measures that are commonly known to also have an impact on sectoral productivity. Hence, the variables that are usually covered in such production function are also applied in our case using data from EUKLEMS. They include labour services (LAB_QI), ICT-based capital (CAPIT_QI), and non-ICT-based capital (CAPNIT_QI). All three measures vary by country-sector-time and so should be included as they are not entirely picked up by our applied fixed effects. The control variables are applied in both equation (D1) and (D2) as part of our vector C_{cst}.

Finally, in both equations we also apply appropriate fixed effects, which are set at country-year (δ_{ct}), sector-year (θ_{st}) in addition to country-sector (γ_{cs}). This means that any variation at these three levels that might have been caused by any other variable that we have omitted are subsumed in these very stringent fixed effects. Note that indeed these fixed effects are extremely strict, which serves our purposes in two ways. One is that since we only have two years of panel without any instrumental variable, we need to make sure that any reversed causality or other endogeneity is prevented. Usually this is done finding an instrument for the STRI or DTRI * STRI variables, but in our case that’s too difficult to find. Second, we want to estimate with certainly whether the regulatory policy restrictions actually have an impact or are at least correlated with productivity and so setting very demanding fixed effect assures us for an outcome that has truly passed the test. Finally, the term ε_{cst} is the error term.

Results

The results of estimating equations (D1) and (D2) can be found respectively in Tables D1 and D2. Looking at Table D1 first, in all three instances the obtained coefficient results have a negative and significant sign (i.e. columns 1-3). The results are less significant when using the EUSTRI in columns 4-6 although the results are weakly significant when using labor productivity. Then, in Table D2 the results hold when applying the interaction term of the STRI and DTRI, but which is again less strong when using the EUSTRI, which is not surprising as there is much less variation of restrictions across this group of countries. The results in Table D1 from equation (D1) are our preferred regression setup as they avoid any potential overlap between the two regulatory policy indicators. Note that in this case, our argument of the combinational impact of both digital and non-digital restrictions that have are negatively associated with services productivity is still valid as the OECD's overall STRI integrates the DGSTRI. Together, therefore, the results show that (a) a negative and significant relationship exists between the combined nature of restrictive digital and non-digital barriers in services and productivity, and (b) that this negative relationship is stronger for sectors with a higher share of firms that are reliant on digital technologies.

Table D1: Regression Results of Combined Services and Digital Trade Restrictions and Productivity

	(1) TFPva_i	(2) TFPlp_i	(3) LP_i	(4) TFPva_i	(5) TFPlp_i	(6) LP_i
STRI * EB	-0.029**	-0.029**	-0.047***			
	(0.020)	(0.020)	(0.008)			
EUSTRI * EB				-0.007	-0.007	-0.038*
				(0.548)	(0.548)	(0.055)
FE C-Y	Yes					
FE S-Y	Yes					
FE C-S	Yes					
Controls	Yes					
Observations	164	164	164	144	144	144
R2A	0.925	0.925	0.930	0.905	0.905	0.903
R2W	0.158	0.158	0.150	0.134	0.134	0.086
RMSE	0.042	0.042	0.042	0.039	0.039	0.038

Note: p-values (and not standard deviations) in parentheses * p<0.10; ** p<0.05; *** p<0.01. All productivity measures are put into logs (ln). TFPva_i stands for the Total Factor Productivity value added based; TFPlp_i stands for the Total Factor Productivity value added per hour worked based, LP_i stands for labour productivity measured as gross value added per hour worked. FE C-Y stands for fixed effects by country-year; FE S-Y stands for fixed effects by sector-year; FE C-S stands for fixed effects by country-sector. Control variables include labour services (LAB_QI), ICT-based capital (CAPIT_QI), and non-ICT-based capital (CAPNIT_QI), all put in logs and varying by sector-country-year. STRI is the OECD's Services Trade Restrictiveness Index; EUSTRI is the OECD's European Union (EEA) Services Trade Restrictiveness Index. EB stands for E-business and is computed following Annex C.

Table D2: Regression Results of Combined Services and Digital Trade Restrictions (cont'd)

	(1) TFPva_i	(2) TFPlp_i	(3) LP_i	(4) TFPva_i	(5) TFPlp_i	(6) LP_i
STRI * DTRI * EB	-0.136**	-0.100	-0.223***			
	(0.018)	(0.118)	(0.005)			
EUSTRI * DTRI * EB				-0.021	0.076	-0.155*
				(0.659)	(0.112)	(0.066)
FE C-Y	Yes					
FE S-Y	Yes					
FE C-S	Yes					
Controls	Yes					
Observations	164	164	164	144	144	144
R2A	0.925	0.925	0.93	0.905	0.903	0.903
R2W	0.158	0.149	0.152	0.134	0.14	0.085
RMSE	0.041	0.043	0.042	0.039	0.041	0.038

Note: p-values (and not standard deviations) in parentheses * p<0.10; ** p<0.05; *** p<0.01. All productivity measures are put into logs (ln). TFPva_i stands for the Total Factor Productivity value added based; TFPlp_i stands for the Total Factor Productivity value added per hour worked based, LP_i stands for labour productivity measured as gross value added per hour worked. FE C-Y stands for fixed effects by country-year; FE S-Y stands for fixed effects by sector-year; FE C-S stands for fixed effects by country-sector. Control variables include labour services (LAB_QI), ICT-based capital (CAPIT_QI), and non-ICT-based capital (CAPNIT_QI), all put in logs and varying by sector-country-year. STRI is the OECD's Services Trade Restrictiveness Index; EUSTRI is the OECD's European Union (EEA) Services Trade Restrictiveness Index; DTRI is ECIPE's Digital Trade Restrictiveness Index. EB stands for E-business and is computed following Annex C.

Annex E: Regression-as-Correlations Between Firms and Productivity Dispersion and E-Business Indicator

To provide a robust conclusion about the negative relationship between the firm productivity gap of the highest and lower firm performance and the use of digital technologies we perform a series of econometric regressions in the form of simple regressions-as-correlations. Due to a limited time span of both variables only a cross-sector section analysis can be performed and therefore results should be interpreted as associations rather than causal effects. Still, meaningful postulations about the directions in which potential causation might be running can be derived from this regression exercise.

More specifically, similar to Annex D we perform the following regression in which we take the regression-as-correlation only for two years:

$$Firm\ poductivity\ dispersion_{cst} = EB_{cs} + \delta_c + \theta_s + \sigma_t + \varepsilon_{cst} \quad \text{(E1)}$$

where in equation (E1) firm productivity dispersion is proxied by several commonly known measures in the empirical economic literature, namely the inter-quartile range (IQR), the standard deviation (SD), the absolute difference between the 90th percentile and 10th percentile productivity performance of firms (labelled 91) as well as the absolute difference between the 80th percentile and 20th percentile productivity performance of firms (labelled 82). We compute these dispersion measures for both labour productivity (LP and Total Factor Productivity (TFP). Data is taken from COMPNET. Also, following Keiko and Lechevalier (2008), we standardise labour productivity by dividing the absolute difference by the median to prevent pure scale differences between industries, i.e. for (91) and (82), which also allow us to compare the one-unit change results of the EB variable.

The EB variable stands for the e-business indicator of which full details of how this measure is developed can be found in Annex C. This index measures digital technology use through firm-level survey and is country-sector specific as we take the average between as throughout the report as explained in the Annex C. We also apply fixed effects by country (δ_c) and sector (θ_s) separately to account for unobserved influences at these two levels that might that might have been caused by any other variable that we have omitted and may interfere with the link between firm productivity dispersion and the use of digital technologies. We also add a time fixed effect (σ_t). Finally, the term ε_{cst} is the error term.

The results are shown in Table E1 below. The regression results show a negative and in half of the entries also a significant coefficient result. In fact, significant outcomes are only visible for each dispersion measures in the case of TFP and not when using labour productivity. In short, a negative relationship appears to be existing between the use of digital technologies by firms (as measured by our e-business indictor) and firm productivity dispersion. In other words, a greater use of digital technologies by firms is associated with a lower dispersion of productivities between the top performing firms and bottom performing firms, closing the productivity gap between them whilst reinforcing aggregate productivity. The results are in line with Keiko and Lechevalier (2008) which also show a negative relationship between the use of digital technologies and productivity dispersion for the case of Japan but with a different proxy.

Table E1: Regression Results of Firm Productivity Dispersion and E-business Indicator

	(1) IQR LP	(2) IQR TFP	(3) SD LP	(4) SD TFP	(5) 91 LP	(6) 91 TFP	(7) 82 LP	(8) 82 TFP
EB	-0.223	-0.751*	-0.334	-0.840**	-0.228	-0.823**	-0.227*	-0.806*
	(0.129)	(0.051)	(0.244)	(0.021)	(0.155)	(0.045)	(0.086)	(0.051)
FE C					Yes			
FE S					Yes			
FE Y					Yes			
Observations	159	151	159	151	159	151	159	151
R2A	0.800	0.505	0.769	0.683	0.819	0.566	0.837	0.510
R2W	0.028	0.031	0.031	0.063	0.027	0.044	0.034	0.036
RMSE	0.140	0.459	0.202	0.356	0.146	0.421	0.130	0.458

Note: p-values (and not standard deviations) in parentheses * p<0.10; ** p<0.05; *** p<0.01. The EB indicator denotes the e-business indicator as developed in Annex C and measures the percentage usage of digital technologies by EU firms in each services sector. IQR LP is calculated as the ratio of the interquartile range of labour productivity over the median labour productivity. IQR TFP is computed as the ratio of the ratio of the interquartile range of Total Factor Productivity (TFP) over the median TFP. SD LP is obtained dividing the standard deviation of the labour productivity by the median labour productivity. SD TFP stands for the standard deviation in the TFP. 91 LP is the difference in the labour productivity between the 90th and the 10th percentile divided by the median productivity. 91 TFP is the difference in TFP between the 90th and the 10th percentile. 82 LP is the difference in the labour productivity between the 90th and the 10th percentile divided by the median productivity. All variables are in logarithmic form and the coefficients are estimated for the year 2012 in the following countries that were available in COMPNET, namely Austria, Belgium, Czech Republic, Germany, Estonia, Finland, Italy, Lithuania, Latvia, Portugal, Romania, Slovenia and Spain. Robust clustering applied at sector-level.

In addition, we also add another variable to equation (E1) that takes stock of the fact that there are market concentration forces in each services market, which in Section 3.2 is more extensively discussed. The variable market concentration accounts for an unequal division of market share among firms in the services sector that distorts competitional forces which therefore also disperses the productivity distribution within a sector. Hence, by extension, we perform the following regression in which we take the regression-as-correlation again for two years:

$$Firm\ poductivity\ dispersion_{cst} = MC_{cst} + EB_{cs} + \delta_c + \theta_s + \sigma_t + \varepsilon_{cst} \qquad \text{(E2)}$$

which is similar to equation (E1) but now with the variable MC_{cst} added which is measured as the turnover share of each sector from the ten largest firms (by turnover) within each services sector available in COMPNET. Alternative market concentration measures are also used available in COMPNET such as the Hirschman Herfindahl index as well as the price-cost market for each firm.[20] All other variables are similar as in equation (E1).

The results are shown in Table E2 below. Throughout columns (2), (4), (6) and (8) the MC variable for market concentration is positive and significant at the 5 percent level. This means that a greater level of market concentration in a services sector is associated with an increase of productivity dispersion in which the gap between the highest and lowest productive firms is bigger. Therefore, this points out to a greater market distortion in case of higher market concentration forces in services, which is in line with what would expect. However, the interesting feature of this estimation is that the e-business indicator remains robustly significant with a negative sign. This indicates that positive impact of the e-business variable is entirely offset by the market concentration variable. When using standardized variables so that both variables are directly comparable with each other, this offsetting effect between both variables are equally large, as reported in Figure 3.3 in the report.

Table E2: Regression Results of Firm Productivity Dispersion and Market Concentration.

	(1) IQR LP	(2) IQR TFP	(3) SD LP	(4) SD TFP	(5) 91 LP	(6) 91 TFP	(7) 82 LP	(8) 82 TFP
MC	-0.081	1.284**	-0.219	1.031**	-0.304	1.022**	-0.092	1.015*
	(0.681)	(0.041)	(0.467)	(0.023)	(0.131)	(0.047)	(0.477)	(0.066)
EB	-0.228	-0.652*	-0.348	-0.761**	-0.247	-0.745*	-0.233*	-0.728*
	(0.133)	(0.078)	(0.235)	(0.031)	(0.130)	(0.053)	(0.085)	(0.066)
FE C				Yes				
FE S				Yes				
FE Y				Yes				
Observations	159	151	159	151	159	151	159	151
R2A	0.799	0.522	0.769	0.695	0.823	0.576	0.836	0.519
R2W	0.030	0.071	0.038	0.105	0.054	0.074	0.037	0.061
RMSE	0.140	0.451	0.202	0.350	0.145	0.416	0.130	0.453

Note: p-values (and not standard deviations) in parentheses * p<0.10; ** p<0.05; *** p<0.01. See for other notes below Table E1. MC refers to market concentration and is measured as the turnover share of each sector from the ten largest firms (by turnover) within each services sector. Robust clustering applied at sector-level.

[20] Results when using these alternative market concentration measures can be obtained from the authors upon request.

4 Annex F: Combined Services and Digital Trade Restrictions and Productivity by Policy Category

The results in Annex D can be further broken down by category for both the STRI and DGSTRI & DTRI. By doing so, and by re-performing the regression analysis, one can obtain a picture in which it becomes clear which of the sub-categories of policies that are covered by both indexes are responsible for the significant impact. We first interact the DTRI with the various components of the STRI, which are (1) Restrictions on foreign entry; (2) Restrictions on the movement of people; (3) Other discriminatory measures; (4) Barriers to competition; and finally (5) Regulatory transparency. Note that we do not interact the OECD DGSTRI with the STRI as they largely overlap as explained in Section 2 and Annex D.

The results in Table F1 shows that the combination of digital restrictions and foreign entry restrictions and restrictions on the movement of people have in particular a significant negative impact – as indicated by the x for each cell in the table. Digital restrictions in combination with barriers to competition are also found to have a negative and significant impact. Similar results are obtained when using the STRI for the EEA instead. However, due to the free movement of people within the EEA, the combination of digital restrictions and restrictions on the movement of people comes out insignificant.

Table F1: Interaction DGSTRI and DTRI with the Various Category Components of Policies of the STRI

	Restrictions on foreign entry	Restrictions on the movement of people	Other discriminatory measures	Barriers to competition	Regulatory transparency
DTRI	x	x			
			EEA STRI		
DTRI	x				

Note: x indicates significance of the interaction variable by at least ** p<0.05. See Annex D for further details on the regression estimations. EEA stands for the European Economic Area. Each interaction term is regressed with the three productivity variables as found in equation (D2) in Annex D.

Similarly, when regression the interaction terms the other way around, it means that we use the various policy components of the DTRI and interact them with the overall indicator of STRI. In doing so, we interact the STRI first with the components of ECIPE's DTRI, namely (A) Fiscal restrictions & Market access; (B) Establishment restrictions; (C) Restrictions on data; (D) Trading restrictions. The interactions are also done with the EEA STRI. Note again that we do not interact the OECD DGSTRI with the STRI as they largely overlap.

Table F2 presents the results of this interaction exercise. Almost all categories of the DTRI come out significant, with only weak significance for the category of Fiscal restrictions & Market access. The non-digital restrictions in combination with the categories of Establishment restrictions, Restrictions on data and finally Trading restriction come out negative and significant. For the category of Fiscal restriction & market access, results are again found to be significant only at the 10 percent level. In case of using the EEA STRI, none of the interaction comes out significant.

Table F2: Interaction STRI with the Various Category Components of Policies of the DTRI

	Fiscal restrictions & Market access	Establishment restrictions	Restrictions on data	Trading restrictions
STRI	x	x	x	x
EEA STRI				

Note: x indicates significance of the interaction variable by at least ** p<0.05. x indicates significant of the interaction variable by **p<0.10. See Annex D for further details on the regression estimations. EEA stands for the European Economic Area. Each interaction term is regressed with the three productivity variables as found in equation (D2) in Annex D.

In sum, it means that digital restrictions are in particular associated with a negative economic outcome in terms of productivity when put in combination with restrictions on foreign entry, which are in large part comprised of investment restrictions, such as equity restrictions, restrictions on the board of directors / managers when foreign firms invest on the partner country. Digital restrictions also have a particular negative impact when putting together with restrictions on the mobility of foreign services providers, such as labor market quotas, residency requirements, etc. as found in Table F1.

Interestingly, the policy picture that emerges from looking at the various components of digital restrictions tells us a consistent story. Both investments restrictions and restrictions on the movement of people are categorized under the DTRI's category of Establishment restrictions as found in Table F2. On top of that, non-digital restrictions in combination with Restrictions on data and Trading restrictions, which comprises e-commerce and online transactions restrictions as well as burdensome standards, are also found to have a particularly negative and significant correlation with productivity.

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