Productivity and Digitilization in Europe: Paving the Road to Faster Growth

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Abstract: This paper reviews the latest evidence on the contribution of Information and Communication Technology (ICT) – and the digital economy more broadly – on economic growth for Europe and the United States since the late 1990s until most recently. The paper provides estimates on the contributions from ICT to growth from three channels affecting the long-term growth performance of entire economies: 1) a productivity effect through the ICT-producing sector, 2) an investment effect from ICT-using industries through capital deepening, and 3) a productivity effect from an efficiency rise through the use of ICT which goes beyond the direct capital deepening effect. The study finds that the slowing of the total factor productivity growth rate in Europe reflects a failure to effectively adopt new technologies and innovation. It is also argued that the lack of rapid accumulation of intangible capital (such as information assets, innovative property, and economic competencies) constrains Europe's ability to accelerate and facilitate the innovation effects from digital technology. Finally, we discuss some policy implication emerging from our work, in particular the need to complete the Single Market in Europe to improve the productivity effects from the digital economy.

Key words: information and communication technology, productivity, economic growth, economic policy, Europe.

While Europe continues to recover from crisis and works to bring down high unemployment rates, the real challenge facing policymakers and citizens alike is the search for a path to sustainable growth in the medium and the long-term. Before the onset of the economic and financial crisis in 2008, the EU-28 grew at a healthy annual average of 2.6% from 1999-2007. However, since 2008 Europe grew only at a mediocre 0.2% from 2008-2014 (The

(*) The Conference Board and University of Groningen. This paper is largely based on a study, under the same title, which I carried out in 2014 for The Lisbon Council (van ARK, 2014). I also made use of material obtained from a research paper I did for the European Commission, DG ECFIN (van ARK, 2015). The views expressed here are of course entirely my own.

Conference Board Total Economy Database, update May 2015). Recovery looks to be set for a moderate 1.7-1.8% for 2015 and 2016. However, for the medium-term The Conference Board projects a base growth scenario for Europe, based on prevailing trends in the underlying economies' principal sources of growth – labour, capital and productivity, which suggests a reversion to a long-term growth trend of around 1.5% by the beginning of the next decade – substantially below its pre-crisis average (The Conference Board Global Economic Outlook 2016). A slower growth in labour supply is among one of the important explanations for this slowdown in trend growth. The impact of the other key sources, investment and productivity, however, are much more uncertain, and have the potential to create an upside as well as the risk to turn out much weaker than predicted.

So is Europe condemned to slow growth, with all of the negative fallout this implies – including high unemployment, fragile public finances and low consumer and investor confidence? Or could the ample availability of new technology create a way out of a downward spiral of low investment and weak productivity? When looking at the drivers for boosting productivity, we will focus on what we believe is one of the biggest opportunities to accelerate productivity growth, which is the ongoing digitalization of the economy. How can greater adoption of Information and Communication Technology (ICT) – and greater integration throughout the EU in the digital market – help to accelerate productivity growth in Europe?

This paper starts off by reviewing the macroeconomic growth performance in Europe, which helps to identify how much investment in ICT capital has contributed to growth. We will then focus on the three main transmission channels of ICT and digital on the economy: 1) a technology impact on productivity from the ICT-producing sector; 2) an investment effect through capital deepening in ICT; and 3) a productivity effect from the adoption and utilization of digital technologies across the economy. Next we will address one of the most important levers for business to accelerate and facilitate the innovation effects from digital technology, which is increased investment in so-called intangible capital. In addition to ICT capital, intangible capital includes other information assets, such as data, but also innovative property, and economic competencies, including workforce training, organizational innovations, branding and marketing. Finally, we argue that from a policy perspective there is an urgent need to improve the productivity effects from the digital economy, especially through the completion of the Single Digital Market.

■ A macroeconomic perspective on ICT as a source of growth

A decomposition of the annual average growth rates in aggregate GDP into the contributions of labour, capital and productivity reveals some stark differences in Europe's growth performance relative to its own history and compared to the United States (Table 1). [1] While, from 1999 to 2007, Europe and the Euro Area saw a faster increase in the contribution of working hours to growth than the United States, hours have contributed negatively since the beginning of the crisis in Europe and provided a zero contribution in the United States.

The contribution of past and present investments, measured as capital services from ICT and non-ICT assets, have been the main drivers of GDP growth in the aggregate EU and the U.S.. Before the crisis, non-ICT capital accounted for about 0.8 percentage points of GDP growth in the EU, but declined to 0.5 percentage points since the crisis. In the Euro Area the contribution of non-ICT capital dropped from 0.7 to 0.3 percentage points, which was comparable to the drop-off in the United States. With regard to ICT capital, the U.S. advance in the ICT capital contribution to growth was much higher (at 0.7 percentage points) than in Europe (at 0.5 percentage points) and the Euro Area (at 0.4 percentage points) during the 1999-2007 period. In the U.S., much of the faster investment pace during the "new economy" era of the late 1990s was driven by the scale effects from larger U.S. markets, especially in market services such as trade and transportation, which could not be easily replicated in Europe (INKLAAR *et al.*, 2008). Since 2008 the ICT capital contribution to growth slowed down considerably in both regions, and even slightly more in the United States (from 0.7 to 0.4 percentage points) than in the EU-28 (from 0.5 to 0.3) and in the Euro Area (from 0.4 to 0.3).

The biggest concern with regard to Europe's growth rate, relates to the slow rate of total factor productivity (TFP) growth, which measures the efficiency of the combined use of labour and capital. As mentioned above, this trend is all the more surprising given the rapid rise of the digital technology in the past decade. It should be stressed that the slowdown in

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[1] Throughout this paper, we use the United States as a benchmark because it is the world's largest industrialised economy and by many accounts the world's most innovative large industrial economy. The purpose is to hold up the U.S. economy as a benchmark, not as an economic model. A deep discussion of the problems particular to the U.S. economy is beyond the scope of this paper.

TFP growth did not exactly coincide with the start of the 2008-2009 crisis, but started in 2007 meaning that cyclical factors are not solely responsible for the slowdown. [2] Beyond the temporary impact from the recession related to weak cyclical demand, slow total factor productivity growth might signal weakening innovation and technological change. Companies may be holding back investment in those areas due to longer term concerns about a negative spiral of weak demand and investment where low nominal interest rates do not help to drive up investment – the so-called secular stagnation hypothesis (TEULINGS & BALDWIN, 2014).

Table 1 - Output, hours and labour productivity growth, and growth contributions by major input, log growth, 1999-2007 and 2008-2014

		Contributions to GDP growth From				
	Growth rate of GDP	Hours worked (weighted) (*)	Labour composition	Non-ICT capital	ICT capital	Total factor productivity growth
1999-2007						
EU-28	2.6	0.5	0.2	0.8	0.5	0.6
Euro Area	2.3	0.6	0.2	0.7	0.4	0.4
EU-15 (**)	2.4	0.6	0.2	0.7	0.5	0.4
EU-12 (***)	4.4	-0.1	0.3	1.2	0.8	2.2
United States	2.8	0.4	0.2	0.7	0.7	0.9
2008-2014						
EU-27	0.2	-0.2	0.2	0.5	0.3	-0.5
Euro Area	-0.2	-0.4	0.2	0.3	0.3	-0.6
EU-15 (**)	0.0	-0.2	0.1	0.4	0.3	-0.6
EU-12 (***)	1.5	-0.3	0.2	1.1	0.7	-0.2
United States	1.1	0.0	0.1	0.3	0.4	0.3

(*) Refers to the contribution of total hours worked, weighted by the share of labour in total compensation, to the log growth rate of GDP.
(**) EU-15 refers to pre-2004 membership of EU.
(***) EU-12 refers to new membership of EU since 2004, and excludes Croatia which became member of EU on 1 July 2013.

Note: For figures by individual countries, see van ARK (2015).

Source: The Conference Board Total Economy Database™, May 2015

Slow total factor productivity growth may also be caused by difficulties on the supply side to implement new technologies. It is a well-known fact that new technology regimes, such as the current convergence of ubiquitous

[2] The TFP growth slowdown in Europe started several years later than in the United States, where it began in 2004, because Europe benefited from a significant cyclical upswing during the early 2000s.

broadband and mobile, supported by cloud computing and big data analytics, and reflected in the rise of the apps economy and the sharing economy, take time to translate themselves in more productivity applications. In the extreme, a minority of scholars argue that the potential impacts of this latest digital technology wave fades compared to previous major technology booms, such as the electricity grid or the combustion engine (COWEN, 2011; GORDON, 2014).

It could also be that the impact of new digital technologies and applications – including big data analytics, artificial intelligence, and "the internet of things" – may help strengthen productivity growth, but that it has yet to come to fruition. New technologies need time to diffuse within organizations before showing a productivity payoff. In this line of thinking technology use will expand even more rapidly in the coming years, challenging the creation of future jobs (BRYNJOLFSSON & McAFEE, 2011).

However, for the total factor productivity growth rate to turn negative, additional explanations are needed. First, it could signal an increase in rigidities in labour, product and capital markets during the crisis, causing increased misallocation of resources away from higher-productivity to lower-productive firms. This may especially be so in times during which scale-dependent technologies such as communication technology require flexibility across a larger economic space. Limited scale effects in Europe, related to fragmented markets and limited impacts from ICT utilization might have played a larger role than in the United States.

Second, we can also not exclude the possibility that measurement issues hide the productivity impacts related to the introduction of new technologies and subsequent innovations. The potential productivity gains from the rise of the digital economy pose huge measurement challenges. Inadequate price measures for new communication equipment, a failure to measure consumer surplus and, importantly, the inadequate reflection of the productivity gains from the apps economy in the output statistics, may cause a potential downward bias in the output measures (WILLIAMS, 2008; BYRNE & CORRADO, 2015). However, as argued below, the lack of proper investment measures reflecting the so-called intangible assets, such as human capital, information assets, innovative property, and economic competencies add to the complexity of measurement issues, and could possibly bias the estimates the other way as there may be much more investment going on than actually measured without the corresponding productivity results. In any case, from the perspective of understanding the growth gap across the Atlantic, it is unlikely that the measurement bias in technology is any bigger in Europe than in the United States. Moreover, the slowdown in total factor productivity growth seems quite widespread across sectors, including less-ICT intensive manufacturing as well as services industries, making it harder to argue that the technology bias in the output and input measures dwarfs the "true" slowdown in productivity growth.[3]

In sum, reviewing the literature and the empirical evidence, while it is too early to decisively attribute the productivity slowdown since 2008 to one specific factor (be it the economic and financial crisis, measurement problems, or issues with technology adoption itself), it seems that the latter explanation has contributed to the slowing of the productivity growth rate in Europe. In the next section we will analyze which channels are mainly responsible for this slow adoption rate in Europe.

How digitalization matters for productivity

Like the rise of other general purpose technologies which affected the long-term growth performance of entire economies, such as the steam engine or electrical grid, ICT's impact on growth typically comes in three phases over a prolonged period of time: 1) a productivity effect through the ICT-producing sector, 2) an investment effect from ICT-using industries through capital deepening, and 3) a productivity effect from an efficiency rise through the use of ICT which goes beyond the direct capital deepening effect. We will look at each in turn.

Productivity effects from ICT producers

In the early stages of implementing new technologies, the productivity effects are foremost realised by the producers of those new technologies. Firms in the tech-producing sector often experience very strong productivity gains. Before the onset of the crisis, U.S. labour productivity in the ICT sector grew at 10.5% *vis-à-vis* 4.4% per year in Europe from 1999-2007 based on a sample of eight major European economies. Since 2008, even

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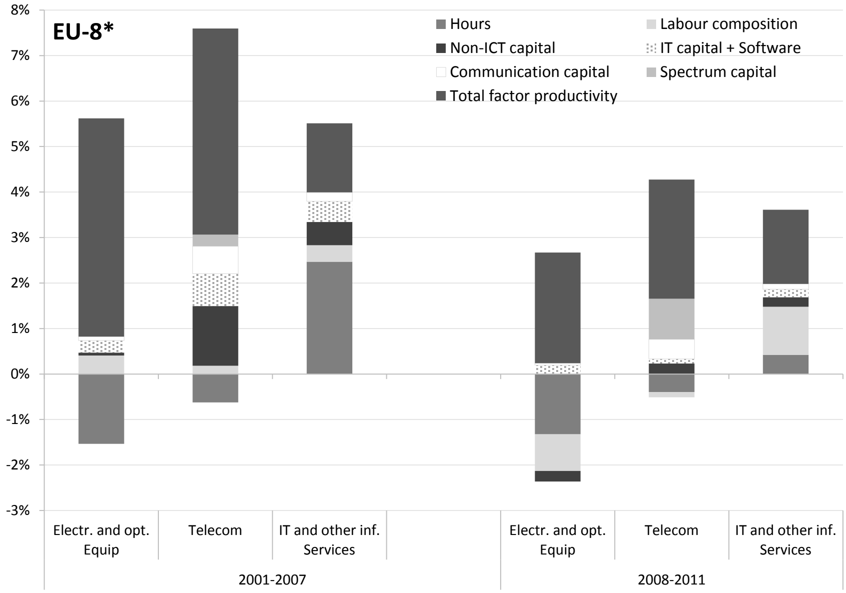
3 For a recent commentary, see my blog post, titled "Blaming the productivity slowdown on measurement issues takes our eyes off the ball".
http://tcbblogs.org/economy/2015/07/22/blaming-the-productivity-slowdown-on-measurement-issues-takes-our-eyes-off-the-ball/

though European countries continued to grow employment in the ICT sector, productivity growth (at 2.1% from 2008-2014) stayed well behind the U.S., although the latter economy also saw productivity growth in the ICT sector being halved to 5% (van ARK & O'MAHONY, 2016). [4]

Figure 1 – Contributions to average annual growth in value added in three major ICT producing sectors for the average of eight major EU-economies (2001-2011)



Note: EU-8* refers to weighted average of contributions for eight EU economies: Austria, Finland, France, Germany, Italy, Netherlands, Spain, and United Kingdom. The estimates are based on updates of the EUKLEMS industry-level productivity accounts (www.euklems.net), which are extrapolated to 2011 through estimations by the authors. The EU-8 averages are weighted by the value added shares of the individual countries.

Source: CORRADO & JÄGER (2014)

Going into more detail, the total factor productivity growth in ICT and other information services was on average 1.5% per year, 4.5% in telecommunication services and 4.8% for the producers of electrical and optical equipment (Figure 1). Even though these industries only represent a small part of the economy, at about 8% of total GDP in Europe, they

[4] The eight EU member states are: Austria, Finland, France, Germany, Italy, Netherlands, Spain, and the United Kingdom. Only Finland posted productivity growth rates in the same range as the U.S., whereas in other Euro Area countries productivity growth rates in ICT production were mostly less than half of that.

accounted for about 50% (0.3%-point) of aggregate total factor productivity growth (0.6%-point) in the market sector of these eight economies between 2001 and 2007. The total factor productivity effect from ICT producers in the U.S. was slightly higher at 0.5% from 2001 to 2007 out of an aggregate TFP growth of 0.7% from 2001-2007 (ROSENTHAL, 2014). Importantly, while the aggregate market-sector total factor productivity growth for the European economies turned negative at -0.5% since the 2008-2009 recession and its immediate aftermath, the total factor productivity contribution of the three ICT sectors remained positive at a modest 0.2% from 2008-2011 (compared to 0.3% in the United States).

Unfortunately, ICT producers are not major net job creators in Europe as there are not enough new companies being created to offset the job shedding in the old ones. Only in ICT and other information services-based companies has hours worked increased, which has dropped off since 2008. However, the growth in labour force skills in ICT services, as measured by the labour composition factor in Figure 1, increased strongly after 2008 making it a key sector for absorbing high-skilled employees.

Growth effects from investment in ICT

Investment in digital technology takes place through the spending on ICT and telecom hardware, software, networks, databases, and user platforms across the economy. As shown earlier, the investment effects from ICT positively contributed to value added growth before the crisis started, and these contributions have remained positive since 2008 even though they slightly weakened.

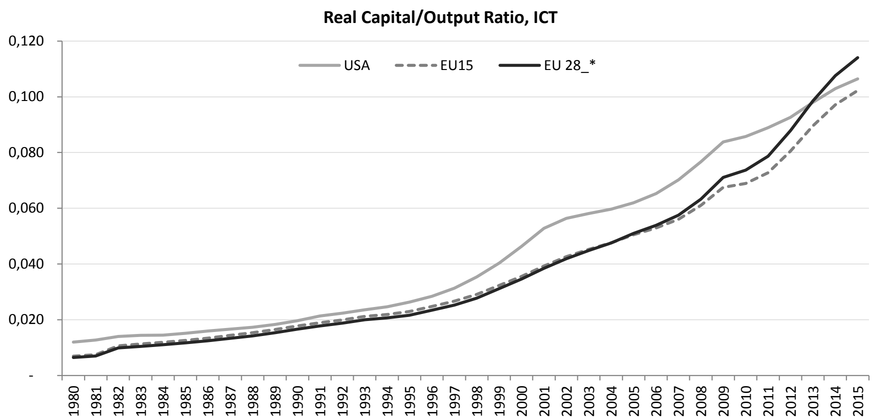
Table 2 shows that, despite the slowdown in investment and output growth since the crisis, ICT investment relative to output, when measured in real terms, kept increasing significantly in both Europe and the United States. Strikingly, the growth of the ICT capital stock showed a much faster increase in Europe than in the U.S. since the crisis. For example, between 2008 and 2014, the Euro Area-19 capital stock increased at on average 8.6% per year (at 8.9% for the EU-28) versus 6.3% in the United States. The faster growth of the stock is in part the result of lower starting levels of ICT capital in Europe, especially in telecommunication equipment, relative to the United States. Europe's growth in telecommunication equipment overtook that of the United States during the second period. Especially in the EU-28 ICT capital-output ratios appear to have fully caught up with the U.S. level in recent years, and the gap between the Euro Area-19 has also significantly narrowed (Figure 2).

Table 2 – Measures of ICT investment and capital growth and intensity in real terms

	USA	*EU-28*	*Euro Area-19*
	ICT investment-output ratio % growth		
1999-2007	2.2%	1.7%	1.4%
2008-2014	3.2%	2.8%	2.4%
	ICT capital stock, % growth		
1999-2007	9.5%	10.2%	8.8%
2008-2014	6.3%	8.9%	8.6%
	ICT capital-output ratio (average)		
1999-2007	0.06	0.04	0.04
2008-2014	0.09	0.08	0.07
	ICT capital-hour ratio (average)		
1999-2007	3.3	2.1	2.0
2008-2014	5.8	4.2	3.9

Source: The Conference Board Total Economy Database, May 2015

Figure 2 - Level of ICT capital stock per unit of output, in 2014 US$ (PPP-converted)



Source: The Conference Board Total Economy Database, May 2015

However, what does the faster investment in ICT mean for productivity? Table 2 also shows that despite the faster rise in capital stock and capital intensity in Europe (as in the top two panels), the amount of ICT capital per employee hour worked (bottom panel) remained well below the U.S. level, suggesting still lower levels of labour productivity related to ICT production in Europe. [5] So, while ICT investment and capital intensity have increased rather strongly in Europe, there does not seem to be much of an effect on overall faster labour productivity growth in Europe.

Investment booms in new technology such as ICT may, temporarily, even cause a productivity slowdown or a decline in efficiency (as measured by total factor productivity). For example, at the end of the 1990s when the investment in ICT hardware boomed, creating the dot.com crisis of 2000-2001, total factor productivity growth significantly slowed in both the EU and the US. This was in part caused by lower utilization rates of the new capital installed. The potential of ICT and digitalization to accelerate growth will therefore have to come primarily from the third factor, which is the use of these technologies by other industries in the non-ICT sector of the economy.

Network effects on productivity from ICT use in non-ICT sectors

It is the long-lasting productivity effects of using ICT and digital content in other industries than ICT itself that are the hardest to come by and take the longest to emerge. Despite the impressive rise in supply and utilization of social media, cloud computing, big data analytics, the quantitative impact on growth is still small. Indeed, this recent phase of new applications is just one little part of a long-term wave of implementing ICT, which started several decades ago. Its impact on growth is akin to other so-called general purpose technologies since the start of the Industrial Revolution, including the rise of steam, electricity or the combustion engine – all of which came about more through a process of ongoing "evolution" than overnight "revolution" (CRAFTS, 2010).

This is not to say that the new capabilities that come along with a general purpose technology cannot be very disruptive for parts of the economy. At first, productivity gains arrive for selected industries only, and spring up like mushrooms across the economy, putting old models out of business and creating room for new activities. The publishing industry, the retail sector and even health care are cases in point of large disruptions due to ICT in the late 1990s and early 2000s (van ARK, 2011). Over time, as more and more companies adopt the technology and innovations spread across the

5 That is: Y/H = (C/H) * (Y/C), meaning that output (Y) per hour (H) is determined by capital (C) per hour (H) times capital productivity (Y/C).

economy, the impact on productivity at the macro level becomes more visible.

The productivity effects of using new technology is not easy to identify or quantify, and the traditional standard growth accounts employed so far do not suffice to disentangle which part of productivity growth can be linked to so-called network externalities. CORRADO & JÄGER (2014) represent a first attempt to do this for European countries (Table 3). They find that, taken together, the impacts of ICT production, investment and use accounted for about 1 percentage point of output growth in the eight European economies from 2001 to 2007, which is substantial given the overall market sector output growth rate of just over 2%. Close to half of the ICT effect comes from investment and the other two quarters from productivity of ICT producers and ICT users. While the productivity contributions from ICT producers and ICT capital were largely sustained since the onset of the crisis, especially the returns-of-scale part of total factor productivity by the non-ICT sector which contracted sharply, bringing the overall contribution of ICT to output growth down from 1% from 2001-2007 to 0.1% from 2008-2011.

According to CORRADO & JÄGER, network externalities come in two parts:

- a return-to-scale effect, which directly relates to Metcalfe's law, which states that the value of a network increases with the square of the number of users of the network; and
- the productivity effects from innovative adaptations from the use of, for example, the internet and wireless technologies.

The productivity impacts of the two network effects, based on an econometric analysis for eight European countries, show these effects to be quite low (Table 3). For example, between 2001 and 2007, the returns-to-scale effect in the non-ICT sector accounted for as little as 0.16% of average output growth in the eight countries we surveyed. Only during the boom years of 2006 and 2007 did total factor productivity growth from higher returns-to-scale add as much as 0.4% to 0.6% to growth. While ICT capital continued to contribute to growth during the 2008-2011 period, the returns-to-scale even detracted 0.3% of growth because of the contraction in economic activity during that time.

At less than 0.1%, the TFP effect of innovative adaptation on growth is even smaller than the returns to scale effect from 2001-2011. However, in contrast to aggregate TFP, it did not decline much more during the 2008-2011 period.

Table 3: Productivity contribution from digitalization to average annual GDP growth for eight major EU economies, 2001-2011

	2001-2007	*2008-2011*
Technology effect through the ICT-producing sector		
TFP growth from ICT hardware	0.12%	0.05%
TFP growth from software	0.04%	0.05%
TFP growth from telecommunication	0.12%	0.06%
Subtotal	*0.28%*	*0.16%*
Investment effect from ICT-using industries through capital deepening		
IT investment	0.33%	0.12%
CT investment, including spectrum	0.11%	0.09%
Subtotal	*0.44%*	*0.21%*
Network effects on productivity from ICT use and in non-ICT sectors		
TFP growth from ICT returns to scale in non-ICT sector	0.16%	-0.31%
TFP growth from ICT adaptions in non-ICT sector	0.09%	0.07%
Subtotal	*0.25%*	*-0.24%*
Total GDP effects from ICT production, investment and use	0.97%	0.13%

Note: EU-8 refers to the weighted average of contributions for eight EU member states: Austria, Finland, France, Germany, Italy, Netherlands, Spain and the United Kingdom. The measures focus exclusively on the market sector of the economy, excluding health care, education and government.

Source: CORRADO & JÄGER (2014), Figure 4; van ARK (2014)

The upshot of this discussion is that the key challenge for accelerating productivity growth through digitalization is not solely with the ICT producers but also with the impacts of widespread use of the technology across the economy. Even when investment will start to accelerate again, the sustainable effect on productivity growth will need to come from stronger network effects, causing faster TFP growth. It is on this point of network effects that Europe has seen the biggest decline in performance.

■ Intangible investments provide the foundation for higher TFP growth from ICT

While Europe and the U.S. could both surely use more investment in the current phase of recovery, the more important focus should be on getting a higher return from the investments they make through new technology and innovation. However, it is important that the impact of technological progress on productivity is not considered in isolation from a broader concept of investment, and not just machinery and equipment, or even ICT and ICT telecom hardware and software only. In recent years an important literature has emerged highlighting that organizational changes and other forms of intangible investment are necessary to gain significant productivity benefits from using ICT (BLACK & LYNCH, 2001; BRYNJOLFSSON *et al.*, 2011). Hence incorporating a broader range of intangible assets such as investments in non-technological innovations (design, financial innovations), workforce training, improvements in organizational structures, marketing and branding, and – importantly – the creation of databases and other digital systems in an economy's creation of capital helps to show that digitalization does not happen on its own.

According to a study by CORRADO *et al.* (2013) Europe (here the EU-15 aggregate) has a much lower investment intensity in intangibles than the United States (Table 4). The share of all measured intangible investment in value added for the market sector in the EU-15 has increased by 1 percentage point from 9.5% of market sector value added in the 1995-2002 period to 10.5% from 2008-2010, by which time it was about two thirds of the U.S. intangibles share in market GDP, which was 15.3 percent. While Europe's intangibles intensity was below that of the U.S. in all categories, it was particularly weak in R&D and other innovative property, and in market research and advertising. Weaker R&D is in part related to the less intensive high-tech nature of Europe's manufacturing sector compared to the United States, whereas lower market research and advertising intensity is due to a smaller share of distributional and personal services in the European economies relative to the United States.

ICT and intangible assets are connected in many ways. Some ICT assets, such as software and databases, are themselves classified as an intangible asset. ICT can facilitate the deployment of other intangible assets and enable innovations across the economy, such as the re-organization and streamlining of existing business processes, for example through order tracking, inventory control, accounting services and the tracking of product delivery. At the same time, capital deepening in intangible assets provides the foundation for ICT to impact productivity. For example, the internal organization of a firm plays a role in its ability to use ICT more efficiently, in particular through managerial and other organizational changes (BRESHAHAN *et al.*, 2002; BERTSCHEK & KAISER, 2004).

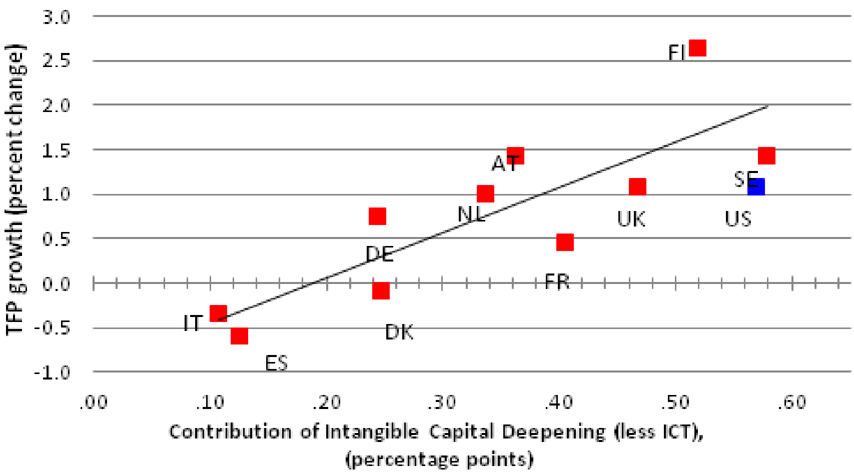
Table 4 - Investment intensity of intangible assets in the market sector as a percentage of market sector GDP for EU-15 economies, 1995-2010

	1995-2002		*2003-2007*		*2008-2010*	
	EU-15	U.S.	EU-15	U.S.	EU-15	U.S.
Computerised Information	1.4%	1.9%	1.6%	2.1%	1.8%	2.3%
Scientific R&D	1.6%	2.7%	1.7%	2.6%	1.8%	3.0%
Other Innovative Property	1.5%	2.0%	1.7%	2.7%	1.8%	2.9%
Market Research & Advertising	1.4%	2.0%	1.3%	2.1%	1.2%	2.0%
Training	1.3%	1.6%	1.3%	1.8%	1.3%	1.7%
Organizational Capital	2.2%	3.1%	2.5%	3.5%	2.7%	3.4%
Total Intangible Capital	9.5%	13.3%	10.0%	14.7%	10.5%	15.3%

Note: EU-15 refers to pre-2004 membership of the European Union.

Source: CORRADO, HASKEL, JONA-LASINIO & IOMMI (2013)

Figure 3 - Relationship between intangible capital deepening and total factor productivity growth in EU Economies and United States, 1995-2007



Note: Regression line is for the 10 EU countries only. Intangible capital excludes software.

Source: CORRADO, HASKEL, JONAS-LASINIO & IOMMI (2013).

Going beyond complementarities between ICT and intangibles, Figure 3 suggests that there is a strong relationship between intangible capital deepening (excluding ICT) and total factor productivity growth, which is consistent with the possibility of total factor productivity spillovers from intangible investments beyond GDP. More extensive regression estimates suggest this to be the case (CORRADO *et al*., 2013). This result is in line with existing evidence on spillover effects from R&D, but this extension to other assets suggests than many intangible capital assets have public-good characteristics. Also recent work on the relationship between product innovation measures shows a strong relationship to TFP. Clearly one also requires caution by not overstating the realization of the spillover potential from intangibles. For example, spillovers might not occur if intangible capital is protected by intellectual property rules (copyright, trademarks, etc.) or tacit knowledge (internal knowledge of supply chain management, for example).

■ Some policy implications

Europe's moderate success in picking up on the productivity effects from digitalization brings the need for active policy intervention into focus. While many current European policies aim at stabilizing financial market conditions and establishing a credible path of fiscal and monetary policy, there is much to be done beyond that to "put ICT to work". There is no shortage of implementing structural policy measures, ranging from more investment in hard and soft infrastructure to smarter regulation, more innovation and greater room for entrepreneurship will matter hugely to improve structural conditions. Indeed the five headline targets set out in the European 2020 Agenda -- create more jobs, accelerate innovation, improve energy efficiency, strengthen education and reduce poverty exclusion – are fundamental components of any successful strategy to deliver positive social change and accelerate growth. [6]

It seems Europe is well placed to benefit from the potential of ICT investment and digitalization. The huge size of its GDP, which has made it potentially the largest single market in the world, its relatively high levels of per capita income and productivity, the major and increasing contributions from European firms to producing for the global value chain of manufactured goods, and the above-average level of innovation infrastructure in which business, government, and research interact, are putting Europe in a favourable position to book results in digitalizing the economy and raising productivity (van WELSUM *et al.*, 2013).

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[6] For more on the Europe 2020 Agenda, visit http://ec.europa.eu/europe2020/index_en.htm.

As the services sector makes up 70% of the EU's GDP, the completion of the single market for services in the EU, and the Single Digital Market in particular, can hugely leverage the potential of ICT to strengthen growth. When consumers and businesses can access services across the EU and benefit from the lower prices at which these services can be offered, companies will be better able to realise the returns to scale which have strongly fallen in recent times. A single digital market provides more room to successful businesses to grow faster, and allows for a more efficient reallocation of productive resources away from failing businesses (BARTELSMAN, 2013). The larger market also creates more room for start-ups and other small innovative companies, including those developed by digital entrepreneurs, which play an important role in energising the business environment, but often face many institutional barriers on their own home turf (CLAYTON & van WELSUM, 2014). Access to finance for such companies is another major issue that needs to be tackled both in terms of seed capital as well as financing that is required to scale up (BARNIER *et al*., 2012).

Finally, none of the measurements of returns-to-scale effects discussed above takes into account the utility effects which consumers can realise through accessing larger networks. The unmeasured consumer surplus, which results from switching from older more expensive technologies to newer and cheaper ones, has been documented to be substantial (GREENSTEIN & McDEVITT, 2011).

Hence a single market for digital services in Europe can help to feed consumer and business demand, which drives innovation through adoption of digital technologies to support productivity growth and GDP, which in turn creates the demand for new jobs to generate the income for consumers to obtain the products and services being produced.

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