European Investment Bank The EU bank

EIB Working Papers 2016 / 08

Intangible investment in the EU and US

before and since the Great Recession and its contribution to productivity growth

Carol Corrado,
Jonathan Haskel,
Cecilia Jona-Lasinio,
Massimiliano Iommi

Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth*

Carol Corrado (The Conference Board), New York
Jonathan Haskel (Imperial College, CEPR and IZA), London
Cecilia Jona-Lasinio (Istat and LUISS Lab), Rome
Massimiliano Iommi (Istat and LUISS Lab), Rome

10 November 2016

Abstract

This paper uses a new cross-country cross-industry dataset on investment in tangible and intangible assets for 18 European countries and the US. We set out a framework for measuring intangible investment and capital stocks and their effect on output, inputs and total factor productivity. The analysis provides evidence on the diffusion of intangible investment across Europe and the US over the years 2000-2013 and offers growth accounting evidence before and after the Great Recession in 2008-2009. Our major findings are the following. First, tangible investment fell massively during the Great Recession and has hardly recovered, whereas intangible investment has been relatively resilient and recovered fast in the US but lagged behind in the EU. Second, the sources of growth analysis including only national account intangibles (software, R&D, mineral exploration and artistic originals), suggest that capital deepening is the main driver of growth, with tangibles and intangibles accounting for 80% and 20% in the EU while both account for 50% in the US, over 2000-2013. Extending the asset boundary to the intangible assets not included in the national accounts (Corrado, Hulten and Sichel (2005)) makes capital deepening increases. The contribution of tangibles is reduced both in the EU and the US (60% and 40% respectively) while intangibles account for a larger share (40% in EU and 60% in the US). Then, our analysis shows that since the Great Recession, the slowdown in labour productivity growth has been driven by a decline in TFP growth with relatively a minor role for tangible and intangible capital. Finally, we document a significant correlation between stricter employment protection rules and less government investment in R&D, and a lower ratio of intangible to tangible investment.

JEL: O47, E22, E01

Keywords: productivity growth, intangible capital, sources of growth, national accounts.

* The opinions expressed are those of the authors only and do not represent the EIB official position nor should be attributed to their institutions. Contact: Massimiliano Iommi, Istat and Luiss Lab of European Economics, miommi@luiss.it.

1 Introduction

The changing nature of the global economy has placed novel attention on intangible capital as a new source of growth. Corrado, Hulten and Sichel (2005, hereafter CHS) expanded the core concept of business investment in national accounts by treating much business spending on "intangibles" – computerised databases, R&D, design, brand equity, firm-specific training, and organisational efficiency – as investment[1].

When this expanded view of investment is included in a sources-of-growth analysis, intangible capital is found to account for one-fifth to one-third of labour productivity growth in the market sector of advanced economies.

As overall business intangible investment is large and growing in advanced countries (Corrado et al., 2013) the development of harmonised methods and measures of intangible capital coherent with national accounting practices is essential for a deeper understanding of the sources of growth and for the design of macroeconomic policies aimed at stimulating sustained growth, competitiveness and sustainable development.

Although the fixed asset boundary in national accounts has been continuously expanded in recent decades to better account for the role of intangibles, official estimates treat as investment only a limited range of intangible assets: R&D, mineral exploration, computer software and databases, and entertainment, literary and artistic originals (SNA 2008/ESA 2010).

Following the work of Corrado, Hulten and Sichel (2005, 2009) and Nakamura (1999, 2001) a significant research effort has expanded the number of countries for which estimates of investment in intangible assets based on the CHS approach are available. Much work on intangibles focused on Europe and is comparative in nature. This applies to two projects funded by the European Commission (COINVEST and INNODRIVE) under the 7th Framework Programme and to work conducted by The Conference Board and published by the European Investment Bank (EIB) in December 2009. These projects generated estimates of business intangible investment and capital for the European economies. More recently, great efforts have been devoted to producing harmonised national estimates. This has led to the publication of the INTAN-Invest dataset[2], which

[1] The seminal contribution of Corrado, Hulten, and Sichel (2005, 2009, hereafter CHS) was to use an economic view of investment to formalise the arguments for capitalising a broad range of intangibles (not just R&D and software) in company and national accounts. Such assets are created when today's resources are set aside and used to expand tomorrow's production capacity. The criterion applies equally to firms' expenditures on product, market and organisational development because firms expend resources on such activities to increase their future production capacity through "organic growth", or innovation. This view of investment is common sense, yet it is firmly grounded in economic theory via the optimal growth literature (e.g. Weitzman 1976; see also Hulten 1979).

[2] "Harmonised" means that, to the extent possible, the same concepts, methods, and data sources are

covered 27 countries of the European Union, plus Norway and the United States (Corrado et al., 2012).

This paper uses a newly revised and updated release of the INTAN-Invest dataset for the market sector (INTAN-Invest 2016) of 18 European countries and the US to analyse the diffusion of intangible investment within Europe and in the US, to investigate the role of intangible capital as a source of growth and to improve our understanding of the drivers of the intangible investment gaps across countries.

The paper is structured into seven sections. Section 2 illustrates the theoretical framework and section 3 provides a data description (INTAN-Invest dataset, 2016). Section 4 illustrates the distribution and trends of intangible investment in the US and in the European economies over the years 2000 to 2013. Section 5 provides evidence about the economic relevance of intangible investment while section 6 explores the drivers of intangible capital accumulation. Section 7 concludes.

2 The theoretical framework

CHS advanced a simple three-sector model that specified production functions for consumer goods, conventional investment goods, and intangibles. The model was used to show how an economy's input and output growth changed when business investment in intangibles was capitalised, and its variables were used to identify the prices and quantities that needed to be measured in order to capitalise intangibles and study their contribution to growth.

Here we follow the same strategy but use the related model by Corrado, Goodridge and Haskel (2011) that integrates the various approaches to innovation and integrates innovation into the national accounts to make it measurable (see also Corrado et al., 2013).

The main assumptions of the model are the following. Knowledge (ideas) is an input needed to produce consumption and tangible investment goods together with labour and tangible capital. There exist two types of knowledge. One is knowledge that is generated without using factors of production and that is freely available to firms (free knowledge). The other is knowledge that is produced using inputs and that firms must pay for to use in their production process (commercialised knowledge). Commercialised knowledge is accumulated over time, generating the stock of commercial knowledge via the standard perpetual inventory relation and with its own user cost (explicit or implicit).[3]

applied and used for each country.

[3] To be more precise, the model considers a simplified economy with just two industries/sectors. The innovation sector produces new finished ideas i.e. it commercialises knowledge (e.g. a way of organising production, or a

The first implication of the model is a broad definition of investment, which includes expenditure to purchase both tangible goods and commercialised knowledge, and a broad definition of aggregate output, which includes not only consumption goods and tangible investment goods but also commercialised knowledge.

$$P^Q Q = P^Y Y + P^N N = P^C C + P^I I + P^N N \qquad [1]$$

The reason can be thought of by analogy to tangible investment. Suppose an aircraft factory buys in aluminium and produces both final output and its own machines. Then its value added should be properly treated as both the final aeroplanes and the machines, i.e. one might think of the factory as consisting of both an aircraft factory and also a machine factory. Its investment should be treated as the equal to the output of the machines. Now suppose the factory also writes its own long-lived software to run the machines. Then we should think of it as both an aircraft factory and machine factory and also a software factory and its investment should include not only the machines but also the software that is produced.

The second implication is that the expression for the sources of growth in value added output is,

$$d\ln Q = s_Q^L dlnL + s_Q^K dlnK + s_Q^R dlnR + dlnTFP \qquad [2]$$

where s_Q is the share of nominal value added accounted for by payments to the particular factor, dlnTFP is defined as the growth in Q (extended output including commercialised knowledge) over and above the growth contributions of labour, the accumulated stock of tangible capital and the accumulated stock of commercialised knowledge (which are in turn their growth rates, times their factor payment shares in total value added).

The final implication is that the model provides a measure of innovation. Equation 2 says that value added growth is due in part to growth in L and K. This formalises the idea that growth can be achieved by duplication i.e. adding more labour and tangible capital. It further says that growth can be due to the increased use of paid-for ideas, dlnR, but they

working software programme adapted to the needs of the organisation, say that implements pay and pension calculations for many part-time workers), while the "production" sector uses the knowledge to produce consumption and tangible investment goods. The innovation sector can, at least for some period, appropriate returns to its knowledge, and so this model is identical to Romer (1990) (where patent-protected knowledge is sold at a monopoly price to the final output sector during the period of appropriability), while the production sector is price taker for commercialised knowledge. Both sectors are price takers for labour and tangible capital.

have to be paid for to be used, and hence make a contribution to dlnQ of s_Q^RdlnR. The final term, dlnTFP is the growth impact of everything else, which in this model can only be free ideas used in both sectors. Thus in this model, innovation in the sense of use of ideas is also growth net of K and L usage, i.e.

$$Innovation = s_Q^R dlnR + dlnTFP = d\ln Q - (s_Q^L dlnL + s_Q^K dlnK) \qquad [3]$$

Many innovation studies have attempted to distinguish between innovation and diffusion, the latter being the spread of new ideas. If the ideas come for free, they are, in this framework, counted in TFP growth. So the part of innovation measured by s_Q^RdlnR is investment in commercialised new ideas and that part measured by dlnTFP might be regarded as the diffusion of free ideas.

3 Implementation: choice of assets and data sources

3.1 Choice of assets

What then are intangible assets? They are investments that enable knowledge to be commercialised. CHS group them into three categories (see Table 1 below)

Table 1: CHS intangible assets, national accounts conventions

Asset	Intang included in Nat Accounts?	Capitalization Factor	Depreciation rate
Computerised Information			
Purchased Software	Yes	1	0.315
Own-Account Software	Yes	1	0.315
Databases	See note	1	0.315
Innovative property			
R&D	Yes	1	0.15
Design	*No*	*0.5*	*0.2*
Mineral Exploration	Yes	1	0.075
Financial Innovation	*No*	1	0.2
Artistic originals	Yes	asset-specific	asset-specific
Economic Competencies			
Advertising	*No*	*0.6*	*0.55*
Marketing research	*No*	*0.6*	*0.55*
Own-Account Organisational Capital	*No*	1	0.4
Purchased Organisational Capital	*No*	*0.8*	*0.4*
Training	*No*	1	0.4

Let us review the assets in Table 1. "Computerised information" includes both purchased and own-account software: note that many intangibles are likely to be generated "in-house". Databases are also included as recommended in SNA 2008.

The second and third broad groups are "innovative property" and "economic competencies". "Innovative Property" is designed to capture a range of assets that may have intellectual property protection associated with them, e.g. R&D, design and artistic originals. Given the huge interest at the time in financial services the CHS list included a special category for them. "Economic competencies" aim at capturing a range of knowledge assets that firms invest to run their businesses, but that might have no IP: the costs of marketing and launching new products, including ongoing investments to maintain the value of a brand, and organisation and human capital management innovations (CHS, 2005, 2009).

3.2 From investment to capital stock

For each asset j, the corresponding stock of intangible capital at time t, $\boldsymbol{R_t^j}$, is determined via the perpetual inventory relation:

$$R_t^j = \left(1 - \delta^j\right) * R_{t-1}^j + N_t^j \qquad [4]$$

where the term $\boldsymbol{\delta^j}$ is the asset specific rate of decay of appropriable revenues from the existing stock of commercial knowledge (assumed constant over time) and $\boldsymbol{N_t^j}$is the value of investment

in volume terms in year t.

How can knowledge depreciate i.e. $\delta^j > 0$, if it does not wear out? As discussed in Pakes and Schankerman (1984), δ is the measure of how the value of the usable stock of capital varies over time and it can fall for at least two reasons (a) wear and tear and (b) obsolescence whereby new capital makes older capital less valuable. Tangible capital depreciation, where wear and tear is well-established should also reflect the obsolescence as well. Intangible capital might have low wear and tear but might have very high obsolescence if (a) new ideas are invented that make old ones obsolescent (or ideas partially "leave" the firm if there are partially embodied in departing workers) and (b) because it might become increasingly difficult for firms to appropriate benefits from knowledge as e.g. knowledge leaks out to competitors (e.g. via patent expiry).

To implement equation 4, we need investment in volume terms, the depreciation rate and the value of initial capital stock. Sources and methods adopted to generate nominal investment in intangible assets are described in Appendix 1. Nominal investment has to be deflated to get real investment. In this paper, we have used national accounts deflators. More precisely, for investment in computer software, R&D, Mineral exploration and Artistic original we have used the corresponding GFCF deflators. For each of the other assets (that are not currently included in the fixed asset boundary of national accounts) we have used the value-added deflator of the corresponding industry that is its main producer[4] (taken as a proxy of the output deflator, that is only available for a limited number of countries). The only exception is new financial products for which we have used the R&D deflator.

As for depreciation rates, we have used the values set out in the final column of Table 1 where the rate for mineral exploration is the US BEA rate.[5] The others are as discussed above or the same as CHS, bar R&D which is 15%. In the US, BEA, for example, places its central estimate of the depreciation rate for R&D at .15. Soloveichik (2010) produced depreciation rates for four categories of total artistic originals that also implied rather long service lives. Surveys conducted by the Israeli Statistical Bureau (Peleg 2008a, 2008b) and by Awano *et al*. (2010) with the UK Office of National Statistics asked about the "life length" of investments in R&D (by detailed industry in Israel) and

[4] In particular, we have used value-added deflator of industry M69-70 - "Legal and accounting activities; activities of head offices; management consultancy activities" for organizational capital; a weighted average of value-added deflator of industry M71-" Architectural and engineering activities; technical testing and analysis" and M74-75 – "Other professional, scientific and technical activities; veterinary activities" for design; value-aded deflator of industry M73 - "Advertising and market research" for brand; value-added deflator of industry P-"Education" for training.

[5] The lifetime of the knowledge created by mineral exploration is the service life of the discovery (a well or a mine). In the Australian national accounts, a service life of 34 years is used whereas the United States uses 12 for oil and gas exploration and 20 for mining. Most U.S. exploration is for oil and gas, and a 12-year life is used for the calculations reported in this paper. Note that investment is mineral exploration is negligible for most EU countries.

intangible assets (R&D plus 5 other asset types in the UK). The Israeli survey supports lengthening the service life for R&D, while the UK survey confirms fast depreciation rates for economic competencies.

3.3 Data sources

Among the intangible assets listed above, only a few are currently capitalised in national accounts (SNA 2008/ESA 2010): R&D, mineral exploration, computer software and databases, and entertainment, literary and artistic originals (in what follows we refer to this group of assets as national accounts intangibles). Expenditures for design, branding, new financial products, organisational capital and firm-provided training are instead currently treated as intermediate costs (in what follows we refer to this group of assets as new intangibles).

This paper uses a newly revised and updated release of the INTAN-Invest dataset (INTAN-Invest 2016) providing harmonised measures of business intangible investment (Table 1) and capital stocks in 18 European economies and the US. Once new intangibles are treated as investment the overall pattern of national account value added is adjusted to account for the extension of the asset boundaries, thus generating a modified picture of the sources of growth.

The INTAN-Invest 2016 measures of intangibles are obtained following the same estimation strategy adopted in the previous releases of INTAN-Invest but resorting to new NA data sources. INTAN-Invest 2016 data cover total investment in industries from NACE sections A to M (excluding M72) and section S plus the market sector component of NACE M72, P, Q and R (while previous INTAN-Invest estimates did not include industries P and Q but incorporated industry R as a whole). In the analysis reported in this paper we exclude the real estate industry (NACE section L).

As for sources and methods adopted to generate INTAN-Invest measures of intangibles see Appendix 1.

4 Intangible investment in the US and the European countries

In this section we provide evidence on the diffusion of business intangible investment over the period 2000-2013 in the US and in 18 EU economies (EU15 excluding Luxembourg (which will be referred to as EU14) plus the Czech Republic, Hungary, Slovakia and Slovenia (which will be referred to as the NMS)).

4.1 The overall picture

In 2000-2013, the average share of intangible investment in GDP is relatively higher in the US (4.2%) than in the EU14 (3.1%) as well as in the four new EU Member States (NMS) included in the analysis (2.2%) (Figure 1). Moreover, national accounts data suggest that the GDP share of tangible investment in the three areas (7.7%, 9.2% and 16.0% respectively) is relatively higher than the intangible share.

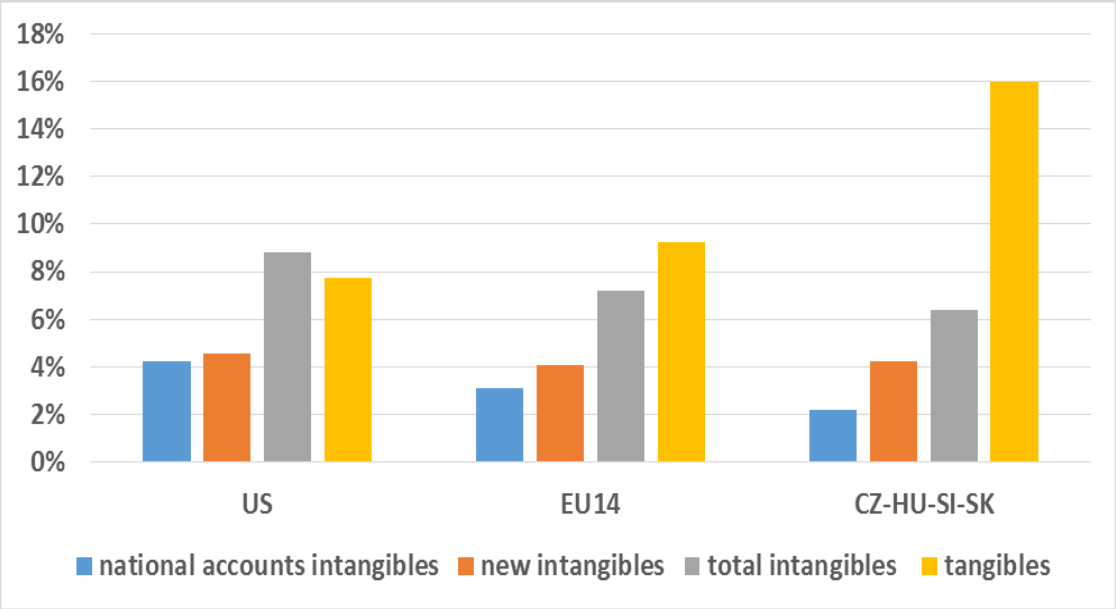
But when new intangible assets are included in the analysis, the intangible investment gap between the European economies and the US broadens. New intangibles account for 4.6% of GDP in the US, and 4.1% and 4.2% in the EU14 and NMS respectively. Adding new intangibles to national account assets makes the GDP share of total intangible investment increase to 8.8% in the US, 7.2% in the EU14 and 6.4% in the NMS. Hence in the US intangibles outpaced tangible investment while in the European economies the opposite was the case[6].

However, within the EU14 economies intangible shares of GDP vary considerably, revealing an interesting geographical pattern (**Table 2**). Northern Europe (Denmark, Finland, Ireland, Sweden and the UK) and non-German-speaking continental European countries (France, Netherlands and Belgium) are highly intangible intensive and characterised by higher intangible than tangible shares of GDP over the years 2000-2013. Sweden is the leading country with an intangible GDP share of 10.4%, followed by the UK (9.0%), Finland (8.8%), France (8.7%), the Netherlands and Ireland (both at 8.5%) and Belgium (8.1%) and Denmark (7.8%) lagging slightly behind.

The Mediterranean and German-speaking countries are relatively less intangible intensive economies. In Austria, the intangible investment rate (6.7%) is lower compared to the more intangible-oriented economies but still close to the average of the EU14. Portugal (6.0%) and Germany (5.9%) are below the EU14 average intangible share of GDP followed by Italy (5.3%) and Spain (4.6%). Greece shows the lowest average share over the period (3.7%) being an outlier also in terms of the tangible GDP share of investment.

[6] Although intangible intensity in the four NMS was slightly lower than in the EU14 region, the ratio of tangible investment to GDP (16%) was almost 50% higher than in the US and almost 60% higher than in the EU14 region.

Figure 1: Intangible and tangible investment (% GDP, average 2000-2013)



Source: INTAN-Invest and authors' elaborations on national accounts

Table 2: Intangible and tangible investment (% GDP, average 2000-2013)

	National Accounts Intangibles	New Intangibles	Total Intangibles	Tangibles
Austria	*3.1%*	*3.6%*	6.7%	11.4%
Belgium	*2.9%*	*5.2%*	8.1%	11.7%
Czech Republic	*2.5%*	*4.6%*	7.1%	17.8%
Denmark	*3.8%*	*4.1%*	7.8%	9.9%
Finland	*4.3%*	*4.4%*	8.8%	6.9%
France	*4.2%*	*4.5%*	8.7%	7.4%
Germany	*2.8%*	*3.0%*	5.9%	9.7%
Greece	*0.9%*	*2.8%*	3.7%	8.8%
Hungary	*2.0%*	*4.0%*	5.9%	13.3%
Ireland	*3.8%*	*4.7%*	8.5%	9.2%
Italy	*1.9%*	*3.4%*	5.3%	10.0%
Netherlands	*3.4%*	*5.1%*	8.5%	8.3%
Portugal	*1.7%*	*4.3%*	6.0%	11.3%
Slovenia	*2.5%*	*4.5%*	7.0%	15.1%
Spain	*2.1%*	*2.6%*	4.6%	12.7%
Sweden	*5.1%*	*5.3%*	10.4%	9.4%
Slovakia	*1.5%*	*3.6%*	5.1%	17.2%
United Kingdom	*3.4%*	*5.6%*	9.0%	7.5%
United States	***4.2%***	***4.6%***	**8.8%**	**7.7%**
EU14	***3.1%***	***4.1%***	**7.2%**	**9.2%**
NMS	***2.2%***	***4.2%***	**6.4%**	**16.0%**

Source: INTAN-Invest and authors' elaborations on national accounts

Table 3: Intangible and tangible capital stock (% GDP, average 2000-2013)

	National Accounts Intangibles	*New Intangibles*	Total Intangibles	Tangibles
Austria	12.3%	9.6%	21.9%	145.5%
Belgium	13.1%	13.2%	26.3%	129.2%
Czech Republic	10.6%	13.5%	24.1%	197.4%
Denmark	18.5%	12.7%	31.3%	151.5%
Finland	21.2%	12.5%	33.7%	84.0%
France	18.3%	12.2%	30.5%	80.6%
Germany	14.1%	8.9%	23.0%	113.7%
Greece	4.1%	7.8%	11.9%	83.0%
Hungary	9.6%	12.1%	21.7%	174.3%
Ireland	15.4%	13.3%	28.6%	78.2%
Italy	7.8%	10.1%	17.9%	114.8%
Netherlands	15.3%	12.7%	28.0%	100.2%
Portugal	6.9%	11.4%	18.3%	122.2%
Slovenia	11.2%	13.1%	24.4%	182.7%
Spain	8.2%	7.1%	15.3%	150.7%
Sweden	24.1%	15.4%	39.4%	102.7%
Slovakia	5.9%	9.5%	15.3%	257.5%
United Kingdom	15.1%	15.1%	30.2%	106.9%
United States	18.2%	11.9%	30.1%	95.4%

Source: INTAN-Invest and authors' elaborations on national accounts

When looking at capital stocks instead of investment flows, the relative weight of tangible and intangible assets changes a lot (**Table 3**). In all countries, the level of tangible capital stock is much higher than the level of intangible. This is due to the fact

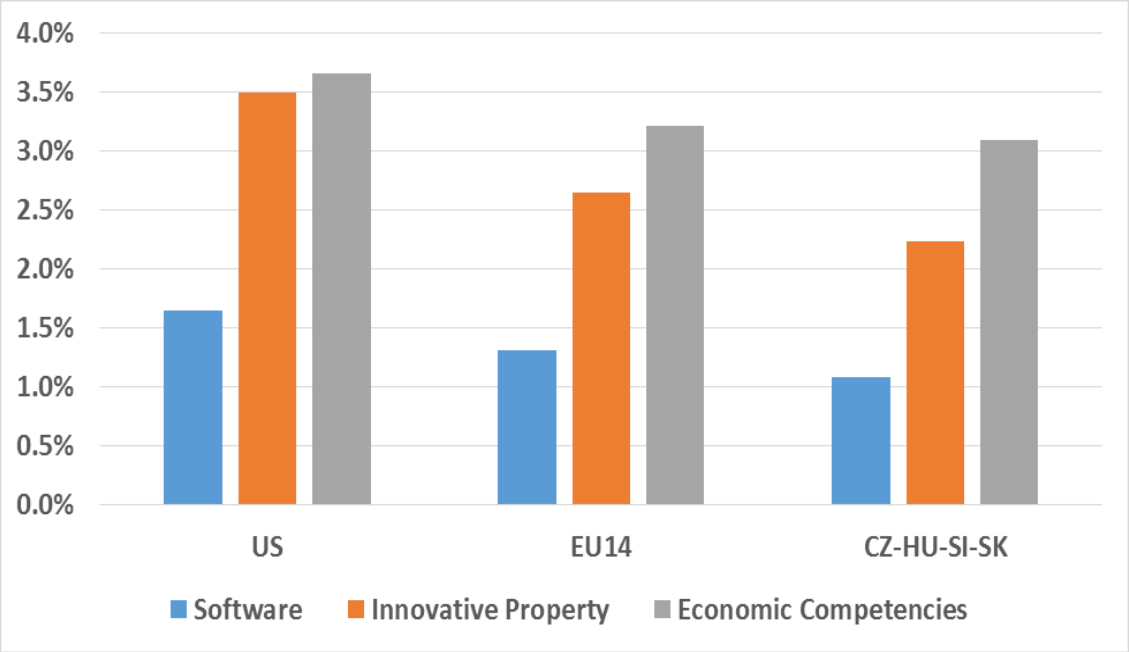
that depreciation rates of tangible assets are much higher than those of intangible ones and this implies, anything else equal, a higher level of capital stock. However, the countries that are more intangibles intensive in terms of investment ratio are also the more intangible intensive in terms of capital stock ratio.

The analysis of the composition of intangible investment (% GDP) reveals that in the US innovative property and economic competencies are the main drivers of intangible capital accumulation (3.5% and 3.7% respectively) while software (1.7%) plays a minor role (**Figure 2**).

Economic competencies are the main driver of intangible expenditure also in the EU14 and NMS and computer software remains the smallest component. The same pattern holds within the European economies with the notable exception of the Scandinavian countries, Germany and Ireland (**Table 4**), where innovative property is the main intangible component (as a result of the high propensity for investing in R&D).

The asset breakdown suggests that Germany is lagging behind the more intangible-intensive EU14 countries and the US because of a lower propensity for investing in economic competencies and software, while Italy and Spain are relatively lower across all intangible asset categories.

Figure 2: Asset composition of intangible investment (% GDP, average 2000-2013)



Source: INTAN-Invest

Table 4: Asset composition of intangible investment (% GDP, average 2000-2013)

	Software	Innovative Property	Economic Competencies
Austria	1.5%	2.2%	3.0%
Belgium	1.1%	2.6%	4.4%
Czech Republic	1.4%	2.4%	3.2%
Denmark	1.4%	3.6%	2.9%
Finland	1.1%	4.3%	3.3%
France	2.2%	2.9%	3.7%
Germany	0.7%	2.9%	2.3%
Greece	0.4%	1.0%	2.3%
Hungary	0.8%	2.1%	3.0%
Ireland	0.5%	4.2%	3.8%
Italy	1.1%	1.8%	2.4%
Netherlands	1.7%	2.2%	4.5%
Portugal	0.7%	1.7%	3.6%
Slovenia	0.8%	3.0%	3.2%
Spain	0.9%	1.8%	1.9%
Sweden	1.9%	4.6%	3.9%
Slovakia	0.9%	1.3%	2.8%
United Kingdom	1.6%	2.9%	4.6%
United States	**1.6%**	**3.5%**	**3.7%**
EU14	**1.3%**	**2.6%**	**3.2%**
Czech Rep - Hungary - Slovenia - Slovakia	**1.1%**	**2.2%**	**3.1%**

Source: INTAN-Invest

The figures in **Table 5** show that in the sample areas services invest more than the industry sector in intangible assets and that agriculture has negligible shares[7]. Services account for 64% of market sector intangible investment in the US, and for 61.4% and 57.6% in the EU14 and NMS. However, manufacturing has a higher value added share of intangibles than services in both the EU14 and NMS, suggesting that the predominant role of services in market sector's spending for intangible investment is driven by their larger share of value added and is not related to a higher propensity for investing in intangible assets (**Figure 3**).

In the NMS, instead, services are more intangible-intensive than manufacturing. In the US intangible intensity in both sectors (12.4% and 14%, respectively) is higher than in the two European regions. In the EU14 manufacturing intangible investment as a percentage of value added is much higher than in the NMS (11.9% vs 8.7%), while services display a comparable share in both European regions (10.3% and 10.2%).

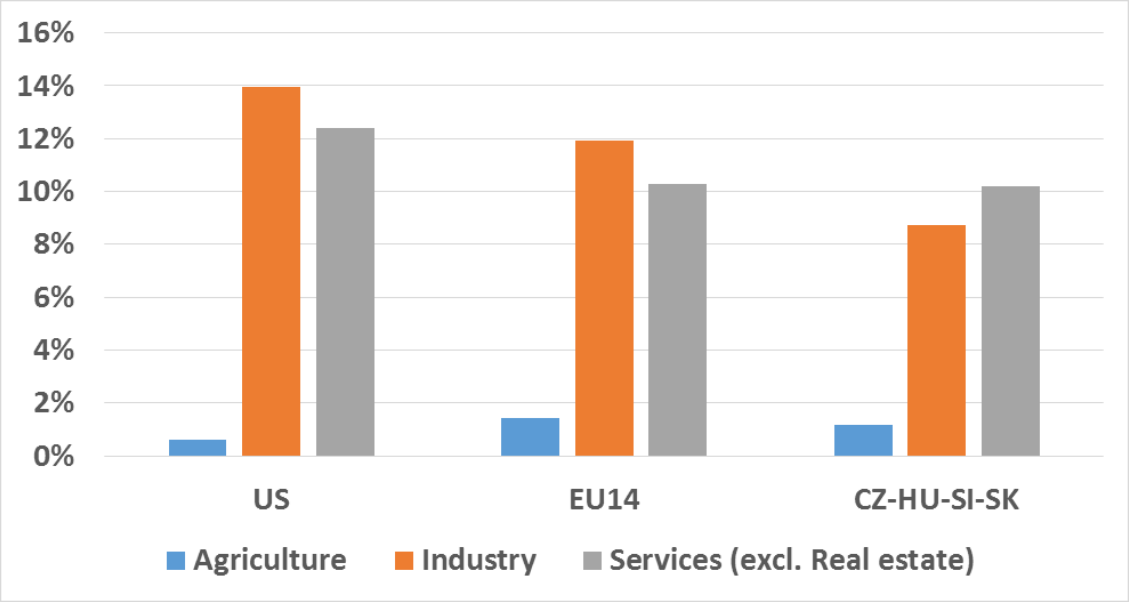
Table 5 shows that in Finland, Germany and Sweden manufacturing is more intangible-intensive than services, while Belgium, Ireland and the Netherland have similar intensities across both sectors.

The low intangible intensity of the Mediterranean countries and, to a lesser extent, Austria, is due to a relatively low investment level in both sectors (with the only exception of Portugal, where intensity in services is higher than the EU14 average). On the other hand, the relatively low level of intangible investment in Germany is mainly driven by the low investment propensity of services, while manufacturing is at the EU14 average (but lower than the US level).

The last three columns in **Table 5** illustrate the intangible to tangible investment ratio across countries and industries. Services are more intangible than tangible-intensive in the US and in both EU regions. The difference between industry and services is much higher in the US (1.25 vs 1.03) and in the four NMS (0.53 vs 0.34) than in the EU14 (0.85 vs 0.79). The EU14 figures mask a great deal of heterogeneity across European countries, where services are more intangible than tangible-intensive in five countries (including Italy, Spain and the UK), and more or less balanced in the other two (including France) while manufacturing takes the lead in the remaining economies (including Germany).

[7] Agriculture corresponds to the NACE Rev.2 section A, Industry to sections from B to F and Services to sections from G to U.

Figure 3: Intangible investment by industry (% officially measured industry value added, average 2000-2013)



Source: INTAN-Invest and authors' elaborations on national accounts

Table 5: Intangible investment by industry (average 2000-2013)

	Industry composition			Value added share			Intangible to tangible ratio		
	AGR	IND	SERx L	AGR	IND	SERx L	AGR	IND	SERx L
Austria	0%	42%	58%	1%	11%	9%	0.02	0.76	0.57
Belgium	0%	33%	67%	2%	12%	12%	0.09	0.70	0.72
Czech Republic	0%	43%	56%	1%	9%	11%	0.04	0.35	0.51
Denmark	0%	39%	61%	2%	14%	10%	0.05	0.98	0.80
Finland	0%	55%	45%	0%	17%	12%	0.01	1.51	1.40
France	0%	36%	64%	2%	17%	13%	0.06	1.31	1.27
Germany	0%	56%	43%	2%	12%	6%	0.05	1.04	0.41
Greece	1%	37%	62%	1%	8%	6%	0.06	0.70	0.41
Hungary	1%	40%	59%	1%	9%	10%	0.05	0.38	0.60
Ireland	0%	40%	60%	1%	12%	12%	0.02	1.33	0.88
Italy	0%	40%	60%	1%	9%	8%	0.02	0.46	0.70
Netherlands	1%	28%	71%	4%	11%	12%	0.09	1.00	1.18
Portugal	1%	23%	76%	2%	7%	11%	0.07	0.31	0.80
Slovenia	0%	45%	54%	1%	11%	10%	0.04	0.49	0.54
Spain	0%	33%	66%	0%	6%	7%	0.02	0.28	0.49
Sweden	0%	53%	47%	2%	22%	13%	0.07	1.42	0.96
Slovakia	1%	38%	62%	1%	6%	8%	0.05	0.21	0.48
United Kingdom	0%	26%	74%	1%	11%	15%	0.02	0.75	1.73
United States	**0%**	**33%**	**64%**	**1%**	**14%**	**12%**	**0.02**	**1.03**	**1.25**
EU14	**0%**	**38%**	**61%**	**1%**	**12%**	**10%**	**0.04**	**0.79**	**0.85**
CZ-HU-SI-SK	**1%**	**42%**	**58%**	**1%**	**9%**	**10%**	**0.04**	**0.34**	**0.53**

Source: INTAN-Invest and authors' elaborations on national accounts

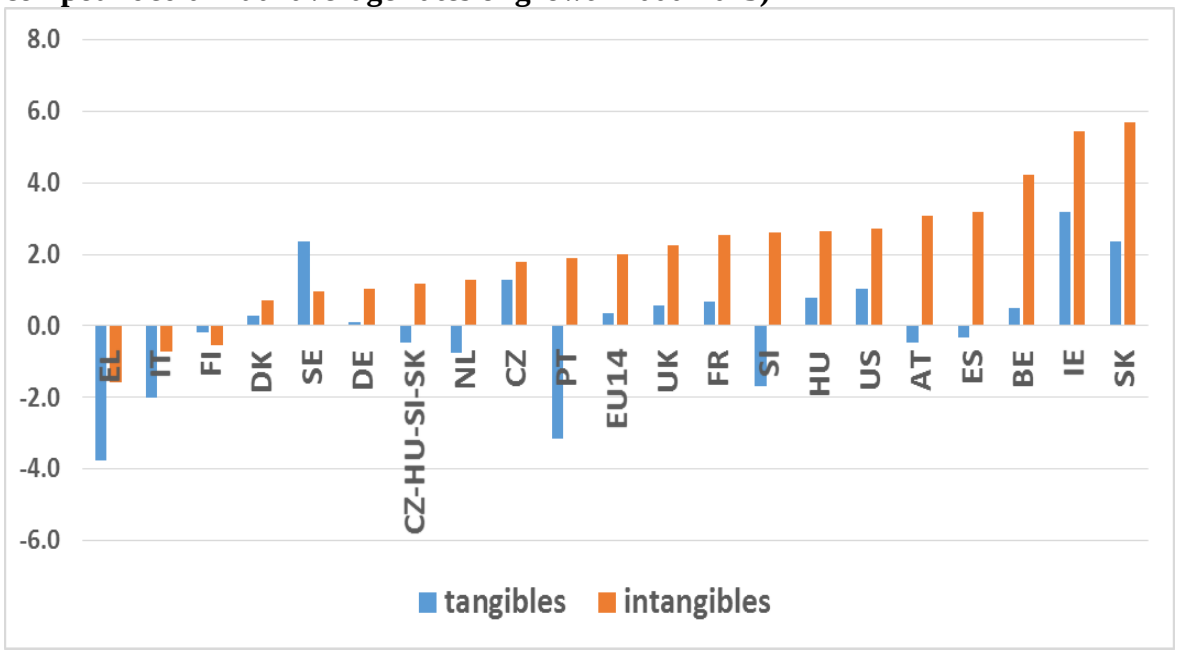
4.2 Trends in tangible and intangible investment over the period 2000-2013

In this section we look at the dynamics of tangible and intangible investment across 18 European economies and the US over the period 2000-2013. **Figure 4** shows that the average annual rate of growth of intangible investment in volume terms is negative in Greece, Italy and, marginally, in Finland. Sweden is the sole country where intangible capital accumulation is significantly less dynamic than tangible capital accumulation. In the US the average rate of growth of intangible investment is 2.6 % per year over 2000-2013, while the rate of tangible investment is 1.0%. The European economies included in our analysis grow at a slower pace both in tangible and intangible investment. In the EU14, intangible investment increases by 2.0% per year while tangibles grow at the modest rate of 0.4% per year. In the NMS the patterns of growth of intangibles and tangibles is even more striking, with the former increasing at 1.2% per year and the latter decreasing by 0.5 % per year. **Figure 5** shows that both intangible and tangible capital stock increased over the period 2000-2013 and that the average annual rate of growth of intangible capital stock in volume terms is lower than the growth tangible capital only in Greece, Italy and, to a lesser extent, in Sweden and Czech Republic.

Tangible investment was significantly affected by the financial crisis in all the sample economies (**Figure 6**). Between the periods 2000-2007 and 2010-2013 the GDP share of tangibles fell across all countries. The decline was stronger in the NMS (probably reflecting the fact that their catching-up process was taking place and that they were converging towards the EU14 levels), in three Mediterranean countries (Portugal, Greece and Spain) and in Denmark. In almost all the sample countries, tangible investment intensity decreased both during (2008-2009) and after the Great Recession (2010-2013).

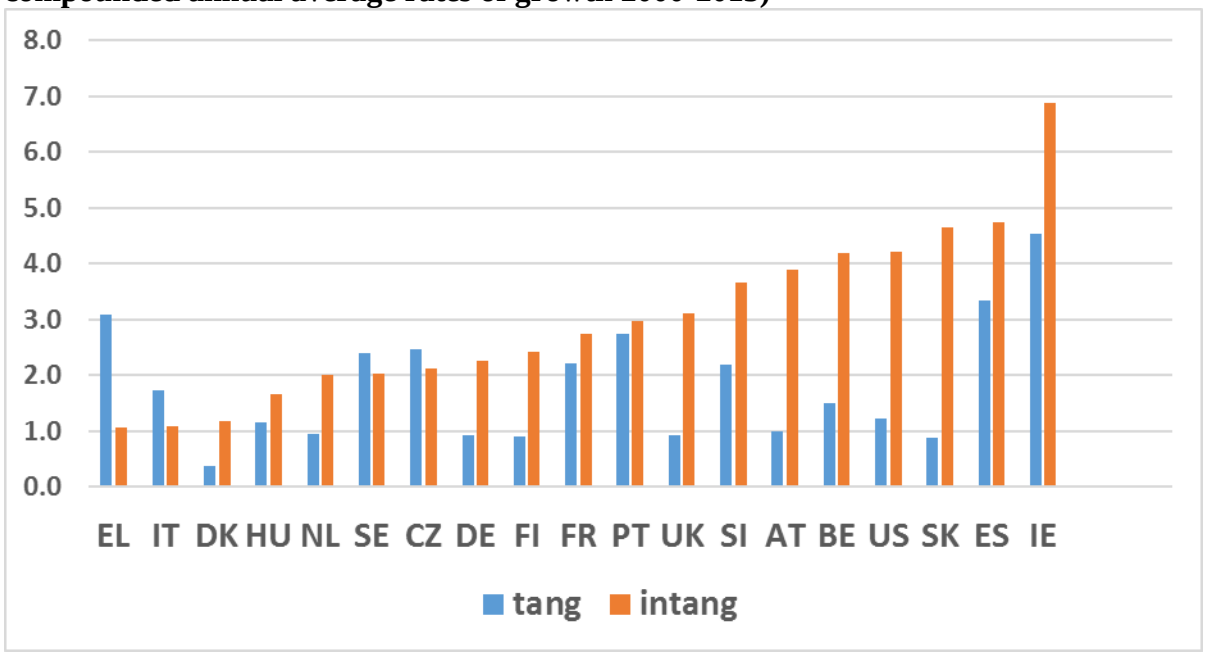
In contrast, **Figure 7** shows that the intangible investment rate in 2010-2013 increased compared to the pre-crisis period 2000-2007 in all countries but Germany and Italy (where it remained stable) and the UK where intangibles decreased. The UK is also the sole country where intangible intensity slowed down during the Great Recession. In Germany, Italy and Sweden intangible intensity remained stable while it increased in all the other economies.

Figure 4: Real tangible and intangible investment growth (chain linked volumes, compounded annual average rates of growth 2000-2013)



Source: INTAN-Invest and authors' elaborations on national accounts

Figure 5: Real tangible and intangible capital stock growth (chain linked volumes, compounded annual average rates of growth 2000-2013)

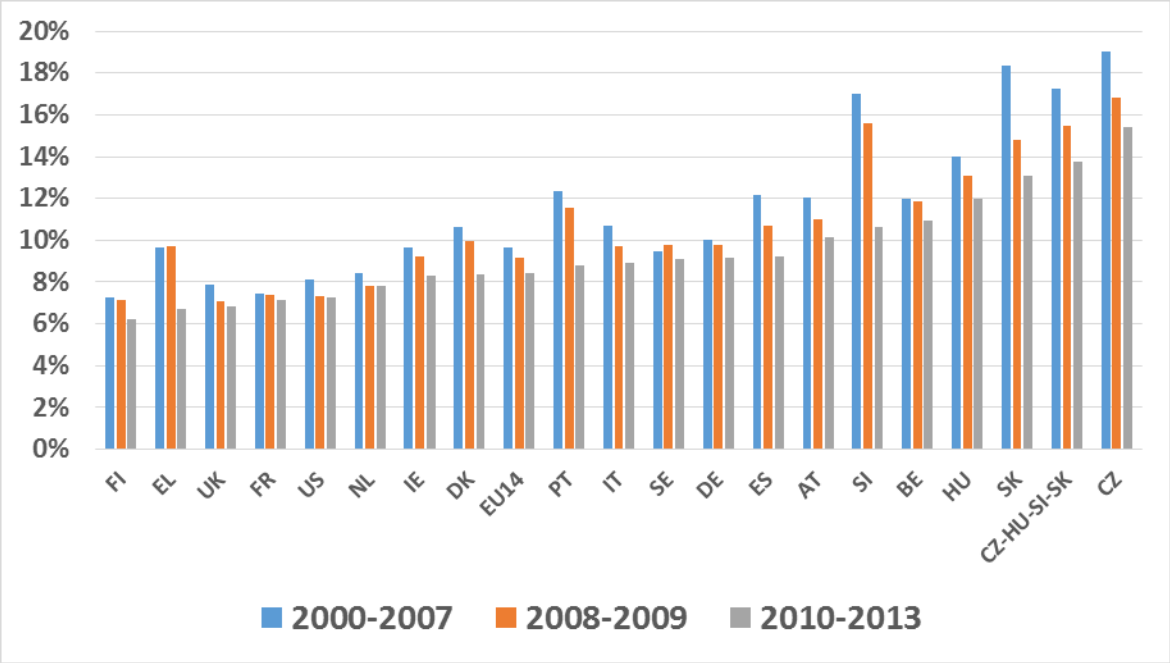


Source: INTAN-Invest and authors' elaborations on national accounts

In the countries with a positive dynamic of intangible investment, the average annual rate of growth of intangible investment is positive in both the industry and service sectors (see Figure A3, in Appendix). Intangible capital accumulation is relatively faster in

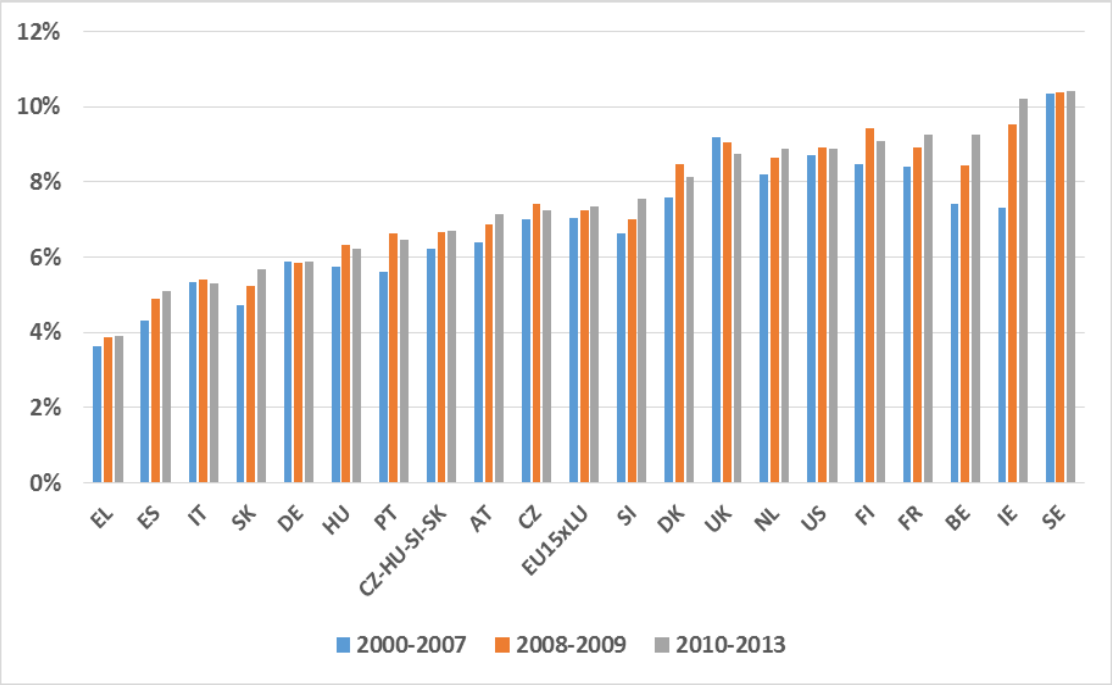
industry compared to services in Slovakia, Austria and, to a lesser extent, in the US. The negative rate of growth for Greece is entirely driven by the industry sector. Italy is the sole country showing a reduction of intangible capital accumulation both in industry and services. In the three sample areas intangible capital accumulation increased after the Great recession compared to the pre-crisis period (2000-2007) in industry as well as in services (see Table A1, in Appendix).

Figure 6: Tangible investment (% GDP), 1995-2007, 2008-2009 and 2010-2013



Source: INTAN-Invest and authors' elaborations on national accounts

Figure 7: Intangible investment (% GDP), 1995-2007, 2008-2009 and 2010-2013



Source: INTAN-Invest and authors' elaborations on national accounts

4.3 Tangible and intangible investment during the crisis

The slowdown of gross fixed capital formation experienced by all advanced economies has been highly debated since the occurrence of the financial crisis. **Figure 8**, **Figure 9** and **Figure 10** illustrate the dynamics of tangible and intangible investment since 2000. In the US, tangibles grew strongly after 2002, fell sharply during the recession (by 24%) and then recovered slightly. Intangibles slowed down too (by 7%) but regained pre-crisis rates rapidly after the crisis. As a consequence, the ratio between intangible and tangible investment increased during the recession, then came back to its mid-2000s level (**Figure 8**).

In Europe the picture looks rather different (**Figure 9** and **Figure 10**). During the Great Recession in 2008-2009, the EU14 economies experienced a relatively lower decline in tangible investment compared to the US (-17%) while intangible investment decreased moderately (-2%). The four NMS showed a slightly smaller decline in tangible investment with respect to the EU14 and a marginally higher decline in intangible investment (-15 % and -4 % respectively).

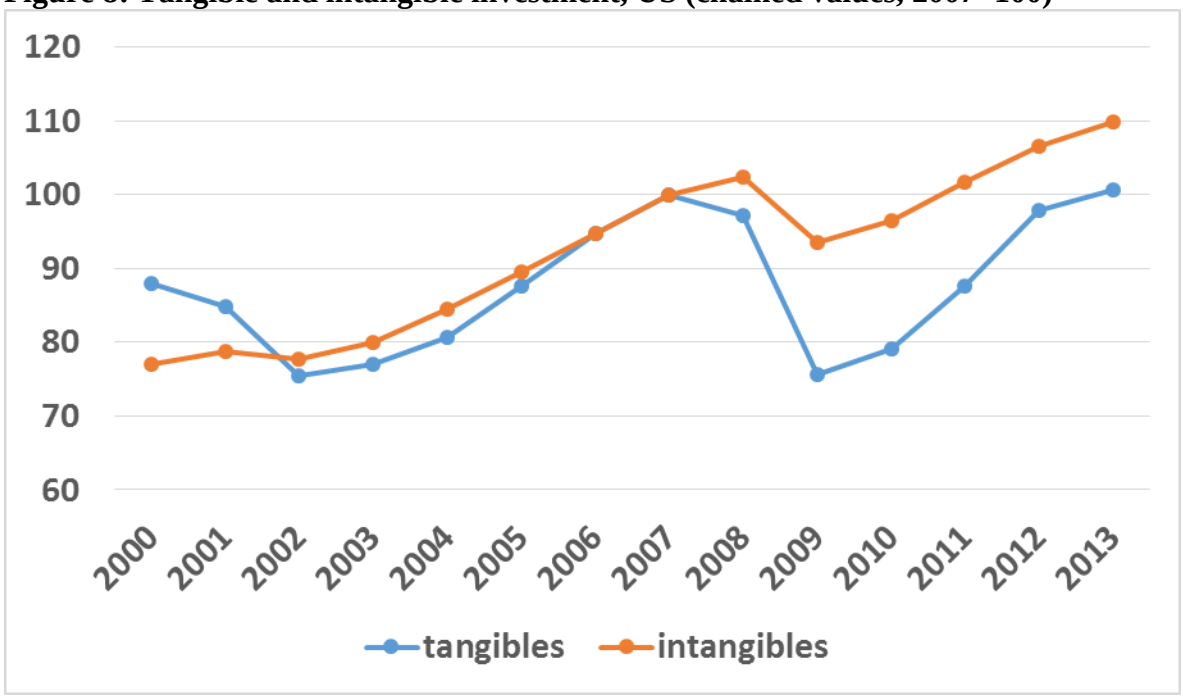
Over the post-crisis period, the US and EU economies experienced different investment dynamics. In the US both tangible and intangible investments increased steadily. Intangible investment exceeded its pre-crisis level in 2011, and in 2013 it was 10% higher than in 2007 (and 18% higher than in 2009). Tangible investment grew even faster than intangibles and reached its pre-crisis level in 2013 (when it was 33% higher than in 2009). In the EU14

intangible investment recovered from the crisis level in 2010, but growing at a slower pace than in the US from 2011 to 2013 (when it was 6% higher than in 2009). Tangible investment increased briefly in 2010-2011 but slowed down immediately with the occurrence of the sovereign debt crisis of 2011-2012. In 2012-2013, tangible investment dropped once more (though less than in 2008-2009), showing in 2013 a level 15% lower than in 2007. In the NMS tangible assets followed a pattern similar to the pattern of the EU14 region. On the other hand, intangible investment increased substantially in 2010 and remained more or less stable until 2013 (when it was only 0.3% higher than before the crisis).

Figure 11 shows intangible investment in the five larger European economies. Over the period 2000-2007, the volume of investment in intangible assets increased by 50% in Spain, 25% in the UK, 20% in France, 8% in Germany and only 3% in Italy. The impact of the Great Recession was fairly strong in Italy and the UK but moderate in Spain, while in Germany and France intangible capital accumulation remained stable. After 2009 investment in intangible assets accelerated in France and the UK and in Germany but at a slower pace, while it remained almost constant in Spain. Italy is the sole country where investment in intangible assets declined continuously for the whole period 2008-2013. Over the years 2007-2013 investment in intangible assets in volume terms increased by 16% in France, 7% in the UK, 6% in Germany, and 1% in Spain, while it declined by 12% in Italy.

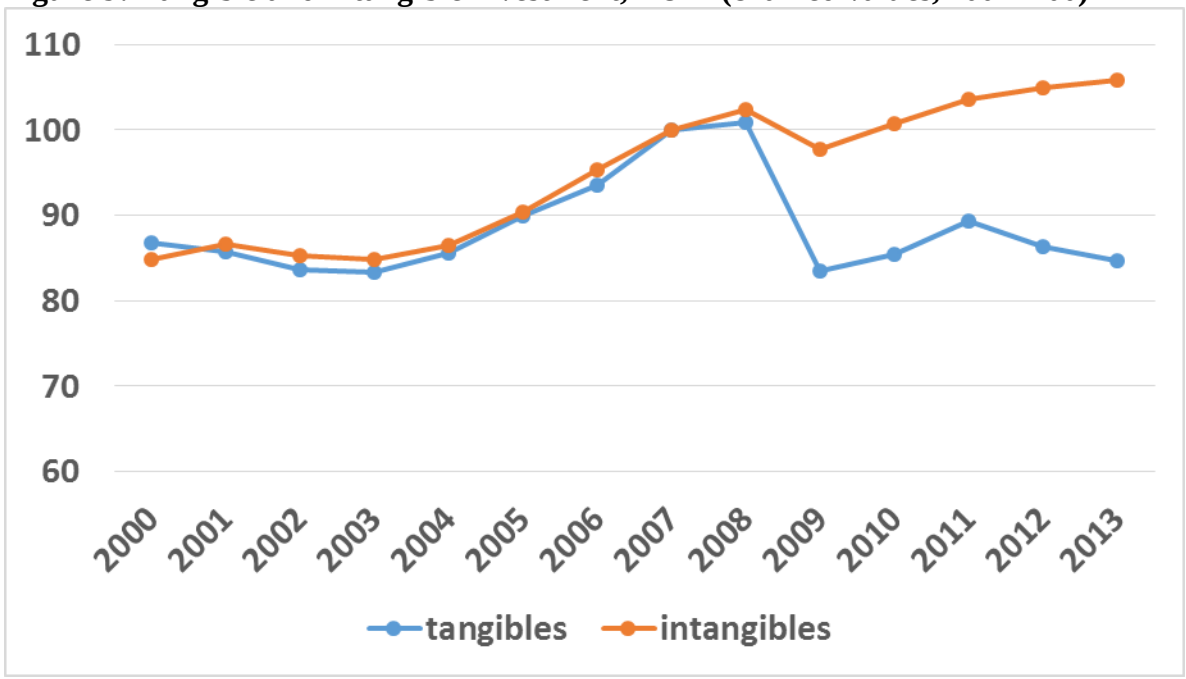
Finally, **Figure 12** shows the intangible/tangible ratio for the five large EU economies. France and the UK record the largest ratio (with intangible investment higher than tangible over the whole period), with Italy and Germany further below. Spain shows the lowest value, but in 2013 it had almost completely converged to the German and Italian levels. In the five countries the ratio increased significantly during the Great Recession and reached higher levels in the following years. In 2013 the intangible/tangible ratio was about 20% higher than in 2000 in the UK, 25% in France, Germany and Italy and 75% in Spain.

Figure 8: Tangible and intangible investment, US (chained values, 2007=100)



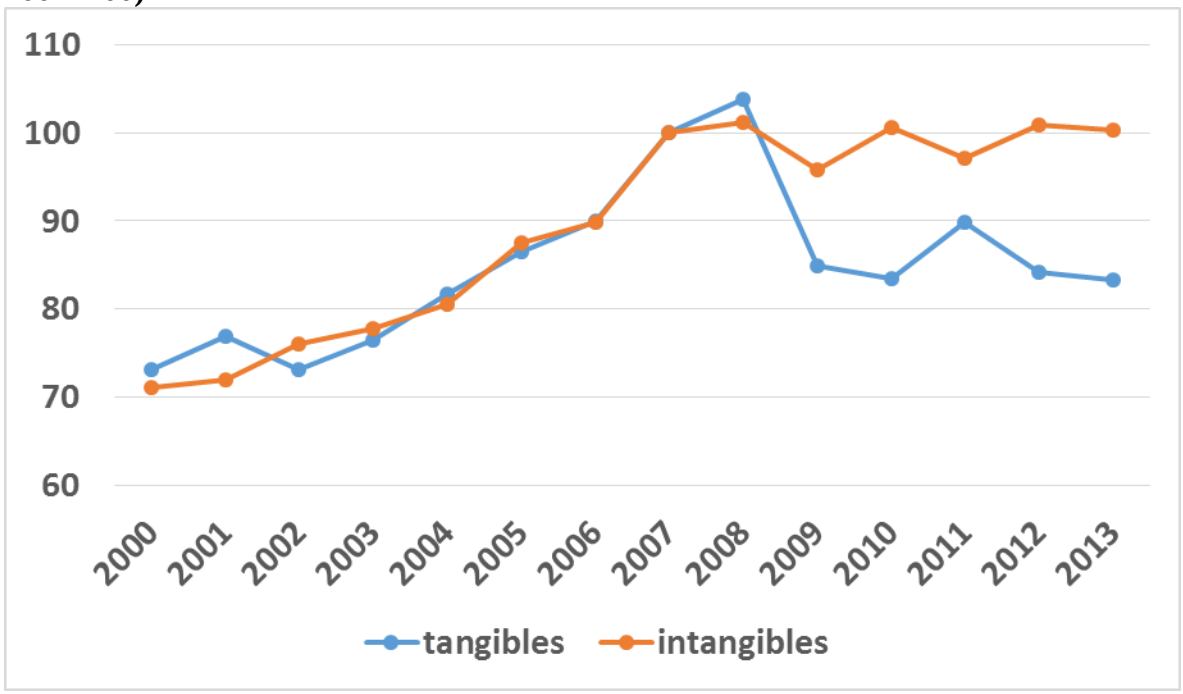
Source: INTAN-Invest and authors' elaborations on national accounts

Figure 9: Tangible and intangible investment, EU14 (chained values, 2007=100)



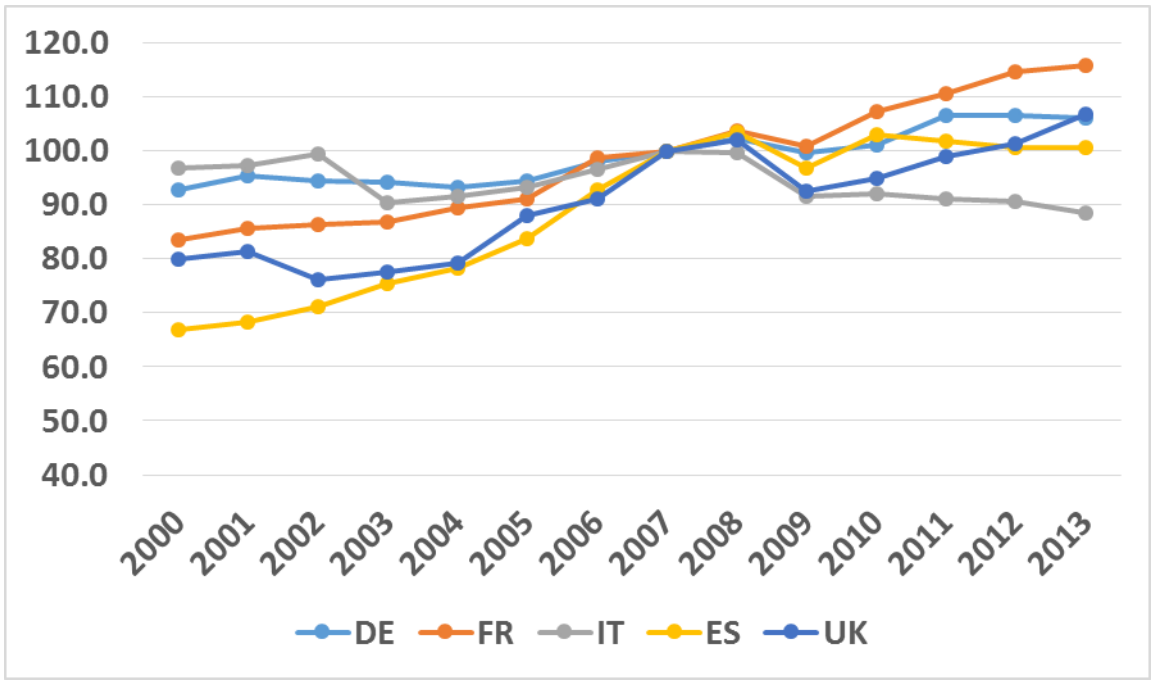
Source: INTAN-Invest and authors' elaborations on national accounts

Figure 10: Tangible and intangible investment, CZ-HU-SI-SK (chained values, 2007=100)



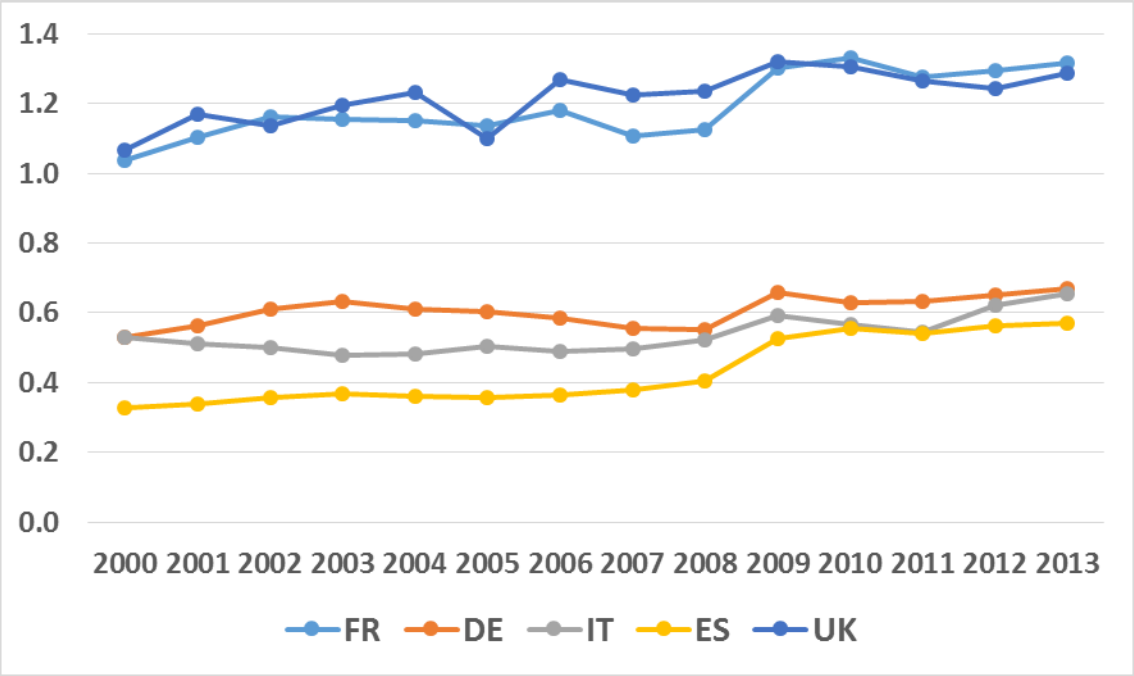
Source: INTAN-Invest and authors' elaborations on national accounts

Figure 11: Intangible investment in the five large EU economies (chained values, 2007=100)



Source: INTAN-Invest

Figure 12: Intangible over tangible investment ratio in the five large EU economies



Source: INTAN-Invest and authors' elaborations on *n*ational *a*ccounts

5 Why intangibles are important

5.1 Intangibles and economic performance

The average intangible intensity (as a percentage of GDP) in 2000-2013 is positively correlated with GDP per head in 2013 (constant prices, constant PPPs). Likewise, the average ratio of intangible over tangible investment in 2000-2013 (see Figure A4 and Figure A5, in Appendix). These correlations suggest the existence of two groups of countries: low and high intangible intensive. The Mediterranean, Central and Eastern European countries are relatively low while the US, the Nordic countries, UK and France are high intangible intensive economies. Germany and Austria are relatively low intangible intensive but are among the countries with higher GDP per head.

Overall the countries that were more intangible intensive before the crisis (2000-2007) were less affected by the crisis or experienced a faster recovery (in 2013) (see Figure A6, in Appendix). The main exceptions are Slovakia (among the countries with the lowest intangible intensity but the country that has showed the fastest growth since 2007) and, to a lesser extent, Finland and Germany. In this respect, the composition of total investment expenditure makes a material difference: there is a positive, although not very strong, correlation between the average ratio of intangible over tangible investment in 2000-2007 and the volume change of GDP from 2007 to 2013 (see Figure A7, in Appendix).

5.2 Sources of growth

The sources of growth exercise covers all 19 countries included in the descriptive analysis. To the best of our knowledge, this is the first attempt to provide an analysis of the sources of labour productivity growth that explicitly accounts for the contribution of tangible capital and an exhaustive list of intangible assets for so many European countries. The extended country coverage is not a free lunch. In fact, there is a trade-off between the number of countries and the number of years and variables that can be included in the analysis. Data availability does not allow us to account for the contribution of labour composition. Therefore, the measure of the residual component is the sum of the contributions of multi-factor productivity (MFP) and labour composition (LQ) to labour productivity growth. Moreover, we are not able to disentangle the contribution of tangible capital into the ICT and the non-ICT components. The analysis covers the period 2000-2013.

5.2.1 2000-2013

From 2000 to 2013, labour productivity growth was by far the highest in the four new Member States and in Ireland (**Table 6**). Also the US and Sweden, Portugal and Austria showed relatively fast productivity growth. Among the larger European countries, the UK, France, Germany and Spain all showed positive rates of growth but well below the US, while productivity growth was slightly negative in Italy. Productivity slowed down significantly in Greece too, while in Denmark, the Netherlands and Belgium it was in line with the UK, France, Germany and Spain.

Capital deepening was the main driver of labour productivity growth in 8 out of 19 countries (FR, EL, HU, IE, IT, PT, ES, SE, US), whereas MFP&LQ accounted for the largest part of labour productivity growth in only six countries (FI, DE, NL, SK, SI, UK) (**Table 6** and **Figure 13**). Capital deepening and MFP&LQ provided a comparable contribution in Austria, Belgium, the Czech Republic, Sweden and Denmark.

Intangible capital emerges as an important source of labour productivity growth in almost all countries, the only exception being the countries that showed negative (Italy and Greece) or modest growth (Denmark).

The last three rows in Table 5 show the rate of growth for the US, EU14 and NMS (CZ-HU-SI-SK). In the US labour productivity growth is 1.8%, in the EU14 1% and in the NMS 3%. Intangible capital provided a relatively smaller contribution in the EU14 than in the US (0.3% against 0.6%) and the same holds for MFP&LQ. In the NMS intangible capital accounts for a similar contribution as in the EU14 while the contribution of tangible and MFP&LQ are significantly higher.

Table 6: Contributions to the growth of labour productivity in 18 European countries and the United States, 2000 to 2013

	Labour Productivity Growth	Contributions of components				Memo items	
		Capital deepening	*Tangible Capital Deepening*	*Intangible Capital Deepening*	MFP&LQ	SNA2008 Intangibles	New Intangibles
AT	1.6	0.8	*0.4*	*0.4*	0.8	0.3	0.1
BE	1.2	0.6	*0.2*	*0.4*	0.6	0.2	0.2
CZ	2.9	1.5	*1.2*	*0.2*	1.5	0.1	0.1
DK	0.6	0.3	*0.2*	*0.1*	0.4	0.2	0.0
FI	1.2	0.4	*0.1*	*0.3*	0.8	0.3	0.0
FR	1.2	0.8	*0.4*	*0.4*	0.4	0.2	0.1
DE	1.1	0.4	*0.3*	*0.2*	0.7	0.2	0.0
EL	-0.2	1.5	*1.4*	*0.1*	-1.7	0.2	0.0
HU	2.7	2.1	*1.6*	*0.5*	0.6	0.2	0.2
IE	2.5	2.9	*1.9*	*1.0*	-0.5	0.8	0.2
IT	-0.1	0.5	*0.4*	*0.1*	-0.6	0.1	0.0
NL	1.0	0.3	*0.1*	*0.3*	0.6	0.1	0.1
PT	1.8	1.4	*1.0*	*0.4*	0.4	0.2	0.2
SK	4.0	0.4	*0.1*	*0.3*	3.5	0.1	0.2
SI	2.5	0.9	*0.6*	*0.4*	1.6	0.2	0.2
ES	0.8	1.3	*1.0*	*0.3*	-0.4	0.2	0.1
SE	1.9	1.0	*0.7*	*0.3*	0.9	0.2	0.1
UK	1.2	0.5	*0.1*	*0.4*	0.7	0.2	0.2
US	1.8	1.1	*0.4*	*0.6*	0.7	0.4	0.2
Memo items (value added weighted average)							
EU14	1.0	0.7	0.4	0.3	0.3		
CZ-HU-SI-SK	3.0	1.4	1.1	0.3	1.6		

Source: INTAN-Invest and authors' elaborations on national accounts

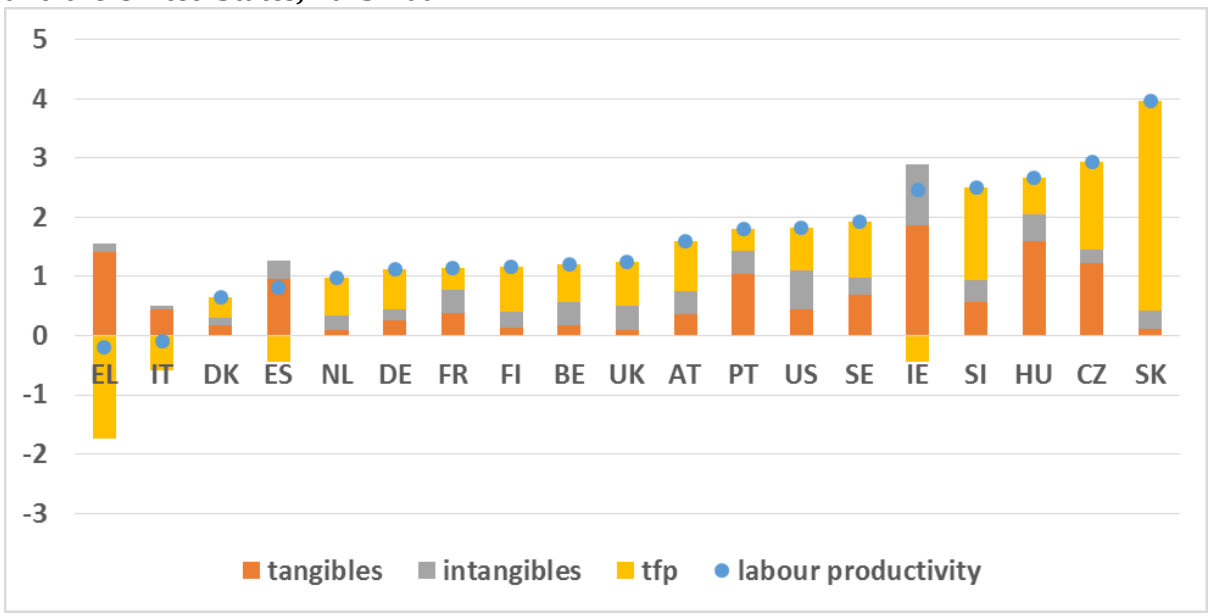
The dismal Italian performance with respect to the US is accounted for by the negative contribution of MFP&LQ and the negligible contribution of intangibles, while tangibles are in line with the US experience. As for Spain, the biggest issue is related to the negative dynamics of MFP&LQ and, to a lesser extent, to the gap in the contribution of intangible capital. Tangible capital provided a contribution of 1 percentage point, well above the contribution in the other five large EU economies. The slower productivity growth in Germany is almost entirely accounted for by the low propensity to accumulate intangible capital, while in France the gap with the US is driven by the lower MFP&LQ and intangible capital contribution. The UK is the sole large European economy where the gap

with respect to the US is driven by the accumulation of both tangible and, to a lesser extent, intangible capital. The EU lagged behind the US in 2000-2013 mainly because of the relatively lower dynamic of intangible capital deepening and of MFP&LQ.

The bottom line in **Table 6** is that, although intangible capital has been an important driver of growth in the EU14 countries excluding Greece, Italy, Denmark, and, to a lesser extent, Germany, the growth contribution of intangible capital is comparatively too small to catch up with the US

A deeper look at the differences between the composition of intangible contributions in the US and in the EU economies reveals that in the US the three asset categories provided a high contribution. Within innovative property, the contribution of minerals and artistic originals[8] seems particularly strong in the US, while R&D, design and new financial products accounted for a similar share in both areas. The high contribution of economic competencies in the US is driven by training, (which is falling in Europe), and brand equity. On the other hand, organisational capital accounted for a larger share in the EU14 than in the US.

Figure 13: Contributions to the growth of labour productivity in 18 European countries and the United States, 2013-2007



Source: INTAN-Invest and authors' elaborations on national accounts

[8] Measurement errors might affect these results.

Table 7: Contributions of intangible assets to the growth of labour productivity in 18 European countries and the United States, 2000 to 2013

	Intangible Capital	Software	Innov. Prop	*R&D*	*Design*	*NFP*	*Min_Art*	Econ Comp.	*Brand*	*Org_Cap*	*Train*
AT	0.4	0.1	*0.2*	*0.13*	*0.01*	*0.01*	*0.00*	0.1	*0.02*	*0.08*	*0.02*
BE	0.4	0.1	*0.1*	*0.06*	*0.03*	*0.00*	*0.00*	0.2	*0.01*	*0.16*	*0.03*
CZ	0.2	0.1	*0.1*	*0.02*	*0.04*	*0.01*	*0.01*	0.1	*0.01*	*0.07*	*-0.01*
DK	0.1	0.1	*0.1*	*0.06*	*-0.01*	*0.00*	*0.01*	0.0	*0.00*	*0.01*	*-0.05*
FI	0.3	0.1	*0.2*	*0.18*	*0.04*	*0.00*	*0.00*	-0.1	*-0.04*	*0.04*	*-0.06*
FR	0.4	0.1	*0.2*	*0.08*	*0.05*	*0.01*	*0.02*	0.1	*0.02*	*0.06*	*0.01*
DE	0.2	0.1	*0.1*	*0.07*	*0.01*	*0.00*	*0.01*	0.0	*-0.03*	*0.05*	*-0.01*
EL	0.1	0.1	*0.1*	*0.07*	*0.03*	*0.01*	*0.01*	-0.1	*-0.05*	*-0.02*	*0.00*
HU	0.5	0.2	*0.0*	*0.12*	*-0.05*	*0.01*	*-0.05*	0.3	*0.06*	*0.15*	*0.05*
IE	1.0	0.1	*0.7*	*0.75*	*-0.07*	*0.03*	*0.03*	0.2	*0.12*	*0.12*	*0.01*
IT	0.1	0.0	*0.1*	*0.06*	*0.02*	*0.01*	*0.00*	0.0	*-0.03*	*0.01*	*-0.02*
NL	0.3	0.1	*0.1*	*0.02*	*0.02*	*0.01*	*0.00*	0.1	*0.00*	*0.12*	*-0.03*
PT	0.4	0.1	*0.2*	*0.11*	*0.02*	*0.01*	*0.01*	0.2	*0.02*	*0.11*	*0.04*
SK	0.3	0.0	*0.1*	*0.01*	*0.05*	*0.00*	*0.03*	0.2	*0.10*	*0.06*	*0.02*
SI	0.4	0.1	*0.1*	*0.10*	*0.04*	*0.01*	*0.00*	0.1	*0.06*	*0.06*	*0.02*
ES	0.3	0.1	*0.2*	*0.10*	*0.04*	*0.01*	*0.02*	0.1	*0.02*	*0.02*	*0.02*
SE	0.3	0.1	*0.2*	*0.10*	*0.04*	*0.01*	*0.01*	0.0	*-0.04*	*0.09*	*-0.02*
UK	0.4	0.1	*0.2*	*0.10*	*0.07*	*0.01*	*-0.02*	0.1	*0.00*	*0.19*	*-0.07*
US	0.6	0.2	*0.3*	*0.12*	*0.05*	*0.02*	*0.13*	0.2	*0.05*	*0.04*	*0.06*
Memo items (value added weighted average)											
EU14	0.3	0.1	*0.1*	*0.09*	*0.03*	*0.01*	*0.01*	0.1	*0.00*	*0.07*	*-0.01*
CZ-HU-SI-SK	0.3	0.1	*0.1*	*0.05*	*0.02*	*0.01*	*-0.01*	0.1	*0.04*	*0.09*	*0.02*

Source: INTAN-Invest and authors' elaborations on national accounts

5.2.2 2000-2007 and 2007-2013

Table 8 shows that in 2007-2013 labour productivity growth decelerated in nearly all countries compared to the 2000-2007 period, the only exceptions being Italy, Portugal, Ireland and Spain (which is the sole country where labour productivity accelerated considerably) (see also Figure A8, in Appendix).

As expected, the slowdown is driven mainly by the negative contribution of MFP&LQ. During the recession years, the measured contributions of capital and labour is distorted by swings in the rate of capital utilisation and effort that are not captured by the available measures of capital stocks and hours worked. Consequently MFP is to a large extent

capturing the changes in labour productivity due to the fact that firms do not reduce instantaneously their inputs according to changes in output (due to, e.g., labour market regulations, labour hoarding, and irreversibility of installed fixed capital).

The contribution of capital deepening significantly slowed down in Greece, the Czech Republic, and, to a lesser extent, Hungary, Slovenia, Sweden and the US. In Greece, Slovenia and Sweden the slowdown was almost entirely driven by the tangible component, while in the Czech Republic, Hungary and the US by both components. Finland and the UK are the only two countries where the contribution of the intangible capital component declined with respect to the previous period while that of the tangible one increased (Finland) or remained stable (UK).

Table 8: Contributions to the growth of labour productivity in 18 European countries and the United States, 2000-2007 and 2007-2013

	2000-2007					2007-2013				
	Labour Productivity Growth	Contributions of components				Labour Productivity Growth	Contributions of components			
		Capital deepening	*Tangible Capital Deepening*	*Intangible Capital Deepening*	MFP&LQ		Capital deepening	*Tangible Capital Deepening*	*Intangible Capital Deepening*	MFP&LQ
AT	2.2	0.6	*0.3*	*0.4*	1.6	0.9	0.9	*0.4*	*0.5*	0.0
BE	2.0	0.6	*0.2*	*0.4*	1.4	0.3	0.5	*0.1*	*0.4*	-0.2
CZ	5.4	1.9	*1.5*	*0.4*	3.4	0.1	0.9	*0.9*	*0.0*	-0.8
DK	1.1	0.3	*0.2*	*0.2*	0.8	0.1	0.2	*0.2*	*0.1*	-0.2
FI	2.8	0.4	*0.0*	*0.4*	2.4	-0.8	0.4	*0.3*	*0.2*	-1.2
FR	1.6	0.8	*0.5*	*0.3*	0.8	0.6	0.7	*0.3*	*0.5*	-0.1
DE	1.8	0.5	*0.3*	*0.2*	1.3	0.3	0.3	*0.2*	*0.1*	0.0
EL	2.6	1.9	*1.8*	*0.1*	0.7	-3.5	1.2	*1.0*	*0.1*	-4.6
HU	4.8	2.2	*1.7*	*0.5*	2.5	0.2	1.8	*1.5*	*0.4*	-1.7
IE	2.3	2.3	*1.5*	*0.8*	0.0	2.7	3.6	*2.3*	*1.3*	-1.0
IT	0.0	0.5	*0.5*	*0.0*	-0.5	-0.2	0.5	*0.4*	*0.1*	-0.7
NL	1.5	0.1	*0.0*	*0.2*	1.4	0.4	0.6	*0.2*	*0.4*	-0.2
PT	1.8	1.4	*1.0*	*0.3*	0.4	1.9	1.5	*1.0*	*0.5*	0.4
SK	6.0	0.0	*-0.2*	*0.2*	5.9	1.6	0.9	*0.4*	*0.4*	0.7
SI	4.7	1.1	*0.8*	*0.3*	3.6	-0.1	0.7	*0.3*	*0.4*	-0.8
ES	0.1	0.7	*0.5*	*0.2*	-0.6	1.7	2.0	*1.5*	*0.5*	-0.3
SE	3.5	1.2	*0.9*	*0.3*	2.3	0.1	0.7	*0.5*	*0.2*	-0.6
UK	2.5	0.6	*0.1*	*0.5*	1.9	-0.2	0.4	*0.1*	*0.3*	-0.6
US	2.4	1.3	*0.5*	*0.8*	1.1	1.2	0.9	*0.4*	*0.5*	0.3
Memo items (value added weighted average)										
EU14	1.6	0.7	0.4	0.3	0.9	0.3	0.7	0.4	0.3	-0.4
CZ-HU-SI-SK	5.2	1.6	1.2	0.4	3.6	0.4	1.1	0.9	0.2	-0.8

Source: INTAN-Invest and authors' elaborations on national accounts

5.2.3 Comparison with national accounts-based results

Table 9 sets out growth accounting but using national accounts intangibles. Looking again at the lowest three lines, and comparing them with the lowest three lines in the equivalent table that uses all intangibles, we see that, broadly, including intangibles raises the capital contribution and lowers TFP growth, with, over this period, growth in output per hour unaffected. So the contribution of capital and TFP with intangibles capitalised in the US for example is 1.1% pa and 0.7% pa, but without is 1% pa and 0.9% pa. In the EU14 the equivalent figures are 0.7% pa and 0.3% pa and 0.6% pa and 0.4% pa. Thus the inclusion of intangibles lowers the "measure of our ignorance".

Table 9: Contributions to the growth of labour productivity in 18 European countries and the United States, only national accounts intangibles, 2000 to 2013

	Labour Productivity Growth	Contributions of components			
		Capital deepening	*Tangible Capital Deepening*	*Intangible Capital Deepening*	MFP&LQ
AT	1.6	0.7	*0.4*	*0.3*	0.9
BE	1.0	0.4	*0.2*	*0.2*	0.7
CZ	3.0	1.5	*1.3*	*0.1*	1.6
DK	0.7	0.4	*0.2*	*0.2*	0.4
FI	1.3	0.5	*0.1*	*0.3*	0.8
FR	1.1	0.7	*0.4*	*0.3*	0.4
DE	1.2	0.4	*0.3*	*0.2*	0.7
EL	-0.1	1.7	*1.6*	*0.2*	-1.8
HU	2.7	2.0	*1.8*	*0.3*	0.6
IE	2.4	3.1	*2.2*	*1.0*	-0.7
IT	0.0	0.6	*0.5*	*0.1*	-0.6
NL	1.0	0.3	*0.1*	*0.1*	0.7
PT	1.8	1.4	*1.2*	*0.2*	0.4
SK	3.9	0.2	*0.1*	*0.1*	3.7
SI	2.4	0.8	*0.6*	*0.2*	1.6
ES	0.8	1.2	*1.0*	*0.2*	-0.4
SE	2.0	1.0	*0.8*	*0.2*	1.0
UK	1.2	0.3	*0.1*	*0.2*	0.9
US	1.8	1.0	*0.5*	*0.5*	0.9
Memo items (value added weighted average)					
EU14	1.0	0.6	0.4	0.2	0.4
CZ-HU-SI-SK	3.0	1.3	1.2	0.2	1.7

Source: Authors' elaborations on national accounts

6 Drivers of investment in intangible assets

In the previous section we showed that the propensity to invest in intangible assets is positively correlated with some measures of economic performance (GDP per head and GDP growth since the beginning of the Great Recession) and that, in a growth accounting sense, intangible investment is an important driver of labour productivity growth. At this point, it is natural to ask why some countries appear to invest more in intangible investment than others. A comprehensive discussion of all the potential determinants of intangible investment is well beyond the scope of the paper. In this section we present a very preliminary analysis of the correlation between intangible investment and two elements that could potentially affect it: firm size, and product and labour market regulation.

6.1 Intangibles and firm size

The issue of the link between firm size and investment in intangible assets is surveyed by Arrighetti et al. (2014). Firm size is likely to have a positive impact on the propensity to invest in intangible assets for three reasons. In the first place, large firms are better able than small ones to exploit economies of scale in intangible asset accumulation (Dierickx and Cool, 1989). Secondly, big firms can be more effective in protecting their intangible stock than small ones, and thus have a greater incentive to invest. Thirdly, it may be argued that large firms are also capable of supporting a greater amount of the uncertainty that is associated with intangible asset investments as compared to small firms (Ghosal and Loungani, 2000).

The (scant) empirical evidence on the link between firm size and intangible investment is consistent with the view that the propensity to invest in intangible assets is positively correlated with firm size. Arrighetti et al. (2014) shows that in a sample of Italian manufacturing firms, size increases significantly the probability of being an intangible-intensive firm (where intangibles are measured as a subset of the costs usually reported under the item "intangible fixed assets" in firms' financial statements). The NESTA survey "Investing in innovation" for the UK (Awano et al., 2010) finds that among firms that replied to the survey, large firms are more likely to report positive spending on one or more intangible assets than smaller firms, although for all intangible spend, intensity does not vary with size, so large firms, who have a higher overall spend, do not have larger intensity. Likewise, a recent study from the European Commission (2013) shows that the smaller the company, the more likely they are to have made no investment in intangible assets (either using internal resources or external providers). For instance, 39% of companies with 1-9 employees say they invested nothing using internal resources for

organisational or business process improvement in 2011, compared to 8% of those with 250 or more. If the empirical evidence on intangible investment is scant, there is a vast literature analysing the links between firm size and innovation (often measured as R&D expenditure). Here we only mention the results of the Community Innovation Survey 2008, which shows that large enterprises are more likely to introduce innovations than SMEs in almost all countries for which data are available (Eurostat, 2012).

To investigate this issue, we have calculated the cross-country correlation between intangible investment (measured both as a percentage of value added and as an intangible/tangible ratio) and the average firm size, measured as the share of persons employed in firms with more than 250 employees. Correlations are calculated by industry to control for different average firm size in various economic activities (see Table A2, in Appendix). Intangible intensity and the intangible to tangible ratio are positively correlated with the average firm size in 10 out of 11 industries, the only exception being "Water supply; sewerage, waste management and remediation activities" (where the correlation is negative but very close to zero). The correlation between intangible intensity and average firm size is higher than 0.2 in 8 out 11 industries, while the correlation between intangible to tangible ratio and average firm size is higher than 0.2 in 9 out 11 industries.

6.2 Intangibles and product and labour market regulation

The issue of the link between product market regulation (PMR) and investment and innovation is surveyed by Schiantarelli (2016) and we rely heavily on his work. Alesina et al. (2005) identify several ways in which product market regulation can affect investment. First, changes in regulation affect the markup of prices over marginal costs, because of their impact, for instance, on entry barriers and, hence, on the number of firms. Second, regulation can influence the costs that even existing firms face when expanding their productive capacity. Third, for certain sectors, regulation imposes a ceiling on the rate of return on capital that firms are allowed to earn; this leads firms to increase the level of capital stock beyond the profit-maximizing level in order to obtain a greater total remuneration for capital. Removing the constraint on the rate of return (if binding) would, instead, reduce the desired capital stock and therefore investment. Finally, if product markets' regulatory reforms occur together with privatisation (or nationalisation) policies, changes in ownership structure can also affect investment. Public enterprises are often heavy investors, either because of political mandates or because of incentives to over-expand on firms' managers. Reduced investment by the public sector may therefore occur. Ultimately, which effect dominates is an empirical question. Alesina et al. (2005), in their empirical work, examine investment in non-manufacturing industries (e.g. energy,

utilities, communication, and transport) in OECD countries that have experienced profound changes in their regulatory framework. The results suggest that reducing regulation has a significant and sizeable positive effect on the investment rate, particularly if the regulation affects barriers to entry.

Studies that focus on liberalisation episodes in specific sectors provide further evidence on the effect of product market regulation on investment. For instance, Schivardi and Viviano (2011) provide evidence on the relaxation of limits to the opening of large stores in Italy. The results suggest that reducing entry barriers stimulates investment in information and telecommunication technologies (which, in their data, also includes investment in computer software).

Contrasting forces may influence the effect of greater competition on innovation. On the one hand, innovation activity is primarily driven by the aim of achieving monopoly profits on new products or processes. If monopoly profits decrease as a result of regulatory reforms, the pace of innovation may likewise be reduced. Furthermore, monopoly profits help firms to accumulate enough funds to finance innovation. In fact, funds generated internally through retained profits are crucial given the presence of information asymmetries, which may make it costly or difficult to obtain external funds from financial markets for risky innovation activities that are difficult to evaluate. Indeed in the early quality ladder endogenous growth models of Aghion and Howitt (1992) and Grossman and Helpman (1991) and in the product variety model of Romer (1990) a reduction in rents generated by regulatory changes would adversely affect the incentive to innovate. Nevertheless, in more recent models, incumbent firms also innovate (rather than just newcomers) (Aghion and Griffith, 2005). In these models, the difference between post and pre-innovation monopoly profits determines the incentive to innovate. Greater competition reduces both, but if the pre-innovation profits decrease more than the post-innovation profits, this fosters innovation. Essentially, competition stimulates innovation due to the threat of (or actual) entry of newcomers into a market, which provides incentives for incumbents to innovate in order to escape competition.

The issue of the effects of employment protection legislation (EPL) on productivity and investment is nicely surveyed by Bassanini, Nunziata, and Venn (2009), who make a number of points. First, the effects of EPL depend on how much they are offset by wage adjustments. If wages do not fully adjust to any costs that EPL might impose, then EPL can have real effects. Second, those effects can vary. If labour costs rise, then investment rises as labour gets more expensive. Against this, investment might fall if workers cannot commit to future wages and EPL strengthens the bargaining position of labour to extract any ex post rents from sunk capital (Grout, 1984). If intangible capital is more sunk relative to tangible capital, then investment in intangibles will fall more. The wage effect,

however, might be moderated by (perhaps centralised) unions, who might find it easier to precommit, perhaps in national wage bargains. This is the story in the Sapir report (Aghion et al., 2003), suggesting that centralised German unions were useful in the long period of post-war tangible capital accumulation by Europe, but might be much less useful now when intangible capital and experimentation are required. Finally, Bartelsman, Gautier, and de Wind (2011) suggest that experimentation with risky technologies might be lessened, so average productivity falls. The effects are likely to be analogous with product market regulation.

Finally, Ciriaci et al. (2016) show that product market regulation and employment protection legislation significantly affect the location decision of top R&D investors' subsidiaries. When taken separately, the level of PMR has the greatest negative effect on companies' location decisions, while EPL does not appear to play a significant role in such choices. When considering the interaction between PMR and EPL, results show that these two regulations exert a mutually reinforcing negative effect on the decision of top R&D investors about where to locate their subsidiaries.

The evidence from INTAN-Invest data is that countries with less stringent regulations in product and labour markets tend to have higher rates of investment in intangible assets and higher intangible to tangible investment ratios (see Figures A9 to A12, in Appendix). The negative relation between the propensity to invest in intangible assets and the level of product market regulation holds for all three major components of intangible assets (computer software and databases, innovative property and economic competencies) and for all three high-level economy-wide indicators of product market regulation (state control, barriers to entrepreneurship and barriers to trade and investment) (see Table A3, in Appendix).

6.3 Determinant of the intangible to tangible investment ratio

In this section we attempt to explore econometrically why some countries appear to invest more in intangible investment than others, allowing for more factors than just the regulatory factors set out above. The following points are worth noting.

First, there may be some "structural" reasons for this. For example, countries with more services might be more intangible-intensive. Or countries with more ICT intensity. Second, public sector R&D might be complementary to private sector intangible investment, and hence it might be that countries with more government-funded R&D are investing more. Third, the neo-classical explanation is that relative prices will determine relative investment, with relative prices particularly affected by the tax treatment of intangibles and tangibles.

Fourth, econometric estimation of investment equations has not often found it easy to find plausible price elasticities and discover the effects of e.g. liquidity constraints and the like. Part of this is that investment seems to be cyclical in ways that prices and adjustment costs have problems describing them, perhaps due to animal spirits and other unmeasureables. This suggests that we might proceed by exploring intangible investment *relative to* tangible investment, thereby sweeping out any common effects affecting investment "sentiment" that seem so hard to model. Thus we ran the following regression where the dependent variable is the log of relative intangible to tangible real investment

$$\ln(I^{INTAN} / I^{TAN})_{c,t} = \alpha_1 \ln(P_i^{INTAN} / P_i^{TAN})_{c,t} + \alpha_2 STRICTNESS_{c,t} + \alpha_3 ICT\_INTEN_{c,t} + \alpha_4 share\_mfring_{c,t} + \alpha_5 (GovR\&D / GDP)_{c,t} + \lambda_t + \nu_{c,t}$$

Where the terms on the right are, respectively, relative investment price, the OECD index of employment strictness, the ratio of ICT capital rental payments to total tangible rental capital payments, the share of employment in manufacturing and the ratio of government-funded R&D to GDP. Each variable is at the country-year dimension, where for convenience the variables are all averages over the following four periods: 1997-1999, 2000-2003, 2004-2008 and 2011-2013. The equation also includes a constant and three time dummies and estimation is by random effects (we could not reject the hypothesis that the fixed effects were jointly zero). For this exercise we have data on 12 countries. The relative investment, prices and ICT intensity data are all for the private sector.

Column 1 in **Table 10** shows the results. The relative price term is correctly signed and significant, showing a strong relative price effect. It would be preferable to incorporate tax adjustment factors for intangibles and tangibles, but at the time of writing we do not have them. Turning to the second and third rows, countries with higher ICT intensity and lower manufacturing shares are associated with higher relative intangible investment, in line with the view that intangibles are complementary to ICT and that the intangible to tangible ratio is higher in the service sector. The OECD strictness index is strongly negatively correlated with relative intangible investment, in line with the graphs in the Appendix. Finally, countries with more government R&D have high relative intangible investment, in line with the view that such public investment is complementary to private intangible investment.

The rest of **Table 10** explores robustness. Column 2 replaces employment strictness with product market regulation and finds, again, a negative and statistically significant association. Column 3 puts them together, but they would seem too collinear (i.e. countries that tend to have a lower level of product market regulation also tend to have a

lower level of employment protection and vice versa) to get a strong relation with both.

Table 10: Intangible/tangible regression, 12 countries, 1997 to 2013

VARIABLES	(1) Employ Strict	(2) Prod mkt reg	(3) Both	(4) drop CZ
ln(Pi_INTAN/Pi_TAN)	-1.149***	-0.986***	-1.106***	-1.195***
	(0.342)	(0.314)	(0.323)	(0.289)
ICT_INTEN	0.169	0.356	-0.276	0.185
	(1.602)	(1.605)	(1.661)	(1.565)
sh_mfring	-0.629	-1.594	-0.979	-0.052
	(0.945)	(1.347)	(1.075)	(1.170)
STRICTNESS	-0.435***		-0.404***	-0.441***
	(0.137)		(0.145)	(0.161)
PROD MKT REG		-0.204**	-0.130	-0.037
		(0.103)	(0.126)	(0.127)
Gov R&D/GDP	75.552***	77.251***	68.335***	72.788**
	(26.499)	(27.001)	(26.192)	(32.043)
Observations	48	48	48	44
Countries	12	12	12	11
R2	0.518	0.527	0.550	0.482

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7 Conclusions and policy implications

Summing up from the descriptive analysis reported in section 4 we can identify the following stylised facts. First, from 2000 to 2013 average intangible intensity (% GDP) in the US (8.8%) was higher than in the EU14 (7.2%) and in the four new Member States included in our analysis (6.4%). In the US investment in intangible assets outpaced tangible capital accumulation, while in the EU regions it is the opposite. Within the EU14 countries the propensity for investing in intangibles varies considerably with Scandinavian, Northern Europe (Denmark, Finland, Ireland, Sweden and the UK) and non-German-speaking continental European countries (France, the Netherlands and Belgium) characterised by relatively high intangible shares of GDP. On the other hand, the Mediterranean and German-speaking countries are relatively more tangible-intensive economies.

In all the sample economies, intangible investments are more dynamic than tangibles.

Greece, Italy and marginally Finland are an exception because they experienced a slowdown of intangible capital accumulation (even if less pronounced than the downturn of tangible capital accumulation). The Great Recession had a differentiated effect on tangible and intangible investment: tangibles fell massively during the crisis and have hardly recovered, whereas intangible investment has been relatively resilient and recovered fast in the US but lagged behind in the EU.

In the previous sections we have shown that intangible intensity and the intangible to tangible ratio are positively correlated with the level of GDP per head and negatively associated with the financial shock of the Great Recession (measured as the ratio of chained GDP in 2013 to the value in 2007).

The sources of growth analysis first support the evidence that intangible capital deepening is an important driver of growth in 2000-2013 in the US and in the EU14 countries with the exception of Greece, Italy, Denmark, and, to a lesser extent, Germany. These results are sensitive to the extension of the national account asset boundary to the CHS list of intangibles. Once all intangible assets are capitalised capital deepening remains a relevant driver of growth but with a more prominent contribution of intangible capital. Sources of growth results suggest that since the Great Recession labour productivity slowdown has been driven primarily by TFP.

Our preliminary analysis of the drivers of investment in intangible assets shows that countries with higher average firm size and less stringent regulations in product and labour markets have a higher intangible investment rate and higher intangible to tangible investment ratio. The econometric analysis on a subset of countries reveals a significant correlation between having stricter employment protection rules and less government investment in R&D, such as in the Mediterranean countries, and a lower ratio of intangible to tangible investment (controlling for other factors).

Our findings suggest that intangible investment is a key policy variable. A relevant characteristic of intangible capital is that it is growth-promoting (Corrado, Haskel, and Jona-Lasinio, 2014) thus potentially contributing to reducing the growth gap between the EU and the US. Therefore policies designed to foster innovation and to make the economic environment more conducive to investment in intangible assets should adopt a view of innovation that is broader than R&D. In fact, our growth accounting results show that the investment gap between the EU14 and the US is more related to the lower contributions of computer software and databases, artistic originals, mineral exploration, brand and training than to the contribution of R&D.

Finally, the very preliminary evidence presented in this paper on the drivers of intangible investment is consistent with the view that economic policies should target SMEs, focus on maintaining well-functioning product and labour markets and guarantee an appropriate

level of government investment in R&D. Additional research is needed to validate our preliminary findings. The next steps will be to refine our econometric analysis extending the number of countries, including additional explanatory variables and exploiting the industry dimension of INTAN-Invest 2016.

References

Aghion, P, G Bertola, M Hellwig, J Pisani-Ferry, A Sapir, J Vinals, and H Wallace. 2003. *An Agenda for a Growing Europe: The Sapir Report*. Book. Oxford University Press.

Aghion, P., and R. Griffith, (2005), *Competition and Growth; Reconciling Theory and Evidence*. Cambridge, MA: MIT Press.

Aghion, P. and P. Howitt, (1992), "A model of growth through creative destruction". *Econometrica*, 60, 323-351.

Alesina, A., S. Ardagna, G. Nicoletti, and F. Schiantarelli. "Regulation and investment." Journal of the European Economic Association 3:4 (2005): 791−825.

Arrighetti Alessandro, Fabio Landini and Andrea Lasagni, (2014), "Intangible assets and firms' heterogeneity: evidence from Italy", *Research Policy*, vol. 43, n. 1:202-213.

Awano, Gaganan, Mark Franklin, Jonathan Haskel, and Zafeira Kastrinaki (2010). "Investing in Innovation: Findings from the UK Investment in Intangible Assets Survey." NESTA Index Report (July).

Bartelsman, Eric J, Pieter A Gautier, and Joris de Wind. 2011. "Employment Protection, Technology Choice, and Worker Allocation." Techreport.

Bassanini, Andrea, Luca Nunziata, and Danielle Venn. 2009. "Job Protection Legislation and Productivity Growth in OECD Countries." *Economic Policy* 24 (58): 349–402. doi:10.1111/j.1468-0327.2009.00221.x.

Ciriaci, Daria, Nicola Grassano and Antonio Vezzani, (2016), "Regulation, Red Tape and Location Choices of Top R&D Investors", European Economy Discussion paper 031, European Commission, Directorate-General for Economic and Financial Affairs.

Corrado, Carol, Jonathan Haskel and Cecilia Jona-Lasinio, (2014), "Knowledge Spillovers, ICT and Productivity Growth". IZA Discussion Paper No. 8274.

Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi, (2012), "Intangible Capital and Growth in Advanced Economies: Measurement Methods and Comparative Results" Working Paper, June, available at http://www.intan-invest.net.

Corrado, Carol, Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi, (2013). "Innovation and intangible investment in Europe, Japan and the United States," *Oxford Review of Economic Policy* 29 (2): 261-286.

Corrado, Carol, Charles Hulten, and Daniel Sichel (2005). "Measuring Capital and

Technology." In *Measuring Capital in the New Economy*, C. Corrado, J. Haltiwanger, and D. Sichel, eds., Studies in Income and Wealth, Vol. 65, 11-14. Chicago: The University of Chicago Press.

Corrado, Carol, Charles Hulten and Daniel Sichel (2009). "Intangible Capital and US Economic Growth." *The Review of Income and Wealth* 55: 3 (September), 661-685.

Corrado, Carol, Peter Goodridge, and Jonathan Haskel (2011). "Constructing a Price Deflator for R&D: Estimating the Price of Knowledge as a Residual." The Conference Board Economics Program Working Paper EPWP #11-03.

Dierickx, I., Cool, K., (1989), "Asset stock accumulation and sustainability of competitive advantage", *Management Science* 35, 1504-1511.

European Commission (2013). "Investing in intangibles: Economic assets and innovation drivers for growth". Flash Eurobarometer No. 369. European Commission, Directorate-General for Enterprise and Industry. Data available at http://dx.doi.org/10.4232/1.1190

Eurostat (2012), "Europe in figures – Eurostat yearbook 2012"

Ghosal, V., Loungani, P., (2000), "The Differential Impact of Uncertainty on Investment in Small and Large Businesses", *Review of Economics and Statistics* 82, 338-343.

Grossman G.M. and E. Helpman, (1991), "Quality ladders in the theory of growth". *Review of Economic Studies*. Vol. (58(1)), 43-61.

Grout, Paul A. 1984. "Investment and Wages in the Absence of Binding Contracts: A Nash Bargaining Approach." *Econometrica* 52 (2): 449. doi:10.2307/1911498.

Hulten, Charles R., "On the 'Importance' of Productivity Change," *American Economic Review*, 69, 126–36, 1979.

Nakamura, Leonard (1999). "Intangibles: What Put the New in the New Economy?" Federal Reserve Bank of Philadelphia Business Review (July/August): 3-16.

Nakamura, Leonard (2001). "What is the US Gross Investment in Intangibles? (At Least) One Trillion Dollars a Year!" Federal Reserve Bank of Philadelphia Working Paper No. 01-15.

Pakes, Ariel, and Mark Schankerman (1984). "The Rate of Obsolescence of Patents, Research Gestation Lags, and the Private Rate of Return to Research Resources." In *R&D, Patents, and Productivity*, ed. Zvi Griliches, 73–88. Chicago: University of Chicago Press.

Romer, Paul M. (1990). "Endogenous Technological Change." *Journal of Political Economy*, Vol. 98:5 (October), Part 2: S71-S102.

Schiantarelli, Fabio (2016). "Do product market reforms stimulate employment, investment, and innovation?". IZA World of Labor 2016: 266. doi: 10.15185/izawol.266

Schivardi, F., and E. Viviano. "Entry barriers in retail trade." Economic Journal 121:551 (2011): 145−170.

Soloveichik, Rachel (2010). "Artistic Originals as a Capital Asset." *American Economic Review* 100:5 (May), 110-114.

Weitzman, Martin L., "On the Welfare Significance of National Product in a Dynamic Economy," *Quarterly Journal of Economics*, 90, 156–62, 1976.

Appendix 1. Measuring Intangible Investments: the INTAN-Invest database

The INTAN-Invest estimates reported in this paper (INTAN-Invest 2016) are the result of a complete revision and update of previous INTAN-Invest data. INTAN-Invest 2016 estimates are based on the same estimation strategy adopted to produce previous releases of INTAN-Invest estimates. However, new data sources have become available since estimates for previous benchmark years were produced. In order to fully exploit the new data sources, a complete revision of previous estimates was needed.

The main pillar of INTAN-Invest estimation strategy is the adoption of the expenditure-based approach to measure the value of investment in intangible assets (i.e., expenditure data are used to develop direct measures of intangible investment). Moreover, the project have the goal of generating measures of harmonized intangible investment satisfying (as much as possible) the following criteria: exhaustiveness, reproducibility, comparability across countries and over time, and consistency with official national accounts data (since our aim is to generate measures of intangible investment coherent with other national accounts aggregates, as output, investment in tangible assets, intermediate costs, compensation of employees and employment)

The above characteristics are assured by the adoption of official data sources homogeneous across countries. An implication of the adopted estimation strategy is that our estimation methods can be applied only for the years when national accounts data are available. For EU countries, the starting date of national accounts data from Eurostat database usually ranges from 1995 (for almost all countries) to 2000 (and even more recent years for detailed data on GFCF by industry in a few countries). The relatively short time coverage for European countries is one of the main weaknesses of our database, because a longer time period would be preferred for the analysis of economic growth.

The industry and sector coverage in INTAN-Invest 2016 has changed with respect to the previous INTAN-Invest releases. New estimates cover total investment in industries from Nace sections A to M (excluding M72) and section S plus the market sector component of Nace M72, P, Q and R (while previous INTAN-Invest estimates did not cover industries P and Q and covered all industry R).

The new definition of the market sector makes INTAN-Invest 2016 fully consistent with SPINTAN estimates. SPINTAN is a project funded by the European Union's Seventh Framework Programme that aims at discovering the theoretical and empirical

underpinning of public intangible policies and that has among its objectives to build a public intangible database for a wide set of EU countries and some other big non-EU countries.

The two projects, although different and independent, share the same measurement approach and refer to two non-overlapping cross-classifications of sectors and industries. INTAN-Invest and SPINTAN estimates, taken together, provide harmonized measures of investment in intangible assets for the total economy cross classified by 21 industries (corresponding to the sections of the Nace rev. 2 classification) and two institutional sectors (market and non-market) - see Bacchini et al. (2016) for an overview of the estimation methods adopted to produce SPINTAN estimates.

The implementation of INTAN-Invest estimation strategy leads to the adoption of two different approaches for intangible assets not currently included in the SNA2008/ESA2010 asset boundary (Design, Brand, Training, Organisational Capital and New financial products) and for the assets already included (Computer software and databases, Research and development, Mineral Explorations and evaluations and Entertainment, literary and artistic originals).

National Accounts Intangible Assets are based on official national accounts estimates of gross fixed capital formation by industry. National accounts data on GFCF in Intellectual property products ("IPP") by 21 industries and total GFCF (with no industry disaggregation) in Computer software and databases ("Soft") and in Research and development ("R&D") are available for all countries included in our analysis. Moreover, for almost all countries also data on Soft and R&D by 21 industries are available. For these countries, we estimate overall GFCF in Mineral Explorations and Originals ("MinArt") by 21 industries as a residual. Instead, for countries where only total IPP by industry is available, we have adopted the following approach. First, we have produced preliminary estimates of the industry distribution of GFCF in Soft, R&D, and MinArt using the available indicators. Then we have rescaled preliminary estimates to make them consistent with total GFCF in IPP by industry and with aggregate GFCF in Soft, R&D and MinArt (using an iterative bi-proportional fitting procedure). The preliminary estimates have been derived from ESA95 national accounts data on GFCF by industry or from capital stocks estimates[9], depending on data availability.

[9] The country coverage of capital stocks data on Soft and R&D by industry is larger than the country coverage of GFCF data. Then, there are several countries for which capital stocks data by industry are available and GFCF is not. In this case, we have used capital stocks data as follows. Starting from capital stock estimates (chained values) for year t and t-1 (Kt and Kt-1) and making an assumption on the value of the depreciation rate (delta) we have computed the implied value of chained investment for year t (It), as
It=Kt – Kt-1 + Kt-1*delta.
If net capital stocks were estimated with the geometric model and if we knew the actual depreciation rate used to compute capital stocks the above calculation would provide the correct value for It. In the EU, national

Once we have obtained total investment in the three asset types by industry, we have obtained the split between the market and the non-market component for each asset in each industry simply deducting from total GFCF by industry the estimates for the non-market component available from the SPINTAN project.

The estimates of the purchased component of Brand, Design and Organisational Capital in INTAN-Invest 2016 are based on completely different sources and methods with respect to the previous release of INTAN-Invest. Old estimates for the business sector were obtained from data on turnover of the corresponding industries and, as for Brand, also on private data sources (Zenith Optimedia and ESOMAR). Industry level estimates were obtained following a top-down approach[10]. New estimates, instead, are obtained directly at the industry level using expenditure data by industry provided by the Use Tables, expressed according to the NACE Rev2/CPA 2008 classifications. Use Tables consistent with ESA2010 national accounts are available for all countries included in this paper for 2010 and 2011 and for almost all countries for the year 2012, while Use Tables consistent with ESA95 national accounts are available from 2008 until 2010.

The Use Tables compiled according to NACE Rev.2/CPA 2008 report intermediate costs of each industry for the following products: Advertising and Market Research Services (CPA M73), Architectural and engineering services, technical testing and analysis services (CPA M71) and Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70). We take the data on total intermediate costs for these products as a proxy for total expenditure, respectively, in Brand, Design and Organisational capital.

The general approach is quite similar for all three assets. The first step is to make the initial data a better proxy of expenditure in the corresponding asset. We deem that in the case of Advertising and Market Research Services (CPA M73) and Architectural and engineering services, technical testing and analysis services (CPA M71) the products identified in the USE Table are good proxies of the corresponding assets and no further

statistical institutes usually do not use the geometric method (with the exception of R&D), then the result of the calculation above can provide only an approximation of the real value of It. We use these approximated estimates as a preliminary estimate of investment by industry (i.e., as seeds for the iterative bi-proportional fitting). On the other hand, it is likely that the bias is quite similar across industries and therefore it should decrease when the initial estimates are re-scaled to make them consistent with total GFCF in IPP by industry and with aggregate GFCF in Soft, R&D and MinArt.

[10] Old INTAN-Invest estimates by industry were obtained as follows. We first produced a detailed benchmark estimate of intangible investment in 2008 based on the USE table and then we built time series for the period 1995 to 2007 applying the rate of change of gross output (National Accounts) by industry to the level of the estimated intangible gross fixed capital formation in 2008. Finally, since our benchmark was the INTAN-invest market sector estimate of intangibles, we rescaled the estimated value for each industry, in each country, for every year, to the total provided by INTAN-invest (see Corrado et al (2014) for more details).

adjustments are needed. In contrast, this is not the case for Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70). In this case, we computed the share of turnover of NACE M701 in turnover of NACE M69 plus M70 for each country and we apply the share to intermediate consumption in CPA M69 and M70. The above correction is based on the assumption that, in each country the share of CPA M701 (consulting services) in total intermediate consumption for CPA M69 and M70 is the same across all industries.

Once expenditure for each asset is identified, the second step is to split total expenditure in each industry between the component due to the market sector and the component due to the non-market sector. This adjustment is applied only to the SPINTAN mixed industries (M72, P, Q and R90-92), while for all other industries we deem that the expenditure is entirely made up either by the non-market sector (industry O) or by the market sector (all remaining industries). The split is based on the share of non-market output over total market and non-market output in each industry.

Finally, in each industry the capitalization factor is applied to total expenditure by market producers to obtain the value of total expenditure that we deem should be treated as GFCF instead than intermediate consumption. Capitalisation factors are asset specific but not industry specific with the only exception of a special treatment for subcontracting. In fact, it is likely that part of Advertising and Market Research Services (CPA M73) bought by the Advertising and Market Research industry, that part of Design services (CPA M71) bought by the Architectural and engineering industry and that part of Legal, accounting and consulting services (CPA M69 and M70) bought by the Legal, accounting and consulting industry are due to subcontracting activity. For this reason, we assume that the capitalisation factors for CPA M73 in the Advertising and Market Research, for CPA M71 in the Architectural and engineering industry and for CPA M69 and M70 in the Legal, accounting and consulting industry are 50% lower than in the other industries.

The approach outlined above is used to obtain estimates from 2010 until 2012 (the years in which USE Tables consistent with ESA2010 national accounts are available). The same approach has been applied to the USE Tables consistent with ESA95 available from 2008 and 2010 and the resulting estimates have been used as indicators to back-cast the level of the estimated intangible gross fixed capital formation in 2010 until 2008. The back-casting procedure has been implemented at the industry level. For the years before 2008, we produced intangible investment time series using the rate of change of the previous release of INTAN-Invest estimates of GFCF by industry as an indicator to back-cast the level of the estimated gross fixed capital formation from 1995 to 2008.

The estimates based on data available from the USE Tables guarantee the exhaustiveness of purchased GFCF in Brand (based on product CPA M73) and Organisational capital

(based on product CPA M6970), but not that of Design (based on product CPA M71). In fact, in the CPA classification, part of design activity is also classified in the CPA M741 "Specialised design activities". The USE Tables currently available from Eurostat do not allow identifying expenditure in CPA M741 because they only report data for the CPA M74_75 ("Other professional, scientific and technical services and veterinary services"). Instead, Structural Business Statistics report data on turnover of NACE M741. Then we have taken the turnover of NACE M741 as a proxy of total expenditure in CPA M741, we have assumed that only the market sector purchases "Specialised design activities" and, finally, we have obtained GFCF estimate applying the same capitalisation factor than CPA M71.

As for the own account component, its estimate requires detailed employment data by type of occupation and by industry (e.g., from the Structure of Earning survey or the Labour Force survey) or a special survey. Eurostat available occupational data allow identifying only those occupations related with organizational capital. This is why, at this stage, we measure only the own account component of Organizational capital, while for Design and Brand we only estimate the purchased component.

In order to estimate organisational capital produced on own account we need to estimate total compensation of managers and then apply a capitalisation factor. The estimate of total compensation of managers requires data on the number of managers and their average compensation. The main data sources for these variables is the Structure of Earnings Survey that is currently available for 2002, 2006 and 2010. From SES we are able to compute industry specific shares of gross earnings of managers in total earnings of all employees for the years 2006 and 2010 and the share for business sector in 2002. We have produced a time series of industry specific shares of gross earnings of managers from 1995 till 2013 as follows. For the years 2007-2009 we have (linearly) interpolated values from SES available for 2006 and 2010. We have updated the industry specific shares for the years from 2010 onwards applying the dynamic of the share of the number of managers in total employees from Labour Force Surveys. For the year before 2006 no data at the industry level are available, then we back-casted 2006 shares using the same indicator for all industries (namely, the change in the share of gross earnings of managers for total business sector between 2002 and 2006 from SESs and the change in the share of the number of managers in total employees from Labour Force Surveys for the previous years). Having produced a time series of the shares of gross earnings of managers at the industry level is a big improvement with respect to the previous INTAN-Invest release, that considered only the business sector with no industry detail and was based on the share obtained from SES 2002 updated using the change in the share of the number of managers in total employees from Labour Force Surveys.

We have then estimated total expenditure for management compensation consistent with national accounts data by applying the share of gross earnings of managers to national accounts measures of total compensation of employees in each industry. Finally, we have estimated the value of own-account investment in organisational capital by applying the capitalisation factor to the total managers' compensation.

As for Firm specific Human Capital, our estimates for the market sector are based on data from the Continuing Vocational Training Survey (CVTS) and Labour Cost Survey, that allow to produce industry level estimates of expenditure in training that include both the purchased and the own account component. For this asset the main improvement with respect to the old estimates is due to the availability of the CVTS for 2010 (while old estimates only used the 1999 and the 2005 survey). For training, we assume that all expenditures increase the value of the stock of FSHC and therefore should be considered as GFCF (i.e. we assume a capitalisation factor equal to one).

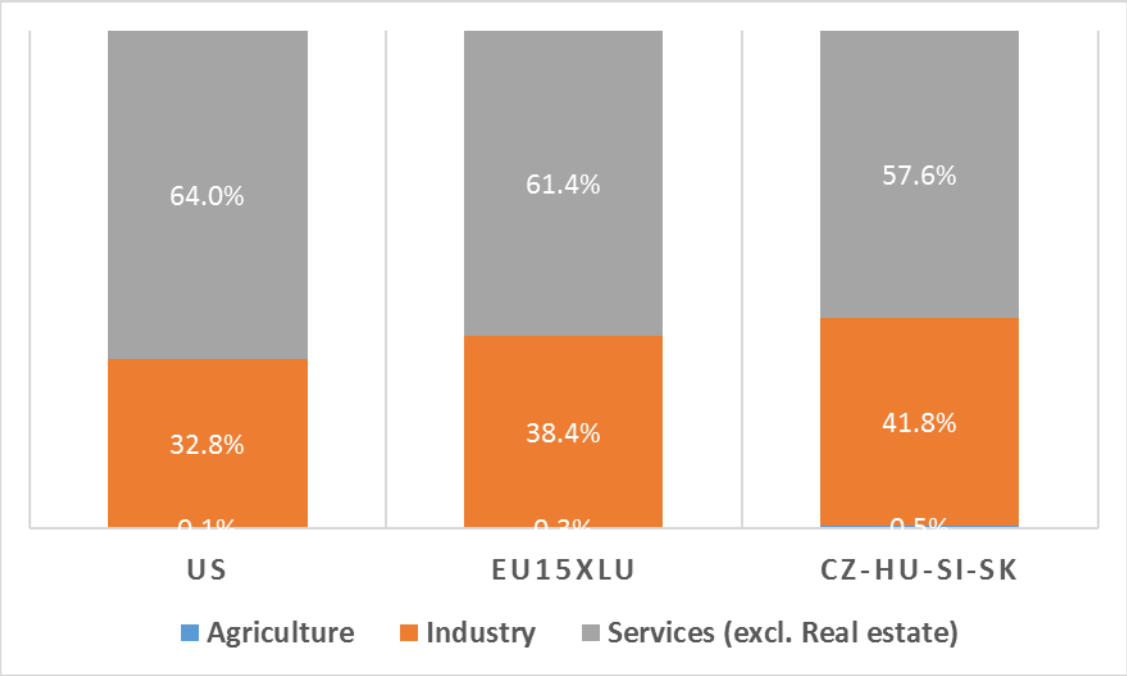
References

Bacchini, Fabio et al., (2016), "Estimates of Intangible Investment in the Public Sector: EU, US, CHINA AND BRAZIL", Spintan working paper series No. 11.

Corrado, Carol; Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi, (2014), " Intangibles and Industry Productivity Growth: Evidence from the EU " Working Paper, available at http://www.intan-invest.net.

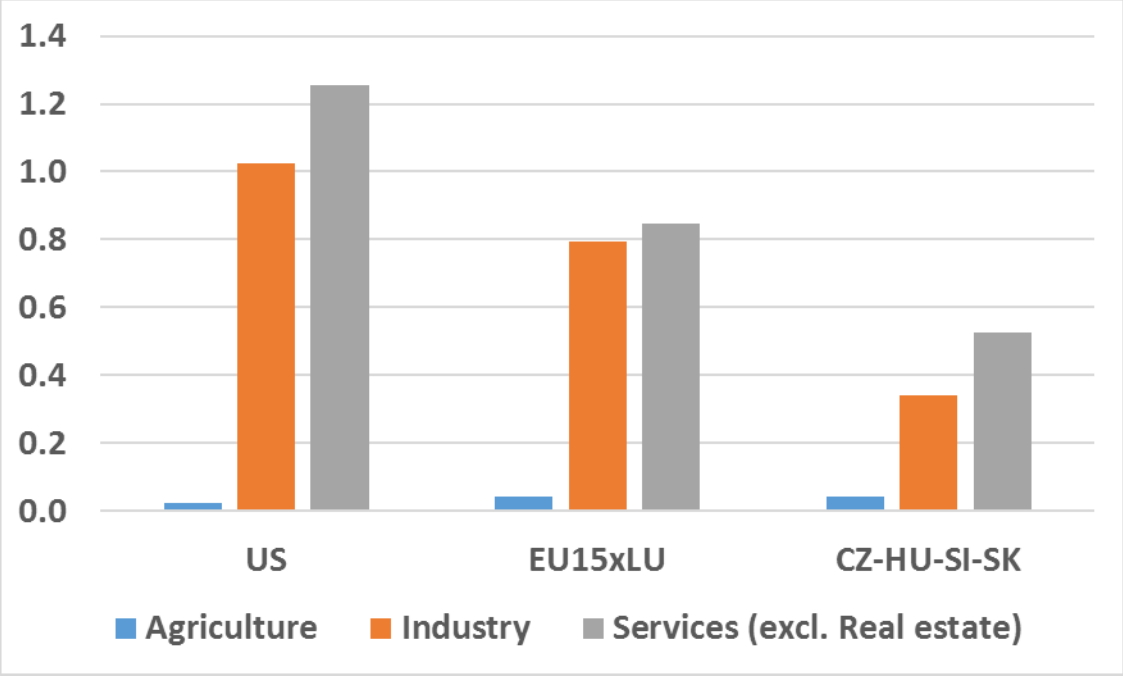
Appendix 2.

Figure A1: Industry composition of intangible investment (average 2000-2013)



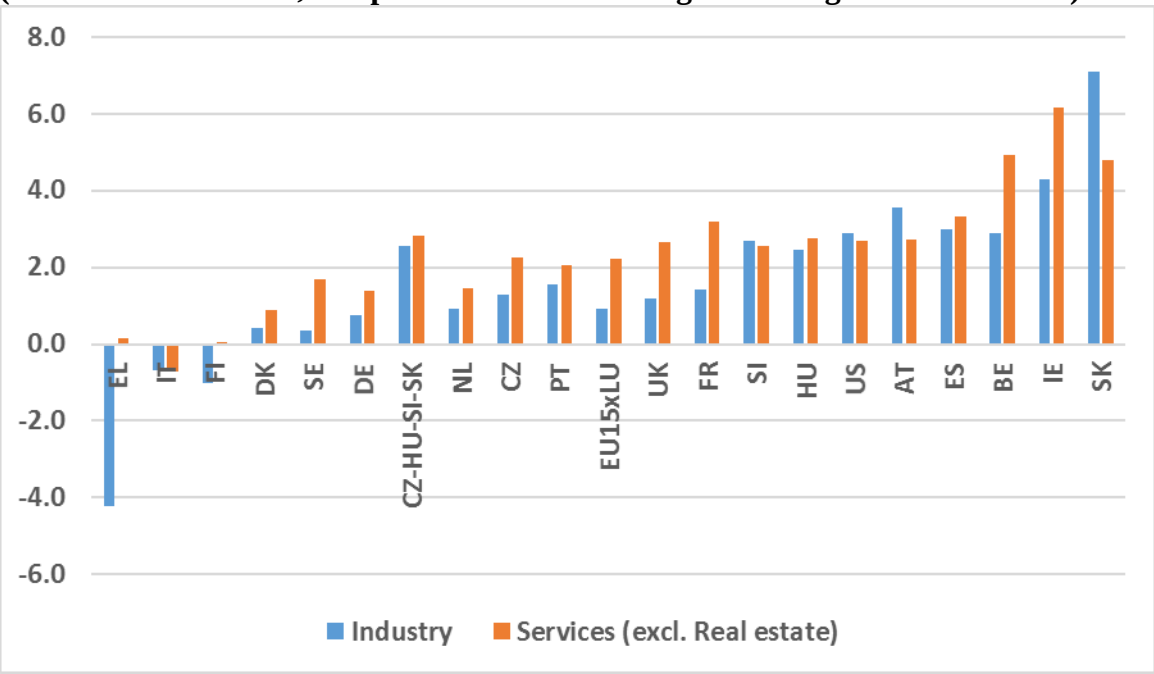
Source: INTAN-Invest

Figure A2: Intangible to tangible investment by industry (average 2000-2013)



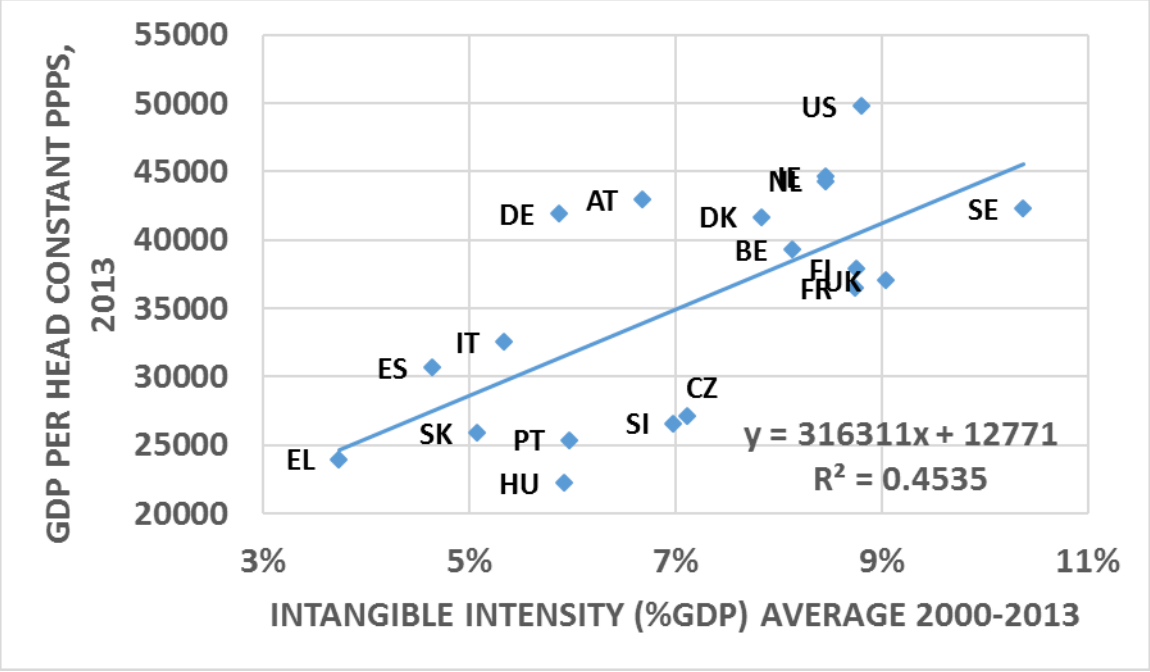
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A3: Real intangible investment growth in the industry and the service sectors (chain linked volumes, compounded annual average rates of growth 2000-2013)



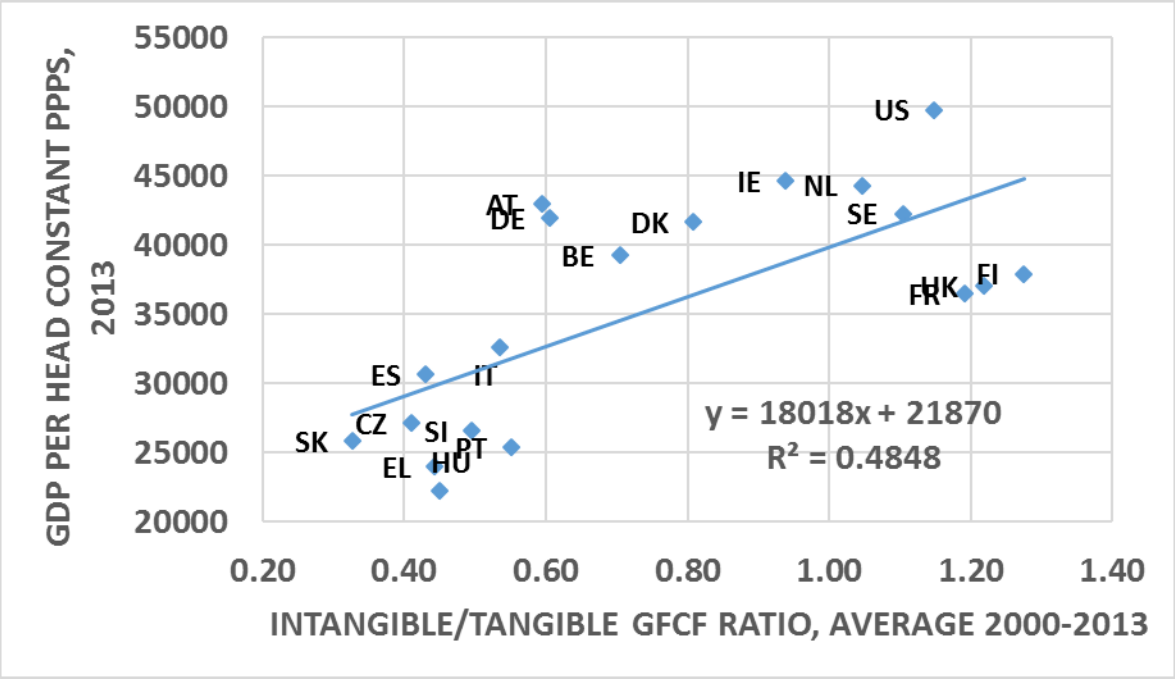
Source: INTAN-Invest

Figure A4: Intangible investment (%GDP) and GDP per head



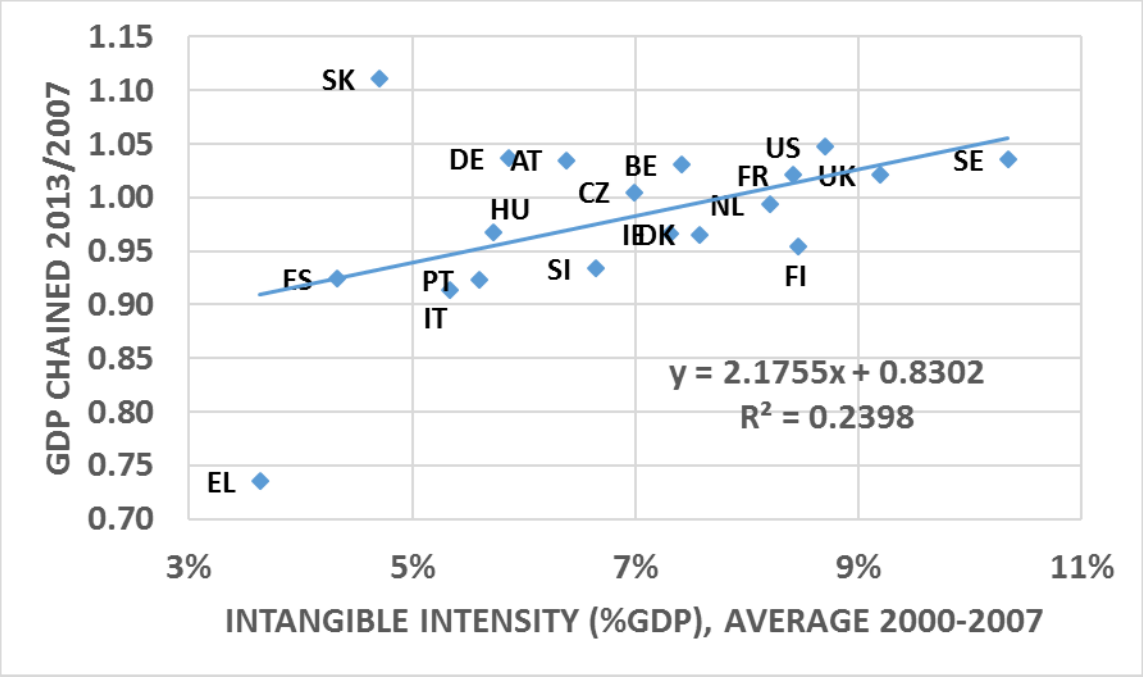
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A5: Intangible over tangible investment ratio and GDP per head



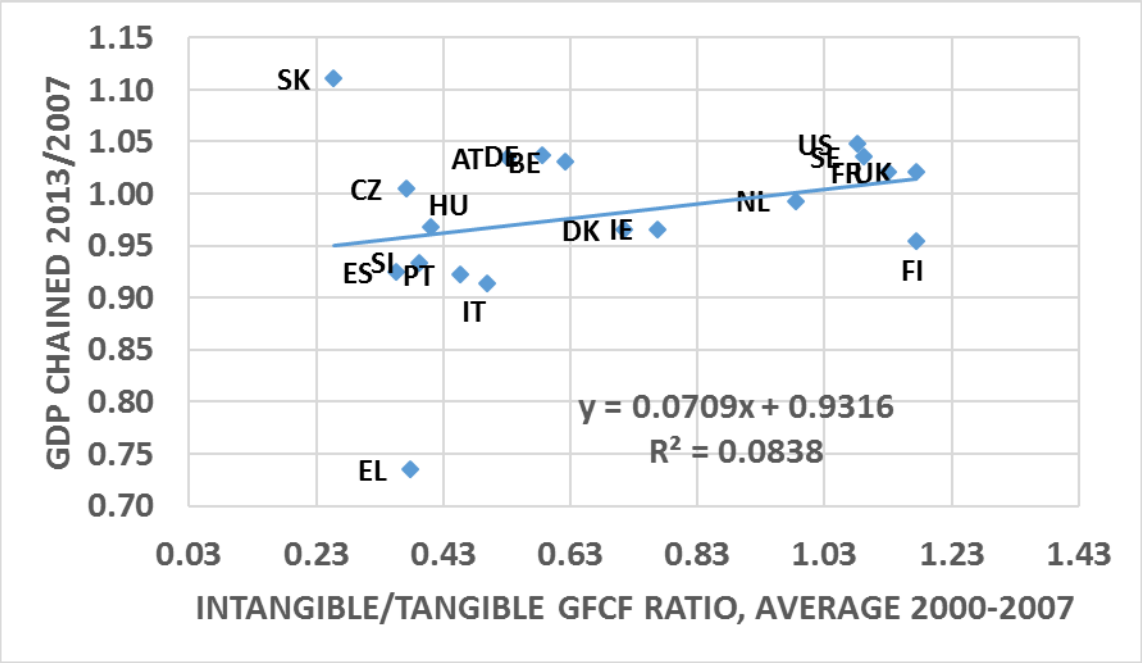
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A6: Intangible intensity before the crisis and the impact of the crisis



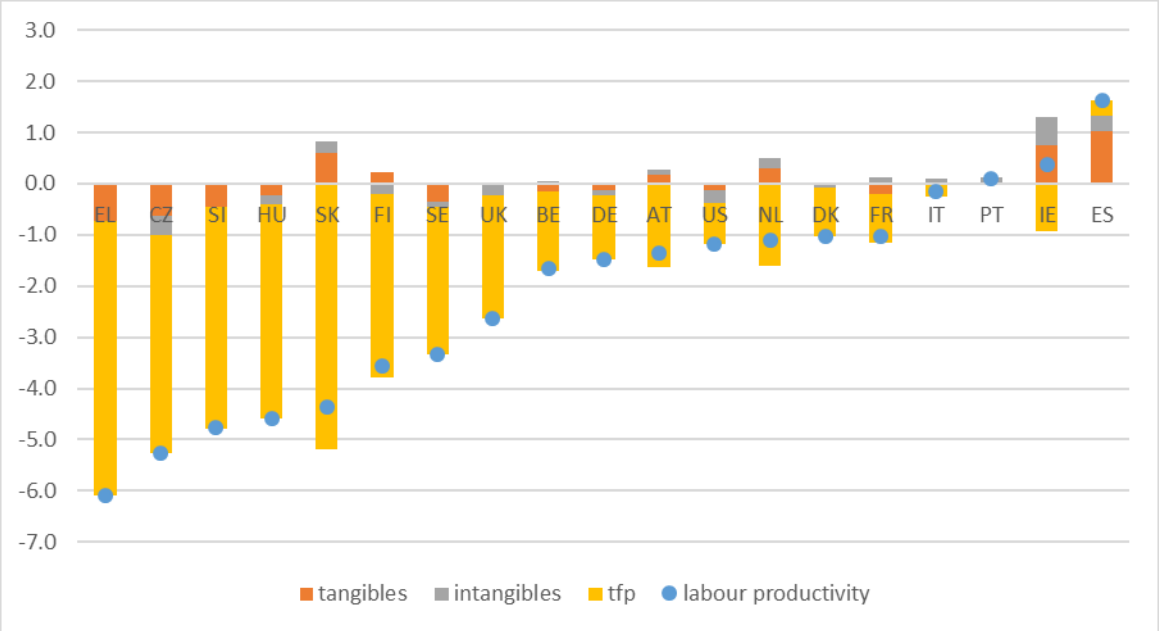
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A7: Intangible to tangible ratio before the crisis and the impact of the crisis



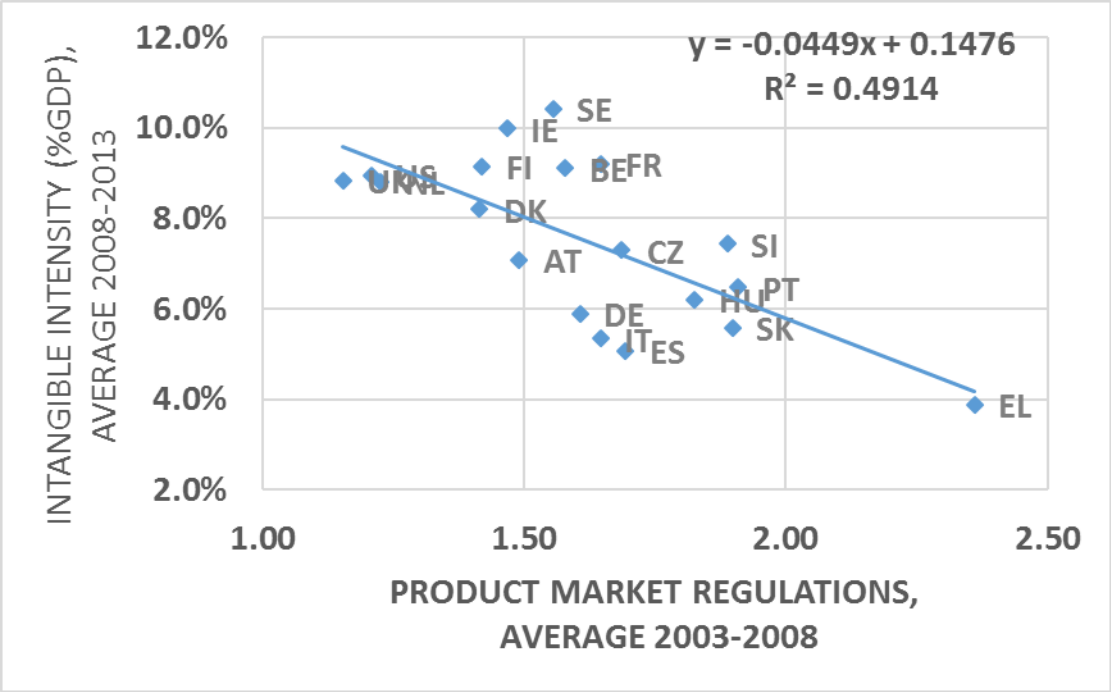
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A8: Changes in the contributions to the growth of labour productivity in 18 European countries and the United States before and since the Great Recession (averages 2007-2013 minus averages 2000-2007)



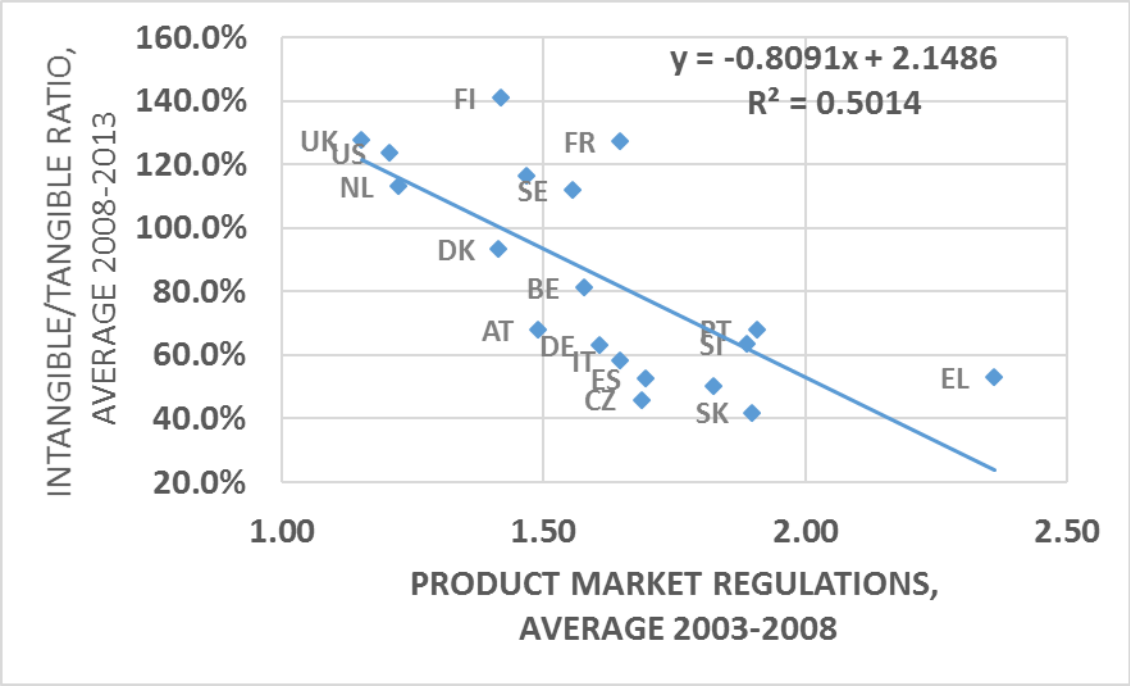
Source: INTAN-Invest and authors' elaborations on National Accounts

Figure A9: Intangible intensity and product market regulation



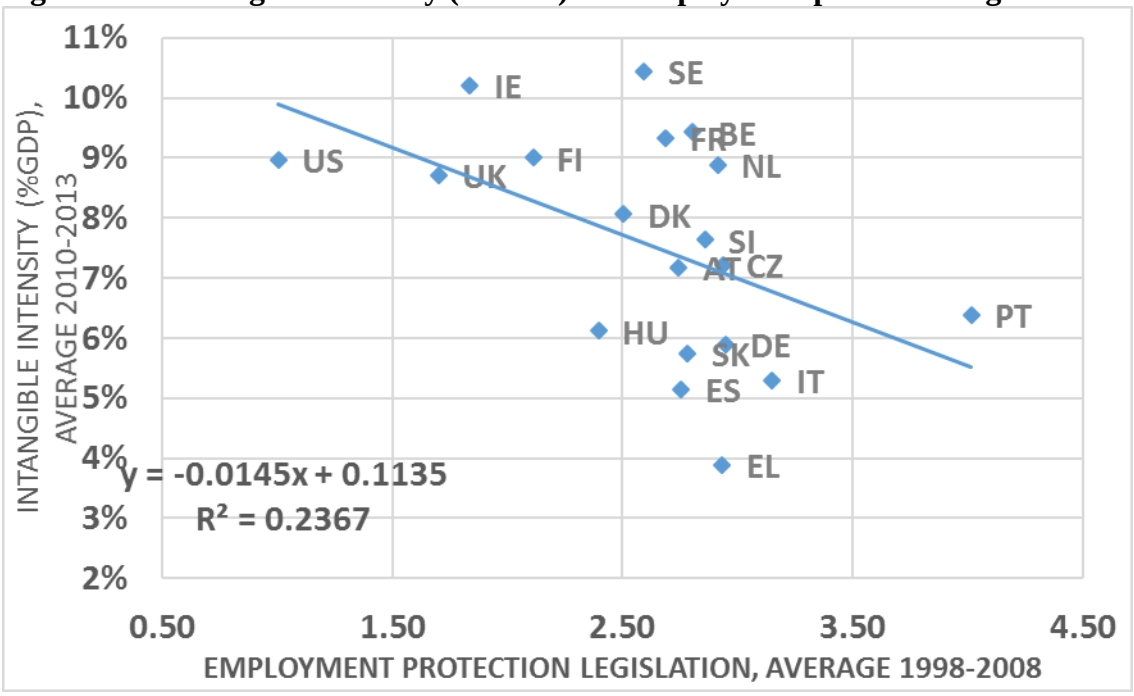
Source: INTAN-Invest and OECD

Figure A10: Intangible/tangible ratio and product market regulation



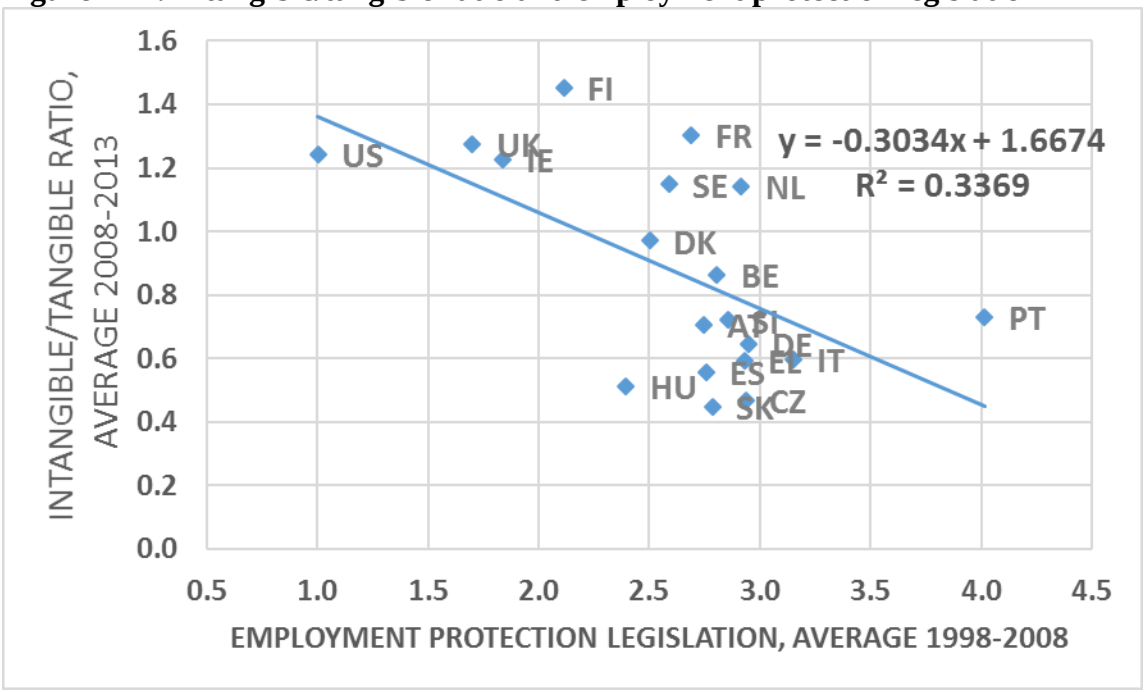
Source: INTAN-Invest and OECD

Figure A11: Intangible intensity (%GDP) and employment protection legislation



Source: INTAN-Invest and OECD

Figure A12: Intangible/tangible ratio and employment protection legislation



Source: INTAN-Invest and OECD

Table A1: Intangible investment by industry (% officially measured industry value added)

	2000-2007		2008-2009		2010-2013	
	IND	SERxL	IND	SERxL	IND	SERxL
Austria	9.6%	8.9%	11.2%	9.1%	12.2%	9.9%
Belgium	11.0%	10.8%	13.0%	12.1%	14.5%	13.6%
Czech Republic	9.1%	10.5%	9.2%	11.6%	9.1%	11.3%
Denmark	13.2%	9.5%	15.0%	10.4%	15.3%	9.7%
Finland	15.3%	12.2%	19.5%	12.4%	20.1%	12.3%
France	15.8%	12.4%	16.8%	13.5%	17.8%	14.2%
Germany	12.3%	6.0%	12.6%	6.1%	12.0%	6.3%
Greece	7.4%	5.1%	9.2%	5.6%	9.1%	6.5%
Hungary	8.6%	10.0%	9.6%	11.0%	10.0%	10.2%
Ireland	9.7%	11.4%	14.9%	13.4%	15.7%	13.9%
Italy	8.9%	8.0%	9.5%	8.1%	9.9%	7.9%
Netherlands	11.0%	11.8%	11.3%	12.4%	12.6%	12.0%
Portugal	5.8%	11.0%	7.5%	12.4%	7.7%	11.8%
Slovenia	10.0%	10.0%	10.7%	10.4%	12.6%	11.0%
Spain	5.3%	6.9%	6.4%	7.5%	7.5%	8.1%
Sweden	21.0%	13.3%	22.2%	12.9%	22.4%	12.8%
Slovakia	5.6%	7.7%	5.8%	8.5%	6.6%	9.2%
United Kingdom	11.3%	14.7%	11.2%	14.5%	11.5%	14.3%
United States	13.3%	12.3%	14.6%	12.5%	15.0%	12.6%
European Union (15 countries excl. LU)	11.5%	10.1%	12.2%	10.3%	12.7%	10.6%
Czech Rep-Hungary-Slovenia-Slovakia	8.5%	9.9%	8.8%	10.7%	9.1%	10.6%

Source: INTAN-Invest and authors' elaborations on National Accounts

Table A2: Cross-country correlation between intangible investment and firm size in EU countries

	Intangible share	intangible/tangible ratio
Mining and quarrying	0.12	0.18
Manufacturing	0.48	0.45
Electricity, gas, steam and air conditioning supply	0.09	0.19
Water supply; sewerage, waste management and remediation activities	-0.02	-0.04
Construction	0.29	0.01
Wholesale and retail trade; repair of motor vehicles and motorcycles	0.29	0.45
Transportation and storage	0.30	0.25
Accommodation and food service activities	0.44	0.47
Information and communication	0.18	0.67
Professional, scientific and technical activities	0.09	0.33
Administrative and support service activities	0.25	0.26

Source: INTAN-Invest, National Accounts and OECD
Note: average firm size is measured as the share of persons employed in firms with more than 250 persons employed

Table A3: Cross-country correlations between intangible investment by asset type and high-level economy-wide indicators of product market regulation

	Product Market Regulations			
	PMR	*State control*	*Barriers to entrepreneurship*	*Barriers to trade and investment*
Intangible Investment (%GDP)	-0.69	-0.62	-0.42	-0.53

Software and Databases	*-0.48*	*-0.44*	*-0.34*	*-0.32*
Innovative Property	*-0.60*	*-0.58*	*-0.32*	*-0.45*
Economic Competencies	*-0.46*	*-0.36*	*-0.31*	*-0.40*
Intangible over tangible Investment	-0.70	-0.54	-0.44	-0.68

Source: INTAN-Invest and OECD

Economics Department
economics@eib.org
www.eib.org/economics

Information Desk
+352 4379-22000
+352 4379-62000
info@eib.org

European Investment Bank
98-100, boulevard Konrad Adenauer
L-2950 Luxembourg
+352 4379-1
+352 437704
www.eib.org