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Original Article

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

Carol Corrado[1], Jonathan Haskel[2], Cecilia Jona-Lasinio[3] and Massimiliano Iommi[4*]

[1] *The Conference Board, New York, NY, USA*
[2] *Imperial College, London, UK; Center for Economic and Policy Research (CEPR), London, UK; and Institute of Labor Economics (IZA), Bonn, Germany*
[3] *Istat and LUISS Lab, Rome, Italy*
[4] *IMF‡, Washington, DC, USA; and LUISS Lab, Rome, Italy*

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 (TFP). 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, respectively, 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 increase. 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.

Keywords: *productivity growth; intangible capital; sources of growth; national accounts*

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1. Introduction

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***CORRESPONDING AUTHOR**
Massimiliano Iommi,
Luiss Lab of European Economics, Viale Romania 32,
00197 Rome, Italy; miommi@luiss.it

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The changing nature of the global economy has placed 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]

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. Many works on intangibles focused on Europe and were comparative in nature. This applies to two projects funded by the European Commission (COINVEST and INNODRIVE) under the 7th Framework Programme and the 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.[2] This has led to the publication of the INTAN-Invest dataset, which 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 2017) of 18 European countries and the US to analyse the diffusion of intangible investment within countries and investigate the growth contribution of intangible capital.

The paper is structured into seven sections. Section 2 illustrates the theoretical framework and Section 3 provides a data description (INTAN-Invest dataset 2017). Sections 4 and 5 offer some descriptive evidence about diffusion and dynamics of intangibles across countries whilst Section 6 explores the drivers of intangible capital accumulation. Section 7 concludes.

2. The theoretical framework

We adopt the model by Corrado, Goodridge and Haskel (2011) that integrates innovation into the

[1] The seminal contribution of Corrado, Hulten and Sichel (2005; 2009) 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 applied and used for each country.

national accounts to make it measurable (following Corrado *et al*., 2013). Knowledge (ideas) is assumed to be an input to produce consumption and tangible investment goods together with labour and tangible capital. There exist two types of knowledge. One is knowledge generated without using factors of production that is freely available to firms (free knowledge). The other is knowledge 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]

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, including consumption goods, tangible investment and also commercialised knowledge:

$$P^Q Q = P^Y Y + P^N N = P^C C + P^I I + P^N N \tag{1}$$

where Q, Y, N, C and I are, respectively, value added, final downstream output, intangible investment, real consumption and investment, all in real terms, and P (appropriately superscripted) their prices. The reason can be thought of by analogy to tangible investment. Suppose an aircraft factory buys in metal 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. Investment by the factory is its production of machines. Now suppose the factory also writes its own long-lived software to run the machines. Then we should think of it as both (a) an aircraft factory and (b) a machine factory and also (c) 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:

$$d\text{lnQ} = s_Q^L dlnL + s_Q^K dlnK + s_Q^R dlnR + dlnTFP \tag{2}$$

where s_Q is the share of nominal value added accounted for by payments to the particular factor, and 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 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*.:

[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 working software programme adapted to the needs of the organisation, for instance, 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.

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

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 $s_Q{}^R$dlnR 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	Intangible Capitalised in National Accounts?	Capitalisation Factor	Depreciation rate
Computerised Information			
Purchased Software	Yes	1	0.32
Own-Account Software	Yes	1	0.32
Databases	Yes	1	0.32
Innovative Property			
R&D	Yes	1	0.15
Design	*No*	*0.5*	*0.2*
Mineral Exploration	Yes	1	0.075
Financial Innovation	*No*	1	0.15
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

Notes: Capitalisation factors convert data on total spending to investment

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, *i.e.*, 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 (Corrado, Hulten and Sichel, 2005; 2009).

3.2 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 2017)[4] 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 2017 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 2017 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.[5] In the analysis reported in this paper we exclude the real estate industry (NACE section L).[6]

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[7] 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%) (Table 2). 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

[4] Data are available at www.intaninvest.net.

[5] Previous edition of INTAN Invest estimates did not include industries P and Q but incorporated industry R as a whole.

[6] The data sources and estimation methods used to generate the INTAN-Invest harmonised measures of investment and capital stocks can be found in the appendix of the working paper version of this paper (EIB Working Papers 2016/08, European Investment Bank (EIB) available at https://www.econstor.eu/bitstream/10419/149979/1/877829535.pdf).

[7] In this section GDP refers to officially measured gross domestic product available from national accounts.

the opposite was the case.[8]

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 with intangibles outpacing tangible investment shares of GDP over the whole time span. 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%), with Belgium (8.1%) and Denmark (7.8%) lagging slightly behind.

As for the Mediterranean and German-speaking countries, they are relatively less intangible intensive. 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 has the lowest average share over the period both for intangibles (3.7%) and tangibles (8.8%).

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%
CZ-HU-SI-SK	2.2%	4.2%	6.4%	16.0%

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

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 (Table 3).

Economic competencies account for the largest share of intangible expenditure in all sample countries

[8] 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.

while computer software accounts for the smallest share. The same pattern holds within the European economies with the notable exception of the Scandinavian countries, Germany and Ireland (Table 3), where innovative property is the main intangible component (as a result of the high propensity for investing in R&D).

The asset breakdown shows that Germany is lagging behind the intangible-intensive EU14 economies and the US because of a lower propensity for investing in economic competencies and software, while Italy and Spain show a relatively high investment gap compared to the EU14 across all intangible asset categories.

Table 3. 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%**
CZ-HU-SI-SK	**1.1%**	**2.2%**	**3.1%**

Source: INTAN-Invest

The figures in Table 4 show that in the sample areas services invest more than the industry sector in intangible assets and that agriculture has negligible shares.[9] Services account for 64% of market sector intangible investment in the US, and for 61% and 58% in the EU14 and NMS, respectively. However, intangible intensity (*i.e.*, intangible investment as share of sector's value added) is higher in the industry sector than in services both in the US and the EU14, suggesting that the predominant role of services in market sector's spending for intangible investment is driven by their larger value added share and is not related to a higher propensity for investing in intangible assets.

In the US both manufacturing and services (14% and 12.4%, respectively) are more intangible intensive than in the other EU regions. In the EU14 industry intangible investment as a percentage of

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

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%, respectively).

Table 4 shows that in Finland, Germany and Sweden industry is the intangible-intensive sector, while in Belgium, Ireland and the Netherland both sectors display comparable intensities.

The low intangible intensity of the Mediterranean countries and, to a lesser extent, Austria, is driven by 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 low level of intangible investment in Germany is accounted for the low investment propensity of services, with industry at the EU14 average (but lower than the US level).

The last three columns in Table 4 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 industry takes the lead in the remaining economies (including Germany).

Table 4. Intangible investment by industry (average 2000–2013)

	Industry composition			**Value-added share**			**Intangible/tangible ratio**		
	AGR	IND	SERxL	AGR	IND	SERxL	AGR	IND	SERxL
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: 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 1 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 grows more slowly than tangible capital accumulation. In the US the average rate of growth of intangible investment is 2.6% per year over 2000–2013, while tangibles increase at 1.0%. The European economies included in our analysis grow at a slower pace both in tangible and intangible investments. 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 are even more striking, with the former increasing at 1.2% per year and the latter decreasing by 0.5% per year.

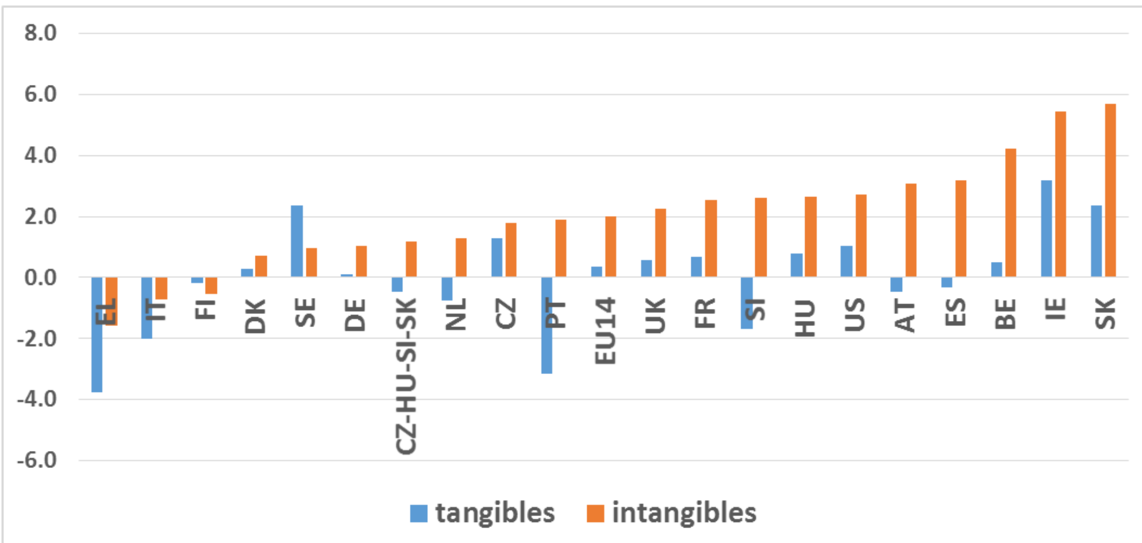

Figure 1. Real tangible and intangible investment growth (chain-linked volumes, compounded annual average rates of growth 2000–2013)

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

The slowdown of gross fixed capital formation experienced by all advanced economies has been highly debated since the occurrence of the financial crisis. Figure 2, Figure 3 and Figure 4 illustrate the dynamics of tangible and intangible investment since 2000. In the US tangibles increased significantly 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 2).

In Europe the dynamic is rather different (Figure 3 and Figure 4). In 2008–2009 the EU14 economies experienced a relatively lower decline in tangible investment compared to the US (-17%) with a moderate reduction in intangibles (-2%). In the NMS the decline in tangibles was smaller than in the EU14 and the slowdown in intangibles marginally higher (-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).

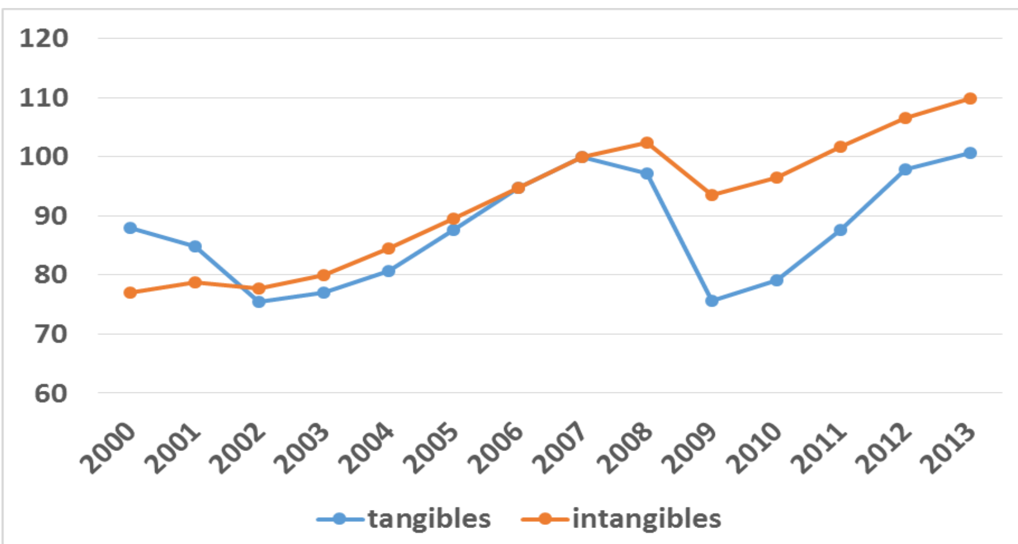

Figure 2. Tangible and intangible investment, US (chained values, 2007=100)

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

Figure 5 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.

The intangible/tangible investment ratio (Figure 6) was very high in France and UK while it was rather low in Italy and Germany, with Spain showing the lowest value. In the five countries the ratio increased significantly during the Great Recession, gaining higher levels in the following years. In 2013 the intangible/tangible ratio was about 20% higher than in 2000 in UK; 25% in France, Germany and Italy; and 75% in Spain.

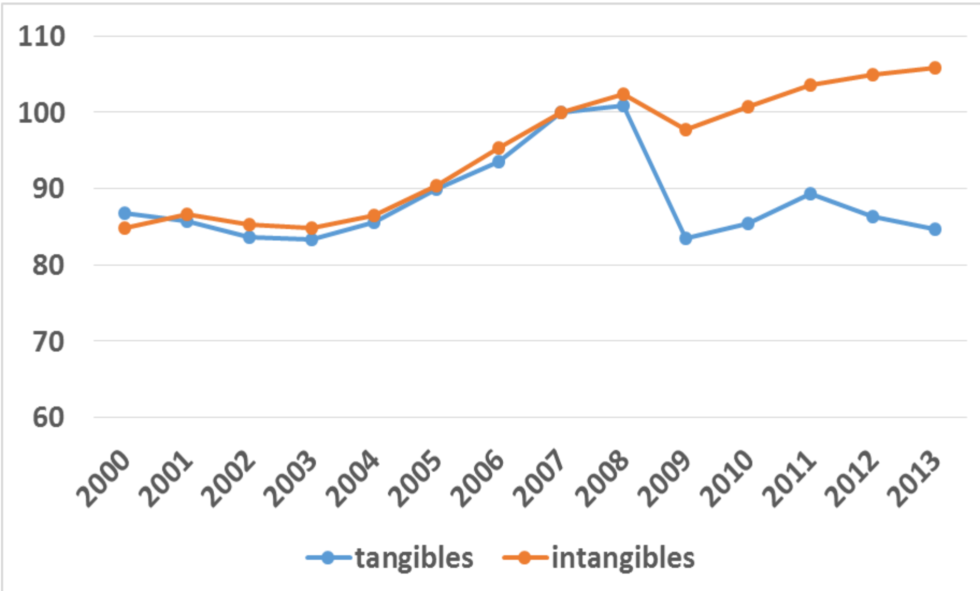

Figure 3. Tangible and intangible investment, EU14 (chained values, 2007=100)

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

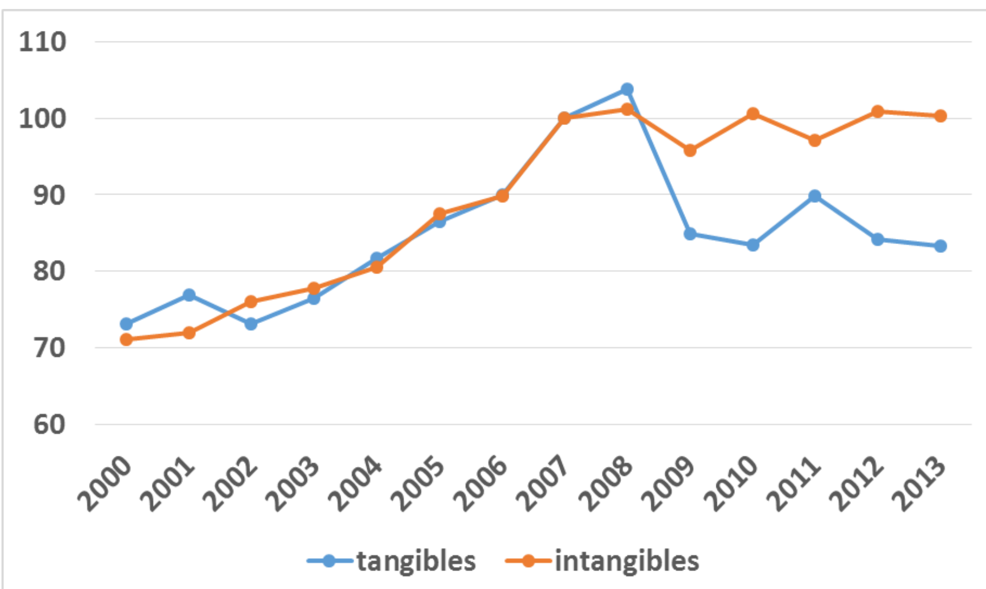

Figure 4. Tangible and intangible investment, CZ-HU-SI-SK (chained values, 2007=100)

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

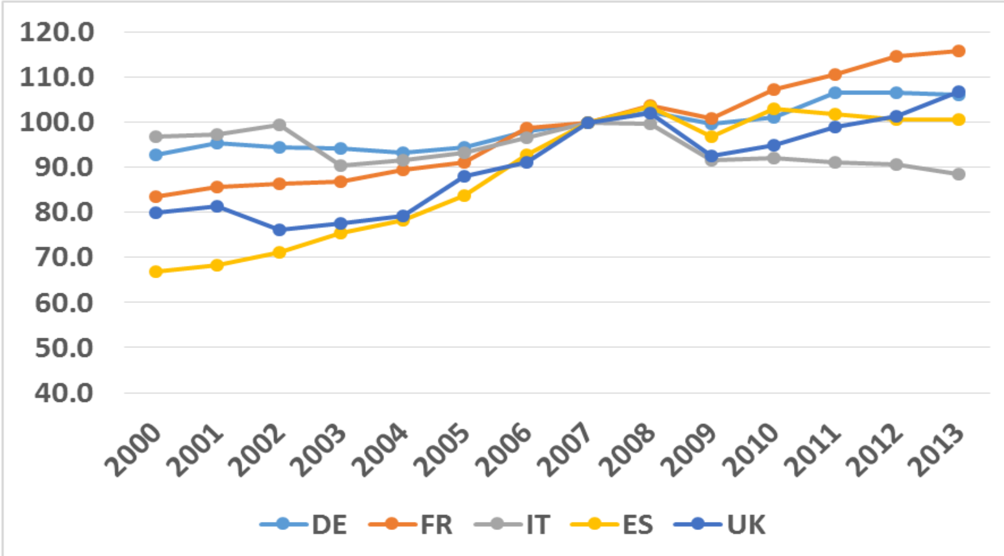

Figure 5. Intangible investment in the five large EU economies (chained values, 2007=100)

Source: INTAN-Invest

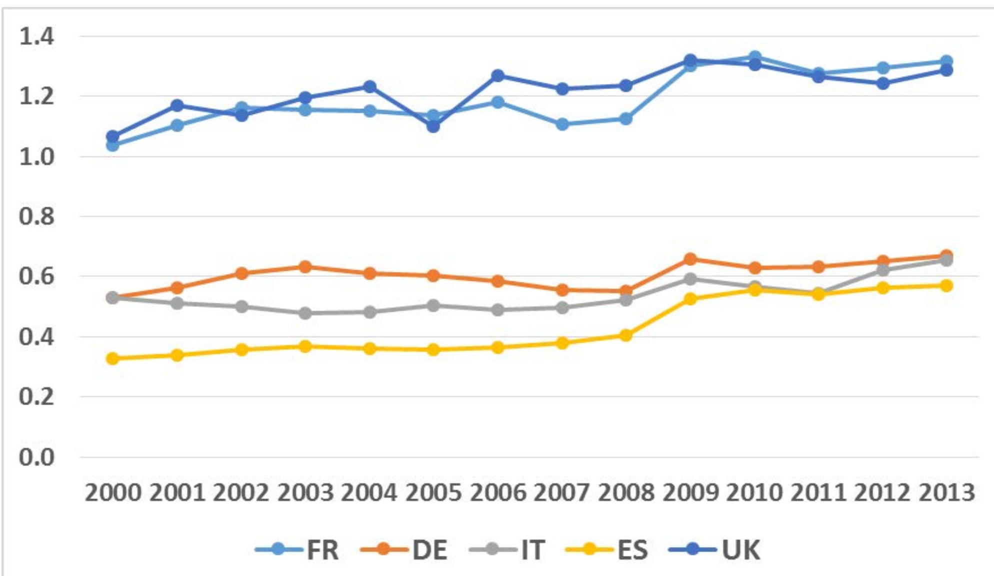

Figure 6. Intangible over tangible investment ratio in the five large EU economies

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

5. Sources of labour productivity growth

The sources of growth exercise cover 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 ICT and non-ICT components. The analysis covers the period 2000–2013.

5.1 2000-2013

From 2000 to 2013, labour productivity growth was by far the highest in the four new Member States and in Ireland (Table 5). Also the US along with 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 9 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 5). Capital deepening and MFP&LQ provided a comparable contribution in Austria, Belgium, the Czech Republic, Sweden and Denmark.

Table 5. 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**	**SNA 2008 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		

Note: Labour composition is unavailable for all these countries, so data in column 5 is MFP and labour composition.
Source: INTAN-Invest and authors' elaborations on national accounts.

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

The last three rows in Table 6 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.

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 coherent 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 both intangible capital deepening and MFP&LQ.

Table 6. 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

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 investigation of the differences between the composition of intangible contributions in the US and in the EU economies reveals that in the US all the asset categories provided a higher contribution. Within innovative property, the contribution of minerals and artistic originals[10] 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.

5.2 2000–2007 and 2007–2013

Table 7 shows that in 2007–2013 labour productivity growth decelerated in nearly all countries compared to 2000–2007; the only exceptions are Italy, Portugal, Ireland and Spain (the sole country experiencing an acceleration of labour productivity).

Table 7. 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

[10] Measurement errors might affect these results.

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 because 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 compared to the previous period while tangible capital increased (Finland) or remained stable (UK).

5.3 Comparison with national accounts-based results

Table 8 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% p.a. and 0.7% p.a., respectively, but without is 1% p.a. and 0.9% p.a., respectively. In the EU14 the equivalent figures are 0.7% p.a. and 0.3% p.a., respectively, and 0.6% p.a. and 0.4% p.a., respectively. Thus the inclusion of intangibles lowers the "measure of our ignorance".

Table 8. 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

A comprehensive discussion of all the potential determinants of intangible investment is well beyond the scope of the paper, but in this section we investigate some correlations between intangible investment firm and variables potentially affecting firm's investment decisions: firm size, product and labour market regulation.

6.1 Intangibles and firm size

Arrighetti, Landini and Lasagni (2014) surveyed the link between firm size and investment in intangible assets and find that firm size is likely to positively affect the propensity of investing in intangibles Firstly, large firms are better able than small firms 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 smaller firms, thus having a greater incentive to invest. Thirdly, large firms are also capable of facing higher uncertainty as that associated with intangible investments (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, Landini and Lasagni (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) shows that among surveyed firms, large firms are more likely to report positive spending on one or more intangible assets compared to smaller firms. 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). Finally, the Community Innovation Survey 2008 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 look at cross-country correlations 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 by industry to control for different average firm size in various economic activities (see Table A1, in Appendix). Intangible intensity and the intangible/tangible ratio are positively correlated with the average firm size in 10 out of 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-maximising 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, examined 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) find that reducing entry barriers stimulates investment in information and telecommunication technologies (which, in their data, also includes investment in computer software) in Italian firms.

Contrasting forces may influence the effect of greater competition on innovation. 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 funds to finance innovation. 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 pre-commit, 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, Grassano and Vezzani (2016) show that product market regulation and employment protection legislation significantly affect the location decision of top R&D investors' 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 A1 to A4, 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 A2, 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, as also 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:

$$ln\left(\frac{I^{INTAN}}{I^{TAN}}\right)_{c,t} = \alpha_1\, ln\left(\frac{P_i^{INTAN}}{P_i^{TAN}}\right)_{c,t} + \alpha_2 STRICTNESS_{c,t} + \alpha_3 ICT_{INTEN\,c,t}$$
$$+\alpha_4 share\_mfring_{c,t} + \alpha_5 (GovR\&D/GDP)_{c,t} + \lambda_t + v_{c,t} \qquad (4)$$

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 refer to the private sector.

Column 1 in Table 9 shows our estimation results. The relative price term has the right sign and it is significant, suggesting a relatively strong price elasticity. Turning to the second and third rows, countries with higher ICT intensity and lower manufacturing shares are associated with higher relative intangible investment, corroborating the evidence that intangibles are complementary to ICT (Corrado, Haskel and Jona-Lasinio, 2017) and that the intangible to tangible ratio is higher in the service sector. The OECD strictness index is negatively correlated with relative intangible investment (see the Appendix). Finally, countries with more government R&D have relatively high intangible investment, supporting the complementarity between public and private intangible investment.

The remaining columns of Table 9 show some robustness checks. Column 2 replaces employment strictness with product market regulation and confirms a negative and statistically significant association. Column 3 puts them together and suggests strong collinearity between them (*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*).

Table 9. 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)
GovR&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
R^2	0.518	0.527	0.550	0.482

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

Notes: a) Regressors are, respectively, relative intangible to tangible investment price, the ratio of ICT capital rental payments to total tangible rental capital payments, the share of employment in manufacturing, the OECD index of employment strictness, the OECD index of product market regulation and the ratio of government-funded R&D to GDP. Estimation includes time dummies. Estimation by random effects. b) Estimates of (4): dependent variable: ln ratio of intangible to tangible investment).

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 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.

The sources of growth analysis first support the evidence that intangible capital deepening is an important driver of labour productivity 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. Second, the EU14 lagged behind the US in 2000–2013 mainly because of the relatively lower dynamic of both intangible capital deepening and multifactor productivity. Third, the 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, 2017) 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 2017.

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Appendix

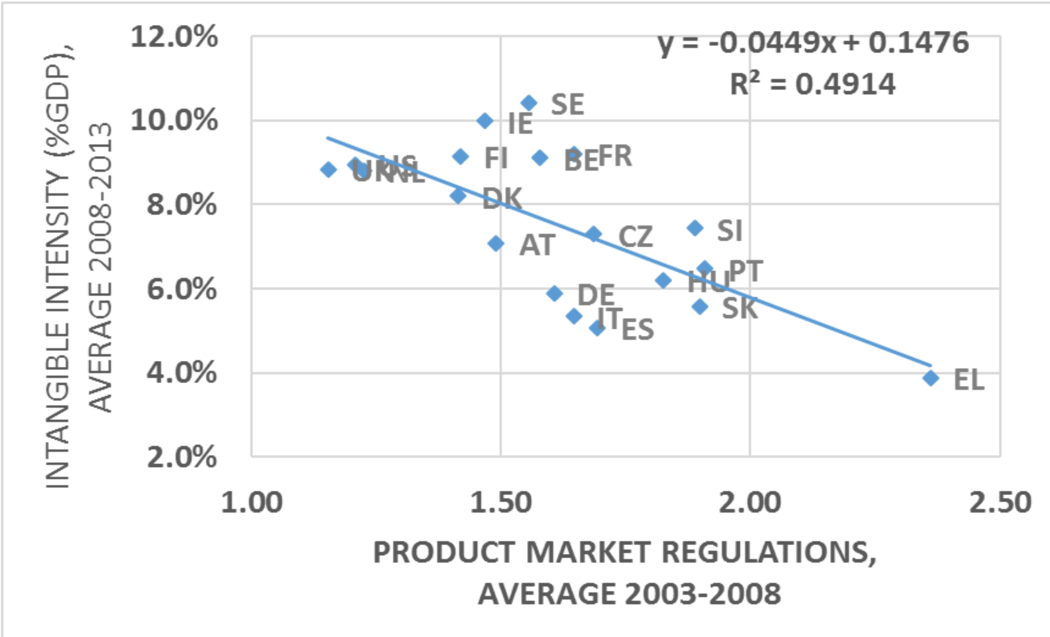

Figure A1. Intangible intensity and product market regulation

Source: Authors' elaborations on national accounts on INTAN-Invest and OECD data

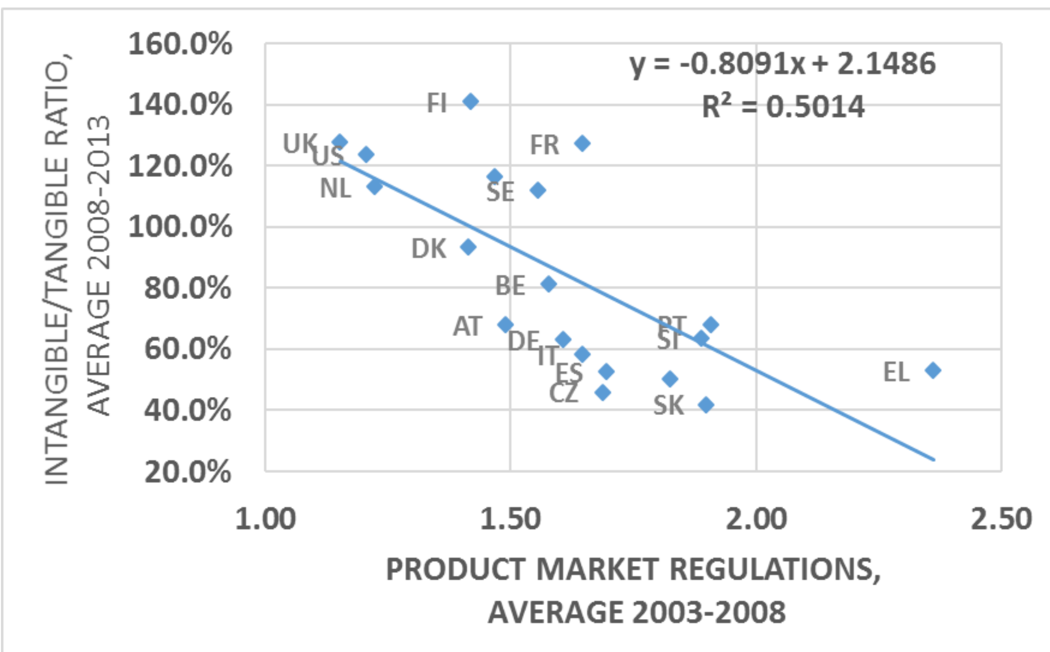

Figure A2. Intangible/tangible ratio and product market regulation

Source: Authors' elaborations on national accounts INTAN-Invest and OECD data

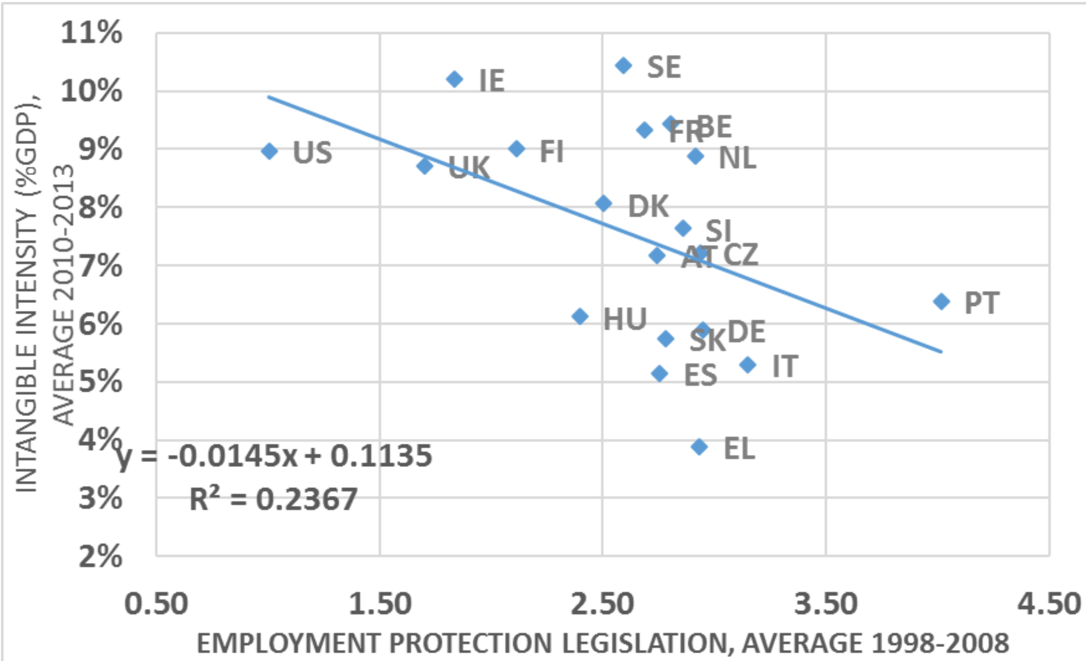

Figure A3. Intangible intensity (% GDP) and employment protection legislation

Source: Authors' elaborations on national accounts INTAN-Invest and OECD data

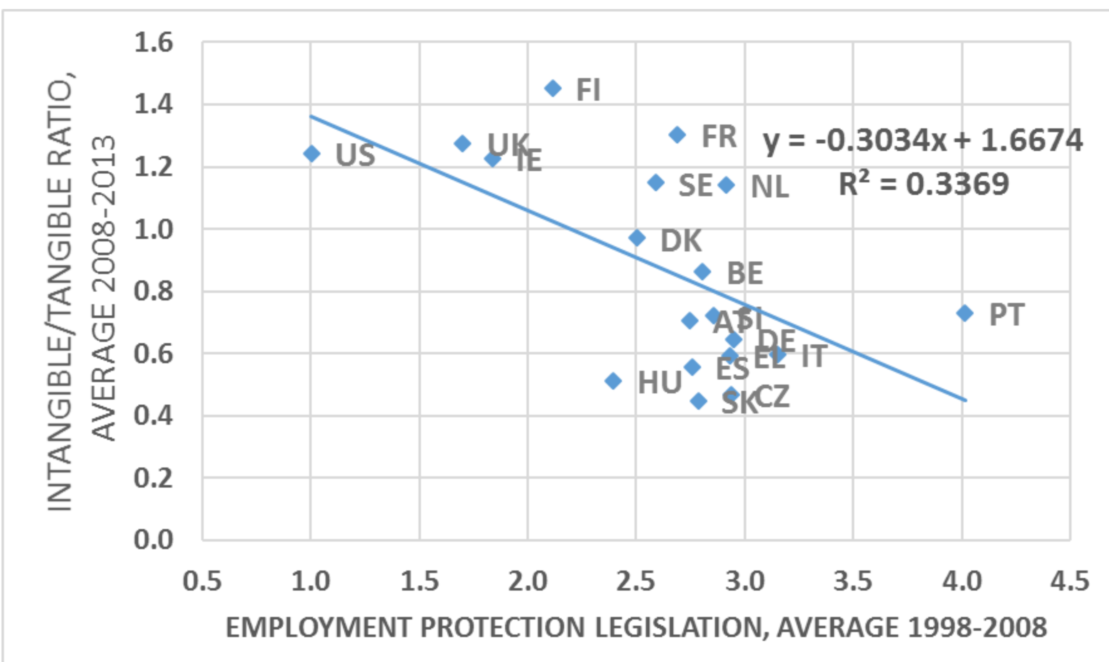

Figure A4. Intangible/tangible ratio and employment protection legislation

Source: Authors' elaborations on national accounts INTAN-Invest and OECD data

Table A1. 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: Authors' elaborations on national accounts INTAN-Invest, National Accounts and OECD data
Note: Average firm size is measured as the share of persons employed in firms with more than 250 persons employed

Table A2. 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: Authors' elaborations on INTAN-Invest and OECD