Intangibles and Industry Productivity Growth: Evidence from the EU

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Intangibles and industry productivity growth: Evidence from the EU*

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Abstract

We set out intangible investment data by industry for 14 EU countries in 1995-2010 and industry growth accounting incorporating these data for 8 countries. We find: (a) intangible investment has grown in manufacturing and services, but most strongly in services (b) the contribution of intangibles to labour productivity growth is similar in both manufacturing and services and in the high growth economies (Austria, Germany, Finland, France, Netherlands, UK) exceeds the contribution of labour quality (c) the very large size of the service sector means that countries with good manfacturing but poor service productivity growth (Germany and France) have done relatively badly overall and those with good service sector growth (UK, Netherlands) have performed well (d) Spain and Itay have very low labour productivity growth due to very low TFP growth.

JEL: O47, E22, E01

Keywords: productivity growth, economic growth, intangible capital, intangible assets.

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1 Introduction

Empirical evidence shows that once intangible capital is included in a sources of growth analysis it accounts for one-fifth to one-third of labour productivity growth in the market sector of the US and EU economies[1]. As a consequence, the measurement of intangible investment is a fundamental challenge in both sources-of-growth analysis and national accounting practice.

Following the work of Corrado, Hulten and Sichel (2005,2009) and Nakamura (1999)major research efforts were undertaken to measure intangible investment and intangible capital for the aggregate business sector of European countries (CoInvest; INNODRIVE). This led to the development of a harmonized framework for measuring intangible investment in these countries (INTAN-Invest).[2] At the same time, estimates for many other countries (not necessarily harmonized), e.g., Japan (Fukao et al. (2009), Australia (Barnes and McClure 2009), Canada (Baldwin et al. 2012), and Korea (Pyo et al 2012), have emerged.

As overall business intangible investment is large and growing in advanced countries (Corrado et al 2013) the development of harmonized methods and measures of intangible capital at an higher level of industry detail[3] 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.

In this paper we illustrate newly produced INTAN-Invest industry[4] measures of intangible investment for 14 EU economies in 1995-2010 and our estimation method. Then we assess the role of ICT, R&D and Non-R&D intangible capital in a source of growth framework and their impacts on country-industries productivity over the sample period.

To examine these issues, we merge international EUKLEMS data on outputs, labour

[1] The most recent report of this accounting is in Corrado, Haskel, Jona-Lasinio, and Iommi (2013). Corrado, Hulten, and Sichel (2009) and Marrano, Haskel, and Wallis (2009) first reported results of about one-fourth for the US and UK, respectively. The contribution in Japan and many EU countries is lower (Fukao, Miyagawa, Mukai, Shinoda, and Tonogi, 2009 and van Ark, Hao, Corrado, and Hulten, 2009).

[2] "Harmonized" means that, to the extent possible, the same concepts, methods, and data sources are applied and used for each country. INTAN-Invest contains harmonized estimates of intangible investment for the EU plus Norway and the United States.

[3] Recently, studies have developed estimates of intangible investment at the industry level Ree (Chun et al. (2012), Miyagawa and Hisa (2013), O'Mahoney et al. (2012) and Dal Borgo, et al, (2013).

In May 2014, INTAN-Invest will release industry measures of intangible investment for EU15 member countries for the years 1995-2010, and estimates for the United States are expected by summer 2014.

[4] Data on intangible investment refer to 14 European countries (Austria, Belgium, Denmark, Germany, Finland, France, Greece, Ireland, Netherland, Italy, Portugal, Spain, Sweden and UK) and to the NACE sectors A through K (excluding real estate) plus sector O. Soon available on www.INTAN-Invest.net

and tangibles capital inputs at the industry level, with INTAN –Invest industry data on intangibles. We set out intangible investment data by industry for 14 EU countries 1995-2010 and industry growth accounting incorporating these data for 8 countries. Our major findings are as follows. First, intangible investment has grown in manufacturing and services, but most strongly in services. Second, the contribution of intangibles to labour productivity growth is similar in both manufacturing and services and in the high growth economies (Austria, Germany, Finland, France, Netherlands, UK) exceeds the contribution of labour quality. Third, the very large size of the service sector means that countries with good manfacturing but poor service productivity growth (Germany and France) have done relatively badly overall and those with good service sector growth (UK, Netherlands) have performed well. Finally, Spain and Itay have very low labour productivity growth due to very low TFP growth.

The paper is organized as follows. Section 2 illustrates the theoretical framework of our analysis and section 3 provides a description of the INTAN-Invest data and methodology to measure intangible investments by industry. Section 4 illustrates the dynamics of intangible investment across European country-industries and shows the industry growth accounting results. Section 5 concludes.

2 Theory

2.1 Output

Consider an industry j producing gross output $P_G G$, using intermediate, labour and tangible capital inputs of value $P_M M$, $P_L L$ and $P_K K$. Consider that part of the intermediate inputs are purchases of intangible services $P_N N^{PURCH}$ (e.g. expenditure on product design provide by a design firm) and that the industry also produces its own intangible goods (e.g R&D), with asset value $P_N N^{OA}$ and corresponding per annum rental value $P_R R^{OA}$. In conventional National Accounts spending on many intangible items, such as R&D and design, is treated as an intermediate good. This implies that purchases of intangible services are considered intermediate costs and subtracted from gross output to obtain value added. It also implies that own account production of intangible is not included in the value of gross output. Then value added of industry j, PvVj, is written as

$$P_v V_j' = P_G G_j - P_M M_j = P_G G_j - P_O O_j - P_N N_j^{PURCH} = P_L L_j + P_K K_j \qquad (1)$$

Where $P_O O_j$ is the value of intermediate inputs other than intangibles and, for notational convenience, it is assumed that K are tangible goods and that only tangible goods are

included in capital stock.

For the whole economy, we sum value added in all the sectors

$$P_v V' = \sum_j P_v V_j' = \sum_j (P_G G_j - P_M M_j) = \sum_j P_L L_j + \sum_j P_K K_j \quad (2)$$

Note that the purchased intangibles are the output of the intangible sector, from whom the individual industry are purchasing and thus in summing all sectors their output is added in, thus expanding aggregate gross output. However they are also inputs of the purchasing industries, expanding aggregate intermediate costs. Then in standard national account they do not contribute to aggregate value added.

Suppose now one decides to treat intangibles as capital. The purchases of services are no longer intermediates but capital expenditure, then they are not subtracted from gross output to obtain value added and they lead to the creation of new capital input. Moreover the own-account production leads to new output and newly owned capital with a (possibly implicit) rental payment. Thus the nominal value added has risen both because intermediate inputs are lower and because gross output is higher. The overall increase in nominal value added of industry j is equal to the additional nominal investment. Incomes generated by industry j has risen by the additional rental payment.

$$P_v V_j = P_G G_j + P_N N_j^{OA} - \left(P_M M_j - P_N N_j^{PURCH}\right) = P_L L_j + P_K K_j + P_R R_j^{OA} + P_R R_j^{PURCH} \quad (3)$$

For the whole economy, we sum value added in all the sectors. This then sums both all the own-account and all the purchased intangibles

$$P_v V = \sum_j P_v V_j = \sum_j (P_G G_j - P_M M_j) + \sum_j P_N N_j^{OA} + \sum_j P_N N_j^{PURCH} = \sum_j P_L L_j + \sum_j P_K K_j + \sum_j P_R R_j^{OA} + \sum_j P_R R_j^{PURCH} = \sum_j P_L L_j + \sum_j P_K K_j + \sum_j P_R R_j \quad (4)$$

2.2 Inputs: labour and capital services

Consider labour, tangible capital and intangible capital of types *l* and *k* and *r*. Following Jorgenson and Grilliches (1963) we may write down labour and capital services in industry *j* as rental share-weighted aggregates over asset or labour types, where the share are averages over adjacent years as follows:

$$\Delta \ln K_j = \sum_k \overline{w}_{k,j} \Delta \ln K_{k,j}, \quad \text{tangible capital type } k$$
$$\Delta \ln R_j = \sum_k \overline{w}_{r,j} \Delta \ln R_{r,j}, \quad \text{intangible capital type } r$$
$$\Delta \ln L_j = \sum_l \overline{w}_{l,j} \Delta \ln L_{l,j}, \quad \text{labour type } l \qquad (5)$$
$$\overline{w}_k = P_{K,k} K_k / \sum_k (P_{K,k} K_k), \; \overline{w}_r = P_{R,\mathrm{r}} R_r / \sum_r (P_{R,r} R_r), \quad \overline{w}_l = P_{L,l} L_l / \sum_l P_{L,l} L_l,$$
$$\overline{w} = \frac{(w_t + w_{t-1})}{2}$$

2.3 Inputs and outputs

Suppose now that industry value added output depends on primary inputs of labour and capital services

$$Q_j = f(K_j, R_j, L_j, A_j) \qquad (6)$$

Where A is an industry TFP index. As Jorgenson et al, (2003) and Stiroh (2003)) discuss, such a production function is a special case of a more general gross output production function. In our data however, we do not yet have consistent disaggregated gross output measures and so cannot work with gross output (see Dal Borgo, et al, 2013 for an implementation of this however on UK data). Thus for each industry, we have the following where $\Delta \ln TFP_j$ is defined residually

$$\Delta \ln Q_j = \overline{v}_{K,j} \Delta \ln K_j + \overline{v}_{R,j} \Delta \ln R_j + \overline{v}_{L,j} \Delta \ln L_j + \Delta \ln TFP_j \qquad (7)$$

The terms in "v" are shares of factor costs in industry nominal value-added, $P_Q Q_j$, averaged over two periods.

The results we present for each country are defined as above, although we work in per hour terms and on occasion break out K into ICT and non-ICT and R into non-R&D and R&D intangibles, so that for each industry we have

$$\Delta \ln Q_j = \overline{v}_{K\_ICT,j}\Delta \ln(K^{ICT}/H)_j + \overline{v}_{NonICT,j}\Delta \ln(K^{NonICT}/H)_j + \overline{v}_{R\_R\&D,j}\Delta \ln(R^{R\&D}/H)_j + \overline{v}_{R\_NonR\&D,j}\Delta \ln(R^{NonR\&D}/H)_j + \overline{v}_{L,j}\Delta \ln(L/H)_j + \Delta \ln TFP_j \quad (8)$$

In what follows we refer to a "contribution" as the terms on the right-hand side, that is, the share-weighted terms, which are of course made up of the share and the "deepening" ie. change in log quantity in per hour terms.[5]

3 Compilation methods

The purpose of this section is to illustrate the INTAN-Invest methodology to estimate intangible capital expenditure at the industry level for the EU member countries. We develop harmonized measures of intangible investment across countries and sectors taking into account the consistency with National Account principles and with the INTAN-Invest Business sector estimates of intangible capital (Corrado et al, 2012).

We produce harmonized industry measures of investment expenditure for the following intangible assets: Design, Advertising and Market research, Organizational capital and Training. R&D data are from Eurostat and software, mineral exploration and spending on the production of artistic originals are gathered from National Accounts. The estimates cover 14 European countries (Austria, Belgium, Germany, Denmark, Finland, France, Greece, Netherland, Italy, Ireland, Portugal, Spain, Sweden and UK) at the NACE sector level. Sectors A through N (excluding real estate) plus sectors R and S are included. Thus our industries are Agriculture, Mining, Manufacturing, Utilities, Construction, Trade, Financial Services and Other services.

The choice of the estimation method to measure intangible investment at the industry level strongly depends on data availability. In principle, there are two alternative approaches: a bottom-up approach (i.e. where available information is available to produce highly disaggregated industry estimates) and a top-down approach (i.e. few data are available so the industry distribution is obtained applying a distribution index to the aggregate estimate). Additionally, a comprehensive measure of intangible investment requires the estimate of two main components: own-account and purchased intangible investments.

[5] Aggregation to the market sector level presents a set of issues set out in Reinsdorf and Yuskavage (2009). For the moment, in our data, ΔlnV is aggregated via a Laspeypes index of real V, K and R are added over all sectors and ΔlnL as a share-weighted aggregate. We show the disaggregated contributions, but the aggregate terms do not quite add to the value added share weighted sum of the contributions due to the contributions being in logs and a labour reallocation term, see Stiroh (2001).

As for the details, we start with intangible assets already measured by National Accounts. Measures of Software, Mineral exploration and Entertainment, artistic and literary originals are gathered from National Accounts, while Research and Development expenditure is from Eurostat, (BERD).

Turning to those assets, not measured in National Accounts, a National Accounts consistent estimate of the own account component 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. A special survey for allows us to calculate Firm Specific Human Capital (Continuing Vocational Training Survey and Labour Cost Survey) as total training investment expenditure ((i.e. the sum of purchased and own account components) and so to adopt a bottom-up approach.

As for the remaining assets, at this stage, Eurostat available occupational data allow identifying only those occupations related with organizational capital. This is why, at this stage, we directly measure only the own account component of Organizational capital, while we make assumptions about the remaining assets, such as Advertising, Market Research and Design. In particular, we assume that the purchased and own-account components have the same industry distribution.

The estimates of Advertising and Market Research, Design and Organizational Capital, are based on expenditure data by industry gathered from the Use Tables, compiled according to the new classification system (NACE Rev2/CPA 2008), and available from 2008 onwards. The Use Tables provide the industry distribution of expenditure for: Advertising and Market Research, Design and Organizational Capital.

For these assets, thus we first produce a detailed benchmark estimate of intangible investment in 2008 and then we built time series for the period 1995 to 2010 applying the rate of change of value added (National Accounts) by industry to the level of the estimated intangible gross fixed capital formation in 2008.

Finally, since our benchmark is the INTAN-invest market sector estimate of intangibles, we rescale the estimated value for each industry, in each country, for every year, to the total provided by INTAN-invest.

Additional information about data sources and estimation methods can be found in the data appendix below.

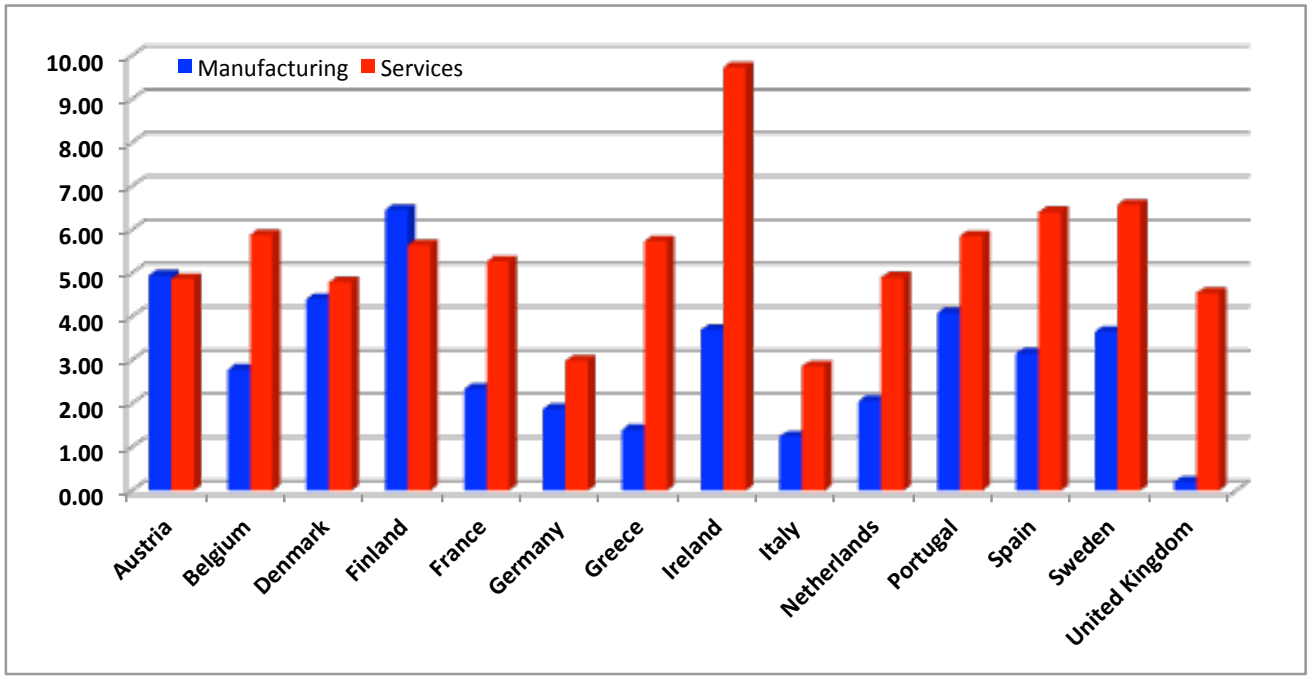
4 Intangible investment across European countries-industries:

4.1 Intangible investment by sector

In this section we look at the dynamics of intangible investment in Manufacturing and Services across 14 European economies and we investigate to what extent R&D, Non-R&D Intangible and ICT[6] capital contributed to productivity growth in eight (Austria, France, Finland, Germany, Italy, Netherlands, Spain and UK) out of the fourteen[7] European economies.

Figure 1 shows that the average annual rate of growth of intangible investment is relatively higher in the service sectors (5.4 percent) than in manufacturing (3.0 percent) in all sample countries. Finland is the sole country where intangible capital accumulation is more dynamic in manufacturing than services.

Figure 1: Real intangible investment growth (chain linked volumes, Compounded annual average rates of growth 1995-2010*)*



Source: INTAN-Invest

[6] Non-R&D intangible investments include: Design, Advertising and Market research, Organizational capital, Training and Artistic Originals.

[7] The country coverage is determined by the availability of industry-level data for ICT and Tangible capital stocks.

4.2 Growth accounting

4.2.1 Market sector

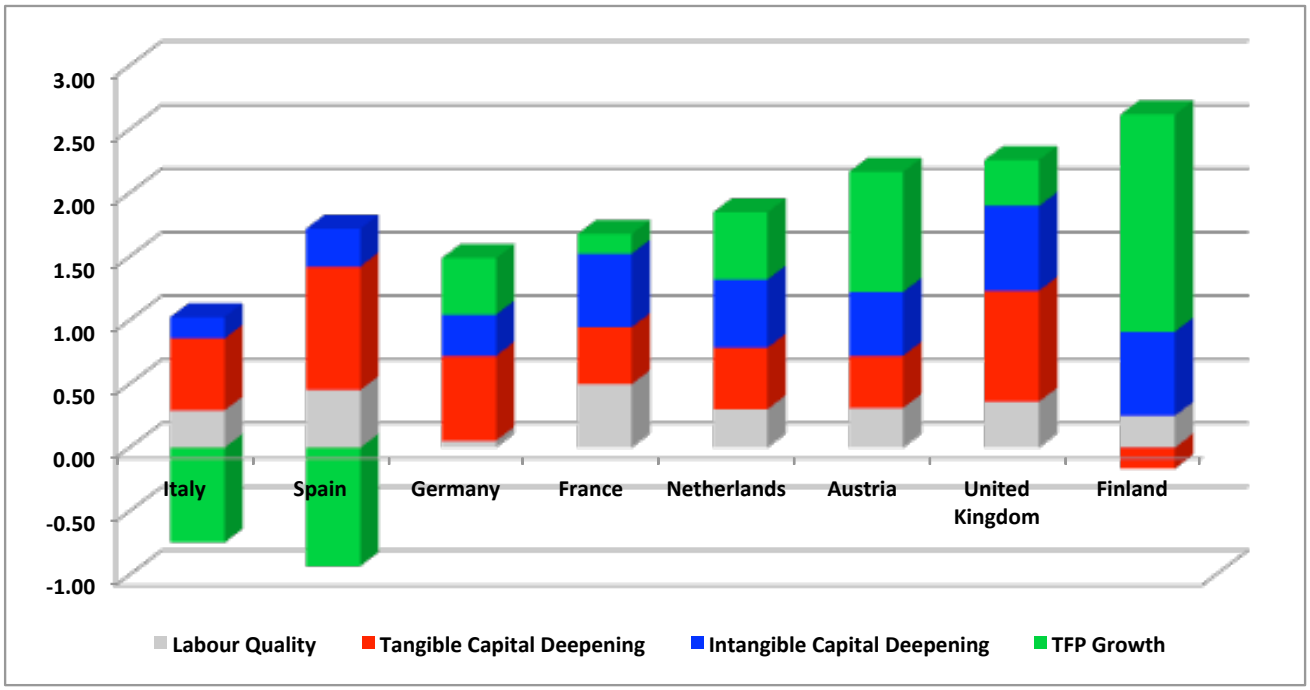
Because we have many countries and industries, it will be somewhat hard to digest the results. We start therefore with data for the whole market sector for each country. Figure 2 below, provides a picture of the main sources of country productivity growth in 1995-2009.

These sources-of-growth estimates reveal that the productivity performance of advanced economies differs widely across Europe. Labor productivity growth in Finland and UK averaged 2.5 percent per year,, in Austria 2 percent, in continental countries (Netherlands, France and Germany) 1.5 percent, while in Spain and Italy just 0.8 and 0.3 percent respectively.

Capital deepening is the major driver of growth in six of the eight economies but the nature of the accumulation, i.e., whether it reflects the contribution of tangible or intangible capital varies considerably across countries. Tangible capital deepening is the main source of growth in slow growing economies, Italy and Spain, and intangible capital provides a very small contribution. In Austria, France and the Netherlands intangible capital accounts for a slightly larger contribution than tangible capital. But in the faster growing economies, Finland and UK, intangible capital provides the largest contribution to productivity growth even if coupled with a different contribution from tangible capital: in the UK tangible capital deepening accounts for a higher contribution than intangible capital, while in Finland tangible capital provides a negative contribution to labor productivity growth.

Changes in labor composition (also called labor “quality”) are significant sources of growth in most countries, with France, Spain and UK showing the largest contributions.

Figure 2 – Contributions to labour productivity growth of growth in: labour quality, tangible and intangible capital and TFP (1995-2009)



Notes to table: Productivity is measured as growth in real value added per hour. Contributions are share-weighed growth rates per hour in named inputs. Data are for market sector. Labour quality is the contribution of compensation-weighted growth in person-hours per hour. Tangible capital deepening is the contribution of rental-price weighted growth in real capital stocks per hour of commercial buildings, vehicles, plant and computer hardware. Intangible capital deepening is the contribution of rental-price weighted growth in real capital stocks per hour of software, R&D, mineral exploration, artistic originals, design, new financial products, branding, training and organisational capital.

Source: authors calculations on INTAN –Invest and EUKLEMS data

The bottom line of figure 2 is that, in our sample, the more intangible-intensive economies are also the faster growth performers, while the more tangible-intensive countries are the slower growth performers. Thus it seems worthwhile to look more closely at the contributions of different tangible and intangible asset types to improve our understanding of the mechanics of productivity growth differentials across Europe.

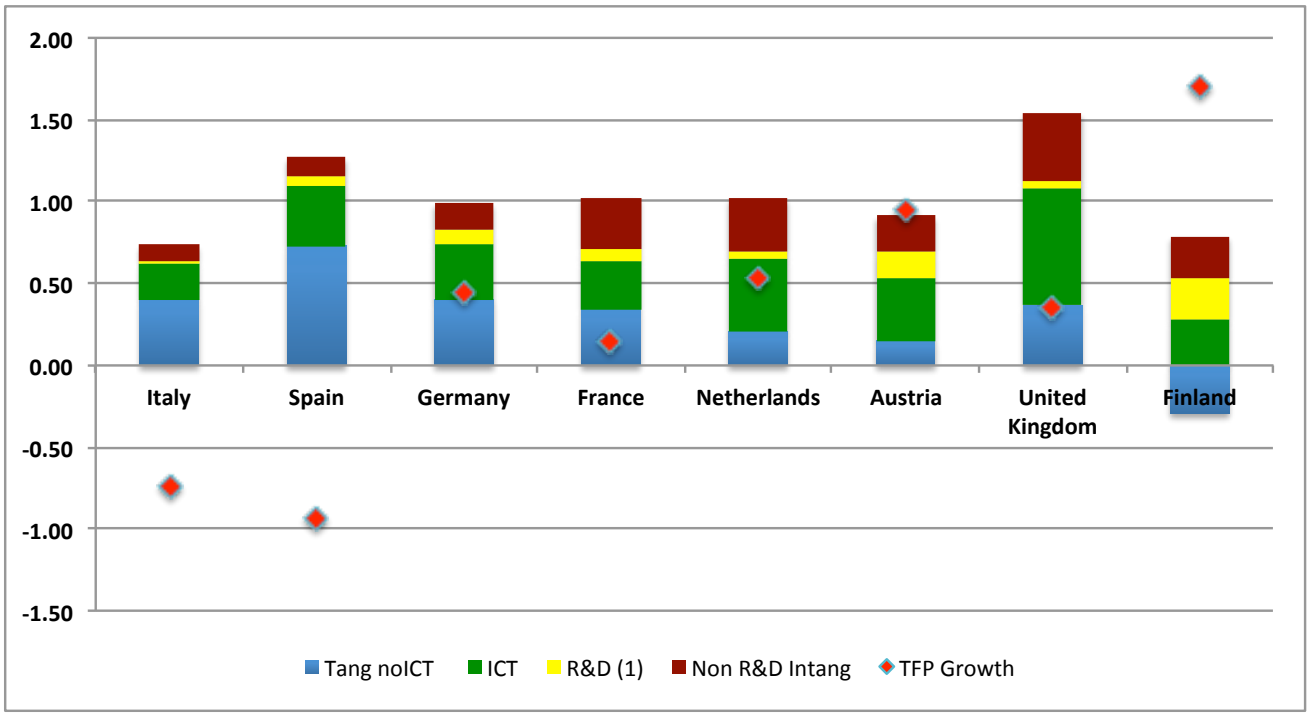
Figure 3 shows the contribution of TFP, Tangible-Non ICT, ICT, Non-R&D Intangible and R&D capital deepening[8]. ICT exceeds tangible non-ICT capital contribution in the best performers while the opposite holds in the slow growing economies where tangible capital accounts for a larger share.

R&D and Non-R&D intangibles are significant sources of growth in almost all sample countries and three main findings emerge: 1) the overall contribution of R&D and Non-R&D intangibles is relatively low (both in absolute value and as share of total capital

[8] See notes to figure 2. ICT refers to hardware, communications equipment and software. R&D is R&D and mineral spending. Non-R&D intangibles are artistic originals, design, new financial products, branding, training and organisational capital.

deepening) in the slow growing economies; 2) ICT, and the overall contribution of R&D and Non-R&D intangible capital is higher than tangible non-ICT capital contribution in fast growing economies; 3) the contribution of Non-R&D intangibles is higher than the contribution of R&D in all countries but Austria and Spain, where the two components provide a similar contribution to productivity growth.

Figure 3 –TFP, Tangible non-ICT, ICT, R&D and non-R&D Intangible Capital Deepening

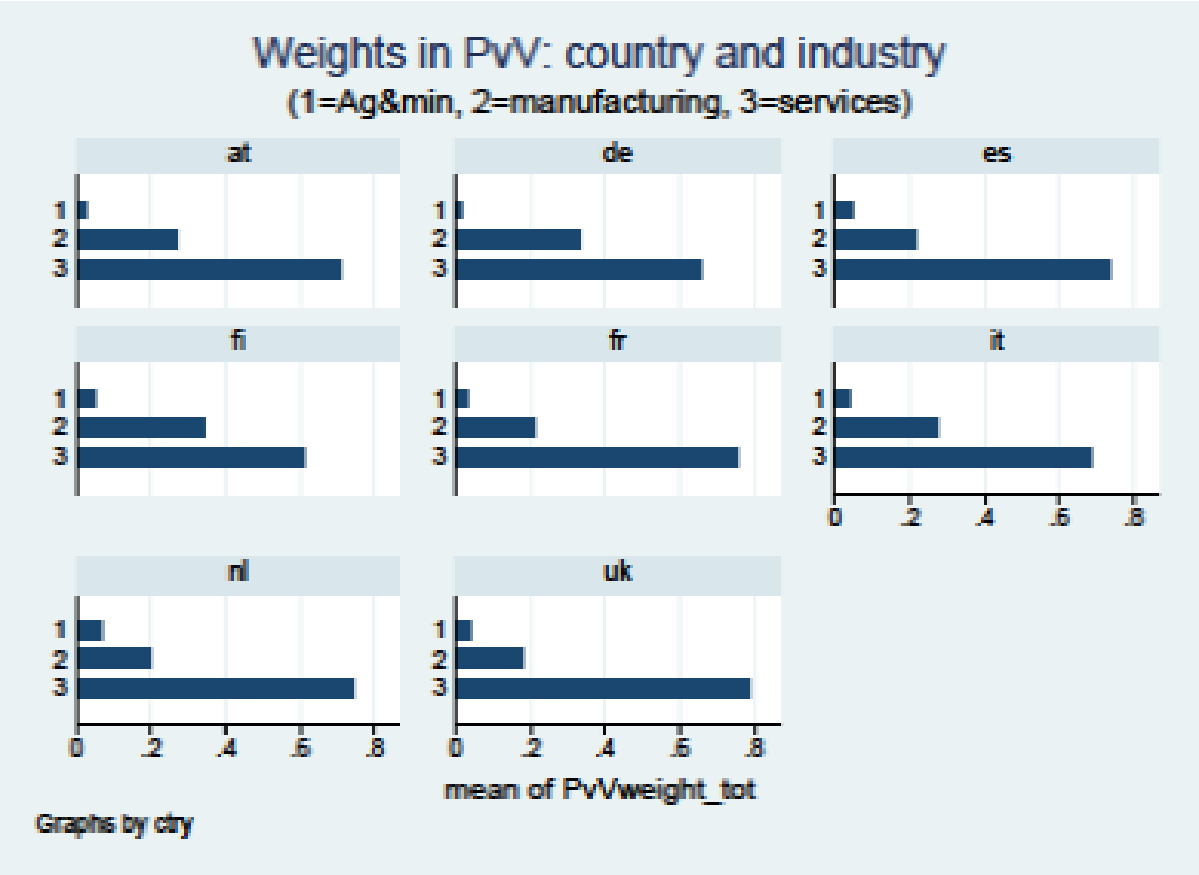


Source: Authors' calculations on INTAN-Invest and EUKLEMS data

Industry/Country data

The full results by industry are set out in the Appendix. Because there are many industries we proceed here by reducing the industries to three: Agriculture/Mining; Manufacturing; and Services (which cover construction, utilities, trade, financial services and other services). First, Figure 4 shows the nominal value added weights of each of these three sectors in the total. As the Figure shows, the services sector dominates in most of our countries, most notably in the UK. The AgMin sector is very small. Thus we shall, in the interests of readability, leave out the AgMin sector in what follows.

Figure 2: Industry share of total nominal value added for each country (average 1997-2009)



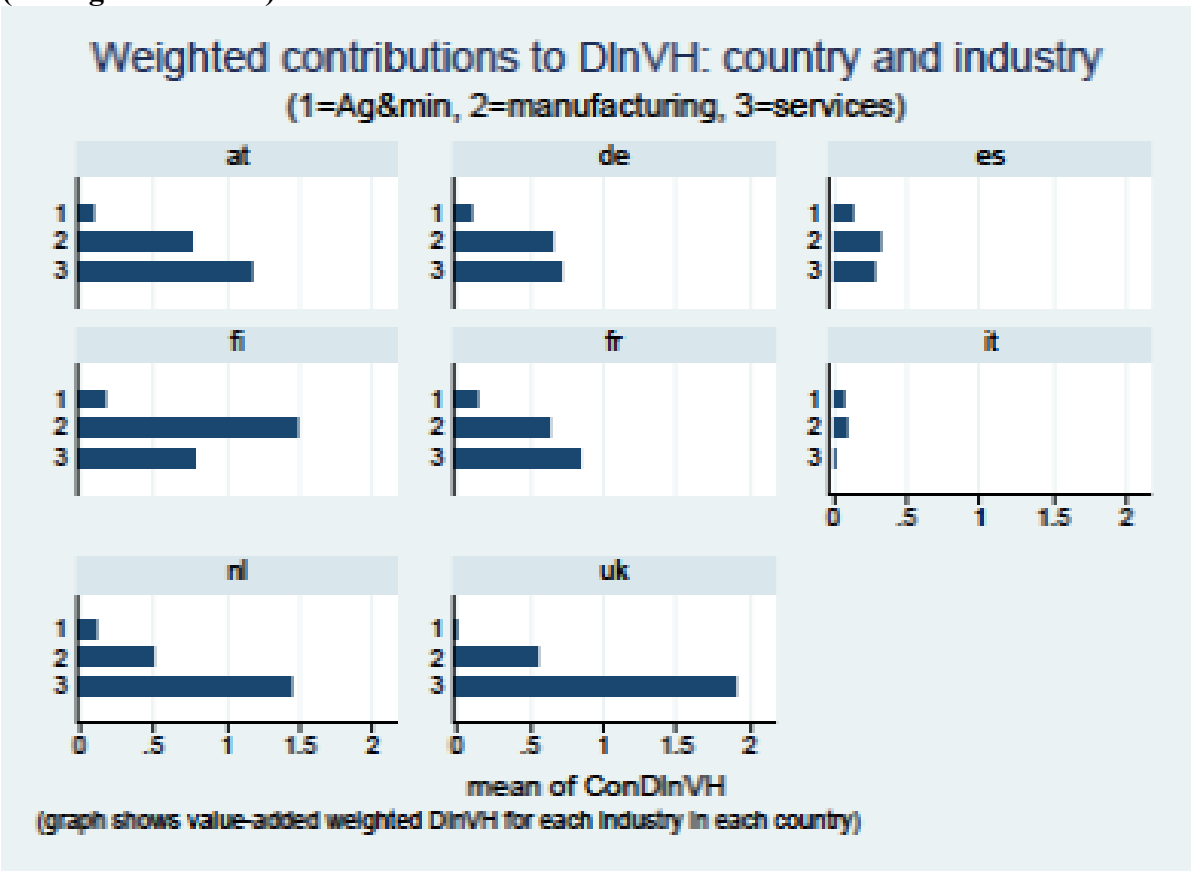
Notes to Figure:

1. Industries are Ag&Min = agriculture and mining, Manufacturing, Services= Utilities, Construction, Trade, Financial Services and Other services, (excluding real estate services)
2. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

Figure 5 shows the contributions to DlnVH of industry DlnVH in each country (i.e. the graph shows v_jDlnV/H the value-added share weighted DlnVH for each industry in each country).[9]

[9] Note that the sum of share-weighted industry labor productivity growth does not necessarily equal labor productivity growth calculated using the corresponding V and H aggregates because of changes in the industry allocation of labor; see Stiroh (2002).

Figure 3: Contributions of each industry labour productivty growth to the country total (average 1997-2009)



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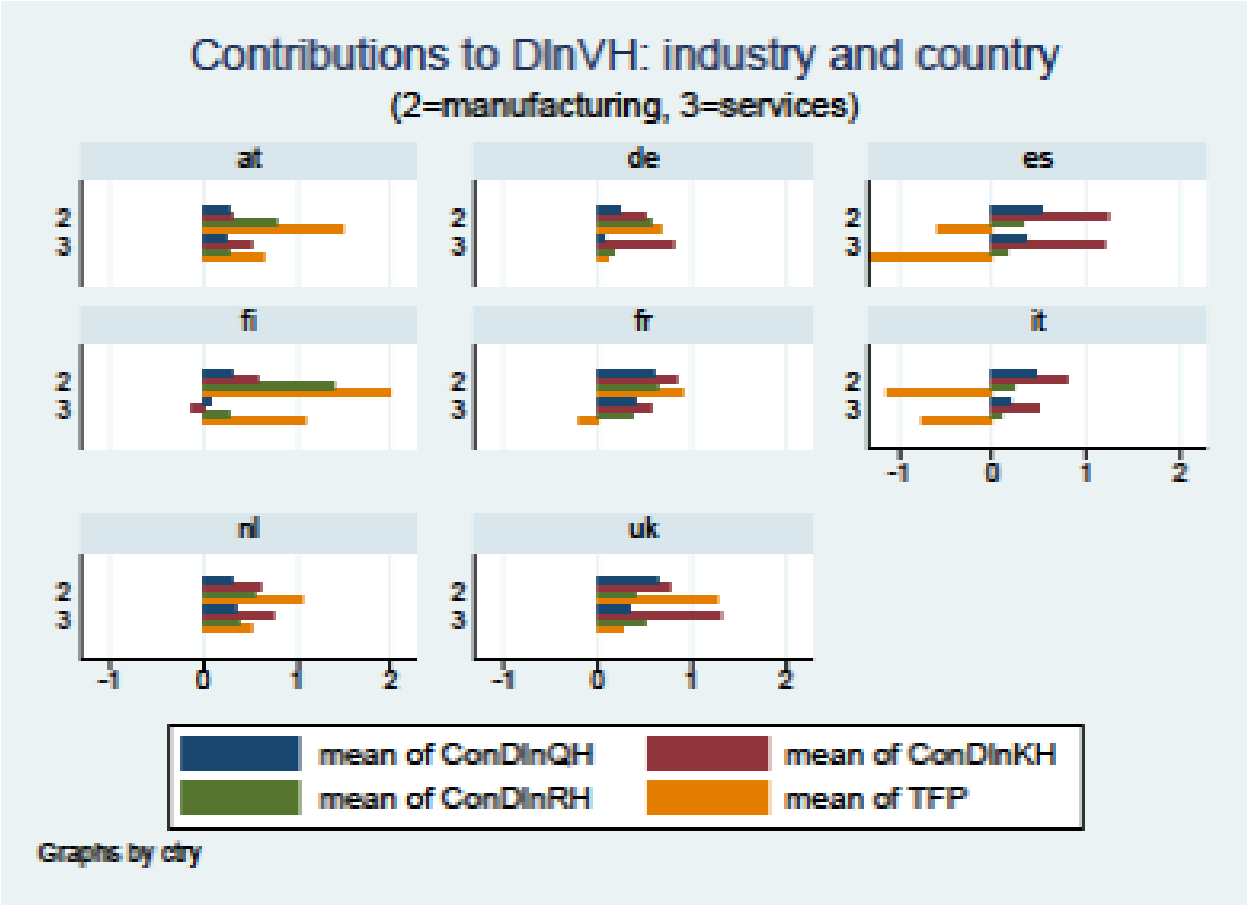
2. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

The horizontal distance in each graph differs since each country has a different DlnV/H: compare the UK and Finland with Spain and Italy. That said, the graph shows once again the importance of the service sector in accounting for aggregate DlnVH in almost all countries. The exception in the high-growth countries is Finland, where manufacturing is dominant. The exception in the low-growth countries of Spain and Italy is that manufacturing is dominant too and in Italy, the service sector contributes even less than Agriculture/Minerals.

Having established the general importance of manufacturing and services, Figure 6, shows the input contributions to industry DlnVH, by country and industry. With the many panels, this is somewhat hard to read and we shall display the graph in a different way below, but shows some variables of interest as follows.

Figure 4: Contributions to industry labour productivity growth of inputs, by country and industry (average 1997-2009



Notes to Figure:

1. Contributions are share-weighed growth rates per hour in named inputs for each industry in each country: sum of contributions is industry DlnVH. Data are for. Manufacturing and services.
2. ConDlnQH=Labour quality contribution: compensation-weighted growth in person-hours per hour. ConDlnKH=Tangible capital deepening contribution: rental-price weighted growth in real capital stocks per hour of commercial buildings, vehicles, plant and computer hardware. ConDlnRH=Intangible capital deepening contribution: rental-price weighted growth in real capital stocks per hour of software, R&D, mineral exploration, artistic originals, design, new financial products, branding, training and organisational capital.
3. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

To read the graph, consider the top left panel. This shows, for Austria, the contributions of the inputs in each industry (note that this is *not* telling us the contributions in addition to total, for we should have to weight these numbers by value added shares, we do this below). Thus we see that the largest contribution was DlnTFP in manufacturing, followed by DlnR/H in manufacturing. With this in mind, what do we learn from this graph?

First, the low growth economies of Spain and Italy are dominated by low TFP in both sectors.

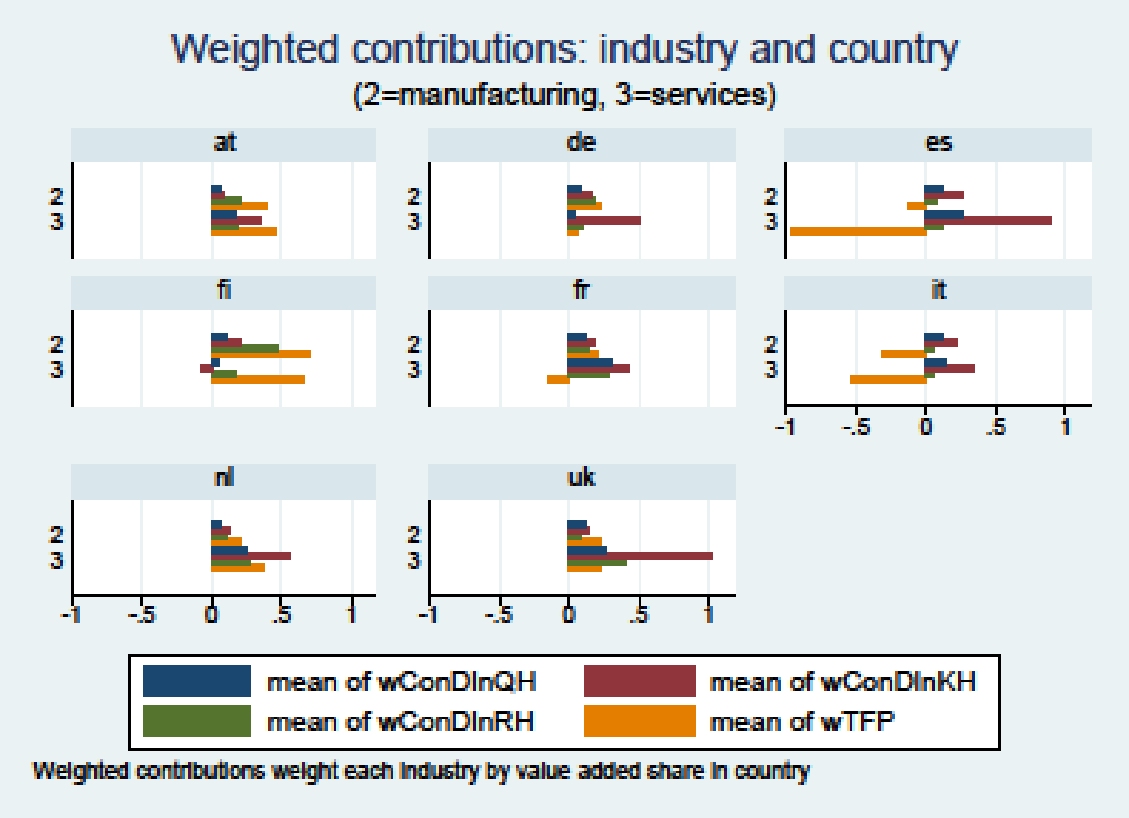
DlnKH is positive and relatively large in international terms, especially in Spain. DlnRH is relatively slow. So in these economies, 1995-2009 saw high tangible contributions, low intangible contributions and strongly negative DlnTFP.

Second, turning to the high growth economies, high DlnTFP has dominated manufacturing, particularly in Finland, but has been relatively disappointing in France and Germany. The services picture is more mixed: high ConDlnKH almost everywhere, except Finland, high DlnTFP except in Germany and France and high DlnR/H everywhere except Germany.

To summarise by country we have three sets of countries. First, Spain and Italy show high ConDlnKH, little ConDlnRH and very poor DlnTFP. Second, Germany and France show relatively high ConDlnKH, modest DlnRH and low DlnTFP. Third, Austria, Finland, Netherlands and the UK show high ConDlnKH, high ConDlnRH and high DlnTFP.

To further understand the data, we now look at weighted contributions, $v_j s_j DlnX_j$. The distance of each line then tells us the contribution to overall market sector DlnVH by taking into account both the industry contribution and that industry's weight in total value added. In comparison with the contributions graph before, what does the graph tell us?

Figure 5: Weighted contributions to industry labour productivity growth of inputs, by country and industry (average 1997-2009)



Notes to Figure:

1. Weighted contributions are value added share times input share-weighed growth rates per hour in named inputs for each industry in each country: sum all of contributions in each country is total contribution of each factor in those two industries. Data are for manufacturing and services.
2. wConDlnQH=weighted labour quality contribution: value added share times compensation-weighted growth in person-hours per hour. wConDlnKH=weighted tangible capital deepening contribution: value added share times rental-price weighted growth in real capital stocks per hour of commercial buildings, vehicles, plant and computer hardware. wConDlnRH=weighted intangible capital deepening contribution: value added share times rental-price weighted growth in real capital stocks per hour of software, R&D, mineral exploration, artistic originals, design, new financial products, branding, training and organisational capital.
3. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

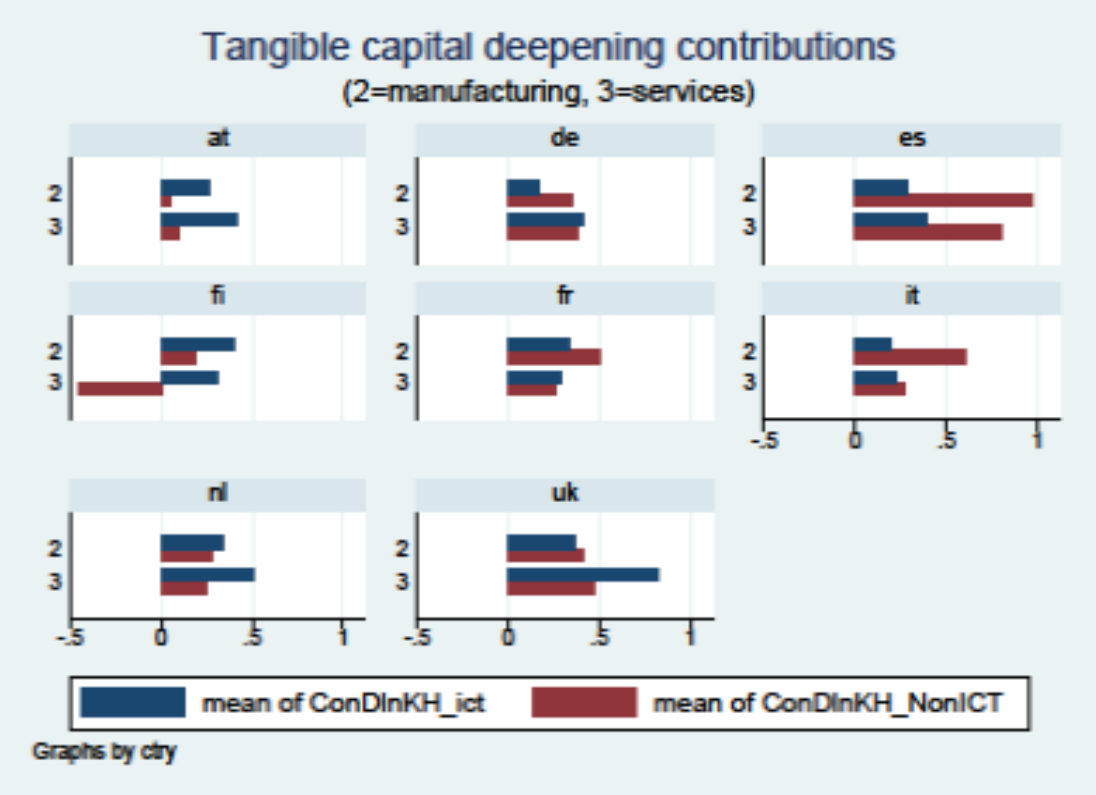
First, looking again at Spain and Italy, we confirm the important role of negative TFP growth. In Spain the large service sector gives a large positive role for tangible capital deepening and similarly in Italy although to a lesser extent, but performance in both countries is dominated by poor TFP growth.

Second, turning to the high growth countries, we see the importance of the service sector. In figure 7 almost all countries, notably Germany, France, Finland and the Netherlands had a very high performing manufacturing sector. But this graph shows these sectors make a small weighted contribution since manufacturing is now small. With the strongly performing service sector, figure 7, the UK and Netherlands show a particular large weighted contribution from services.

4.2.2 Decomposing the tangibles and intangibles

Figure 8 breaks out tangible capital into the contributions of ICT and non-ICT. All countries have positive DlnKH_ICT, but as the figure shows, Spain and Italy have relatively very high Non-ICT contributions. In the high-growth economies, the ICT contributions in services are particularly notable: exceeding that of non-ICT capital in all cases, especially in the UK.

Figure 6: Contributions to industry labour productivity growth of tangible capital inputs, by country and industry (average 1997-2009)

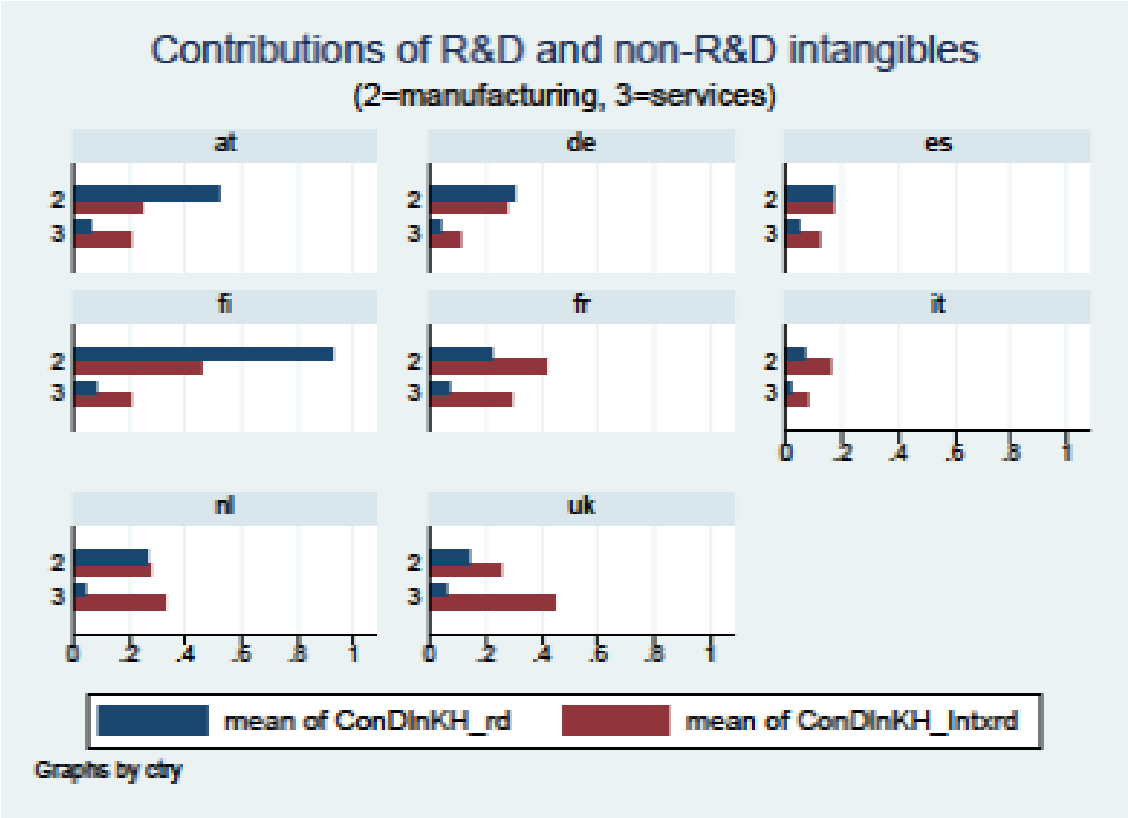


Notes to Figure:

1. ConDlnKH_ICT= rental-price weighted growth in real capital stocks per hour of computer hardware. ConDlnKH_NonICT= rental-price weighted growth in real capital stocks per hour of commercial buildings, vehicles, and plant.
2. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

Finally, figure 9 shows the contributions in manufacturing and services of R&D and non-R&D intangibles.

Figure 7: Contributions to industry labour productivity growth of intangible capital inputs, by country and industry (average 1997-2009)



Notes to Figure:

1. ConDlnKH_rd= rental-price weighted growth in real capital stocks per hour of R&D. ConDlnRH= rental-price weighted growth in real capital stocks per hour of software, , mineral exploration, artistic originals, design, new financial products, branding, training and organisational capital.
2. Countries are Austria (at), France (fr), Finland (fi), Germany(de), Italy (it), Netherlands (nl), Spain (es) and UK (uk).

As the figure shows, R&D is important in manufacturing Finland, Germany, Austria and Spain. Non-R&D intangible are more important in the other countries and everywhere in services.

Finally, to relate the tangible and intangibles contributions if we regress the contributions of intangible capital deepening on the contribution of ICT capital deepening (controlling for country and industry) we obtain a positive relation between the two, suggesting that ICT and intangible capital deepening contributions are positively related.

4 - Concluding remarks

This paper provides an overview of the INTAN Invest harmonized country-industry estimates of intangible investment and our estimation method. Our data cover the EU14 member countries in 1995-2010, and the NACE sectors A through N (excluding real estate) plus sectors R and S. Data for the United States will be included in the database later this year.

The sources-of-growth analysis suggests splitting the sample into slow growing (Italy, Span) and fast growing (UK, France, Germany, Holland, Austria, Netherland, Finland). First, the slow-growth economies of Spain and Italy, have relatively high non-ICT capital growth, but have very poor overall productivity growth due to their very slow TFP. They have had some contribution to growth from intangible capital, but their intangible capital growth is relatively low. In addition, these economies have a growing service sector, so that poor intangible growth and poor TFP growth in services greatly outweighs a reasonable performance in manufacturing.

Second, the fast growing economies all have good manufacturing performance, but the UK and Netherlands also show particularly good service performance while in Germany and France service performance is poor. The large size of the service sector in the UK and Netherlands delivers good productivity growth overall in these countries. Germany's high-performing manufacturing sector is shrinking and is contributing less to the overall performance. Both Germany and France have service sectors with low TFP growth and relatively high non-ICT tangible investment.

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Table 2 – Growth accounting Results - France

fr	**France**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	4.2	0.6	1.2	*1.05*	*0.02*	*0.01*	*0.07*	2.5
Mining	-1.1	0.1	2.7	*1.83*	*0.43*	*0.02*	*0.47*	-4.0
Manufacturing	3.0	0.6	1.5	*0.51*	*0.33*	*0.22*	*0.42*	0.9
Utilities	0.9	0.0	-0.3	*-0.50*	*0.08*	*-0.01*	*0.16*	1.1
Contruction	-0.5	0.2	0.6	*0.21*	*0.09*	*-0.01*	*0.33*	-1.3
Trade	1.1	0.4	0.7	*0.17*	*0.20*	*0.09*	*0.24*	0.0
Financial Services	2.6	0.3	1.9	*0.60*	*0.74*	*0.20*	*0.33*	0.4
Other Services	1.2	0.5	1.0	*0.33*	*0.33*	*0.06*	*0.31*	-0.3
Business Sector	**1.7**	**0.5**	**1.0**	***0.34***	***0.30***	***0.07***	***0.31***	**0.2**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data.

Table 3 - Industry Growth Accounting Results - UK

uk	**United Kingdom**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	2.3	0.5	1.0	*0.95*	*0.04*	*-0.01*	*0.04*	0.8
Mining	-1.8	0.0	1.0	*0.64*	*0.02*	*0.00*	*0.34*	-2.7
Manufacturing	3.1	0.6	1.2	*0.41*	*0.37*	*0.14*	*0.26*	1.3
Utilities	1.9	0.1	3.7	*2.05*	*0.74*	*0.77*	*0.14*	-1.9
Contruction	0.5	0.3	0.8	*0.36*	*0.13*	*0.01*	*0.35*	-0.6
Trade	2.0	0.2	1.8	*0.67*	*0.65*	*0.00*	*0.47*	0.0
Financial Services	4.5	0.5	2.7	*0.16*	*1.28*	*0.21*	*1.01*	1.3
Other Services	2.5	0.4	1.6	*0.38*	*0.92*	*0.00*	*0.35*	0.5
Business Sector	**2.3**	**0.4**	**1.5**	***0.37***	***0.71***	***0.05***	***0.41***	**0.4**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 4 - Industry Growth Accounting Results - Germany

de	Germany							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	7.3	0.1	1.0	*0.85*	*0.08*	*0.02*	*0.04*	6.3
Mining	0.5	0.0	1.3	*0.90*	*0.24*	*-0.12*	*0.25*	-0.8
Manufacturing	2.0	0.2	1.1	*0.34*	*0.17*	*0.31*	*0.27*	0.7
Utilities	3.0	0.1	2.0	*1.34*	*0.26*	*0.00*	*0.35*	1.0
Contruction	-0.3	0.2	0.1	*0.02*	*0.07*	*0.00*	*0.01*	-0.6
Trade	2.7	-0.1	0.6	*0.24*	*0.33*	*0.01*	*0.04*	2.1
Financial Services	0.7	0.3	1.0	*0.15*	*0.44*	*0.07*	*0.37*	-0.7
Other Services	0.5	0.0	1.1	*0.42*	*0.52*	*0.05*	*0.08*	-0.6
Business Sector	**1.5**	**0.1**	**1.0**	***0.40***	***0.34***	***0.09***	***0.16***	**0.4**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 5 - Industry Growth Accounting Results – Italy

it	**Italy**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	2.3	0.4	0.9	*0.86*	*0.02*	*0.00*	*0.01*	1.1
Mining	0.2	0.0	3.2	*3.02*	*0.08*	*0.18*	*-0.12*	-3.0
Manufacturing	0.3	0.5	1.0	*0.60*	*0.19*	*0.07*	*0.16*	-1.1
Utilities	0.2	0.2	0.1	*0.25*	*0.21*	*-0.33*	*0.01*	-0.2
Contruction	-1.0	0.1	0.6	*0.53*	*0.09*	*0.00*	*0.02*	-1.8
Trade	-0.1	0.3	1.0	*0.69*	*0.20*	*0.01*	*0.13*	-1.5
Financial Services	2.6	0.2	0.5	*-0.17*	*0.54*	*0.07*	*0.09*	1.8
Other Services	-0.2	0.2	0.4	*0.11*	*0.21*	*0.03*	*0.06*	-0.8
Business Sector	**0.3**	**0.3**	**0.7**	***0.40***	***0.22***	***0.02***	***0.09***	**-0.7**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 6 - Industry Growth Accounting Results – Spain

es	**Spain**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	3.1	0.4	1.7	*1.66*	*0.01*	*0.04*	*0.01*	1.0
Mining	0.5	0.2	1.0	*0.60*	*0.19*	*0.07*	*0.12*	-0.6
Manufacturing	1.5	0.5	1.6	*0.96*	*0.28*	*0.16*	*0.17*	-0.6
Utilities	1.3	0.2	0.8	*0.63*	*0.13*	*-0.06*	*0.08*	0.3
Contruction	0.5	0.4	1.8	*1.38*	*0.12*	*0.04*	*0.25*	-1.7
Trade	1.7	0.6	1.1	*0.67*	*0.29*	*0.02*	*0.14*	0.0
Financial Services	4.4	0.2	1.8	*0.21*	*1.22*	*0.18*	*0.19*	2.4
Other Services	-1.1	0.3	1.2	*0.74*	*0.42*	*0.05*	*0.04*	-2.7
Business Sector	**0.8**	**0.5**	**1.3**	***0.73***	***0.37***	***0.05***	***0.12***	**-0.9**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 7 - Industry Growth Accounting Results – Austria

at	Austria							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	2.7	0.3	0.6	*0.51*	*0.07*	*-0.01*	*0.02*	1.8
Mining	5.9	0.2	1.6	*0.91*	*0.21*	*-0.10*	*0.55*	4.1
Manufacturing	2.8	0.3	1.1	*0.06*	*0.26*	*0.52*	*0.24*	1.5
Utilities	2.6	0.0	0.9	*0.60*	*0.16*	*0.01*	*0.15*	1.7
Contruction	0.3	0.2	0.2	*-0.09*	*0.07*	*0.01*	*0.19*	-0.1
Trade	1.6	0.2	0.4	*-0.24*	*0.40*	*0.06*	*0.17*	1.0
Financial Services	5.6	0.4	0.9	*0.12*	*0.49*	*0.09*	*0.22*	4.4
Other Services	1.1	0.3	1.1	*0.25*	*0.53*	*0.10*	*0.22*	-0.3
Business Sector	**2.2**	**0.3**	**0.9**	***0.15***	***0.38***	***0.16***	***0.22***	**0.9**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 8 - Industry Growth Accounting Results – Netherlands

nl	**Netherlands**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT Capital Deepening*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	1.9	0.4	0.6	*0.39*	*0.11*	*0.02*	*0.08*	0.9
Mining	1.2	0.1	2.9	*1.97*	*0.28*	*0.00*	*0.67*	-1.9
Manufacturing	2.5	0.3	1.2	*0.28*	*0.34*	*0.26*	*0.28*	1.0
Utilities	2.5	0.5	1.0	*0.26*	*0.24*	*0.02*	*0.51*	1.0
Contruction	0.0	0.3	0.7	*0.27*	*0.16*	*-0.03*	*0.28*	-1.0
Trade	3.2	0.2	1.0	*0.22*	*0.37*	*0.02*	*0.40*	2.0
Financial Services	3.1	0.4	2.0	*0.29*	*1.24*	*0.18*	*0.27*	0.7
Other Services	1.4	0.4	1.0	*0.24*	*0.48*	*0.03*	*0.30*	0.0
Business Sector	**1.8**	**0.3**	**1.0**	***0.20***	***0.44***	***0.05***	***0.32***	**0.5**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Table 9 - Industry Growth Accounting Results – Finland

fi	**Finland**							
	Extended Asset Boundary							
	Contributions to Labour Productivity Growth							
	1995-2009							
	Labor Productivity Growth	Labour Quality	Capital deepening	*Tang noICT*	*ICT*	*R&D (1)*	*Non R&D Intang*	TFP Growth
Agr	4.0	0.3	0.8	*0.69*	*0.09*	*-0.01*	*0.02*	2.8
Mining	1.8	0.2	2.0	*0.96*	*0.22*	*0.02*	*0.84*	-0.5
Manufacturing	4.3	0.3	2.0	*0.19*	*0.40*	*0.93*	*0.46*	2.0
Utilities	1.2	0.0	0.2	*-0.08*	*0.28*	*-0.02*	*0.06*	1.0
Contruction	-0.2	0.0	0.6	*0.29*	*0.06*	*0.02*	*0.22*	-0.8
Trade	2.7	0.0	0.4	*-0.27*	*0.29*	*0.05*	*0.34*	2.3
Financial Services	2.2	0.1	0.6	*-1.24*	*1.30*	*0.30*	*0.23*	1.4
Other Services	1.0	0.1	-0.2	*-0.67*	*0.25*	*0.10*	*0.15*	1.0
Business Sector	**2.5**	**0.2**	**0.5**	***-0.29***	***0.28***	***0.25***	***0.26***	**1.7**
(1) Including New financial products								

Source: authors calculations on INTAN –Invest and EUKLEMS data

Appendix

Sources and estimation method: benchmark year 2008

The Use tables compiled according to the NACE Rev.2/CPA 2008 (available from Eurostat database from the year 2008 onwards[10]) 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).

In current national accounts, business expenditure for the above products is classified as intermediate cost. For our purposes instead, we assume that a share of this expenditure is intermediate cost and the rest by gross fixed capital formation. Thus, given that the USE tables provide the industry distribution of "total expenditure" for each of the above products (both intermediate costs and purchased GFCF), we have to make some assumptions about the industry distribution of intangible investments and intermediate costs.

Assumption 1: for each of the above products, we assume that the industry distribution of investment expenditure and intermediate costs is the same as the distribution of total expenditure available from the USE tables.

Assumption 2: the share of consulting services in total expenditure for CPA M69 and M70 is the same across all industry (in each country).

Under the above assumptions, the industry distribution provided by the USE tables can be used to allocate the share of purchased intangible GFCF in Advertising and Market Research, Design and Organizational Capital across sectors.

The only exception is for subcontracting. Since it is likely that a share of Advertising and Market Research Services bought by the Advertising and Market Research industry, a share of Design services bought by the Architectural and engineering industry and a portion of Legal, accounting and consulting services bought by the Legal, accounting and consulting industry are subcontracting, we make the following additional assumptions:

1. The share of intermediate input in total expenditure for CPA M73 is 50 percent higher in the Advertising and Market Research industry than in any other industry;
2. The share of intermediate input in total expenditure for CPA M71 is 50 percent higher in the Architectural and engineering industry;
3. The share of intermediate input in total expenditure for CPA M69 and M70 is 50 percent higher in the Legal, accounting and consulting industry.

[10] At the time the calculations described in this note were made, only table for the year 2008 were available.

Time series estimates

As mentioned above, the Use tables compiled according to NACE Rev 2 are available only for year 2008. Thus the estimates for the previous years require the adoption of different data sources. We produced intangible investment time series using the rate of change of gross output by industry (National accounts) as an indicator to retropolate the level of the estimated intangible gross fixed capital formation in 2008. Then each country industry level estimates has been rescaled to the corresponding GFCF estimate from INTAN-Invest.

Alternative: use total intermediate costs as indicator instead than gross output. The two indicators provide different results only to the extent that, in each country, the ratio intermediate cost/gross output shows different dynamic across industries.