



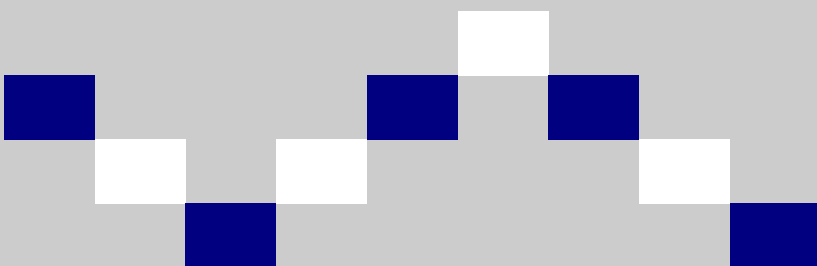
Intangible capital and Productivity Growth in European Countries

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and Stefano Manzocchi

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Introduction

The changing nature of the global economy has placed a novel attention on intangible capital as a new source of growth. The structural and technological changes associated with the rapid progress in Information and Communication Technologies (ICT), the rising role of the service sector and the emergence of new business models made intangible investment a key element of global competition. The seminal paper by Corrado Hulten and Sichel (2005) is the first of a number of country studies¹ showing that intangible capital is an essential ingredient for economic growth. CHS extended the standard growth accounting model to identify the contribution of intangible capital to economic growth. They estimated that investment in intangibles averaged US\$1.1 trillion between 1998 and 2000 (1.2 times tangible capital investment) or 12 per cent of GDP, and they showed that an important part of the US productivity acceleration since the mid-1990s can be attributed to growth in intangible assets. The nature of the impact of the inclusion of intangible capital in the growth accounting model is similar across the countries for which the estimates are available. It determines an increase in labour productivity growth and in the contribution of capital deepening and a decrease in TFP growth. But intangible expenditure is currently treated as current expense in the national accounts rather than as an investment. This determines an understatement of investment in the economy and an incomplete picture of the main sources of growth.

The aim of this paper is to provide a contribution in this respect analyzing the diffusion of intangible investment across the EU27 member countries and to investigate the role of intangible capital as a source of growth in a set of European countries to improve our understanding of the international differences in the mix of drivers of productivity growth in the EU member economies.

In this paper we use the estimates of intangible capital for the European countries produced by the INNODRIVE² project for the period 1995-2005.

The paper is structured into seven sections. The next section briefly summarizes some of the literature background on intangibles and productivity growth, with particular reference to the related measurement issues. Section 3 introduces the data, whilst Section 4 provides a descriptive analysis of the diffusion of intangible spending and of its composition in the business sector in the EU27 area as a whole as well as in its member states. Section 5 describes the extended growth accounting model applied to explore the impact of intangible capital on productivity growth and section 6 illustrates our empirical results. Section 7 concludes indicating the main policy implications and the next steps in our research.

¹ See Barnes and McClure, 2009, for a comprehensive review of the empirical literature.

² INNODRIVE “Intangible Capital and Innovations: Drivers of Growth and Location in the EU”, is a project financed by the European Commission – FP7 Work Programme. The aim of this research project is to provide new data on intangibles and new estimates of the capacity of intangible capital to generate growth both at firm-level and at national level.

2. Background literature

There is an extensive literature on intangible investment but most of it focuses only on some assets (R&D capital, for example) leaving outside other elements such as organizational capital or brand equity. Some of the most recent and general approaches to measuring intangibles in the economic literature can be identified following Sichel (2008) as — financial market valuation, other performance measures, and direct expenditure data.

The financial market valuation approach assume that the value of intangible capital corresponds to the difference between the market value of firms and the value of tangible assets.

Brynjolfsson, Hitt and Yang followed this approach in some papers to analyze the relationship between intangible investments and investment in computers in the United States (Brynjolfsson and Yang 1999, Brynjolfsson, Hitt and Yang 2000 and 2002). They used firm-level data and their main finding was that each dollar of installed computer capital in a firm was coupled with between five and ten dollars of market value. According to them this difference indicates the existence of a large stock of intangible assets that are complementary with computer investment.

Webster (2000) adopted a comparable approach to analyze Australian data. He assumed that any residual market value of the firm (stock market value plus liabilities) not explained by the balance sheet value of tangible assets must be due to intangible assets. He found that the ratio of intangible to all enterprise capital rose by 1.25 per cent a year over the 50 years to 1998.

On the same line is the work done by the World Bank (2006) to measure intangible capital at the country level. The value of intangible capital was obtained as the residual once natural capital and produced capital have been subtracted from total wealth (measured as the net present value of future sustainable consumption).

Another widely used method to estimate the value of intangible capital is the —other performance|| based approach, focusing mostly on measures such as productivity or earnings. Cummins (2005), for example, using US firm-level panel data, estimated intangible capital in terms of adjustment costs by means of econometric techniques. His idea was to create a proxy for the intrinsic value of the firm from discounted value of expected profits based on analysts' forecasts (which he suggested reflect the analysts' valuation of intangibles) and to estimate the return on each type of capital (tangible and intangible). He found no significant intangibles related with R&D and advertising but sizable intangibles (organizational capital) generated by IT. McGrattan and Prescott (2005) inferred the value of intangible capital from corporate profits, the returns to tangible assets, and the assumption of equal after-tax returns to tangible and intangible assets. They calculated a range for the value of intangible capital from 31 to 76 per cent of US GDP.

From a similar perspective, Lev and Radhakrishnan (2005) provided a firm-specific measure of organizational capital, modeling the effect on sales of organizational capital. They found that the marginal productivity of organizational capital ranged between 0.4 and 0.6, and the mean organizational capital was 4 per cent of average sales of their sample of US firms.

The direct expenditure-based approach was adopted the first time by Nakamura (1999, 2001) who measured gross investment in intangible assets by means of a series of measures including R&D expenditure, software, advertising and marketing expenditure, and wages and salaries of managers and creative professionals. He found that in 2000 US investment in intangibles was US\$1 trillion (approximately equal to that in nonresidential tangible assets), with an intangible capital stock of at least US\$5 trillion.

Starting from Nakamura's work, Corrado, Hulten and Sichel (CHS) (2005) developed expenditure-based measures of a larger range of intangibles for the United States. They calculated that previously unmeasured intangible capital contributed 0.24 of a percentage point (18 per cent) to conventionally-measured MFP growth in the United States between the mid-1990s and early 2000s. The CHS methodology has been applied in a number of other country studies — with estimates of the contribution of previously unmeasured intangible capital to MFP growth of 14 per cent (United Kingdom in Marrano, Haskel and Wallis 2007), 3 per cent (Finland in Jalava, Aulin-Ahmavaara and Alanen 2007) and 0 per cent (the Netherlands in van Rooijen-Horsten et al. 2008), over a similar period. Other country studies estimated only the contribution of all intangibles to MFP growth — -19 per cent in Japan (Fukao et al. 2008), 19 per cent in France, 18 per cent in Germany, 9 per cent in Spain and 0 per cent in Italy (Hao, Manole and van Ark 2008).

3. Data description

Our estimates of intangible investment include the three main categories of assets identified by CHS (2005): economic competencies, innovative property and computerised information. Economic competencies include spending on strategic planning, worker training, redesigning or reconfiguring existing products in existing markets, investment to retain or gain market share and investment in brand names. Innovative property refers to the innovative activity built on a scientific base of knowledge as well as to innovation and new product/process R&D more broadly defined.

Computerised information basically coincides with computer software.

We adopted an expenditure based approach so that we produce direct estimates of intangible gross fixed capital formation and capital, including both purchased and own-account components, based on expenditure data. In this respect, we followed the assumptions of CHS (2005) about the proportion of intangible expenditure to be capitalized. Whenever possible, our measures of

intangibles are computed by means of official data sources homogeneous across countries (mainly Eurostat surveys, national accounts data and supply and use tables, data from National Statistical Institutes) to guarantee reproducibility and international comparability of our estimates. Our results refer to the non-agriculture business sector, defined as a grouping of all industries except Agriculture, Fishing, Public administration, defence and compulsory social security, Education, Health, Other community, social and personal service activities and Private households. A detailed description of the methodology and the data sources is provided in the Report on data gathering and estimations for the INNODRIVE project – Macro approach (Deliverable No. 15, WP9)³. Here we provide only a brief description of the main data sources.

The estimate of the own account component of organizational structure is based on the Structure of Earnings surveys and Labour Force Surveys. The purchased component is measured using data from the Structural Business Statistics (SBS). For Austria, Czech Republic and Netherlands SBS data available from Eurostat do not report data on NACE 7414 (Business and management consultancy activities): for these countries we have used data from the FEACO Survey of the European Management Consultancy Market (FEACO is the European Federation of Management Consultancies Associations). Eurostat Continuing Vocational Training Survey is the main data source for the estimation of Firm-specific human capital. R&D data are from Business Expenditure on Research and Development (BERD) surveys. Advertising and Market research estimates are based on SBS data⁴.

National accounts data are taken from the Euklems database. The calculation of national accounts' value added consistent with the newly measured intangible GFCF is obtained increasing national account value-added with intangible investment (both purchased and produced on own-account). Then the measured intangible GFCF is deflated using the GDP deflator.

4. Intangible capital in European countries

In this section we provide evidence on intangible spending of the business sector in the EU25⁵ area as a whole and in its member economies in the period 1995-2005. Figure 1 shows the investment share of Gross Domestic Product (GDP) for the business sector in both tangible and intangible assets⁶. The data refer to the EU25 area as a whole, to the EU15 and to the main EU25 regions in 2005.

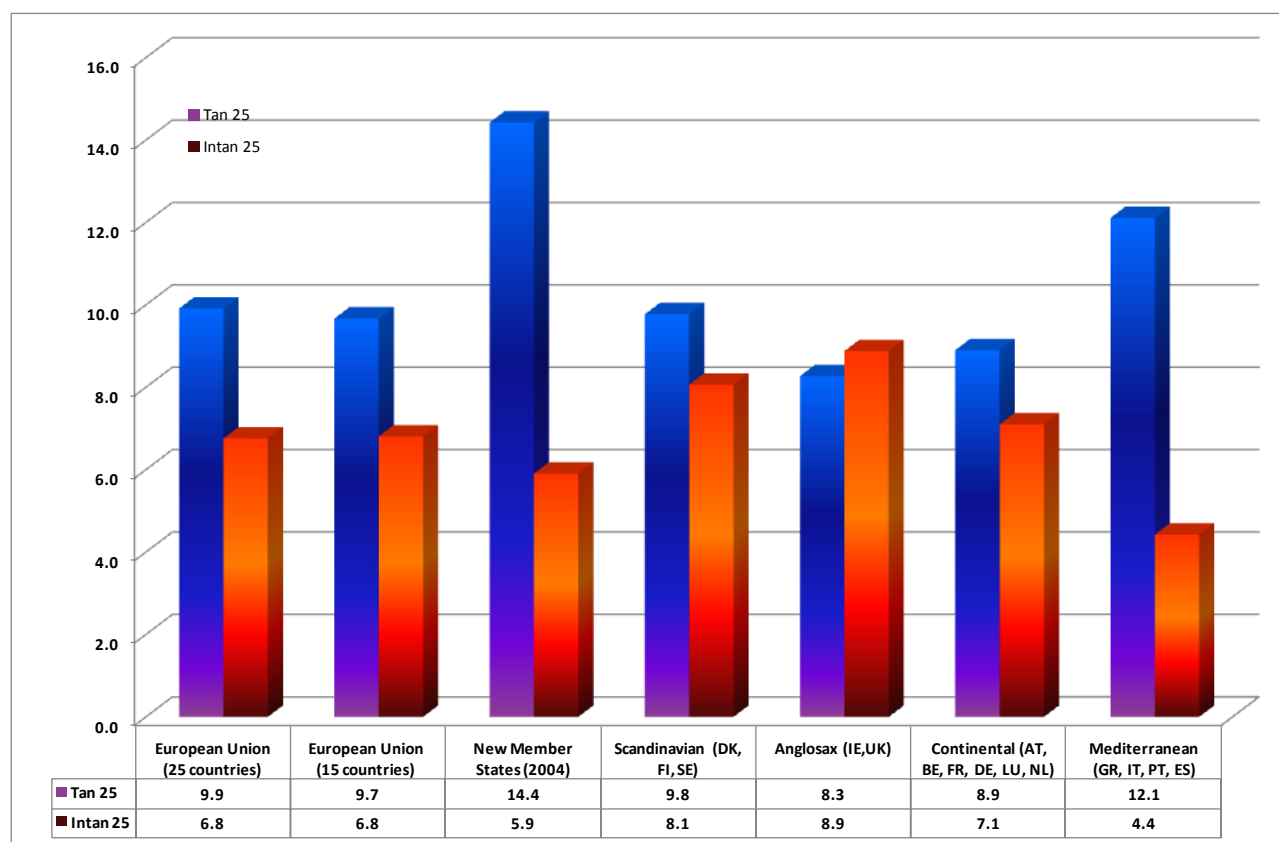
³ Available on www.innodrive.org

⁴ The estimates of Advertising and Market research has been provided by the CEPS team.

⁵ We cannot look at the EU27 as a whole for the entire period because the data for the 2007 member states go back only to 1998.

⁶ See appendix 1 for a definition of the type of assets included in both tangible and intangible capital.

Figure 1- Tangible and Intangible Shares of GDP – European Union 2005



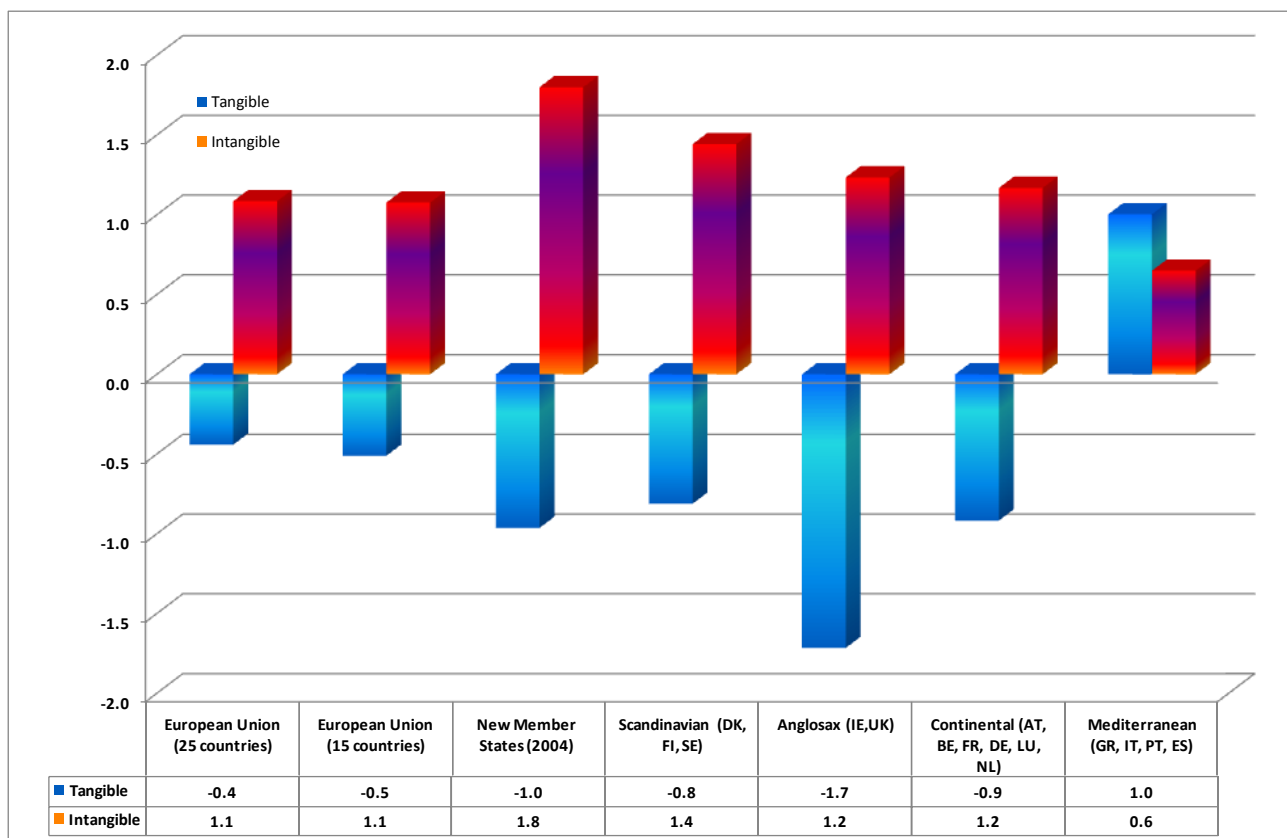
Source: INNODRIVE estimates

In 2005, intangibles account for 6.8 per cent of GDP in both EU25 and EU15 while tangible assets provide a slightly different contribution in the two areas accounting for 9.9 per cent and 9.7 per cent of GDP respectively. In the EU25 area as a whole, contrary to what happened in the US where the business sector spent more in intangible than in tangible assets (van Ark et al, 2009), the GDP intensity for intangibles is lower than for tangibles. But if we look at the GDP shares by area the differential between tangible and intangible GDP intensities is rather heterogeneous across the EU25 regions. The New Member States (NMS2004) and the Mediterranean countries (MED) show the highest differential with tangible investment being respectively 8.5 percentage points and 7.7 percentage points higher than intangible investment; Continental Europe and the Scandinavian economies instead have a small gap of 1.7 and 1.8 percentage points; while the Anglosaxon area has a higher GDP share of intangibles than tangibles, with a difference of 0.6 percentage points. This finding goes in the same direction as the results of van Ark et al (2009) showing that intangible expenditure is concentrated on the more richer countries. More advanced economies tend to be specialized in knowledge intensive sectors where intangible capital plays a strategic role.

Investment in human capital, R&D and organizational capital are key elements to foster sustained economic growth.

Figure 2 examines the average rate of growth of tangible and intangible shares of GDP in the EU25 areas over the period 1995-2005.

Figure 2- Tangible and Intangible Shares of GDP – European Union 1995 – 2005
(average rate of growth)



Source: INNODRIVE estimates

In all the EU25 regions the rate of growth of intangible investment increased while, the rate of growth of tangible investment decreased over the period, with the exception of MED countries where it increased. In the Aglosaxon countries, where the GDP intensity of intangibles is higher than of tangibles, the slowdown of tangible expenditure is relatively more pronounced than in the other European economies. The NMS and the Scandinavian countries maintain an average rate of growth of intangibles of 1.8 per cent and 1.4 per cent while the MED economies grew by 0.6 per cent over the entire period.

Table 1 shows the composition of intangible expenditure in 2005 in the EU25 area. Economic competencies represent the largest share of intangible investment in the EU area as a whole as well

as in all its regions but the Scandinavian area where innovative property accounts for the largest share. This is related to the high R&D expenditure in the Scandinavian economies accounting for the 25.2 per cent of innovative property representing the 42.5 per cent of total intangible expenditure.

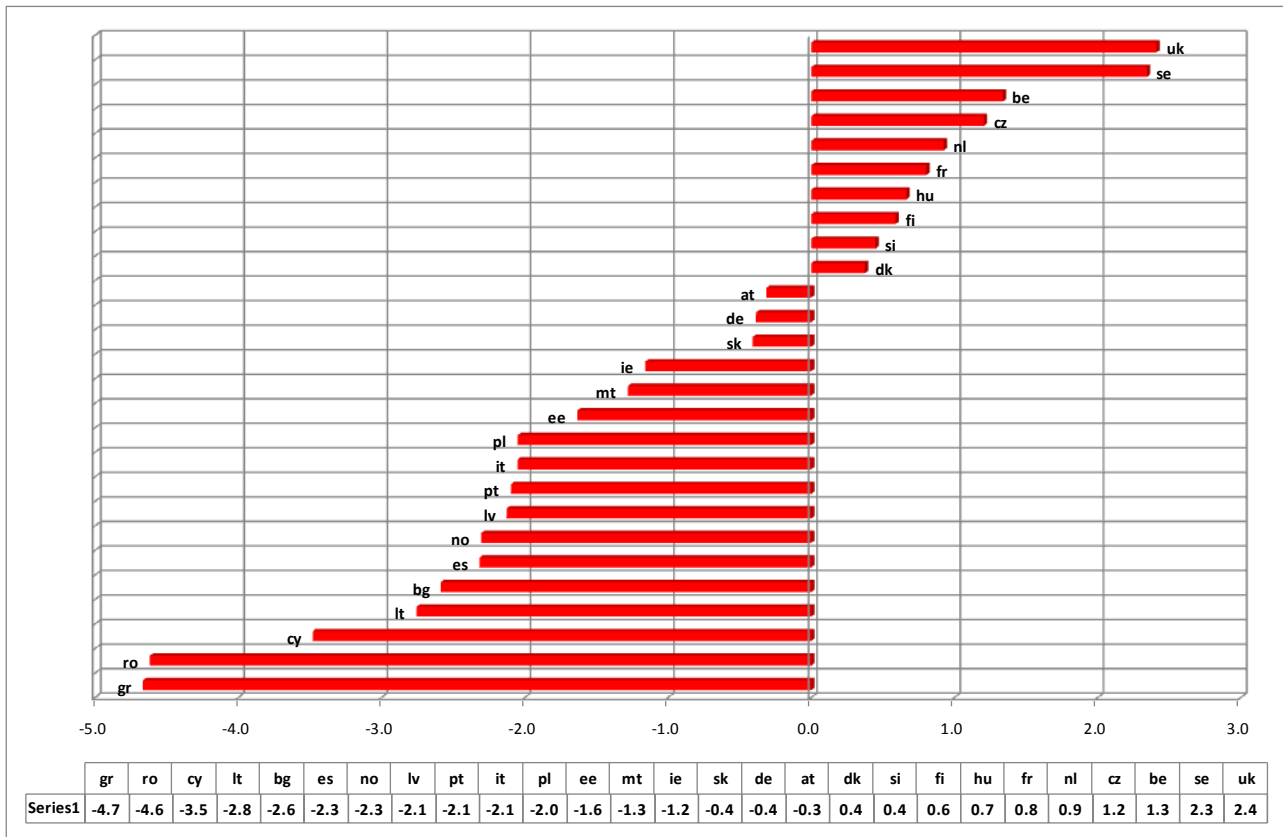
Table 1- Composition of Intangible Investment: European Union 2005

	EU 27	EU 25	EU 15	NMS 2004	Scandinavian	Anglosax	Continental	Mediterranean
Software	17.3	17.3	16.0	6.4	21.6	17.5	14.2	16.9
Innovative property	38.0	38.0	38.3	31.4	42.5	30.2	42.3	36.5
R&D	15.6	15.7	16.1	5.9	25.5	10.1	19.4	10.8
Other national account	2.7	2.7	2.6	5.4	1.8	2.7	2.4	3.3
New financial product	7.3	7.3	7.3	6.4	3.6	6.4	8.5	6.9
Architectural and engineering design	12.4	12.4	12.3	13.7	11.8	11.0	12.0	15.5
Economic Competencies	46.5	46.4	45.7	62.2	35.9	52.3	43.6	46.6
Advertising	9.1	9.1	8.5	20.7	7.2	8.2	7.7	12.1
Market Research	4.9	4.8	4.7	6.1	2.2	4.3	4.7	6.8
Firm specific human capital	8.0	8.0	8.0	8.6	9.1	6.1	8.8	7.6
Organizational capital	24.5	24.6	24.4	26.8	17.5	33.7	22.4	20.2
Total	100	100	100	100	100	100	100	100

Source: INNODRIVE estimates

In the other regions, the contribution of economic competencies to total intangibles varies between 62.2 per cent in the NMS to 43.6 per cent in the Continental area. This result is linked to the significant role played by organizational capital accounting for 20.2 per cent (MED) to 33.7 per cent (Anglosax) of economic competencies. In the NMS the high share of economic competencies depends also on the elevated contribution of advertising (20.7 per cent).

Figure 3- Intangible Shares of GDP: Member economies vs EU25



Source: INNODRIVE estimates

Figure 3 compares the intangible distribution⁷, at the country level, for the EU25 member economies. There are sizable differences among countries with UK and Sweden at the top and most of the NMS and the MED countries at the bottom end of the distribution. It is interesting to note the top position of the Czech Republic and Hungary being 1.2 percent and 0.7 percent higher than the EU25 average. As we will see below, the rank of the Czech Republic is linked to the high share of innovative property while the location of Hungary depends on the significant share of economic competencies.

Now we take a closer look at the diffusion of intangible investment across the EU27 member economies. Table 2 shows the GDP shares of intangibles for the all the EU27 economies in three benchmark years 1995, 2000 and 2005. The GDP intensities are rather heterogeneous across countries with Sweden and UK maintaining the pole positions and Greece and Romania at the bottom end over the whole period.

⁷ The differential effect is computed as the difference of the GDP share for intangibles between each member state and the EU25 as a whole.

Table 2 – Intangible Shares of GDP: EU27 Countries 1995-2000-2005

Eurostat name	1995	2000	2005
Austria	4.5	6.0	6.4
Belgium	6.4	7.6	8.1
Bulgaria	0.0	3.3	4.2
Cyprus	2.7	2.9	3.3
Czech Republic	5.4	6.6	7.6
Denmark	5.7	6.8	7.1
Estonia	5.1	4.6	5.2
Finland	5.7	7.0	7.3
France	6.4	7.3	7.6
Germany	5.4	6.6	6.2
Greece	1.7	2.0	2.0
Hungary	5.8	7.0	7.3
Ireland	4.6	4.6	5.4
Italy	4.1	5.2	4.8
Latvia	2.8	3.8	4.7
Lithuania	2.4	3.2	4.0
Malta	4.0	4.2	5.3
Netherlands	6.5	8.4	7.5
Poland	3.0	4.8	4.6
Portugal	3.3	4.2	4.5
Romania		2.0	2.2
Slovakia	3.2	5.8	6.4
Slovenia	6.0	6.8	7.0
Spain	3.6	4.0	4.3
Sweden	7.7	10.1	9.1
United Kingdom	7.5	9.2	8.9
Norway	5.0	4.8	4.4

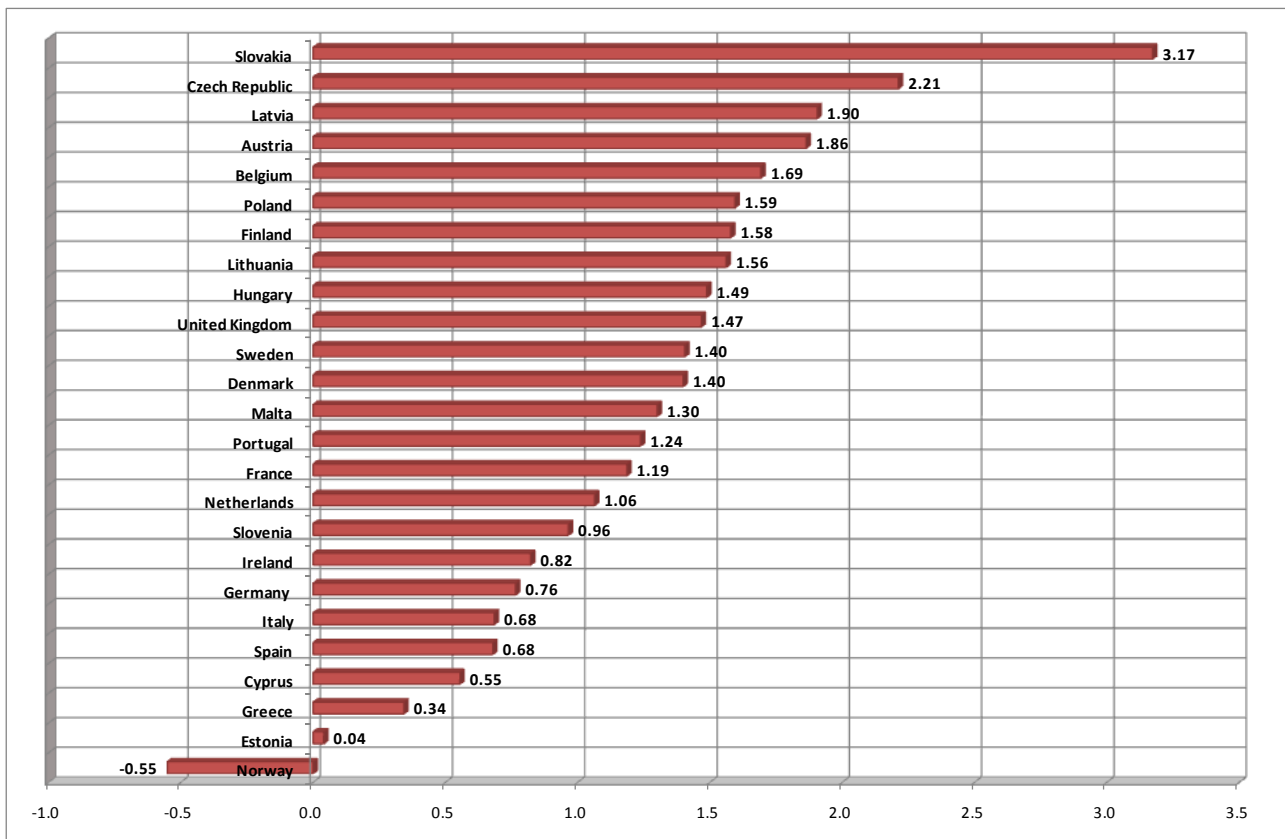
Source: INNODRIVE estimates

In 2005, the GDP shares are higher or equal to 7 per cent in Sweden (9.1 per cent), UK (8.9 per cent), Belgium (8 per cent), Czech Republic and France (7.6 per cent), Netherlands and Finland (7.5 per cent and 7.3 per cent respectively); while they are lower than 5 per cent in Italy (4.8 per cent), Spain (4.3 per cent), Norway (4.4 per cent) and in most of the NMS. Germany and Ireland are in the middle with GDP intensity for intangibles of 6.4 per cent and 5.4 per cent.

It is interesting to note that, at the end of the period, Czech Republic has the same intangible share of GDP as France and Netherlands. This huge increase is accounted for by a rising share of advertising (plus 0.7 percentage points) and of organizational capital (plus 0.5 percentage points) over the decade.

Figures 4-6 examine the dynamics of the intangible shares of GDP across the entire period and in two sub-periods. In 1995-2005, the expenditure in intangible assets increased in all countries but Norway where it decreased by 0.6 percentage points (Figure 4). The most dynamic countries are Slovakia (plus 3.17 percentage points) and Czech Republic (plus 2.2 percentage points).

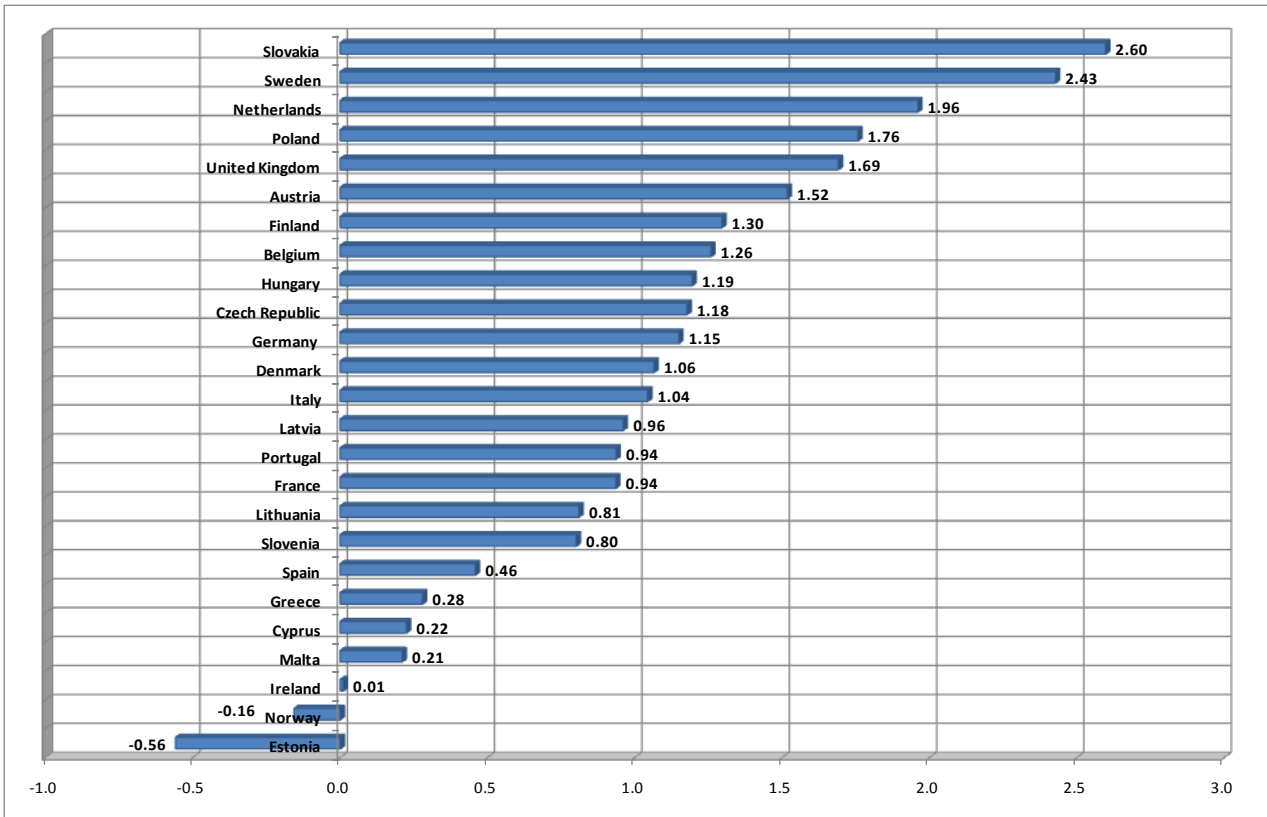
Figure 4 – Intangible Shares of GDP: EU27 Countries 1995-2005



Source: INNODRIVE estimates

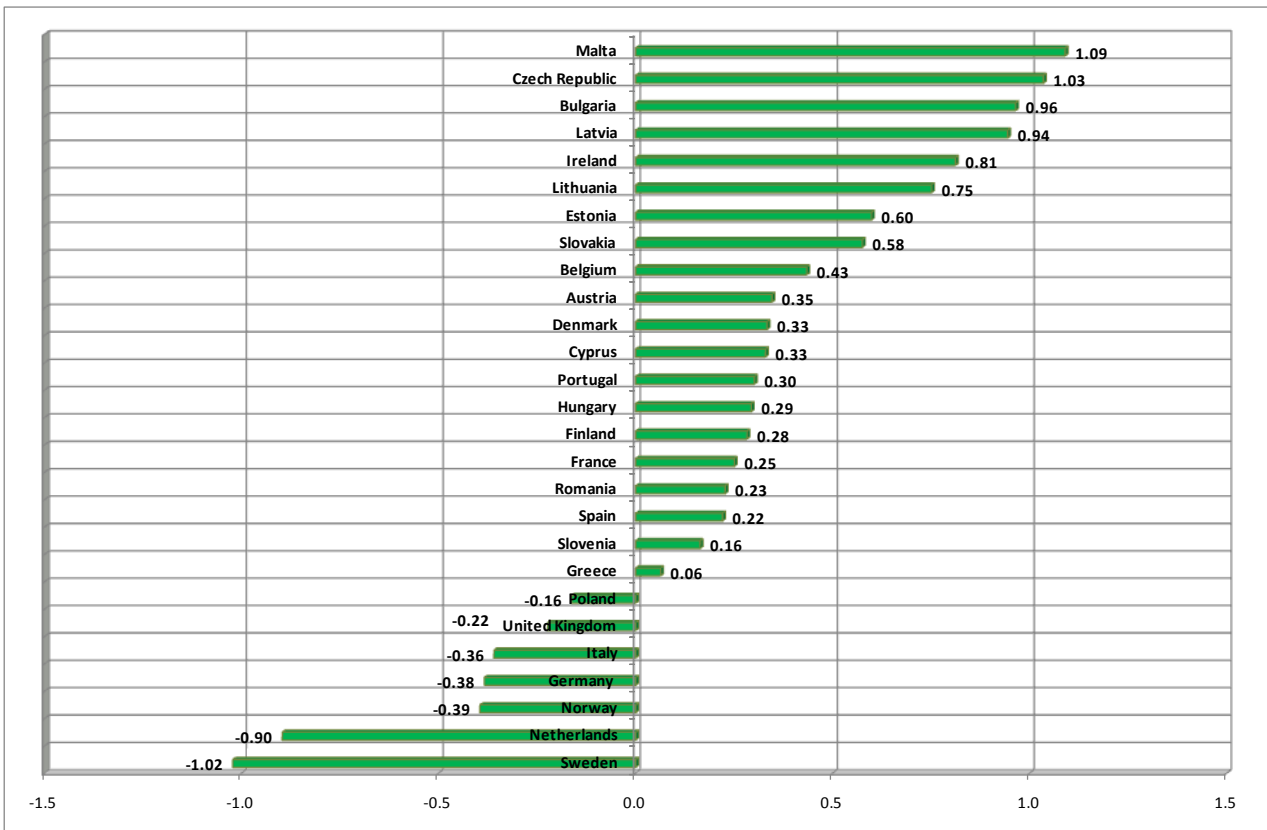
The dynamic over the period 1995-2000 (Figure 5), has been positive in all countries but Norway and Estonia. Slovakia experienced by far the highest increase (plus 2.6 percentage points) followed by Sweden (plus 2.43 percentage points). Most of the other countries recorded an increase in the range of 1.9 – 1.0 percentage points. Thus in the second half of the nineties there is a general and extended increase of intangible expenditure across the European economies. In the following five years instead there is a widespread slowdown of the rates of growth of intangible investments with UK, Sweden, Germany, Italy and the Netherlands showing negative rates of growth (Figure 6). On the other hand, intangible capital accumulation has been fairly dynamic in some of the NMS: Malta, Czech Republic, Bulgaria and Lathvia registered on average an increase of 1 percentage point.

Figure 5 – Intangible Shares of GDP: EU27 Countries 2000-1995



Source: INNODRIVE estimates

Figure 6 – Intangible Shares of GDP: EU27 Countries 2005-2000



Source: INNODRIVE estimates

The composition of intangible investment, as defined by CHS, varies a lot across countries and time. Table 3 shows the composition of intangible expenditure for a sample of countries. We choose one representative from each of the EU25 regions. Over the whole period Economic competencies account for the largest share in Czech Republic, Italy and UK; where Organizational capital is the core of intangible expenditure. In Finland and Germany instead Innovative property was main component of intangible investment driven by R&D expenditure that accounted for the largest share of total investment.

Summing up from this descriptive analysis we can identify the following stylized facts:

- Intangible expenditure accounts for a significant share of GDP in the European countries even in a different extent across them: Scandinavian, Anglosax and Continental regions playing a leading role while NMS and MED areas lagging behind;
- Intangible investment increased over the decade in all EU25 areas while tangible accumulation decreased everywhere but not in the MED economies;
- Fast growing investors were: NMS (+1.8 pp), Scandinavian economies(+1.4 pp), Anglosax and Continental Europe (+1.2 pp);
- R&D and Organizational capital are the main components of intangible investment;
- Among EU27 member countries there are sizable differences of intangible intensity: UK and Sweden are the top leaders while Greece, Romania and Cyprus are the laggards;
- The most dynamic economies are Slovakia, Czech Republic, Austria, Belgium and Finland.
- In 2000-2005, EU27 is divided in two regions with respect intangible accumulation: fast and slow adopter countries.

Table 3 - Composition of Intangible Gross Fixed Capital Formation – Selected European Countries 1995-2005

	Czech Republic			Finland			Germany			Italy			UK		
	1995	2005	D	1995	2005	D	1995	2005	D	1995	2005	D	1995	2005	D
Software	9.4	8.9	-0.4	14.6	17.8	3.2	10.2	11.7	1.5	13.7	13.6	-0.1	14.5	18.7	4.2
Innovative property	44.6	36.0	-8.7	40.3	46.0	5.6	46.0	46.9	0.9	34.8	39.1	4.2	32.0	27.7	-4.3
R&D	11.0	10.4	-0.6	22.4	29.6	7.2	26.4	26.4	0.0	12.1	10.6	-1.5	14.8	10.4	-4.4
Other national account	0.9	0.2	-0.7	3.8	2.4	-1.4	0.1	0.1	0.0	3.5	4.5	1.0	0.1	0.0	-0.1
New financial product	8.6	6.7	-1.9	4.7	2.8	-1.8	5.3	7.9	2.6	5.1	7.7	2.7	6.8	5.8	-1.0
Architectural & engineering design	24.1	18.6	-5.5	9.5	11.1	1.6	14.2	12.4	-1.7	14.2	16.2	2.0	10.2	11.5	1.2
Economic Competencies	46.0	55.1	9.1	45.1	36.3	-8.8	43.8	41.5	-2.3	51.5	47.3	-4.1	53.5	53.6	0.1
Advertising	8.1	15.5	7.4	10.6	8.4	-2.2	12.3	9.6	-2.8	9.2	9.9	0.7	9.7	8.2	-1.6
Market Research	2.2	6.8	4.6	1.3	1.7	0.4	2.9	3.7	0.8	9.2	8.1	-1.1	3.8	4.5	0.7
Firm specific human capital	10.5	8.0	-2.5	14.9	7.2	-7.7	9.9	8.0	-1.9	11.7	7.1	-4.6	6.2	6.0	-0.2
Organizational capital P	15.3	17.2	1.9	7.4	6.8	-0.7	8.6	12.5	3.9	11.7	13.7	2.0	8.1	12.0	3.9
Organizational capital O	10.0	7.7	-2.3	10.9	12.3	1.3	10.0	7.7	-2.4	9.7	8.4	-1.2	25.7	23.0	-2.7
Total	100	100		100	100		100	100		100	100		100	100	

5. The Growth Accounting Framework

The Growth accounting framework allows to decompose GDP growth into its labour, capital and total factor productivity (TFP) components. The reference model to evaluate the contribution of intangibles to economic growth is the CHS Model (2005). In their model intangibles are treated symmetrically as tangibles in the standard growth accounting framework. The explicit inclusion of intangible capital within a growth accounting framework can affect both the input and output sides of the model thus influencing also the residual TFP growth⁸.

This section presents a brief overview of the modified growth accounting model and the results obtained performing a growth accounting exercise to evaluate the contribution of tangible and intangible assets (national account intangible assets, new intangible and tangible assets) to economic growth in a set of European countries.

The CHS Model

As stated above the extended growth accounting framework proposed by CHS (2005) treats intangibles and tangibles symmetrically. Therefore the extended growth accounting equation is

$$g_Q(t) = v_L(t)g_L(t) + v_T(t)g_T(t) + v_I(t)g_I(t) + g_A(t) \quad (1)$$

where $g_X(t)$ denotes the logarithmic rate of growth of variable X and $v_Y(t)$ denotes the share of input Y in total output (more precisely the average of the shares between time t and time t-1). L, T and I are, respectively, the labour input, tangible capital and intangible capital and $g_A(t)$ denotes the rate of growth of multifactor productivity.

Theoretical model

In the standard growth accounting framework, the volume growth of capital input is obtained aggregating the growth rates of the productive stock of the various assets using cost-share weights for each asset type:

$$g_K(t) = \sum_{i=1}^{n_i} 0.5(v_t^i + v_{t-1}^i) \ln(S_t^i / S_{t-1}^i) \quad (2)$$

where S_t^i is the productive stock of asset i ,

$$v_t^i = u_t^i S_t^i / \sum_{i=1}^n u_t^i S_t^i$$

⁸ See Barnes and McClure (2009) for a detailed description of the effects of capitalizing intangibles.

is the cost-share of asset i in period t , u_t^i is its user cost and n is the number of asset types (both tangibles and intangibles).

The standard framework outlined above is modified to evaluate the impact of intangible assets on the aggregate growth of capital services, by computing volume indexes of the flow of capital services from both tangible and intangible assets. The volume indexes of the flow of intangible capital services is obtained by aggregating across productive stocks of intangible capital goods with weights equal to the share of each asset in the value of total cost for intangible capital services.

If there are n_z intangible-type assets, then the index of intangible capital services is:

$$g_i(t) = \sum_{i=1}^{n_z} 0.5(v_i^t + v_i^{t-1}) \ln(SI_t^i / SI_{t-1}^i) \quad (3)$$

where

$$v_i^t = u_t^i SI_t^i / \sum_{i=1}^{n_i} u_t^i SI_t^i$$

is the share of intangible asset i in the value of total cost for intangible capital services and SI_t^i is the productive stock of intangible asset i .

The index of the flow of capital services from tangible assets is defined symmetrically.

Implementation issues.

Our estimate of productive capital stock is based on the following simplifying assumptions:

1. geometric pattern [$SI_t^i = (1-d^i)SI_{t-1}^i + I_t^i$]
2. constant depreciation rates over time
3. the depreciation rate for each type of asset is the same for all countries.

The first assumption eases the calculations because it implies that the rate of efficiency decay is identical to the rate of economic depreciation (put it differently, age-efficiency and age-price profiles coincide). Further, since each type of asset (e.g. machinery and equipment, office machinery and so on) is an aggregate of many different types of individual assets that are somewhat heterogeneous with respect to their service life, it is necessary to find a proxy of an

average profile. The geometric depreciation is the best approximation of the average profile, even if each assets component in the group follows a different pattern⁹.

The depreciation rates of tangible assets have been gathered from EUKLEMS, while those for the intangibles have been obtained as in CHS¹⁰.

The user cost of capital of asset i has been calculated as:

$$u_t^i = q_t^i (r_t + d_t^i - g_t^i) \quad (4)$$

where:

- q_t^i is the investment deflator for asset i (i.e. the same price index that is used to deflate nominal expenditure),
- r_t is the net rate of return common to all assets (both tangibles and intangibles) in year t ,
- d_t^i is economic depreciation rate of asset i and
- g_t^i measures expected capital gains-losses on asset i .

The depreciation rate “ d ” is the same we used to calculate the capital stock of asset i , while the asset revaluation term has been derived from the investment price index (e.g. it can be defined as a moving average of the rates of changes in the asset price in the three years priors to t).

As suggested by CHS, we calculated the nominal net rate of return as an internal rate. This choice is based on the assumption that the total value of the remuneration of capital services (both for tangible and intangible capital) exhausts total non labour income, that is:

$$P_Q Q - P_L L = P_K K = \sum_{i=1}^n u_t^i S_t^i \quad (5)$$

where the summation runs over all the assets (tangibles and intangibles).

Thus, once total capital income, productive capital stock and the other components of the user-cost for each asset have been determined, the expression above can be used to identify the value of $r(t)$ that causes the identity to hold.

The labour income $P_L L$ has been obtained as the sum of labour compensation of employees and of an imputation of labour compensation of self-employed¹¹ ().

⁹ see Hulten C., 1990 “The Measurement of Capital”, in E. Berndt and J. Triplett, eds, Fifty Years of Economic Measurement, NBER; and Schreyer, P., E. Diewert, A. Harrison, (2005), “Cost of capital services and the national accounts”, Issues paper for the July 2005 AEG Meeting.

¹⁰ CHS used an annual rate of 33 percent for computerized information, 15 percent for R&D, 60 percent for advertising and 40 percent for firm specific assets.

¹¹The imputation has been done by assuming that the average compensation of self-employed is equal to the average compensation of employees.

Then the remunerations of intangible and tangible capital are:

$$P_I I = \sum_{i=1}^{nz} u_i^i S I_i^i \quad \text{and} \quad P_T T = \sum_{j=1}^{nt} u_j^j S T_j^j \quad (6)$$

where $S I_i^i$ is the productive stock of intangible asset i , and $S T_j^j$ is the productive stock of tangible asset j , with $P_I I + P_T T = P_K K$ and $n=nt+nz$.

Finally, the income share of each input is obtained as:

$$v_L = P_L L / P_Q Q; \quad v_I = P_I I / P_Q Q; \quad v_T = P_T T / P_Q Q. \quad (7)$$

6. Empirical results

In this section we illustrate the results of the growth accounting exercise based on equation (1).

Table 4 shows the relative contributions of capital deepening and total factor productivity to labour productivity growth in the current asset boundary compared to the extended asset boundary that is when intangible assets are capitalized.

Labour productivity growth is generally higher when intangibles are included in capital stock in all the sample countries with the exception of Sweden where it decreases a bit. The major impact is in Austria where labour productivity increases by 0.18 percentage points, Portugal with an increase of 0.13 percentage points and Germany with 0.11 percentage points. Among them only Austria is an intangible intensive country even if all of them were fast growing economies in the second half of the nineties.

The relative contribution of capital deepening and TFP to labour productivity growth changed considerably after the inclusion of all intangibles, with the role of capital deepening increasing and the growth of TFP decreasing. The contribution of capital deepening increased from 0.28 percentage points a year to 0.62 percentage points a year in Finland (an increase of 0.34 percentage points), from 1.14 percentage points to 1.45 percentage points a year in Sweden (an increase of 0.32 percentage points) and from 0.78 to 1.06 percentage points in Austria (an increase of 0.29 percentage points).

Table 4 – Impact of the capitalization of intangible assets: NA vs New Intangibles

	Current Asset Boundary			Extended Asset Boundary				Estimated Impact		
	Contributions to Labour Productivity Growth			Contributions to Labour Productivity Growth						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(d-a)	((e+f)-b)	(g-c)
	LPG	CD	TFPG	LPG	NA CD	NI CD	TFPG	LPG	CD	TFPG
Austria	1.87	0.78	1.08	2.05	0.72	0.34	0.97	0.18	0.29	-0.11
Denmark	1.55	0.55	1.00	1.61	0.50	0.27	0.83	0.06	0.22	-0.16
Finland	2.98	0.28	2.69	3.07	0.25	0.37	2.43	0.09	0.34	-0.26
France	2.01	0.39	1.61	2.07	0.36	0.23	1.47	0.06	0.20	-0.14
Germany	1.59	0.80	0.78	1.69	0.74	0.27	0.68	0.11	0.21	-0.11
Italy	0.17	0.55	-0.37	0.26	0.51	0.09	-0.35	0.09	0.06	0.02
Netherlands	2.20	0.69	1.50	2.25	0.62	0.31	1.31	0.05	0.24	-0.20
Portugal	1.81	1.82	-0.01	1.94	1.72	0.24	-0.03	0.13	0.14	-0.02
Spain	0.21	0.53	-0.32	0.24	0.50	0.03	-0.29	0.04	0.01	0.03
Sweden	3.73	1.14	2.56	3.69	1.01	0.44	2.20	-0.04	0.32	-0.37
United Kingdom	2.62	1.06	1.55	2.71	0.95	0.34	1.39	0.09	0.24	-0.15

Source: authors calculations on INNODRIVE data

LPG stands for labour productivity growth, CD is capital deepening then distinguished between National Account (NA) and New Intangible (NI) CD, TFP is total factor productivity.

Denmark, Germany, Netherlands and UK registered a quite similar effect from capitalising new intangibles with an average increase of the contribution of capital deepening of 0.22 percentage points. Italy and, Spain stand out as exceptions, with a negligible increase of the contribution of capital deepening equal to 0.06 and 0.01 percentage points.

The lower TFP growth shows that when intangibles are not capitalized their contribution to labour productivity growth is captured by TFP in line with its residual nature (Jorgenson and Griliches (1967)). In all countries, apart from Italy and Spain, the inclusion of intangibles in the asset boundary involves a larger role of capital deepening that in most cases becomes the main source of growth. However, the effect on TFP growth is quite heterogeneous across countries and mirrors only partially the effect on capital deepening. For instance, in Sweden the strong increase in the contribution of capital deepening is associated with a negligible effect on labour productivity growth: as a consequence the capitalization of intangibles causes a strong decrease in TFP growth (0.37 percentage points). On the other hand, in Austria the high increase of the contribution of capital deepening is associated with a high increase in labour productivity growth: then the reduction in TFP growth is relatively smaller (0.11 percentage points).

However, the inclusion of the intangibles in the asset boundary produces different effects on labour productivity growth according to the business cycle. We found a positive effect in the second half of the nineties while an opposite impact in 2000-2005. The differentiated effects may be connected to the different performance of the European economies in these time periods since while in 2000-2005 most of them experienced a sharp decline in labour productivity growth and in the rate of

labour utilization, in 1995-2000, some of them experienced a pick-up in both labour productivity and labour utilization¹². Another issue is related to the well known dependence of growth accounting estimates on the period of analysis (CHS, 2005). However, these findings are worth to be further investigated.

Table 5 summarizes the contribution of tangible and intangible assets to labour productivity growth in the business sector of the sample countries.

Intangible capital deepening contributes more than tangible capital in France, Denmark, and Finland. In the two latter economies, this result depends on innovative property assets accounting for the largest share of intangible capital substantially driven by R&D capital accumulation. France has equally distributed shares of software, innovative property and economic competencies accounting for the intangible capital deepening.

Note that the fast growing countries, Sweden and UK, where intangible capital accounts for 0.8-0.7 percentage points of labour productivity growth, are also the most intangible intensive economies (Table 2). On the other hand, Italy and Spain, the slow growing member states are also the less intangible intensive economies. This finding goes in the same direction as van Ark et al (2009) showing a positive association between the GDP share of intangible and hourly labour productivity. Looking at the contribution of each intangible asset, we observe that for Sweden and Finland, R&D is the key source of growth, while for UK, organizational capital is the main driver of growth. Interestingly, in Finland, where intangible capital plays a greater role than tangible capital, the largest part of Finnish labour productivity growth is accounted for by R&D capital deepening and by a relatively high TFP.

Summing up, the results shown in Tables 4 and 5 suggest that intangibles that are currently excluded from the asset boundary of national accounts matter for growth accounting analysis, because the growth of labour productivity is significantly modified when they are capitalized. We showed that the composition of the sources of growth is affected by the inclusion of intangible capital, with a considerably greater role for capital deepening and a proportionally smaller role for TFP as firstly showed by (CHS, 2005). Intangible capital is definitely a relevant source of growth in the advanced EU member states with a more important role in the Scandinavian economies. On the other hand, it plays a minor function in the slow growing countries. .

¹² See OECD Productivity Report, 2008.

Table 5 – Intangible assets as new sources of growth

	LPG	TCD	ICD	SW	INN PROP	<i>R&D</i>	<i>Arch_Des</i>	<i>NFP</i>	<i>Other_NA</i>	Econ Comp	<i>Advert+Mkt_Res</i>	<i>Org_Cap</i>	<i>FSHC</i>	TFPG
Austria	2.05	0.62	0.47	0.10	0.22	<i>0.13</i>	<i>0.05</i>	<i>0.03</i>	<i>0.00</i>	0.15	<i>0.06</i>	<i>0.07</i>	<i>0.02</i>	0.95
Denmark	1.61	0.37	0.38	0.17	0.17	<i>0.11</i>	<i>0.05</i>	<i>0.01</i>	<i>0.00</i>	0.04	<i>0.03</i>	<i>0.03</i>	<i>-0.01</i>	0.84
Finland	3.07	0.18	0.40	0.09	0.27	<i>0.23</i>	<i>0.06</i>	<i>-0.01</i>	<i>0.00</i>	0.04	<i>0.03</i>	<i>0.08</i>	<i>-0.08</i>	2.48
France	2.07	0.25	0.43	0.14	0.13	<i>0.03</i>	<i>0.07</i>	<i>0.02</i>	<i>0.01</i>	0.16	<i>0.02</i>	<i>0.10</i>	<i>0.04</i>	1.38
Germany	1.69	0.60	0.38	0.05	0.18	<i>0.08</i>	<i>0.05</i>	<i>0.05</i>	<i>0.01</i>	0.14	<i>0.03</i>	<i>0.08</i>	<i>0.04</i>	0.71
Italy	0.26	0.46	0.13	0.03	0.06	<i>-0.01</i>	<i>0.03</i>	<i>0.03</i>	<i>0.01</i>	0.04	<i>0.03</i>	<i>0.04</i>	<i>-0.03</i>	-0.34
Netherlands	2.25	0.50	0.47	0.12	0.15	<i>0.03</i>	<i>0.06</i>	<i>0.06</i>	<i>0.00</i>	0.19	<i>0.05</i>	<i>0.15</i>	<i>-0.01</i>	1.27
Portugal	1.94	1.61	0.37	0.09	0.12	<i>0.03</i>	<i>0.02</i>	<i>0.05</i>	<i>0.01</i>	0.16	<i>0.07</i>	<i>0.10</i>	<i>0.00</i>	-0.05
Spain	0.24	0.43	0.10	0.06	0.04	<i>0.02</i>	<i>0.02</i>	<i>-0.01</i>	<i>0.00</i>	-0.01	<i>0.00</i>	<i>0.01</i>	<i>-0.02</i>	-0.29
Sweden	3.69	0.78	0.66	0.18	0.28	<i>0.19</i>	<i>0.08</i>	<i>0.00</i>	<i>0.01</i>	0.20	<i>0.03</i>	<i>0.13</i>	<i>0.03</i>	2.21
United Kingdom	2.71	0.74	0.57	0.15	0.11	<i>0.01</i>	<i>0.08</i>	<i>0.04</i>	<i>-0.01</i>	0.30	<i>0.06</i>	<i>0.19</i>	<i>0.06</i>	1.38

Source: authors calculations on INNODRIVE data

TCD is tangible capital, ICD is intangible capital, Sw is software, INN PROP is innovative property, R&D is Research and development, Arch_des stands for architectural and engineering design, NFP is new financial products; nuovi prodotti finanziari, ADV is advertising, FSHC is training, OrgCap is Organizational Capital.

7. Conclusions

Despite the recent financial crisis has put much emphasis on stabilization macro-policies and regulatory issues, long-term growth and labour productivity are still high in the international economic agenda, as they are crucial for living standards all around the globe.

“Intangible capital”, as it is currently defined and has been measured in this paper, has been neglected for a long time as a source of economic growth, although some of the items it includes had been recognized as relevant factor of social development.

Our study shows that including intangible capital as a “production factor” helps clarifying the sources of long-run growth. In particular, the “unexplained” component of macro-economic dynamics, the so-called Total Factor Productivity, becomes less important, while physical capital turns out to be strongly complementary with intangible capital.

Labour productivity, which in the long term is commonly viewed as deeply related with wages and the living standards of the workforce, is prompted by the accumulation of intangible capital.

Investing in intangibles is therefore an engine of rising social welfare.

According to our estimates, in the most recent years, the intangibles have been a relevant source of growth across European countries so that they cannot be omitted from national account data.

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