Intangible capital and Productivity Growth in European Countries

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Introduction

Corrado, Hulten and Sichel (2005, 2006)[1] developed an experimental methodology to measure gross fixed capital formation for a large number of intangibles. Further they extended the standard growth accounting framework 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. Since the publication of their seminal paper, many authors, applying their methodology, provided evidence of the bias in the estimates of TFP growth when intangible assets are ignored in a number of country studies.[2] Therefore according to the available evidence intangible capital matters for growth empirics.

The aim of this paper is to measure intangible investment following CHS and to analyze its contribution to economic growth in a set of European countries. The idea is to provide evidence on the role of intangible capital as a source of growth and to improve our understanding of the international differences in the mix of drivers of productivity growth in European countries.

In this paper we use the preliminary estimates of intangible capital produced by the INNODRIVE project for a sample of European countries (Austria, Denmark, Finland, Germany, Italy, Netherlands, Portugal, Sweden and United Kingdom) for the period 1995-2005. The aim of the INNODRIVE project is to measure intangible capital and to perform growth accounting analysis for the EU27 member countries, but since data are not yet available for all EU27 economies, at the moment the growth accounting analysis can be done only for the above selected countries.

The paper is structured into seven sections. The next section briefly summarizes some of the literature background on new 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 of the selected European economies. Section 5 describes the extended growth accounting model applied to explore the impact of intangible capital on productivity growth and section 6 illustrates our preliminary results. Section 7 concludes indicating the main policy implications and the next steps in our research.

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

[1] CHS onwards.
[2] See Barnes and McClure, 2009, for a comprehensive review of the empirical literature.

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 form 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 data[4].
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

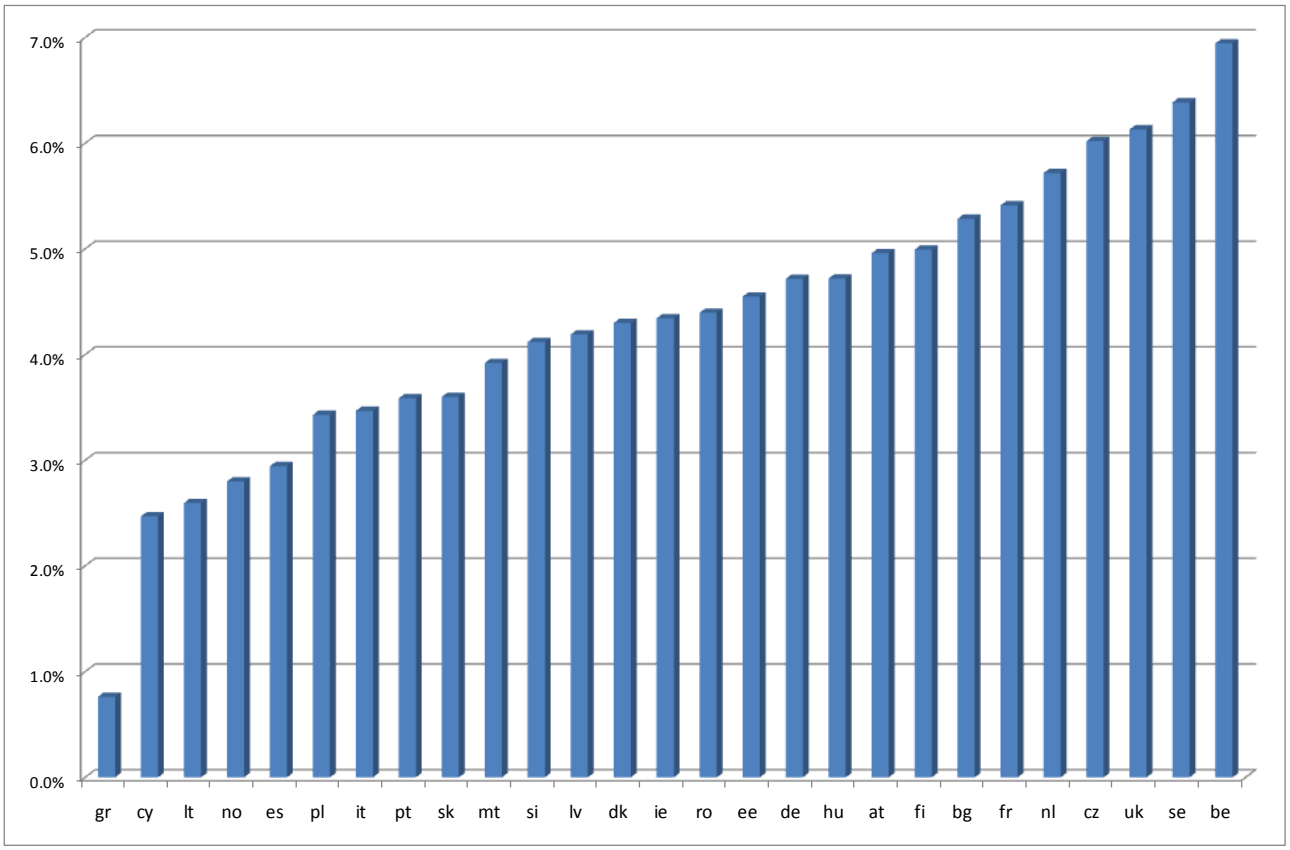
In this section we provide evidence on intangible spending in the business sector of the European countries (EU27) in the period 1995-2005.
Figures 1 and 2 show the GDP shares of new intangible investment for the EU27 economies in three benchmark years 1995, 2000 and 2005.

[3] Available on www.innodrive.org
[4] The estimates of Advertising and Market research has been provided by the CEPS team.

Table 1 – New Intangible Shares of GDP : European Countries 1995-2000-2005

		1995	2000	2005
at	Austria	3.7%	4.4%	5.0%
be	Belgium	6.2%	6.9%	6.9%
bg	Bulgaria	-	5.8%	5.3%
cy	Cyprus	2.0%	2.1%	2.5%
cz	Czech Rep	4.2%	4.8%	6.0%
dk	Denmark	4.1%	4.5%	4.3%
ee	Estonia	4.9%	4.4%	4.5%
fi	Finland	3.9%	5.2%	5.0%
fr	France	5.3%	5.4%	5.4%
de	Germany	4.0%	4.8%	4.7%
gr	Greece	0.9%	0.9%	0.8%
hu	Hungary	3.8%	4.0%	4.7%
ie	Ireland	3.9%	3.6%	4.3%
it	Italy	3.2%	3.8%	3.5%
lv	Latvia	2.7%	3.7%	4.2%
lt	Lithuania	1.7%	2.2%	2.6%
mt	Malta	2.9%	3.1%	3.9%
nl	Netherland	5.4%	6.5%	5.7%
pl	Poland	2.4%	3.5%	3.4%
pt	Portugal	3.3%	3.6%	3.6%
ro	Romania	-	2.9%	4.4%
sk	Slovakia	2.6%	4.5%	3.6%
si	Slovenia	3.8%	4.1%	4.1%
es	Spain	2.9%	3.3%	2.9%
se	Sweden	5.9%	7.2%	6.4%
uk	United Kin	5.5%	6.6%	6.1%
no	Norway	3.7%	3.4%	2.8%

Figure 1 – New Intangible Shares of GDP : European Countries 2005



The New Intangibles are here defined as all those assets identified by CHS as intangible but not included in national accounts. Therefore in figures 1 and 2 we consider a new aggregate composed by R&D, New Product Development in financial industry and all the items classified as Economic Competencies by CHS. In the following it is important to bear in mind that the results are preliminary and that may be subject to some revisions.

The New Intangible shares of GDP are highly heterogeneous across European countries both in terms of absolute values and in terms of their evolution over time (Table 1 and figure 1). In 2005 the shares are higher or equal to 6 per cent of GDP in Belgium (6.9 per cent of GDP), Sweden (6.4 per cent), UK (6.1 per cent) and Czech Republic (6.0 per cent), while they are lower than 3 per cent of GDP in Spain (2.9 per cent), Norway (2.8 per cent), Lithuania (2.6), Cyprus(1.7 per cent) and Greece (that stands out as an outlier, with a share equal only to 0.8 per cent of GDP)

With respect to 1995, in 2005 the expenditure in new intangible assets has increased in almost all countries, the only exceptions being Spain (where the share has remained unchanged) and Greece, Estonia and Norway, where it has decreased. The most dynamic countries are Czech Republic,

Latvia and Austria, that registered an increase in the share of new intangibles over GDP well above 1 per cent.

The dynamic over the period 1995-2000 has been positive in all countries but Ireland, Norway and Estonia. Slovakia experienced by far the highest increase (from 2.6 per cent in 1995 to 4.5 in 2000). Besides Slovakia, other six countries registered an increase in the range of 1.1-1.3 percentage points: Sweden, Finland, Poland, Netherlands, Latvia and UK. The importance of investment in new intangible assets increased also in the large continental economies (with the partial exception of France, where the share increased only of 1 percentage points).

Figure 2 – New Intangible Shares of GDP : European Countries change 2005-1995

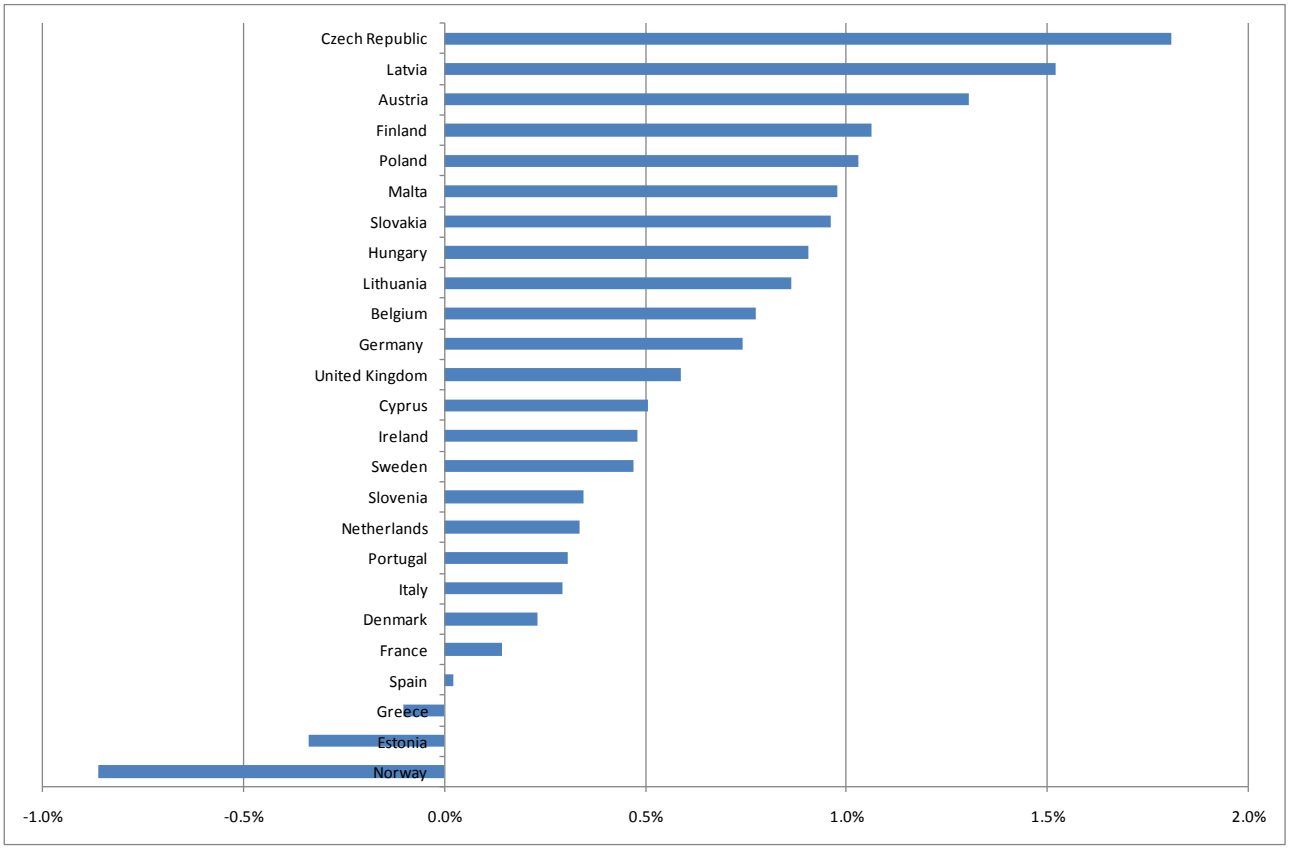
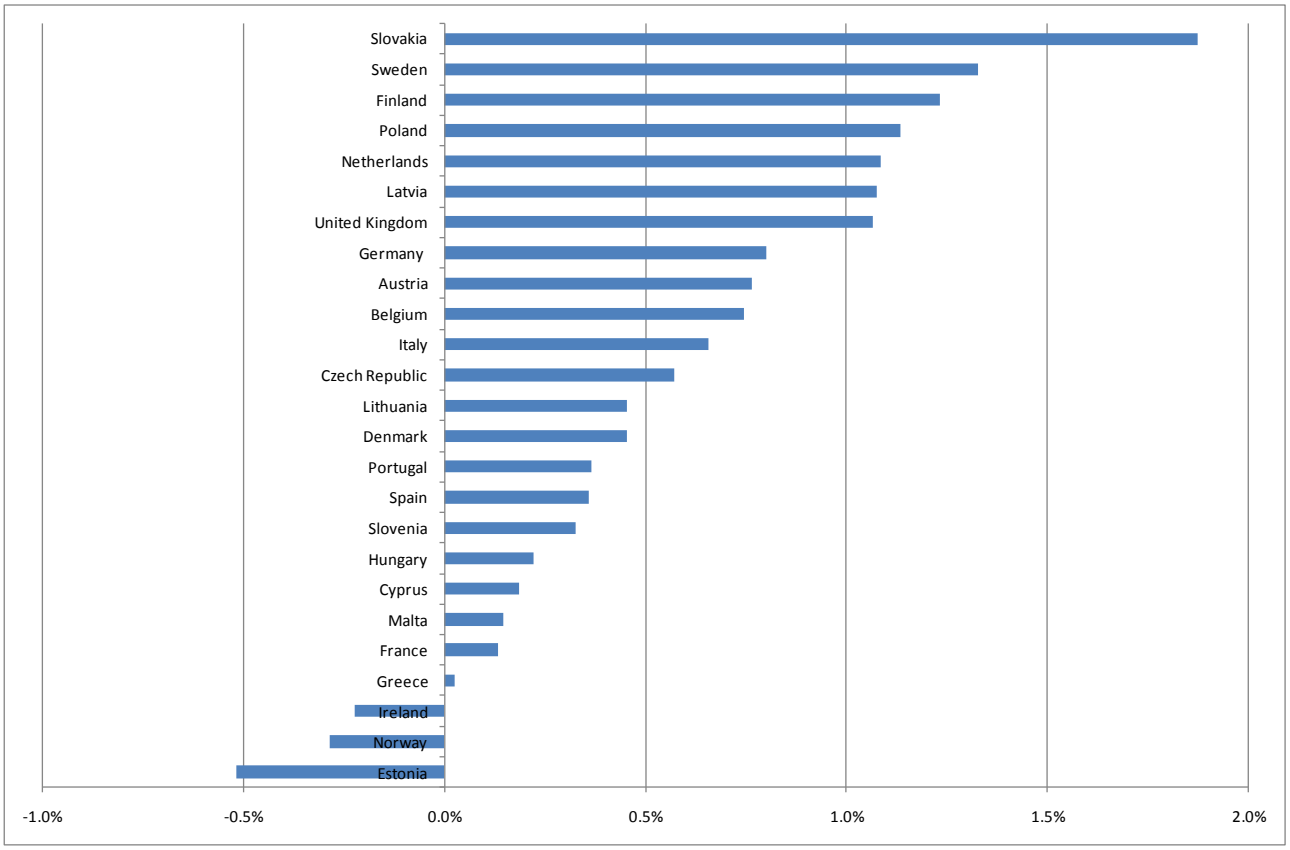


Figure 3 – New Intangible Shares of GDP : European Countries change 2000-1995



In 2000-2005, the picture is rather different, with fourteen countries showing a decrease of the GDP share of intangible investment. Among the Western European economies, only Malta, Ireland and Austria have registered a remarkable increase of the share (respectively equal to 0.8, 0.7 and 0.5 percentage points) (Table 1 and Figure 4). On the other hand, intangible capital accumulation has been fairly dynamic in some of the Eastern economies. Romania and Czech Republic registered the highest increase (1.4 and 1.2 a percentage points respectively). Also Hungary experienced a remarkable increase (0.7 pecentage points).

Figure 4 – New Intangible Shares of GDP : European Countries, change 2005-2000

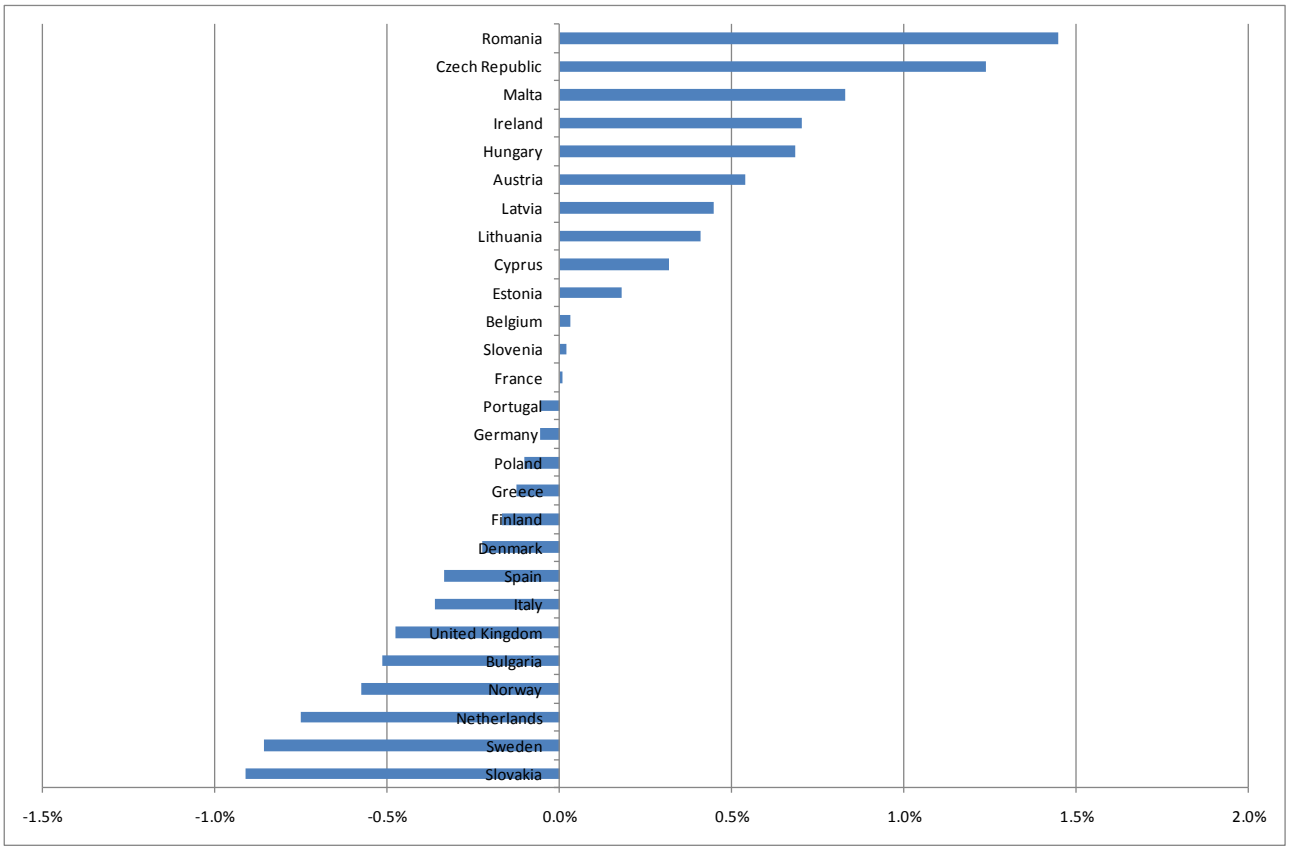


Table 2 – New Intangible Shares of GDP : EU 1995-2005

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
EU27				4.7%	4.9%	5.1%	5.0%	4.9%	4.8%	4.8%	4.8%
EU25	4.3%	4.4%	4.5%	4.7%	4.9%	5.1%	5.0%	4.9%	4.8%	4.8%	4.8%
EU15	4.4%	4.4%	4.6%	4.8%	5.0%	5.1%	5.1%	5.0%	4.8%	4.8%	4.9%
NMS_2004	3.0%	3.1%	3.4%	3.7%	3.7%	3.8%	3.8%	3.8%	3.9%	3.9%	4.1%
NMS_2007				3.6%	3.7%	3.8%	3.9%	3.8%	3.9%	4.0%	4.2%

NMS_2004: Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia

MNS_2007: NMS_2004 plus Bulgaria and Romania

At the EU25 level, business spending in intangible assets not currently included in the national accounts asset boundary amounted to 4.3 per cent of GDP in 1995, 5.1 per cent in 2000 and to 4.8 per cent in the year 2005 (table 2). Both the level and dynamics of the GDP share for EU25 largely coincide with the results for EU15 area. On the other hand, the new member states show a clear process of catching up. Considering only those countries that acceded to EU in 2004, the new intangibles accounted for 3 per cent of GDP in 1995 (1.4 percentage points lower that the share in EU15 area); the share registered a strong increase in the second half of the 90's, being equal to 3.8 per cent in the year 2000; in the following years the EU15 area registered a decrease in business

spending in new intangibles (with the share equal to 4.9 per cent in the 2005), while New Member States still registered an increase, although at a slower pace: in 2005, the share of new intangibles in NMS was only 0.8 lower than the share in EU15 (4.1 vs 4.9 percentage points).

The composition of intangible investment, as defined by CHS, varies a lot across countries and time. Tables 3 to 5 show the composition of intangible gross fixed formation for a sample of countries whose estimates and data sources are more reliable. Over the whole period Economic competencies account for the largest share ranging from 45 to 75 per cent of all intangibles assets across all countries. For most of the selected economies Advertising and Organizational capital account for the biggest share of Economic Competencies. In 1995, Portugal and Spain recorded the highest shares of Economic competencies, with 79.6 per cent and 77.2 per cent of Intangible investment respectively (Table 3). In Portugal, purchased organizational capital accounted for 34 per cent of economic competencies and advertising for 33 per cent; while in Spain advertising was 36.5 per cent of economic competencies and own account organizational capital was 21 per cent. In the same year, the shares of economic competencies were slightly lower in Greece, Belgium and Ireland. Ten years later, the same countries but Greece maintained the highest share of economic competencies with organizational capital becoming the main driver of growth of economic competencies (Table 4).

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

	Austria			Belgium			Denmark			Finland			France		
	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
Computerized information	**8,7**	**14,9**	**15,3**	**0,0**	**0,0**	**0,0**	**20,0**	**30,2**	**34,0**	**20,2**	**18,1**	**21,5**	**0,0**	**0,0**	**0,0**
Innovative property	**33,2**	**35,2**	**41,1**	**32,1**	**36,1**	**31,8**	**27,7**	**27,8**	**30,1**	**34,5**	**40,4**	**41,2**	**36,1**	**34,9**	**34,4**
Scientific R&D	23,1	24,7	30,3	23,9	25,6	21,9	18,8	20,4	22,1	26,7	34,7	35,5	27,2	25,1	24,1
Mineral exploration	0,0	0,2	0,1	0,0	0,0	0,0	0,1	0,1	0,3	0,2	0,2	0,2	0,0	0,0	0,0
Artistic originals	0,2	0,2	0,1	0,0	0,0	0,0	0,1	0,1	0,2	0,1	0,0	0,0	0,0	0,0	0,0
NPD	8,3	8,4	8,9	8,2	10,4	9,9	6,7	5,3	6,3	5,3	3,0	3,2	8,9	9,8	10,2
New AED	1,5	1,6	1,5	0,0	0,0	0,0	2,0	1,8	1,2	2,3	2,4	2,2	0,0	0,0	0,0
Economic competencies	**58,1**	**49,9**	**43,6**	**67,9**	**63,9**	**68,2**	**52,3**	**42,0**	**35,9**	**45,3**	**41,5**	**37,3**	**63,9**	**65,1**	**65,6**
Advertising	15,8	15,3	14,7	30,3	26,9	25,0	14,6	11,9	9,0	8,0	9,9	8,4	19,9	18,7	17,1
Market research	0,4	0,9	0,5	5,0	5,5	5,8	0,6	0,6	1,0	0,4	0,7	0,6	1,7	2,5	1,5
Firm specific human capital	13,1	9,8	8,3	11,7	10,9	10,7	20,0	15,5	11,7	15,8	11,5	7,7	15,6	15,1	14,4
Organisational capital	28,8	23,9	20,1	21,0	20,6	26,8	17,1	14,1	14,2	21,0	19,5	20,7	26,7	28,9	32,5
purchased	*3,6*	*3,6*	*3,8*	*2,9*	*3,0*	*3,3*	*7,9*	*7,1*	*6,4*	*9,5*	*8,5*	*7,6*	*14,3*	*16,4*	*17,9*
onwn account	*25,2*	*20,3*	*16,3*	*18,1*	*17,6*	*23,4*	*9,1*	*7,1*	*7,9*	*11,5*	*11,0*	*13,1*	*12,4*	*12,5*	*14,6*
Total intangible capital	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**	**100,0**

Table 4 - Composition of Intangible Gross Fixed Capital Formation – Selected European Countries 1995-2005

	Germany			Greece			Ireland			Italy			Netherlands		
	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005	1995	2000	2005
Computerized information	**13,5**	**17,0**	**18,3**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**0,0**	**15,8**	**15,5**	**13,9**	**16,1**	**21,3**	**22,1**
Innovative property	**37,0**	**39,4**	**38,7**	**28,9**	**33,6**	**34,8**	**33,8**	**34,5**	**34,0**	**26,8**	**26,8**	**31,4**	**28,5**	**27,2**	**31,2**
Scientific R&D	30,2	29,9	29,3	13,7	14,1	20,1	22,6	18,0	11,6	13,0	11,4	12,5	18,1	15,1	17,5
Mineral exploration	0,1	0,1	0,1	0,0	0,0	0,0	0,0	0,0	0,0	3,6	3,4	5,1	0,9	0,9	0,8
Artistic originals	0,1	0,2	0,2	0,0	0,0	0,0	0,0	0,0	0,0	1,5	1,8	1,9	0,0	0,0	0,0
NPD	6,0	8,6	8,7	15,2	19,5	14,8	11,2	16,5	22,4	5,3	7,4	8,9	9,1	10,8	12,6
New AED	0,6	0,5	0,3	0,0	0,0	0,0	0,0	0,0	0,0	3,4	2,9	2,9	0,4	0,4	0,2
Economic competencies	**49,5**	**43,7**	**43,0**	**71,1**	**66,4**	**65,2**	**66,2**	**65,5**	**66,0**	**57,3**	**57,7**	**54,8**	**55,4**	**51,4**	**46,7**
Advertising	11,9	10,7	11,5	32,1	26,7	28,8	13,6	9,1	8,1	18,8	16,7	19,4	18,3	16,8	14,3
Market research	1,6	0,9	1,2	1,0	0,9	0,5	1,5	3,7	0,6	2,9	3,9	2,8	1,9	2,9	2,9
Firm specific human capital	10,9	9,6	8,5	14,6	13,5	10,0	17,2	16,9	11,0	11,9	9,6	8,0	17,5	14,7	12,3
Organisational capital	25,1	22,4	21,8	23,4	25,3	25,9	33,9	35,9	46,3	23,8	27,5	24,7	17,8	17,0	17,1
purchased	*14,2*	*13,6*	*13,8*	*11,4*	*10,1*	*10,9*	*13,6*	*13,9*	*30,4*	*14,1*	*14,9*	*15,4*	*4,0*	*4,0*	*5,4*
onwn account	*10,8*	*8,7*	*8,0*	*12,0*	*15,1*	*15,0*	*20,3*	*22,0*	*15,9*	*9,7*	*12,7*	*9,2*	*13,8*	*13,0*	*11,7*
Total intangible capital	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**

Table 5- Composition of Intangible Gross Fixed Capital Formation – Selected European Countries 1995-2005

	Portugal			Spain			Sweden			UK		
	1995	**2000**	**2005**	**1995**	**2000**	**2005**	**1995**	**2000**	**2005**	**1995**	**2000**	**2005**
Computerized information	**6,8**	**12,1**	**10,6**	**0,0**	**0,0**	**0,0**	**18,6**	**21,0**	**20,4**	**18,1**	**21,5**	**22,3**
Innovative property	**13,6**	**18,3**	**18,1**	**22,8**	**22,0**	**28,3**	**37,1**	**34,8**	**37,1**	**25,2**	**22,4**	**20,4**
Scientific R&D	2,7	4,6	6,4	13,5	14,4	20,2	32,2	30,5	33,2	17,0	13,8	13,1
Mineral exploration	2,8	2,8	1,8	0,0	0,0	0,0	0,0	0,0	0,0	0,1	0,0	0,0
Artistic originals	1,5	1,6	1,1	0,0	0,0	0,0	0,0	0,0	0,0	0,4	0,1	0,1
NPD	6,5	9,3	8,8	9,3	7,7	8,2	3,7	3,4	3,1	7,4	8,1	6,9
New AED	0,1	0,1	0,0	0,0	0,0	0,0	1,1	0,9	0,8	0,3	0,3	0,3
Economic competencies	**79,6**	**69,6**	**71,3**	**77,2**	**78,0**	**71,7**	**44,4**	**44,3**	**42,5**	**56,7**	**56,2**	**57,3**
Advertising	33,0	29,5	16,3	36,5	40,8	33,2	11,9	12,3	11,8	10,6	11,8	10,3
Market research	1,9	1,4	1,5	2,5	3,0	2,4	0,6	0,7	0,6	1,2	1,1	1,5
Firm specific human capital	10,1	8,6	7,0	16,3	14,2	13,0	11,7	10,4	8,8	6,2	5,7	6,4
Organisational capital	34,6	30,1	46,4	21,9	20,0	23,0	20,1	20,9	21,2	38,7	37,7	39,1
purchased	*25,0*	*23,2*	*36,5*	*7,8*	*8,0*	*9,5*	*13,7*	*15,4*	*15,1*	*12,0*	*14,0*	*13,4*
onwn account	*9,6*	*7,0*	*9,9*	*14,1*	*12,0*	*13,5*	*6,4*	*5,4*	*6,2*	*26,7*	*23,7*	*25,7*
Total intangible capital	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0	100,0

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 growth[5].

This section presents the results obtained performing a growth accounting exercise including two definitions of capital:

- all tangible and intangible assets (national account intangible assets, new intangible and tangible assets);
- only national account assets (which includes a subset of intangible assets[6] and all tangible assets).

An analysis of the results obtained for the above definitions provides a picture of the impact of intangibles on measured productivity growth and the extent to which national accounts are affected by omitting some intangible assets.

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

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

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.

[5] See Barnes and McClure (2009) for a detailed description of the effects of capitalizing intangibles.
[6] See the SNA for a detailed asset description.

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:

$$g_K(t) = \sum_{i=1}^{ni} 0.5\left(v_t^i + v_{t-1}^i\right)\ln\left(S^i{}_t / S^i{}_{t-1}\right) \qquad (2)$$

where S^i_t is the productive stock of asset *i*,

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

is the cost-share of asset *i* in period t, u^i_t 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 *nz* intangible-type assets, then the index of intangible capital services is:

$$g_I(t) = \sum_{i=1}^{nz} 0.5\left(vi_t^i + vi_{t-1}^i\right)\ln\left(SI^i{}_t / SI^i{}_{t-1}\right) \qquad (3)$$

where

$$vi_t^i = u_t^i SI_t^i / \sum_{i=1}^{ni} u_t^i SI_t^i$$

is the share of intangible asset *i* in the value of total cost for intangible capital services and SI^i_t 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 [$S^i_t=(1-d^i)S^i_{t-1}+I_t$]
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 pattern[7].

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

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

$$u^i_t = q^i_t (r_t + d^i_t - g^i_t) \qquad (4)$$

where:

- q^i_t 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^i_t is economic depreciation rate of asset i and
- g^i_t 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:

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

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

[7] 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.

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-employed[8] ().

Then the remunerations of intangible and tangible capital are:

$$P_I I = \sum_{i=1}^{nz} u_t^i SI_t^i \quad \text{and} \quad P_T T = \sum_{j=1}^{nt} u_t^j ST_t^j \tag{6}$$

where SI^i_t is the productive stock of intangible asset *i*, and ST^j_t 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:

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

6. Empirical results

In this section we illustrate the results of the growth accounting exercise based on equation (1). Tables 6 and 7 show the relative contributions of capital deepening and total factor productivity to labour productivity growth respectively when only national account intangible assets are capitalized and when all new intangibles are included. The comparison of the two tables is very useful to draw some conclusions about the effects of the capitalization of intangibles on productivity growth.

The overall impact on labour productivity growth in the period 1995-2005 is positive but not very large, with the exception of Austria and, to a lesser extent, Finland and Germany. The modest effect is due to the fact that the inclusion of intangibles has an opposite effect on the rate of growth of labour productivity according to the period of analysis. In 1995-2000, the capitalization of intangibles increases labour productivity in all countries considered, while in 2000-2005 it has the opposite effect (with the exception of Austria). It is worth noting that since the beginning of the new millennium, many European countries have decreased in the rate of labour utilization, which was also accompanied by a sharp decline in labour productivity growth, while in the second half of the nineties some of them experienced a pick-up in both labour utilization and labour productivity growth[9]. This results are also related to the well known dependence of growth accounting estimates on the period of analysis (CHS;2005).

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

[9] See OECD Productivity Report, 2008.

In 1995-2000, the positive effect of capitalizing intangibles on labour productivity growth varies across countries. Finland and Sweden recorded the highest growth in labour productivity both when new intangibles are excluded from the asset boundary and when they are capitalised, with labour productivity growing respectively at 3.19 per cent a year and 3.38 per cent (Table 6) when only national account intangibles are treated as capital compared to 3.38 and 3.65 per cent a year (Table 7) when all intangibles are included. The highest increase in labour productivity growth is recorded in UK (0,32 percentage points), while Denmark and Portugal are the countries where capitalising new intangible causes the lower increase (respectively 0,12 and 0,11 percentage points).

Table 6 – Including National Account Intangible Assets (Current Asset Boundary) – Contributions to Labour Productivity Growth

	1995-2005			1995-2000			2000-2005		
	LPG	CD	TFP G	LPG	CD	TFP G	LPG	CD	TFP G
Austria	1,95	0,88	1,06	3,00	0,96	2,02	1,29	0,90	0,38
Denmark	1,36	0,48	0,87	0,75	-0,19	0,95	1,85	1,12	0,72
Finland	2,77	0,38	2,37	3,19	-0,17	3,37	2,64	0,95	1,68
Germany (including ex-GDR from 1991)	2,10	1,17	0,92	2,11	1,01	1,09	1,94	1,17	0,76
Italy	0,14	0,44	-0,30	0,97	0,35	0,62	-0,29	0,56	-0,85
Netherlands	2,15	0,76	1,38	2,50	0,43	2,07	2,15	1,22	0,92
Portugal	1,73	2,03	-0,29	2,65	2,05	0,59	0,56	2,00	-1,41
Sweden	3,38	1,08	2,28	3,38	0,76	2,60	3,73	1,31	2,39
United Kingdom	2,50	1,01	1,48	2,66	0,96	1,68	2,19	1,08	1,10

Table 7 – Including New Intangible Assets – Contributions to Labour Productivity Growth

	1995-2005				1995-2000				2000-2005			
	LP-G	NA-CD	NI-CD	TFP-G	LP-G	NA-CD	NI-CD	TFP-G	LP-G	NA-CD	NI-CD	TFP-G
Austria	2.11	0.83	0.29	0.98	3.19	0.90	0.32	1.94	1.43	0.85	0.29	0.29
Denmark	1.39	0.45	0.20	0.73	0.88	-0.18	0.17	0.88	1.79	1.04	0.22	0.52
Finland	2.87	0.35	0.32	2.18	3.38	-0.16	0.35	3.19	2.56	0.88	0.29	1.37
Germany	2.19	1.10	0.23	0.85	2.37	0.95	0.23	1.17	1.91	1.09	0.24	0.57
Italy	0.19	0.42	0.06	-0.29	1.18	0.34	0.14	0.70	-0.38	0.54	0.00	-0.91
Netherlands	2.18	0.70	0.24	1.23	2.75	0.39	0.33	2.01	1.96	1.12	0.20	0.63
Portugal	1.77	1.92	0.19	-0.34	2.76	1.94	0.22	0.58	0.54	1.89	0.17	-1.49
Sweden	3.37	0.98	0.38	1.99	3.65	0.69	0.43	2.50	3.45	1.19	0.33	1.90
UK	2.57	0.92	0.26	1.37	2.98	0.88	0.37	1.70	2.07	0.98	0.17	0.90

In 2000-2005, the decrease of labour productivity growth due to the capitalization of the intangibles is very high in Sweden (0.28 percentage points) and quite relevant in the Netherlands and UK (respectively 0,19 and 0.12 percentage points), while it is negligible in Portugal. On the other hand

including new intangibles in GFCF increases labour productivity growth in Austria also in the years 2000-2005 (an increase of 0.14 percentage points).

The relative contribution of capital deepening and TFP to labour productivity growth changed considerably after the inclusion of all intangibles, with the contribution of capital deepening increasing and the growth of TFP decreasing. In the whole time period the contribution of capital deepening increased from 0.38 percentage points a year to 0.67 percentage points a year in Finland (an increase of 0.29 percentage points), from 1.08 percentage points to 1.35 percentage points a year in Sweden (an increase of 0.27 percentage points) and from 0.88 to 1.12 percentage points in Austria (an increase of 0.24 percentage points). Denmark, Germany, Netherlands and UK registered a quite similar effect from capitalising new intangibles (on average equal to 0.17 percentage points). Italy and, to a lesser extent Portugal, stand out as exceptions, with an increase of contribution of capital deepening equal, respectively to 0.04 and 0.08 percentage points. The same effect is confirmed in the sub-periods.

The fall in the rate of TFP growth indicates that before the capitalization a portion of labour productivity growth that was attributed to TFP was actually driven by intangible capital deepening. In all countries but Italy, including new intangibles in the asset boundary increases the contribution of capital deepening more than labour productivity growth and this implies that TFP growth decreases when new intangibles are capitalised. 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 capitalising new intangibles causes a strong decrease in TFP growth (0.29 percentage points). On the other hand, in Austria the high increase in capital deepening is associated with an high increase in labour productivity growth: then the reduction in TFP growth is quite modest (0.08 percentage points).

The decrease of TFP contribution to labour productivity growth is more pronounced for the 2000-2005 period. The decrease of the annual growth rate of TFP amounted to 0.49 percentage points in Sweden where the growth of TFP dropped from 2.39 percentage points to 1.90 percentage points when the intangibles are capitalized. It was 0.31 percentage points in Finland (from 1.68 percentage points to 1.37) and 0.29 percentage points in Netherlands (from 0.92 percentage points to 0.63 percentage points when the intangibles are included). The decline of the TFP rate of growth was greater than 0.10 percentage points in the remaining countries but in Italy and in Portugal. However the TFP decline is in line with Jorgenson and Griliches (1967) and with the fact that TFP is measured as a residual.

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, both because the growth of labour productivity is modified when they are included in GFCF and because they are an important source of growth in all the countries considered (with the exception of Italy and Portugal). Further the role of capital deepening in the growth of labour productivity is significantly larger when intangibles are included. In other words, as showed in CHS (2005) our results confirm 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 .

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 preliminary 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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