1. Introduction

The ideas of “knowledge economy” and “knowledge capital” have been central to the economic debate since at least the mid-1990s. ICTs play a prominent role in this debate, because they are regarded as a general purpose technology underpinning the development of a wide range of inventions.

The adoption of ICTs requires firms to undertake complementary expenditures in intangible inputs: training, management and organisation. As these intangible inputs will contribute to the firm’s production over a prolonged period of time, they can legitimately be regarded as assets. Therefore, the expenditures in intangibles inputs that accompany the adoption of ICTs should be regarded as an increase in the stock of intangible capital, ie: as an investment in intangibles.

Intangible assets do not appear on firms’ conventional balance sheets, but they may account for higher firms’ market valuations and “excess” returns to ICT investments. Van Reenen et al. (2010) point out that high and “above normal” returns accrued to investments in ICTs are a proxy for the contribution of complementary investments in intangibles.

Similarly, the inclusion of intangible investments in the System of National Accounts (SNA) tend to result into a significant increase in the growth of valued added and productivity (Corrado, Hulten and Sichel, 2006 and further studies based upon it).

Lack of reliable statistics on intangibles assets may incorrectly or incompletely inform policy making. While the economic and policy communities agree on the key role played by intangibles in the knowledge economy, the rational, design and evaluation of any policy targeted to support investment in intangibles requires a solid measurement of them.

The aim of this paper is to highlight these issues as a background for the ICTNET workshop on ICT, R&D and Intangibles which will be held in London the 11-12 of April 2011.

The paper is organised as follows. Section 2 presents the measurement issues related to the capitalisation of intangibles, both at the level of firms’ financial accounts and of national accounts. Section 3 examines the main approaches for the measurement of intangibles. Section 4 reviews the empirical evidence on the contribution of intangible assets to productivity and economic growth. Finally, Section 5 raises some issues for discussion at the workshop.

2. Accounting definitions of intangibles

According to the System of National Accounts (SNA 2008), firms’ expenditures should be capitalised if they are made in order to increase future output production. The distinction between intermediate goods or capital is based on this criterion. As a general rule, if an intermediate good has a useful life (i.e. it contributes to output production for) longer than one taxable year, the cost of this good is capitalised.
Both firm-level and national accounting practices have historically treated expenditure on intangible inputs as an intermediate expense and not as capital. However, to the extent intangible inputs are intended to yield output in some future period, many intangibles should be capitalised (Corrado et al., 2006).

An incorrect classification of intangibles inputs as intermediate consumption would result into an underestimation of the value added produced by firms. For instance, the capitalization of software in the national accounts has had an appreciable effect on the growth of output per worker in the non-farm business sector.

A growing literature suggests that this is just the tip of the iceberg and more intangible expenditures should be capitalised. The recognition of expenditures on research and experimental development (R&D) as capital formation in the SNA 2008 (OECD, 2010a) clearly support this orientation.

There are, however, a number of difficult problems in the capitalisation of expenditures in intangibles.

First, the accounts of business enterprises are not designed to provide information on intangible capital formation, especially when the capital formation consists of production for own final use.

Second, for some types of intangible investment, especially organizational capital and advertising, it is often not directly clear whether expenditures have an expected service life of less than one year—in which case they should be treated as current expenditures—or more than one year—in which case they should be classified as capital formation.

Third, intangible expenditures are generally not adequately measured in official price statistics, so there is a lack of appropriate quality-adjusted price or volume indices. There is also little or no information on service lives or depreciation rates.

Finally, the most vexing problem is the lack of adequate information on valuation, other than the highly aggregated and indirect information that may be reflected in share prices.

Because of the substantial data and measurement problems associated with intangibles, the development of estimates as part of satellite accounts appears as a promising approach. If the analysis of data on certain types of intangible assets, within the context of satellite accounts, demonstrates that they are robust and useful, it may then be appropriate to consider their inclusion in the core accounts. Data on R&D and on worker training appear to be better developed than for other intangibles, and serious attention should be given to the research needed for evaluating them as potential fixed assets in the SNA.

At the firm level, the problems in measuring intangibles reflect the different definitions used in economics and in accounting. Economists define an intangible investment as any expenditure that is not immediately embodied in a physical matter, but which is intended to generate long term benefits. The accountants’ definition is more restrictive. The International Accounting Standards (IAS 381) require a firm to recognise an intangible asset, whether purchased or self-created, only if two conditions are met. First, it is probable that the future economic benefits that are attributable to the asset will flow to the entity; and, second, the cost of the asset can be measured reliably.

1 http://www.iasplus.com/standard/ias38.htm
As a general rule, accountants require the existence of property rights to the benefits associated with intangible investments (Hunter, Webster and Wyatt, 2009). Property rights indicate that firms will be able to appropriate the expected benefits from an investment and permit a reliable measure of its costs. As a result, intangibles assets purchased on the market will tend to be accounted as assets whereas internal investments in brand development, workforce skills and innovation will be charged to expense accounts.

Firms’ balance sheets, therefore, exclude most of the intangible assets accumulated within a company. Money spent on R&D and brand development is still treated as current expenses by accountants, even though the success of many companies depends on their capacity to develop and market new products.

3. The measurement of intangibles

The extensive literature on intangibles focuses mainly on some assets such as R&D expenditures, leaving out other components such as organisational capital or brand equity. Following Sichel (2008) the most recent approaches to measuring intangibles in the economic literature can be classified into three groups:

- Financial market valuation
- Alternatives performance measures
- Direct expenditure data.

The financial market valuation approach assumes that the value of intangible capital corresponds to the difference between the market value of a firm and the value of its tangible assets (Hulten, Hao, Jaeger, 2008). The “market-to-book” gap seems too large to be attributed solely to the mismeasurement of conventional equity while the absence of most intangible assets from financial statements appears like a more convincing explanation of this gap.

Brynjolfsson, Hitt and Yang followed this approach to analyse the link between intangible investments and investment in computers in the US (Brynjolfsson and Yang, 1999; Brynjolfsson, Hitt and Yang, 2000 and 2002). Their estimates suggest that each dollar of installed computer capital in a firm was associated with between five and ten dollars increase in the market value. According to the authors, this difference reveals the existence of a large stock of intangible assets that are complementary to computer investment.

Webster (2000) adopted a similar approach with Australian data, assuming 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% a year over a period of 50 years, from 1948 to 1998.

Following a similar approach, the World Bank (2006) has made estimates of intangible capital at the country level. The value of intangible capital is obtained as the difference between total wealth (measured as the net present value of future sustainable consumption) and natural capital plus produced capital.

The financial market valuation approach may be subject to considerable measurement error as the stock market value is sensible to market inefficiency (Cummins, 2005). It may reflect a mismeasurement due to the investors’ limited information on the value of firm’s intangibles. It
may also be affected by the large variability of the market value of a company due to the short-run expectations of the investors.

Another widely used method to estimate the value of intangible capital uses \textit{alternative measures of firms’ performance}, such as expected profits, earnings or sales. This approach is well exemplified by Cummins (2005). Contrary to the tendency in the literature to treat intangibles as any other fixed factor of production (firms buy intangibles as they would buy machinery), Cummins defines intangible capital as the distinctive way companies combine the usual factor of productions (inputs). Therefore, the value of the intangible capital can be measured as the difference between the “market value” of inputs and the “firm value” of the same inputs, i.e.: their value once they have been internalised in the production of the firm. This difference corresponds to the adjustment costs that the firm is willing to support in order to use these inputs in its production process.

To estimate the return on intangible capital, Cummins proxies the intrinsic value of the firm as the discounted value of expected profits, based on analysts’ forecasts (which he suggested reflect the analysts’ valuation of intangibles). He found no appreciable intangibles associated with R&D or advertising but sizable intangibles (organisational capital) created by IT.

The argument by Brynjolfsson, Hitt and Yang (2002) may be useful in interpreting the above results. They argue that the analyst-based measure of the value of a company may be subject to measurement error as it reflects the biases of analysts and the mistakes in the way forecasts are discounted. Therefore, the effects of intangibles assets on the firms’ market valuation would materialise over a longer period of time.

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 ranging from 31 to 76% of US GDP (using respectively a restricted and a broader definition of intangibles).

From a similar perspective, Lev and Radhakrishnan (2005) developed a firm-specific measure of organisational capital, modelling the effect on sales of organisational capital (proxied by reported ‘sales, general and administrative expenses’ as this includes expenditures that generate organisational capital).

The \textit{direct expenditure approach} was adopted the first time by Nakamura (1999 and 2001), who measured gross investment in intangible assets as the sum of a range of expenditures including R&D, software, advertising and marketing expenditure, and the wages and salaries of managers and creative professionals. He found that US investment in intangibles in 2000 was $1 trillion (roughly equal to that in non-residential tangible assets), with an intangible capital stock of at least $5 trillion.

Building on Nakamura’s work, Corrado, Hulten and Sichel (2005) developed expenditure based measures of a larger range of intangibles for the US, classified capital into three broad categories: computerised information, innovative property, and economic competencies. They estimated that investment in intangibles averaged $1.1 trillion between 1998 and 2000 (1.2 times the tangible capital investment) or 12% of GDP.

Schreyer (2007, p. 79) notes that the Corrado-Hulten-Sichel (2006) approach appears practical for regular measurement of intangibles. This approach does not require explicit
econometric techniques and would appear the best fitted for the purpose of monitoring intangibles as part of a periodic measurement program carried out by a statistical office.

However, this approach is subject to measurement error and data limitations, including whether the list of measures of intangibles is comprehensive and able to capture changes in the nature of intangibles over time.

The Corrado, Hulten and Sichel methodology has been applied in a number of other country studies. Giorgio Marrano and Haskel (2006) show that in the United Kingdom the private sector spent on intangibles a sum equivalent to 11% of GDP in 2004. Jalava, Aulin-Ahmavaara and Alenen (2007) found that the Finnish investment in intangibles was 9.1% of GDP in 2005.

Fukao, Hamagata, Miyagawa and Tonogi (2007) estimated that 7.5% of GDP in Japan was invested in intangible capital in 1995-2002. Hao, Manole and van Ark (2008) estimated the spending on intangibles as percentage of GDP in Germany, France, Italy and Spain in 2004. They found that the GDP share of intangibles was 5.2% in Italy and Spain, 7.1% in Germany and 8.8% in France.

Van Rooijen, Van den Bergen and Tanriseven (2008) found that the Netherlands spent 10% of its GDP in intangibles over 2001-2004. Barnes and McClure (2009) found out that intangible investment in the market sector in Australia was almost half the size of tangible investment and that the average annual growth in intangible investment was about 1.3 times that of tangibles from 1974-75 to 2005-06. Baldwin, Gu and Macdonald (2011) found that investment in intangibles totalled 151 billion dollars in the Canadian business sector in 2008, which represented 13.2% of GDP.

Figure 1. Investment in fixed and intangible assets as a share of GDP, 2006


Estimates refer to the total economy for Canada, Japan, and Sweden; the market sector for Australia, France, Germany, Italy, Spain and the United Kingdom; the non-financial business sector for Finland; and the non-farm business sector for the United States.
Edquist (2009) found out that total spending on intangibles in Sweden was equivalent to 10.6% of GDP in 2004. Nakamura (2010) estimates that investments in intangibles in the United States were as important as investments in tangibles over the period 1959-2007.

The European Commission has financed two research projects (INNODRIVE and COINVEST) on the contribution of intangible investments to innovation, competitiveness, growth and productivity in Europe. Both projects aim at providing new data on intangibles and new estimates of the capacity of intangibles to generate growth. The results by COINVEST were released in 2010 while those by INNODRIVE are forthcoming in 2011.

A breakdown of intangibles by type of assets shows that ICT intangibles (proxied as computerised information) account for a small share in all countries for which data are available (Figure 1). Investments in computerised information reach about 2% of GDP in Japan, Sweden and Denmark. For the other countries the share of ICTs appears lower and typically below 1.5% of GDP.

4. The impact of intangibles on the economy

It is widely recognised that intangibles are a major determinant of innovation, growth and employment in the “knowledge economy”. Endogenous growth models have emphasized knowledge and skill as important intangible assets and stressed the role of intangibles, such as knowledge spillovers, in generating persistent growth (Romer, 1986 and Lucas, 1988).

The importance of R&D and innovation is also explicitly recognised in the “Lisbon process” aimed at improving the growth and employment performance of the EU. However, our understanding of the contribution of intangibles to economic performance remains incomplete.

Several empirical studies have tried to estimate the contribution of intangible to economic growth. The most common approach is to introduce measures of intangibles as an additional input into a production function. Within this approach, one can distinguish two groups of studies. The first group derives the elasticities of substitutions between output and inputs from the economic theory (growth accounting); the second group estimates these elasticities through econometric analysis (growth regressions).

Growth accounting

Corrado, Hulten and Sichel (2006) developed a methodology to estimate the contribution of intangible capital to economic growth using the growth accounting framework by the US Bureau of Economic Analysis (BEA). They classify intangible capital into three broad categories (computerized information, innovative property, and economic competencies) and used them as additional inputs into the US economy-wide production function.

The inclusion of the intangible assets makes a significant difference in the observed patterns of US economic growth. The rate of change of output per worker increases more rapidly.

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3 Data on intangible assets for the United States provided by C. Corrado; data for Japan provided by T. Miyagawa; data for Sweden provided by H. Edquist; data for Germany, Italy, Spain and the United Kingdom provided by J. Haskel, A. Pesole and members of the COINVEST project; data for Austria, Denmark and the Czech Republic provided by J. Hao and B. van Ark; data on intangible and tangible investment for Australia provided by P. Barnes; for Canada by N. Belhocine. Data on tangible investment for France is based on INSEE data. For other countries figures for tangible investment are OECD calculations based on EU KLEMS Database and OECD, Annual National Accounts Database.
when intangibles are counted as capital and capital deepening becomes the unambiguously dominant source of growth in labour productivity. The role of multifactor productivity is correspondingly diminished, and labour's income share is found to have decreased significantly.

The capitalization of intangibles increases the rate of productivity growth by 20% in the period 1973-1995 and by 11% in the period 1995-2003 in the United States. The portion of productivity growth explained by intangibles is 26% and 27%, respectively. In 1995-2003, the contribution of intangibles to economic growth became as large as the one of tangibles while the multifactor productivity decreases from 51% to 35% of GDP growth.

Marrano, Haskel and Wallis (2007) applied the methodology of Corrado, Hulten and Sichel (2006) to the United Kingdom and found that the inclusion of intangibles in the asset boundary increased productivity growth by 11% in 1979-1995 and by 13% in 1995-2003. About 15% of growth in output per hour was accounted for by intangible capital deepening in 1979-2005 and 20% in 1995-2003 while the contribution of multifactor productivity declined from 25% to 16%.

Jalava, Aulin-Ahmavaara and Alanen (2007) undertook a similar growth accounting exercise for Finland and found that intangible capital rose in importance after 2000. Intangible capital accounted for 16% of labour productivity growth in 1995-2000 and for 30% in 2000-2005. According to Fukao et al. (2007), an increase in the growth contribution of intangible capital over time seems to hold also for Japan. They find that intangible capital explains 11% of the Japanese growth rate in 1980-1990 and 40% in 1990-2002. They also find further that the inclusion of intangible capital increases growth by 3% in 1980-1990 and by 7% in 1990-2002 and that the importance of multifactor productivity declines.

Baldwin, Gu and Macdonald (2001) found that for Canada Investment in intangibles increased much faster than investment in tangibles over time and the ratio of intangible investment to tangible investment increased from 23% in 1976 to 66% in 2008. They also found that intangibles made a significant contribution to labour productivity growth and the contribution of intangibles to labour productivity growth was only slightly lower than that of tangibles in the Canadian business sector over the period 1995-2003 (29% versus 33% for tangibles).

Hao, Manole and van Ark (2008) analysed Germany, France, Italy and Spain in the period 1995-2003. They find that intangible capital deepening accounts for 31% of labour productivity growth in Germany, 37% in France, 59% in Italy and 64% in Spain. Labour productivity growth increased by 10% in Germany, 14% in France, 37% in Italy and 40% in Spain.

More recently, Corrado et al. (2009) carried out a growth accounting exercise for the United States, some selected EU 27 countries and the average of the EU-15 countries over the period 1995-2006. Similar to the findings by Corrado, Hulten and Sichel (2006), they found that intangible capital accounted for 28% of labour productivity growth in the US but only for 22% in Germany, France, Italy, Spain, Austria and Denmark.

Growth accounting studies find a positive effect of intangible capital on various measures of economic growth in different countries and for different time periods. However, the assumptions underlying the growth accounting approach are strong (eg: perfect competition, constant return to scale, perfect knowledge of the returns from intangibles) and, generally, not tested. Econometric analysis, on the contrary, does not need these assumptions.


**Growth regressions**

Several recent studies based on growth regression find positive effects of intangibles on economic growth. Roth and Thum (2010) performed a growth regression and a dynamic panel analysis at the macro level on EU-15 countries from 1995 to 2005. They detected a positive and significant relationship between business investments in intangible capital and labour productivity growth. Intangible capital deepening is associated with faster labour productivity growth. In addition, intangibles explain a significant portion of the unexplained variance in labour productivity growth across countries and over time. The relationship between intangibles and labour productivity growth appears stronger in the period 1995-2000 and in Germany, Austria, Belgium, Netherlands, Luxembourg and France, but it does not hold when controlling for country-specific effects.

At the micro level Bontempi and Mairesse (2008) examine the size and productivity of total intangible capital relative to total tangible capital for a large panel of Italian Manufacturing firms. They decompose total intangibles in two ways: intangibles expenses in firms' current accounts (as usually considered in empirical studies) versus intangible capitalized in firms' balance sheets (usually not considered); and "intellectual capital" (i.e. R&D expenditures, and patenting and related costs) versus "customer capital" (i.e., advertising expenditure, and trademarks and related costs). Their results suggest that firms' accounting information on intangible investments is genuinely informative, and that intangible capital and its different components are at least as productive as tangible capital. These findings are robust to different specifications of the production functions, although they results into different elasticities of substitution between tangible and intangible capital.

Oliveras and Castillo (2008) measure the effect of intangible assets on productivity using data on 10000 Spanish firms selected randomly by size and sector, over a ten-year period, from 1995 to 2004. They analyse to what extent labour productivity can be explained by physical capital deepening, by intangible capital deepening and by firm’s economic efficiency (or total factor productivity –TFP).

Their results confirm the hypothesis that TFP weight has increased during the period studied, especially in those firms that have experienced a significant raise in intangible capital. This suggests the existence of complementary effects between capital investment and intangible resources on productivity growth. These results show significant differences also across economic sectors and by firms’ size.

Haskel and Wallis (2010) use data on market sector productivity, R&D and non-R&D intangible assets, and public sector R&D spending to look for evidence of market sector spillovers from intangible investment and from public R&D. They find (a) no evidence of spillover effects from intangible investment at the market sector level, including from R&D, (b) strong evidence of market sector spillovers from public R&D spend on research councils, and (c) no evidence of market sector spillovers from public spending on civil or defence R&D. Their findings tentatively suggest that for maximum market sector productivity impact, government innovation policy should focus on direct spending on research councils.
5. Issues for discussion

- The Corrado-Hulten-Sichel (2006) methodology has been applied to a number of countries and appears suited for the purpose of monitoring intangibles as part of a periodic measurement program carried out by a statistical office. Can this approach be realistically adopted as a common cross-country framework for the measurement of intangibles?

- As Hulten (2009) states, current measurement of intangibles relies on a “high ratio of assumption to fact”. Existing surveys do not capture intangible investment well; at best only partially (e.g. The European Innovation surveys) and, at worst, not at all. The type of measures that need to be improved concern above all information on intangibles’ valuation, service lives, prices and depreciation. How can these measures be improved?

- The growth accounting approach finds a strong contribution of intangibles to productivity and growth whereas regression results are less clear-cut about the existence and the size of these effects. In addition, the evidence of spillovers, which would provide a rational for public support to investment in intangibles, remains weak. What are the policy implications from these studies? How can economic research on intangibles help to define a policy agenda for growth?
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