Abstract: This paper provides an overview of the methods developed so far to measure intangible assets and to evaluate their contribution to economic growth. We review the work carried out under the INTAN-Invest research collaboration and the SPINTAN EU Funded project to generate cross-country estimates of intangible investments coherent with the Corrado, Hulten and Sichel (2005) model. We also provide a summary of recent empirical evidence on the role of intangible capital as a driver of growth across industries and sectors in European countries and the US as an illustration of uses of the intangibles assets data.

JEL codes: O30, O47, E22

Keywords: Intangible investments, productivity growth, innovation

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Advancements in measuring intangibles for European economies

1. Introduction

Investments in intangible assets are widely recognized as major determinants of innovation, growth and employment in the ‘knowledge economy.’ Endogenous growth models emphasize that knowledge and skills are important determinants of growth and stress that knowledge spillovers generate persistent growth (e.g. Romer, 1986; Lucas, 1988). The importance of R&D and innovation was also explicitly recognized in the ‘Lisbon process’, and in its successor the ‘Europe 2020’ agenda, aimed at improving the growth and employment performance of the EU.

Corrado, Hulten and Sichel (2005, 2009), hereafter CHS, addressed the conceptual problem of defining intangible assets using an inter-temporal framework e.g. Weitzmann (1976, 2003). The CHS analysis leads to the conclusion that ‘any use of resources that reduces current consumption in order to increase it in the future qualifies as investment’ and that all types of capital should be treated symmetrically. Therefore, ‘investment in knowledge capital should be placed on the same footing as that of investment in plant and equipment’ (Corrado et al. (2005), p. 19 and Corrado et al. (2009), p. 666). A convenient consequence of the CHS approach and its emphasis on the symmetric treatment of all assets is also that one does not have to worry too much about defining ‘intangibles’ by way of specific characteristics. Rather it is more important to determine whether a spending type meets the test of being a current outlay that enhances the future capacity of producers (and thereby future consumption). Additionally, the CHS approach does not require explicit econometric techniques and rather offers a practical approach to monitoring intangible capital as part of the measurement program carried out by a statistical office (which, after all, already counts investment in some intangibles such as software and R&D).

Building on Lev (2001) and Nakamura (1999, 2001), CHS developed expenditure measures for intangible investment in the United States, classifying intangible capital into three broad categories: computerized information, innovative property, and economic competencies. At that time only software and artistic and entertainment originals were recognized as assets in official guidelines for national accounts. Since then, the national accounts fixed asset boundary has been expanded to include R&D (SNA 2008/ESA 2010).

The empirical understanding of the contribution of intangibles assets to economic performance improved substantially over recent years. A significant research effort generated measures of intangible investment for business sectors for twenty-eight European member states plus the US (INTAN-Invest (1), drawing on the COINVEST and INNODRIVE projects (2)). In addition, industry level estimates of intangible investment were developed as part of the INDICSER project (3) (Niebel et al. (2016)) and INTAN-Invest has recently incorporated industry estimates into their database (see below). At the same time, researchers in other countries have looked at intangible investment in, for example, Japan (Fukao et al. (2009)).

More recently, Corrado et al. (2017b), under the SPINTAN (4) project, extended and modified the CHS framework for application to the public sector. They proposed the construction of a satellite national account to capture public investments in intangibles at the level and detail needed for modeling the creation and use of knowledge-based capital in a society. Merging the INTAN-Invest and SPINTAN measures of intangibles allows completing the coverage of intangible investment by industry sector, making possible the generation of total economy

(1) www.intaninvest.net.
(2) www.coinvest.org.uk; www.innodrive.org.
(3) www.indicser.net.
(4) www.spintan.net.
growth accounts with intangibles as productive assets. This is a crucial advancement because policy analysis of an economy’s growth and productivity performance requires complete data on both private and public intangible investments.

The aim of this paper is to provide an overview of recent developments in measuring intangible investment in the EU countries and the US. The paper is structured as follows. The theoretical framework is set out in the next section. This is followed in Section 3 by a description of the measurement methods and data. Section 4 presents some summary descriptive measures for the total economy whereas Section 5 quantifies the empirical implications of capitalizing intangibles for growth. The paper concludes with a brief summary and discussion of future measurement challenges.

2. The theoretical framework

CHS (2005, 2009) advanced a simple three-sector model that specifies production functions for consumer goods, conventional investment goods, and intangibles. The model was used to show how an economy’s input and output growth changed when business investment in intangibles was capitalised. The model was also adopted to identify the prices and quantities that needed to be measured in order to capitalise intangibles and study their contribution to growth.

The approach outlined below follows Corrado et al. (2011), integrating the various approaches to innovation (this section), and implementation into a national accounts measurement framework (Section 3) — see also Corrado et al. (2013). The main assumptions of the model are the following. Knowledge (ideas) is an input needed to produce consumption and tangible investment goods, together with labour and tangible capital. There exist two types of knowledge. One is knowledge that is generated without using factors of production and that is freely available to firms (free knowledge). The other is knowledge that is produced using inputs and that firms must pay for to use in their production process (commercialised knowledge). Commercialised knowledge is accumulated over time, generating the stock of commercial knowledge via the standard perpetual inventory relation and with its own user cost.

To be more precise, the model considers a simplified economy with just two industries/sectors. The innovation (‘upstream’) sector produces new finished ideas, i.e. it commercializes knowledge (e.g. a way of organizing production, or a software programme adapted to the needs of the organisation that implements pay and pension calculations), while the ‘production’ (‘downstream’) sector uses the knowledge to produce consumption and tangible investment goods. The innovation sector can, at least for some period, appropriate returns to its knowledge, and so this model is identical to Romer (1990) (where patent-protected knowledge is sold at a monopoly price to the final output sector during the period of appropriability), while the production sector is a price taker for commercialised knowledge. Both sectors are price takers for labour and tangible capital.

The first implication of the model is a broad definition of investment, which includes expenditure to purchase both tangible goods and commercialised knowledge, and a broad definition of aggregate output, which includes not only consumption goods and tangible investment goods but also commercialised knowledge.

\[ P_0^Q = P^Y + P^N = P^C + P^I + P^N \]
Where $Q$ is real value added in the whole economy, $Y$ is the output of the downstream sector $N$ is commercialised knowledge, $C$ is consumption, $I$ is tangible investment, and $P$ with the appropriate superscript are the corresponding prices.

The idea of including intangible investment as part of GDP can be thought of by analogy to tangible investment. Suppose an aircraft factory buys in aluminium and produces both final output and its own machines. Then its value added should be properly treated as both the final aeroplanes and the machines, i.e. one might think of the factory as consisting of both an aircraft factory and also a machine factory. Its investment should be treated as equal to the output of the new machines. Now, suppose the factory also writes its own long-lived software to run the machines. Then we should think of it as both an aircraft factory and machine factory and also a software factory and its investment should include not only the machines but also the new software that is produced. The second implication is that the expression for the sources of growth in value added is,

\[
d\ln Q = s\frac{1}{Q}d\ln L + s\frac{K}{Q}d\ln K + s\frac{R}{Q}d\ln R + d\ln TFP
\]

where $d\ln TFP$ is defined as the growth in $Q$ (extended output including commercialised knowledge) over and above the growth contributions of labour ($L$), the accumulated stock of tangible capital ($K$) and the accumulated stock of commercialised knowledge ($R$) and where $s^X$ is the share of nominal value added accounted for by payments to factor $X$.

The final implication is that the model provides a measure of innovation. Equation (2) says that value added growth is due in part to growth in $L$ and $K$. This formalises the idea of Jorgenson (2007), that growth can be achieved by duplication i.e. adding more labour and tangible capital, but also by innovation, that is, adding more ideas. It further says that growth can be due to the increased use of paid-for ideas, $d\ln R$, weighted by their rental price (the licence fee to use a patent in an industrial process, for example); hence their contribution to $d\ln Q$ is $s^Q d\ln R$. The final term, $d\ln TFP$ is the growth impact of everything else, which in this model can only be free ideas used in both sectors. Thus in this model, innovation in the sense of use of ideas is also growth net of $K$ and $L$ usage, i.e.

\[
Innovation = s\frac{1}{Q}d\ln R + d\ln TFP = d\ln Q - (s\frac{1}{Q}d\ln L + s\frac{K}{Q}d\ln K)
\]

Many innovation studies have attempted to distinguish between innovation and diffusion, the latter being the spread of new ideas. If the ideas come for free, they are, in this framework, counted in TFP growth. So the part of innovation measured by $s^Q d\ln R$ is investment in commercialised new ideas and that part measured by $d\ln TFP$ might be regarded as the diffusion of free ideas.
3. Measuring intangibles for the total economy: concepts and methods

The empirical counterpart of the model outlined above requires measures of intangible investment. Corrado et al. (2013) set a general expression for estimating nominal intangible investment for a country or a region as follows:

\[
P_{\text{int}}^{\text{N}} = \sum_{i=1}^{N} \sum_{s=1}^{S} (\gamma_{\text{own-account}}^{i,s,t} \cdot \text{OwnCost}^{i,s,t}_{\text{own-account}} + \gamma_{\text{Purchased}}^{i,s,t} \cdot \text{Purchased}^{i,s,t}_{\text{Purchased}})
\]

where \(P_{\text{int}}^{\text{N}}\) is nominal expenditure, \(i\) is a subscript for industries, and \(s\) is a subscript for sectors. \(\text{OwnCost}\) and \(\text{Purchased}\) are time-series indicators of the own-account and purchased components of intangible investment, respectively. The other symbols, which though fully subscripted (i.e., by industry, sector, and time), are parameters: \(\lambda\) and \(\gamma\) are sector — and asset-specific capitalization factors that adjust the own cost and purchased indicators to benchmarks for each asset and sector. More specifically, \(\lambda\) is a time series indicator that is needed to transform the intermediate expenditure on intangibles into a sector-industry gross output (own-account) or gross spending measure varying over time \((^1)^{11}\); \(\gamma\) is the capitalization factor \((^{12})\), namely, a parameter that adjusts a spending measure to a measure of investment — a fraction of revenues or employee time, say, devoted to long-lived activities (see Corrado et al. (2005)).

Intangible assets can thus be distinguished between assets that are already classified as investment in national accounts (software, R&D, mineral explorations and entertainment and artistic originals) and those assets that are not considered as investment (brands, organizational capital, design, training). Each intangible asset can be assumed to be composed of two different parts: purchased and own-account. In what follows we will take a closer look at the distinction between purchased and own-account intangibles distinguishing between intangibles already classified as investments in national accounts (NA) and assets that are not included in the NA asset boundary (non-NA).

**Purchased intangible investment**

With regard to the purchased component of non-national accounts CHS intangibles the time series for \(\text{Purchased}\) indicators are obtained from use tables in current prices (NACE Rev. 2 basis), available from most national statistical offices (NSOs) from 2002 onwards; for earlier years, it is possible to resort to the input-output tables generated from the WIOD project (see Bacchini et al. (2016)), for a detailed description of sources and methods). The use tables provide intermediate purchases by industry (columns) and by product (rows) according to the Classification of Products by Activity (CPA) codes. For the four CHS purchased assets, design, brands, organizational capital, and training, the following codes are selected: Architectural and engineering services, technical testing and analysis services (CPA M71); Advertising and market research services (CPA M73); Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70); and Education services (CPA P85).

\(^{11}\) If annual time series of the use tables are available the \(\lambda\) parameters for the purchased component are implicit in the time series or can be estimated based on the relationship between those series and an indicator of intangible expenditure.

\(^{12}\) The capitalization factors are percentage values applied to the total expenditure on intangibles classified as intermediate costs to determine what part of it can be included in the asset boundary. For the non-national account assets these are set as follows (Corrado et al. (2016b)): design, 0.5; advertising and market research, 0.6; purchased organizational capital, 0.8; own-account organizational capital, 0.2; and training, 1.
Then once intangible expenditure by market and non-market industries is identified, the CHS methodology is adopted to capitalize each series (Corrado et al. (2005)).

As for national accounts intangibles, estimates rely on R&D and software data released by NSOs but then it is necessary to make further elaborations to generate intangible investment measures cross-classified by industry and institutional sector. Data availability depends on two different scenarios and these can vary also depending on the asset: one when NSIs provide gross fixed capital formation (GFCF) by industry and by sector but not the cross-classification between them and the other when GFCF data are available only by industry for software and/or R&D and there is no information classified by institutional sector. To deal with both situations two calculation methods have been identified within the SPINTAN project and they are exhaustively described in (Bacchini et al. (2016)).

**Own-account intangible investment**

The standard approach to measure gross fixed capital formation for own final use is based on the costs of production, i.e. the sum of compensation of employees, intermediate consumption and the cost of capital (consumption of fixed capital and, only for market producers, net operating surplus). The key variable in the calculation is the labour cost component frequently measured on the basis of compensation of specific occupational groups directly involved in the production of the asset for internal use (thus for example own-account software spending might be inferred from the wages of software occupations outside the software-producing industry).

Estimate of own-account training is a bit problematic since there is no information available about the labour costs of specific occupational groups directly involved in internally produced training activity; thus the lion’s share of such costs are the opportunity costs of workers undergoing firm-specific training.

As for the remaining assets it is assumed that the own-account production of design, advertising and market research in the non-market sector is negligible and might be omitted while for the market sector this remains an open issue (see Bacchini et al. (2016), and Corrado et al. (2016b)). INTAN-Invest (2017) generates measures of brand and design only for the purchased component because there is not detailed occupational information available to estimate the own-account portion of these assets.

Measures of own-account organizational capital are produced by estimating total compensation of managers and then applying the corresponding capitalization factor (that takes into account also the other components of the cost of production, besides labour cost).

**Prices and volume measures of intangibles**

Generating measures of intangible investment in real terms is a big challenge because units of knowledge cannot be readily determined. Most intangible assets are unique products (with the exception of copies, e.g. in the case of pre-packaged software) and a large amount is produced on own account. Thus to get volume measures of intangibles it is necessary to make some assumptions, taking into account the current practice in NSOs. Purchased intangible assets, independently of the sector performing the investment, are generally deflated using average price indices because sector specific price information is not available. Own-account intangibles in real terms instead are obtained with an input based approach built on cost indices varying across sectors.

Specific recommendations about price measures for intangibles are provided by the *Handbook*
on Deriving Capital Measures for Intellectual Property Products (OECD (2010)), that identifies three broad categories of intangibles and the corresponding prices: copies for sale, originals for sale, and originals for own-use. Hedonic methods are suggested to deflate copies; Producer prices (see the Producer Price Index Manual) are considered the best price measures for originals for sale, and originals for own-use has to be evaluated by means of productivity-quality adjusted price measures, and when these are not available it is recommended to adopt input-based methods.

The IPP suggestions can be easily followed to deflate purchased organizational capital, design, advertising and market research, because producer price indices for the corresponding industries are generally available, even if the statistical practice varies across countries. Service Producer Price Indexes (SPPIs) are generated taking into account quality adjustments and they are rather heterogeneous across countries and industries. Further, they are asset specific. Thus we assume, that currently, they are the best available price measure to deflate purchased intangible assets not included in the SNA asset boundary.

National accounts intangibles (software, R&D, mineral explorations and entertainment, literary and artistic originals) are deflated following two different approaches. Software is deflated adopting the harmonized price deflator developed by Corrado et al. (2012) and based on the OECD method. The harmonized price is obtained using a country-specific input cost index, the US pre-packaged software price index, and adjusting it for the relative inflation differential between the country of interest and the US.

Volume measures of R&D, mineral explorations and entertainment, literary and artistic originals, are obtained resorting to official national accounts deflators. The guidelines from Eurostat suggest using an input-based deflation method for R&D. The input-cost approach is currently the only viable option to deflate R&D because it guarantees a satisfactory degree of international comparability (13).

Summing up, the volume measures of purchased non-NA intangible investments are obtained applying national accounts value added prices of the industry corresponding to the main producer of each asset. Real measures of national accounts intangibles, besides software, are built applying investment deflators by branch of economic activity, and when these are not available, the asset price for the total economy.

Sources and data

In this paper we provide empirical evidence for the total economy drawing on INTAN-Invest estimates of business sector intangibles and on the SPINTAN measures of public intangible investment (14). The two sets of intangible estimates, although generated from two different and independent projects, share the same measurement approach and refer to two non-overlapping cross-classifications of sectors and industries. INTAN-Invest and SPINTAN estimates, taken together, provide harmonized measures of investment in intangible assets for the total economy cross classified by 21 industries (corresponding to the sections of the NACE rev. 2 classification) and two institutional sectors (market and non-market) for 15 European countries and the US.

The main pillar of the SPINTAN and INTAN-Invest estimation strategy is the adoption of the

13 A contrasting approach is in a paper by Corrado et al. (2011), which casts the calculation of a price deflator for R&D in terms of estimating its contribution to productivity. Applying their method to the United Kingdom yielded a price deflator for R&D that fell at an average rate of 7.5 percent per year from 1995 to 2005 and thus implied that real UK R&D rose 12 percent annually over the same period.

14 INTAN-Invest measure of intangible investment are available at www.intaninvest.net and SPINTAN estimates are downloadable from www.SPINTAN.net.
expenditure-based approach to measure the value of investment in intangible assets (i.e., expenditure data are used to develop direct measures of intangible investment). Moreover, both projects have the goal of generating measures of harmonized intangible investment satisfying (as much as possible) the following criteria: exhaustiveness, reproducibility, comparability across countries and over time, and consistency with official national accounts data. The above characteristics are assured by the adoption of official data sources homogeneous across countries. The main data sources are national accounts, whose availability dictates starting estimates of intangibles in 1995.

SPINTAN provides estimates of intangible investment performed by the non-market sector in a set of industries of interest. More precisely, the SPINTAN non-market sector consists of the non-market producers classified in the following industries: (1) Scientific research and development (NACE division M72); (2) Public administration and defence; compulsory social security (NACE section O); (3) Education (NACE section P); (4) Human health and social work activities (NACE section Q), and (5) Arts, entertainment and recreation (NACE divisions R90-92) – see Corrado et al. (2017b). Non-market producers are defined consistently with national accounts definitions (i.e. establishments that supply goods or services free, or at prices that are not economically significant and that are classified in the Government sector (S.13) or in the Non Profit Institutions Serving Households (NPISH) sector (S.15)).

In the system of national accounts, units are classified by industry according to the activity they carry out, being market or non-market producers. Therefore, each industry can (potentially) consist of a mix of market and non-market producers. In particular, this is true for all the industries covered by the SPINTAN estimates, with the exception of the industry ‘Public administration and defence; compulsory social security’ (NACE section O), that includes only units belonging to sector S.13. We refer to these industries as SPINTAN mixed industries. Note that the SPINTAN non-market sector differs from the total of sectors S.13 and S.15 from national accounts as it does not cover non-market producers that are not classified in the industries of interest listed above.

INTAN-Invest covers investment by asset in industries from NACE sections from A to M (excluding M72) and Section S plus the market sector component of NACE M72, P, Q and R. In other words, it is the business sector complement to SPINTAN necessary to cover the total economy. For the sake of simplicity, we refer to the INTAN-Invest estimates as covering the market sector (19). Details of the calculations and assumptions required to calculate investments in intangible assets for the business sector can be found in Corrado et al. (2016b) and for the public sector in Corrado et al. (2016a).

3.1. Market and non-market intangible investment

What then are intangible assets? Table 1 summarizes the CHS list of business intangible assets (on the left) and maps them to the public or non-market sector (on the right). The correspondence between the two columns is not one-to-one. As may be seen, the asset boundary is slightly different depending on the market-non-market nature of the sector (16). But before we discuss differences across the two columns, let us make a few points about the similarities. First, while the character of some assets are rather different when produced by public institutions, e.g.,

(15) In fact they also include the non-market sector component not covered by SPINTAN. The industry and sector coverage in INTAN-Invest 2017 has changed with respect to the previous INTAN-Invest estimates that did not cover industries P and Q and covered all industry R.

(16) For a detailed discussion about the different nature of intangible investment in the market and non-market sector see Corrado et al. (2017).
R&D, organizational, and mineral exploration, one may still draw a correspondence between these assets across sectors. For example, Jarboe (2009) defines public investments in brand as expenditures for export promotion, tourism promotion, and consumer product and food and drug safety (i.e., investments in product reputation). The correspondence for computer software, purchased investments in organizational capital, and function-specific worker capital (employer-provided training) is even closer.

The circled items are rather different in a public sector context. Open data refers to information assets in the form of publicly collected data issued and curated for public use. This runs the gamut from patent records to demographic statistics and national accounts to geographic information and local birth/death records. Indeed, after asking the question, ‘What are public sector intangible assets in the United Kingdom?’ Blaug and Lekhi (2009, p.53) concluded that ‘perhaps the most important . . . is information assets.’ Jarboe (2009) includes government information creation as a high-level category in his estimates of U.S. federal government intangible investments. The category includes spending on statistical agencies, the weather service, federal libraries, nonpartisan reporting and accounting offices, and the patent office, which suggests information assets loom large in the United States as well.

Cultural assets are public intangible assets whose services are used in production in cultural domains dominated or influenced by the public and non-market sectors; cultural domains are defined by the UNESCO Framework for Cultural Statistics. The capital used in many domains is included in existing estimates of private capital (tangible and intangible), but public investments (or funding) for new asset creation needs to be identified and newly capitalized. Note that cultural assets are notionally grouped with public architectural and engineering design, on the grounds that the British Museum’s tessellated glass ceiling or the Louvre Pyramid are as valuable
Advancements in measuring intangibles for European economies

(and as incalculable) as the museums’ contents although of course their correspondence to private counterparts is apparent.

3.2. National account intangibles: software and R&D

R&D, software and other intangible assets are already incorporated in the national accounts under the ESA 2010 revision.

Computer software together with large databases were recognized as intangible fixed assets under ESA 95 (par. 3.110). Both assets are a subcomponent of intellectual property products, together with research and development, mineral exploration, and artistic originals.

Computer software and databases and other originals of intellectual property products are valued at the acquisition price when traded on markets in the national accounts. The initial value is estimated by summing their costs of production, appropriately revalued to the prices of the current period. If it is not possible to establish the value by this method, the present value of expected future receipts arising from using the asset is estimated. GFCF, net capital stocks, GFCF at previous year’s prices and the corresponding implicit deflators for price-volume decomposition for software and databases by industry based on ESA 2010 are widely available from Eurostat for most European countries (especially EU-15 countries) from 1995 onwards. Research by the OECD suggests that the valuation of databases varies across country statistical agencies (OECD (2010)).

Research and development (R&D) is defined in ESA 2010 as: ‘Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications.’ The value of research and development should be determined in terms of the economic benefits it is expected to provide in the future. This includes the provision of public services in the case of R&D acquired by government. In principle, R&D that does not provide an economic benefit to its owner does not constitute a fixed asset and should be treated as intermediate consumption. Unless the market value of the R&D is observed directly, it may, by convention, be valued at the sum of costs, including the cost of unsuccessful R&D, as described in chapter 6 of SNA 2008 par. 10.103. Thus R&D can be classified as a fixed asset if some criteria are satisfied, such as the provision of an economic benefit (*) to its owner. The INTAN-Invest and SPINTAN measures for market and non-market R&D and software are based on national accounts data (**).

3.3. Non-national accounts intangibles: brand, organizational capital and training

Given the complex nature of intangible assets, there is no definition of, or single method to, measure intangibles not included in national accounts asset boundaries that is accepted worldwide (Corrado et al. (2005)). Most of the literature simply identifies three critical attributes of intangibles: i) they are viewed as sources of probable future economic profits, ii) they lack physical substance, and iii) to some extent, they can be retained and traded by a firm (OECD (2008)). Yet, characteristics (i) and (iii) are also largely reflected in the more general definition

(*) Economic benefit refers to the repeated and continuous use in the production process over a long period of time (more than one year). The SNA clarifies that the concept of economic benefit includes also the provision of public services in the case of R&D acquired by government.
(**) See Corrado et al. (2016b) and for the public sector in Corrado et al. (2016a).
of economic assets provided by the System of National Accounts (SNA) that classifies them as those entities: over which ownership rights are enforced by institutional units, individually or collectively; and from which economic benefits may be derived by their owners by holding them or using them over a period of time (Harrison (2006)).

On the other hand, Corrado et al. (2005) proposed the widest definition of intangibles, referring to a standard intertemporal framework that leads to the conclusion that any use of resources that reduces current consumption in order to increase it in the future qualifies as an investment. This definition implies that all types of capital should be treated symmetrically, thus leading to a very broad definition of capital, including, for example, intellectual and human capital as well as organisational assets (Schreyer (2007)).

Non-national accounts intangibles, as seen above, include Innovative Property, other than R&D, designed to capture a range of assets that may have intellectual property protection associated with them, e.g. design rights. Economic competencies, instead aim at capturing a range of knowledge assets that firms invest in to run their businesses, but that might have no intellectual property. These include the costs of marketing and launching new products, including ongoing investments to maintain the value of a brand, and firm provided human capital in the form of training (Corrado et al. (2005, 2009)). These assets are conceptually straightforward although require assumptions to implement as detailed in Corrado et al. (2016b).

Economic competencies also include organisational capital which is conceptually more difficult and has a different characterization according to if we refer to the market or non-market sector. In the literature there is a broad consensus that organisational capital can have a significant impact on the outcome and performance of a firm (see for example Aral and Weill (2007) and Kapoor and Adner (2011)). Organisational capital is the cumulated knowledge that is built up in firms through investment in organising and changing the production process. These investments can be purchased externally by the firm, through expenditures on management consultancy and similar services, or can be own-account, produced within the firm through the actions of employees. Corrado et al. (2005, 2009) see own-account organisational capital as knowledge produced by persons in authority in a firm (managers), which yields a firm specific capital good jointly produced with output, and embodied in the organisation itself. This begs the question if managers, as defined in standard codes of occupations, are the only persons within the firm who have such authority. In particular in the public services there may be other high level employees who also possess authority. In SPINTAN the definition of own-account organisational capital was broadened to include some professionals such as senior doctors, who have the specific knowledge to set goals and the authority to ensure they are implemented.
4. Empirical evidence

The overall picture

In what follows we look first at the relevance of intangible investment over GDP distinguishing between what is already capitalized in national accounts and what is not (non-NA intangibles) to get a sense of the weight of the assets left outside the asset boundary (Figure 1). Then we move to a framework where we assume that all intangibles are capitalized and so we analyse the shares of intangible investment over adjusted (19) value added.

In 2000-2013, as shown in Figure 1, the average share of intangible investment in GDP as measured in the national accounts was higher in the US (4.2 %) than in the EU14 (20) (3.1 %) as well as in the four new EU Member States (NMS) (21) included in the analysis (2.2 %). Moreover, national accounts data suggest that the GDP share of tangible investment in the three regions (7.7 %, 9.2 % and 16.0 % respectively) is higher than the intangible share.

However, when new intangible assets are included in the analysis, the intangible investment gap between the European economies and the US broadens. New intangibles account for 4.6 % of GDP, adjusted to include the new intangibles, in the US, and 4.1 % and 4.2 % in the EU14 and NMS respectively. Adding new intangibles to national account assets makes the GDP share of total intangible investment increase to 8.8 % in the US, 7.2 % in the EU14 and 6.4 % in the NMS. Hence in the US intangibles share of GDP was greater than the share of tangible investment while in the European economies the opposite was the case (22).

Within the EU14 economies, total intangible shares of GDP vary considerably, revealing an interesting geographical pattern. Northern Europe (Denmark, Finland, Ireland, Sweden and

Figure 1: Intangible and tangible investment
(\% GDP, average 2000-2013)

Source: INTAN-Invest and authors’ elaborations on national accounts.

(19) Value added is adjusted to account for the capitalization of non-NA intangible assets (Corrado et al. (2012)).
(20) The sample countries are EU15 member economies excluding Luxemburg.
(21) New member states are: Czech Republic, Hungary, Slovenia and Slovakia.
(22) Although intangible intensity in the four NMS was slightly lower than in the EU14 region, the ratio of tangible investment to GDP (16 %) was almost 50 % higher than in the US and almost 60 % higher than in the EU14 region.
the UK) and non-German-speaking continental European countries (France, Netherlands and Belgium) are highly intangible intensive and characterised by higher intangible than tangible shares of GDP over the years 2000-2013. Sweden is the leading country with an intangible GDP share of 10.4 %, followed by the UK (9.0 %), Finland (8.8 %), France (8.7 %), the Netherlands and Ireland (both at 8.5 %) and Belgium (8.1 %) and Denmark (7.8 %) lagging slightly behind.

The Mediterranean and German-speaking countries are relatively less intangible intensive economies. In Austria, the intangible investment rate (6.7 %) is lower compared to the more intangible-oriented economies but still close to the average of the EU14. Portugal (6.0 %) and Germany (5.9 %) are below the EU14 average intangible share of GDP whereas Italy (5.3 %) and Spain (4.6 %) are far behind. Greece shows the lowest average share over the period (3.7 %), being an outlier also in terms of the tangible GDP share of investment.

Looking at sectoral value added shares of public and private intangibles reveals that overall (market and non-market) intangible investments account for from nearly 14 % (Sweden) to just under 6 % (Spain) of value added (Figure 2). The market sectors accounts for the main component of intangible investment as a share of value added - averaged across countries, the market sector shares of value added are 8 % compared to 1.5 % for the non-market sectors.

In those countries with the highest shares of intangibles (Sweden, the US and the UK), intangible investments now account for a larger value added share than tangible capital investments (Figure 3). Countries such as Spain and Italy have a much lower share of intangibles than tangibles.

**Figure 2: Market and non-market intangibles (2013)\(^{1}\)**
(Adjusted value added shares of intangible investment)

<table>
<thead>
<tr>
<th>Country</th>
<th>Non-market</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT</td>
<td>1.1</td>
<td>8.0</td>
</tr>
<tr>
<td>DE</td>
<td>1.0</td>
<td>6.5</td>
</tr>
<tr>
<td>DK</td>
<td>1.0</td>
<td>8.9</td>
</tr>
<tr>
<td>ES</td>
<td>0.5</td>
<td>5.5</td>
</tr>
<tr>
<td>FI</td>
<td>1.2</td>
<td>9.4</td>
</tr>
<tr>
<td>FR</td>
<td>0.7</td>
<td>9.9</td>
</tr>
<tr>
<td>IT</td>
<td>1.0</td>
<td>5.6</td>
</tr>
<tr>
<td>NL</td>
<td>1.1</td>
<td>9.2</td>
</tr>
<tr>
<td>SE</td>
<td>1.9</td>
<td>11.6</td>
</tr>
<tr>
<td>UK</td>
<td>1.6</td>
<td>9.3</td>
</tr>
<tr>
<td>US</td>
<td>2.7</td>
<td>8.9</td>
</tr>
</tbody>
</table>

Source: authors' elaboration on SPINTAN and INTAN-Invest data.
Advancements in measuring intangibles for European economies

5. Intangibles and growth

Arguably the main interest in constructing measures of capital services is their use in explaining international growth trends. Therefore we conclude this paper with a brief summary on efforts to link intangibles to growth. Note that in the papers referred to in this section, intangible inputs are based on the capital services that arise from their use. Interested readers should consult the papers for details on moving from investment to capital stocks and capital services. A common finding is that the spillovers referred to in Section 2 are evident in the data.

Using data for the market economy for 13 countries, Roth and Thum (2013) suggest that once accounting for business intangibles i) capital deepening becomes the dominant source for explaining labour productivity growth and ii) the explanatory power of TFP growth is diminished from 25 percentage points to 10 percentage points. In econometric production function estimates, these authors report a coefficient of intangible investment of about one quarter - this turns out to be much higher than the coefficient identified by this asset’s factor share in growth accounting.

Using the INTAN-Invest data, Corrado et al. (2017a) find a coefficient of similar, in some specifications even larger magnitude. They formally investigate the presence of spillovers that are suspected if the estimated marginal product of a factor exceeds the marginal product implied by the factor remuneration under competitive markets. Their results strongly support

Figure 3: Tangible and intangible investment (2013) (Adjusted value added shares)

Source: authors’ elaboration on SPINTAN and INTAN-Invest data.
Advancements in measuring intangibles for European economies

the possibility of spillovers. Moreover, they find evidence of a complementarity between intangible assets at the aggregate level and ICT capital at the sectoral level.

A first attempt to produce internationally comparable estimates of intangible investments at the industry level was undertaken by Niebel et al. (2013) for the INDICSER project. The growth accounting estimates by industry suggest that the importance of intangible capital assets by type varies across sectors, with R&D the most important asset in manufacturing whereas organisational capital dominates in many service sectors. In terms of contributions to labour productivity growth, however, there appear to be common sectoral patterns across countries, with high investment in all sectors in some countries (the UK and the Netherlands) and low investment in others (Italy and Spain). The paper performed an econometric estimation of the relationship between indicators of intangible capital and labour productivity growth at a sectoral level. This confirms the positive impact of intangible capital on economic performance as found by previous authors. However, the paper estimates coefficients on intangibles, ranging from 10% to 17%, which is much lower than the coefficients using aggregate data. The paper suggests that unexplained heterogeneity at the macro level is likely to explain this difference and such biases are partially addressed using industry data. Nevertheless these estimates remain higher than average growth accounting impacts, consistent with some spillovers from this asset type.

Recent empirical evidence (Corrado et al. (2016b)) confirm that intangible investment is a key policy variable. A relevant characteristic of intangible capital is that it is growth-promoting (Corrado et al. (2014)), thus potentially contributing to reducing the growth gap between the EU and the US. Therefore policies designed to foster innovation and to make the economic environment more conducive to investment in intangible assets should adopt a view of innovation that is broader than R&D. Corrado et al. (2016b) show that the investment gap between the EU14 and the US is more related to the lower contributions of computer software and databases, artistic originals, mineral exploration, brand and training than to the contribution of R&D.

In a recent paper Corrado et al. (2016b) use the recently constructed INTAN-Invest cross-country cross-industry dataset on investment in tangible and intangible assets for 18 European countries and the US, in a growth accounting framework, to analyse the impact of capital before and after the Great Recession in 2008-2009. The major findings are the following. First, tangible investment fell massively during the Great Recession and has hardly recovered, whereas intangible investment has been relatively resilient; it recovered fast in the US but lagged behind in the EU. Second, the sources of growth analysis including only national account intangibles (software, R&D, mineral exploration and artistic originals), suggest that, over the period 2000-2013, capital deepening is the main driver of growth, with tangibles and intangibles accounting for 80% and 20% in the EU, while both account for 50% in the US. Extending the asset boundary to the intangible assets not included in the national accounts increases the contribution of capital deepening. The contribution of tangibles is reduced both in the EU and the US (60% and 40% respectively) while intangibles account for a larger share (40% in EU and 60% in the US). Their analysis shows that since the Great Recession, the slowdown in labour productivity growth has been driven by a decline in TFP growth with relatively minor roles for tangible and intangible capital. Finally, they document a significant correlation between stricter employment protection rules and less government investment in R&D, and a lower ratio of intangible to tangible investment.
6. Conclusion

The main purpose of this paper was to set out the existing research on measuring intangible capital and its impact on economic performance. It illustrated the theoretical framework for understanding the impact of intangibles on output and then discussed which types of activities might be deemed to be intangible assets. The paper then uses the newly developed data from INTAN-Invest and SPINTAN to investigate differences across countries and suggests that the EU lags the US in investing in this type of asset. Recent empirical evidence using these data show that intangible investment is important for understanding the pattern of economic growth, both across time and countries. The econometric analysis using these data yield estimates that are consistent with spillovers of intangibles to growth.

This paper has reviewed the research on intangibles from a macro or industry perspective. It should be noted that there is also a considerable body of evidence emerging on the importance of intangibles at the firm level. Examples include Görzig et al. (2010), Piekkola (2016), Riley and Robinson (2011) and Riley and Rosazza Bondibene (2017), which highlight a positive relationship between firm performance and the use of intangibles. However, as with some of the macro estimates, intangible assets are indirectly measured using occupation data.

Further analysis could also consider the regional dimension, to link in with the extensive literature on the concentration of knowledge assets by geographical location, especially the role of cities. In this respect, some progress has been made by Mas et al. (2017) who construct intangible data for the 17 Spanish regions and 24 industries covering the period 1995-2014.

In all these approaches, macro/industry, firm and region, the analysis would benefit from more and better data, e.g. direct surveys of the intangible investment behaviour of firms or use of administrative databases.

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References


Advancements in measuring intangibles for European economies


