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Measuring Intangible Assets – A Review of State of the Art

Abstract

This paper presents an overview of the state of the art in the field surrounding the measurement of 'intangibles' for productivity analysis. The purpose of the paper is to inform indicator development and implementation in economic analysis, both at the micro and aggregated levels. Our review seeks to capture the development of intangibles measurement, which has explored a variety of directions, both in terms of definition, method and data. We both characterize the diversity of the field and its development over time. Current national and firm level accounting rules lead, from an economic viewpoint on intangibles, to both an underestimation of intangible assets and of productivity growth. Further work is needed, both concerning the estimation of 'technical' aspects such as depreciation rates and deflators, and in the continued testing and comparison of different measurement efforts. Many opportunities exist to aggregate across or cross-validate between the measures that are currently being used, enhancing our understanding of the properties of these measures. Even though micro-based work faces great challenges in terms of data availability, it will be important for the estimation of depreciation rates and in developing our understanding (and thereby better measurement) of broader forms of intangibles, which can thereafter inform measurement at more aggregated levels.

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1. Introduction

A relative shift from physical to intangible means of production has been taking place in the last several decades (e.g. Haskel & Westlake, 2018). Scholars voiced critiques regarding the lack of adequate accounting for these ever more important intangibles (Lev, 2003). At the same time, the western world has seemingly experienced a slowdown in productivity growth. Subsequently, much scientific work has revolved around how intangibles investments contribute to productivity, and thereby constitute a missing piece in the productivity puzzle (C. Corrado, Hulten, & Sichel, 2005). For example, Solow noted early on that "the computer age can be seen everywhere except in the productivity numbers". The existence of a difference between the real and the measured economy can explain at least partly this paradox. It underlines the importance of quantitative measures for the accumulation of 'intangibles'.

Work on intangibles measurement faces a number of challenges. These include addressing the restrictive treatment of intangible investments in accounting regulations and in national accounts, the conceptualization of intangibles, data collection and the construction of measures of intangible assets. While these issues are quite diverse, and to some degree have been addressed in separate strands of literature, they are also very much interrelated and have in common that they deal with the conceptualization and measurement of intangibles.

The literature has stressed the need for better and more complete measures of investments in intangible assets, along with the many challenges involved in producing reliable measures. For example, Nakamura (2010) builds a formal microeconomic model to make his case of why and how measurement of intangibles can move forward. From the model, he concludes that while perfect competition has been underlying our measurement of nominal economic activity, private stocks of intangibles have not historically been included in measures of wealth, and temporary monopoly based on intellectual property was not considered a relevant factor of production.

This paper seeks to give an overview of the state of the art in 'intangibles measurement' and identifies potential routes for future economic research. We aim to capture the development of intangibles measurement, which has explored a variety of directions, both in terms of definition, method, and data. The issue of measurement of intangible assets (or intellectual assets) has been considered in several different strands of literature: the accounting literature, the economics or productivity literature, and the management literature (Lev, 2018). As is mentioned above, the focus of this review is intangibles measurement from an economic perspective, where a comprehensive overview of existing measurement methods aiming to improve economic research practice is currently lacking. We argue that the accounting and management literature provide important insights towards the further development of intangibles measurement agendas, and thus they are touched on in this review. In particular, the accounting and management literature includes a wide range of measurement and validation approaches for management, accounting, and reporting purposes (Guthrie, Ricceri, & Dumay, 2012; Osinski, Selig, Matos, & Roman, 2017; Petty & Guthrie, 2000; Sveiby,1998).

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The review is based on a hybrid search that combines both snowballing based on core literature and a systematic search in the Web of Science database.

In order to both characterize the diversity of the field and its development over time, the review of literature will be guided by four key dimensions: purposes for the measurement of intangibles; the methods of measuring intangibles; the conceptualizations and types of intangible assets (IA); and the level of aggregation for measures.

In the next section, we describe the methods for literature selection and analysis. In the subsequent four sections of this document, we review the thus found academic literature where each section corresponds to one of the identified key dimensions. Finally, the last section concludes.

2. Method

To identify relevant literature for review, we conducted snowballing based on core literature that was identified by the authors combined with a systematic key-word-search in Web of Science (WoS). Firstly, in an effort to scope the literature, Google Scholar was used to search for the strings 'measuring intangibles' and 'measuring intangible assets'. From this search, we identified 2005 as a suitable starting point for reviewing the (recent) literature, as the number of relevant articles seems to grow quickly afterwards. We retained the relevant articles and snowballed its references for further literature. Secondly, we complemented our free form search with a a structured search in the Web of Science database.

> (TI=((intangible* OR intellectual) AND (measure* OR indicator) AND (asset* OR capital OR invest*)) OR AB=((”intangible capital” OR ”intellectual capital” OR ”intellectual assets” OR ”intangible assets”) AND (measure* OR indicator))) AND PY=(2005-2020)

The search focused on article titles or abstracts containing both an element of 'intangibles' and 'measurement'. This search delivered us 1438 results. Limiting the list to 'article' and 'review' document types brings the number down to 776. Since we searched the abstract text in a rather broad manner we first checked manually whether the article is related to intangibles measurement. Deleting those articles that did not brought the list down to 217. Full text screening left us with 35 additional references that have intangibles measurement at its core and add to our understanding of intangibles measurement along the 4 dimension identified in the review.

We have also reviewed work in a number of international research projects that have contributed to the advancement of intangibles measurement.

This literature search is by no means claimed to be exhaustive, but seeks to be indicative for trends in the field.

As noted above, the review is structured around four dimensions that are relevant for intangibles measurement. First, we distinguish between data and measures for different *purposes*, each raising a number of measurement issues. These include measurement activities to inform firm-specific strategic or managerial analysis, productivity analysis, and national accounts measures. While interconnected, these purposes are

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linked to different measurement needs. For example, work on intellectual capital within managerial accounting is directed at the development of indicators that can inform internal strategic and managerial practices. While there is also interest in producing comparable statistics, a key factor is managerial use. The productivity literature is centered around creating comparable measures across firms, and accurate measures of firms' intangible investments.Second, one can distinguish three *measurement methods*: expenditures based, market valuation based and intellectual property right (IPR) based. *Expenditures based approaches* estimate intangibles by projecting forward the past flow of expenses into a current stock of assets. In other words, they apply a net present value type (NPV) of rule (see e.g.C. Corrado et al., 2005). Existing studies have captured expenses from accounting data, national statistics, surveys and labor-occupation data. The underlying assumption of the expenditures approach is that firms are willing to invest in intangible assets until the discounted present value of the expected income stream equals the cost of producing the marginal asset. *The market valuation approach* seeks to assess the value of intangibles based on the difference between the book and market value of the firm by calculating Tobin's Q types of measures. The crucial assumptions are that the market value anticipates 'all' future revenue streams whereas the book value does not include intangible assets. *An Intellectual property right (IPR) based approach* relies on the legal rights being awarded and their value in the market.

Third, depending on how intangible assets are conceptualized, one can distinguish between a spectrum of *types of measures* ranging from 'broad intangibles' to 'specific intangibles', where broader intangibles aggregate a larger set of more specific types of intangible assets. Corrado et al. (2005) for example identify three components of intangible assets, economic competencies, innovative property and software and computerized information. Depending on which part of the spectrum is measured, a full range of measures potentially emerges. Work devoted to organizational assets, as in for example (Squicciarini & Mouel, 2012) or (Eisfeldt & Papanikolaou, 2013, 2014), is only one example of efforts concentrating on a particular range of the spectrum. Work on measurement of investments in brands, as in (C. A. Corrado & Hao, 2013), is another.

Fourth, depending on the *level of aggregation*, one can distinguish between micro (firm), meso (industry), and macro (national) level measures of intangibles. Where some studies use firm level information to estimate economic aggregates, or use the aggregates (we will call these macro/meso studies), others conduct analysis where the main interest lies in identifying relations based on the firm level information (we will call these micro level studies). While (C. Corrado, Hulten, & Sichel, 2009) establish macroeconomic data on intangibles, the work of (Görzig, Piekkola, & Riley, 2010) establish a method to estimate micro-level intangibles from register data.

3. Purposes of intangibles measurement

In broad terms, there are several uses for data on IAs, each with their own separate issues, but at the same time closely interconnected. We discuss here three purposes of intangibles measurement: internal and accounting use by businesses, national accounts statistics and productivity and other forms of analysis. Productivity

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analysis is arguably the most central use in this review, which covers several studies that have measured intangibles expressly for this purpose. Many of these papers will be summarized below in later sections. We start here with internal use, which motivates a discussion of the "accounting perspective" (Lev, Cañibano, & Marr, 2005) on the capitalization of intangibles.

Treatment of intangible assets in accounting standards

The treatment of intangible capital in accounting standards is important for measurement as a whole, because it provides guidance on how firms should identify and account for expenditures on intangible capital. This both involves the issue of what extent intangibles expenditures can be recorded as capital formation, and the classification of diverse types of intangibles expenditures.

International Accounting Standard (IAS) 38 defines an intangible asset as "An identifiable nonmonetary asset without physical substance. An asset is a resource that is controlled by the enterprise as a result of past events (for example, purchase or self-creation) and from which future economic benefits (inflows of cash or other assets) are expected."[1] IAS 38 forms a central criteria concerning the capitalization of intangibles assets, stating that a company can only recognize an asset, if it is identifiable, controlled, measurable, and if it is probable that future benefits of the asset can be accrued to the company (Lev et al., 2005). This restrictive treatment of intangible assets, particularly concerning the required certainty of eventual income generation, has strong implications for rules on the capitalization of intangible expenditures. According to US rules (Generally Accepted Accounting Principles, GAAP[2]), essentially no internally generated intangibles are capitalized, while acquired intangibles can in some cases be capitalized. Rules according to the International Financial Reporting Standards (IFRS)[3] are similar, though allow for capitalization of development costs when strict conditions are met concerning certainty in terms of feasibility and financing for project completion. Baruch Lev and others have been very critical of the treatment of intangibles in accounting rules, arguing that by not recognizing value-creating resources as assets, financial reports fail to state the true value of companies (Chalmers, Clinch, & Godfrey, 2008; B Lev, 2018; Baruch Lev et al., 2005; Baruch Lev & Gu, 2016; Zadorozhnyi & Yasyshena, 2019). Furthermore, they create a bias with greater understatement of the earnings and assets of companies with growth in intangibles investments and overstatement for companies with declining investment. Experience is varied concerning the market valuation of intangibles assets reported under current IFRS standards. For example, (Cordazzo & Rossi, 2020) find that goodwill and IP rights are associated with stock market valuations, but not R&D expenditures. (Wyatt & Abernethy, 2008) argue that the separate identification and reporting of investments in intangible assets is essential in order to understand intangibles' role in value creation.

Internal use and measurement of intangible capital

A further consequence of current accounting practices is in terms of intangibles measurement. Without the standardized requirements to financially report specific intangible assets, companies may decide themselves,

[1] https://www.ifrs.org/issued-standards/list-of-standards/ias-38-intangible-assets/. Accessed 22.04.20.
[2] https://asc.fasb.org/
[3] https://www.ifrs.org/

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based on managerial or strategic considerations, whether to record expenditures on intangibles investments and in what way. Literature that can fall under the heading of Intellectual Capital Accounting Research (ICAR) is driven by the growing importance of knowledge creation and human capital for value creation, and it motivates the need for better measurement of intangibles for management, accounting and reporting purposes (Guthrie et al., 2012; Petty & Guthrie, 2000). This literature is concerned with understanding how intellectual capital creates value and communicates the value of investments to stakeholders. Two central focus areas of ICAR are external reporting to capital markets and stakeholders, and the use of measurement in managerial control or strategies (Guthrie et al., 2012).

Intellectual capital disclosure has received growing interest, both in terms of disclosure strategies and reporting practices. (Curado, Henriques, & Bontis, 2011) develop a framework and methodology for reporting intellectual capital. Studies suggest that many knowledge intensive companies do in fact record some intangibles expenditures, but in varying ways. For example, Hunter et al. (2012) survey 614 Australian companies and find that around 40% record expenditures for diverse types of intangibles, with shares varying greatly according to which types were recorded. (Chiucchi & Dumay, 2015) question whether increased focus on the measurement of intangibles in accounting practices and greater use of indicators can actually detract from a more strategic managerial work to promote the development of intangible capital and its effective use (see also the critical review of IC measurement in (Kianto, Ritala, Vanhala, & Hussinki, 2020)**)**. The managerial use of IC indicators in practice appears also to be varied (Chiucchi & Montemari, 2016). (Vergauwen, Bollen, & Oirbans, 2007) find among Danish, Swedish and British firms that IC disclosure is greater for firms with a high level of structural capital. (Sharma & Dharni, 2017) observe an increase in both quantitative and qualitative IC disclosures among firms in India.Intangibles in national accounts statistics

A distinction between statistics and analysis is to some degree artificial, but it is still instructive to examine work on intangibles with the intention of greater incorporation of intangibles investments into national accounts. Here, it is a question of agreement on standard practices for which expenditures should be capitalized in national accounts and which should be considered as consumption and expensed. As Nakamura (2010) points out, different perspectives on which expenditures constitute investments in intangible assets can greatly influence our view of the dynamics of investment activity in economies. For example, a narrow measurement of intangible assets (that only includes assets that are capitalized according to current standards) shows little growth in investment over time, while there is robust growth in broader forms of intangibles (that are currently only expensed) (Nakamura 2010).

The 1993 System of National Accounts[4] treated only a very limited set of intangibles as capital formation (software, mineral exploration rights, subscriptions to databases, patenting, goodwill and artistic originals). Yet, it also discussed the main reasons for the expensing of other intangibles: “Expenditure by enterprises on activities such as staff training or research and development are … designed to raise productivity or increase

[4] Inter-Secretariat Working Group on National Accounts, and Commission of the European Communities. (1993). *System of national accounts 1993* (Vol. 2). INTERNATIONAL MONETARY FUND.

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the range of production possibilities in the future … However, expenditures on training and research or development do not lead to the creation of assets that can be easily identified, quantified and valued for balance sheet purposes." (SNA 1993, para. 51)

Hence, many other intangibles have long been recognized as constituting capital formation in an economic sense, but are not included due to measurement difficulties (many of these issues were carefully reviewed in Moulton (2004)). Further connected to these issues, the lack of available information on intangibles from firm balance sheets (due to current accounting rules for the capitalization of intangibles) greatly limits our knowledge on these technical measurement issues.

The current SNA from 2008[5] notes that these same challenges are still relevant, though a series of advances have been made (Mortensen, 2013):

- ICT equipment included as new category under machinery and equipment
- "intangible fixed assets" renamed to "intellectual property products", and now include R&D products
- "other intangible fixed assets" renamed to "other intellectual property products", and now includes R&D, mineral exploration and evaluation, computer software and databases, literary or artistic originals.
- "mineral exploration" renamed to "mineral exploration and evaluation" to conform with international accounting standards
- Computer software modified to include databases

As noted by Mortensen (2013), satellite accounts potentially provide a way forward from the current situation where we may not be able to fully resolve the many technical challenges in measuring IAs that have been noted, but we at the same time accept that broader intangibles (such as training, design and other organizational assets) play a significant role for value creation and growth. Satellite accounts allow greater flexibility in expanding national accounts in selected areas, for example through rearrangement of central classifications, or the use of alternative concepts (such as changing the boundary between consumption and capital formation).

Additionally, household R&D and innovation is currently not counted as investment in national accounts even though it constitutes an important source of knowledge and skills which firms can tap in to. In recent work, Sichel & Hippel (2019) estimate that household product R&D accounts to about half of what producers spend. To gauge the overall innovation landscape, it is thus important to account for these investments, not because of the significance and importance only in their own regard, but also because they might carry over into the realm of the firm and serve as a means of production.

A number of studies have had a dual focus, both seeking to further discussions of the official statistical treatment of intangible as capital formation and *conducting analysis* using these broad measures of IAs (C. Corrado, Haskel, & Jona-Lasinio, 2017; C. Corrado, Haskel, Jona-Lasinio, & Iommi, 2013; C. Corrado, Hulten,

[5] United Nations European Commission OECD et.al. (2009) System of National Accounts 2008. UN: New York.

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& Sichel, 2005b; C. Corrado et al., 2009; Crass & Peters, 2014; Nakamura, 2010; Niebel, O'Mahony, & Saam, 2017a; Roth & Thum, 2013; van Ark, Hao, Corrado, & Hulten, 2009).

4. Measurement methods

In this section, we review the different quantitative approaches that have been taken towards intangibles measurement. We focus on the current practice which can inform the further development of measuring intangibles. Qualitative evidence from interviews and case studies is harder to generalize with development of statistics in mind. For example Giuliani (2016) investigates how companies give sense through their intellectual capital measurements. It is, however, less clear how his findings, which are mainly managerial in nature, can contribute to statistics development.

In line with our stated focus on measurement from a productivity perspective, this section focuses on methods to measure intangible assets for use in economic analysis. First, we review the CHS expenditures-based approach (C. Corrado et al., 2005b). Second, we describe the survey-based work that has been conducted with regard to intangibles measurement. Third, we discuss measurement based on firm balance sheet data. Fourth, we summarize measurement work implementing the occupation or task-based approach. Fifth, we discuss IPR based measurement. And, sixth, we consider intangibles measurement approaches based on market valuation.

CHS Expenditures based approach

Corrado, Hulten and Sichel, CHS, made seminal theoretical and empirical contributions in the mid-2000's (C. Corrado et al., 2005) that take an expenditures-based approach and measure a spectrum of specific intangibles at the macro-economic level. They make the simple, straightforward argument that "any outlay that is intended to increase future rather than current consumption is treated as a capital investment." (Corrado et al. 2005, p. 13). While it is not necessarily novel in itself, this argument in combination with a feasible approach has had a significant impact on the measurement of IAs. Bundling together specific intangibles, they arrive at a broad measure of intangibles and use this as an input in a growth accounting exercise, by expanding the conceptual framework of the sources-of-growth with a variant of the standard model of intertemporal choice developed in Hulten (1979) (Corrado et. al. 2005). The empirical test of this new framework (C. Corrado et al., 2009) uses macroeconomic US data from the period spanning 1950 to 2000 to arrive at some profound conclusions. First, many intangible assets are still unaccounted for in GDP. Second, when capital deepening becomes the dominant source of labor productivity growth, then the role of multi-factor productivity is correspondingly diminished. Further, labor's income share is found to have decreased significantly over the last 50 years.

CHS (2005) identify three main categories of intangible assets: economic competencies, innovative property and computerized information[6]. 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 branding such as investing in brand names. Innovative property refers to innovative activity

[6] These three categories can be broken down into in all nine types of intangible assets.

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built on a scientific base of knowledge as well as to innovation and new product/process R&D more broadly defined. Computerized information essentially coincides with computer software and databases.

Corrado et al. (2009: 669-672) construct their estimation of intangible capital types from several sources. For the broad category of *computerized information*, the source is National Income and Product Account (NIPA). The broad category of *innovation property* utilizes National Science Foundation Industrial R&D survey for scientific R&D and Census Bureau's Services Annual Survey (SAS) for non-scientific R&D. *Economic competencies* estimate a wide area from advertisement to strategic development and are covered by Bureau of Labor Statistics (BLS), SAS and employer paid training is captured from American Society for Training and Development (ASTD). Corrado et al. (2009) note that one can expect only 60% of advertisement expenditures to have effects lasting over a year.

Corrado et al. (2009) construct their capital stocks using specific depreciation rates for each IA type. The depreciation rate for computerized information (33%) is based on expected life cycles of 5 years. Scientific R&D's depreciation rate (20%) is the middle value used in the literature. Corrado et al. (2009) highlight that advertisement efforts last over a year but do depreciate higher than the other types; they assume it to be 60%. An intangible investments price deflator is approximated from the price index of non-farming industries using a three-year moving average.

Following this CHS approach, the EU FP7 Innodrive project[7] implements a macro approach measuring intangibles for all EU27 countries (see Jona-Lasinio, Iommi, & Roth, 2011; Roth & Thum, 2013).

Survey based measurement of expenditures

Several studies have used a survey-based approach to measure investments in intangibles. Innovation surveys have long sought to measure expenditures connected to innovation activities, including R&D, other purchases of IPR, training, design, and other expenses related to the development, testing and implementation of product and process innovations (OECD & Eurostat, 2005). The Oslo Manual for collection of data on innovations has also recently been revised (OECD/Eurostat, 2018). Innovation expenditures are closely related to investments in intangibles, though are restricted to expenditures that can be directly related to the development of product or process innovations.

An example is Crass & Peters (2014), who utilize innovation survey data from the German Mannheim Innovation Panel. They create measures of intangibles within three categories: innovative capital, human capital and branding capital. Innovation capital is estimated from R&D, patent stock and design and licenses. Branding capital is proxied from firms' total marketing expenditures: "in-house and purchased advertising expenditure, conceptual design of marketing strategies, market and customer demand research and establishment of new distribution channels". Human capital is approximated from the survey with the share of highly educated employees and expenditures on professional development training, both internal and external. The survey does not cover expenditures on computerized information. Organizational capital is

[7] http://www.innodrive.org/

covered by dummy variables from the survey for: new business processes, new methods in workplace organization and new types of external relationships.

Recent work has further summarized and analyzed the existing survey work on measuring intangibles (Redek et al., 2019). The Investments in Intangible Assets (IIA) survey is directly targeted at the measurement of investments in intangibles for UK firms.(Awano, Franklin, Haskel, & Kastrinaki, 2010). The survey measures in all six categories of intangibles (both in-house activities and purchases): employee training, software development, reputation and branding, R&D, design and business process improvements. Additionally, the IIA survey seeks to measure depreciation rates for different intangibles by collecting data on expected benefit times for the six asset categories.

Further dedicated surveys for the measurement of investments in intangibles have been conducted for; Europe in the Flash Eurobarometer (Eurobarometer, 2013); for Albania (Prasnikar, Redek, & Memaj, 2012); the UK, with a focus on design investment (Moultrie & Livesey, 2014); Italy (Angotti, 2017).

Measurement based on firm balance sheet data

A few studies have used data from firm balance sheets to measure intangible assets, where they consider both data on activities that have been capitalized and those that have been expensed . The availability of data on intangibles from firm balance sheets varies across countries and is also influenced by the accounting standards used in each country. As discussed above, there are two key issues that influence the quality and scope of measures of intangible assets based on balance sheet data. First, rules are very conservative on what types of activities may be capitalized (the accounting perspective on intangibles is much more restrictive than the economic perspective), so financially reported measures of intangible assets are typically very narrow. Second, due to this, there is a lack of standard practice for how firms financially record different intangibles related activities.

Peters & Taylor (2017) also rely on balance sheet data, drawing on Compustat data for US companies. They include both financially reported intangible assets (which are subject to very strict rules on what can be capitalized according to US standards, see below), R&D expenditures as a measure of Knowledge Capital and Selling, General and Administrative (SG&A) expenses as a measure of organizational capital. SG&A is essentially a mix of expenditures that are viewed to contribute to intangible asset accumulation (such as advertising and marketing), but also a number of purely administrative expenses. Peters and Taylor assume that 30% of SG&A expenses contribute to intangible asset accumulation.

Similarly, Marrocu, Paci, & Pontis (2012) use the variable “intangible fixed assets” from the BVD Amadeus company database, for firms in six European countries. Hence, the measure relies on intangible assets that firms have chosen to (and were allowed to) capitalize.

Bontempi & Mairesse (2015) argue that Italian accounting standards allow for broader measurement of intangibles based on balance sheets than in other countries. They construct measures of two types of intangible assets, Intellectual Capital and Customer Capital, based both on reported assets and on expensed costs.

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Intellectual Capital consists of R&D, advertising costs essential to the start-up phase of new products, purchases of patents, IPR and software, and licensing costs. Customer Capital consists of trademarks and similar rights, and additional advertising costs. Bontempi & Mairesse (2015) excluded start-up and expansion costs and goodwill as these types require further analysis.

Belo, Lin, & Vitorino (2014) have used balance sheet data to specifically measure brand capital. They empirically relate the relevant Computstat item XAD (advertising expenses) to the firms' stock returns. Dubin (2007) alternatively uses advertising expenses from the Leading National Advertisers (LNA) data, which tracks the multimedia advertising expenses for the 6 largest US media (broken down by firms and brands).

Occupation or task based approach

Another expenditures based approach can be characterized as occupation or task based approaches. This approach seeks to quantify intangibles investments based on the resources used in generating intangibles, forming estimates of both own-account and purchased investments. The approach is based on three assumptions. First, the generation of new knowledge and knowhow is assumed to be undertaken by employees within *knowledge intensive occupations* that are related to the specific type of intangible. The second assumption is that a share of these knowledge intensive workers' time is devoted to the development of intangible capital. The remaining share is devoted to day-to-day operations. The final assumption concerns an estimate of purchased intangible capital that is connected to the own-account activities. As part of the Innodrive project, Görzig, Piekkola, & Riley (2010) established a new micro-level method where intangibles are approximated from intangibles producing employees, using Linked Employer-Employee Data (LEED) on occupations, education level and employee salaries. These employees are persons with relevant higher education and occupations that are viewed to produce intangible assets. Three types of intangible assets are identified: organizational, ICT and broadly measured research and development.

Labor shares and intermediate factor shares are approximated based on the EU KLEMS database, multiplying through the investment share of labor (i.e.. the share of labor that is an investment towards intangible asset formation) and the factor multiplier (i.e. the multiple of the salary to labor that constitutes the investment in intangible asset formation), yields a *combined multiplier*. Table 1 summarizes these numbers together with depreciation rates. The combined multiplier is used to approximate intangible investments from salary expenses. Capital stocks are calculated using the perpetual inventory method. This method has since been updated in the Horizon 2020 Globalinto project (see www.globalinto.eu)

Table 1. Innodrive methodology in numbers.

Intangible capital type	Investment share of labor input	x	Factor multiplier	=	Combined multiplier	Depreciation rate
ICT[1]	0.5		1.48		0.7	0.33
RD[2]	0.7		1.55		1.1	0.2
OC[3]	0.2		1.76		0.35	0.25

[1] information communication technology, [2] broad research and development, [3] organizational capital.

Source: Görzig et al. (2010: p. 14)

Squicciarini & Mouel (2012) utilizes a related approach to measure organizational capital in US companies. Instead of classifying according to the type of occupation, they identify relevant, intangibles generating occupations based on the individual tasks for each occupation (thereby seeking to capture managerial activities undertaken by non-managerial staff). Intangible investments are assumed to comprise 20% of these workers' time, and purchased organizational capital is estimated at an aggregate level to correspond to 80% of the turnover of the management consulting services industry. In contrast to the Innodrive method, Squicciarini and Le Mouel (2012)'s approach creates measures at the sectoral and macro level. Instead of using LEED data, their method uses occupation data combined with estimates of average earning for individual occupations from the US Current Population Survey.

Further occupational based work focuses on specific types of intangibles; see e.g. Martin (2019) for branding, design and organizational capital, Blanco-Alcantara, Diez-Esteban, & Romero-Merino (2019) on board member networks, and Chamberlin, Clayton, & Farooqui (2007) for software.

IPR based measures

Investments into innovative property are inputs into an innovation production function where intellectual property rights (IPRs) are part of the output. Formal IPR counts, i.e., number of patents, trademarks and designs can thus be seen as a crude measure of the volume of protected intangible capital within a firm. When an intangible asset is protected by formal intellectual property rights, a low correlation between the investment series and the corresponding IPR counts would indicate that the investment series is inadequate. Accordingly, de Rassenfosse (2017) test whether expenditures-based measures of brand equity and architectural and engineering designs are adequate. The data is unbalanced data from 1980 to 2010 and covers 32 countries. de Rassenfosse (2017) finds that brand equity predicts trademarked applications, but that design activity does not correlate with design rights. Thus, the article suggests that brand equity captures what it is supposed to, but design activity needs more development. Apart from specific use cases, e.g., industries that heavily rely on IPRs for their innovation, the use of IPR based measures might seem fairly limited. These cases do however provide the opportunity to cross check expenditure type measures for their adequateness.

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Market valuation approach

Some valuation methods can be viewed as a "residual approach", based on the argument that differences between the market valuation of companies and their book value. Here, the book value may include intangible assets, if they are financially reported. The difference reflects the value of intangible assets, where the ratio of equity market to book value corresponds to the standard estimation of Tobin's Q.

An example is Forte, Tucker, Matonti, & Nicolo (2017), who examine the determinants of Tobin's Q for a sample of listed Italian companies. To measure intangible assets, they use valuation from balance sheets. However, it is not fully clear what this reported measure includes. Their data is a sample of 140 Italian firms from Milan Stock exchange over the period 2009-2013.

Another market-based approach is to estimate intangible capital value based on market transactions. For example, Ewens, Peters, & Wang (2019)use acquisition prices to estimate intangible capital stocks. They find that their measures correlate well with several specific types of intangible assets: human capital, brand ranking and patent valuations.

An additional example is the Value-Added Intellectual Capital Coefficient method, which seeks to measure the extent to which a company produces added value based on intellectual (capital) efficiency or intellectual resources (Bassetti, Dal Maso, Liberatore, & Mazzi, n.d.; Nadeem, Dumay, & Massaro, 2019). The method defines two types of intellectual capital: human and structural capital. Human capital is measured as labor expenses and structural capital as the difference between value added and human capital. While being straightforward to construct based on generally available data, the method can only be considered as indirect in its measurement of intangible assets, leading to questions of its validity (see e.g., Stahle, Stahle, & Lin (2015).

There are a large number of additional valuation models that are designed as strategic management tools for individual companies (Osinski et al., 2017). These include the Intangible Assets Monitor (Sveiby, 1997), IC-dVAL (Bonfour, 2003) and the Value-chain Scoreboard (Lev, 2001). However, in general, it is difficult to see how these approaches can be adapted to produce comparable statistics on intangibles.

5. Types of Intangibles

Given that intangibles investments include any activities or purchases that have a positive expected value for future growth, there may in principle be many different types of intangibles. While there are some studies that mainly concerned with estimation and analysis of a single overall measure of intangibles, a number of studies either focus on a single specific type or construct a typology of different types. Many of these types have already been mentioned above. While there are commonalities across typologies, classifications of intellectual assets from an accounting or management perspective and classifications of intangible assets from an economic perspective have developed to a large degree independent of one another. While the precise terminologies differ, intellectual assets can be grouped into three general categories: structural, human and relational assets (Bontis, 2001). For example, in (Brooking, 1996), human-centered assets include skills and knowhow,

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infrastructure assets include technologies, processes, management and networks, while market assets include brands and customer relations. While terms can differ slightly, other early studies such as (Stewart, 1997 - human, structured, relational) and (Sveiby, 1998 - human, internal and external) have similar classifications (Hunter, Webster, & Wyatt, 2005).

The literature on intellectual capital has developed a broad range of asset types that fall within these three broad categories. (Ferenhof, Durst, Bialecki, & Selig, 2015) review in all 83 models of intellectual capital, identifying 11 main dimensions. (Pedro, Leitao, & Alves, 2018) conduct an extensive, systematic review of intellectual capital classifications. They distinguish between their use at the national, regional, and organizational level. As a result, they identify 35 types of intellectual capital defined in the literature.

One distinction between these classifications and economic classifications of intangible capital is that economic classifications generally place greater focus on the identification of R&D and other technological knowhow, which can be seen as going across human capital and infrastructure capital.

In an OECD study, Young (1998) proposes a measurement framework consisting of six categories:

- Computer-related (software, large databases, other computer services)
- Production and technology (R&D, Design and engineering, new quality control systems, patents and licenses, knowhow)
- Human resources (organized training, learning by doing, activities to improve workforce well-being, remuneration for innovative ideas)
- Organization of the firm (new organizational methods, networks, new working methods)
- External: marketing and sales (market research, advertising, brands, customer lists, quality certificates, goodwill)
- Industry specific (mineral exploration, production of entertainment, literary and artistic originals)

The purpose of this classification is similar to that of guidelines concerning the classification of R&D expenditures (OECD 2015) or innovation (OECD/Eurostat 2018), to promote standardized reporting across companies, either in financial reporting or in survey-based data collection. With the exceptions of R&D, innovation, and the treatment of some intangible assets in national accounts, this has not yet been successful on a broader scale.

This fairly detailed list of types corresponds well with the categories in CHS that are listed above and the more detailed list of intangibles used in the IIA survey, which also builds on CHS[8]. Computerized information and innovative property coincide well with the first two types in Young (1998) while economic competencies encompass the next three types. The six types in the IIA survey (Software, R&D, Training, Business process improvement, reputation and branding, design) are quite similar to Young (1998), though where design is given a separate, and arguably more prominent, position as a type of intangibles investment.

The Innodrive approach (Görzig et al. 2010) also includes three categories: organizational capital, which relates to marketing and management, and research and development, relating to R&D work and to technical and

[8] Though it should also be noted here that the CHS categorization includes a more detailed list of nine types of intangibles.

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engineering work in general, and information and communication technologies. As general concepts, these types correspond fairly closely with those of CHS and the other typologies, though except for the types of investments that are primarily based on purchases of intermediate inputs (such as worker training). This method has been further refined in the Horizon 2020 GLOBALINTO project, which further tested and refined measures of mulitipliers and occupational classifications (www.globalinto.eu. See also Bloch, Eklund, & Piekkola, 2021)

While there appears to be much common ground in terms of the conceptualization of diverse types of intangibles investments, each measurement approach draws on in some cases very different types of data, and at various levels of aggregation. An important question is how these different approaches compare in their estimation of amounts of intangible assets. We will return to this question below.

6. Level of measuring intangible assets

With a macroeconomic research purpose in mind, the seminal work by Corrado et al. (2005), CHS, sets up a framework to measure intangible assets. It builds a set of estimated aggregate series of investments into an array of intangibles for the US economy in the 90's. Early empirical tests of the framework (Corrado et al. 2009) use macroeconomic US aggregate data to conduct a national growth accounting exercise. Corrado et al. (2013) makes an international comparison (including EU, UK and US) of growth accounting results. Corrado et al. (2014, 2017) takes the analysis to the industry level and investigates if and how intangibles affect sectoral growth. Empirical work using an expenditure-based approach to measurement has been mainly grounded in the theoretical framework set up by CHS (Crass, Licht, & Peters, 2015; Crass & Peters, 2014; Marrano, Haskel, & Wallis, 2009; Roth & Thum, 2013; Squicciarini & Mouel, 2012; van Ark et al., 2009).

Recent work by Adarov, & Stehrer (2019) also uses a standard growth accounting approach augmented by investments in intangible assets. Based on national accounts, labor and capital accounts data, they estimate a set of intangibles outside national accounts.

Other recent macro-work by McGrattan (2020) incorporates intangible investment into a dynamic multi-sector general equilibrium model. She parameterizes income and cost shares, from the input-output table of the Bureau of Economic Analysis (BEA) that includes expenditures on intellectual-property products—software; R&D; mineral exploration; and entertainment, literary, and artistic originals—as part of investment rather than as part of intermediate inputs. Navarro, Ruiz, & Pena (2011) draws on country level data from the World Bank, United Nations and World Economic Forum to construct measures of intangibles within human capital, process capital, relational capital, marketing capital, R&D and innovation capital, and social capital.

Work by Piekkola on the other hand has investigated measures of intangibles from another angle. In terms of theorizing, he starts at a more disaggregated firm, assuming intangibles are created by firms expensing labor effort. The data used stems mainly from micro sources, i.e., linked employer-employee data (LEED), where available. Ilmakunnas & Piekkola (2014) measures the returns to three types of labor that create intangible

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capital by accounting for differences in their productivity compared with other labor inputs. Piekkola (2016) analyzes how well market equity measures of value capture intangible assets of Finnish firms for the period 1997-2011. Piekkola (2018) uses industry level data to find out to which extent intangibles have contributed to growth in the post financial crisis period 2008-2013 in a set of European Countries. Further, closely related work by Roth and Thum (2013) investigated the relation between labor productivity and intangibles, where their decomposition of intangibles follows CHS.

As pointed out earlier, a wide array of data sources have been used to construct measures for intangibles; national and sectoral accounts data, balance sheet and other accounting data (Bontempi & Mairesse, 2015; Cucculelli & Bettinelli, 2015; Forte et al., 2017), recurrent data capture such as the Community Innovation Survey (e.g., Crass and Peters, 2014), dedicated surveys such as the 'Investment in Intangible Asset (IIA) Survey' (Awano et al., 2010)and linked employer-employee data (Piekkola, 2016, 2018; Ilmakunnas, and Piekkola, 2014).

The level of aggregation places constraints on the data sources that are available and thereby can potentially have influence on the definitions and measures of intangibles. On one hand, meso/macro studies can use data that is not available at the micro level and there is also no requirement for micro-linking of different data sources, which makes decomposing the measures easier. In empirical macro studies, the contribution of intangibles to growth (e.g., van Ark et al. 2009, Nakamura 2010, Corrado et al. 2013, Corrado et al. 2014, Niebel et al. 2017) has been extensively discussed. Meso/Macro studies have also addressed an array of other topics relevant to regional dynamics: the composition of intangible investment and its effect on market sector value added and labor productivity (Marrano et al. 2009), knowledge spillovers (Corrado et al. 2017), participation and value creation in global supply chains (C. Corrado, Haskel, Jona-Lasinio, & Iommi, 2018), and complementarities between intangibles (W. Chen, Niebel, & Saam, 2016; C. Corrado et al., 2017) .

Relational capital can be seen as value creation between firms. Chen, Zhao, & Wang (2015) and Veltri & Bronzetti (2015) both seek to measure external intangible capital formation that is created through network relationships.

(Marrano et al., 2009) use the CHS definition of intangible capital to compare UK and US data and show what the difference is when intangibles are treated as capital instead of consumption. Niebel, O'Mahony, & Saam (2017) and Chen, Niebel, & Saam (2016) follow CHS in the types of intangibles used utilizing the INTAN- invest data source.

Micro studies on the other hand face additional data challenges. When the individual firm is the unit of observation and data from various sources are being used, micro-linking the data becomes a necessity in order to, for example, make the decomposition ala CHS possible. Potentially, this tends towards the use of more narrow conceptualizations of intangibles for many micro studies. With (linked) micro data constructed however, finer-grained questions can be addressed. An example is Cucculelli and Bettinelli (2015), who find that a firm's chosen business model is one important factor in how intangibles impact firm performance. Forte

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et al. (2017) more broadly investigate the drivers of IC value at the firm level and find, amongst other things, that knowledge management is important for all firms, also outside the KIBS (Knowledge intensive business services) sector. In line with this, Crass and Peters (2015) find strong positive productivity effects of intangible assets in a representative cross section of the economy. In addition, Ilmakunnas, and Piekkola (2014) find evidence for this positive relation in Finish register data. Other studies find evidence of complementarities between certain specific types of intangibles (Brynjolfsson, Hitt, & Yang, 2002; Crass & Peters, 2014; Saunders & Brynjolfsson, 2016), which further underscores the importance of firm level analysis.

7. Conclusion

This article sets out to review the literature on measurement of intangibles with the aim to point out their applicability in economic analysis. Wehave distinguished between three *measurement methods*: expenditures based, market based, and intellectual property right (IPR) based. In general, the expenditure method has become the most widespread. Further, one can distinguish between a spectrum of *types of measures* ranging from 'broad intangibles' to 'specific intangibles', where broader intangibles aggregate a larger set of more specific types of intangible assets. In terms of *level of aggregation*, one can distinguish between micro (firm), meso (industry), and macro (national) level measures of intangibles, and often also in the measurement methods used at different levels.

In order to be fit for use in economic analysis, work on intangibles measurement faces a number of challenges. These include addressing the restrictive treatment of intangible investments in accounting regulations and in national accounts, the conceptualization of intangibles, data collection and the construction of measures of intangible assets. While these issues are quite diverse, and to some degree have been addressed in separate strands of literature, they are also very much interrelated, and have in common that they deal with the conceptualization and measurement of intangibles.

Baruch Lev and others have voiced critiques on the treatment of intangibles in accounting rules, arguing that by not recognizing value-creating resources as assets, financial reports fail to state the true value of companies (Chalmers et al., 2008; Lev, 2018; Lev et al., 2005; Lev & Gu, 2016; Zadorozhnyi & Yasyshena, 2019).Current accounting rules create a bias with greater understatement of the earnings and assets of companies with growth in intangibles investments and overstatement for companies with declining investment.

This article focused on assessing existing methods to measure intangible assets for use in economic analysis. We reviewed the expenditures-based approach (C. Corrado et al., 2005b), the survey-based work on intangibles, measurement based on firm balance sheet data, measurement work implementing the occupation or task-based approach, IPR based measurement, and intangibles measurement approaches based on market valuation.

Several studies have helped to further work on the measurement of intangible assets, both at the macro and micro level. This also includes both technical types of intangibles (such as R&D and software) and broader

forms of intangible such as organizational competences. However, there is a large gap between the broad measurement of intangible assets in many studies, such as Corrado et al. (2009) and Görzig et al. (2010), and the more limited set of intangibles that are treated as capital formation in accounting practices or national accounts. In 2008. national accounts included R&D that is defined much more restrictively than the broad economic conceptualizations of intangibles, which have been shown to be positively related to future value creation. Accounting standards are even more restrictive than the national accounts. These rules lead to, at from an economic viewpoint on intangibles, to both an underestimation of intangible assets and of productivity growth.

To bridge this gap, further work is needed, both concerning the estimation of 'technical' aspects such as depreciation rates and deflators, and in the continued testing and comparison of different measurement efforts. Given the plethora of existing measurement methods many opportunities exist to aggregate across or cross-validate between the measures that are currently being used, enhancing our understanding of the properties of these measures. And, while it faces greater challenges in terms of data availability, micro-based work will be important for the estimation of depreciation rates and in better understanding (and thereby better measuring) of broader forms of intangibles, which can thereafter inform measurement at more aggregated levels.

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