

## MEASUREMENT OF INTANGIBLES AND KNOWLEDGE: AN EMPIRICAL EVIDENCE

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**Abstract:** Knowledge has become the main source of value creation in many businesses. In the paper we investigate applied approaches for estimating the value of intangible assets published in recent years. The objective of our paper is to compare three main approaches, which were used as intangible intensity indicators in last five years. We apply them on a sample of data of European companies from database Amadeus. The analysis covers ROTA measure as well as investment in intangible assets and expenses into research and development as the key drivers of the knowledge creation in a company. We show that for European firms with increasing ROTA rank measure, the value of R&D expenses and disclosed intangible assets increase as well.

**Keywords:** intangible assets, intangible-intensive firms, R&D expenses, intangible fixed assets, ROTA rank measure.

### 1 Introduction

The success of most firms relies on intangible assets and investment in research and development (R&D) that creates this kind of assets within a company. Traditional view recognized only capital and labor as factors of production; however newer research underlines the role of knowledge, education, productivity and human capital in long term economic growth.

According to Guellec and Pottelsberghe (2004) a new paradigm has emerged that recognize that the productivity and growth are more dependent on knowledge. Even Organization for Economic Co-operation and Development (OECD) uses and accepted term knowledge-based economies, whereby OECD (2005) defines this type of economy as “trend in advanced economies towards greater dependence on knowledge, information and high skill levels, and the increasing need for ready access to all of these by the business and public sector”.

Malhotra (2000) expresses knowledge as the hidden assets of a country that underpin its growth. Rosenberg (2004) concludes that economic growth can be achieved either through increasing the inputs that enter to the productive process or through searching for new ways of doing things. Managing knowledge (regardless of the economic level) underpins the second part of Rosenberg's view as it should be directed towards making new connections between disparate ideas and knowledge (Boden, 2003) and our willingness to innovate is our only limitation for these combinations to happen.

Even Denison (1979) in his early investigation of resources of growth in the US concluded that the knowledge, skill and energy of labor were important determinants of economic growth.

A further step in the analysis of the effect of intangibles on economics growth we can find in Corrado, Hulten and Sichel (2006). They qualify any use of resources that reduces current consumption in order to increase it in the future as an investment. They require an equal treatment of all kinds of capital. According to them, investment in knowledge capital should be placed and recognized with same importance as investment in tangible assets. They also expanded definition of capital by including all investments in human capital, R&D expenditures, and also any expenditure in which a business devoted resources to projects which increase rather future than current output.

Knowledge is the main determinant of innovation that helps to strengthen economic growth and sustainable development, employment, and competitiveness in the European Union. Importance of knowledge or intangible assets increased also in private sector, mainly due to the development of information

technology. Globalisation, deregulation of key economic sectors, and exponential growth in the area of technology changes move new information and communication technologies forward and allow global access to information and knowledge. These trends stand for the birth of economy of intangible assets that is also known as the knowledge-based economy. Increasingly more businesses invest its sources into the management of intangible assets, which allow them to reach sustainable economic growth and became more competitive in comparison with other businesses. According to Peter Drucker (1969), “If you can't measure it, you can't manage it. This reason led academicians, researchers, and practitioners towards developing new quantitative and qualitative methods, which can determine or estimate the value of intangible assets.

Intangible assets include all identifiable assets without physical substance that dispose of monetary value – e.g. computer software, patents, copyrights, licenses, customers' and suppliers' relationships or marketing rights. OECD (2004) differentiates between intangible fixed assets that are non-financial produced fixed assets that mainly consist of mineral exploration, computer software, entertainment, literary or artistic originals intended to be used for more than one year, and intangible non-produced assets that are assets that entitle their owners to engage in certain specific activities or to produce certain specific goods or services and to exclude other institutional units from doing so except with the permission of the owner (e.g. patented entities or purchased goodwill). In original papers of OECD are intangible assets denoted also as knowledge assets or intellectual capital. The system of national accounts (SNA) recognizes several types of intangible assets (e.g. R&D, computer software and databases, mineral exploitation, artistic and literary works). Other types of intangible assets, such as organization capital, brand or copyrights might play an important role in the growth of GDP and productivity. Their exclusion from the group of SNA is related to the practical problems of their measurement (OECD, 2016).

Accounting for intangible assets is governed by the law of the country. International Financial Reporting Standards (IFRS) were developed as an effort to unify compilation and comparison of financial statements. Accounting according to IFRS is in Slovakia obligatory for consolidated financial statements of European enterprises and all institutions in public interest (banks, insurance companies, etc.). All the other institutions may apply IFRS voluntarily. Montresor, Perani, and Vezzani (2014) define intangible assets as non-financial, non-physical assets, which are created over time and through investment, and are identifiable as separate assets. This definition results in three conditions that each intangible asset must meet to be recognized in accounting. The first condition is identifiability. An asset is identifiable when it is separable and arises from contractual or other legal rights. The second condition is the control (power to obtain benefits from the asset) and the last one is the possibility to create future economic benefits (International Accounting Standards Board, 2016). IAS 38, that is part of IFRS, defines intangible assets as non-monetary assets which are without physical substance and identifiable (either being separable or arising from contractual or other legal rights). This, however, is a very narrow definition of intangible assets eliminating the majority of internally generated intangible assets, goodwill, etc.

One of the most problematic aspects of intangible assets is their intangibility and therefore difficult measurability. Measurement of intangible assets became a challenge for academicians and practitioners. During the decades it was proven that intangible assets contribute to the growth of firms and the whole economics, improve business performance and represent a significant competitive advantage. Firms systematically rebalance their financial sources with increasing proportion of intangible and decreasing proportion of tangible resources. The biggest boom of inventing and estimating new intangible asset measurement methods have been noted over the years 1988 –

2009 (Osinski, Selig, Matos and Roman, 2017). However, the problem of measurement remains unsolved. It is still not possible to capture the value of all intangible assets in the firm; we can only estimate their value and recognizing of an intangible asset in financial statements of the firm must undergo strict regulations. A comprehensive taxonomy of intangible asset measurement methods has been done by Sveiby (2010). He assigned more than 40 measurement methods into four categories: direct intellectual capital methods, methods based on ROA, market capitalization based methods and scorecard methods. More than half of methods belong to the scorecard methods that have mainly qualitative character. Because it is difficult to make a comparison between companies, their contribution is limited (Hunter, Webster and Wyatt, 2005).

## 2 Literature Review

The first step in measuring intangible assets is to define what we understand under intangible assets within our measurement method. Intangible assets in general cover all types of internally created and externally acquired assets of the firm that generate intangible driven earnings. Denicolai, Zucchella, and Strange (2014) state that intangible assets are able to create value only in combination with other tangible assets. In praxis, it is not possible to capture all dimensions of intangible assets, we can only estimate the value. Moreover, it is not easy to choose the best method from all that are available for estimating the value of intangible assets. Choosing the right method depends on two main factors – quality and availability of data and purpose of value estimation.

Corrado, Haltiwanger, and Sichel (2009) divided intangible assets into three broad categories: computerized information, innovative property, and economic competencies. A major component of computerized information is software. Innovative property groups all investments and activities that lead to discovery and development of new assets.

Usually, they are listed in profit and loss statement as expenses, not as intangible assets in a balance sheet. Many authors, therefore, use R&D expenses as a proxy for intangible intensity. Economic competencies cover knowledge that is embedded in firm's human and structural capital. A typical example might be market-based assets, such as brands, customer loyalty, strategic relationships or marketing knowledge (Barney, 1991; Doyle, 2000). Another market-based asset, customer equity represents value added to existing and potential customers generating profit for the firm (Sacui and Dumitru, 2014).

When it comes to recognition and disclosure of intangible assets in a balance sheet, strict rules must be applied. Accounting treatment that internationally regulates such assets is the IAS 38 directive. It respects several cost-, earnings- or market-based methods, according to which it is possible to calculate the value of an asset and disclose it in a balance sheet. Most of the assets disclosed are externally acquired asset recognized at their purchasing price and intellectual property, which includes all creations of the mind and WIPO (World Intellectual Property Organization) divides it into the industrial property (patents, trademarks, industrial designs and geographical indications) and copyrights.

This paper is based on qualitative research of published publications that apply some of the valuation methods for intangible assets. We have limited our research to analyzing financially and economically related journals with articles published over the years 2013 – 2017. We have analyzed publications of ScienceDirect database as it belongs to one of the most effective search engines for investigating research documents. We have limited our output by submitting keyword "intangible asset" and choosing only journals with economic or research focus. Our initial sample then consisted of 250 most relevant publications, from which ten was directly linked to our research.

Table 1. An overview of papers on valuation of intangible assets in 2013-2017

Author	Journal	Intangible asset measurement	Applied method and objective of the paper
Andonova, Ruiz-Pava (2016)	J. of Business Research	Possession of intangible assets - Brands, Patents, Franchise, Know-how, Licenses	Analysis of the relationship between ROA/ROS and intangible assets using hierarchical linear models for variance decomposition.
Sacer, Malis, Pavic (2016)	Procedia Economics and Finance	Non-current intangible assets according to IAS 38 (development expenditures and licenses)	Determination of the influence of different management estimates on the overall financial position and business performance (ROA, profit margin, total assets turnover). Financial statements analysis instruments are used to quantify the impact of accounting estimates on the financial position and business performance.
Contractor, Yang, Gaur (2016)	J. of World Business	Intangible assets from Orbis database	Using panel data model for verifying internalization theory about the positive relationship between parent intangibles and foreign affiliate performance.
Arrighetti, Landini, Lasagni (2014)	Research Policy	Intangible assets originally reported as assets on companies' balance sheets (intangible fixed assets, i.e. research and advert. expenditures, patents, licenses, and trademarks).	Probit analysis of factors that motivate firms to invest in intangible assets.
Clausen, Hirth (2016)	J. of Corporate Finance	ROTA Rank Measure based on Calculated Intangible Value (CIV)	Estimating the value of intangible assets and relationship between estimated intangible assets and firm performance.
Peters, Taylor (2017)	J. of Financial Economics	Knowledge (R&D spending) and organizational (% of selling, general and administrative spending) capital	Calculation of new Tobin's q proxy that accounts for intangible capital.
Borisova, Brown (2013)	J. of Banking & Finance	R&D investments	Using a variety of estimation approaches for testing the relationship between tangible asset sales and investments in intangible assets.
He, Wintoki (2016)	J. of Corporate Finance	R&D investments	Investigating the relationship between R&D investments and cash holdings of US firms.

Source: author's own elaboration

Table 1 shows that R&D expenses are used the most often as proxies for intangible assets. Clausen and Hirth (2016) suggested new, earnings-based method for calculating the value of

intangible assets that summarizes the value of existing and new intangible assets. Another group of published paper base their intangible assets' value on intangible assets recognized on

balance sheets. We, therefore, look in more detail on this three groups of estimation approaches, analyze them further and describe main advantages and disadvantages of using each approach.

### 3 Research Methodology

Our data sample consisted of 4799 European companies listed on a stock market from 37 European countries of database Amadeus for the years 2011 – 2015. Based on results from our qualitative literature review, we decided to compare three basic measures: intangible fixed assets from the balance sheet, R&D expenses from profit and loss account and indirect measure of intangible assets suggested and proved to express intangible intensity by Clausen and Hirth (2016).

Table 2. Geographical data structure

Country	ISO Code	Number of companies	
		Data sample	Cleaned data
Germany	DE	410	70
France	FR	551	131
United Kingdom	GB	941	176
Switzerland	CH	159	69
Luxembourg	LU	3	1
Sweden	SE	235	45

Source: author's own elaboration

Our final sample consisted of several most developed countries of Europe. In these countries, we expect a higher value of intangible assets in comparison to the other countries.

Table 3. Mean values of selected indicators for each analyzed year

	2015	2014	2013	2012	2011
Mean ROTA rank measure	0.025	0.038	0.026	0.054	0.036
Observations	3537	3586	3563	3580	3569
Mean R&D expenses (EUR)	97163.148	88069.567	79237.487	85278.984	81817.287
Observations	932	946	952	949	949
Mean Intangible fixed assets (EUR)	509407.572	466326.091	438196.084	454227.287	440209.011
Observations	4651	4664	4660	4656	4586

Source: author's own elaboration

All necessary data were available in financial statements. ROTA rank measure was more difficult to obtain and we calculated it according to the procedure proposed by Clausen and Hirth (2016). Return on tangible assets (ROTA) was calculated as the ratio of EBITDA and tangible assets. Authors devote their model from Cobb-Douglas production function and prove that return on tangible assets affects the intensity of intangible assets and allows us to estimate their value indirectly. We started with the calculation of ROTA and we deducted industry and year median from each value to eliminate the effect of business cycle variations and other factors not related to the productivity of intangible assets. Finally, we normalized our data by standard deviation. As proposed by Clausen and Hirth (2016) and resulting also from the problem of interpretation of CIV by Stewart (1998), we assigned zero value to the items, where ROTA rank measures were negative. In these companies, we assume no value of intangible assets. Financial statements' items related to intangible assets are known for problematic accounting recognition and disclosure. For that reason, we had to clean our data for missing and extreme values.

We excluded firms with the negative or missing value of R&D expenses or intangible fixed assets. Table 2 provides mean values of our indicators and numbers of available observations.

After excluding unsuitable observations, we analysed 492 companies from six countries of Europe. Geographical structure of our data sample is listed in Table 3

Table 4. Mean values for 2015 deciles

Mean values sorted by ROTA rank measure										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
In R&D expenses	7.932	8.336	9.149	9.905	9.840	9.765	9.973	9.894	9.799	8.610
In Intangible assets	8.035	9.420	11.083	12.178	11.607	12.344	12.006	12.162	11.433	10.527
In Total assets	10.252	11.523	13.654	14.544	13.902	13.957	13.691	13.644	12.875	11.934
Mean values sorted by R&D expenses										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
ROTA	0.109	0.099	0.169	0.095	0.111	0.101	0.134	0.111	0.114	0.113
In Intangible assets	8.773	8.618	9.628	9.803	10.104	11.017	10.952	12.459	13.777	15.576
In Total assets	10.647	10.721	11.567	11.660	12.076	13.055	13.225	14.429	15.466	17.040
Mean values sorted by intangible fixed assets										
	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10
ROTA	0.067	0.141	0.097	0.108	0.140	0.126	0.117	0.137	0.112	0.11
In R&D expenses	7.445	7.724	7.827	7.91	9.101	9.013	9.657	10.205	11.230	13.014
In Total assets	9.782	10.553	11.132	11.606	12.478	12.837	13.616	14.613	15.791	17.473

Note: D1, ..., D10 represent deciles from the lowest 10 percent to the highest 10 percent of observations sorted by ROTA rank measure, R&D expenses normalized by standard deviation, and intangible fixed assets normalized by standard deviation, respectively. Color scales represent conditional formatting from the lowest (red) to the highest value (green) in a selected category.

Source: own editing

From Table 4 we can observe that R&D expenses and disclosed intangible assets tend to increase with increasing ROTA rank measure. From Table 4, we can clearly see increasing values of intangible fixed assets with increasing R&D expenses and increasing values of R&D expenses with increasing intangible fixed assets. The variable total assets is used to express the size of the firm and tends to be lower for companies with the lower intensity of intangible assets measured by all three indicators and higher for higher intangible intensity. This result indicates that bigger firms are more intangible intensive and it is clear for R&D expenses and intangible fixed assets and less clear for ROTA rank measure.

From the comparison of ROTA rank measure and other two indicators, we can confirm that ROTA rank measure estimates the value of intangible assets of European companies and might be used as useful intangible intensity indicator. This is observable for first eight deciles. Last two deciles move in opposite directive.

### 5 Discussion and Conclusion

Our paper provides empirical evidence on three basic intangible assets measurement approaches published in economic journals in the period of last five years. European data sample is less intangible intensive measured by all three indicators. This was confirmed also by INNODRIVE and COINVEST project funded by European Commission and concluded by Corrado, Haskel, Jona-Lasinio, and Iommi (2016). They state that in Europe in comparison with the US, the share of intangible assets is lower and the share of tangible assets is higher. Moreover, whereas the share of intangible assets in the US exceeds tangible assets, we can observe an opposite trend in Europe.

We compared our results for the last analyzed year by dividing it into ten deciles according to each measurement approach. We already know that R&D expenses and intangible fixed assets represent only small part of the intangible intensity of the firm. R&D expenses are related to newly generated intangible assets and do not involve intangible assets created in the past. On the other hand, not all investments allocated to R&D must be successfully translated into intangible assets. In such cases, we can talk about them as about sunk costs. Intangible fixed assets are usually externally acquired or we can clearly determine their monetary value when they are internally generated. That means that they do not include most of the internally generated assets, which are difficult to evaluate. We were therefore interested, whether the third indicator – ROTA rank measure is more suitable for estimating the value of all intangible assets of the firm. We assumed that increasing value of ROTA rank measure will be accompanied by increasing R&D expenses and increasing intangible fixed assets as proved by Clausen and Hirth (2016) on the sample of US firms. This assumption was confirmed for first eight deciles. In last two deciles, the value of R&D expenses and intangible fixed assets decreased again. The analysis of Clausen and Hirth (2016) has been performed on the sample of US companies that are more homogenous and their accounting regulations are similar. European countries are a more diverse entity. Our sample consisted of intangible intensive France, UK and Sweden and less intangible intensive Germany (Corrado, Haskel, Jona-Lasinio, and Iommi, 2016). This might be the reason for the not monotonical development of R&D expenses and intangible fixed assets with ROTA rank measure.

We see that all approaches have their limitations in case of measuring intangible intensity. ROTA rank measure represents just estimation of intangible assets based on rentability of tangible assets, R&D expenses are investments made for creating new intangible assets and do not include already existing intangibles and intangible fixed assets cover just small part of all

intangible assets that might be present in a firm. However, we have no other possibility to get more historical data.

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**Secondary Paper Section: AE, AH**