GLOBALINTO

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A review of GLOBALINTO work to advance intangibles measurement

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1. About GLOBALINTO

Close to ten years after the start of the financial crisis, productivity growth rates are still very low in European Union (EU) and OECD countries (Van Ark and Jäger 2017). Low growth stems partly from the financial crisis, but also appears to be part of a longer-term slowdown in productivity growth since the 1970's. This has prompted strong attention to possible reasons for the slowdown and potential policy responses also in relation to intangible capital.

While several possible explanations have been put forward, we lack convincing evidence of the main reasons behind the slowdown. Both research and policy are hampered by a lack of data and evidence. The GLOBALINTO project seeks to fill this gap.

The focus of GLOBALINTO, both in measurement and analysis, is on the role of intangibles; their sustainable measurement, their accumulation and diffusion, and their use in generating innovation and productivity growth. These processes are central in understanding the underlying factors behind the role of globalization, demographic change, the public sector and growth in SMEs.

GLOBALINTO will:

- Review existing literature, methodologies and data for measuring intangible assets.
- Conduct conceptual work on intangible assets and their relation to innovation and productivity, mapping key factors such as globalization and the role of value chains, how the demand side effects innovation and productivity, IT and digitization, and the role of public sector intangibles.
- Develop new measures of intangibles and advanced methods to link data and construct them.
- Utilize this new data to analyze the various potential explanations of the productivity puzzle, at both micro and macro levels.
- Conduct analyses of existing economic policies and their role in promoting intangibles investment, innovation and productivity growth.

The project runs from February 2019 to April 2022.

2. Terminology used in GLOBALINTO

Intangible investments

Intangible investments are defined as any use of non-physical resources that creates value that can be used in the future. This definition, which follows Corrado et al. (2005, 2009), is broad in that it does not depend on any other specific characteristics. Aligned with this definition, GLOBALINTO explores the use of a number of different approaches to measure intangible investments, drawing on different data sources and at different levels of aggregation. While all these approaches adhere to the same conceptual definition provided here, the nature of each data source means that the specific construction of each of these measures differs across approaches. Approaches include occupation-based measurement of investments in organizational capital, R&D capital and ICT capital using firm-level register data, firm-level survey-based measurement of intangibles classified according to six types (training, software/databases, research and development (R&D) and acquisition of external knowledge, design, company reputation and branding, and organization or business process improvements), and industry and country level measures from the INTAN-invest and EUKLEMS datasets which measure intangibles investments based on the production of intangibles producing service industries. The specific measure of intangible investments used and how it is constructed is described in each separate deliverable.

Intangible assets (IA)/Intangible capital

Intangibles assets (IA) are the accumulation of intangible investments minus depreciation. The terms "intangible assets" and "intangible capital" are fully equivalent and are used interchangeably in project deliverables. See above concerning the definition and measurement of intangible investments. In the occupation-based approach, intangible assets are calculated using a perpetual inventory model.

Micro-based approaches

Organizational capital (OC)

Organizational capital (OC) is intangible capital and in the occupation-based approach includes value created through management, marketing and other administrative activities. See Box 1 below for a list of relevant occupations.

Research and Development (R&D) capital

R&D capital follows the OECD definition of R&D ("Research and experimental development (R&D) comprise creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge."; OECD 2015), where total R&D expenditures are the sum of current R&D expenditures (labor and other current costs) and capital R&D expenditures. R&D capital is the accumulation of R&D expenditures minus depreciation. The specific measure of R&D capital used in each approach and how it is

constructed is described in each separate deliverable. For example, in the occupation-based approach, R&D expenditures are estimated as a share of labor costs for R&D occupations, and using a factor multiplier to estimate the use of tangible capital and intermediate inputs in the generation of R&D capital per unit of labor costs. Asset accumulation is calculated using a perpetual inventory model.

Information and communication technology (ICT) capital

ICT capital is intangible capital that is accumulated through information and communication activities and the development of intangible ICTs. The specific measure of intangible assets used in each approach and how it is constructed is described in each separate deliverable.

Intangible work occupations

Intangible work occupations are occupations based on the ISCO08 classification that are classified as being involved in the accumulation of intangible assets. Occupations are in occupation-based approach classified according to three types of intangible assets: R&D, ICT and OC (organizational capital). These occupations are used to construction measures of intangible assets with the occupation-based approach. For more details, see below.

Intangible capital work

Intangible capital work refers to the work time involved in the generation of intangible investments in the occupation-based approach. For each type of intangible capital (R&D, ICT and OC), a group of occupations are identified as being involved in the accumulation of intangible assets, and a share of labor costs are assumed to contribute to intangible investments. These shares are 90% for R&D occupations, 60% for ICT occupations and 45% for organizational capital occupations. Factor multipliers estimate the use of tangible capital and intermediate inputs in the generation of intangible capital per unit of labor costs. See deliverable below for more details.

R&D capital work

R&D capital work refers to the work time involved in the generation of R&D expenditures using the occupation based approach. Factor multipliers estimate the use of tangible capital and intermediate inputs in the generation of R&D capital per unit of labor costs.

Organizational capital work

Organizational capital work refers to the work time involved in the generation of organizational capital investments using the occupation based approach. Factor multipliers estimate the use of tangible capital and intermediate inputs in the generation of organizational capital per unit of labor costs.

ICT capital work

ICT capital work refers to the work time involved in the generation of ICT capital investments using the occupation based approach. Factor multipliers estimate the use of tangible capital and intermediate inputs in the generation of ICT capital per unit of labor costs.

Intangible-work biased technological change (IBTC)

Intangible-work biased technological change (IBTC) measures the change in productivity that can be attributed to intangible capital work; i.e. work performed by employees that contribute to the accumulation of intangible assets. The relative quality of intangible capital work is approximated by the relative value of intangible capital work to non-intangible work (estimated using Cobb-Douglas production function) and the technological impact depends on the ratio of intangible capital work and non-intangible work.

R&D-intangible-work biased technological change (R&D-IBTC)

R&D-IBTC is intangible-work biased technological change based on R&D workers.

OC-intangible-work biased technological change (OC-IBTC)

OC-IBTC is intangible-work biased technological change based on organizational capital workers.

Factor multiplier

Factor multipliers are the intermediate and tangible capital investment costs per unit of labor costs in intangible capital work. Factor multipliers are estimated based on the allocation of labor costs, intermediate use and tangibles in relevant knowledge intensive NACE industries: ICT services (computer programming, consultancy 62, information service activities 63), R&D services (architectural, engineering 71, R&D 72), and management services (legal 69, head office 70, advertising, market research 73). Factor multipliers are used in the occupation-based approach for measuring intangible assets. See below for more details.

Combined multiplier

Combined multipliers are calculated as the product of the employment share of intangible work of intangible capital occupations and factor multipliers. Combined multipliers are used in the occupation-based approach to measuring intangible assets. See below for more details. Working time share are shown in the table together with the factor and combined multiplier in Table 4.1.

Linked employer-employee data (LEED)

Linked employer-employee data (LEED) includes employee occupations, salaries, work experience and education, balance sheet data amended with trade data.

LEED is used in micro-level construction of intangible assets using the occupation-based approach and subsequent analysis.

Community innovation survey (CIS)

Community innovation survey (CIS) is the reference survey on innovation by enterprises co-ordinated by EUROSTAT.

Innovation

The standard definition of innovation, jointly devised by the Eurostat and the OECD, presented in the 2018 Oslo Manual is as follows: "a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)" (OECD/Eurostat, 2018). Innovations can also be defined as patents applications or grants". The term innovation is defined specifically in each relevant deliverable.

Total factor productivity (TFP)

Total factor productivity (TFP) is a measure of productive efficiency, calculated as the portion of output not explained by the amount of inputs used in production. It is usually calculated as the residual of production function estimations with labor and physical capital as inputs.

Multifactor productivity (MFP)

Multifactor productivity (MFP) is a measure of overall efficiency of inputs used in the production process. In GLOBALINTO, it is calculated as the residual of production function estimations including labor and both tangible and intangible capital inputs, where labor and capital inputs are used together in the production process.

Macro-based approaches

INTAN-invest

The **INTAN-Invest** dataset is a follow-up dataset of the INNODRIVE Macro database. The database follows the classification proposed by Corrado et al. (2005), which divides intangibles into nine types, aggregated into three broader categories: computerized information, innovative property and economic competencies.

EUKLEMS

EUKLEMS is a database which provides measures of economic growth, productivity, employment, capital formation, and technological change at the industry level for all European Union member states, Japan, and the US. It follows a similar but slightly more "conservative" methodological approach than the INTAN-INVEST dataset. Both the 2019 release and the 2021/2022 releases have been utilized in GLOBALINTO.

Global value chains (GVC)

Global value chains (GVC) refer to the distribution of value chain activities (from research to production to marketing and sales) across different countries.

Global value chain participation

Global value chain participation is a measure of the level of participation in global value chains. The measure is defined both at the industry and country levels. The precise measurement of global value chain participation is specific to individual analyses, such as in D2.2 and D6.1. See individual deliverables for the precise measurement.

3. Introduction

Over the last 20 years, work on intangibles measurement has made significant progress in demonstrating the contribution of intangible assets to productivity and how the exclusion of intangibles as investments has led to a systematic underestimation of productivity growth (Corrado, Hulten, and Sichel 2005; Nakamura 2010).

A number of 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.

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 and Mairesse, 2015; Cucculelli and 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' (e.g. Awani 2010) and linked employer-employee data (Piekkola, 2016, 2018; Ilmakunnas, and Piekkola, 2014).

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.

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. While national accounts treatment of intangible assets were expanded in 2008 to include R&D, this definition is still much more restrictive than broader economic conceptualizations of intangibles, which have been shown to be positively related to future value creation. Accounting standards are even more restrictive. These rules lead to, at from an economic viewpoint on intangibles, to both an underestimation of intangible assets and also of productivity growth.

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. Micro studies on the other hand face additional data challenges. When the individual firm is the unit of observation and data from different sources are being used, micro-linking the data becomes a necessity in order to, for example, make the decomposition ala CHS possible. Potentially this perhaps 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. Cucculelli and Bettinelli (2015) find that a firm's chosen business model is one important factor in how intangibles impact firm performance. Forte 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 (Aral et al. 2007, Crass and Peters 2014), further underscoring the importance of firm level analysis.

A key objective of the GLOBALINTO project is to address many of the challenges in intangibles measurement through a number of measurement initiatives. The different potential uses of intangibles data and limitation both concerning data access and guidelines for capitalization of intangibles expenditures combine to create a complex set of needs and challenges. These include:

- Further development of standards and guidelines that take into account a broader range of intangibles. Both advances in the measurement of intangibles at the firm level and analysis can help inform this process.
- There is in particular an increasing need for greater measurement at the firm level, combined with firm level analysis that can shed light on questions that are difficult to examine at more aggregated levels.
- There is a need for data at different levels of aggregation in order to investigate the many questions concerned intangibles and productivity. Many advances have been made at the macro level, and more recently at the meso/industry level. In particular, the role of global value chains is in need of greater analysis.
- Work on the public sector much less advanced, but has taken on increasing interest, both due to increasing pressures on the public sector to innovate and the need to address pressing societal challenges.
- Important theme for all of this is moving towards greater sustainability in data collection and measurement. This can include either new data collection that can be established and maintained across EU countries or extensions or utilization of existing data sources that can be implemented on a regular basis.

The purpose of this paper is to summarize work in the GLOBALINTO project on intangibles measurement, and how it has sought to further the measurement agenda. The paper will describe four major contributions by the project. The first is the refinement of occupation-based measurement of intangibles based on register data, and the establishment of comprehensive databases to construct and analyze this micro data. These datasets have been constructed in four countries: Finland, Norway, Slovenia and Denmark. The second is the GLOBALINTO I-O Intangibles database, which is based on an input-output concept, and

uses available data from the World Input-Output Database covering 56 economic sectors of 43 countries (including all the EU-28). The third is the GLOBALINTO Intangibles Survey, which is a large scale survey conducted among seven countries (France, Germany, UK, Greece, Finland, Slovenia and Denmark). The fourth contribution is the advancement of intangibles measurement in the public sector, which draws on our occupation-based approach for firms.

Selected analyses in the GLOBALINTO project have utilized existing measures of intangible assets, which have been developed outside of this project. These include data from the INTAN-INVEST and EUKLEMS datasets. In order to provide a full summary of the measures of intangibles utilized in GLOBALINTO, a brief description of these methods is also included in this paper.

This paper thus draws to a large degree on the extensive work conducted within the project. We will refer throughout to the other project deliverables for more detailed information on both data work and analysis within the project. The paper will conclude with a discussion of paths by which this work can help move towards sustained intangibles data and measurement.

4. Measuring intangible assets at the firm level – an occupation based approach

Intangibles are derived from the labor costs of innovation-type occupations using linked employer-employee data. The approach is consistent with National Accounting and offered as one method in OECD (2010) and applied in statistical offices, e.g., in measuring software. OECD and Eurostat (2005) sets forth the guidelines for innovation surveys to cover a wider set of intangibles. The occupational classification is similar to the OECD study by Squicciarini and Mouel (2012), who use the US Occupational Information Network (O*NET) data.

Our approach seeks to quantify intangibles investments based on the resources used in generating intangibles, forming estimates of own-account investments, which though may also encompass some intangibles purchases. 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 is that a share of these knowledge intensive employees' time is devoted to the development of intangible capital (while 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. Three types of intangible assets are identified: organizational, ICT and broadly measured research and development.

The approach is outlined in a number of GLOBALINTO deliverables. For more detailed information, see for example, Bloch et al. (2020), Bloch et al. (2021), Piekkola (2020a, 2020b) and Piekkola et al. (2021).

Innodrive uses factor shares based to large degree on original work to create aggregated measures of intangibles by Corrado, Hulten, and Sichel (2005) (CHS). As we have noted above, shares in Innodrive are 20% for organizational work, 70% for R&D work and 50% ICT work. Several analyses have been conducted in recently (see Martin (2019) for a review of this work), and this bulk of evidence tends to suggest that these estimates of factor shares still appear to be reasonable (Martin 2019). A review of recent work suggests that existing intangible work labor share in intangible work occupations labor shares, such as used in Innodrive should be revised upwards for organizational, R&D and ICT work. Hence, the labor shares used in GLOBALINTO are 45% for organizational, 60% for ICT and 90% for R&D.

The rate of return's share on tangible capital and intermediate input for one unit of labor costs in relevant IA producing services is viewed as model for how different factor inputs are used for intangible investment in other industries. GLOBALINTO factor multipliers are calculated for the average over EU countries (or average over Northern, Central and Southern Europe), whereas in Innodrive they were derived using EU KLEMS data from six countries and weighting them by their GDP. The revised multiplier estimates are 1.55 for organizational assets, 1.53 for R&D, and 1.7 for ICT.

GLOBALINTO has examined multiplier calculation using both Eurostat national accounts data on NACE 2-digit IA producing industries and micro data, where the former was viewed to give the most reasonable estimates. The following table 4.1 shows the final GLOBALINTO combined multipliers, including factor shares.

Table 4.1. GLOBALINTO combined multipliers

	OC	R&D	ICT
Labor shares l^Y	45%	90%	60%
Factor multiplier z^{IA}	1.56	1.24	1.5
Combined multiplier $z^{IA}l^{IA}$ (rounded)	70%	110%	90%

The intangible assets are constructed based on standard assumptions concerning capital accumulation. The depreciation rate is assumed to be 20%for organizational assets. The depreciation rate of R&D is assumed to be 15%, and 33% for ICT (accumulated value of respective tangible investment assumes 13% depreciation of machinery and equipment and 5% depreciation of buildings).

Based on preliminary analysis, the GLOBALINTO project arrived at a refined occupational classification of the Innodrive method that is both simplified and more narrowly defined. In particular, the revisions of the specification revolve around three basic aspects. The first is

simply updating according to the new occupation classification, ISCO08. Taking ISCO08 as a point of departure results in a more coherent specification. Second, criteria or requirements concerning educational level have been removed for simplicity and to emphasize the focus of the method on types of occupations. Third, and related to the above, the new method does not involve any change in IA type based on educational field or determination of IA solely on the basis of educational qualifications. Finally, the range of classifications has been narrowed to a slight degree. In particular, a number of occupations within "3 Technicians and Associate Professionals" have been excluded.

Below is a detailed list of occupational classifications for ISCO08, where each of the three IA types are highlighted.

Box 4.1 GLOBALINTO Intangibles Assets occupation classification (based on ISCO08)

1 Managers 112 Managing Directors and Chief Executives 12 Administrative and Commercial Managers **121 Business Services and Administration Managers (OC)** 122 Sales, Marketing and Development Managers **1221 Sales and Marketing Managers (OC)** **1222 Advertising and Public Relations Managers (OC)** **1223 Research and Development Managers (R&D)** 13 Production and Specialized Services Managers **131 Production Managers in Agriculture, Forestry and Fisheries (OC)** **132 Manufacturing, Mining, Construction and Distribution Managers(OC)** **133 Information and Communications Technology Services Managers (ICT)** **134 Professional Services Managers (OC)** 14 Hospitality, Retail and Other Services Managers **2 Professionals** 21 Science and Engineering Professionals **211 Physical and Earth Science Professionals (R&D)** **212 Mathematicians, Actuaries and Statisticians (R&D)** **213 Life Science Professionals (R&D)** **214 Engineering Professionals (excluding Electrotechnology) (R&D)** **215 Electrotechnology Engineers (R&D)** 2151 Electrical Engineers **2152 Electronics Engineers (R&D)** **2153 Telecommunications Engineers (ICT)**	**216 Architects, Planners, Surveyors, Designers (R&D)** 22 Health Professionals **221 Medical Doctors (R&D)** **222 Nursing, Midwifery Professionals (R&D)** 223 Trad. and Complementary Medicine Professionals; 224 Paramedical Practitioners **226 Other Health Professionals (R&D)** 23 Teaching Professionals 24 Business and Administration Professionals **241 Finance Professionals (OC)** **242 Administration Professionals (OC)** 243 Sales, Marketing and Public Relations Professionals **25 Information and Communications Technology Professionals (ICT)** 26 Legal, Social and Cultural Professionals **3 Technicians and Associate Professionals** 31 Science and Engineering Associate Professionals **311 Physical and Engineering Science Technicians (R&D)** 312 Mining, Manufacturing and Construction Supervisors; 313 Process Control Technicians **314 Life Science Technicians and Related Associate Professionals (R&D)** 315 Ship and Aircraft Controllers and Technicians 32 Health Associate Professionals **321 Medical and Pharmaceutical Technicians (R&D)** 33 Business and Adm. Associate Professionals; 34 Legal, Social, Cultural Associate Professionals; **35 Information and Communications Technicians (ICT)**

Following recent recommendations from the OECD and Eurostat and accounting also for general accounting principles of reducing uncertainty in capitalization, we have chosen to exclude many occupations that can be considered to contribute with a very low factor share. This essentially implies a more restricted specification of organizational capital.

Table 4.2 below, taken from Piekkola et al. (2021), shows shares of intangibles workers for Finland, Slovenia, Norway and Denmark.

Table 4.2. Intangible-worker occupation shares of total employment

Year	OC emp. share	R&D emp. share	ICT emp. share	All	OC emp. share	R&D emp. share	ICT emp. share	All
	Finland				Denmark			
2000	1.7	7.8	1.6	11.2	2.0	7.1	1.9	11.0
2002	1.8	8.3	1.7	11.7	1.8	6.8	1.9	10.5
2004	1.6	7.6	1.7	10.9	1.9	6.6	2.0	10.5
2006	1.7	7.1	1.7	10.6	2.0	7.0	2.0	11.0
2008	1.8	7.2	1.7	10.7	2.0	6.4	2.1	10.5
2010	1.3	7.2	2.4	11.0	2.6	8.3	3.2	14.2
2012	1.3	7.2	2.5	11.0	2.5	8.2	3.3	14.0
2014	1.3	7.1	2.4	10.8	2.4	8.1	3.2	13.7
2016	1.3	7.1	2.3	10.7	2.6	8.7	3.4	14.7
2018	1.5	7.4	2.0	11.0				
	Norway				Slovenia			
2000					1.02	6.00	0.84	7.87
2002					0.96	5.54	0.92	7.43
2004					1.13	5.26	1.10	7.50
2006					1.27	5.38	1.23	7.89
2008	2.82	5.78	2.62	11.21	1.37	5.57	1.38	8.32
2010	2.98	6.58	2.59	12.15	1.67	5.95	1.52	9.14
2012	3.20	7.57	2.87	13.64	1.76	6.23	1.58	9.56
2014	3.18	8.07	2.90	14.15	1.78	6.47	1.60	9.85
2016	3.33	7.70	2.99	14.01	1.75	6.63	1.56	9.95
2018	3.20	7.47	3.10	13.78				

Source: Piekkola et al. (2021)

Productivity and the financial crisis of 2008-2009 (Bloch et al. 2021), spillovers and diffusion (Bloch et al. 2021), firm size and market power (Piekkola and Bounfour 2019, Piekkola and Parikka 2021), environmental regulation and innovation (Rahko and Piekkola 2020), innovation-biased technical change and firm markups (Piekkola 2020a,b, Piekkola et al. 2021), and gender balance (Bloch et al. 2021).

5. The GLOBALINTO I-O Intangibles database

Building on the seminal works from Nakamura (2001) and CHS (2005, 2009), a number of studies have sought to construct databases measuring intangible investments at the country level, and more recently at the industry level. These include for example INNODRIVE (Jona-Lasinio et al. (2011)), INDICSER (O'Mahony et al. (2012)), INTAN-Invest (Corrado et al. (2016)) and the most recent release of the EUKLEMS (Stehrer et al. (2019)).

These databases have been instrumental in advancing the measurement of intangibles, particularly at the macro level. And, in recent years, these datasets have been broadened to also include detailed industry level data, which is important to understand what can often be substantial differences across industries. At the same time, more work is needed to understand the flows in intangibles investments. While firms may have own account investments in intangibles, a major source of investments is through purchases from firms from main intangibles producing industries. These questions of where the intangibles go and who capitalizes on these investments is particularly relevant in order to better understand the role and functioning of global value chains. Input-output data can serve as a proper tool to properly address these questions.

The GLOBALINTO I-O Intangibles database offers a different approach on the quantification of the impact of intangibles by treating them as production inputs based on an input-output concept, using available data from the World Input-Output Database3 (Timmer et al. (2015)), which provides the raw data on inter-sectoral global trade between 56 economic sectors of 43 countries (including all the EU-28). For more detailed information on the database, see in particular Tsakanikas et al. (2020a) and Tsakanikas et al. (2020b).

The GLOBALINTO I-O Intangibles database relies on the framework first developed in CHS (2005) to identify the intangible assets and categorizing them as: computerized information (computer software and database), innovative properties (scientific and engineering R&D, mineral exploration, copyright and license costs, other product development, design and research expenses) and economic competencies (brand equity, firm-specific human capital, organizational structure). The fact that these assets are intangibles does not imply that access to them is free, nor that some of them are provided by nature. From the I-O perspective, intangible assets are provided mainly by certain economic sectors. As a result, intangibles can be regarded as intermediate products and services in the inter-industry

trade. Indeed, similar to the treatment of all other tangible intermediate inputs, intangibles are also included in the flow of global trade among different industries in different countries. Accounting for intangibles as intermediate inputs within an I-O framework is the main novelty of the GLOBALINTO Intangibles I-O database.

Building on this conceptual framework, the GLOBALINTO Intangibles database is based on a 2- digit NACE Rev.2 sector inputs approach, covering both the inter-sector and inter-country trade of intangibles. The dataset is constructed at the industry level, based on production input data from those sectors that produce intangibles. Specifically, the database covers 56 sectors and the overall economy in the EU-28 countries. Its construction is based on the 2016 release of the WIOD. The sectors that are considered producing intangibles are J62-J63 (Computer programming, consultancy and related activities; Information service activities), M72 (Scientific research and development), M73 (Advertising and market research) and N (Administrative and support service activities).

Moreover, the GLOBALINTO I-O Intangibles database provides estimations regarding sectoral export activities, sectoral productivity and sectoral productivity performance relative to the world, as well as statistics related to R&D investment from Eurostat Structural Business Statistics and National Accounts.

This work contributes to the emerging field of approximating and quantifying the impact of intangible inputs in an industry's production cycle by introducing a higher level, 2-digit sector analysis of the inter-sector and inter-country input and output flows of their utilities. The study of intangible inputs in combination with various statistics regarding investment in Research and Development (R&D) allows us to successfully approximate and quantify the impact of intangibles on a sector's activity. Moreover, using trade statistics and further study of inter-industry relationships, we are able to map the intangibles trade between countries.

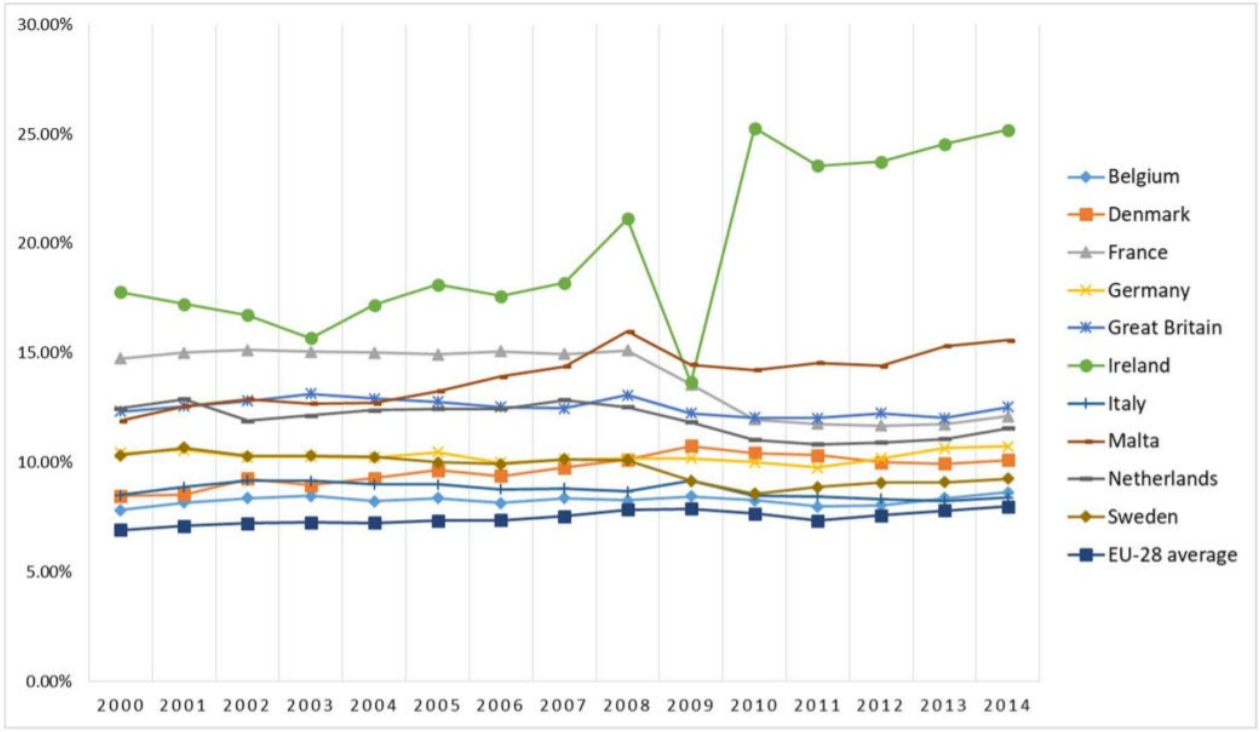
The GLOBALINTO I-O Intangibles database is divided into two categories of data and indicators: sector inputs (Inputs side) and sector outputs (Outputs side).

Intangible inputs are produced in these sectors in 43 countries (all EU members included) and the rest of the world (RoW) and are used by 56 NACE Rev.2 (2-digit) sectors in each EU country, during the period 2000-2014. Overall country inputs, per category of intangibles in each year, are also provided. Moreover, the database includes aggregates of intangible inputs imported from BRIC economies (Brazil, Russia, India and China), the euro area and the EU-28.

To capture sector outputs, the database includes statistics on the share of production that is absorbed from exports for 56 NACE Rev. 2 sectors (2-digit), in each EU country. Exports are classified into five categories, with respect to usage, following the classification in the I-O tables of WIOD: exports used as intermediate inputs; exports used for household consumption; exports to non-profit organizations serving household consumption; exports used for government consumption; and exports pertaining to gross fixed capital formation.

The figure below, taken from Tsakanikas et al. (2020), show intangibles intensities for the top intangibles users among EU-28 countries.

Figure. Shares of Intangibles Inputs to total intermediates consumption – top EU-28 intangibles users, 2000-2014.



Source: Tsakanikas et al. (2020b) Calculations based on the GLOBALINTO I-O Intangibles database

This database has already been applied in a number of analyses that focus on the role and functioning of Global Value Chains (Tsakanikas et al. 2020a, 2020b, 2020c).

6. The GLOBALINTO Intangible Assets Survey

A central element in GLOBALINTO work to further intangibles measurement was to develop and conduct a large scale, international survey on intangibles. Survey-based approaches to collect data on firm investments in intangibles remain limited. In order to heighten the chances that GLOBALINTO work could contribute to sustained data collection, survey work was closely informed by previous studies. Primarily, the following surveys have made a more pronounced mark or have been used in more than one country (Redek and Bavdaž 2019):

1) NESTA & ONS (2009; 2010): Investment in Intangible Assets Survey (UK).

2) Eurobarometer survey (2013): "Investing in Intangibles: Economic Assets and Innovation Drivers for Growth" (EU-27, Croatia, Iceland, Japan, Norway, Serbia, Switzerland, Turkey, the Former Yugoslav Republic of Macedonia and the United States).

3) ISFOL & ISTAT (2013): "Rilevazione statistica sugli investimenti intangibili (in English: Statistical survey of intangible investment)" (Italy)

4) Prašnikar et al. (2012) survey of intangible capital in the private and public sector.

The UK Investment in Intangible Assets Survey (IIA Survey) targeted companies from production and service sectors, but focusing on those with 10 or more employees. The purpose was to measure more in detail primarily the following aspects (ONS, 2009): - Employer funded training - Software - Reputation and branding - R&D - Design - Organization and business process improvement The survey was conducted twice: in 2009 and 2010 explored the level of spending and life lengths investment into intangible assets. According to Haskel et al. (2010) the survey was characterized by three innovative elements: 1) The survey is broader than innovation due to its focus on intangibles, 2) The survey includes both intangibles developed within the firms as well as those purchased. 3) The survey also attempted to estimate depreciation rates by accounting for the expected duration of benefits from an intangible asset (Office for National Statistics & Imperial College London, 2016).

Eurobarometer study "Investing in intangibles: Economic assets and innovation drivers for growth" was conducted in 2013 to investigate the corporate investment in intangible assets as they were recognized by the European Commission as being increasingly important in the process of economic growth of the developed countries (Eurobarometer, 2013). The survey covered 27 EU countries and also Croatia, Iceland, Japan, Norway, Republic of Serbia, Switzerland, Turkey, the Former Yugoslav Republic of Macedonia and the United States.

A survey on intangible assets was carried out also in Italy, in the cooperation between ISFOL (National Instistute for the Analysis of the Public Policies), and ISTAT (the National Statistical Institute) (Angotti, 2017). The purpose was to capture the nature of intangible investment in Italian companies, based on the experience in the UK. The survey focused on companies with 10 or more employees and in total collected 10 thousand responses (Angotti, 2017).

The study of intangible capital in the Balkan region was carried out by a team of researchers from the University of Ljubljana, led by Prašnikar, while the interdisciplinary team comprised members from many fields of economics and business in order to be able to appropriately capture the nature of different dimensions of intangibles. Their first survey-based study of intangible capital was carried out in 2010 among largest manufacturing companies in Slovenia, followed by an extended study to services sector in 2011. Good results allowed the extension of the study to Bosnia and Hercegovina and Albania in 2012.

The development of the GLOBALINTO Intangible Assets Survey questionnaire draws on the questionnaires of the surveys mentioned above, combined with the project group's experience with related surveys. The development of the questionnaire is detailed in Caloghirou et al. (2019) while implementation issues are discussed in Bavdaž and Redek (2020).

The figure below, taken from Caloghirou et al. (2019), outlines the framework for the questionnaire's development.

The first section includes general information about the firm including firm's primary and secondary activities, whether the firm belongs to a national or multinational enterprise group and firm size. The second section concentrates on firm's intangible's investments drawing on previous surveys on intangibles, particularly the one commissioned to NESTA by the UK Office for National Statistics (see Awano et al. 2010) and the Innobarometer 2013.

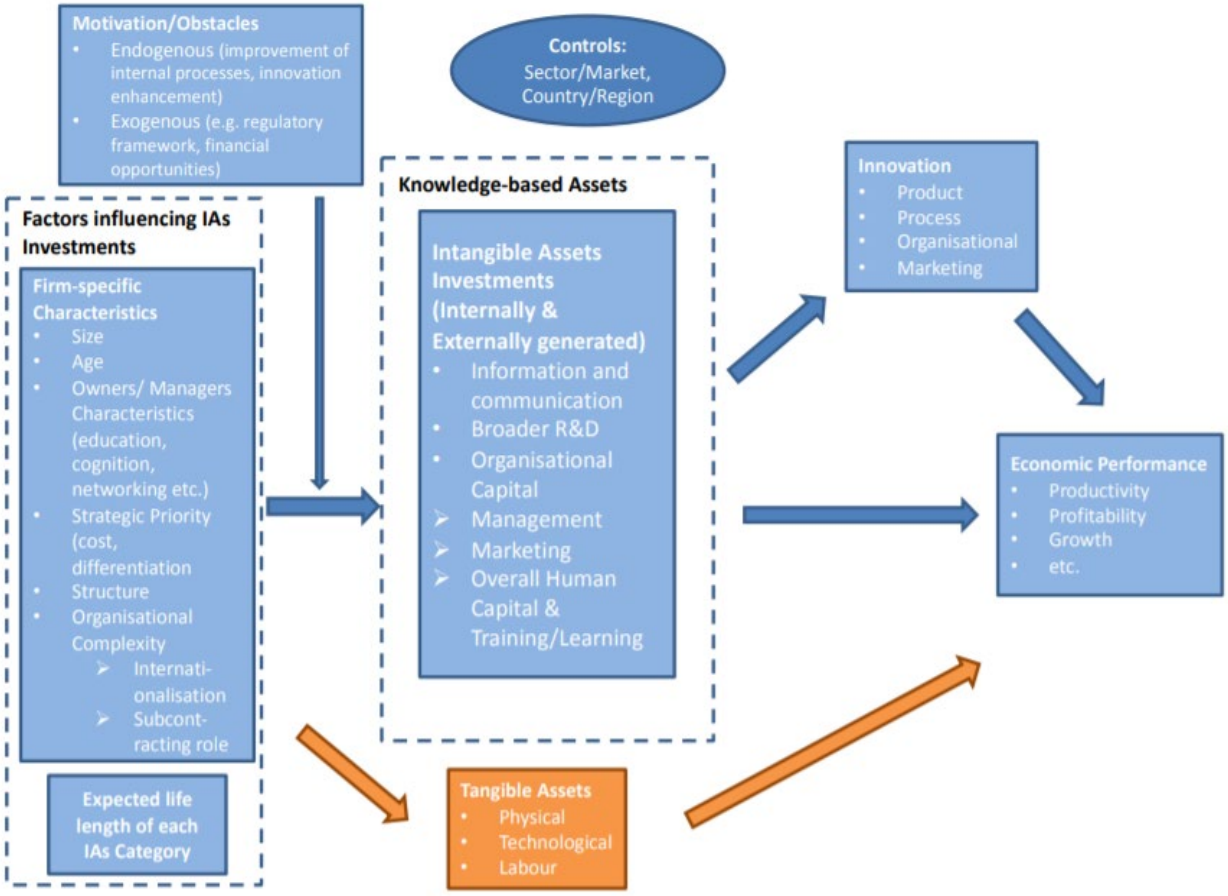
Following the classification developed by NESTA, the questionnaire investigates investment decisions on six types of intangible assets: (i) training, (ii) software/databases, excluding research and development and web design, (iii) research and development (R&D) and acquisition of external knowledge, (iv) design of products and services (excluding research and development), (v) company reputation and branding, and (vi) organization or business process improvements. This includes both in-house investments and purchases of intangibles.

The third section covers strategic factors behind the firm's investment in intangible assets. In line with the capability view of the firm (e.g. Dosi et al, 2001; Teece et al, 1997, 2007; Helfat et al, 2007 etc.) it is argued that a firm's propensity to invest in intangible assets can be understood mainly as a bundle of resources and capabilities that the firm has evolved over time and only marginally as a result of exogenous technological contingencies (e.g. Arrighetti, Landini and Lasagni 2014; Montresor and Vezzani, 2016).

The fourth section concerns the impact of investments in intangible assets using various performance measures including innovative firm performance. Thereafter, number of questions related to the impact of public policies on the intangible investments of a firm are included in the fifth section.

Finally, due to the pandemic, a set of questions was also developed to understand how strategic management and investment decisions were affected by COVID-19.

Figure 6.1. Framework for GLOBALINTO Intangible Assets Questionnaire development



Source: Caloghirou et al. (2019)

The data from the survey has just recently been processed, hence statistical analysis of the data has not yet been completed. The project plans both to report the statistical results of the survey and conduct a number of analyses in the coming months.

7. Public sector intangibles

While there has been growing interest in public sector innovation and the many challenges that the public sector faces, this has generally not translated into measurement activities for intangibles in the public sector. The most prominent work in this area is the SPINTAN project, which defined methodological guidelines for the collection and the measurement of intangibles in the public sector.

The GLOBALINTO project set out to advance work on measurement of public sector intangibles by exploring how previous and ongoing work on private sector measurement in Innodrive and GLOBALINTO could inform measurement in the public sector. In this work, we propose an alternative approach to measuring intangibles relying on the existing Innodrive and GLOBALINTO methodology for the private sector, however upgrading it and extending it to make it suitable for the analysis of the intangible capital in the public sector. For more information, see in particular Piekkola et al. (2020) and Farčnik et al. (2020).

Given that public sector activities often involve multiple tasks, the identification of intangibles creating employees can be more complex than in the private sector. For this reason, a higher education requirement was considered. It is also clear that the different sectors may further require the adjustment of intangible workers. Hence, further work will be done to adjust the measurement. These were some of the further challenges that are being encountered in the preparation of the methodology and in practice primarily are linked to:

- Identification of variation in relevant sectors at 2- 3-digit levels;
- Identification of further sector-specific occupations at 4-digit levels and
- Identification of relevant sector-specific educations including doctoral degree

It is important to emphasize that this work is still ongoing, but the project has already explored different applications of this type of data, for example to map trends in intangibles investments across public services (Farčnik et al. 2020) and to examine the relation between public sector intangibles and private sector productivity (Bounfour and Nonnis 2021). An important additional application would be to examine the relation between intangibles investments and public sector performance or outcomes, though this is challenged by a lack of appropriate outcome measures for the public sector.

8. Intangibles measurement in INTAN-INVEST and EUKLEMS

8.1. INTAN-Invest

The INTAN-Invest dataset is a follow-up dataset of the INNODRIVE Macro database (Roth 2022a). It estimates of cross industry and cross-country investments of intangible investments, for 29 countries and 21 1-digit industries (NACE rev. 2 classification). The idea behind the database is that intangible capital should be treated in the same way as tangible capital, as "*any use of resources that reduces current consumption in order to increase it in the future qualifies as investment*" (Corrado et al., 2005).

The database follows the classification proposed by Corrado et al. (2005), which divides intangibles into nine types, aggregated into three broader categories: computerized information, innovative property and economic competencies (cfr. Table 8.1). In particular,

the distinction between innovative property and economic competencies is made such that the former includes those intangibles that have some kind of intellectual property protection, while the latter includes those that do not have such protection. Therefore, innovative property includes *"the scientific knowledge embedded in patents, licenses and general know-how and the innovative and artistic content of commercial copy-rights, licenses and designs"* (Corrado et al., 2005). Instead, economic competencies 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., 2017), plus organizational capital, that is *"the cumulated knowledge that is built up in firms through investment in organizing and changing the production process"* (Corrado et al., 2017).

Table 8.1. INTAN-Invest intangible assets

INTAN-Invest intangible assets
Computerized Information Software and Databases
Innovative property R&D Entertainment and Mineral Exploration Design
Economic competencies Brands Organizational capital Firm-specific human capital (training)

Intangible assets in Table 8.1 can also be distinguished between those that are already considered as investment and included in national accounts (software and databases, R&D, mineral explorations and entertainment) and those that are not (brands, organizational capital, design, training). A further important distinction is whether the assets are produced and used within the same firm (*own-account*) or are purchased from outside.

Methodologically, nominal intangible investment ($P^N N_t$) for an aggregate of J intangible assets is computed as in the following formula:

$$P^N N_t = \sum_{i=1}^{J} \sum_{s=1}^{S} (\gamma_{i,s,t}^{OA} \lambda_{i,s,t}^{OA} OwnCost_{i,s,t} + \gamma_{i,s,t}^{P} \lambda_{i,s,t}^{P} Purchased_{i,s,t})$$

Where, on the right hand side, the summation involves own-account intangible components (*OwnCost*), and intangible components that are purchased from outside the firm (*Purchased*). The two components, *OwnCost* and *Purchased*, are time series indicators. The

parameter λ transforms intermediate expenditure into a sector-industry gross output, while the parameter γ is a capitalization factor, needed to convert expenditure measures into investment measures. In other words, the latter determines the fraction of intangible spending to be considered as investment. Note that both the parameters are both asset specific, sector specific and specific to each category of intangibles, namely own-account or purchased, hence the superscripts *OA* and *P*. Finally, the subscripts *i*, *s* and *t* denote intangible asset type (as per Table 8.1), country-sectors and time, respectively.

As for the source of the data used, the time series for the purchased components (that are not already included in the national accounts) are obtained from most national statistical offices (NSOs) and from the use tables in the WIOD project, which provide intermediate purchases by industry and by product. As for the intangibles included in national accounts, data are taken from NSOs, and they are valued at the acquisition price. Finally, time series for the own account components are again derived from NSOs, using the costs of production, for which the availability varies from asset to asset, with brands and design that are not available and for which purchased components only are computed.

8.2 EUKLEMS

8.2.1 EUKLEMS – 2019 release

The EUKLEMS 2019 release (Stehrer et al. 2019) is a database which provides measures of economic growth, productivity, employment, capital formation, and technological change at the industry level for all European Union member states, Japan, and the US. It follows a similar but slightly more "conservative" methodological approach than the INTAN-INVEST dataset (p.32). The EUKLEMS 2019 release it is the first dataset to offer a harmonized tangible-intangible capital dataset. It entails detailed data for the 28 EU Member States and various country aggregates, Japan and the US over the period 1995-2017 and for 40 detailed industries according to NACE Revision 2 (ISIC Revision 4) and twelve industry aggregates (including the total economy). Table 2 list the three broad categories seven individual intangible capital indicators as used within in Deliverable 6.6 in the GLOBALINTO project (Roth and Sen 2021, Roth 2023). The dataset can be accessed at: Archive & History - wiiw KLEMS release 2022 (euklems.eu)

8.2.2 EUKLEMS –2021/2022 release

The EUKLEMS 2021/2022 release (Bontadini et al. 2021) is an updated version of the 2019 release. It follows the methodological approach of the INTAN-Invest dataset. The EUKLEMS 2021/2022 release provides detailed data for 27 EU Member States, the US, Japan and the United Kingdom, across 40 industries, 23 industry aggregates, over the period 1995-2019. The database includes information on key variables for studying productivity including output, intermediate inputs, gross value added, employment, compensation of employees, as well as investment in capital stocks across both tangible and intangible assets.

Table 8.2 list the three broad categories seven individual intangible capital indicators as used within an updated version of Deliverable 6.6 (Roth 2022b). It can be accessed at: Documentation - Luiss Lab of European Economics

Table 8.2. EUKLEMS intangible assets

EUKLEMS – 2019 release	**EUKLEMS – 2021/2022 release**
Computerized Information	Computerized Information
Computer Software and Databases	Computer Software and Databases
Innovative property	Innovative property
R&D	R&D
Other Intellectual Property Products	Other Intellectual Property Products
Design and Other Product Developments	Industrial Design
Economic Competencies	Economic Competencies
Advertising, Market Research and Branding	Brand
Vocational Training	Training
Purchased Organizational Capital	Organizational Capital

9. Conclusion

This paper has reviewed GLOBALINTO work on intangibles measurement, covering four initiatives. The first is the refinement of occupation-based measurement of intangibles based on register data, and the establishment of comprehensive databases to construct and analyze this micro data. The second is the GLOBALINTO I-O Intangibles database, which is based on an input-output concept, and uses available data from the World Input-Output Database. The third is the GLOBALINTO Intangibles Survey, which is a large scale survey conducted among seven countries (France, Germany, UK, Greece, Finland, Slovenia and Denmark). The fourth contribution is the advancement of intangibles measurement in the public sector, which draws on our occupation-based approach for firms.

Due in part to national data regulations that may limit the sharing or merging of data across different registers, LEED data is not available in all countries. This is a significant limitation for developing aggregated statistics based on LEED, since it is highly unlikely that such statistics could be produced for a broad range of countries. On the other hand, LEED data is available in a number of countries, and it may be possible that the list could be expanded for the purpose of conducting research.

For this reason, we view our register-based approach, and the use of LEED data more generally, to be of primary use for analysis as opposed to creating statistics. Our occupation-based approach for the measurement of intangibles can be readily applied in other countries or by other researchers with access to LEED data. Project work has demonstrated that the

measures are reliable across countries and can be used to investigate a number of questions concerning intangibles, innovation and productivity. We hope that our work to date and upcoming analyses will act to promote this approach and encourage others to apply it in relevant analyses.

Work on the measurement of public sector intangibles is still in its early stages. Our approach contributes to this work by exploring the use of occupation and education data to measure intangibles investments across different areas in the public sector.

There is a lack of data on firms' investments in intangible assets. Due to accounting rules, firms are not able to capitalize a large share of their expenditures on intangibles, hence there is no standard account of most intangibles. Furthermore, while methods to estimate intangibles based on existing data (such as our own approach based on LEED data) may be useful in a number of contexts, they still do not eliminate the need for primary data collection that inquires about firms' intangibles investments and key factors affecting their investment decisions. Given the strong focus on intangibles and their role for innovation and productivity growth, we believe that there is a strong need for regular international data collection on intangibles investment. The GLOBALINTO Intangible Assets Survey has added to experience in intangibles surveys, seeking to align with previous classifications of intangibles, such as the UK IIA Survey, while contributing with new questions on strategic aspects and the effects of the pandemic.

While we expect that the survey data will prove to be very useful in itself, a key additional goal is that the GLOBALINTO Intangible Assets Survey will foster further work on the measurement of intangibles investments through surveys. There are in principle two route through which this can be realized, through a dedicated survey or through the incorporation of selected questions in an existing survey, where the Community Innovation Survey would clearly be the most obvious choice. Questions on innovation activities (that must be directly linked to innovations) could very straightforwardly replaced with questions on intangibles investments. These same questions were also relevant following earlier surveys, particularly the IIA Survey. However, this additional survey, which has been conducted in seven countries, may act to strengthen arguments for regular data collection on intangibles investments.

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