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MEASURING INTANGIBLE CAPITAL IN THE PUBLIC SECTOR: A MANUAL

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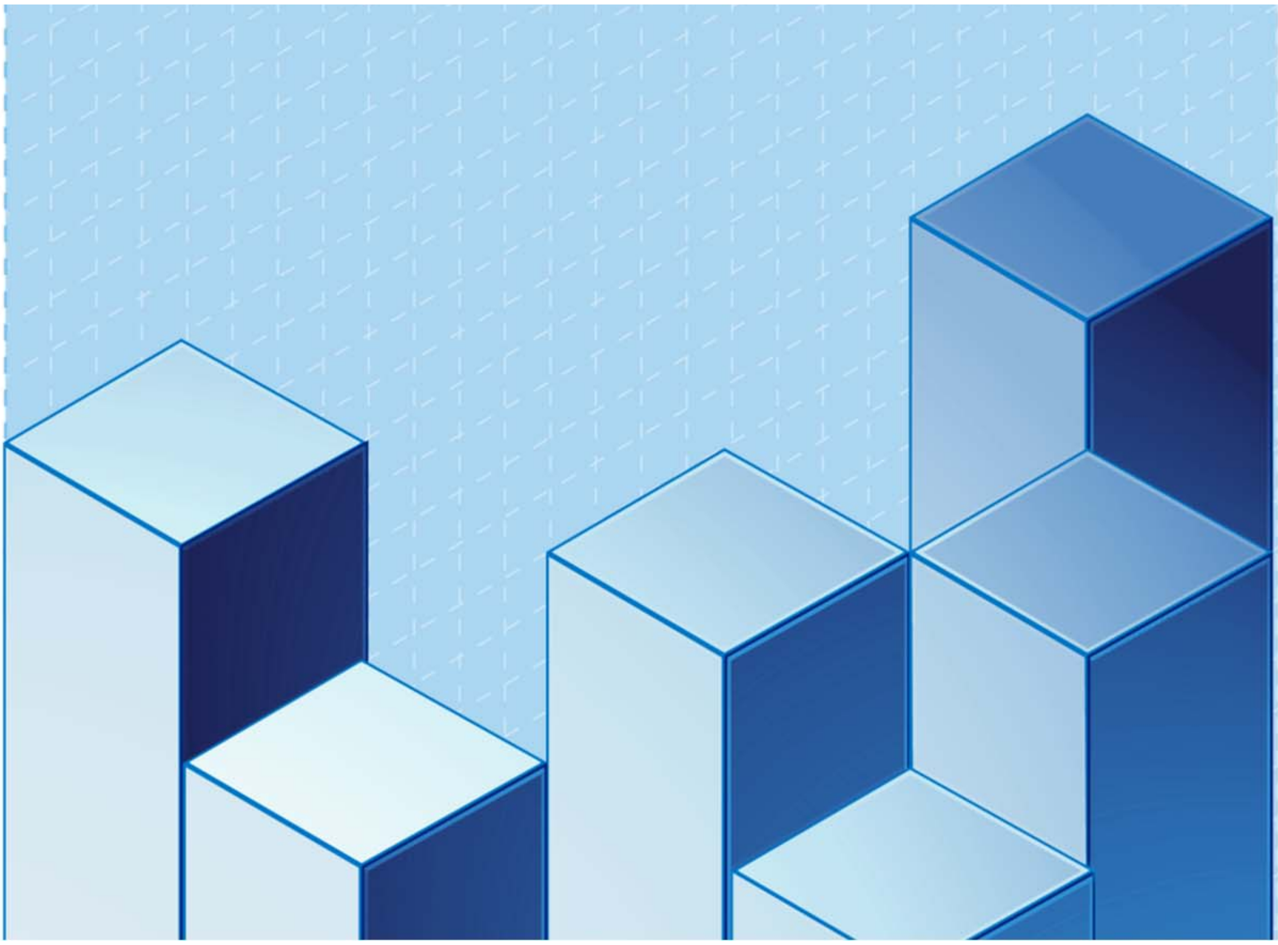

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Measuring Intangible Capital in the Public Sector: A Manual

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Introduction

Intangible investments are widely recognized as a major determinant of innovation, growth and employment in the “knowledge economy.” Endogenous growth models emphasize that knowledge and skills are important determinants of growth and stress that knowledge spillovers generate persistent growth (e.g. Romer, 1986; Lucas, 1988). The importance of R&D and innovation is also explicitly recognized in the “Lisbon process,” including the Europe 2020 agenda, aimed at improving the growth and employment performance of the EU. The empirical understanding of the contribution of intangibles assets to economic performance remains incomplete, however. The strain of empirical research on intangible assets that follows Corrado, Hulten, and Sichel (2005, 2009), hereafter CHS, is confined to the business sector of the economy and ignores the potentially important role played by intangibles in public sector organizations.

A study of intangibles in the public sector must start with a definition of what is included within the production boundary. CHS addressed the conceptual problem of defining intangible assets using an inter-temporal framework. The inter-temporal framework e.g., Weitzmann (1976, 2003), leads to the conclusion that “*any* use of resources that reduces current consumption in order to increase it in the future qualifies as investment” and that all types of capital should be treated symmetrically, namely, that “investment in knowledge capital should be placed on the same footing as that of investment in plants and equipment” (Corrado et al., 2005, p. 19; and Corrado et al., 2009, p. 666).

A convenient consequence of the CHS approach and its emphasis on the symmetric treatment of all assets is also that one does not have to worry too much about defining “intangibles” by way of specific characteristics. Rather it is more important to determine whether a spending type meets the test of being a current outlay that enhances the future capacity of producers (and thereby future consumption). Additionally, the CHS approach does not require explicit econometric techniques and rather offers a practical approach to monitoring intangible capital as part of a periodic measurement program carried out by a statistical office.

Building on Lev (2001) and Nakamura (1999, 2001), CHS developed expenditure measures for intangible investment in the United States, classifying capital into three broad categories:

computerized information, innovative property, and economic competencies. At the time only software and artistic and entertainment originals were recognized as assets in official guidelines for national accounts. Since this seminal paper, increasing emphasis has been put on the need to capitalize expenditures on R&D as well as expenditures on new product and new process development beyond R&D—e.g., expenditures on organizational change, training, design, market research and branding—to better understand drivers of innovation and productivity change. All told, analyzing business sector intangibles as a source of growth has by now involved many researchers across a wide range of institutions and countries.[1]

The CHS framework was developed for application to the market (or business) sector, and aplying the framework to the public sector requires extension and modification. The primary purpose of this manual is to review the extended framework and economic underpinnings of public intangibles as developed under the SPINTAN project. One could say that the SPINTAN goal at its most practical level is to complete the coverage of intangible investment by industry sector, making possible the generation of total economy growth accounts with intangibles as productive assets.

Policy analysis of an economy's performance requires complete data on public investments and knowledge of how such investments impact private sector outcomes. There are many challenges to providing data on public investment in intangible assets. Indeed there are challenges to defining what we mean by public investment and how we identify the "public" sector. The chapters that follow carefully analyze the relevant asset and production boundaries and review how public and nonmarket entities are represented in national accounts. The notion of "social infrastructure" is also introduced. Social infrastructure, as distinct from physical infrastructure, consists of societal investments that lead to assets (e.g., schooling-produced assets) that add to a nation's wealth. The chapters also review the difficulties in identifying and measuring certain intangible assets in a nonmarket context, e.g., cultural assets, open data, and organizational capital arising from expenditures on staff training.

A subsequent set of chapters explores some basic conceptual issues in the economic measurement of intangible capital, including the estimation of nominal investment flows, net stocks, and the rate of return ascribed to public assets.

[1]Significant portions of this research has been funded by European Commission FP7 framework grants. Two past projects, COINVEST and INNODRIVE, led to the (unfunded) INTAN-Invest research collaboration that constructs and maintains a harmonised dataset on intangible capital investments for 22 EU countries plus the United States. The WIOD project led to the initial development of intangible capital estimates for China and India. Elsewhere, researchers have developed estimates for Japan, Australia, Brazil, and Canada.

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1 Knowledge capital in the Public Sector

by **Carol Corrado, Jonathan Haskel, Kirsten Jäger, Cecilia Jona-Lasinio, Massimiliano Iommi**

What is the nature and scope of measures the SPINTAN project aims to develop? As set out in Corrado, Haskel, and Jona-Lasinio (2014b), although the existing intangibles framework will be expanded, broadly speaking, the current scope of GDP will continue to be regarded as the production possibilities frontier. In other words, while nonmarket production by public and nonprofit institutions is the primary focus of the project, *nonmarket production by households is excluded.*

Many challenges are nonetheless encountered when estimating the value of public investments germane to this scope. Restricting the scope of nonmarket production does not, for example, circumvent the need to impute a rate of return to public capital formation for coherency of total economy productivity analysis. And once we delve into certain topics, we encounter very specific measurement and research challenges, such as how to account for cultural assets, many of which are not, strictly speaking, intangible assets but whose intrinsic value to citizens is incalculable and therefore often described as "intangible." Indeed defining what we mean by public investment presents challenges.

Industries of interest. Our measurement goal at its most practical level is to complete the coverage of intangible investment by industry, making possible analysis of productivity for the total economy based on a complete accounting of intangible capital *inputs*. Most existing estimates of intangible assets, e.g., INTAN-Invest,[2] cover a *subset of industries* in the economy that productivity researchers (e.g., Timmer, O'Mahony, Inklaar, and van Ark, 2010) refer to as the "market" sector. SPINTAN thus estimates the intangible capital of "nonmarket" industries. "Nonmarket" industries consist of the following NACE Rev. 2 sections: (1) public administration and defence; (2) education; and (3) human health and social work activities.[3] To this list we add (4) scientific research and development and (5) arts, entertainment and recreation

[2] INTAN-Invest is an unfunded research collaboration that maintains and extends work done under COINVEST and INNODRIVE. Until very recently, INTAN-Invest estimates were available for the aggregate market sector only, but now estimates according to 8 disaggregate industry sectors for 23 EU member states are freely available at www.INTAN-Invest.net. See Corrado, Haskel, Jona-Lasinio, and Iommi (2013, 2014) for further details, and also Niebel, O'Mahony, and Saam (2013) for related work conducted under INDICSER.

[3] The usual grouping of nonmarket industries also includes real estate, which is not discussed in this paper.

because these industries contain significant nonmarket production (e.g., federally-run research laboratories, public parks and museums) in many countries; see table 1 below. The use of "market" vs. "nonmarket" groupings of industries is thus not precise because an industry can reflect activity carried out by a mix of producers, as is evident with NACE Section R and the larger section of which NACE Section MB is a part.[4]

Table 1: **SPINTAN Industries of Interest**

NACE SECTION	INDUSTRY TITLE	NACE NUMBER
MB	Scientific research and development	72
O	Public administration and defence; compulsory social security	84
P	Education	85
QA	Human health activities	86
QB	Residential care and social work activities	87-88
R	Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities	90-91
	Gambling and betting activities; sports activities and amusement and recreation activities	92-93

NOTE—NACE Rev. 2.

Before we leave the subject of NACE-defined industries, it must be said that in some countries there are industries with significant government or nonmarket production besides those listed in table 1. These tend to be industries that engage in activities not germane to our topic areas, e.g., transportation, housing, and utilities. On the other hand, there are industries of interest to our work in SPINTAN that are not listed, e.g., those receiving government R&D subsidies, but such industries tend to have little nonmarket production other than their own-produced intangible assets for which we have already accounted.

Industries vs. Institutional Sector. National accountants classify economic activity according to institutional sectors, or industries. Figure 1 illustrates the relationship between national account sectors and the nonmarket/market conceptual distinction in a simplified way. The national accounts *nonmarket* sector is found above the horizontal line in figure 1 and consists of general government (GG) and nonprofit institutions serving households (NPISH). The *public* sector is found to the left of the vertical line in figure 1 and consists of general governments and government sponsored enterprises (GSEs).

[4]Appendix table A1 (page 171) shows the full intermediate structure of NACE Rev. 2.

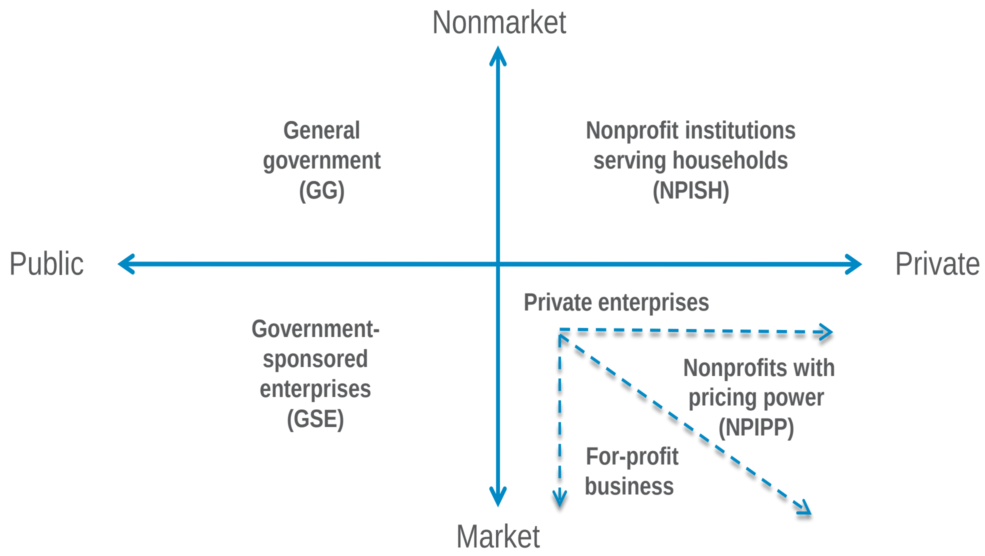


Figure 1: Enterprise types in the SNA: Groups according to control (private, public) and ability to charge economically significant prices (market, nonmarket)

Investment activities of the general government and nonprofit institutions (NPI) are the focus of SPINTAN. It is important to recognize that many nonprofit institutions are considered market producers according to the System of National Accounts (SNA) because they are able to charge "economically significant" prices.[5] In other words, such institutions are not NPISH but rather are NPIPP (nonprofit institutions with pricing power) where NPI=NPISH+NPIPP. Educational institutions, for example, can be public or private, and among the latter, while most are nonprofit institutions, some are classified as market producers, i.e., they are in the NPIPP segment of the lower right quadrant of figure 1. The arts and entertainment industry is equally diverse in terms of its institutional composition, as is health and social services in certain countries. All told, all but one of the industries that we work with (NACE 84, public administration and defence) consists of a mix of institutions: business (whether for-profit or nonprofit), nonprofit institutions serving households, and general government.[6] The distinction

[5]The SNA instructs that producers be classified as businesses if they are able to charge economically significant prices, e.g., schools, colleges, universities, hospitals constituted as nonprofit institutions are to be classified as market producers when they charge fees that are based on their production costs and that are sufficiently high to have a significant influence on the demand for their services (European Commission et al., 2009; para 4.88). In practice, for European countries, the European System of National and Regional Accounts (ESA) implement this as a quantitative criterion, considering economically insignificant prices to be those that cover less than half the cost of production.

[6]Note that the United States and Canada follow a different convention in that the general government and government sponsored enterprises sectors are kept as separate industries in industry and input-output accounts, with the result that other industries largely pertain to private enterprises, i.e., activity to the right of the vertical line in figure 1. This means that U.S. public schools and universities, Veterans Administration hospitals and the like are *not* included in the U.S. education and health industry; the postal system is *not* in the transportation sector, etc., whereas such organizations would be spread across industries based on homogeneity of production

between institutional sector and industry is very important because the information provided by the available data is quite different. We elaborate on this issue in section 4 below.

Finally, we note that because of the societal focus of our topic areas, in SPINTAN we do not concern ourselves with GSEs even though these tend to be companies traditionally associated with public infrastructure investment, e.g., rail and power companies. And to be perfectly clear, we also do not concern ourselves with segments of nonprofits outside our topic areas, e.g., religious organizations, or membership organizations serving business.[7]

CHS type of asset: market vs nonmarket. Table 2 summarizes the CHS list of intangibles assets (on the left) and maps them to the public or nonmarket sector (on the right). We introduce two broad categories of public intangible assets: information, scientific, and cultural assets, and societal competencies. The correspondence between the two columns is not one to one. As may be seen, the asset boundary is slightly different depending on the market-nonmarket nature of the sector. But before we discuss what's different across the two columns, let us make a few points about the similarities. First, while the character of some assets are rather different when produced by public institutions, e.g., R&D, organizational, and mineral exploration, one may still draw a correspondence between these assets across sectors. For example, Jarboe (2009) defines public investments in brand as expenditures for export promotion, tourism promotion, and consumer product and food and drug safety (i.e, investments in product reputation). The correspondence for computer software, purchased investments in organizational capital, and function-specific worker capital (employer-provided training) is even closer.

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

process if European conventions were followed.

[7] The two-digit classification structure for the purposes of NPI is shown as Appendix table A2 (page 172), in which it can be seen we cover three of the nine one-digit categories.

Table 2: Knowledge Capital for a Total Economy

Market Sector		**Nonmarket Sector**	
Computerized Information		**Information, Scientific, and Cultural Assets**	
1	Software	1	Software
2	Databases	2	Databases, including open data
Innovative Property			
3	R&D, broadly defined to include all new product development costs[a]	3	Basic and applied science research, industrial and defense R&D
4	Entertainment & artistic originals	4	Cultural and heritage, including design
5	Design		
6	Mineral exploration	5	Mineral exploration
Economic Competencies		**Societal Competencies/Social Infrastructure**	
7	Brands	6	Brands
8	Organizational capital	7	Organizational capital
(8a)	Managerial capital	(7a)	Professional/managerial capital
(8b)	Purchased organizational services	(7b)	Purchased organizational services
9	Firm-specific human capital (employer-provided training)	8	Function-specific human capital (employer-provided training)
		9	Schooling-produced human capital

a. New product development costs include expenditures for testing and development of new products (including financial products and other services products) not included in conventional science-based R&D, software, databases, and design.

information assets loom large in the United States as well. Indeed, it has long been held that the U.S. Census Bureau's release of its TIGER (Topologically Integrated Geographic Encoding and Referencing) dataset—in 1991—bootstrapped the country's booming geospatial industry.

Cultural assets are public intangible assets whose services are used in production in cultural domains dominated or influenced by the public and nonmarket sectors; cultural domains as defined by the UNESCO Framework for Cultural Statistics are shown in figure 4 below. The capital used in many domains is included in existing estimates of private capital (tangible and intangible), but public investments (or funding) for new asset creation needs to identified and newly capitalized.[8] Note that cultural assets are notionally grouped with public architectural and engineering design, on the grounds that the British Museum's tessellated glass ceiling or

[8]Note this assumes national statistical offices have not already done so as part of their efforts to capitalize artistic and entertainment originals. Unfortunately, this is difficult to ascertain because the published investment by asset type data for most European countries include a category called "other intangible assets" that (a) is defined as mineral exploration + artistic and entertainment originals, (b) is usually very small in magnitude, and (c) implies little or no public investment. An exception to (c) is mineral exploration in Norway. An exception to (a) and (b) is the United States where these assets are separately shown yet (c) holds true. It appears then that public cultural assets are in practice distinct from artistic and entertainment originals and investments in them need to be capitalized as public intangibles.

the Louvre Pyramid are as valuable (and as incalculable) as the museums' contents although of course their correspondence to private counterparts is apparent.

The characteristics of these public intangible asset categories are analyzed more deeply in the following sections/

2 Information, scientific and cultural assets

2.1 Information assets

Public sector information (PSI) refers to information and content that is produced and/or collected by a public body as part of its public task, e.g. meteorological data, geo-spatial data and business statistics [9]. It is typically stored in databases. But before discussing the content of PSI it is worth to review the asset definition provided by the System of National Accounts (SNA) 2008 to draw the boundaries of information asset in a public context: (SNA, 3.30) "An asset is a store of value representing a benefit or series of benefits accruing to the economic owner by holding or using the entity over a period of time. It is a means of carrying forward value from one accounting period to another." In the case of PSI, the government, as the public sector information holder (PSIH), constitutes the economic owner (SNA, 3.28). If produced assets, including intellectual property products (IPP), are used repeatedly or continuously in production processes, they are called fixed assets (SNA, 10.11). Where Intellectual property products are the result of research, development, investigation or innovation leading to knowledge that the developers can market or use to their own benefit in production because use of the knowledge is restricted by means of legal or other protection (SNA, 10.98). Then, the development of databases represents the development of intellectual property products: (SNA, 10.112) "Databases consist of files of data organized in such a way as to permit resource-effective access and use of the data. Databases may be developed exclusively for own use or for sale as an entity or for sale by means of a licence to access the information contained. The standard conditions apply for when an own-use database, a purchased database or the licence to access a database constitutes an asset." If a database satisfies the definition of a fixed asset, then it should be regarded as one (SNA, 10.98). That holds even if a database is just a copy (SNA, 10.100).

To go a step further in the analysis, it is useful to look at the domains of PSI as shown in Table 3 below.

[9]We thank Thomas Niebel and Sang Hyu Hahn for useful discussion and collaboration in drawing this subsection

Table 3: **MEPSIR Information Types and Sub-types**

	Type or Sub-type	
1	**Business information**	
	1.1	Chamber of Commerce information
	1.2	Official business registers
	1.3	Patent & trademark information
	1.4	Public tender databases
2	**Geographic information**	
	2.1	Address information
	2.2	Aerial photos
	2.3	Buildings
	2.4	Cadastral information
	2.5	Geodetic networks
	2.6	Geology
	2.7	Hydrographical data
	2.8	Topographic information
3	**Legal information**	
	3.1	Decisions of international and foreign courts
	3.2	Decisions of national courts
	3.3	National legislation
	3.4	Treaties
4	**Meteorological information**	
	4.1	Climatological data (including models)
	4.2	Weather forecasts
5	**Social data**	
	5.1	Economic statistics
	5.2	Employment statistics
	5.3	Health statistics
	5.4	Population statistics
	5.5	Public administration statistics
	5.6	Social statistics
6	**Transport information**	
	6.1	Information on traffic congestion
	6.2	Information on work on roads
	6.3	Public transport information
	6.4	Vehicle registration

Source—Dekkers, Polman, te Velde, and de Vries (2006).

PSI assets vary considerably also in their availability and accessibility. Figure 2 shows the three standard degrees of availability for PSI:

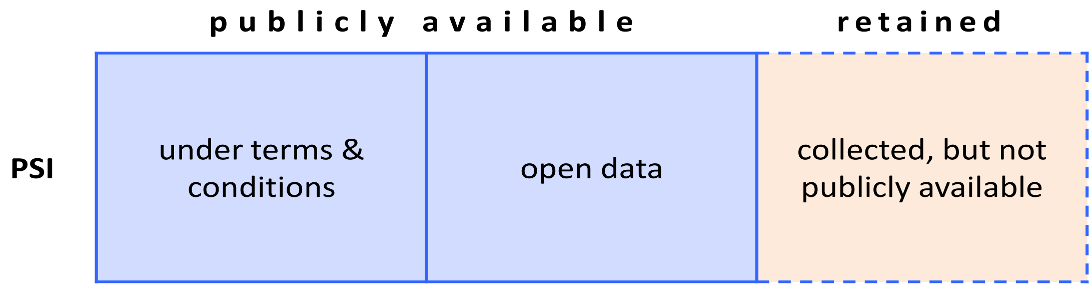


Figure 2: PSI and SNA

NOTE—Source: modified version of Deloitte (2013)

The first category of PSI availability, PSI that is publicly available under terms and conditions, is typically sold. The second category that is publicly available, open data, refers to PSI that is freely available for use and re-use. The SNA does account for open data as well (SNA, 10.101). When copies are distributed by the owner free of charge, then no flows between the owner and recipients are recorded in the SNA. If, despite making copies freely available, the owner still expects to obtain benefits, then the present value of those benefits should be recorded in its balance sheet. Databases are currently capitalized in the SNA (2008) according to the following principles: "The creation of a database will generally have to be estimated by a sum-of-costs approach. The cost of the data base management system (DBMS) used should not be included in the costs but be treated as a computer software asset unless it is used under an operating lease. The cost of preparing data in the appropriate format is included in the cost of the database but not the cost of acquiring or producing the data. Other costs will include staff time estimated on the basis of the amount of time spent in developing the database, an estimate of the capital services of the assets used in developing the database and costs of items used as intermediate consumption" (SNA, 10.113). And "Databases for sale should be valued at their market price, which includes the value of the information content. If the value of a software component is available separately, it should be recorded as the sale of software" (SNA, 10.114). According to OECD's Handbook on deriving capital measures for Intellectual Property Products, the exclusion of the cost of obtaining the data is justified by the following motivations: (a) measurement issues; (b) [If included,] the door to the capitalization of knowledge in general would have been opened indirectly; (c) the capitalization of knowledge would create an inconsistency in the SNA, because its capitalization would depend on how it was stored; (d) the data/information may already be recorded in the accounts as fixed assets, in the category "entertainment, artistic or literary originals." While motivation (a) seems plausible, (b), (c) and (d) need further considerations. In fact, (b) contradicts paragraph 10.114 SNA which "includes the value of the information content"; and (c) could be dissolved by also taking into account all other storage media, e.g. paper files. (d) does not apply when it comes to PSI. Therefore, we assume that the cost of obtaining the data should be included.

Measuring Information Assets. There are two main approach to measure investment in information asset: demand and supply side approaches. The demand side approach (micro) is based on survey data in which PSI holders are asked to provide details of their production of PSI databases. According to the information gathered from the survey investment in databases can be estimated as either the net present value of future royalties (mainly applies to PSI that is sold) or, more commonly, by summing their production costs. More specifically, the costs of production include total labour costs and other costs to be calculated as follows:

Total labour costs

- The number of in-house staff involved in the production of PSI content and the number of those involved in the specification of the database management system and loading data/information into it, including updates;
- Estimate of average percentage of time spent by in-house staff on PSI production tasks and another estimate for database tasks;
- Average compensation of the staff engaged in PSI production and database creation, including wages, salaries, bonuses, employer social contributions and other special benefits.

Other costs

- Overheads associated with employing the staff engaged on PSI production and database creation as well as updating, includes management costs, training, personnel management, office requisites, electricity, rent, etc. and the cost of using the enterprise's fixed assets;

- Any other intermediate consumption associated with PSI production and database creation, including the costs of software not recognised as a fixed asset;
- Taxes associated with the cost of PSI production and database creation, such as payroll taxes[10].

The supply side approach (macro) is most widely adopted since it makes use of aggregate information available from NSOs. The supply method assumes that the value of the PSI database is the sum of the cost to produce the information asset. Thus we need to add to the NA investment measures of databases the cost of acquiring or producing the data. In the absence of any data on the proportions of time spent by occupation groups on database creation, it is recommended that the direct labour costs is determined by the time spent by database assistants/clerks (ISCO-88 4113) not allocated to software production. As direct data on non-labour costs of own-account database production are hardly available, they have generally to be estimated based on the relationship between labour costs and non-labour costs of relevant industries. At the moment we gather NA measures of databases with the purpose of improving them according to data availability for selected countries and domains.

2.2 Software

R&D, Software and other intangible assets are included in the National Accounts. The changes in the new European System of National Accounts (ESA 2010) required a revision to the structure of the non-financial assets classification. ESA 2010 includes not only more assets in the definition of Gross Fixed Capital Formation (GFCF), but also existing assets have been redefined, reorganized and re-numbered in the nomenclature. Computer software has already been recognized as an intangible fixed asset under ESA 95 (AN.1122) and has been modified to include databases under ESA 2010 in the joint category computer software and databases (N1173G). Computer software and databases are a subcomponent of intellectual property products, together with research and development, mineral exploration, and artistic originals Figure 3 demonstrates where computer software and databases are positioned in the new breakdown of assets in ESA 2010.

Computer software and databases and other originals of intellectual property products are valued at the acquisition price when traded on markets in the national accounts. The initial

[10] in proportion to the spent on database creation

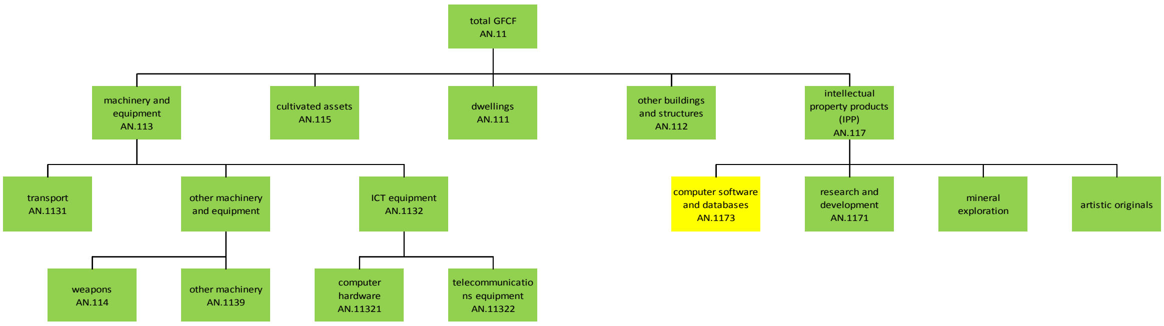


Figure 3: Structure of gross fixed capital formation by assets, based on ESA 2010

NOTE—Source: modified version of Deloitte (2013)

Intellectual property products (AN.117)	Fixed assets that consist of the results of research and development, mineral exploration and evaluation, computer software and databases, entertainment, literary or artistic originals and other intellectual property products, as defined below, intended to be used for more than one year.
Computer software and databases (AN.1173)	**Software**: Computer programs, program descriptions and supporting materials for both systems and applications software. Included are the initial development and subsequent extensions of software as well as acquisition of copies that are classified as. **Databases**: Files of data organised to permit resource-effective access and use of the data. For databases created exclusively for own use the valuation is estimated by costs, which should exclude those for the database management system and the acquisition of the data.

Table 4: Classification of Intellectual property products and software and databases.

NOTE—: table comprises the detailed of intellectual property products and software and databases as set out in Eurostat (2013).

value is estimated by summing their costs of production, appropriately revalued to the prices of the current period. If it is not possible to establish the value by this method, the present value of expected future receipts arising from using the asset is estimated. GFCF, net capital stocks, and GFCF at previous year's prices to compute implicit deflators for price-volume decomposition for software and databases by industry based on ESA 2010 are widely available from Eurostat for most SPINTAN countries (especially EU-15 countries) from 1995 onwards. Unavoidable country and industry gaps were filled in with data from National Statistical Institutes (NSIs) and other national sources.

2.3 R&D

Research and development (R&D) is defined in ESA 2010 as follows: "Research and [experimental] development consists of the value of expenditures on creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and use of this stock of knowledge to devise new applications." The value of research and development should be determined in terms of the economic benefits it is expected to provide in the future. This includes the provision of public services in the case of R&D acquired by government. In principle, R&D that does not provide an economic benefit to its owner does not constitute a fixed asset and should be treated as intermediate consumption. Unless the market value of the R&D is observed directly, it may, by convention, be valued at the sum of costs, including the cost of unsuccessful R&D, as described in chapter 6 (SNA 2008 par. 10.103).

Then, in order to have a R&D fixed asset in national accounts some criteria must be met. The first point is that only R&D that provide an economic benefit to its owner constitute a fixed asset (as is the case for any other asset in the system of national accounts (SNA 2008 par. 3.303). In the case of R&D, as for all fixed assets, economic benefit means that it may be used repeatedly or continuously in production over a long period of time (which is taken to be more than one year). The SNA clarifies that the concept of economic benefit includes also the provision of public services in the case of R&D acquired by government. In the case of European countries this has been interpreted as a justification to record as GFCF all expenditures by government on Intellectual Property Products (IPPs), including freely available R&D, if they satisfy the requirement that IPPs are intended for use in production more than one year. Only R&D activity undertaken on a systematic basis is included in the SNA asset boundary.

According to the SNA, unless the market value of the R&D is observed directly, it may, by convention, be valued at the sum of costs, including the cost of unsuccessful R&D. The basis for using a sum of costs approach in estimating output of R&D is as follows (Eurostat Manual on measuring Research and Development in ESA 2010). An enterprise will incur costs in order to generate products. In incurring the costs of performing the R&D, the producer will look to cover the costs. The business model is that although it is not possible to identify immediately after production which of the products will be a success and bring in revenue, on average and over time the business has prospered by generating enough successes along with the inevitable failures to be a going concern to cover its costs and give a sufficient return to its owners. For non-market producers, there is no incentive to give a return to owners, but for market producers, the prices must be set to pay sufficient dividends to owners to keep them satisfied with performance. This explains why a mark-up equal to net operating surplus should be added to costs for market producers, but not for non-market producers.

Another issue regarding R&D is the distinction between who produces it (performer), who sustain the cost for its production (fonder) and who is the actual owner of the R&D asset that is created as a result of the R&D activity (owner). The national accounts assumption is that funders of the performance of R&D will be the ultimate owners of the product, unless there is clear evidence that this is not the case (as when the Government founds R&D activity). Then, for example, in national accounts government-funded defence R&D performed in the private sector is treated as a public not private, asset.

2.4 Cultural assets

Table 2 illustrates how we aim at extending the CHS framework for the public sectors and which additional public sector intangibles are proposed. Cultural assets were not included in the traditional CHS framework but are one of the additional categories of intangibles that need to be considered when it comes to public sector intangibles. Cultural goods and services in general have artistic, aesthetic, symbolic and spiritual values. Their irreproducible characteristic is linked to their appreciation or pleasure and differs therefore from other tangible and intangible products. Public cultural assets are intangible assets whose services are used in production in cultural domains dominated or influenced by the public and nonmarket sectors. Not all cultural assets are, strictly speaking, intangible assets but their intrinsic value to citizens is incalculable and therefore regarded as intangible.

The capital used in many cultural assets is already included in existing estimates of private capital (tangible and intangible), but public investments in cultural assets needs to be identified in the COFOG data (Classification of the Functions of Government), and added to the SPINTAN framework. We incorporate cultural assets as an additional asset type besides national accounts intangibles and non-national accounts intangibles to cover public intangible investment to the extent possible. If cultural investment are capitalized and added to growth accounts, they are subtracted from economic growth (on a rental equivalence basis) and finally from multifactor productivity of the public industries. Cultural assets are notionally grouped with public architectural and engineering design, on the grounds that the British Museum's tessellated glass ceiling or the Louvre Pyramid are as valuable (and as incalculable) as the museums' contents although of course their correspondence to the private CHS counterparts is apparent.

To complement the CHS framework and to produce comparable data on cultural public investment for the SPINTAN countries, it is crucial to develop measurement guidelines for cultural assets that are widely applicable for SPINTAN countries. In the following section, we review existing cultural industry models from the literature and propose methods and sources to estimate public sector cultural assets.

Culture. Defining and measuring culture is widely recognized as a difficult task. UNESCO (2001) defines culture as the set of distinctive spiritual, material, intellectual and emotional features of society or a social group, that encompasses, not only art and literature, but lifestyles, ways of living together, value systems, traditions and beliefs. Cultural activities include non-market or market orientated activities, with or without a commercial purpose, carried out by any type of producers and structure, whereas cultural industries are industries that specifically provide cultural goods and services, that are considered to have a specific attribute, use or purpose which embodies or conveys cultural expressions, irrespective of the commercial value they may have at the time they are developed. Some examples for cultural industries are film, radio, books, and music, besides the traditional arts sectors comprising performing arts, visual arts, and cultural heritage. Cultural industries need to be distinguished from creative industries, where creativity is an identifiable and significant input. Creative industries have a cultural dimension and use culture as an input, although their outputs are mainly functional. They include graphic design, advertising, but also architecture and design (UNESCO (2009)).

Creative / Cultural Industry Models. Table 5 illustrates three selected models that conceptualize structural features of cultural and creative industries by combining the "cultural" and "industry" dimension and provide a systematic understanding of the structural characteristics of arts and culture industries.

DCMS Model	Concentric Circles Model	WIPO Copyright Model
Department for Culture, Media and Sport UK (1998)	Throsby (2001)	World Intellectual Property Organization (2003)
Advertising	**Core creative arts**	**Core copyright industries**
Architecture	Literature	Advertising
Art and antiques market	Music	Collecting societies
Crafts	Performing arts	Film and video
Design	Visual arts	Music
Fashion		Performing arts
Film and video	**Other core cultural industries**	Publishing
Music	Film	Software
Performing arts	Museums, galleries, libraries	Television and radio
Publishing	Photography	Visual and graphic art
Software		
Television and radio	**Wider cultural industries**	**Interdependent copyright industries**
Video and computer games	Heritage services	
	Publishing and print media	Blank recording material
	Television and radio	Consumer electronics
	Sound recording	Musical instruments
	Video and computer games	Paper
		Photocopiers, photographic equipment
	Related industries	
	Advertising	
	Architecture	**Partial copyright industries**
	Design	Architecture
	Fashion	Clothing, footwear
		Design
		Fashion
		Household goods
		Toys

Table 5: Selected Creative / Cultural Industry Models

The first formal concept about the creative industries was the DCMS model (DCMS and Sport (1998)). Cultural production was regarded to be creative with a symbolic production, and defined with the term "creative industries". Creative industries are derived from individual creativity, skill and talent. A potential for wealth and job creation is given through the generation and exploitation of intellectual property. Throsby (2001) presented creative industries via concentric circles based on the idea that cultural industries services and goods have cultural and economic values. The perimeter of the circles represents creativity in the wider economy with core creative arts being in the center of the model. The outer layer of the concentric circles makes clear that the creative industries do not work in isolation; they are an important bridge to the wider economy. The WIPO (2003) model, alternatively, focuses on industries that produce or distribute copyrighted goods. It proposes a systematic way to isolate the effects produced by copyright in the categories identified to measure the impact of domestic copyright industries on domestic economies. The closest model in the literature for our purpose is the UNESCO Framework for Cultural Statistics Domains (Figure 4). This framework moved away from cultural and creative industries and presents cultural domains. Cultural domains cover a number of industries (commonly termed as cultural industries) and include furthermore all cultural activities under the appropriate heading, including informal and social activities. The UNESCO framework is a hierarchical model that comprises cultural domains and related domains. The cultural domains encompass rather traditional cultural activities, goods and services, whereas the related domains are linked to the broader definition of culture, include social and recreational activities. Three transversal domains that can be applied to all of the cultural and related domains are added under the heading intangible cultural heritage (UNESCO (2009)).

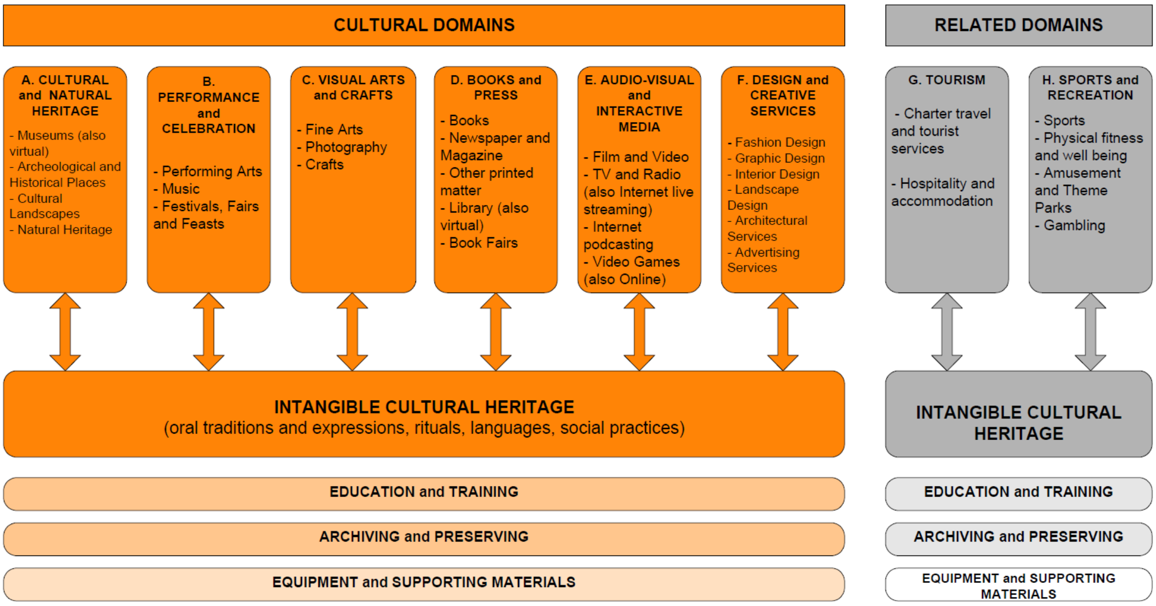


Figure 4: UNESCO Framework for Statistics on Cultural Domains

Based on the early 1986 UNESCO Framework, the LEG-Culture [11] (Leadership Group Culture) has developed a consensus on the definition of a cultural field and identified eight cultural domains (cultural heritage; archives, libraries; books and press; visual arts; architecture; performing arts; audiovisual and multimedia) and six functions (preservation, creation, production, dissemination, trade/sales and education). The goal of ESSNET-Culture [12] (European Sta-

[11] LEG-Culture, the first European working group on cultural statistics, has brought together 14 of the EU-15 members from 1997 to 2000 in a programme aiming to study and describe the conditions for implementing a system of comparable cultural statistics. Given the limited duration of the project and heterogeneity of existing sources, LEG-Culture has not produce a set of reliable and comparable cultural statistical data, but it has played an essential role in the development of methodologies that allow a regular production of cultural statistics.

[12] Resulting from a EUROSTAT call for proposals, ESSnet-Culture was created in September 2009 for a period of 24 months. ESSnet-Culture organized a network of experts coming from 27 countries. It's mandate was of

tistical System network on Culture) was to update and further develop the UNESCO based methodology from LEG-Culture. It established a common framework to collect data on public cultural expenditure and to foster the development of comparable cultural statistics. ESSnet-Culture (2012) added two domains to the LEG-Culture framework, namely advertising and art crafts, as well as the function management/regulation.

SPINTAN cultural domains. We build on the research strand mentioned above and evaluate all cultural domains regarding their applicability to the public sector to finally add cultural assets to our framework. We also follow an integrative approach where cultural domains comprise both creative domains and cultural components. Figure 5 lists the selected cultural domains that are relevant for our purpose and that need to be measured in work package 2, ideally for all SPINTAN countries. The selected cultural domains for the public sector within SPINTAN are cultural heritage, archives and libraries, visual arts, performing arts, books and press, audiovisual and multimedia, and cultural education. It shall be mentioned that there is no hierarchy among the cultural domains. They provide a base for the measurement of cultural assets in the next step by minimizing the risks of drowning cultural assets in any other industry or sector.

The SPINTAN cultural domains are associated with the functions that were already identified by ESSNET-Cultures, based on UNESCO (2009) and LEG-Culture. These functions are sequenced functions and range from creation to dissemination, along with education or support functions. Cultural activities result if these functions are crossed with cultural domains (ESSnet-Culture (2012) : Creation, Production & Publishing, Dissemination & Trade, Preservation, Education, Management & Regulation).

Measuring Cultural Assets. We aim at developing a measurement method of public investment in cultural assets that is applicable for all SPINTAN countries. Our method can only be the best approximation since gross fixed capital formation is not available in the national accounts on the level of detail needed. Only the 4-digit NACE code [13]

methodological nature and the project group aimed to develop the EU methodological base for all future data generation.

[13]For example, NACE Rev. 2 classes 91.02 (museums activities) and 94.03 (operation of historical sites and buildings and similar visitor attractions) cover cultural heritage; 91.01 (library and archives activities) covers archives and libraries; 90.01 (performing class) and 90.02 (support activities to performing arts) covers performing arts. The remaining cultural domains can be similarly allocated to NACE Rev. 2 4-digit classes (see also ESSnet-Culture (2012))

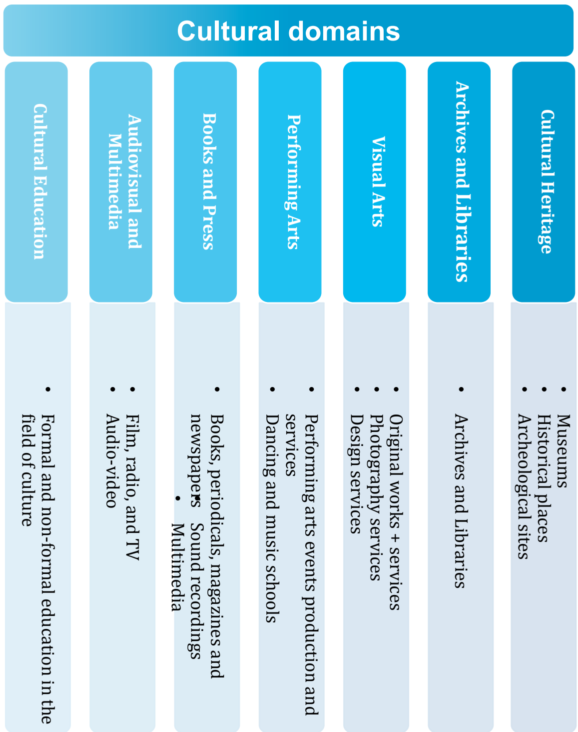


Figure 5: SPINTAN cultural domains

(NACE Rev.2) would provide the level of detail necessary for measuring cultural investment in each cultural domain, with the remaining task to separate public investment from private investment.

Comparable time series on public cultural expenditures by cultural domain are also not available for all SPINTAN countries. The Council of Europe/ERICarts publishes data on public cultural expenditure by sector for almost all countries that are to be analyzed within SPINTAN. Unfortunately, not all cultural domains are available for all countries and the tables comprise rather cross-sectional data. In absence of full sets of cultural domains, time series, and overlapping years, the figures on cultural spending are not entirely comparable across countries.

Nevertheless, country differences regarding public cultural expenditures exist among the countries shown in figure 6. Denmark and Austria spent most on SPINTAN cultural domains, while Ireland is the lagging country among the eleven countries. But not only has the amount spent differed among the selected countries, but also the composition of expenditures in figure 7.. While expenditures on cultural heritage are the main cultural expenditure in Ireland, they play only a less prominent role in Denmark where audio, audiovisual, and multimedia as well as archives and libraries are the two cultural domains with higher shares in total spending.

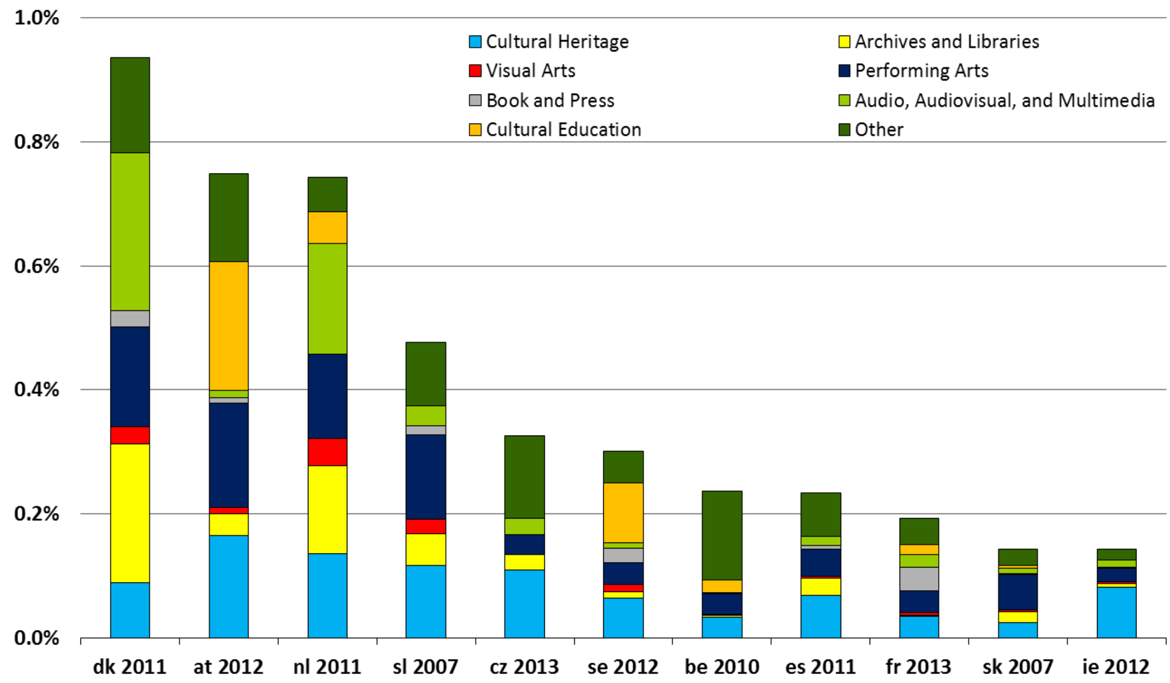


Figure 6: Public cultural expenditure, percent of GDP, latest available year

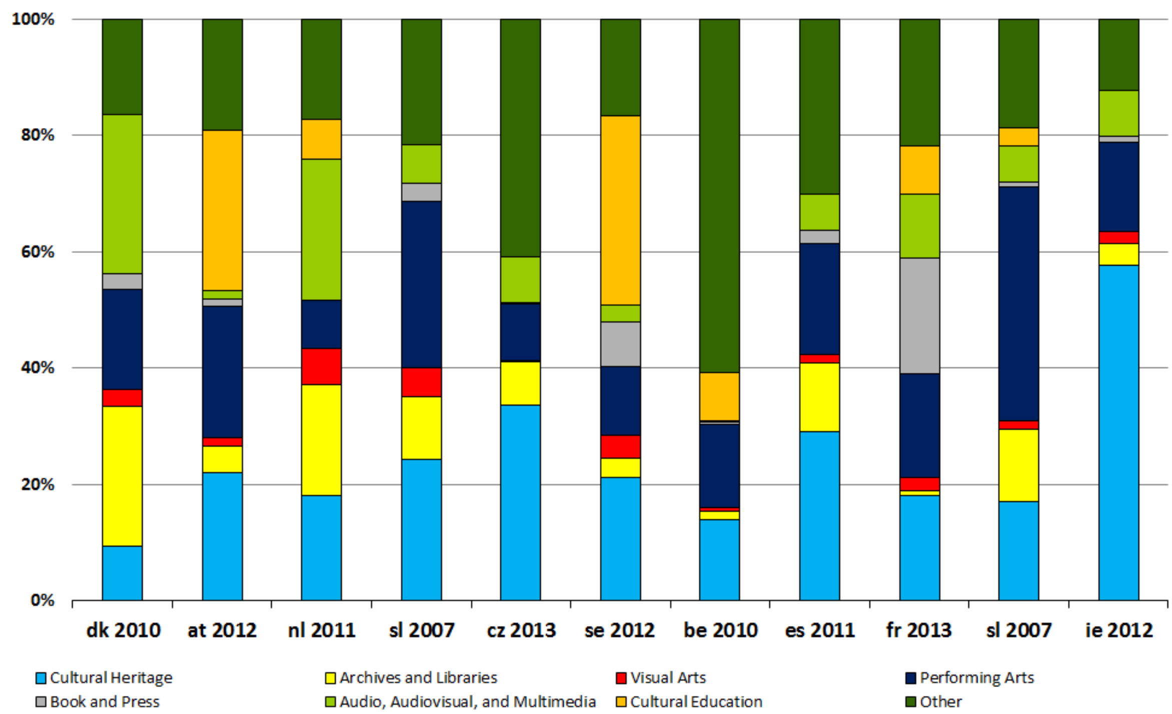


Figure 7: Public cultural expenditure, percent of GDP, latest available year

Note: Cultural education not separated from other expenditures in cz, dk, es, ie, sl
Data sources: Council of Europe/ERICarts, "Compendium of Cultural Policies and Trends in Europe, 15th edition", 2014; and underlying national sources

Satellite accounts provide detailed information and supplement the existing accounts by focusing on a particular aspect of the economy like for example tourism, health, or culture. Cultural satellite accounts have been compiled in different countries all over the world, and among the SPINTAN countries in Spain, Finland, and the United States. So far, there is no internationally agreed method for producing culture satellite accounts. The results of the satellite accounts for different countries are not directly comparable because the industry selection and thus the cultural domains (if at all available) vary across countries. One example is Spain where it is not possible to estimate total government spending on cultural assets based on the Spanish satellite accounts. They contain information for all SPINTAN cultural domains for the central government and regional administrations, but spending on culture of the local government is categorized in a different way and cannot be allocated to the cultural domains. The US satellite accounts have their own categories that are allocated to core arts and supporting arts that cannot be matched with the SPINTAN cultural domains. To obtain comparable results across countries, generalized methods that are applicable for as many SPINTAN countries as possible are preferred.

Detailed satellite accounts on culture and ERICarts data across all SPINTAN countries are not available or not as time series. Public investment in cultural assets can be approximated using COFOG data if sufficient divisions are available. Even though the divisions required to get close to the selected SPINTAN cultural domains are not available, we can use the existing COFOG classification to estimate public expenditures and investment in total SPINTAN cultural domains for illustrative purposes. OECD and Eurostat release total general government expenditures and general government gross fixed capital formation in the divisions cultural services (GF0802[14]) and broadcasting and publishing (GF0803) for all EU-SPINTAN countries and the United States since 1995 - with only minor gaps in prior to 2000. The vast majority of cultural domains is covered by cultural services, whereas audiovisual and multimedia are part of broadcasting and publishing. But both cultural divisions include additional expenditures that are not part of our SPINTAN cultural domains and we excluded the following activities from our framework, which is in line the ESSnet-Culture approach (ESSnet-Culture (2012)):

- general system software or applications software activities
- information activities (telecommunications)

[14]The content of the culture related COFOG divisions GF0802 and GF0803 is shown in appendix table A.1

- leisure activities (games, entertainment activities, gambling etc.) and tourism
- natural reserves, zoos or botanical gardens
- manufacture of ornamental products (ceramics, jewelry etc.)

We exploited the sources mentioned in ESSnet-Culture (ESSnet-Culture (2012)) to extend the cross-sectional information from the Council of Europe/ERICarts where possible to get time series on detailed total expenditures on the SPINTAN cultural domains for four reference countries: Germany, Spain, Finland, and France [15] Knowing how much the governments in the reference countries spent on total SPINTAN cultural domains, we can identify the share of public expenditures on SPINTAN cultural domains that is covered by total government expenditures on cultural services and broadcasting and publishing services in COFOG. We assume that the proportion of SPINTAN cultural domains that is covered the COFOG divisions cultural services (GF0802) and broadcasting and publishing (GF0803) is constant and apply it on total government GFCF (also from COFOG) on all European SPINTAN countries and the United States to obtain public investment in the SPINTAN cultural domains. To approximate the few missing years in our COFOG based investment series, the SPINTAN back-casting method is applied for a handful of countries prior to 2000 to obtain final results. Cultural investment on EU-SPINTAN average as a percentage of GDP fell from 1995 to 2000 before it grew steadily for the next ten years (figure 8).

Figure 9 shows the average public cultural investments for 2000-2007 and 2008-2011 for all 22 EU-SPINTAN countries, the United States, and the EU-SPINTAN average. It is interesting to see which countries reduced their investments in culture from the first to the second period and which did not. Romania, Poland, Hungary, and Slovenia are the four countries with the highest increases in investment, whereas investments in culture were heavily cut in Greece, Denmark, and Luxembourg. Investment on EU-SPINTAN average rose by 19 percent from 0.047 percent in 2000-2007 to 0.055 percent 2008-2011. Most EU-12 countries invested more in culture than the EU-SPINTAN average and cultural investment in most of the EU-15 countries was below EU-SPINTAN average in both periods.

[15] Cultural Finance Reports (Kulturfinanzberichte) by the German Federal Statistical Office (DESTATIS) comprise detailed public expenditures that can be allocated to our SPINTAN cultural domains. The French DEPS (Dpartement des tudes de la prospective et des statistiques) publishes public cultural expenditures. The Finnish culture satellite accounts contain public expenditures of cultural industries 2008-2012 that can be matched with the selected SPINTAN cultural domains. The Spanish public cultural expenditures stem from CULTURABase, published by the Spanish Ministry of Education, Culture and Sport.

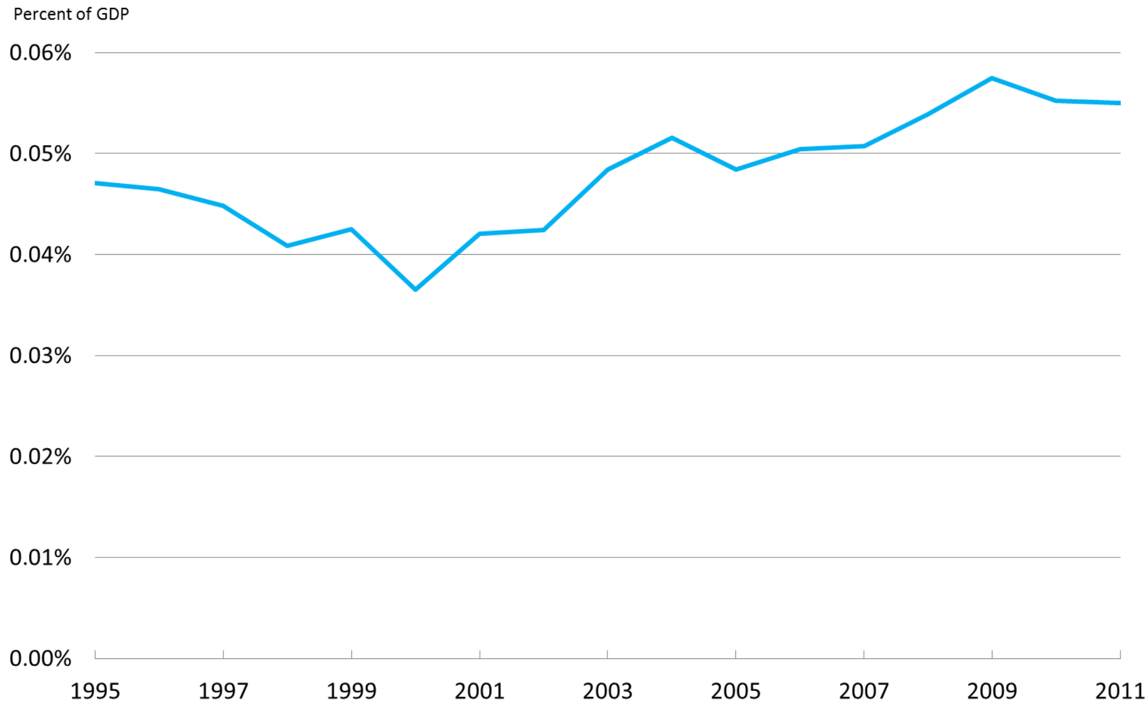


Figure 8: Public cultural investment in SPINTAN domains, EU-SPINTAN average 1995-2011

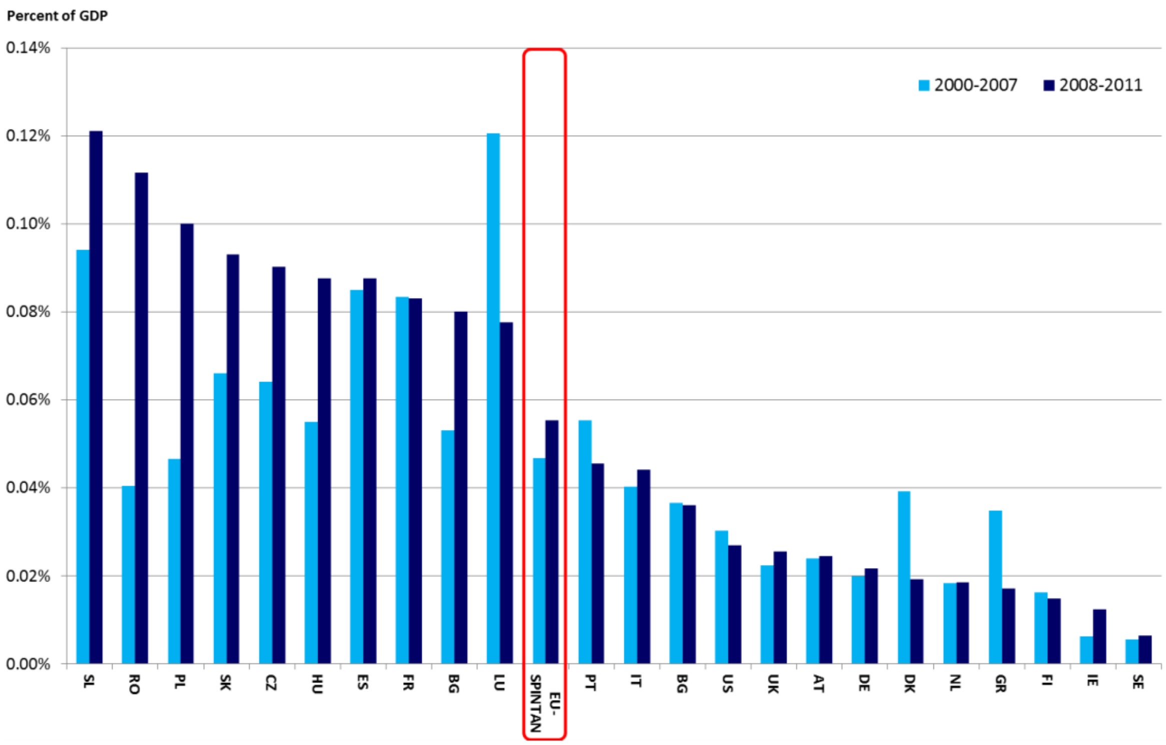


Figure 9: Public cultural investment in SPINTAN domains, 2000-2007 and 2008-2011

Source: Authors' calculations based on COFOG data from Eurostat and OECD.stat

3 Societal Competencies

3.1 Brands

by Ulrika Stavlöt

Brands are included in the CHS list of intangible assets for both the market and nonmarket sectors. In Handbook of Marketing and Finance, Srinivasan et al (2011) argue that ”Brand equity is a complex concept with many different applications and meanings among academics, marketing managers and marketing research professionals”. Kotler (1991; p.442) define a brand as ”a name, term, sign, symbol, or design, or combination of them which is intended to identify the goods and services of one seller or group of sellers and to differentiate them from those of competitors”. Aaker (1991) define brand equity as ”a set of brand assets and liabilities linked to a brand, its name and symbol that add to or subtract from the value provided by a product or service to that firm’s customers”. In the market sector, brand equity is often referring to the monetary value of a brand, which can be used to systematically assess and benchmark performance of profit-driven companies. Although this notion of brand equity is not directly applicable to the nonmarket sector, it is recognized that brands are key also for this sector.

Non-profit organizations of interest for SPINTAN include for example charitable foundations, sport and recreational clubs, cultural groups, citizens’ militia, education and science foundations, many facing competition in fundraising from state and private donors, for volunteers and for projects. In response to these human and financial resource challenges, nonprofits have increased their marketing effort (Faircloth 2005).

There are also governmental organizations with strong public brands, for example some universities and colleges, or organizations within infrastructure, often competing with private actors, such as the telecommunications, transportation, electricity and water supply sectors. As previously mentioned, public investments in marketing-like activities could involve promotion of specific issues of a commercial character, like export or local areas for tourism, also called national branding, or it could involve direct promotion to citizens regarding information on consumer product, food and drug safety. Other areas have more character of core public services such as health care, military service, government reforms or urban plans (e.g. Wraas 2008, Walsh 1994).

The scholarly interest of branding in the non-market sector has increased over the last years (Chapleo 2015) but there is still little knowledge of how public organizations use branding or marketing to promote their activities or attractiveness as employer (Waeraas 2008). Oster (1995) identifies five areas in which nonprofits differ from market sector organizations; i.e. in organizational culture, human resources, collaboration versus competition, complexity of clients and customers. For these reasons Laidler-Kylander and Simonin (2009) argue that nonprofits build brand equity differently than market organizations and suggest a model for non-profit organizations for managing and building brand equity, resting on four key variables; consistency, focus, trust and partnerships. An alternative brand equity model for nonprofits was developed by Faircloth (2005), stating that brand value is built from three dimensions; brand personality, brand image and brand awareness. In addition to these three variables, Murillo-Acuna and Oubina-Barbolla (2013) propose a model also including brand loyalty and perceived quality. Other studies argue that while performance of market sector organizations can be universally assessed and benchmarked, the performance measurement within non-profit organizations are multidimensional and cannot be reduced to a single measure (Herman and Renz 1999).

To summarize, it is recognized that brands are no less important for non-market organizations than it is for market sector organizations, but the concept and drivers of brand equity differ.

Approaches to measure brand equity on the organizational level. Estimations of brand values are usually made for accounting purposes or by mergers, acquisitions or divestitures. The motivation could also be strategic, to increase the efficiency of marketing. Although not so systematically or widely used, also non-profits are conducting brand valuations, e.g. Habitat for Humanity International (Quelch and Laidler 2003) and Greenpeace (D'Cruz 2003), the reason often being for licensing agreements, cobranding or to select appropriate partners.

The concept of brand equity can be viewed in a consumer, product-market or financial perspective (e.g. Keller and Lehmann 2006; Srinivasan et al 2011). Consumer-based brand equity reflects the difference in consumers perception and reactions toward a branded versus an unbranded good, market-based brand equity is the value-added performance of a branded versus an unbranded offering, and the financial-based brand equity represents the value of an tradable asset and the price it could bring in the financial market, reflecting the net present value of anticipated future cash flows. The approaches for measuring brand equity vary according to what perspective on brand equity that are in focus. Estimations of consumers-based brand equity focus on brand knowledge in consumers' minds, using a variety of techniques, e.g. interviews and experiments. Approaches measuring product-market equity includes estimates of price, sales and revenue premiums. Market-based brand equity is based on financial market performance and could be estimated by the cost needed to establish a brand of similar strength or as a residual of a model of the firm's assets.

To the academic models discussed above there are also a large number of models proposed and operationalized by a range of market research suppliers, each supporting different metrics (Srinivasan et al 2011). Thus, the methods for measuring brand equity vary immensely (for a summary see e.g. Laidler-Kylander and Simonin 2009; Faircloth 2005; Keller and Lehmann 2006), and in 2010 a new international standard, ISO 10668, for brand valuation was introduced to increase coherence in valuation approaches.

In the ISO 10668 the monetary value of a brand represents the economic benefit conferred by a brand over its expected useful economic life, where monetary value is calculated from cash flows, earnings, economic profits or cost savings. The standard stipulates three alternative valuation methods; the income approach, the market approach and the cost approach. In short, the income approach measures the value of the brand by reference to the present value of the cash flow streams attributable to the asset over its remaining useful economic life, and presents six different methods to determine the cash flows. The market approach measures value based on what other purchasers in the market have paid for similar assets. The cost approach, measures the value based on the cost invested in building the brand, or its replacement or reproduction cost. However, the standard emphasize that past expenditures should be compared with the awareness of the brand without assuming that there necessarily is a link between money spent and value.

Brand consultancies use various brand value calculation models, combining financial, market and brand analyses, to establish a specific brand's value. Since non-profits do not involve conventional economic earnings, the approaches for brand analysis could be different and less straightforward than for market organizations, valuing other kinds of output, like lives saved, or nonfinancial value, such as volunteer time (see e.g. Quelch and Laidler 2003). Interbrand, one of the leading brand consultancies, has calculated brand equity in the non-profit sector based on the discounted value of future earnings, that is, operating income due to the brand itself.

Earlier work. Barth et al (1998) find that brand value estimates are significantly positively related to advertising expenses. CHS use expenditure-based measures to approximate investments in brand equity in the US, using data on expenditures on advertising and market research.

This approach is replicated for Sweden (Edquist 2011), the UK (Marrano and Haskel 2006), the Netherlands (van Rooijen-Horsten et al 2008), Finland (Jalava et al 2007) and for a number of European countries within the INNODRIVE project (Jona-Lasinio et al 2010; Piekkola 2011). In the next paragraphs follows a very brief summary of the approaches used.

In three of the studies, data on advertising expenditures have been collected from national or international, private or public sector, advertising associations, such as the Advertising Association (UK), Universal-McCann (US) and the Swedish Institute for Advertisement (SE). The INNODRIVE study combine turnover data from Eurostat's Structural Business Survey with time series expenditure data from a private advertising association (Zenith Optimedia). The Finnish study use business register data to calculate marketing expenditures. The Dutch study is based on national accounts data on marketing and advertisement expenditure.

To arrive at capital spending, all studies but the Dutch follow CHS and assume that 60% of expenditure are capitalized. In the NL study, van Rooijen-Horsten et al argue that some advertising expenditure e.g. employment advertisements, certain government information campaigns or adverts to increase short-term sales, do not have as main purpose to strengthen the brand name and therefore should be excluded. By excluding all spending by advertising agencies, public administration, defence services, public sewage and refuse disposal services, and all spending on free local papers and advertising pamphlets and half of the spending on advertisements in newspaper and specialist journals, van Rooijen-Horsten et al estimate the investment in brand equity. In the UK study, Marrano and Haskel reason along the same line and exclude "classified" advertising, which typically are small advertisements for sales or vacancies. Also CHS subtract local advertising.

The Swedish study and the INNODRIVE project subtract public sector spending from the data by considering estimates of public-sector consumption as a percentage of total spending. The Dutch and UK study subtract specific governmental sectors from the data to calculate market sector spending. CHS proxy outlays on market research by doubling data on turnover of market research firms published by the Census Bureau's Services Annual Survey, to account for in-house market and consumer research. This approach was replicated by all studies except the Dutch that use spending data from the National accounts.

Measuring brand equity in the non-market sector. Based on academic insights, available approaches and data collected in SPINTAN, we can make following suggestions on a general approach to measure brand equity in the non-market sector. If we want to use an expenditure-based approach in line with the methods described above for the market sector, one alternative would be to use national input-output data. The input-output data show the use of certain services, in this case the use of advertising and market research, over industry and institutional sector. Use data is by definition the part of spending that is used immediately, i.e. the effect of the consumption is no longer than a year. However, since it is reasonable to believe that some effects of advertising and market research last longer than a year, we need to assess the relative size of these long-term effects, thus the investment share. Moreover, since input-output data only contains external spending, we also need to estimate the cost of own-account market research.

In a new survey launched in 2014 by the Swedish statistical agency, entrepreneurs in the private business sector was asked to state the investment share of their spending on advertising and marketing (the share of the spending that they estimate have a longer effect than one year). This spending data includes both external purchases and internal wage costs, thus the own-account share of total spending. If it is assumed that governmental and other non-profit organizations marketing are similar to marketing in the business sector, or at least that the effects are equal, we could use these investment and own-account shares combined with the use table data to calculate yearly investment. The Swedish data includes investment shares in different industries, however only the art and entertainment industry (NACE 90-93), of the industries of interest in the SPINTAN framework, is specifically included in the data. For the rest of the SPINTAN industries the survey reports an average for NACE 69-82. According the survey the internal to external spending ratio is 14% for NACE 90-93 while the ratio is 41% on average for NACE 69-82. Hence, we would arrive at total spending by adding 14% and 41% respectively to the use table data. The entrepreneurs assess investment share of the spending to be 20% and 28% respectively, which would give us a mark-up of 39% and 23% for NACE 90-93 and NACE 69-82 respectively on the use table data.

We also would need to assume that marketing in non-market industries in different EU countries are similar. The Swedish statistical agency do not know of any other country that have collected the same kind of data (perhaps the NL), but more references would obviously be warranted.

We could also estimate the public sector share of turnover data as in CHS and the following literature. Internal branding is as important as external branding for governmental organisations and other nonprofits (Laidler-Kylander and Simonin 2009). To attract volunteers and competence and staff commitment these organizations need to have a clear identity, core values etc. that are consistent with the external brand. This could suggest that spending on jobs adverts, public information campaigns, advertising in local newspapers etc. should not be excluded in the data. In 2001, Eurostat launched a survey on market research and public opinion polling (NACE 74.13) and advertising services (NACE 74.4) (Alajaasko and Blackburn 2004). Eight Member States (Denmark, Spain, France, Ireland, Portugal, Finland, Sweden and the United Kingdom) provided data. This data shows the turnover share of market research and public opinion polling ($50-90\%$) and advertising services (around 90%). It also shows the public sector share of the clients ($8-9\%$). If investments in brand equity are to be measured by turnover data, this survey could be used to proxy for investments and public sector share.

New approaches to measure brand value. If we want to go beyond the perpetual inventory model, there are a huge amount of other approaches to measure brand equity suggested in the literature. However, most of them are not suitable for the non-market sector.

If it is assumed that there is a relation between the organizations' revenue and brand equity, a revenue multiplier approach could be used to estimate brand equity on organization or industry level. For example, it is likely that a charity within the health sector could attract larger donations with a stronger brand. In these kinds of sectors, it could be reasonable to believe that brand equity and revenues are related, in a similar manner as for organizations in the market sector.

The revenue multiplier method to estimate brand equity is based on firm level data on revenues, market-shares, current and past advertising expenditure and various economic and demographic factors that are likely to impact industry-wide revenues. Other variables, often prevalent in various brand equity evaluations, could be age of organization, order of market entry, revenue growth, media coverage, percent of revenue from direct public support, historic performance, future trends, donations, voluntary income, number of volunteers and/or members, market scope (number of markets in which the organization has a significant presence) ratio of charitable expenditure as a percentage of income (efficiency) etc. This methodology creates a baseline to be compared with the organization or industry of interest. Any systematic revenue impact that is unexplained by the analysis could be interpreted as the brand equity multiplier.

In the literature, this baseline brand equity is typically assumed to be zero. For our purposes, the market sector could be included as default.

For the government sector, however, a relation between budget and brand seem more unlikely. Governmental organizations provide society with a large range of services and each entity may build brand value completely differently. Finding a general method of valuing brand equity on industry-level in the public sector will be more challenging. The public opinion on a governmental organization could be formed by personal experiences, what other people and media communicate, or by the external communication efforts of the organization itself. In governmental organizations, it seems likely that the advertising and marketing work is practiced by the external, or strategic, communication departments, and not by specific marketing divisions. Finding data on wages for governmental external communication officers would be helpful to estimate the in-house share of advertising and market efforts.

In 2009, Cone and Intangible Business released "The Cone Nonprofit Power Brand 100", a report ranking and valuing the USA's leading non-profit brands, focusing on the sectors domestic social needs, education/youth, environmental/animal, health and international needs. The valuation method applied was replicating the approach used in the report "The UK's Most Valuable Charity Brands", encompassing analysis of financial and consumer data for each entity. Since the sectors of interest in these reports partly are overlapping with the SPINTAN industries, it would be valuable to compare the averages of the estimated brand equity share of revenue in the different industries with the estimated brand equity shares in the SPINTAN data.

Next steps. For the non-profit organization, it would be useful to contrast estimates of investments in branding from both supply-use tables and data on turnover, comparing the results from the original CHS method and the shares derived from the new Swedish survey and the Eurostat survey (Alajaasko and Blackburn 2004). Another test would be to compare results with the brand equity shares derived in "The Cone Nonprofit Power Brand 100" and "The UK's Most Valuable Charity Brands".

An alternative approach would be to use firm-level data to estimate the brand equity share of revenue, as according to the method sketched above. Although this method would be novel, we need to investigate the availability of this kind of firm-level data for the non-profit sector.

For governments, the suggested measurement methods are different. Since it seems likely that a large share of spending on branding would be in-house costs of communication, we need to investigate the availability of this kind of data. Governmental organizations notwithstanding, national branding and consequent international comparisons would be another interesting extension. Ken Jarboe (2013) estimates national branding by valuing export promotion activities and investments in product safety, food safety and drug safety. By replicating his method for all, or some, of the 22 SPINTAN countries, interesting national comparisons would be possible.

3.2 Organizational capital

by **Jonathan Haskel and Mary O'Mahony**[16]

Introduction. When Steve Jobs passed away, Apple did not physically or financially collapse. This suggests that at least some of the valuable assets in Apple were embodied not in its charismatic founder, but in the organisation itself. We seek in this section to try to measure such assets.

The assets associated with Apple as a private sector organisation are multi-dimensional: reputation, company-specific skills of the workforce and tacit knowledge and relationships within the firm. Such assets are similarly present in the public sector organisations. Take for example a public-sector organisation that many are familiar with, namely the BBC. This organisation has a bundle of reputation, specific skills and within-company routines. We shall seek to measure reputation and skills in other parts of this project. We concentrate here on trying to measure the "organisational capital". What is it defined by and how might we measure it?

This section will discuss the concept of organisational capital and its measurement, focusing particularly on its role in the public sector. It will draw on a range of literatures from economics and management to first discuss the concept of organisational capital. It will then consider issues of how best to translate this concept into something that is measureable. We focus mostly on the own account component of organisational capital as this presents the most difficult measurement issues. First it will examine which occupations can be considered as contributing to the generation of organisational capital, going beyond those classified as managers to include other professionals. This will draw on evidence from work exploiting information from the PIAAC survey carried out by the OECD as well as research on education and health carried out for work package three of the SPINTAN project, on types of professionals and time spent

[16] This section benefited from contributions from Marie Le Mouel, Mariagrazia Squicciarini, Lucy Stokes, Laura Beckmann, Erika Schulz, Hector Espinoza Bustos and Lea Samek.

on management tasks. This is followed by a discussion on if there is a need to adjust other assumptions in the existing literature on measuring intangible assets in the public sector, namely using wages as a proxy measure for nominal investments, deflators and depreciation rates. The section concludes with some recommendations on next steps.

Organisational capital: defining the concept. In the literature there is a broad consensus that organisational capital can have a significant impact on the outcome and performance of a firm (see for example Aral and Weill, 2007 and Kapoor and Adner, 2011). However there lacks a consensus on how to define this concept. In the economics literature OC has been defined as the firm-specific information that affects the production possibility set and is augmented through output-related learning processes (Prescott and Visscher, 1980) or the know-how needed to create systems of production combining human skills and physical capital (Evenson and Westphal, 1995). In the management literature OC has been defined as the ability to integrate individual members' specialised knowledge, which serves as the basis upon which firms establish their long-term strategies (Grant, 1996).

In the SPINTAN project we are interested in measuring capital assets. An asset must have (a) an owner and must be (b) durable. Thus we can define organisational capital as the knowledge stock, within a firm, concerning the functioning of the organisation. It is perhaps closest to what management scholars, such a Kay (1993) have called "architecture" or Teece (1997) have termed as part of the capabilities of the firm. The origin of such architecture is, according to Kay (1993), the tacit knowledge of routines and relationships that are vested in the firm. Such knowledge should be long-lasting, to be an asset, and if it is vested in the firm it is effectively owned by the firm, even if they have no particular title to it.

Organisational capital is the cumulated knowledge that is built up in firms through investment in organising and changing the production process. These investments can be purchased externally by the firm, through expenditures on management consultancy and similar services, or can be own account, produced within the firm through the actions of employees. This is consistent with the concept employed by Corrado, Hulten and Sichel (2005, 2009). In particular these authors see own account organisational capital as knowledge produced by persons in authority in a firm ('managers'), which yields a firm specific capital good jointly produced with output, and embodied in the organisation itself. As anticipated by Coase (1937) and set out in, for example, Milgrom and Roberts (1995), the role of management can be seen as a co-ordination alternative to allocating activities by the invisible market. The defining feature is that managers have the authority over others in the firm and so can direct activities as they see fit. This begs the question if managers, as defined in standard codes of occupations, are the only persons within the firm who have such authority. In particular in the public services there may be other high level employees who also possess authority.

The management literature differentiates between management and leadership. It emphasises the distinction between Hierarchical Management - command and obey - and Leadership - cooperation and integration. The general presumption is that not all managers are leaders, nor all leaders managers. Leadership is seen as setting direction, determining priorities and goals and engaging people to deliver these goals. Therefore understanding organisational capital requires an understanding of leaders - especially what do they do and who are they?

Leadership theory in the economics literature is relatively thin on the ground. In the benchmark competitive model with complete markets, economics actors are assumed to be able to write complete contracts with each other that specify performance for a price, leaving no role for either management or leadership. Management, as discussed above, might arise when it is expensive to write contracts so that market relations are replaced by authority/co-ordintation relations. This does not explain leadership however. If as, as Hermalin, (1998) argues, the distinguishing feature of leaders is that they have followers, but crucially, voluntary followers, then this cannot be due to authority, but something else. Hermalin's model then asks how to understand leadership with voluntary followers i.e. those who choose to follow a leader because it is in their interests to do so. Consider team production in a small firm. The owner of the firm wants the team to work hard, but each member of the team has the usual free-rider incentive not to contribute to common effort. But, suppose the leader has information about the returns to this common effort. If she can convince the team of high marginal returns, she and they can benefit. The model sets out two ways to a team: leading by example and leader by sacrifice. Leading by example involves, for example, the leader working long hours (or being at the head of a demonstration, or remaining in a war zone) to convince followers effort is worthwhile. Leader by sacrifice involves the leader giving gifts to followers e.g. pizza for late workers which, although incur costs for the leader, again convince workers to exert effort.

This makes at least two predictions. First, in principle, anyone in the organisation can be a leader, not merely the manager (who by definition has the authority power). Second, whilst the actions of a leader might or might not raise effort of the followers, it is not clear that such actions build "organisational capital." As discussed above, Steve Jobs might have been a leader by example, but Apple did not immediately cease without him. More generally, if the firm wishes to appropriate leadership gains so that the organisation remains if the leader leaves, one might think that the mere mechanisms of leadership discussed above are not part of organisational capital: rather, institutional routines embedded in the design of the organisation are.

Recently, leadership theory in the management literature has emphasised distributed leadership, where two or more individuals in teams share leadership roles and responsibilities. For example von Kroch, Nonaka and Rechsteiner (2012) set out a framework that shows that distributed leadership is an integral part of organizational knowledge creation. Distributed leadership is likely to characterise the organisation of the delivery of many public services. As argued below, in the public sector leaders might be professional staff, such as senior doctors, who have the specific knowledge to set goals and the authority to ensure they are implemented.

Consistent with the management view above, Dickinson et al. (2013) see health care organisations as professional bureaucracies, where control is horizontal rather than vertical. This has three implications for leadership. First in professional bureaucracies, professionals play key leadership roles. Second professional bureaucracies are characterised by dispersed or distributed leadership - there is a need for a large number of leaders at different clinical levels. Finally collective leadership is important in health care organisations - team working and power-sharing, between doctors, senior nurses and management are more likely to lead to innovation, than the traditional approach characterised by conflict between professionals and management. These authors conclude that both management and professionals are important in generating organisational capital.

Who generates organisational capital? Some information on who is involved in generating organisational changes is available in the European Working Conditions Survey. The most recent wave for 2010 asks respondents about the extent to which they are involved in organisational changes. Table 6 shows the proportions of the relevant workforce answers to the question "You are involved in improving the work organisation or work processes of your department or organisation" cross classified by occupation. These data suggest that professionals are heavily involved in undertaking organisational changes in both the private and public sectors. The table shows that the private sector tends to be more hierarchical than the public sector in that managers are more likely to answer that they are always involved in organisational changes. Again, however, the proportions across the categories are not very different between the private and public sectors.

Private (proportions):

	You are involved in improving the work organisation or processes					
Occupation	**Always**	**Most of the time**	**Sometimes**	**Rarely**	**Never**	**Total**
Managers	60.24	22.02	10.35	3.67	3.72	100
Professionals	34.19	28.56	19.91	8.75	8.59	100
Other	19.08	19.96	19.98	14.36	26.62	100
Total	23.81	20.86	19.16	12.99	23.18	100

Public (proportions):

	You are involved in improving the work organisation or processes					
Occupation	**Always**	**Most of the time**	**Sometimes**	**Rarely**	**Never**	**Total**
Managers	53.86	28.26	12.14	3.53	2.21	100
Professionals	30.48	30.85	21.26	9.16	8.26	100
Other	21.78	23.22	21.14	12.51	21.35	100
Total	25.9	25.77	20.76	11.08	16.49	100

Table 6: Proportions of the workforce involved in organisational changes. Source EWCS, 2010, Eurostat

LeMouel and Squicciarini (2015) use information from the OECD Programme for the International Assessment of Adult Competencies (PIAAC) in a systematic attempt to identify occupations responsible for generating organisational capital. This takes a task based approach. The authors suggest that the set of tasks that existing studies suggest to be essential for the generation and accumulation of organisational knowledge relate to:

- developing objectives and strategies;
- organising, planning and prioritising work;
- building teams, matching employees to tasks, and providing training;
- supervising and coordinating activities;
- communicating across and within groups to provide guidance and motivation.

Most of these tasks, traditionally carried out by managers, have been progressively devolved upon non-managerial occupations, due to the decentralisation of authority and the delayering of managerial functions (as underscored in Caroli and Van Reenen, 2001 and von Krogh et al., 2012). The PIAAC questionnaire contains information on 15 general tasks, such as "sharing information with colleagues" or "working physically", as well as 25 tasks related to skill use in literacy, numeracy and ICT, such as "reading letters, memos or emails" or "calculating prices, costs or budgets". Respondents are asked how often they perform these tasks or use these skills, on a scale of 1 ("Never") to 5 ("Every day"). The authors use a list of 9 tasks which they identify with OC, although they also present sensitivity analysis to using either a finer or broader list (see the paper for details). The 9 tasks are shown in Table 7.

Task Code	Task Name
10	Cooperating and collaborating
11	Sharing information with co-workers
12	Instructing, training, teaching people
20	Negotiating with people
16	Planning your own activities
17	Planning the activities of others
18	Organising your own time
21	Faced with simple problems
22	Faced with complex problems

Table 7: OC related tasks Identified in PIACC.
Source: Le Mouel and Squicciarini (2015)

The authors then use both a threshold measure, first quartile of occupations that show the highest scores in the answers related to the OC tasks, and cluster analysis to identify the occupations that are primarily responsible for carrying out these tasks. They find that the occupations listed vary across country with, on average, 19 occupations identified as OC related. The results confirm the importance of managers in contributing to the formation and accumulation of OC in firms, as they consistently appear in the selection across countries. In addition, a number of other occupational categories, especially professionals and associate professionals in science and engineering, health, education, and business administration, are identified as being OC-related in many countries. These results are also consistent with an earlier study by the same authors that based OC occupations on the US O*NET survey (Squicciarini and Le Mouel, 2012).

Using labour force data, LeMouel and Squicciarini (2015) calculate the proportions of total employment in OC-related occupations in EU countries, shown in Figure 10. This clearly shows that concentrating on managers alone is likely to underestimate the extent of investments in organisational capital.

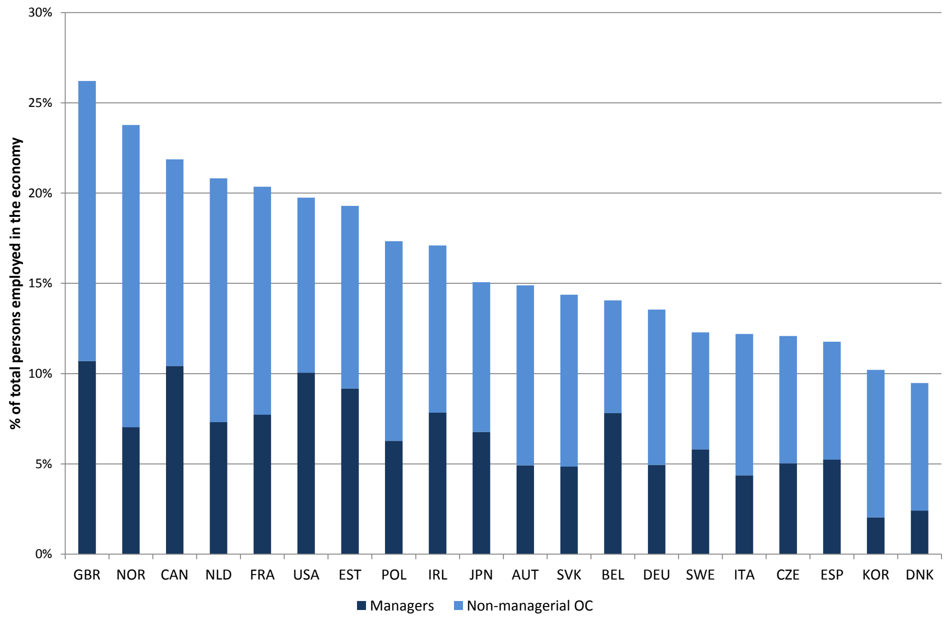


Figure 10: OC-related workers, 2012.
Source: Le Mouel and Squicciarini (2015)

The authors caution that the importance of professional and associate professional occupations, especially in the field of science and engineering, suggests that the creation and accumulation of OC is likely to overlap with the building up of other knowledge-based assets, such as R&D, design and computerised information. This is likely to be a source of spillovers with respect to the generation and accumulation of other KBC types, but also of double-counting, when the estimates of the resources devoted to the creation of these different assets uses a labour cost approach as employed by Corrado, Hulten and Sichel (2005, 2009). In addition one of the tasks included in Table 7, "Instructing, training, and teaching people", is likely to overlap with firm specific human capital which is estimated separately in the Corrado et al. framework. We argue in the conclusion that such overlap may not be significant in many parts of the public sector, with the important exception of higher education. Before discussing the labour cost approach to valuing investments in OC we first consider some case study evidence for a few countries.

An interesting case study is provided by Edmonston et al. (2001). This was a US study of the implementation of new technology, minimally invasive cardiac surgery (MICS) rather than traditional heart bypass operations. The authors surveyed 16 hospitals and compared the 7 best (in terms of implementation) with the 7 worst. They found that successful implementation required new organisational routines (less hierarchical) requiring a team learning to work together. The success depended on the leadership style of the chief surgeon—ability to listen while not giving up on authority.

O'Mahony, Beghelli and Stokes (2015) present evidence on types of organisational changes and who was responsible for these based on a recent survey of the literature for the UK. They focus on publicly funded hospitals which are part of the National Health Service (NHS). The NHS has typically been characterised by a 'top-down' management approach, and large-scale reforms and initiatives often originate at a national level. At a structural level, various reforms in recent years have set out to decentralise the NHS and devolve decision-making powers, such as the establishment of Foundation Trusts and Clinical Commissioning Groups (Ham, 2014).

In a study of the views of more than 100 strategic stakeholders on effective leadership for quality and safety in the NHS, McKee et al (2013) found that good leadership was thought to require both distributed leadership, involving individuals at multiple levels within an organisation, combined with some elements of a more concentrated or traditional management approach, particularly to ensure accountability and focus. Dickinson et al. (2013) argue that it is politicians and senior managers who have been the key drivers of change, with medical and patient leaders having much less influence. However they make a distinction between processes of reform (typically the domain of politicians and senior managers) from decision-making on a day-to-day basis, where doctors have considerable autonomy over what happens on the frontline in delivering care.

Dixon-Woods et al (2014) explored innovation at both NHS board level and among clinical teams, as one part of a study exploring the influence of culture and behaviour on quality and safety in the NHS. Through analysing the minutes of board meetings from around 70 NHS Trusts, and a survey of around 600 clinical teams, they find both showed relatively low levels of innovations. Interestingly, innovations that arose from clinical teams were predominantly focused on those that aimed to improve quality of patient care, while the majority of board level innovations had been aimed at improving productivity.

O'Mahony, Beghelli and Stokes (2014) summarise the key features of ten case studies describing a selection of organisational changes in the NHS. The case studies selected involve both managers and health professionals to varying degrees. These include changes to patient discharge procedures, the introduction of a nurse-led clinic for deep vein thrombosis, re-design of stroke services, changes to reduce the rate of in-hospital cardiac arrests and changes to ward processes. In general the case studies highlight the difficulties in disentangling the roles of managers and health professionals in instigating and implementing organisational changes in hospitals. Even where changes are described as being led by health professionals, some are nevertheless instigated at higher levels in an organisation. Furthermore, the changes were frequently a response to national policy initiatives. In practice, both managers and health professionals need to be genuinely engaged with any change initiative in order to both make it happen and to sustain the change once it is in place.

Schultz and Beckmann (2014) review organisational changes in German hospitals. They suggest that changes are mainly driven by externally driven factors. In particular the introduction of the DRG system as a remuneration system for acute care hospitals with a mandatory participation since 2004, is one of the most important drivers of organisational changes in German hospitals in the last decade. The change from a per-diem remuneration to a "per case" remuneration based on the classification of patients according to their needed (financial) resources based on diagnoses, procedures, surgeries and other treatments had an impact on the financial situation of the single hospital, and set incentives to implement structural changes. Additionally, for quality assurance, minimum procedural volumes for some specific treatments were implemented.

These trends were reinforced by enlarged possibilities to provide ambulatory services in hospitals regulated by law, the promotion of medical health-care centres, the promotion of integrated care as well as disease-management-programs. The authors discuss the impacts these changes have had on the number of hospitals and their ownership structures, the number of cases, patients' average length of stay and employment structures. They also discuss some particular examples of organisational changes, such as out- and insourcing and the development of quality management departments or the creation of medical health care centres, centralised emergency reception units and comprehensive stroke units.

The high documentation burden and quality requirements have led to an increase in management staff and managerial departments in German hospitals (Fuerstenberg et al. 2011a, 2011b). Personnel working in quality management generally rose by 4.3% and the ratio of quality management staff to all full-time staff rose from 0.62% to 0.68% between 2008 and 2010 alone. During the same period 7% of hospitals created departments for medical controlling and

66% extended their departments. Quality management departments were newly created in 10% and extended in 54% of hospitals. Finally, a third of all hospitals reported to have created departments or positions relating to discharge management, while 41% expanded these departments. The overwhelming majority of hospitals indicated that the DRG system was responsible for these changes. Other non-medical departments and positions that were specifically created as a result of the DRG introduction between 2008 and 2010 include ones in the areas of case and patient management, development of IT infrastructure, documentation of performance and accounting. This suggests that the German healthcare system was investing significantly in building up organisational capital in the past decade due to a major external change. These changes are likely to have included inputs from both clinical staff and general managers but appear to have led to a large increase in employment of the latter.

The survey carried out by Fuerstenberg et al. (2011b) indicates that more than 50% of hospitals report significant changes in the organisational structures of their medical and care services. These include the creation and development of medical health care centres, the creation or splitting of departments and the extension of the service portfolio. Hospitals further report the creation and extension of the structures necessary for ambulatory operations, the establishment of Intermediate Care Units and a reorganisation of admissions (e.g. creation of a centralised emergency admissions), as well as establishing specialised provisions, such as stroke units or chest-pain-units. These changes often required inputs from senior medical staff. For example the head of a medical service centre is required to be a medical practitioner who works in the centre and leads on medical questions. Senior clinical personnel are also heavily involved in managing central emergency admission units and in dedicated stroke units.

While the above discussion provides ample evidence professionals are involved in developing organisational capital in the healthcare sector, less information exists on the proportions of clinical staff who have management responsibilities and how much of their time is devoted to those activities. A survey of NHS Trusts, conducted by Dickinson et al. (2013) as part of their study of medical leadership, showed variation in leadership structures across Trusts. Most Trusts (71 per cent) had just one doctor on their Board of Directors, with the maximum reported as four. There were typically more doctors on Trust management boards, ranging from 1 to 17. The proportion of medical consultants who were involved in formal leadership roles was typically between 10 per cent and 20 per cent in the majority of Trusts. In a case study of nine of these

Trusts, medical directors typically spent around half their time on leadership, with clinical directors spending around one fifth of their time.

Time spent on management activities. There is some survey evidence on how much time clinical staff devote to managerial and administrative tasks in Germany. One such study is Klinke and Muller (2008), who surveyed doctors in Hessian hospitals, in which they had to indicate the amount of time spent on six different areas of tasks. The scale on which they indicated the time spent on each of these areas of tasks was between "0 hours" and "more than 8 hours". The figure 11 gives an overview of the time physicians spend on each of the six areas of tasks within a regular working day. On average doctors spend 4.3 hours per working day with medical tasks, 2.1 hours with admin tasks, 1.4 hours talking with patients and relatives and 1.2 hours writing medical reports. In addition for the study of medical literature they indicated 35 minutes and for research 30 minutes per working day on average. If medical tasks and patient conversations are grouped into "close-to-patient" tasks, they together take up 5.7 hours of a normal working day. If admin tasks and the writing of medical reports are classified as "patient-distant" tasks, these together take up 3.2 hours. In this way the surveys indicate a ratio of about 2:1 between direct patient services and patient administration.

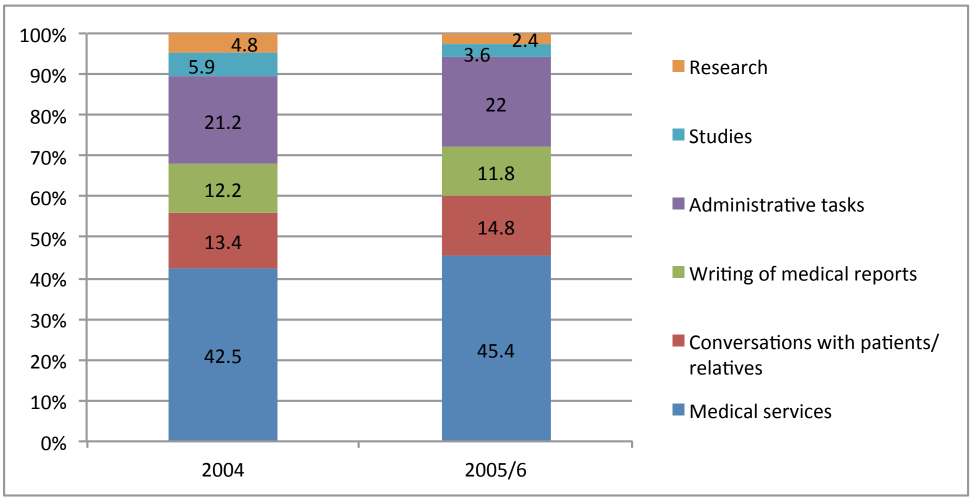


Figure 11: Physician working time allocation
Source: Klinke and Muller (2008)

Another survey (HIMSS Europe, 2015) asks clinical staff how much of their time is devoted to administrative rather than medical tasks. This found that in medical services, 4 hours per day are spent on average on such tasks. This represents 44% of the working time. For chief physicians the time spent on administration is highest, with 5.5 hours, followed by assistant physicians with an average of 4 hours. Nursing services document on average three hours per working day, which represents 37% of working time. However these tasks are often just routine documentation rather than "managerial."

Less information is available on the organisational capital in education. Stokes (2015) investigates the location and implementation of organisational changes in schools in England. As with hospitals much of the impetus for organisational changes comes from external political sources. A recent example is the introduction of academy schools, which receive funding directly from government (rather than through their local authority) and have greater autonomy, in particular over staffing, curriculum and resource allocation. The first set of academies opened in 2002, and were largely schools that were demonstrating poor performance. These schools were required to find a sponsor, which was seen as key to bringing about organisational change and raising performance. Following the 2010 Academies Act, there was a change in focus, with the option to become an academy opened to a wider range of schools, allowing them to "convert"' to academies rather than having to find a sponsor. This led to a dramatic increase in the number of academy schools; almost two-thirds of secondary schools now have academy status.

Cirin (2014) explores whether academies actually make use of their autonomy. They conducted a survey of around 700 academy schools in 2013. Many respondents believed that academy status had brought about improvements in performance and one of the key mechanisms for doing so was a change in school leadership, as well as increased collaboration with other schools and changes to the curriculum.

Stokes (2015) suggests that schools in England now operate a more distributed leadership mode of operation. Many classroom teachers also have some form of leadership role in their school, for example, as head of a year group or head of department. Leithwood et al. (2006) report evidence that school leadership is more influential for improving pupil attainment when it is widely distributed. Total leadership (defined as "leadership provided by many possible sources—individual teachers, staff teams, parents, central office staff, students and vice-principals—as well as the principal or headteacher") explained much more of the variation in pupil achievement between schools than individual headteacher effects. There is also some evidence to support the idea that co-ordinated patterns of leadership are the most beneficial for school performance, although the authors note that the different patterns of leadership distribution within schools and their impacts on teaching quality and pupil attainment still need to be better understood.

On balance, the evidence identifies the important role headteachers have in determining school performance. However, many staff in schools outside of the immediate management team do have leadership responsibilities, and evidence to date suggests that where leadership is more distributed, there are beneficial effects for school performance.

To date we have little evidence on who is responsible for generating organisational capital in higher education. This probably varies considerably from country to country. For example, academic staff in UK universities typically allocate one third of their time to administration and especially professorial staff are heavily involved in management. Some of this time will be spent on research related activities which should be captured by R&D in the Corrado et al. framework. In contrast, in the US only a minority of academic staff have managerial responsibilities. In the task based analysis of LeMouel and Squicciarini (2015), 10 of the 20 countries included have higher education teachers as part of the OC related occupations, confirming the diversity of roles. There appears to be no systematic review available on management responsibilities in higher education.

Measuring investments in OC

Overall issues. The discussion above suggests a number of things. First, the data suggests that a variety of workers can carry out tasks that have at least some organisational change element to them. This is in line with the theory discussion suggesting that both "managers" (who motivate workers by authority) and leaders (who motivate by voluntary means) can potentially obtain more output from an organisation. Note though that not all managerial and leader time is spent on such activities.

Second, the discussion above suggests that organisational capital should be that capital asset that is embodied within the organisation, so that, for example, it remains if a manager/leader departs. This is much more difficult to measure from the data at hand. One might imagine that if, for example, staff effort is built on the motivational power of a single charismatic leader, organisational capital falls when that leader leaves (unless some reputation stays behind). On the other hand, if there are many such leaders, who have built a company-specific mentoring system embodied in the work practices of the firm, there would be much less capital loss.

Third, there might be special considerations for the public sector due to incentives in the public sector, that are set out below.

All this suggests that an ideal data set would combine costs, time spent and translation into company-owned assets. Since this is not available, we adopted a conservative approach. First, we look for costs of managers and leaders, but scaled by the fraction of their time, as best we can estimate it, on organisational activities. Second, given the difficulties of translating this into firm-owned assets, we are conservative by depreciating organisational capital very quickly (40%pa). One way of thinking about this is via turnover rates or competition: of the 100 spent by a firm on organisational capital investment, almost half of it (40%) leaks away from the organisation due to, for example, individuals leaving or other organisations improving.

Nominal investments. We first consider purchased organisational capital, as arguably this is easier to measure than own account. The private sector method is to assume that firms buy in expertise from management consultants and so use the sales of the management consulting industry as a measure of such bought-in expertise. This has the appeal of passing the market test, for the actual money spent, by revealed preference, tells us at least the marginal value of such spending. But it raises a number of questions (many of which apply to both the public and private sector). First, not all management consulting builds purely organisational assets. In some countries we have surveys of management consulting by function and so can subtract off, say, IT or finance consulting (although it might be argued that IT consulting in practice also concerns organisational changes around IT implementation). Second, not all management consulting builds long-lasting assets. In the absence of data from specialist questionnaires to consultants, we deal with this by scaling down spending by 40%.

For measuring own account investments there appears to be very little alternative to using a proportion of payments to those responsible for generating organisational capital. implementing Our review of the literature failed to throw up any additional evidence on the magnitude of this proportion so in the SPINTAN project we suggest to continue to use 20% of payments to managers as their contribution to the value of OC investments, as used by Corrado, Hulten and Sichel (2005, 2009). This assumption remains a weak element of the estimation of own account organisational capital.

The next question is should we also use the same assumption for high level professionals. Le Mouel and Squicciarini (2015) employ the 20% of payments assumption to calculate investment in own account OC as a percent of value added, taking account of both managers and professionals. The authors conclude that including non-managerial occupations results in estimates of investment in OC that are on average 2.3 times higher than those obtained considering only managerial occupations. These authors also present estimates comparing the public and private sectors. The sectoral breakdown follows the definition of non-market industries proposed by Corrado et al. (2014). The public sector refers to public entities, as reported in the PIAAC data, operating in ISIC revision 3 sectors 73 and 75 to 93. The private sector refers to private entities operating in the business sector (ISIC revision 3 codes 01 to 72 and 74). That authors find that, with the exception of Belgium and the Netherlands, investment in OC as a share of value-added is higher in the public than in the private sector. This is largely driven by non-managerial occupations, such as health and education professionals, that form a large share of employment in the public sector.

The discussion on healthcare above, however, suggests that the calculations by Le Mouel and Squicciarini (2015) may overstate the extent of investments in organisational capital. Professionals only spend a fraction of their time on management tasks, with the remainder devoted to clinical duties, much of which is likely to be routine. Recall that we are trying to capture organisational knowledge generation brought about by persons in authority so we might assume instead that such changes are related to the extent to which professionals also assume managerial roles. This suggests an alternative calculation, that investment of 20% of the payments to these professionals might be multiplied by the proportion of their time spent on managerial activities. The (scant) survey evidence for healthcare for Germany and the UK suggests a factor of about one third.

Leaving aside issues over the choice of particular multiples, do special considerations apply when considering the public sector? One question might be over rent-seeking within organisations. Managers might spend time not on building future organizational assets, but on lobbying for an allocation to themselves of those existing assets. Of course, they still might be spending 20% of their time on asset-building rather than asset-allocation, but if at the margin there is more rent-seeking time spent in public organsiations, then it is more likely that the 20% figure is an overestimate. Without explicit data on this, we must appeal to theory. Haskel and Sanchis (1995) propose a model whereby workers bargain with firms about not only their wages but their "effort" (think of effort as work practices, time spent in on-the-job leisure etc.). It is assumed that workers have some bargaining power with firms: see Milgrom and Roberts, 1988, for a more explicit information-theoretic approach to this. Workers at the margin prefer more wages and less effort and firms the opposite: a Nash bargain reconciles these opposing objectives.

What is the role of the public sector in this? There are two effects. First, in the private sector, firms press for high effort levels, since they are assumed to be pure profit maximisers. However, public sector firms are assumed to be social welfare maximisers and therefore at the margin do not bargain such high levels of effort since they have broader interests at heart. So the model predicts lower effort (or greater X-inefficiency) in the public sector. Second, to the extent that public sector firms have advantageous market positions, they have more market power. That gives them potentially more surplus to share with their workers and hence effort might be lower in the public sector.

If we are prepared to use this logic over effort to apply to organizational capital building, it might be that public sector managers spend less time on organizational capital building then in the private sector. In the absence of such direct data on time use, we instead test if wages for otherwise identical public and private sector managers differ.

Data from the European Structure of Earnings Survey (EU SES) were used to estimate if there is a premium for managers in the public sector after controlling for personal characteristics such as skill level, age, gender, contract type and part-time work, and firm variables such as size and industry. The results are reported in O'Mahony and Samek (2015). The main finding is that, after controlling for other influences, the majority of countries show lower wages for managers in the public versus the private sector - this is especially so for Southern and Eastern European countries where we might expect a greater degree of non-competitive markets. These hourly wage reductions are of the order of 10% but vary by country and time period. These authors also investigated if annual bonuses yielded a premium in the public sector. Here the coefficients were positive in some Eastern European countries, but the average size of bonuses were small relative to wages and so did not compensate for the negative wage premium. Another consideration is that public sector employees frequently have generous pensions that are paid for through general taxation rather than employers? contributions, which might explain some part of the negative premium. However there is no information in the dataset to take account of pensions. On balance these results suggest little evidence for rents to public sector managers.

Deflators and Depreciation rates. Finally in order to use the investment data to construct real capital stocks we need to convert the nominal investments to volumes and incorporate a depreciation rate. Corrado et al. use the GDP deflator in their calculations of OC. As nominal investments are based on wages a general earnings deflator might be more appropriate. This was used by O'Mahony (2012) in her calculations of firm provided training on the grounds that the opportunity cost element of this was based on wages. This turns out to make a big difference for Eastern European countries but little difference for other countries. Corrado, Hulten and Sichel (2005, 2009) assume a 40% depreciation rate for organisational capital. Such a high depreciation rate can be justified if organisational changes are sufficiently frequent such that knowledge of production processes depreciate rapidly. In this context we should also ask if the extent of these changes differ between the public and private sectors. Some evidence for this is available in the European Company Survey (third wave carried out in 2013) which asked managers about organisational changes in their workplaces. The following table shows the answers to the question, "Since the beginning of 2010, has this establishment introduced any organisational change?", distinguishing between private and public sector firms. The table shows both the total number of companies and the proportions. This suggests that such changes occurred in nearly half establishments and are more likely to occur in the public sector. A similar finding is apparent in the second wave carried out in 2009. We would expect more changes to occur in the public sector as a response to externally imposed regulations and political influence, but such changes might generate little by way of organisational capital. Taking account of this, the numbers in Table 8 are consistent with there being little difference between the private and public sectors in depreciation rates. What about the magnitude of the depreciation rate? Given that own account OC is based on payments to persons in certain occupations, it might be worthwhile examining turnover rates, as used by Squicciarini and Le Mouel (2012).

	Organisational change		
Sector	Yes	No	Total
Private	10,245	14,129	24,374
	42.03	57.97	100
Public	1,168	1,117	2,285
	51.12	48.88	100
Total	11,413	15,246	26,659
	42.81	57.19	100

Table 8: Numbers of firms and proportions of firms undertaking organisational changes
Source: ECS, 2013, Eurostat

Conclusions The main conclusion from this analysis is that there is a need to take account of professional employees as well as managers in using the labour cost approach to estimate organisational capital in the public sector. However, unlike managers, there are arguments in favour of only allocating a proportion of the time of professionals in the calculations. In the next step we will consider the sensitivity of the estimates of own account organisational capital to alternative assumptions on the proportion of professionals' time devoted to generating organisational capital.

3.3 Function-specific human capital

by Mariagrazia Squicciarini, Luca Marcolin, and Peter Horvát

Introduction. Knowledge-based capital (KBC, also known as intangibles) comprises assets like R&D and organisational capital which are knowledge-intensive and lack physical embodiment. KBC is becoming increasingly important both as a share of total business investment, and as a contributor to productivity and economic growth (see OECD, 2013; Jona-Lasinio et al., 2011; Marrocu et al., 2011; and Corrado et al., 2012, for recent evidence). For instance, Corrado et al. (2013) report that intangible (vs tangible) capital deepening accounts for 23.8 percent (vs 41.6 percent) of labour productivity growth between 1995 and 2007 in Europe (GDP weighted average), and 31.9 percent (vs 26.8 percent) in the U.S..

While the many KBC definitions that exist (e.g. Choong, 2008; Corrado et al., 2009) emphasise the key role that human capital plays in the generation and accumulation of KBC and in fostering economic growth and development (Galor and Moav, 2004), measuring investment in human capital remains an unfinished and challenging task. The present work contributes to address this shortcoming by proposing a novel methodology for the measurement of investment in human capital in the form of training of employees. Human capital is defined following de la Fuente and Ciccone (2003), as the set of knowledge and skills obtained through schooling, training and every day experience that are useful in the production of goods, services and further knowledge.

This work takes advantage of the availability of new and rich individual-level information collected through the OECD Programme for the International Assessment of Adult Competencies (PIAAC) survey. It builds on the work of O'Mahony (2012) and improves on it by encompassing investment in three forms of training, namely formal and on-the-job training as well as informal learning. The proposed estimates cover 22 OECD countries, at both the economy and industry levels. Contrary to existing estimates, this work relies on data collected via harmonised questionnaires and definitions of training and account for both the opportunity and the direct cost of each of the forms of training considered. Lastly, the presented methodology allows to separately estimating investment in training carried out by private and public entities, whereas established measures of intangible investment usually refer to the market sector only.

The first section of the paper summarises existing approaches to measuring firm-specific training, while the second discusses the drivers of investment in training, typifies the different types of training, and considers the industry- and firm-specific features that may shape such investment. A description of the proposed expenditure-based approach and of its main assumptions follows, accompanied by a detailed account of the way in which formal and on-the-job training and informal learning are estimated. The data used for the analysis are then outlined. A description of the sample in terms of frequency of training by skill, training type and industry precedes the estimates of investment in the different forms of training for 22 countries, at the industry and country-wide level, and by the private and public sectors. Some robustness checks are shown before concluding by briefly discussing possible future analytical paths.

Defining and measuring investment in training: a review. The present study distinguishes between "formal training", "on-the-job training" and "informal learning". Formal training refers to training taking place in an organised, outside-work environment, and aiming at the attainment of a degree at an education institution (e.g. university degrees as MSc or BA). On-the-job training is a structured type of training that may take place both inside and outside a company (e.g. computer programming at a vocational education-type of institution). On-the-job training does not typically lead to the attainment of an education degree, and may take place during or outside working hours. Finally, informal learning results from the daily activities of employees at the workplace, and can be understood as learning by doing or learning from peers and/or supervisors.

Neither informal learning nor on-the-job training require enrolling in the formal education system, and only informal learning certainly takes place on the job according to the data available for this study. Informal learning is not included in the usual definition of on-the-job training (e.g. Barron et al., 1997), as it typically lacks an organised structure. On-the-job training, however, can also be carried out outside working hours and the working space. As a consequence, informal learning and on-the-job training together certainly account for more than what is usually understood as on-the-job training.

Existing work from Werquin (2007) and CEDEFOP (2014) also takes into account all three types of training, but differences in definitions exist between these studies and the present analysis. According to CEDEFOP (2014) informal learning can also happen outside the working environment, while this is not the case in the context of the present study; and non-formal learning is usually not explicitly designed as learning, while it can be here. Also, for CEDEFOP

(2014) formal learning can happen at the work place if sufficiently structured, whereas this is not the case in this analysis[17].

The three types of training contemplated in this study are by no means to be considered as mutually exclusive in nature or time. In particular, as informal learning often pertains to acquiring firms-specific capabilities and information, it may occur in the presence or absence of other types of training.

The inclusion of formal training is motivated by the evidence, in PIAAC, that many individuals are involved in both on-the-job and formal training. This may to some extent appear surprising, given the literature considering formal training as typically being of a "general" nature, and therefore a type of training that should not be firm-specific and that is easily transferrable to other companies. But formal training could increase the marginal productivity of workers more than their salaries, independently of its general or specific nature, thus justifying employers' investment. Furthermore, training cannot be defined as strictly specific or general in nature in the same way as knowledge is neither strictly general nor specific. Even training that is considered to be general can have a firm-specific component, at least to some extent (Loewenstein and Spletzer, 1999).

Informal learning has proved especially hard to measure, in light of its non-organised, non-structured nature (Bassanini et al., 2007). Barron et al. (1989) provide evidence for the U.S. whereby newly recruited employees declared to have received 96 percent of their training on the job in an informal way from peers. Using French data from 1992, Destr et al. (2008) highlight that informal training in the form of learning by doing and learning from peers can increase an employee's human capital by 10 percent with respect to the employee's capital level upon joining the company. This accumulation of human capital is decreasing with the employee's tenure, i.e. with the learning opportunity from others. Finally, informal learning is found to be very heterogeneous across firms and occupations.

What drives investment in training? Measuring investment in training requires understanding the drivers and incentives that may lead both employers and employees to make such an investment.

Since Becker (1964), the literature on continuous education has been modelling and investigating the incentives of both employers and employees to invest in training. From an employee

[17] It could to some extent be if formal education is pursued through online courses or distance learning.

perspective, it can be expected that training that is broad in scope and generic in nature (e.g., university degree) will benefit workers, in terms of e.g. higher wages and vertical mobility, in any company. Conversely, firm-specific training is likely to bring maximal payoffs if employees remain in the company providing or sponsoring the training. From an employer perspective, theory predicts that in perfectly competitive and frictionless labour markets employer-sponsored general employee training should not be observed. If firms behave rationally they should not pay for general training knowing that the likelihood of separation is very high, and employees might be able to find better (paid) jobs elsewhere. Hence, if general training takes place, it should be entirely employee-funded, for instance through lower wages during the training period. Firm-specific training, however, might be in theory co-sponsored, since both the employer and the employee might benefit from it. Employers might appropriate at least part of the returns from training by offering wages that are lower than the actual increased (marginal) productivity of workers. These wages, however, might still be higher in the company providing the training than in competing firms, thus benefitting employees as well (see Becker's Nobel lecture, 1993, for a discussion).

While the above theoretical prediction seem to only partially match what is observed in reality, theory and evidence on the source of funding for training gets reconciled if one discards the assumption of perfect competition on the labour market. While Lerman et al. and Riegg (2004) find that in 1994 and 1997 U.S. employer-funded training was mainly, although not exclusively, firm-specific, Loewenstein and Spletzer (1999) and Booth and Bryan (2007), find that most job-related training is at least partially paid by employers, even when respondents view it as general. This is in line with Bassanini et al.'s (2007) analysis of European countries in the 1990s. Brunello and Medio's (2001) also report that investment in training appears to be decreasing in unemployment, as the latter widens the pool of workers who can be hired at a relatively lower cost from the market. Furthermore, labour market frictions are at the root of employers' monopsony power in the models by Acemoglu and Pischke (1999a and 1999b) and Booth and Zoega (2008). Such monopsony power on wage setting translates in the ability of firms to appropriate the rents from training, thus raising the propensity that such training is funded by firms themselves. Lastly, further evidence of the response of training to imperfect labour market settings are provided, among others, by Conti (2005), and Bassanini and Brunello (2008)[18].

[18] A more thorough discussion of the literature on the role of labour market imperfections in the provision of firm level training is offered in Squicciarini et al. (2015).

Measuring training: an expenditure-based approach The measurement of firm specific training at the macroeconomic level has mainly followed two approaches. The first approach relies on data from national surveys to gather information about vocational training and apprenticeship. This is the approach followed, for instance, by Corrado et al. (2012), who measure total investment in training as the sum of firms' investment in vocational training and investment in apprenticeships using data from the Continuous Vocational Training (CVT) survey, from National Accounts and from Labour Cost Survey. Clayton et al. (2009) similarly estimate firm specific human capital expenditure for the United Kingdom using the National Employer Skills Survey. A recent extension of this approach (Corrado et al., 2015) focuses on the estimation of intangible investment by public and non-market entities.

The second approach generally relies on the European Labour Force Survey (LFS) and estimates investment in training as the sum of the direct expenditures incurred for the training and the opportunity costs of training. The most important contribution in this respect is by O'Mahony (2012) who combines data from LFS and the Continuous Vocational Training Survey and estimates total investment in vocational training. This corresponds to the product of the hours spent in training and the hourly cost of training, with the hourly cost of training composed of the direct cost of training and the opportunity cost of the forgone production or leisure time. The present chapter merges the two approaches to yield expenditure-based estimates of investment in training, under the following set of assumptions: some key assumptions.

- Firms are held to behave rationally: no firm would invest in training that would not be useful to its purposes, these being to increase its productivity or e.g. to reward employees in order to minimise separations and workforce turnover.

- Second, a revealed preference approach is pursued whereby the fact that firms pay for at least part of the training and/or allows it to happen fully or partially during working hours is understood as a signal that the company deems the training useful or needed, and hence considers it as an investment. Also, the willingness of employees to enrol in training at their own expense ? in terms of time and monetary cost ? while actively in the workforce is understood as investment aimed at e.g. avoiding being dismissed or finding a better job, and is thus taken into account, even if companies do not pay for it.

- Third, information about the perceived usefulness of training is used to discount investment in the different types of training for which such information is provided in PIAAC, as this is taken as an indication of the 'real' value of the training provided in terms of prospects for productivity increases for the company.

- Fourth, investment in training is measured in terms of both the direct and opportunity costs of training. The opportunity cost of training is proxied by the forgone hours of work or leisure due to training. The direct cost of training is estimated using information about the repartition of the training costs between employers and workers. Coherently with, among others, O'Mahony (2012) and Corrado et al. (2014), only part of training expenditure is considered as productive investment.

- Also, in this study the estimation of investment in training based on expenditure data takes into consideration that the cost of training might vary with firm size and that companies of different size might have different propensities to provide and sponsor training. Estimates further account for the private or public nature of the companies and are provided for the private and the public sector (institutional entities or government-sponsored enterprises) separately.

As a general caveat, it should be noted that the methodology proposed in this paper implicitly assumes imperfect labour markets. While it estimates the opportunity cost of training based on reported individual wages, these are not assumed to reflect the marginal product of labour.

Data sources: linking PIAAC to national data As mentioned, the principal source for the present analysis is the PIAAC 2012 survey (see Annex 1, with respect to the exact wording of questions considered in the analysis). This survey allows assessing investment in different types of training while guaranteeing maximal international comparability, in terms of classifications used with respect to educational attainment (according to ISCED 1997), field of economic activity (by ISIC rev. 4) and occupation (by ISCO 2008). PIAAC provides information about an individual's: employment status, i.e. whether employed, self-employed or none of the two; employment sector; type of occupation; wage; working hours; educational background; and current education or training activities, in terms of formal and on-the-job training and informal learning.

In order to estimate investment in training, however, it is also necessary to link PIAAC with other sources of information. This implies addressing a few challenges, and in particular taking into account that: (1) the age structure of the surveyed population in PIAAC and Labour

Force Surveys are slightly different; (2) only some regions, rather than the entire country, were surveyed in Belgium and the United Kingdom; (3) some countries were surveyed in 2011, others in 2012.[19]

Estimating investment in training in a way that would be representative at the country and industry level requires constructing a new set of weights for the individuals in the PIAAC survey. Such a need becomes evident upon comparing the employment figures of the full PIAAC sample with those obtained from LFS for the 15 EU countries included. A direct comparison is reported in Squicciarini et al., (2015).

Adjusting the survey weights to account for the population not included in the PIAAC sample, and aligning the structure of employment arising from PIAAC to the one emerging from official sources implied accessing a number of other data sources. Information about age by gender, employment status, economic sector and occupation were taken from EU LFS for EU countries and from the Current Population Survey (CPS) for the United States and from the Economically Active Population Survey (EAPS) for Korea. For the sake of brevity, these data sources are collectively referred to as LFS. For the other non-EU OECD member states included in the analysis, necessary data were not available in internationally comparable occupational and industrial classifications, which required additional effort in data collection and treatment. Data for Australia, Japan and Korea at one digit ISCO 2008 level were obtained from the International Labour Organization statistics ILOSTAT. Similarly, data for Canada at one digit ISCO 2008 level were obtained from the United Nations statistics UNSTATS.

In the absence of a data source providing U.S. employment by occupation data following the ISCO 2008 classification, a crosswalk was built between CPS, where occupations are classified following the Census 2010 occupation codes, and PIAAC, where occupations are classified according to the ISCO 2008 classification. Finally, recalibrating the PIAAC-provided weights requires using data from the System of National Accounts (SNA) on wages and salaries by ISIC rev.4 sectors. These were increased by a proportion equal to the ratio of self-employed and employees over employees, to account for the wages and salaries of self-employed individuals, which are not reported in the SNA. For Japan and Korea, missing SNA data on wages and salaries by ISIC rev. 4 have been estimated on the basis of total compensations of employees and the ratio between total compensations and total wages and salaries by ISIC rev. 4.

[19] More information on the way these issues were dealt with is contained in the Squicciarini et al. (2015).

Final estimates were further refined by winsorising the distribution of the key input variables at the 1% and 99% values, thus limiting the role of possible outliers and the measurement error triggered by extremes values. In particular, wages were corrected taking into account industry-specific distribution, while employment per hour was corrected with respect to the occupation-specific distributions.

The final calculation of set of weights making PIAAC-based statistics representative for the entire population of countries follow Deville and Srndal (1992) and the subsequent literature (e.g. 2013b). Weights are obtained through the generalised regression estimator (GREG), which uses the link between survey information and out-of-survey auxiliary variables to adjust the sampling weights.[20]

Measuring training: a PIAAC-based methodology The estimates proposed encompass investment in three forms of training, namely formal and on-the-job training and informal learning, and thus improve on existing work which typically overlooks formal training and informal learning. They cover 22 OECD countries, at the economy-wide and the industry levels and, contrary to existing estimates, the proposed figures rely on data collected via the same survey, which uses harmonised definitions of the types of training considered. They further account for both the opportunity and the direct cost of each form of training, similarly to the approach used by O'Mahony (2012) when estimating on-the-job training.

Direct and opportunity costs of training As anticipated, another noteworthy feature of this study is the inclusion of both the direct and opportunity costs of training in the measure of expenditures in training. The opportunity cost of training is estimated in terms of forgone hours of work due to training. While this information is not explicitly contained in PIAAC, the survey provides data related to the allocation of training between working and leisure hours, and to the usefulness of training to the worker's current employment, which can be used to proxy the opportunity cost of training. As far as the direct cost of training is concerned, an estimate of the repartition of the training costs between employer and worker will be needed, as discussed later.

[20] This study exploits the following auxiliary variables. For the entire population: age, gender, economic status (employed, unemployed, inactive); for the employed population: economic sector, occupation, total wages and salaries by industry, employment in working hours. Further details can be found in Squicciarini et al. (2015).

Surveyed individuals in PIAAC are asked to report whether training took place "only during working hours", "only outside working hours", or somewhere in between, out of four possibilities (see the "*Allocation*" variable). If firms behave rationally and labour markets are competitive, employers might allow training to take place during working hours if and only if workers' productivity is expected to increase at least as much as the cost incurred in terms of foregone working hours due to training. However, when labour markets are not perfectly competitive or when employees' outside options are (relatively) fewer because of excess labour supply and consequently high unemployment rates, employers may be able to (at least partially) shift the time and cost of training onto employees, while still benefitting from the productivity returns driven by training. This reasoning drives the choice made in the present study to consider also training happening outside working hours as investment in training. In PIAAC, information about the time in which training takes place is complemented by information on the employees' perceived usefulness of the learning activity for their current job. Answers are reported on a four-step scale, ranging between "very useful" and "not useful at all" ("*Subjective Usefulness*").

Hence, expenditure in training configures itself as investment the more workers report it to be useful for their current jobs, and the more training happens during working hours, as it is assumed that training can happen during working hours only if it is a rentable investment for the company. This latter occurrence can be considered a revealed preference of the employers, and of the expectations they have about the usefulness of their employees' training. However, relying on the "*Subjective Usefulness*" question only is not sufficient to capture the proportion of expenditure that should be considered as investment. PIAAC asks employees rather than employers to assess the usefulness of their training, and relying only on the subjective usefulness assessment of employees might lead to overlook training considered as irrelevant by the employee but of value to the employer. To make the "*Subjective Usefulness*" and "*Allocation*"-related answers usable for estimation purposes, an order based on the semantic understanding of their meaning is imposed on the answers. This has been translated into values bounded between 0 and 1, and used as a capitalisation factor of the expenditure in training. Given the impossibility to compare the precise meaning of "'moderately" and "somewhat" relative to "very" or "not at all" (likewise for "mostly during" and "mostly outside" working hours), the two intermediate answers of each question have been attributed values that are equidistant between 0, 1 and between each other, i.e. 0.33 and 0.66 (see Table 9). This choice relies on the implicit assumption that respondents see the possible answers as equidistant from each other, rather than seeing, e.g. "mostly during working hours" closer to "only during working hours" than to "mostly outside working hours". The values of "*Allocation*" are increasing in the proportion of training happening during working hours, coherent with the idea that training happening during working hours is more likely to be rentable for the employer, therefore a more rentable investment.

The variable p summarises the joint answers to the "*Allocation*" and "*Subjective Usefulness*" questions, by taking the average of the values attributed to the answers to each question[21]. Table 10 shows the values of p resulting from all possible answers to the two PIAAC questions considered.

PIAAC also registers whether the employer pays for at least part of the training ("*Employer's Quota*"). Table 11 shows the value attributed to the "Employer's Quota" answer, based on the assumption that the greater employers' participation in the cost of training is, the more likely that this expenditure is seen as investment. The implicit assumption made here is that the value of training does not correspond only to what the employer pays, as other firms might ultimately benefit from this training when employees move across firms, between and across industries.

Allocation	Attributed Value	Subjective Usefulness	Attributed Value
Only during working hours	1	Very useful	1
Mostly during working hours	0.667	Moderately useful	0.667
Mostly outside working hours	0.333	Somewhat useful	0.333
Only outside working hours	0	Not useful at all	0

Table 9: Answers and assigned numerical values to "Allocation" and "Subjective Usefulness"
Source: Authors' own compilation on data from the PIAAC survey

Allocation → / **Subjective Usefulness ↓**	1	0.667	0.333	0
1	1	0.833	0.667	0.5
0.667	0.833	0.667	0.5	0.333
0.333	0.667	0.5	0.333	0.167
0	0.5	0.333	0.167	0

Table 10: Values of p
Source: Authors' own compilation

[21] Alternatively, a variable representing the joint distribution of "Subjective Usefulness" and "Allocation" could be derived by multiplying the row and column values. This would, however, have the undesirable property of setting p to zero whenever one of the two underlying variables is zero. It is in fact reasonable to suppose that training taking place during working hours signals an interest of the employers, even when employees perceive it as useless, and that training taking place completely outside working hours can be useful for the company as well. Nevertheless, one such specification is proposed as robustness check.

Employer's Quota	Attributed Value
Yes, totally	1
Yes, partly	0.5
No, not at all	0
There were no such costs	0

Table 11: "Employer's Quotas" possible answers and assigned numerical values
Source: Authors' own compilation on data from the PIAAC survey

From the joint answers to "Employer's Quota" and "Subjective Usefulness" a new variable, q, is derived. Similar to what done above, employers' participation in the costs of training is understood as signalling an interest of the employers in the training of employees, even if the training is considered useless by the employee. Symmetrically, training which is not paid by the employer in any proportion need not necessarily be irrelevant for the job tasks. Table 11 reports the values of q as an average of the possible answers to the two original PIAAC questions

Employer's Quota → / Subjective Usefulness ↓	1	0.5	0
1	1	0.75	0.5
0.667	0.833	0.583	0.333
0.333	0.667	0.417	0.167
0	0.5	0.25	0

Table 12: Values of q
Source: Authors' own compilation

Questions on "*Allocation*", "*Subjective Usefulness*" and "*Employer's Quota*" are asked twice in PIAAC, once in reference to formal training, and once in reference to on-the-job training.

Formal training. The definition of formal training used in this study corresponds to formal education in PIAAC, i.e. the highest level of schooling the interviewed employee reports to have attended in the last 12 months[22]. It therefore refers to formal education provided by schools, universities or other education institutions, full- or part-time, which lead to a certification reported in the National Educational Classification. Investment in formal training I^F in a given country and year is estimated as a sum over individual information in each occupation and sector, according to equation 1:

[22] Although PIAAC surveys also unemployed people, this analysis is restricted to individuals in employment at the moment of the interview, to provide a relevant, industry- or occupation-specific estimate of investment in training. The terms "individual" and "employee" are therefore used interchangeably.

$$I^F = \sum_{k,o,j} (p_{k,o,j} h_{k,o,j} w_{k,o,j}) + \sum_{k,e,o,j} (q_{k,e,o,j}) \frac{C_e}{S_e} \tag{1}$$

where $p_{k,o,j}$ and $q_{k,e,o,j}$ are the individual-specific weights discussed before, and "Allocation", "Subjective Usefulness" and "Employer's Quota" refer to formal education (subscripts for country and time are omitted to ease notation). They are derived for an individual k:

- working in occupation o, defined according to the 2008 International Standard Classification of Occupations (ISCO 2008) at the 4 digit level;
- in industry j, defined according to the most recent revision of the International Standard Industrial Classification of All Economic Activities (ISIC 4), at the 4 digit level;
- attending education e, defined according to a modified version of the one digit International Standard Classification of Education (ISCED 1997);
- h corresponds to the annual hours worked by the individual;
- w to her gross hourly income[23];
- C_e/S_e is the yearly public and private expenditure in education per student for the year 2011, as reported in the OECD "Education at a Glance" statistics and converted from purchasing power standards (PPS) to national currency using the OECD PPS for 2011.
- and S_e is the number of students attending formal education.

The first part of the right hand side of equation 1 reflects the opportunity cost of formal training. It is computed as the corresponding proportion of an employee's annual wage bill ($h_{k,o,j} w_{k,o,j}$) multiplied by a weight taking into account the repartition of training between working and non-working hours, and the perceived utility of the training, i.e. p. Holding that "Allocation", and hence p, should be able to capture whether an employee is or is not enrolled in full-time education, the proposed indicator for formal training is based on a proportion of the annual wage bill of the employee. Data restrictions influence this choice: PIAAC does not ask

[23] Hours worked are not censored to 60 per week. Monthly wages for individuals who did not report any income are estimated with the aid of a country-specific Mincer-like equation where the individual's wage is a function of her level of schooling (6 categories), age (5 categories), gender, industry (21 categories), occupation (11 categories) and country of operation.

the number of hours invested in formal training, contrary to other forms of training, so that h cannot be the number of hours of formal training.

The second part of equation 1 approximates the direct cost of formal education based on the per-student expenditure in the level of education attended by the individual (C_e/S_e). This ratio is multiplied by q, a variable weighting expenditure in education by the perceived usefulness of training, and the quota of training costs paid by the employer. If one were to ignore q, the sum of the per student expenditure over all individuals in PIAAC might become greater than the total country-wide expenditure on education, if the number of students is smaller than the number of employees. This should not represent a problem if the number of employees in formal training is included in the national education statistics (as it should be).

On-the-job training. On-the-job training in PIAAC encompasses different forms of training ranging from seminars and workshops, to on-the-job training periods, extra courses or private lessons, and open or distance education courses. They are usually planned and organised in nature, but not in the context of a formal education degree; they might but need not take place at work, nor be exclusively relevant for a specific firm.

On-the-job training I^N is defined here as:

$$I^N = \sum_{k,o,j} (p_{k,o,j} h^N_{k,o,j} w_{k,o,j} + q_{k,o,j} h^N_{k,o,j} C^N_j) = \sum_{k,o,j} h^N_{k,o,j} (p_{k,o,j} w_{k,o,j} + q_{k,o,j} C^N_j) \tag{2}$$

where h^N is the number of hours invested in on-the-job training in a year reported by the employee, and $p_{k,o,j}$ and $q_{k,o,j}$ are calculated as described above, but when questions on "Allocation", "Subjective Usefulness" and "Employer's Quota" refer to on-the-job training. C_j stands for the average cost of an hour of training in the industry and firm size class.

The first part of Equation 2 ($p_{k,o,j} h^N_{k,o,j} w_{k,o,j}$) accounts for the opportunity cost of on-the-job training, following the same line of reasoning as above. The number of hours worked are here substituted by the number of hours effectively spent on training, as reported in PIAAC. The second part of Equation 2 conversely computes the individual's direct cost of on-the-job training ($q_{k,o,j} h^N_{k,o,j} C^N_j$), as a weighted product between the cost of one hour of on-the-job training and the number of hours invested in such activity. The weighting follows the intuition described for formal training, so that costs are capitalised into investment in function of the perceived usefulness of the training and the participation of the employer to its costs ("Subjective Usefulness" and "Employer's Quota").

C_j^N takes into account both the firm's own cost of training and the fee paid to external training companies for their services, thanks to information available in the Continuing Vocational Training Survey, the dataset used to estimate the direct cost of training. As C_j^N is available only for a given subsection of the economy[24], the direct cost of training for public administration, education, healthcare, and activities by households is the average of the cost of all other services (Nace Rev. 2 sections F-N, R and S), in a similar fashion to O'Mahony (2012).

A further adjustment takes into account the size of the firm where the individual in PIAAC reports to have worked when in training. For PIAAC individuals working in firms smaller than 10 employees, there is no cost information in the CVTS. This study therefore uses the average direct cost reported by firms operating in the same sector in the class size $10 - 49$, thus making the implicit assumption that the direct cost of on-the-job training is the same for all firms in an industry with less than 50 employees.

Finally, as the CVTS surveys only European countries, the cost of on-the-job training for non-European countries (and Ireland, whose last available year is 2005) needs to be estimated. All countries in the sample are clustered using multiple PIAAC-based features of relevance for firm-level training, as well as information from other datasets reflecting occupation and industrial structure features of the countries. When clusters include European countries and at least one country for which no training cost information is available, the average industry cost reported by the European countries in the cluster is taken as a proxy for the non-European country in the same cluster. This is done at the industry level. The country groupings resulting from the clustering are chosen using the Duda and Hart criterion (Duda, Hart, and Storck, 2001)[25].

Informal learning. Informal learning, by definition, is neither structured nor organised; it is therefore impossible to identify a direct and explicit cost of informal learning[26]. Such a training component is therefore estimated as a function of the opportunity cost of the employee's lower output during the hours of training and the opportunity cost of other workers who may be

[24] In NACE rev. 2 codes: B- N+R+S.

[25] More information on how the CVTS structure is adapted to fit this methodology is provided in Squicciarini et al., (2015), including the list of variables used for the clustering and the country groupings resulting from the clustering itself.

[26] Informal learning to some extent sets itself apart from formal and on-the-job training and an alternative choice might be not to include informal learning and training in the analysis.

involved in the training. The opportunity cost of informal learning is thus believed to be a positive function of the following frequencies:

- learning from co-workers or supervisors (”*Peer Learning*”);
- learning-by-doing, i.e. while processing the daily job tasks (”*Learning-by-Doing*”);
- keeping up to date with novelties in the product market (”*Knowledge Updating*”).

A conservative lower and upper bound estimates of the *number of days* spent in informal learning per year is thus proposed using PIAAC information.

PIAAC asks whether each of the ”*Peer Learning*”, ”*Learning-by-Doing*” and ”*Knowledge Updating*” activities takes place less than every day, at least once a week, less than once a week, less than once a month, or not at all. These categories are transformed into numbers by assigning the lowest possible amount of working days implied by the categorisation. For instance, if an individual reports to have engaged in one of the three activities above ”less than once per month”, it is assumed that the individual devoted exactly one working day per year to that specific activity. Absent a more precise definition of the frequency of the activities above, and in an effort to avoid overstating the importance and cost of training, the outlined approach is here preferred.

Table 13 shows the number of working days per year associated to each possible answer to the questions about ”Peer Learning” (d^p), ”Learning-by-Doing” (d^d), and ”Knowledge Updating” (d^u). The number of working days when the individual is learning from its peers or supervisors is doubled so as to take into account the opportunity cost of the peers who are investing their own time as well in the informal learning activity. This is also a conservative approach, as (i) the cost of one hour of a supervisor's time should cost more than an hour of the employee's time, and (ii) employees may be learning from more than one peer or supervisor at a time. However, whenever ”Peer Learning” benefits more than one individual at the same time, the opportunity cost of the peers or supervisors which are ”teaching” may be double counted, if ”Peer Learning” is reported by all learning individuals at the same time. Unfortunately, no elements are available in order to understand if all these effects are biasing the estimation of hours of informal training univocally, and the direction of the bias.

A variable reflecting the number of working days actually devoted to informal learning in a year is then constructed. This corresponds to $\bar{d}_{k,0,j}$, the sum of working days invested in each of

Frequency of occurrence	Attributed Days per Year	
	d^d, d^u	d^p
Never	0	0
Less than once a month	1	2
Less than once a week but at least once a month	12	24
At least once a week but not every day	52	104
Every day	252	504

Table 13: Possible answers to the questions on "Peer Learning", "Learning-by-Doing" and "Knowledge Updating", and corresponding assigned working days.
Source: Authors' own compilation on data from PIAAC. Legend: d^d and d^u are, respectively, the days associated to each reported frequency when the question refers to "Learning by Doing" and "Knowledge Updating". d^p is the same but when the activity is "Peer Learning".

the three activities considered, namely "Peer Learning", "Learning-by-Doing" and "Knowledge Updating".

It should be noted, however, that one cannot assume these three activities to be mutually exclusive.. That is why taking the sum of the frequencies of all activities together may lead to double counting some days. Moreover, it can be argued that the time spent in "Learning by Doing" and "Updating knowledge" (d^u and d^d) cannot be considered informal learning, as it might not entail a clear opportunity cost in terms of foregone hours or productivity of the employee.. The lower bound number of days instead ($\underline{d}_{k,0,j}$) is estimated as corresponding to the number of days associated to the "Peer Learning" only.

Finally, the frequencies reported by PIAAC individuals about their "Peer Learning", "Learning-by-Doing" and "Knowledge Updating" activities refer to the number of days in the year when these activities take place. Such training, however, most likely does not last for the entire day, and estimating investment in informal learning requires knowing the number of hours per day that are spent in informal learning, on average, by each employee.

To the authors' knowledge, only three papers report such estimates: Loewenstein and Spletzer (2000) for the U.S. in 1993-1994, Kurosawa (2001) for Japan in 1994, and Nelen and de Grip (2009) for the Netherlands in 2007. Table in Appendix B, reports how the different estimates were made comparable, and shows that different types of employees engage in significantly different spells of informal learning depending on the country they belong to and the year in which informal learning takes place. For the purpose of this study, a conservative approach is again followed, whereby an average of the hours of training per day for Japan and the U.S.

is used and applied to all other countries. More precisely, an average of the figures for supervisors and co-workers is taken for the U.S., and then averaged once again with figures from Japan. This procedure yields a value of 0.57 hours per day of informal learning (i.e. about half an hour) for employees with job tenure lower than one year, and 0.24 hours (about a quarter of an hour) for employees with longer job tenure. These values are summarised in a vector $z_(k, o, j) = \{0.57; 0.24\}$, where the applicable value depends on the employee k's tenure. Combining these data with the more recent information contained in PIAAC aims at limiting the possible biases imposed by the distance in the past when such estimates were collected (1993-94 for the U.S. and Japan). Summarising the steps mentioned thus far, the upper and lower bound investment in informal learning is estimated, respectively, as:

$$(3) \qquad \bar{I}^{IN} = \sum_{k,o,j} (\bar{d}_{k,o,j} z_{k,o,j} w_{k,o,j}) \qquad OR \qquad \underline{I}^{IN} = \sum_{k,o,j} (\underline{d}_{k,o,j} z_{k,o,j} w_{k,o,j})$$

As a consequence, according to equation 1 to 3, the total (lower bound) investment in training can be estimated as:

$$(4) \quad I = \sum_{k,o,j} w_{k,o,j}(p_{k,o,j} h_{k,o,j} + p_{k,o,j} h^N_{k,o,j} + \underline{d}_{k,o,j} z_{k,o,j}) + \sum_{k,e,o,j} (q_{k,e,o,j}) \frac{C_e}{S_e} + \sum_{k,o,j} (q_{k,o,j} h^N_{k,o,j} C^N_j)$$

where the first term on the right side of equation 4 corresponds to the opportunity costs of an employee in training, the second and third terms estimate the direct cost of formal and on-the-job training, respectively.

The estimates retrieved from 4 are then adjusted by purchasing power parity. Both cost and wage measures mentioned so far and used to estimate $I$are collected in local currency, at current 2010 prices. With the appropriate choice of PPP ratios, these can be made comparable (in PPP U.S. dollars), thus obtaining PPP-corrected estimates of investment in training[27].

[27] This work uses the 2010 PPP values for GDP computed by the OECD. It may be argued that a measure of prices for GDP does not correct price differences in training appropriately, as estimates expenditures in training relate more closely to wages than to GDP at large (O'Mahony, 2012). Criticism to the use of GDP deflators for specific kinds of KB assets whose price is not reported in national accounts is also put forward by Corrado et al. (2011). However, their criticism refers to the time dynamics of prices within a given country, while this study requires different international prices in a given year. What is more, their criticism applies to investment in R&D, whose price declined in recent years in most OECD countries, contrary to the general level of prices as captured by GDP deflators. The same should not apply when considering investment in training, as wages typically increase with time, often at a faster rate than GDP.

As a last caveat, it should be noted that the methodology detailed thus far yields estimates of investment in firm-based training. As only one wave of the PIAAC survey data has been collected at the moment of writing, it is impossible to test the sensitivity of the methodology to the use of data related to other time spans, and to verify their coherence with the other structural figures and consistency over time. The best that can be done at present to estimate investment in training for different years would be to exploit time series of wages and incidence of training from external sources and assume p and q to be constant over time. The Perpetual Inventory Method (PIM), a standard way to capitalise investment, also in the intangible assets measurement literature, could then be applied to this time series of investment. Pursuing this endeavour, however, would require making further assumptions about, among others, (i) the most appropriate price for training, and (ii) the service life, decay and depreciation of training as an intangible investment. This goes beyond the purpose of the current chapter.

Public vs private sector investment in training. The methodology proposed thus far aims to estimate investment in training independently on the institutional nature of the firm or establishment where workers are employed, i.e. a privately-owned company, or a non-market institution, be it a public entity (i.e. either a part of the public administration or a government-sponsored firm), or a not-for-profit institution.

While existing estimates, mostly relying on the Corrado et al.'s (2009) analytical framework, usually encompass the business (or market) sector only, other chapters in this manual propose to estimate non-market investment in intangible assets for the following industries: scientific research and development (ISIC Rev.4 sector 72); public administration and defence (84); education (85); health and social work (86-88); and arts, entertainment and recreation (90-93). The present analysis estimates public investment in a different way. It exploits the availability of information about the private, public or non-profit nature of the institution in which PIAAC surveyed individuals work. If the government is (at least) majority shareholder, as a consequence, firms are classified as publicly owned. As a consequence, estimates of investment for each sub-section of the economy can be obtained using Equation 4 and restricting the population of interest according to the institutional nature of the workplace. PIAAC micro-level data allow accounting for the private or public nature of firms in all industries, including e.g. public firms in industries not usually classified as public-services, like transportation and electricity production (two investment-intensive ones). Nevertheless, to enhance comparability with ongoing studies, public sector estimates in the present paper relate to the five non-market industries here above. Within these sectors, the availability of microdata allows excluding private firms in sectors usually classified as non-market, like education, hence shedding light on the relative size of public vs private investment within a given sector. This appears especially important since both non-market and market entities are operating in four out of the five industries mentioned above.

The implemented definition of public ownership in PIAAC, however, does not distinguish between public owned firms and other public institutions. If this allows a more encompassing assessment of the role of public investment in the economy, it also reduces comparability with the already scant literature and the SNA, which excludes publicly-owned firms from the boundaries of the non-market economy.

A final concern on the application of Equation 4 to public investment may arise if one assumes the relationship between workers' salaries and productivity to be different in private, public and non-profit entities. Neglecting such differences may bias both the direct and the opportunity cost of training, which are a function of the individual's wage. It should be stressed, however, that the link between wages and productivity in the proposed methodology is mediated by the discount factors p and q, so that only a fraction of the expenditure on wages is considered as investment. As p and q are worker-specific, they also change depending on the institutional nature of the workplace, if it is the case that the latter impacts the usefulness and location of the training spell, or the proportion of training cost paid by the employer.

Investment in formal and on-the-job training and in informal learning: first descriptive evidence

Incidence of training. Almost all surveyed individuals who are either employed or self-employed received some training in the sample years, in all countries considered. The number of highly skilled and medium skilled individuals receiving some training represents approximately the same proportion of total employees (40 to 50 percent for each category of skill) across all countries considered.[28] Also, training of low skill workers accounts for less than 10 percent of total employment in each country. Figure 12 provides more information in this respect, by

[28] Skills are categorised in three classes ("High", "Medium", "Low") based on occupational information reported by the individual in PIAAC. This classification is based on the ILO mapping of ISCO classes into skill levels (ILO, 2012).

breaking down incidence by type of training. Percentages are calculated as the country-specific number of individuals in each skill category receiving a specific type of training, over the total number of employees and self-employed individuals interviewed in PIAAC. The figure omits the bar for informal training, as 97 percent of individuals in employment were exposed to some informal learning on average between 2011 and 2012 and across country, with roughly similar proportion in each country. On the contrary, on average only 18 percent of individuals in employment stated to have benefited from formal training, with the notable exception of Italy, Japan, France, Korea, the Slovak Republic and Belgium, where these figures are approximately halved. However this does not necessarily lead to lower-than-average incidences for Belgium, Korea and Japan when on-the-job and formal training are considered together.

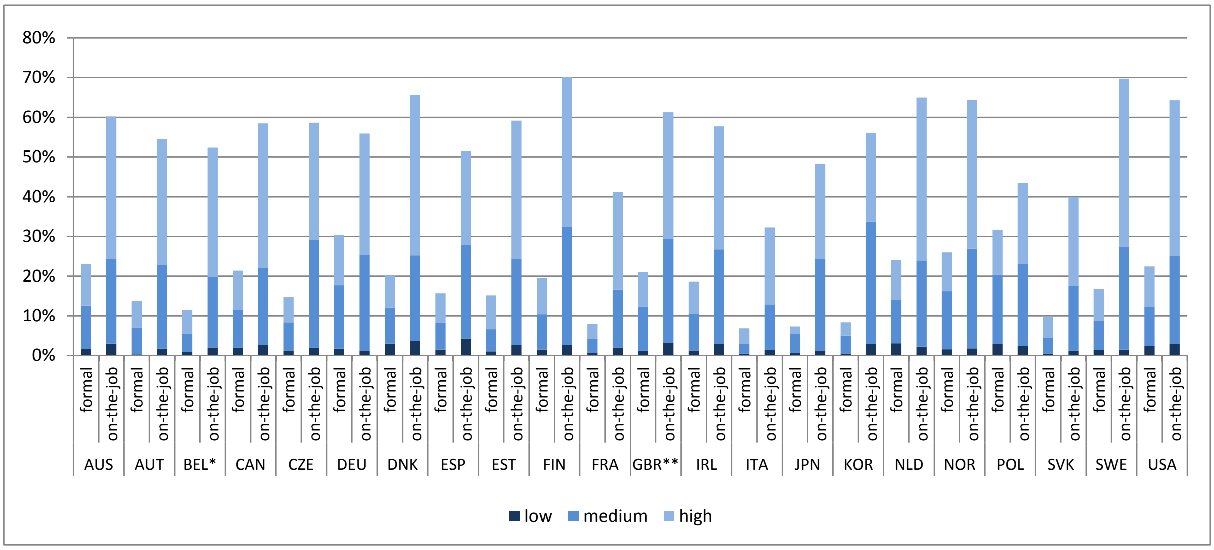


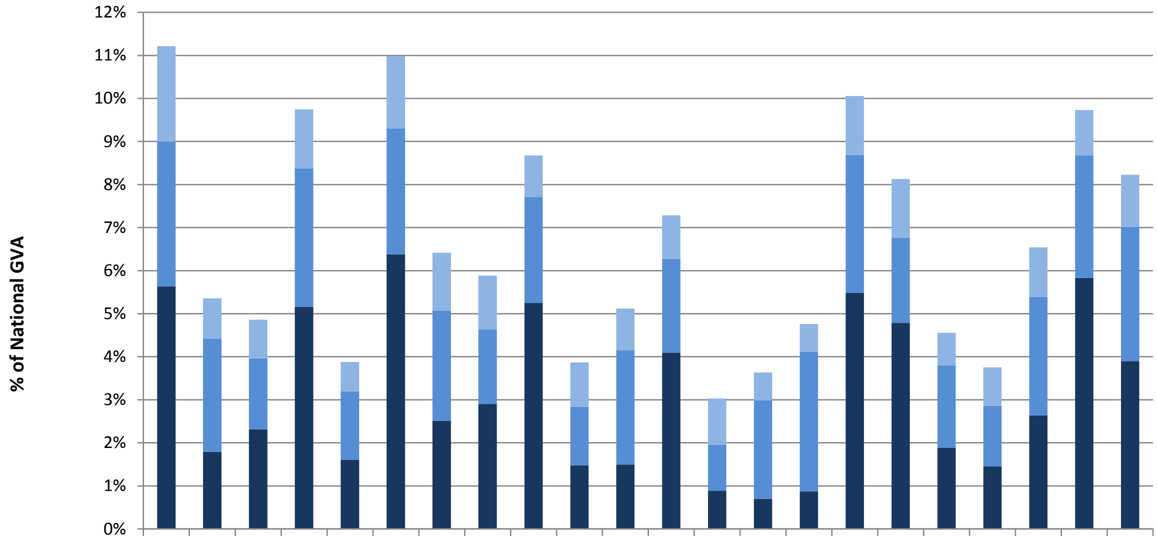
Figure 12: Incidence of training by type of training and skill level, as a % of total employment, by country. (average of 2011 and 2012)
Source: Authors' calculations on the PIAAC sample. Percentages reflect the number of individuals in each skill category receiving the specific type of training, over the total number of employees in the same country in PIAAC. PIAAC data from Belgium only cover Flanders. PIAAC data from the UK only cover England and Northern Ireland.

Within each type of training, low-skilled workers typically account for the lowest proportion of total employment. More precisely, less than 10 percent of employees receiving each type of training display low skills, with consistently lower percentages when the training is on-the-job (about 4 percent of the employees receiving on-the-job training is low skilled) (figures not reported). Low and medium skilled employees represent a lower percentage of total employment (approximately 44 percent) in on-the-job training than in other forms of training (approximately 55 percent). Skills and firm level training hence seem positively correlated and especially so for on-the-job training, coherent with training being a tool through which employers can gain the loyalty of employees and limit turnover of key workforce. On the one hand these country-wide patterns may simply capture the different skill composition of industries within each country. On the other hand, considering that returns to training may be higher for skilled employees, the percentage of trained employees by skill may not simply reflect the skill composition of industries. An analysis of the proportion of employees receiving training by skill type[29] reveals that the percentage of high skill workers receiving on-the-job training is always larger than the percentage of, respectively, medium and low skill workers in the same situation, independent of the sector or country considered, except for the business sector in Australia. The same pattern is not found for formal training, where countries and sectors within a country display important heterogeneities. What is more, the percentage of workers receiving on-the-job training is usually higher than the percentage of workers receiving formal training, across skills, industries and countries, with very few exceptions across country.

Investment in training. The methodology in this study allows estimating investment in training at the industry and country level for the year of reference. Figure Figure 13 reports the estimates of total investment in formal training, on-the-job training and informal learning as a percentage of countries' Gross Value Added (GVA), where the total figures have been computed taking into account the lower bound estimates for informal learning and the reweighted sample of PIAAC individuals. At the denominator the average GVA in current prices between 2011 and 2012 is used.

Notable differences in countries' investment in total training emerge, with Australia, Denmark, the Netherlands, Canada and the UK exhibiting substantially more training - as a percentage of Gross Value Added - than the other countries in the sample. The same can be said when looking at on-the-job training, although country differences in this case are much less pronounced. The magnitude of the on-the-job training estimates is much lower, reaching between 30 to 50 percent of total investment. In particular, median formal training accounted for 2.58 percent of GVA vs 2.51 for on-the-job one and 1 percent for informal one. Informal learning accounts for a lower percentage of GVA (1.1 percent on average across countries), despite the fact that almost all workers report to have undergone some. Cross country differences may be explained by national specificities in the number of hours of training (vs number of employees involved) and real wage dynamics.

[29] More descriptive evidence at the country-industry-skill level is reported in Squicciarini et al. (2015).



	AUS	AUT	BEL*	CAN	CZE	DNK	ESP	EST	FIN	FRA	DEU	IRL	ITA	JPN	KOR	NLD	NOR	POL	SVK	SWE	GBR **	USA
informal	2.22	0.93	0.90	1.37	0.68	1.68	1.34	1.25	0.96	1.03	0.97	1.01	1.09	0.65	0.65	1.36	1.37	0.76	0.90	1.15	1.06	1.21
on-the-job	3.37	2.63	1.65	3.21	1.59	2.93	2.56	1.74	2.46	1.36	2.66	2.18	1.06	2.28	3.25	3.21	1.97	1.91	1.41	2.76	2.84	3.12
formal	5.63	1.79	2.31	5.16	1.61	6.38	2.51	2.90	5.25	1.48	1.50	4.10	0.89	0.70	0.87	5.48	4.78	1.89	1.45	2.64	5.83	3.90

■ formal ■ on-the-job ■ informal

Figure 13: Investment in training as a percentage of GVA
Source: Authors' own calculations based on PIAAC. PIAAC data from Belgium only cover Flanders. PIAAC data from the UK only cover England and Northern Ireland.

Although cross-country heterogeneity in intensities seem to be mainly driven by formal training, many other factors may contribute to explain the stylised facts reported above, including differences in framework conditions, in the propensity of firms to invest in human capital, or in the turnover of employees and the consequent need or not to (re)train the employees. While explaining country-specific patterns is left to future research, it may still be important to highlight how the low incidence of total training for Korea and Japan may reflect low levels of employment turnover. This is especially true for Japan, where not only total training but also on-the-job training intensity is relatively low in comparison to other countries. On-the-job training constitutes 38 percent of total investment in training on average in all countries, with the notable exception of Germany, Japan and Korea, where it represents more than 50 percent of total training and becomes the most important component.

Figure 14 below reports the breakdown of total investment by type of training and macro-sector, i.e. production, business services and public services[30]. When on-the-job training is important with respect to other forms of training, this usually is the case in all three macro industries. Notable exceptions are the Czech Republic, the Slovak Republic, Japan, Korea, Sweden and Spain. Investment in on-the-job training is on average more relevant in business services than in production and in public services (but with exceptions, i.e. Australia), while public services seem to be more intensive in investment in formal training than other sectors. Public services further appear to be more intensive in formal training than the aggregate economy throughout the sample.

Germany, Italy, Japan, and Korea, arguably all manufacturing-oriented economies, are characterised by a lower weight of formal training in total training investment, irrespective of the macro-industry of interest, and contrary to the other economies in the sample. This might also be due to the different way in which formal training is provided in the countries considered. Australia, Canada, the United Kingdom and the Unites States are countries where tuition fees are comparatively higher than those of the other countries in the sample, and where formal education is often provided by private institutions. This may inflate the estimated investment in formal training, as the cost per student might be comparatively higher in countries where private education is more common and tuition fees are generally higher. Countries usually invest relatively less in informal learning than in other forms of training, with the exception of Italy

[30]"Production" includes sectors C to F. "Business services" include sectors G to N but not ISIC Rev.4 industry 72. "Public services" include industries O to S and industry 72 (as in other chapters of this book). Agriculture, mining and private households with employed persons are therefore excluded from this graph.

and the Slovak Republic, especially in production and business services industries, while this proportion is low on average for informal learning.

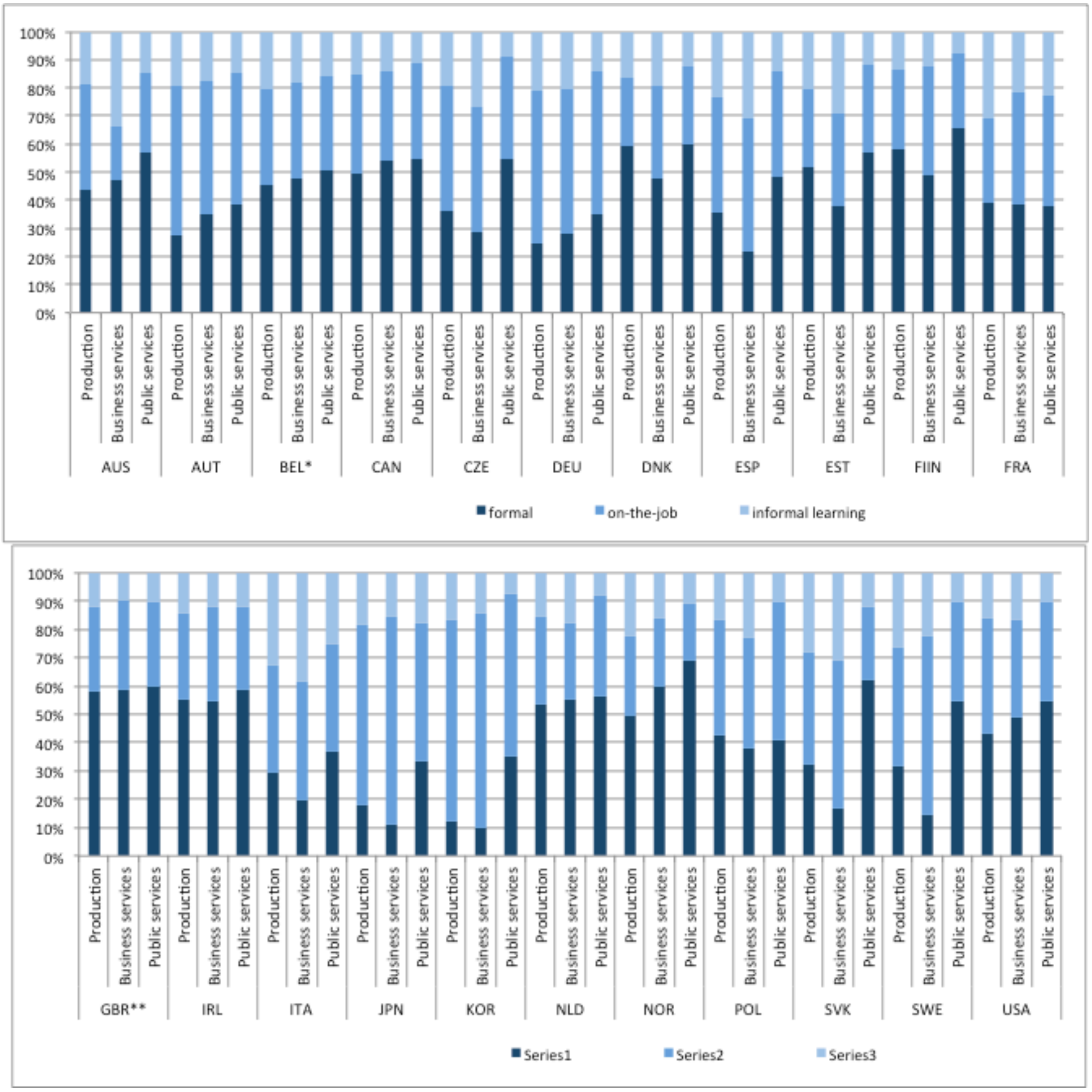


Figure 14: Investment in training by type and industry, as a % of total training investment in the industry
Source: Authors' estimations based on PIAAC. PIAAC data from Belgium only cover Flanders. PIAAC data from the UK only cover England and Northern Ireland.

Determinants of Investment in training. To investigate the extent to which countries' differences in the magnitudes of the investment in training can be - at least partially - explained by differences in the production structure of the country, and in the relative intensity in training of industries, industry-specific estimates are proposed. To be consistent with the approach of this manual, this section explores the differences between the public and private sector in particular.[31] Thanks to the availability of information in PIAAC about the institutional nature of the individual's workplace (private company, public entity or non-profit organisation), it is possible to separately estimate the contribution of the public sector on intangible investment. In what follows, public investment relates to public companies operating in one of the five macro sectors identified in other chapters of this book, and mentioned here above, which are especially intensive in public investment (ISIC Rev.4 industries 72 and 84-93).

The 20 percent of the total reweighted sample is composed by individuals working in public entities, either publicly-owned companies or public institutions.[32] This percentage rises to 53 percent when focusing only on the industries where public ownership is more frequent. Among these industries, public administration and education display the highest proportion of trained public employment over total employment on average across country (respectively, 94 and 78 percent), while other community and personal services display the lowest (21 percent).

Table 14 reports the proportion of employees working in public entities and receiving training, as a percentage of the total employment in all public entities in the considered sectors. The values for total investment (i.e. also including informal learning) are omitted, as they reach 99 percent on average across country (almost all individuals report to benefitting from informal learning at least once in the year). Incidence of formal training is almost the same as in the total economy: 17 percent, on average across country), while the figures substantially differ for on-the-job training: 73 percent of public employees in these sectors receive on-the-job training, vs approximately 50 percent of employment in the total economy.

The public sector also invests more in training than the private sector: the ratio of investment over GVA in the overall economy reaches only 60 percent of the same ratio for the public sectors considered.[33] When only formal and on-the-job training are considered, 10.4% and 4% of the sector value added are invested, respectively, in the public and private sector, on average across country (Figure 15). Investment intensity for total training is still lowest in Italy, Japan and France, but still significantly higher than in the total economy. While on average private

[31] Further disaggregation of the business sector, as well as estimates of investment intensity in value added, is proposed in Squicciarini et al., 2015. The Science, Technology and Industry Scoreboard 2015, section 2, also explores investment in training by detailed sector and size of the investing company.

[32] An additional 4 percent work in non-profit organisations.

[33] Investment intensity is calculated as a proportion of gross value added, which has been decreased by a proportion equal to the percentage of public employees in the mentioned sectors of the economy. Using the entire value added of the sectors of interest would have been inappropriate to deflate public investment, as such figures of value added would be the product of both private businesses and non-market entities.

Country	Formal	On-the-job	Country	Formal	On-the-job
AUS	23.8%	84.1%	GBR**	21.8%	79.2%
AUT	13.3%	70.9%	IRL	17.6%	74.0%
BEL*	12.1%	64.9%	ITA	9.6%	47.9%
CAN	19.6%	79.2%	JPN	7.8%	66.4%
CZE	17.3%	73.5%	KOR	12.1%	85.5%
DEU	14.7%	72.8%	NLD	22.3%	81.9%
DNK	19.4%	79.9%	NOR	26.3%	73.7%
ESP	20.4%	73.9%	POL	29.4%	66.2%
EST	19.2%	81.4%	SVK	15.6%	51.6%
FIN	21.7%	84.6%	SWE	20.0%	80.5%
FRA	8.7%	56.3%	USA	23.5%	82.3%

Table 14: Incidence in training in public entities, by type of training, as a percentage of public sector employment. Selected sectors (Average of 2011 and 2012)
Source: authors' own calculations based on PIAAC. The frequencies are calculated as the number of employees in public entities who received training at least once in the period, over total employment in public entities in ISIC Rev.4 sectors 72 and 84-93. "Total" includes all types of training. PIAAC data from Belgium only cover Flanders. PIAAC data from the UK only cover England and Northern Ireland.

sector investment in training is equally distributed between formal and on-the-job training, formal training is more important in the public sector and accounts for up to 77% (Norway) of total investment in the sector. This to some extent may reflect the presence of the education sector itself in the public sector, where the likelihood of investment in formal training is higher. The dispersion in investment intensity in formal training is also almost double for the public sector than in the overall economy (as measured by the coefficient of variation among countries' intensities), possibly reflecting the high cross-country heterogeneity of the education sector.

Robustness checks. This section aims to assess the robustness of the proposed training estimates. The estimates of on-the-job training are first compared with those contained in previous studies. On-the-job training is the type of training closest to the concepts of continuous and on-the-job training which have been usually explored in previous studies. The studies by O'Mahony (2012) and Corrado et al. (2014) are taken as reference points, as they represent the most recent and methodologically closest investigations to our study. Table 15 reports the comparison across the estimated intensities for the total market sector and the production sectors across the three methodologies.[34]

[34]The market sector is here composed by private companies only, independently on their industry of operation, and figures may differ from those reported in Fig. 15. The denominators used to construct the shares are respectively: value added calculated in a manner consistent with the estimation of investment in intangibles for

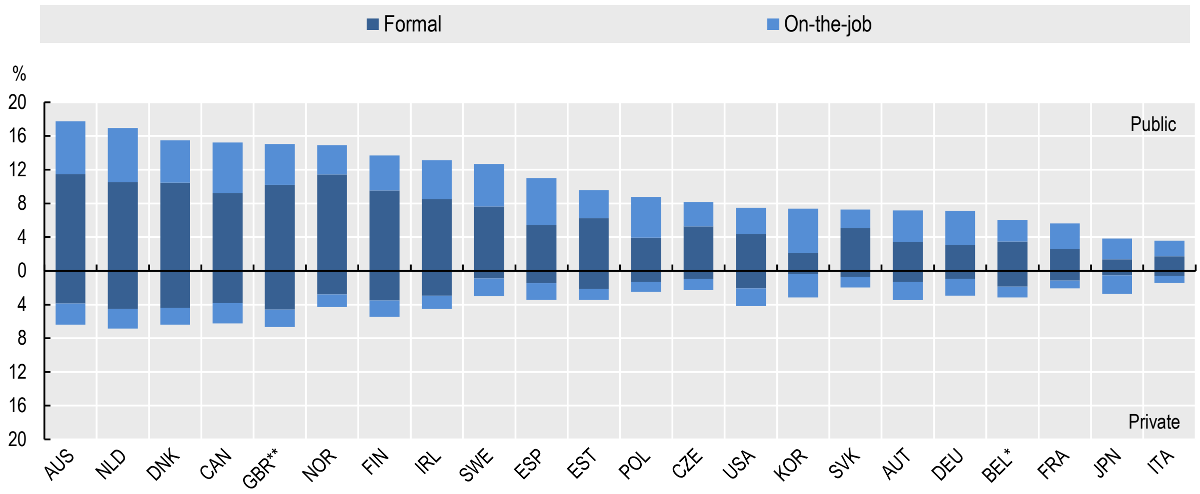


Figure 15: Investment in formal and on-the-job training in the public and private sector, as a % of value added in the sector
Source: authors' own calculations based on PIAAC, and OECD Science, Technology and Industry Scoreboard (2015). The height of the histogram for the public sector corresponds to the sum of formal and on-the-job training investment.
PIAAC data from Belgium only cover Flanders. PIAAC data from the UK only cover England and Northern Ireland.

The estimates obtained with the methodology presented in this study do not appear to be biased univocally upwards or downwards with respect to the reference papers, neither for the total economy, nor for production. Although higher estimates than the two benchmark methodologies are obtained for total investment in Germany, Spain and Sweden, this is not the case for all other countries. What is more, the increase with respect to previous studies is of different magnitude for the total economy and the production sector. These differences may have been triggered by a number of factors, including the methodological choices made, the slightly broader definition of on-the-job training used by PIAAC as compared to existing studies; the reference period considered; and the sampling strategies used. However, all in all, the figures presented in this paper do not seem to alter the relative intensity of investment in training in those economies where a direct comparison with the two previous studies is possible.

As explained when describing the methodology, the computation of p and $q4$ entailed attributing a numerical value between 0 and 1 to each of the four possible answers to the "Subjective Usefulness" and "Allocation" questions. p and q for each individual were then computed averaging the individual-specific values obtained, duly highlighting the possible perceived arbi-

Corrado et al. 2014; a modified estimate of value added including investment in training for O'Mahony (2012); GVA at current prices for the present study, without the correction presented in the previous paragraph, so as to enhance the comparison with other articles.

	O'Mahony (2012)		Corrado et al. (2014)		On-the-job based on	
	Total	Production	Total	Production	Total	Production
AUT	2.1%	1.3%	1.2%	1.0%	1.9%	2.0%
DEU	1.3%	0.9%	1.4%	1.5%	1.8%	2.1%
DNK	4.2%	3.1%	2.3%	1.6%	1.6%	1.9%
ESP	1.3%	0.9%	0.6%	0.5%	1.7%	1.8%
FIN	2.2%	1.2%	0.9%	0.8%	1.5%	2.0%
FRA	1.5%	1.5%	1.6%	1.3%	0.8%	1.8%
GBR**	4.4%	3.1%	1.6%	1.0%	1.8%	2.1%
IRL	0.6%	0.2%	1.8%	4.7%	1.4%	1.2%
ITA	0.3%	0.2%	0.9%	0.8%	0.8%	0.9%
NLD	2.5%	1.4%	1.4%	1.0%	2.0%	1.9%
SWE	1.5%	1.1%	1.1%	1.1%	1.7%	1.4%

Table 15: On-the-job training investment in the market sector as a percentage of GVA
Source: O'Mahony (2012), Corrado et al. (2014) and PIAAC, where "on-the-job" stays for "continuous" training in O'Mahony (2012) and for "employer-based" training (vocational+apprentiship) in Corrado et al. (2014). "Production" follows the definition of O'Mahony (2012) and refers to (NACE C-F) sectors. Data in O'Mahony (2012) are yearly averages over 2003-2007, in Corrado et al. (2014) they refer to the year 2010, in the present paper they refer to the average of 2011 and 2012. The market sector includes private entities only operating in any business industry.
PIAAC data from the UK only cover England and Northern Ireland.

trariness of both choices. To investigate the sensitivity of the estimates to these choices, investment in training is recomputed changing one of the assumptions made at a time. In "Method 2", the "somewhat useful" and "mostly outside working hours" answers are given a value 0.25 instead of 0.33, while the "moderately useful" and "mostly during working hours" answers are attributed a value of 0.75 instead of 0.66. In "Method 3", answers are attributed values ranging from 1 to 4, with p and q that are obtained by multiplying the values attributed to the answers to each question, and then normalising the thus obtained results so that indicators are defined in a [0 , 1] interval.

Table 16 reports the estimates for total training obtained following each of the alternative methodologies proposed above. As can be seen, while the baseline methodology (the one used throughout the paper) and "Method 2" yield remarkably similar estimates, taking the product instead of the average of the answers to the "Subjective Usefulness" and "Allocation" questions lead to lower investment estimates across all countries considered. This was expected, as taking the product instead of the sum shifts the distribution of p and q towards the left and gives more weight to the individuals featuring lower values. The rank correlations among the different sets of estimates obtained from these three methodologies are then computed (table not reported -

ref. STI Working Paper 2015). Such correlations are extremely high (at least 98 percent). This should further reassure that the different ways in which p and q can be specified do not drive estimates apart and do not change in essence the stylised facts depicted so far.[35]

	Baseline	*Method 2*	*Method 3*		*Baseline*	*Method 2*	*Method 3*
AUS	11.22%	11.07%	9.26%	GBR**	9.73%	9.69%	8.15%
AUT	5.36%	5.37%	4.17%	IRL	7.29%	7.22%	5.66%
BEL*	4.86%	4.88%	4.12%	ITA	3.03%	2.92%	2.42%
CAN	9.75%	9.67%	7.62%	JPN	3.63%	3.60%	2.63%
CZE	3.88%	3.88%	2.96%	KOR	4.76%	4.78%	3.38%
DEU	5.12%	4.95%	4.16%	NLD	10.06%	10.04%	8.35%
DNK	10.99%	10.79%	9.45%	NOR	8.13%	8.17%	6.75%
ESP	6.41%	6.46%	4.71%	POL	4.56%	4.53%	3.20%
EST	5.89%	5.87%	4.54%	SVK	3.76%	3.77%	2.81%
FIN	8.67%	8.68%	6.53%	SWE	6.54%	6.54%	5.18%
FRA	3.87%	3.87%	3.44%	USA	8.23%	8.15%	5.94%

Table 16: Investment in total training as a percentage of GVA - Different methodologies
Source: authors' own calculations based on PIAAC. "Baseline" refers to the methodology used to issues the estimates reported so far; "Method 2" uses a different set of weights in the calculation of p and q for each surveyed individual; "Method 3" computes p and q as a product (instead of the average) of the responses to the underlying questions.
PIAAC data from Belgium only cover Flanders.

Main findings and future work. The present work contributes to the long-term intangible assets measurement agenda, and in particular tries to address the measurement of workforce training in particular. It proposes a new methodology to estimate investment in training at the industry and country level for the years 2011-2012, mainly based on new survey data (PIAAC) collected at the individual worker level by the OECD for twenty two countries.

This methodology looks at training of employees and self-employed individuals from the perspective of the expenses incurred to improve the employee's human capital, rather than in terms of the output or productivity increase engendered by training. Doing so, it follows in the steps of an established literature on the measurement of intangible assets in general (e.g. Corrado et al. 2014) and of human capital in particular (e.g. O'Mahony, 2012), and their expenditure-based approaches.

The present methodology takes into account three different types of training, adding investment in formal training and informal learning to estimates of on-the-job training, which

[35] Further robustness checks relate to individuals' employment status in PIAAC and exploit the self-reported working status of individuals (as opposed to using a derived synthetic variable, as done so far in this chapter). The results, shown in Squicciarini et al. (2015), are in line with the results presented here.

is usually the sole focus of the literature (mainly in light of data constraints). The estimates proposed here take into account both the direct cost and the opportunity cost of training, where the latter refers to the foregone earnings of workers and the foregone output of production when the individual is in training. The training activity considered in the estimation is allowed to take place either during or outside working hours, and can be funded by either the employee or the employer, where these features impact the proportion of expenditure in training which can be treated as investment.

This work finds that while almost every worker is the recipient of some informal learning, formal training is much less frequent (10-20 percent of employment). Evidence also suggests that low-skill individuals participate much less in training than medium- or high-skill individuals, pointing to a complementarity between skills and training.

When focusing on the measurement of investment in training, a higher degree of country heterogeneity emerges, with Australia, Denmark, the Netherlands, Canada and the UK investing substantially more as a percentage of GVA than the other countries with the same pattern being displayed by on-the-job training as well.

Investment in formal training, while found to be much less frequent, represents a sizeable share of total investment in training (20 to 60 percent, 44 percent on average across country). Conversely informal learning, which is found to be affecting almost all workers, makes up a much smaller percentage of investment in training (10 to 30 percent) across industries and countries. There is substantial sector heterogeneity in the relative importance of formal training, on-the-job training and informal learning investment, especially when comparing figures across countries. Investment in on-the-job training is on average more relevant in business services than in production, while public services seem to be more intensive in investment in formal training than other sectors.

Overall the figures proposed suggest on-the-job training to be relatively more important in advanced services activities such as professional and business services, as well as in public-oriented services such as education and health services, which appear very intensive in formal training too. Estimates seem to be broadly consistent with two key references in the literature as far as on-the-job training is concerned, and are robust to changes in the proposed methodology.

4 Social Infrastructure

by **Carol Corrado and Mary O'Mahony**

This section suggests a method of integrating the Jorgenson-Fraumeni (1989, 1992a,b) lifetime income approach to measuring human capital with the treatment of education as social infrastructure as argued in the SPINTAN framework document (Corrado, Haskel, and Jona-Lasinio, 2015). The SPINTAN framework document suggests that society's consumption of education services is the acquisition of schooling knowledge assets ΔE whose change in value PESΔE should be included in saving and net investment. The assets are held in inventory, within the school system, until students graduate and enter the working age population, at which point the school system ceases to contribute to a graduate's real stock of human capital. In this view, education services production is the schooling-produced increment to the beginning period knowledge stocks held by this year's students. The Jorgenson-Fraumeni framework is set out below, followed by a discussion of conceptual issues that arise when using the framework to estimate the value of a society's investments in education.

4.1 The Jorgenson-Fraumeni (JF) framework

Lifetime income. We begin by abstracting from non-market activities, employment outcomes and labour force dropouts and simply assume that any student enrolled in school will, in the following year if they leave education, earn the market wage corresponding to that level of education. The JF framework calculates the values of human capital stocks based on lifetime incomes by sex (s), age (a) and education level (e). Their original papers calculate this for all persons in the population. A more common approach is to calculate the stock only for the working population, e.g. Gu and Wong (2010), Wei (2004).

Let:

pop = population

y = current market income

li = lifetime income

δ = the discount rate

g = average income growth

senr = the enrolment rate

sr = the survival rate.

The JF framework calculates lifetime income by s, a and e for essentially two groups. Assume no-one of age 35 and above is enrolled in education. The first group, for those aged 35 and over, is the most straightforward. The simplest assumption is to say that lifetime income is 0 beyond some age, say 80. For those aged 80, lifetime income (li) in year t is just current labour income.

$$li_{s,a=80,e,t} = y_{s,a=80,e,t} \tag{5}$$

For those aged 79 lifetime income is current labour market income plus discounted future income of those aged 80 with the same education and gender, conditional on survival:

$$li_{s,a=79,e,t} = y_{s,a=79,e,t} + sr_{s,a=80,e,t}\frac{1+g}{1+\delta}y_{s,a=80,e,t} \tag{6}$$

In general the lifetime income of those aged 35+ is given by:

$$li_{s,a,e,t} = y_{s,a,e,t} + sr_{s,a+1,e,t}\frac{1+g}{1+\delta}li_{s,a+1,e,t} \mid a \geq 35 \tag{7}$$

This valuation for individual i at time t is the value of current income plus the income of those one year older of the same age, sex and educational attainment times growth in income discounted to the present, plus the income of those two years older and so on up to age 80. It therefore assumes that the best estimate of a person's income next year is that earned this year by a similar person who is one year older. The nature of the income growth term, g, is discussed further below.

For persons aged between 5 and 34, lifetime income takes account of if they are enrolled in education or not. For these age groups:

$$(8)\quad li_{s,a,e,t} = y_{s,a,e,t} + sr_{s,a+1,e,t}\frac{1+g}{1+\delta}[senr_{s,a,e,t}li_{s,a+1,e,t} + (1-senr_{s,a,e,t})li_{s,a+1,e,t}] \mid 5 \leq a < 35$$

Thus, if a person aged a is enrolled in education level e, their lifetime income depends on that for a person one year older with level $e+1$. If the same individual is not enrolled in education their lifetime income depends on that for an individual one year older with education level e. Finally lifetime income for those aged 0 to 4 is calculated the same way as for those aged 35 and over except that earnings are zero and education is set at the lowest level.

Value of human capital. The total value of the human capital stock in year t can be calculated by summing the lifetime earnings by s, a and e:

$$(9)\qquad HC_t = \sum_s \sum_a \sum_e pop_{s,a,e,t} li_{s,a,e,t}$$

Note if the working population is used as the weighting factor in 9 then those enrolled in compulsory education (usually aged $5-15$) no longer feature. This is an issue for calculating the output of the education sector as discussed below.

Christian (2010) defines net investment in human capital (NIH) as the effect of changes from year to year in the size and distribution of populations. This is given by:

$$(10)\qquad NIH_t = \sum_s \sum_a \sum_e (pop_{s,a,e,t+1} - pop_{s,a,e,t}) li_{s,a,e,t}$$

This in turn can be broken down into various components such as births, deaths, "net investment from education of persons enrolled in school" and depreciation and aging of persons not enrolled in school.

In measuring the nominal value of education as social infrastructure we concentrate on the portion of the population enrolled in education.

The term corresponding to those enrolled in school is therefore given by:

$$(11) \qquad NIH(enr)_t = \sum_s \sum_a \sum_e (enr_{s,a,e,t+1} - enr_{s,a,e,t})[\frac{1+g}{1+\delta} sr_{s,a+1,e,t} li_{s,a+1,e^*,t}]$$

where enr are school enrolments, and

$$(12) \qquad li_{s,a+1,e^*,t} = [senr_{s,a+1,e,t} li_{s,a+1,e,t+1} + (1 - senr_{s,a+1,e,t}) li_{s,a+1,e,t}]$$

via equation 8, as these persons are enrolled in education their current market income is zero.

Christian (2014) also discusses an alternative measure, "gross investment, that excludes the effect of ageing of the enrolled". He states "Gross investment in education in a given year is equal to the effect of school enrolment on the stock of human capital: the difference between actual human capital and what the stock of human capital would have been had no one enrolled in school that year". This measure is very sensitive to assumptions of how much individuals would have earned if they had not enrolled in school, especially for younger age groups who might earn the school dropout rate (go off track) or just lose one year of education and then go back on track. In Christian (2010, 2012) the terminology "net of ageing" is used to describe the calculations when individuals get back on track.

4.2 Valuing net Investment in human capital for persons enrolled in education

There are a number of issues to resolve in order to value equation 11. These include the attribution of lifetime earnings to education, the nature of the income growth term g and the survival probabilities sr.

Attribution. What is the income of a person one year older with the same education level capturing? If it is a return to experience or additional training while working rather than services provided by education then the income stream arising from education services should be constant at the graduation earnings through time. In that case the lifetime income stream only depends on how long the person is in the workforce after graduation.

The other extreme is to assume that all future labour income is attributable to the level of educational attainment of the individual. This amounts to using the full JF calculation - however, in our context it is difficult to justify this assumption.

A practical solution might be to derive the wages on graduation as a T-year average from the point of graduation. This could be justified by assuming some degree of asymmetric information whereby firms do not pay the full marginal product immediately in case the worker turns out to be a lemon. T could be set at say 3 years.

Another approach is to use Mincer regressions, controlling for other influences such as experience ? this was the method used by O'Mahony and Stevens (2009) and O'Mahony et al. (2012). This method also allows for adjustments to take account of the probability of employment. The calculations should also take account of the opportunity costs of staying in education beyond the age of compulsory education. However these foregone earnings are likely to be small relative to lifetime earnings. Finally we need to take account of foreign students.

Survival rates. If we concentrate on the working population then sr takes account of both mortality and retirement. These in turn can be calculated using life tables and age-specific retirement rates.

Arguably survival rates should also depend on the probability that a person is employed (and not unemployed or exited the labour force). If we ignore employment probabilities we are estimating the potential human capital only adjusting for permanent exits such as death and end of working life retirement. This would be equivalent to ignoring utilisation rates for physical capital (and thus related to the valuation basis of the stock).

Growth in income and the discount rate. Constructing values for equation 11 requires assumption about the growth in income (g) and the discount rate (δ).

A relevant question in our context is, does the g that determines income growth include productivity and/or inflation gains. In other words, are nominal holding period gains to schooling part of the value of human capital? It seems that something of the sort must be there if g is, say 2 or 3 percent as in the human capital measurement literature, and thus part of the nominal change in human capital may be in fact be a holding period (i.e., capital) gain in a national accounting sense, e.g., as in the total change in the value of schooling produces assets is given by

$$(13) \qquad \Delta(P^{ES}E) = P^{ES}\Delta E + \Delta P^{ES}E$$

where from before $PES\Delta E$ is the acquisition value of schooling-produced human capital, and the second term on the RHS is the holding gain (where other changes in volume and higher order terms are ignored). Looking at this equation makes it abundantly clear that the value of school system production is the first term on the RHS. The second term is not included as per the usual exclusion of asset valuation changes from GDP. In this case it makes sense to set $g = 0$ if, as argued above, changes in individual's income after graduation mostly reflect experience and training which again suggests a zero value for g. On the other if education effectiveness needs time to mature, especially perhaps for university graduates, and it is thought desirable to take a T-year average as discussed above, then setting $g > 0$ is likely necessary.

In addition we need to assume a value for δ. In the JF framework this is the annual discount rate to construct the present value of the future income stream but is not discussed in any detail in that literature. Theoretically, this should be a rate of time preference, which in this case would be a social rate. An empirical strategy for estimating the social rate of time preference (SRTP) for a country is set out in the OECD capital manual; updated SRTP estimates for each SPINTAN country are reported in Corrado and Jger (2015).

Deflators. These calculations are in nominal values. Real education output can be estimated as weighted enrolments, with weights equal to the present value of the lifetime return to an additional year in education. For example Gu and Wong (2010) estimate a volume index of education output as:

$$(14) \qquad lnQ_t - lnQ_{t-1} = \sum_{s,a,e} \bar{\nu}[lnenr_{s,a,e,t} - [lnenr_{s,a,e,t-1}]$$

where $\bar{\nu}$ is the share of individuals with s, e, a in the total value of investment in education, averaged over year $t-1$ and t. The price index of education services (PES) can then be estimated by dividing the nominal value of education services by the volume index of education services.

Christian (2012) also discusses the alternative of measuring real net investment in education by deflating nominal net investment in education by the consumer price index. This he terms an outcome based measure as it captures the amount of goods and services that could be consumed by the education services rather than the amount produced, i.e., it captures the opportunity cost of foregoing current consumption for investments in schooling. A third alternative is to divide PESE by the number of school system graduates in the workforce (aged < 35).

Interestingly Gu and Wong cite Diewert (2008) as showing that "valuing output at average costs in measuring output and productivity growth is a second best option while the best option would be to use final demand prices to value output. The use of the final demand prices should correspond to the [lifetime] income-based approach in the context of education services."

4.3 Education services and education expenditures.

What is the relationship between the nominal value of investment given by equation 11 and expenditures on education as currently measured in national accounts (i.e., education costs)? It could be a measure of rate of return, or effectiveness of the school system, i.e.

$$P^{ES}\Delta E = \gamma * EducationExpenditures \tag{15}$$

where γ ($\cong$ 1+rate of return) can be equal to, greater than, or less than one. We usually think of "effectiveness" as a correction for quality, but here it is more like a rate of return. If γ is less than one, then one could say that there is a penalty exacted from society due to the resources of the school system not being used effectively - or, put differently, due to the labour market not using schooling-produced human capital effectively (i.e., when there is long-term unemployment). The potential policy relevance of ? suggests that the assumptions used to derive equation 11 - the treatment of employment probabilities, the use of a T-period average for wages, and choice of discount rate-need to be conceptually valid and empirically well understood. Note further that if the LHS of equation 15 replaces education expenditures in intangibles-augmented growth accounts, the contribution of the education services sector to productivity growth is boosted (or diminished) directly by γ.

4.4 Data sources.

The data sources needed to carry out the computations described above include:

- National and EU Labour Force Surveys - Earnings only available in this source for the UK and US
- EU Structure of Earnings Survey (SES) - Firm level survey but excludes small firms, only available for 2002, 2006, 2010
- EU SILC - Individual survey available annually
- Enrolment statistics from Eurostat and US National Center for Education Statistics
- Life Tables

Calculations for the U.K. are reported in Corrado, O'Mahony and Samwek (2016), to be followed by computations for the United States and a few other EU countries. Owing to the minited results, rhis asset is not included in the December 2016 version of the SPINTAN database.

5 Empirical Measurement

by **Carol Corrado, Jonathan Haskel, Cecilia Jona-Lasinio, Massimiliano Iommi**

SPINTAN is a three year EU-funded project started December 2013, whose main goal is to develop harmonized measures of intangible investment in the public sector for 22 European countries and the U.S. from 1995 to 2013. This section illustrates the challenges and the methods adopted to generate nominal and volume measures of intangible investments and net stocks for the sample countries. As section 2 makes clear, there are broadly two main tasks involved in documenting the scope of intangible assets used by the public sector. First, because some industries span institutional sectors, we must split these industries into their respective institutional sectors. Second, we must now capitalize intangibles for all industries in the economy (as well as for each industry's mix according to institutional sector). Within this second task, it is necessary to assemble two datasets on intangibles by industry and institutional sector: one for assets already capitalized in national accounts (such as software and, in some countries, R&D) and the other covering estimates for all other non-national accounts intangibles. To split industries into institutional units as well as capitalize new categories of intangibles for new industries, whilst keeping to a national accounts framework, we proceed in distinct steps. Consider first the industry dimension, and in particular, our industries of interest as listed in table 1. We will refer to this collection of industries as the "nonmarket" sector (even though we have seen of course from figure 2 that this is not precise language). We adopt this classification because these industries cover most of the public production in the sample countries and they complement the INTAN-Invest estimates for the market sector (see previous discussion on page 4) allowing to generate measures of intangible investment for the total economy. Henceforth in this manual, which is focused on developing data and estimates of intangible investment in the public sector, when we refer to the nonmarket and market sectors, we mean industry groups split according to table 1 and, in keeping with these purposes, public intangibles are identified as the assets these industries use in their production. Figure 16 thus sets out the scope of the SPINTAN measures of nonmarket intangibles.

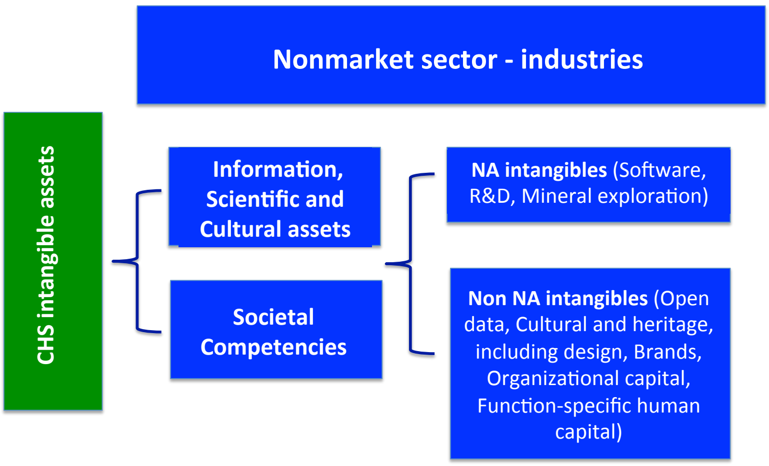


Figure 16: Measurement Dimensions of Public Intangibles

Consider next the institutional dimension. To split industries into institutional units as set out in figure 1, we exploit, either directly or as controls, information from the sequence of national accounts according to institutional unit. The System of National Accounts asks statistical agencies to classify each organization in each industry according to whether the activity they carry out is market or nonmarket production (in the sense of figure 1, SNA 2008 par 5.47). Besides public administration and defense (NACE Rev. 2 industry 84), which is entirely nonmarket as previously discussed, the other industries in table 1 contain a mix of producers. Hence the task of splitting activity by industry can be carried out by identifying, within an industry, activity by the reporting units engaged in nonmarket production (government sector and NPISH, S.13+S.15) distinguished from the units involved in market production (corporations, either non-financial or financial, and households, S.11+S.12+S.14).

5.1 Nominal investment flows

A general expression for estimating nominal intangible investment for a country or a region is set out in Corrado, Haskel, Jona-Lasinio, and Iommi (2012) and can be summarized as follows:

$$P^N N_t = \sum_{i=1}^{N} \sum_{s=1}^{S} (\gamma_{i,s,t}^{own-account} \lambda_{i,s,t}^{own-account} OwnCost_{i,s,t}^{Indicator} + \gamma_{i,s,t}^{purchased} \lambda_{i,s,t}^{purchased} Purchased_{i,s,t}^{Indicator}) \tag{16}$$

where $P^N N_t$ is nominal expenditure, i is a subscript for industries, and s is a subscript for sectors. $OwnCost$ and $Purchased$ are time-series indicators of the own-account and purchased components of intangible investment, respectively. The other symbols, which though fully subscripted (i.e., by industry, sector, and time), are parameters: λ indicates the adjustment to the time-series indicator that is needed to transform it into a sector-industry gross output (own-account) or gross spending measure; [36] γ is the capitalization factor, namely, a parameter that adjusts a spending measure to a measure of investment—a fraction of revenues or employee time, say, devoted to long-lived activities.

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

[36] To place own-account estimates on the same footing as purchased components, for market sector industries, it is also necessary to account for industry margins. This aspect of analysis is ignored in equation (16).

and management consulting services (CPA M69 and M70); and Education services (CPA P85). Then once intangible expenditure by nonmarket industries is identified, we follow the CHS methodology to capitalize each series (Corrado et al., 2005).[37]

As for national accounts intangibles, we rely on R&D and software data released by National Statistical Institutes (NSIs) but we need to elaborate them to get estimates cross-classified by industry and institutional sector. There are two different situations according to data availability and that can vary also depending on the asset : one when NSIs provide gross fixed capital formation (GFCF) by industry and by sector but not the cross classification between them and the other when GFCF data are available only by industry for Software and or R&D and there are no information classified by institutional sector . To deal with both situations we identified two calculation methods exhaustively described in (Bacchini et al (2016)). Official data for the United States by industry and by asset (software, artistic and entertainment originals, R&D, and mineral exploration) are readily available from 1901 to 2013.

Own account intangible investment The standard approach to measure gross fixed capital formation for own final use is based on the costs of production, i.e. the sum of compensation of employees, intermediate consumption and the cost of capital (consumption of fixed capital and, only for market producers, net operating surplus). The key variable in the calculation is the labour cost component frequently measured on the basis of compensation of specific occupational groups directly involved in the production of the asset for internal use. Estimate of own account training is a bit problematic since there are no information available about the labour costs of specific occupational groups directly involved in internally produced training activity. As for the remaining assets we assume that the own-account production of design, advertising and market research in the non-market sector is negligible and might be omitted (see (Bacchini et al (2016) for a detailed description of sources and methods). Measures of own account organizational capital are generated estimating total compensation of managers and then applying the corresponding capitalization factor (that is supposed to take in to account also the other components of the cost of production, besides labour cost).

5.1.1 Back-casting

by **F. Bacchini, A. Bykova, G.Giungato, R. Iannaccone, M. Schwarzhappel**

[37] These are: design .5; advertising and market research .6; purchased organizational capital .8; own account organizational capital .2; and training 1.

Introduction Macroeconomic analysis of investments in intangible assets requires times series of sufficient length. However, the introduction of the new classification of economic activities (NACE Rev. 2) together with new system of national accounts (ESA 2010) generated some difficulties to NSIs to release time series data for the years prior to 2010. This is particularly relevant for the use tables that are the main source to generate estimates of nominal investments flows of non National Account intangibles. Moreover, data disaggregated by institutional sectors are not always available thus requiring the definition of method to retropolate nonmarket intangibles cross classified by industry and institutional sector.

Methodology The USE tables, and in particular the nonmarket components of the industries of interest, have thus to be retropolated backwards for per period 1995-2009. But since the time coverage of existing information differs considerably across industries and countries, we identified two approaches depending on data availability. As a first step, it has been necessary to backcast the use tables for the total economy (S.1) over the whole period, then we estimated nonmarket expenditure applying the share of nonmarket output to intermediate expenditure for the following SPINTAN industries of interest (according to NACE Rev. 2 classification):

- M72 Scientific research and development
- O84 Public administration and defence; compulsory social security
- P85 Education
- Q86 Human health activities
- Q87-88 Residential care and social work activities
- R90-92 Creative, arts and entertainment activities; libraries, archives, museums and other cultural activities; gambling and betting activities

Then to generate measures for purchased Organisation capital, Training, Advertising and Design (corresponding to the products M702, P85, M73 and M71) we followed two different approaches. With the first method, the **Shares based method**, we apply the share of each single asset over the total of all products of each industry to total intermediate expenditure to backcast the series between 2009 and 1995. Then we apply the growth rates of total intermediate consumption of each SPINTAN industry (see figure 17).

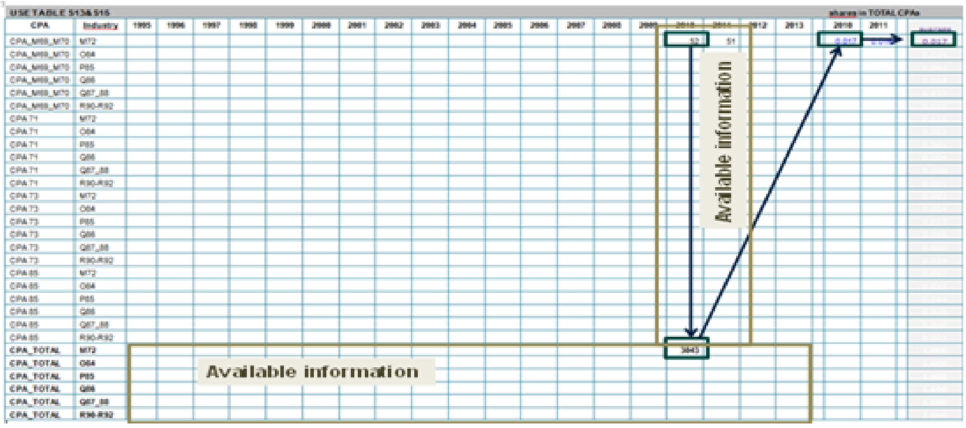


Figure 17: Description of the shares method

The second method, the **Growth rate method**, resorts to the information contained in the World Input-Output Database (WIOD) that make available time series for the USE tables back to 1995 (see figure 21). The availability of longer time series allows to compute the rates of growth of intermediate expenditure by industry and CPA products back to 1995 and to use them to retropolate the ESA2010 USE tables. But, the WIOD tables provide data classified by the CPA 2002 and Nace Rev.1classifications while the ESA2010 USE tables adopt the CPA 2008 and Nace rev2 classifications. Therefore it is necessary to map the two classifications to guarantee the coherence with ESA2010 as shown in the next figure:

Assets		Industries	
Cpa 2002	Cpa 2008	Nace Rev 1.1	Nace Rev 2.1
Other services	Organisation Capital	Public Administration	O84 Public administration and defence...
	Advertising	Education	M72 Scientific research and development
	Design		P85 Education
Training	Training		R90-R92 Creative, arts and entertainment activities...
		Health and Social Work	Q86 Human Health Activities
			Q87-Q88 Social work activities

Figure 18: Correspondence table for products and industries

The comparison between the two approaches has been carried out for Italy and Czech Republic for which we have all the information set. The first method is based on the assumption that the industry dynamics is the same across all the assets while the second is rather sensitive to the presence of the outliers. For this reason we adopted a combined approach. The method is based on the estimate of a linear regression combining the detailed information (industry, products and institutional sector) available for some countries (i.e Italy and Czech Republic) with the WIOD growth rates after that the outliers have been removed. The specification is as follows:

$$y^I_{p,t} = \alpha_1 X^I_t + \alpha_2 X^{\hat{I}}_{\hat{p},t} + \epsilon_t$$

where:

- $y^I_{p,t}$ is the growth rate of intermediate expenditure for product p and industry I in a benchmark country for which detailed use tables are available
- X^I_t is the growth rate of total intermediate consumption for industry I from National accounts;
- $X^{\hat{I}}_{\hat{p},t}$ is the growth rate of intermediate expenditure for product $\hat{p}$ and industry $\hat{I}$ from the WIOD database. The correspondence table showed above between the industries I and $\hat{I}$ and between product p and $\hat{p}$ is used. [38].

The regressions are estimated for each asset and each industry and the estimates for parameters α_1 and α_2 are used for the calculation of the estimated growth rates $\hat{y}^I_{p,t}$ used as input for the backcasting procedure. In Figure 19 an example of the results of the combined approach is showed. In particular, the estimated values refer to the growth rates for training expenditure in the Italian Public administration (Combined) compared to the the true values gathered from NA.

[38] WIOD data have been screened with an outlier procedure to exclude rates of growth smaller than -15% or bigger than 15%. The threshold has been identified trough an empirical evaluation of the original data.

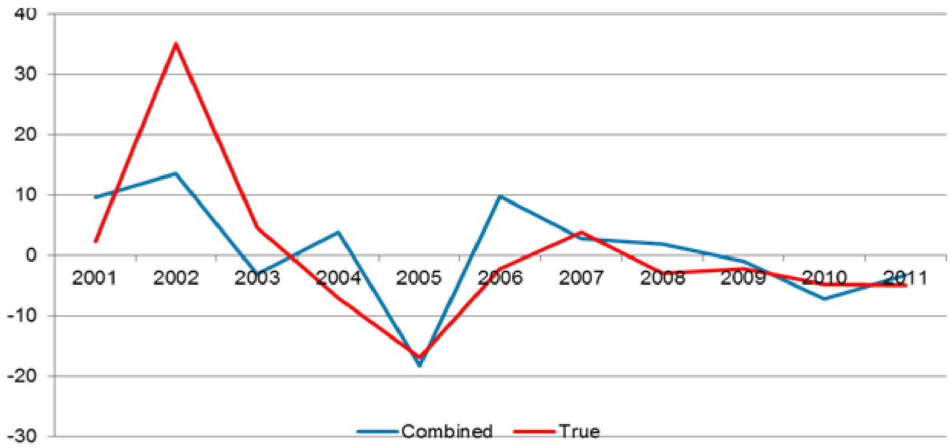


Figure 19: Performance of backcasting method: Training (P85) expenditure in the Italian Public administration (O84) - yearly rates of growth 2001-2010

5.1.2 Real-time measures of public intangibles

by **Fabio Bacchini, Roberto Iannaccone**

Introduction To provide policymakers with dnamic tools to better address European policies it is fundamental to produce real-time estimates of public intangible investment. However complete national accounts picture are usual linked to structural business statistics that are available approximately 2 years after the reference period. The underlying data sources for the scope of the SPINTAN project are equally not available with a sufficient time coverage thus limiting the time span of the project to 2012. In order to be able to get a real time perspective on the role of public intangibles, it is important to develop and implement a now-casting method that complements the historical data. We can take the same perspective as quarterly national accountants providing a preliminary estimation of the annual figures using the short-term statistics information. Using a similar approach, we adopted an alternative method to extend the timeliness of the estimates of public intangibles and thus their analytical relevance for policy making. Our approach is a three steps procedure based on quarterly turnover for service sector and national accounts aggregates for industry, both available for the last year. In the first step we compute a preliminary estimation of the use table constrained to the known growth rate for industry and institutional sector. In the second stage we generate a new estimate of the use table conditioned to the growth rate of the products observed in the quarterly turnover for industry. The final estimate is the average of the two independent estimates elaborate in each step.

The framework The provision of a preliminary picture of the most important economic indicators is a common challenge in the domain of short-term statistics (see for example Schumacher et al. 2008 and Bacchini et al. 2010 referring to GDP). Eurostat and UNSD are currently working on an Glossary and Handbook on Rapid Estimates (Mazzi 2014), as part of a common project to improve the quality and the standardization of infra-annual macro-economic statistics. The glossary reports 4 main dimensions to characterize a real time estimate:

1. **Who** makes the evaluation
2. **What** is evaluated
3. **How** is the evaluation done
4. **When** is the evaluation done

The first dimension refers to the producer of the real time estimates (see for example the project at https://www.now-casting.com/). The second and the third dimensions are closely related to the characteristics of the intangible assets that are not estimated by statistical agencies. Software and research and development are estimated by national accounts but they are released only at the aggregate level and often as a portion of investment in the intellectual property. Thus our main challenge is to introduce for the time the estimates of intangible investment in the domain of real time estimation. The last dimension (**When**) refers to the the information set available at a given point in time to estimate the target variable. The target for intangibles is to provide preliminary estimates up to t-1 (i.e. in 2016 will provide an estimation up to 2015).

Our aim to produce a preliminary estimation of both non NA and NA intangibles, that is Organizational capital, Training, Advertising and Design (hereafter, OTAD assets), Software and R&D. Data for Software and R&D are updated at t-1 but generally in at the aggregate level (see Figure (20).

According to the theoretical framework developed in Corrado et al. (2012), use tables are required to produce estimates for OTAD. Use tables are released by National Institute of Statistics with a delay of two years from the reference year. Thus for example, at the end of 2014 the use tables are available up to 2012. Assume then that the rate of growth of nominal values of intangibles can be approximated by the growth rates of total intermediate expenditure for the SPINTAN industries of interest (M72, O84, P85, Q86, Q87-88, R90-92) as shown in Figure 21.

	Organisational capital	Training	Advertising	Design	Software R&D
1995					
...					
2011		Use table			
2012					
2013					
2014					National account

Figure 20: Use Table availability

Assets		Industries	
Cpa 2002	Cpa 2008	Nace Rev 1.1	Nace Rev 2.1
Other services	Organisation Capital	Public Administration	O84 Public administration and defence...
	Advertising	Education	M72 Scientific research and development
	Design		P85 Education
Training	Training		R90-R92 Creative, arts and entertainment activities...
		Health and Social Work	Q86 Human Health Activities
			Q87-Q88 Social work activities

Figure 21: Information set for OTAD products and industries

To explain the information set at the glance we look at the Italian data, for which in 2012 we have intermediate expenditures cross-classified by industry and assets for the total economy (last row in Figure 22).

	M72	O84	P85	Q86	Q87-Q88	R90-R92		Total S13 -M72-R92
Organisational capital	44	1,383	719	805	517	118	...	3,586
Design	66	264	436	872	235	33	...	1,906
Advertising	3	65	93	82	25	65	...	333
Training	5	918	360	185	142	25	...	1,634
	...	...	...	...	...	...	...	
Total S1	4,434	31,516	10,720	47,378	10,844	15,457		

Figure 22: Information set for OTAD products and industries: Italy

To provide a preliminary estimation for the use table we need to explore the information available for the years 2013-2015 that can be used as a proxy for the dynamics of intermediate expenditures by products and industries. National Accounts provide intermediate consumption by industry. As shown in Figure 23 data for Italy are available up to year 2015 at current prices but for the total economy. This represents the maximum breakdown for production, consumption, investment and income released by annual national accounts.

NACE_R2	NACE_R2(L)/TIME	2010	2011	2012	2013	2014
TOTAL	Total - All NACE activities	1,673,556.4	1,743,101.3	1,683,002.1	1,639,348.8	1,618,436.0
M72	Scientific research and development	4,421.1	4,433.9	4,932.6	4,622.6	4,809.6
O	Public administration and defence; compulsory social security	33,449.2	31,516.4	30,263.8	30,419.4	29,627.4
P	Education	10,782.6	10,720.0	10,978.0	10,928.5	11,296.1
Q86	Human health activities	45,906.4	47,377.5	47,606.9	47,332.4	48,608.9
Q87_Q88	Residential care activities and social work activities without accommoda	10,982.4	10,844.1	10,903.6	10,828.5	11,183.2
R90-R92	Creative, arts and entertainment activities; libraries, archives, museums	14,541.9	15,457.1	16,148.4	16,462.2	:

Figure 23: Intermediate consumption for industries - Italy

Another important source are the annual accounts by institutional sectors. The sector accounts show detailed economic developments of the main variables by institutional sectors but only at current prices (in nominal terms). From the sector accounts we can gather information also about the composition of intermediate consumption by institutional sectors up to 2015.

date of transmission of non-financial accounts: 01/10/2014

Uses							Current accounts	
Households including NPISH (S.14+S.15)	General government (S.13)	Financial corporations (S.12)	Non-financial corporations (S.11)	Total economy (S.1)	Rest of the World (S.2) Extra-EA	Sum over sectors (S.1+S.2)		
							PRODUCTION ACCOUNT	
							P.1	Output
132,403	87,251	55,291	1,375,739	1,650,684			P.2	Intermediate consumption
454,179	218,781	70,505	713,338	1,456,803			B.1g	Gross value added
							D.21-D.31	Taxes less subsidies on products
				1,618,904			B.1g* (n)	Gross Domestic Product (GDP)

Figure 24: Total production for institutional sector - Italy

At the same time the dynamic of each assets (products) can be approximated by the quarterly turnover for the service sector except for training for which we have to use hours worked from National Accounts in the training industry (P) available up to 2015.

Methodology Real estimates are obtained with a procedure organized in three steps. In the first step we compute a preliminary estimation of the use table conditioned to the known growth rate for industry and institutional sector. In the second stage we elaborate a new estimate of the use table conditioned to the growth rate of the products observed in the quarterly turnover for service sector. The final estimate is the average of the two independent estimates elaborate in each step above. To illustrate the procedure we assume that the use tables are available up to 2010 for the S13-S15 sectors and we want to generate a real estimate for 2011. We use the Italian data as shown in figure 22.

If the last data available refers to 2010, by means of the intermediate consumption available for 2011 (see figure 23) we can update the total intermediate consumption by industry. Because these values are referred to the total economy we need a proxy for intermediate consumption for the non-market sector. 2011data cover also total production and intermediate consumption by institutional sectors (see figure 24). Thus we can calculate the growth rate of the share of intermediate consumption in non market sector in the whole economy. This information can be combined to estimate the total of intermediate consumption in non market sector in 2011 by industry. Intermediate expenditure on intangibles is then calculated on the basis of the distribution of intermediate products observed in 2010 (see figure 25).

2011 -Italy S13-S15 estimated Industry

	M72	O84	P85	Q86	Q87-Q88	R90-R92		Total S13 -M72-R92
Organisational capital	39	1,494	728	831	530	127	...	3,749
Design	59	209	416	882	224	32	...	1,823
Advertising	3	62	88	82	23	61	...	319
Training	4	829	343	183	134	25	...	1,518
	...	...	...	...	...	...	...	
Total S13-15	106	2,593	1,574	1,978	912	245	7,409	
Total S1	4,434	31,516	10,720	47,378	10,844	15,457	120,349	
	2.4	8.2	14.7	4.2	8.4	1.6	**-4.2**	

Figure 25: Real time estimation procedure: step 1

At the same time we can derive an estimate of the use table for 2011 resorting to the data on the quarterly index of turnover for services. These are then applied to the intermediate consumption by products in 2010. The second step is focused on the estimate of total expenditure by product and intermediate consumption for all the Spintan industries (see figure 26).

2011 -Italy S13-S15 estimated STS+NA

	M72	O84	P85	Q86	Q87-Q88	R90-R92		Total S13 -M72-R92
Organisational capital	41	1,647	761	836	558	124	...	3,968
Design	59	224	422	863	229	30	...	1,828
Advertising	3	67	90	81	24	59	...	325
Training	5	906	355	183	140	24	...	1,613
	...	...	...	...	...	...	...	
Total S13-15	108	2845	1629	1963	951	238		7,734

Figure 26: Real time estimation procedure: step 2

Finally, in the third step we obtain our real time estimation for 2011 as an average of the single cell elaborated in the first and in the second step (see figure 27)

The pseudo real time estimates for 2011 are compared with the true value. Overall our method entails an error of 1.5% that affects significantly the estimates of organisational capital in the public administration (13.5%).

2011 -Italy S13-S15 Final average

	M72	O84	P85	Q86	Q87-Q88	R90-R92		Total S13 -M72-R92
Organisational capital	40	1,570	745	833	544	126	...	3,858
Design	59	217	419	872	227	31	...	1,825
Advertising	3	64	89	82	24	60	...	322
Training	4	868	349	183	137	25	...	1,566
Total S13-15	107	2,719	1,602	1,971	932	242	...	7,571

Figure 27: Real time estimation procedure: step 3

2011 -Italy S13-S15 error

	M72	O84	P85	Q86	Q87-Q88	R90-R92		Total S13 -M72-R92
Organisational capital		13.5					...	7.6
Design							...	-4.2
Advertising							...	-3.5
Training							...	-4.2
Total S13-15	-9.6	3.4	-0.4	1.3	1.5	0.6	...	**1.5**

Figure 28: Real time estimation procedure: errors

Results The procedure presented in the previous paragraph has been applied to generate estimates of OTAD assets for 22 European countries up to 2015. Figure **??**) illustrates the results for France, Germany, Italy and Spain. The method presented in the previous pages has been applied to the European countries to update the SPINTAN estimates up to 2015 (www.spintan.net). Real time estimates for software and R&D are obtained resorting to NA data (see Bacchini and Innaccone, 2016).

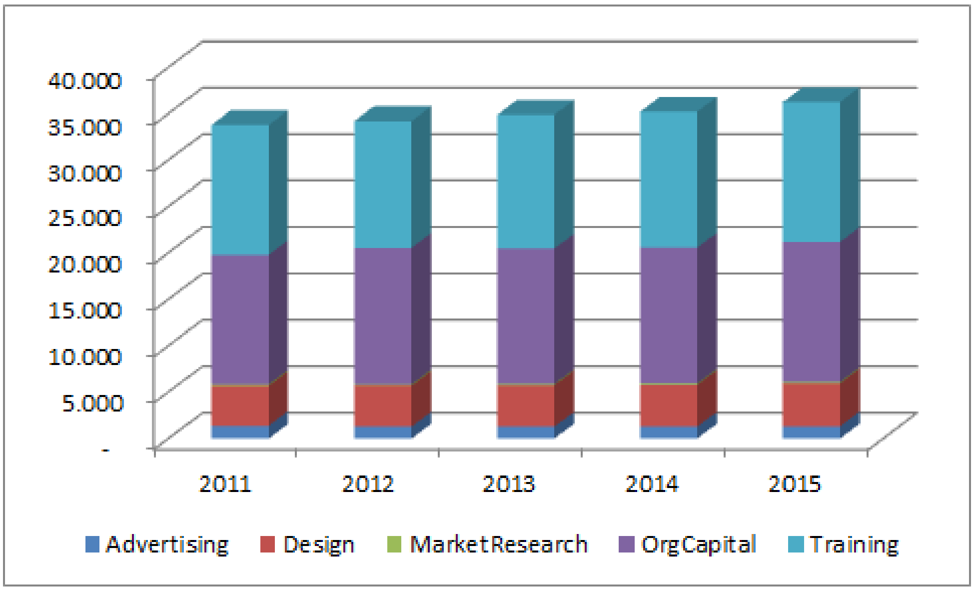


Figure 29: Investments in intangible assets: France, Germany, Italy and Spain, 2011-15

5.2 Prices and volume measures of intangibles

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

The Handbook on Deriving Capital Measures for Intellectual Property Products (OECD 2010) provides specific recommendations about price measures for three broad types of intangible assets: copies for sale, originals for sale, and originals for own-use. Hedonic methods are suggested to deflate copies; Producer prices (see the Producer Price Index Manual) are the best price measures for originals for sale; finally originals for own-use has to be evaluated by means of productivity-quality adjusted price measures, and when these are not available it is recommended to adopt input-based methods. The IPP suggestions can be easily followed to deflate purchased organizational capital, design, advertising and market research, because producer price indices for the corresponding industries are generally available, even if statistical practice varies across countries. In particular, the collection of service output price indices poses a number of statistical problems because most services are unique and tailor-made for the client. As a consequence, NSIs adopt some ad-hoc adjustments to produce quality-adjusted producer prices (OECD/Eurostat (2014), "Eurostat-OECD Methodological Guide for Developing Producer Price Indices for Services: Second Edition", OECD Publishing).

Table 17 shows the availability of price indicators to deflate purchased intangible investment and provides a comparison of the dynamics of Service Producer Price Index (SPPI) and Market Sector Value Added Deflator (MSVAD) for the following service industries: Legal, accounting and management consultancy activities, Architectural and engineering activities and technical testing and Advertising and market research. Data suggest significant differences both in industry productivity and dissimilarities of SPPI compilation methods across countries.

	Legal, accounting and management consultancy activities			Architectural and engineering activities			Advertising and Market Research		
	SPPI	MSVAD	Difference	SPPI	MSVAD	Difference	SPPI	MSVAD	Difference
	(a)	(b)	(a)-(b)	(a)	(b)	(a)-(b)	(a)	(b)	(a)-(b)
BE	1.0	1.6	-0.6	1.4	1.6	-0.2	0.8	1.6	-0.8
BG	na	-	-	na	-	-	na	-	-
CZ	0.5	0.3	0.1	1.1	0.3	0.7	2.9	0.3	2.6
DK	1.8	2.1	-0.3	2.4	2.1	0.3	na	-	-
DE	1.4	1.3	0.1	1.8	1.3	0.5	0.6	1.3	-0.7
IE	-0.5	-0.4	-0.1	-3.9	-0.4	-3.5	-1.0	-0.4	-0.5
EL	na	-	-	0.4	1.0	1.0	-2.5	1.0	1.0
ES	0.8	0.4	0.4	1.1	0.4	0.6	1.3	0.4	0.9
FR (1)	1.0	0.5	0.5	0.3	0.9	0.9	-1.4	0.9	0.9
IT	na	1.3	Na	na	-	-	na	-	-
LU	2.1	3.8	-1.7	0.5	3.8	-3.3	0.5	3.8	-3.3
HU	0.8	3.4	-2.6	0.8	3.4	-2.6	-1.2	3.4	-4.6
NL	-0.2	1.4	-1.6	0.5	1.4	-0.9	0.0	1.4	-1.4
AT	2.2	1.4	0.8	2.2	1.4	0.8	1.6	1.4	0.2
PL (1)	1.3	2.3	-1.1	1.6	2.6	2.6	0.3	2.6	2.6
PT	na	-	-	na	-	-	na	-	-
RO (2)	4.7	4.0	0.7	3.5	5.3	5.3	1.8	5.2	5.3
SI	0.5	1.2	-0.7	-0.8	1.2	-2.0	1.9	1.2	0.7
SK	na	-	-	na	-	-	na	-	-
FI	na	-	-	2.8	1.3	1.3	1.3	1.3	1.3
SE	na	-	-	na	-	-	na	-	-
UK	0.5	2.3	-1.8	1.6	1.7	0.0	3.0	2.3	0.7
(1) 2010-2013 (2) 2009-2012									

Table 17: Service producer price index (SPPI) vs market sector value added deflator (MSVAD), 2007-2013

SPPIs are generated taking into account quality adjustments and they are rather heterogeneous across countries and industries. Further, they are asset specific. Thus we assume, that at the time of this writing, they are the best available price measure to deflate purchased intangible assets not included in the SNA asset boundary.[39] Software is deflated adopting the harmonized price deflator developed by (Corrado et al., 2012) and based on the OECD approach. The harmonized price is obtained using a country-specific input cost index, the US prepackaged software price index, and adjusting it for the relative inflation differential between a country and the US). For R&D, Mineral Explorations and Entertainment, Literary and Artistic Originals, we use official national accounts deflators. The guidelines from Eurostat suggest to use an input-based deflation method for R&D. The input-cost approach is currently the only viable option to deflate R&D because it guarantees a satisfactory degree of international comparability. A contrasting approach is in a paper by Corrado, Goodridge and Haskel (2011), which casts the calculation of a price deflator for R&D in terms of estimating its contribution to productivity. Applying their method to the United Kingdom yielded a price deflator for R&D that fell at an average rate of 7-1/2 percent per year from 1995 to 2005 and thus implied that real UK R&D rose 12 percent annually over the same period.

In SPINTAN, volume measures of purchased non NA intangible investments are obtained using national accounts value added prices for the industry corresponding to the main producer of each asset. NA intangibles are deflated by investment deflators by branch of economic activity, and when these are not available, by the asset price for the total economy.

5.3 Net stocks

5.3.1 Summary

by **Carol Corrado, Jonathan Haskel, Cecilia Jona-Lasinio, Massimiliano Iommi**

Given the unexpected nature of returns to certain investments in intangibles, it is natural to question the plausibility of applying the perpetual inventory model (PIM) to calculate net stock estimates for intangible capital. The task of estimating net stocks for intangibles is complicated by certain other theoretical factors, the most important of which is that intangibles are partially non-rival and returns to investments in intangibles are not fully appropriable. In the context of the market sector, the value of the investment to the firm or innovator is limited to the returns on the investment that can be captured, which in turn provides the conceptual basis for measuring depreciation and calculating net stocks (Pakes and Schankerman, 1984). While this provides a sound conceptual basis for estimating deprecation rates and net stocks for intangibles produced

[39] Even if there is any SPPI available to deflate training investment.

and/or used in the market sector, nonmarket organizations do not necessarily capture returns to innovations in a conventional sense (i.e., via increased revenue flows and market valuations). This does not imply there are no returns, but rather they may be difficult to identify in the available data (e.g., when services output is not adequately adjusted for quality change).

Still other technical and data issues confront the estimation of net stocks of intangibles using PIM. For example, one of the most important conceptual issues is to recognize that a model of economic depreciation must capture two distinct processes, survival and economic decay. One often hears the question, "How can you treat [fill in the blank, say, organization-provided employee training] as an asset of the firm? The organization doesn't own [it.] Indeed [it] can walk out the door." This concern is akin to the "lemons" problem in asset valuation in that some assets tend to fail (or need lots of repairs) at an unusual rate early in their lifetime. The probability that a given asset type will survive in productive use from one period to the next is thus summarized by a stochastic discard, or survival, function.

The productivity of an asset as it ages, conditional on its survival from one period to the next, is described by a decay function. A decay function can be highly concave (i.e., possess an age-price profile bowed out toward the origin) in the case of, say, certain training investments shown to have long-lasting effects for employees who remain with the investing employer. But when a decay function implying long-lasting productivity conditional on survival is interacted with a discard function with a high early failure rate and age cohorts are aggregated, the end result is a convex geometric-like profile that can be summarized using a relatively fast rate of geometric depreciation in the PIM. A series of papers by Hulten and Wyckoff (e.g., Hulten and Wykoff, 1981) revealed this property of economic depreciation. For a technical exposition, see OECD (2009).

In a growth accounts framework with geometric depreciation, an estimate of the service life of an asset is usually where one must begin, and then the depreciation rate needed in the PIM equation must be derived.[40] Of course, the geometric form of PIM implies an age-price profile that is convex toward the origin. To calculate a geometric depreciation rate using an estimate of the mean service life, the formula $\delta = d/T$ is used. The parameter d is the "declining balance rate," which, intuitively, reflects the degree of convexity of the asset age-price profile. For a

[40] The stock of knowledge (R_t) grows via the perpetual inventory relation: $R_t = N_t + (1 - \delta^R)R_{t-1}$ where the term δ^R is the rate of decay of appropriable revenues from the existing stock of commercial knowledge. This concept of depreciation was introduced and applied to the conduct of private R&D by Pakes and Schankerman (1984).

given service life, higher values for this parameter result in faster rates of economic depreciation. The next section of this chapter discusses these concepts more deeply.

On the basis of the review and research reported in the next section, the SPINTAN project assumed depreciation rates for individual assets in the nonmarket sector as shown in table 18. The next section of the chapter sets out the theory and approach to estimating rates for certain assets, e.g., for organizational capital, an approach based on teams and *quit rates* by occupation is used.[41] All told, the analysis implies that capital service lives are longer for assets in the "competencies" group in nonmarket industries compared with market industries but that elsewhere differences occur mainly because a different mix of underlying assets types (e.g., basic research vs. experimental development) is used.

Table 18: **Depreciation rates for nonmarket sector intangible assets**

Asset type	Depreciation rate
Information, Scientific, and Cultural Assets	
1. Software	.315
2. Data and databases	.315
3. R&D	- -[1]
(a) Basic research	.050
(b) Applied research & experimental development	.150
4. Cultural and heritage, including architectural design	.200
5. Mineral exploration	.075
Societal Competencies	
6. Brands	.400
7. Organizational capital	
(a) Professional and manager capital	.400
(b) Purchased services	.400
8. Function-specific human capital	- -
(a) EU countries	.165
(b) United States	.236

1. The depreciation rate for total nonmarket R&D reflects a mix of asset types. The total depreciation rate for R&D is set at .075 for EU countries and at .115 for the US where, note, defense R&D falls into category 3(b).

5.3.2 Why Service Lives of Assets Matter

by **Bernd Görzig and Martin Gornig**

[41] More generally, one could argue that average employee tenure provides an upper bound for the service life of assets in the organizational competencies category. The depreciation rate for employer-provided training in the original CHS study (.4) is in fact consistent with the average tenure of employees in the private sector of the United States (4 years or less). To see this, let d =1.65, the declining balance rate for equipment used by the U.S. BEA, then $\delta = d/T = 1.65/4 = .41$. Average employee tenure varies across countries, industry sectors, and time, however. In the US government sector, employee tenure averaged 7 years in 2006 but rose to nearly 8 years in 2014. The latest statistical release can be found here: `https://www.bls.gov/news.release/pdf/tenure.pdf`. The OECD reports that employee tenure for EU economies ranged between 8 and 10 years in 2014, and to our knowledge, further information on public vs private rates is not readily available.

A multitude of measurement issues is related to quantify the amount of intangible assets in the public sector. Given, that intangible investment, the contribution to the increase in intangible capital stock has been measured properly, we concentrate in this chapter on the opposite the decrease of the value of capital stock, the depreciation of intangibles in the public sector. Assessing depreciation for intangible assets in the public sector should not be fundamentally different from the methodology applied for tangible assets. Therefore, this chapter is based on the discussion on assessing net capital stock and depreciation for tangible assets and discusses the possible and necessary deviations in the case of intangible assets. First, we deal with the question whether or how we need to consider the distinction between public and private assets. Then we deal with the choice of the methodology to assess appropriate values for depreciation for intangible assets, which are in line with the National Accounts conventions as suggested by ESA 2010 (henceforth ESA). Subsequent sections focus on the different perceptions of the service life and their impact on the resulting depreciation rate.

It is known (OECD, 2001) and easy to demonstrate that service life assumptions have a strong influence on capital stock and consumption of fixed capital. OECD (2009, p. 106) notes that
"textitthe accuracy of capital stock estimates derived from a PIM is crucially dependent on service lives - i.e. on the length of time that assets are retained in the capital stock."

OECD (2010, p. 128) argues
"*The most important PIM parameter is the service life. Specifying a service life of 10 years rather than 5 years would make a huge difference to the estimates of the capital measures. Net capital stock would be approximately double, and with a typical scenario of strong growth, consumption of fixed capital would be appreciably smaller. It therefore deserves a good deal attention.*"

According to ESA, service lives together with capital stock are relevant to assess depreciation. This condition is independent of the way capital stock is assessed. Also in the case that PIM is not applied to calculate capital stocks, knowledge on service life is a necessity to conform to ESA. In addition, PIM models as a rule need the knowledge on service life as a parameter.

Available studies on the use of intangible assets in the private sector assume comparatively short service lives for intangible assets (Corrado et al., 2015, p. 31). In this case, even very small differences in the service life assumption, i.e. a year (which is the lowest possible ESA time unit for investment) may have a comparatively strong impact on the level of depreciation.

According to ESA (3.139), consumption of fixed capital (CFC), which is the National Accounts notion of depreciation "*... is the decline in value of fixed assets owned*[42] *, as a result of normal wear and tear and obsolescence.*"

In the case of tangibles, this implies that even if goods in a proper physical shape are not necessarily counted as assets if they have no economic value.
The "*... decline in value includes a provision for ... losses of fixed assets as a result of accidental damage*[43]" and "*... is estimated on the basis of the*

- *stock of fixed assets and the*
- *expected average economic life*
- *of the different categories of those goods.*"

In the following, we discuss the points underlined above in a different order.

Private and public intangibles An important feature with respect to the levels of depreciation and net stock is the breakdowns of assets to allow for different service lives by type of asset. Breakdown in the context of service life does not mean the asset and industry breakdown for which GFCF time series are available or which have been defined in the transmission programe (ESA 2012). If we could assume the same service life for all types of assets, we would not need any further breakdown by asset type or by industry to assess the amount of depreciation. The level of overall depreciation would not be different if we make the calculations for the aggregate or for the different types of asset.

Therefore, the question whether one has to assume different service lives for public intangibles in comparison with the service life assumption of private intangibles lastly is a question of the degree of breakdown by type of asset. If the asset breakdown can be deep enough in a way that the individual types of assets can be considered as homogeneous goods, then there would be no further need to distinguish between private and public assets. In this case, of course it will happen that public intangibles are related to certain industries and a number of industries are not related to public intangibles.

[42] The condition of ownership is another necessary diversion where intangible assets have to be calculated different from ESA recommendations. ESA refers to legal ownership. Suggestions have been made to refer to economic ownership (OECD, 2010).

[43] " ... which can be insured against."

ESA suggests that the average economic life of a specific asset should be the regular case for all units of the economy (ESA, 3.141). The underlying idea is that there exists some kind of homogeneous type of asset, whose loss of value is always the same independent of the surrounding of its use. The underlying idea of a unique service life for homogeneous types of asset is its model of perfect competition. The asset breakdown for GFCF as described by ESA (3.127) certainly cannot be seen to be of sufficient detail to represent homogeneous types of asset.

In practice, with respect to expenditures for tangible assets, only a few countries seem to adhere to the concept of a unique service live by type of asset. ESA does not give a specific suggestion on the necessary degree of asset breakdown for capital stock purposes. However, the ESA classification of asset types in the transmission programe with 11 different types of asset (ESA 2012, table 22) is certainly below the factual asset breakdown as practiced by a number of Statistical Offices.

Gorzig (2007) describes that according to a UNECE (2004) survey, in most of the old EU 15 countries, the asset breakdown for tangibles has been reported to be more or less in line or below that of the classification as given in ESA. That is the reason, why some countries, are reporting to have an additional breakdown according to the industries in which the assets are used. Reasons for an additional industry breakdown can be twofold:

- *The applied asset classification is not deep enough to cover homogeneous types of asset, or*
- *Different market structures in the industries will induce different economic service lives for the same type of asset.*

Obviously, there is a trade-off between the level of asset breakdown and the necessity to distinguish between different service lives by industry. The lower the asset breakdown the more might it be a necessity to apply different service lives by industry for a given type of asset. Table 19 informs on the breakdown of intangible assets in the private (INTAN-Invest) and public sector (SPINTAN).

It is certainly an important question to find the optimal asset breakdown. An idea of the magnitude of different service lives applied by firms might be given by the fact that the German tables for tax service lives cover more than 2000 different types of assets (BMF, 2006). EU KLEMS (2007) distinguishes between 10 types of asset. For some asset types, different depreciation rates by industry are applied. The asset breakdown in the BEA (1999) estimates

	Private sector	Depreciation Rate Private sector	Public sector
	CHS[3]	INTAN-Invest[1]	SPINTAN[2]
Computerized information			
Software	0.330	0.315	0.315
Databases	0.330	0.315	-
Open Data	-	-	0.315
Innovative property			
Mineral exploration	-	0.075	0.075
R&D	0.200	0.150	0.150
Cultural and heritage	-	-	??
Entertainment and artistic originals	-	0.200	-
Design and other new product/systems	-	0.200	0.200
New product/systems in financial services	-	0.200	-
Economic/Societal competencies			
Brands	0.600	-	0.400
Advertising	-	0.550	-
Market research	-	0.550	-
Employer-provided training	0.400	0.400	0.240
Organizational structure	-	0.400	-
Manager capital	-	-	0.400
Purchased services	-	-	0.400

[1]INTAN-Invest: Intangible Capital and Growth in Advanved Economies:Measurement Methods and Comparative Results (Table 2). -
[2]SPINTAN: Measuring intangible investment in the Public sector (Table 6). -
[3]CHS:INTANGIBLE CAPITAL AND U.S. ECONOMIC GROWTH (Page 14).

Table 19: Depreciation rates for Intangibles in SPINTAN by asset type

is about 150. For Germany, the statistical office is using more than 200 different types of assets. A survey on asset service lives (Cope, 1998) is asking for more than two hundred different types of assets. All these studies have the focus on tangible asset.

If we want to transfer the experience collected for tangible assets on intangible assets we have to consider that according to most researchers many types of intangible assets are much more firm specific than tangible assets are assumed to be in the standard setup of economic theory. From this, we would expect an even bigger variation of the service lives for intangible assets. The assumed service lives in Corrado et al. (2015) can only be understood as a mean value of the factual values.

General remarks. The broadly accepted methodology to assess capital stock and hence capital services is the perpetual inventory methodology (PIM). This methodology calculates the current value of the stock by adding up the value of new assets - "ESA: gross fixed capital formation (GFCF)" - to the previous years' stock and deducting the loss of value "ESA: consumption of fixed capital (CFC)" - of the previous years' stock. This methodology is proposed by ESA (3.141) as the standard methodology to be applied in the National Accounts if no direct information on stocks is available.

Alternative approaches as direct estimates of capital stocks are using balance sheet information or surveys. Compared with direct estimates of capital stocks, estimates derived with the PIM have the advantage to be based on a consistent valuation concept in line with economic theory. Furthermore, the costs of collecting direct information on stocks and converting it into the appropriate values are mostly very high (OECD, 2001, chapter 8). In addition, the available valuation of the stocks collected in a direct way is mostly not appropriate and not in line with the state of the art as given by the economic theory. Most important however, these alternative methodologies can only be applied if some information on the value of stocks is available. For intangible assets, this is normally not the case. Therefore, for assessing intangible capital stock, direct estimates as a rule are not possible if there is no observable information on stocks. The PIM seems to be the only practical device to arrive at meaningful estimates for net stocks for intangible assets.

Initial stocks. The PIM affords the information on an initial stock or alternatively long series of GFCF and a model that describes the loss of value, CFC, also called depreciation of the current stock. An application of this kind of model is described in the EU KLEMS (2007, 6.1) methodology volume. Applying this methodology, intangible stocks can be calculated as follows. The opening stock K_t, for an establishment is given with:

$$K_t = K_{t-1}(1-\delta) + I_t \tag{17}$$

with I_t the capital formation of the current year t and a constant depreciation rate, δ. Initial values for capital stocks can be calculated in applying a modified version of a methodology suggested by Griffith (1999). Capital stock calculations are based on observed figures of investment and an estimate of the initial closing capital stock $K_{\Theta-1}$, in the year prior to the beginning of observations in the data. Long service lives, often seen as an obstacle for capital stock estimates, can be handled with the sum formula of a geometric row (Grzig and Gornig, 2012).

We assume a constant growth of investment g, before the first year of observations. Let Θ be the first observation available, then back extrapolating yields:

$$I_{\Theta-1} = I_{\Theta}(1-g) \tag{18}$$

with I_{Θ} for the capital formation of the current year and a constant growth rate g for capital formation. Given the general cumulative definition of the closing stock in equation 17, we can apply the following equation to calculate the initial stock:

$$K_{\Theta-1} = I_{\Theta-1}\sum_{0}^{\infty}(1-\delta-g)^t \tag{19}$$

δ is the depreciation rate and g is the growth rate of investment in the years preceding the initial year. Applying the sum formula for a geometric row leads to

$$K_{\Theta-1} = \hat{I}\frac{1-(1-\delta-g)^t}{1-(1-\delta-g)} \tag{20}$$

The initial investment $\hat{I}$, stands for the starting value $I_{\Theta-1}$, in the back extrapolation, assuming the growth rate of investment g, before the first observation. In theory, T should be infinite, for practical purposes it can be set to 100. The growth rate g, depends on the average growth rate of intangible investment in the observation period. This implies that we assume that the past and current average growth rates are similar. $\hat{I}$ is set to be the investment value available for the first observation year Θ. The average is used to assess the average investment over the business cycle. It is corrected by a discount factor reflecting the growth of investment in the observation period.

Depreciation: wear and tear and obsolescence. Subsuming intangible assets under the broad heading of knowledge capital, the OECD (2001, p.117) suggests that the physical service life of knowledge is infinite. The only reason for retiring intangible assets is that there is no longer any demand for their services. If they have only limited service life in practice, it must be due to obsolescence. No wear and tear and no damages occur. The only impact, which shortens the service life of knowledge, comes from obsolescence. This opinion is shared by Ker (2013a) with respect to R&D assets.

The notion of obsolescence is not discussed uniquely. Diewert and Wykoff (2006) define the case of disembodied obsolescence as a result of demand shifts. An asset is not any longer needed in the production process if the demand ceases for the products that can be produced with it.

Embodied obsolescence occurs if new knowledge deteriorates current knowledge. The impact of new knowledge on the depreciation of current knowledge is also articulated by Alston et al. (1998). According to Grubler and Nemet (2012) obsolescence occurs either as technological obsolescence by innovation or "... due to turnover of the holders of that knowledge". Knowledge can get lost by staff turnover is argued by Arnulf and Nemet (2013). This is also the position of Squicciarini and Le Mouel (2012) who derive depreciation rates of organisational capital from job turnover data. In this paper (Chapter 6), we present an example, how knowledge capital in the shape of the capital value of a team can be destroyed.

Assuming complementarity between capital stock and its operating factors of production, Bliss (1965) found that obsolescence results if costs to operate the capital stock are higher than the return from the stock. Given the parameters of the production function, Gorzig (1973) shows that the return depends on the price of the good produced with the asset in question while the costs depend on the price of the operating factor of production. If product prices develop differently across firms, then even with the same cost prices a given type of asset will have diverging service lives. This would of course be only the case if imperfect competition prevails.

In economic models, depreciation is modelled time dependent. Different models are suggested. ESA (3.143) proposes a straight-line development. Most economic models prefer geometric schedules. The assumption of time dependency can be seen as a pragmatic aggregation of the multitude of influences, which can affect the "loss of value". Wear and tear might follow from the use of an asset. It therefore determines depreciation over time. Obsolescence on the other hand is not necessarily increasing over time, since it depends on economic factors, which can change speed and direction of the depreciation. If prices are changing, even assets, which have been discarded, can be reanimated. In the above-mentioned case of embodied obsolescence, depreciation on existing assets may also depend on the velocity, that new assets with different features are becoming available. This might also be a relevant issue for information assets.

Service life. Population statistics define the average life (expectancy) as the average age a member of a certain population can be expected to reach[44]. It denotes the average number of years; an individual will stay in the population. Formally, the average life expectancy can be calculated as the sum of all observed annual survival rates in a population. If direct observation of the age structure of a stock is available, the average life can be calculated from the observed values. A model, estimating the stock would use the observed average life as a parameter in calculating the survival rates of the members of the stock. This model should generate an age structure of the members of the stock, which would exactly return the observed value for the life expectancy.

Models to calculate capital stock are making use of this notion of service life. The classical example in capital stock calculations is the well-known “one hoss shay” survival curve.[45] Here, the assumption is that all but the last survival rate are 100%. In this case, the assumed average service life in the capital-stock model and the resulting average lifespan of an asset in the stock are the same by definition. Different notions of service lives are in use for models, which

[44]Different from population statistics, we do not deal with the service life of observable units. Instead, we look at the service life of assets in these units. In assessing these service lives from observed stocks, we have to consider the survivor bias, induced by the fact that stocks of firms that have been closed are no longer observable.

[45]Based on an Irish folk song.

apply geometric depreciation. In the BEA calculations, the service life assumption is mainly a denominator, needed for calculating the depreciation rate (BEA, 1999, p. 32).

$$\delta = R/T \tag{21}$$

The assumption on the declining balance rate R together with the service life assumption T determines the - constant - depreciation rate δ, which in turn lastly is relevant for the size of the calculated net capital stock and the level of consumption of fixed capital (depreciation). In this case, the assumption on service life does not describe the average lifespan of assets in net capital stock. Obviously, there is a trade-off between the two parameters for service life and declining balance rate. High values for the declining balance rate and high values for the service life yield the same depreciation rate and finally the same amount of depreciation as lower values for both. The service life assumption applied in the above described geometric depreciation formula is not necessarily comparable with the notion of average service life in the sense of average life expectancy.[46]

Depreciation rate The discussion on depreciation rates has to distinguish between the rate as descriptive number, which can be calculated as the relation between the value of depreciation and the value of net capital stock and the depreciation rate as a parameter in a depreciation model. Depreciation rates are inversely related with the service life of an asset. ESA recommends a linear or straight-line depreciation model but acknowledges also geometric depreciation if appropriate. Except for this, ESA does not give any recommendation on the depreciation rate. In fact, the straight-line recommendation implicitly results in an increasing descriptive depreciation rate over time. A capital stock model based on PIM with geometric depreciation pattern is commonly applied by many researchers[47] for tangibles as well as for intangibles. Note that also with straight-line depreciation pattern for individual assets the resulting depreciation rate for the aggregated depreciation curve (OECD, 2009, p. 41) can be convex. OECD (2009, p. 99) describes a number of formal advantages which result from the application of geometric depreciation schedules.

[46] In fact, if geometric depreciation is assumed together with an infinite serving period, the average life expectancy M of an asset in net capital stock converges with an increasing serving period to the reciprocal of the depreciation rate. This can easily be calculated with the sum formula for geometric rows.

[47] For instance EUKLEMS (2007), Corrado et al. (2009), Piekkola et al. (2011), Corrado et al. (2012)

According to OECD (2009, p. 99), econometric estimates of the as constant assumed depreciation rate are rare. One procedure to arrive at results here is the double declining balance rate. In commercial uses of geometric depreciation, the declining-balance rate frequently is assumed to have a value of 2. This is for instance the standard value, which is used in spread-sheet applications like MS Excel. The US Bureau for Economic Analysis (BEA. 1999), which applies geometric depreciation for most assets, assumes in general a factor of 1.65. For some assets, as for instance CT equipment, the value of the declining balance rate goes up to a value of more than two. In other cases, it is around 0.9, as in the case of dwellings and other kinds of buildings (BEA, 1999, p. 29). Economists agree that depreciation/service life is an economic notion. From this, one could expect that depreciation rates depend on the different economic conditions in a firm or industry. Principally, they could differ even across the smallest observable decision units. Where micro level studies are available (Grzig and Gornig, 2012), they show a rather wide spread of depreciation rates. This is independent from the question, whether we look at tangible or intangible assets. In the case of intangible assets, this is supported by the general opinion that these are in many cases own account assets, which are assumed to be firm specific. As discussed above, in the case of tangible assets, National Statistical offices try to do calculations on a rather disaggregated level by type of asset, such that one can assume rather homogeneous units for which a ? mostly ? invariant depreciation rate is assumed. Another methodology is to assess industry specific variances in the depreciation rate.

Assessing service lives Model based explanations

Given the commonly accepted PIM, the question of net stocks is mainly a question of appropriate depreciation rates applied for intangible assets. One of the basic differences with tangible assets is the fact that for intangible assets there exist no physical stocks. The question of depreciation as a measure of the loss of value can only be handled by applying standard economic theory. Available models that explain service lives rely heavily on the return rate. In the case of public intangibles, the return rate is rather difficult to evaluate. Most economists agree that the economic service life of an asset ends if there is no return on that asset. An economic value can only be associated with those goods, which are able to deliver a return. Principally, the return should not necessarily be a return in money, however in the generally applied accountancy schemes, it is. Within the definitions of ESA, it becomes rather difficult to assess the return on public assets Service life for public intangible assets based on this methodology cannot rely on the conventional ESA system (see WP 2 and the discussion in Corrado et al., 2015, chapter 2.5). The following models can only give an impression how these relationships could be assumed.

Modelling obsolescence - Bliss (1965) Given a putty clay production function, Bliss shows that the optimal service life of an asset depends on the expected increase in real cost of operating the asset. Furthermore, in his simultaneous non-linear model he derives equilibrium values for the planned capital labour intensity and the internal rate of return if the real price of operating input is given exogenously. The model describes that high planned service lives are the result of an expected slow increase in the real price for the operating costs and vice versa. The model has originally been developed for the market sector economy and needs reliable information on capital compensation as an input. Furthermore, it deals only with one type of asset. Therefore, it is not directly applicable for the question of this paper.

A forward-looking profit model - LI (2014) Li develops a model to estimate the depreciation rate of organizational capital. The core idea of the model is that business intangible capital depreciates because its contribution to a firm's profit declines over time. As the Bliss model, this model refers to the private sector of the economy and deals with one type of asset only [48] In the present form, it cannot be applied to solve the questions of this paper.

Empirical sources Statistical sources to get information on the service life for a particular type of asset are suggested by OECD (2009, chapter 13.1):

- Tax-live, administrative records, survey on discards of assets or age structure, company accounts, other countries estimates

In the case of tangible assets, all these sources are applied by National Statistical Offices to assess depreciation in the National Accounts. However, little is known to what extent service lives for intangible assets can be derived from these sources. Tax service lives do not necessarily represent the factual economic service lives. They are very often governed by policy goals. Furthermore, they are based on agreements between industry representatives and the tax authorities. In general, industry representatives urge to apply low service lives in the balance sheets. Case studies have shown that tax service lives for tangible assets might represent the lower margin of possible service lives. Depending on the country's taxation-system, the diversion from the economic service live differs across countries. Information on tax service lives for intangibles

[48] Calculations have been made separately for R&D and organizational capital.

is rare and can in the best case assessed by an indirect methodology. In some countries, for instance Germany, the firm value - as the difference between the asset value as given by the accountancy, adequately valued, and the market value, as given by the purchasing price of a firm - can be subject to depreciation. In the case of tangible assets, frequently use is made of administrative data. With respect to intangible assets, estimates of R&D service lives frequently are based on patent statistics (Ker, 2013b).

Surveys on service lives have to distinguish between surveys on discards (Bobbio et al., 2014) or on the age structure of the capital stock. Such surveys have been proofed a reliable source in the case of tangible assets. However, for intangible assets such surveys are not possible if the information on stocks is lacking. Surveys that ask for the expected service life of current investment have been conducted on R&D for the business sector (Awano et al., 2010; Ker, 2013c). They show that these service lives can vary considerably. They seem to indicate that the range is determined by additional factors like industry, sample, and the type of depreciation model. In any case, a survey asking directly for the expected service life needs a very detailed asset breakdown. To cover homogeneous assets, the necessary breakdown would have to be considerably deeper than the classification suggested by ESA for gross fixed capital formation (GFCF) by type of asset or the one in the transmission programe of Eurostat.

Another method to get information on service lives is asking for the age structure of the current stock, preferably the gross stock. In this case, values, which are available in the companies? accounting system can be aggregated and reported. Since accounting values are normally reported at historic acquisition prices, additional assumptions and a valuation at current replacement costs will be needed. Age structure based service live estimates suffer from a survivor bias, since stocks of closed firms might not be included, except in the case that these stocks have been purchased by still existing firms. This implies the possibility of overestimating the service live. As discussed before, this methodology is not applicable for intangibles if their stocks cannot be observed. Other countries estimates are usually applied by smaller countries that do not have the resources to conduct surveys by their own. In addition, datasets on international comparable data as EU KLEMS make use of the assumption that the service life of a certain type of asset is the same in all countries considered. In the case of intangible assets, Eurostat (2014) recommends: "Service Life estimates used in the calculations of R&D should be based on dedicated surveys or other relevant research information, including information of other countries with comparable market/industry characteristics. In case, where such information is not available, a single average Service Life of 10 years should be retained." OECD (2009) argues that producer of assets might have reliable insight to assess the probable service life of the assets they produce, such that they give experts' advice in this matter. This might be a possible source in the case of tangible assets, when producer have knowledge on stocks and replacements of their customers. With respect to intangible assets again the knowledge on stocks becomes difficult even if one considers that an important part of the intangibles can usually be assumed to be own produced.

Depreciation rates for organisational capital - the team value What is organisational capital?

It does not seem that there is a convincing agreement on the nature of organisational capital. Corrado et al. (2009) see organisational competencies as part of the firm specific resources. Corrado et al. (2015) argue that organisational capital of public sector is knowledge capital and part of the societal competencies. Researchers seem to agree on the tacit, team related, and firm specific nature of organisational capital. Chen (2012) argues that the "firm-embodied concept of organizational capital enjoys popular support among scholars", referring to Evenson and Westphal (1995): "it is an agglomeration of knowledge that is used to combine human skills and physical capital into systems for producing and delivering want-satisfying products." Other approaches rely on the economics and management literature, where organisational capital is defined as a firm-specific knowledge asset embedded in a firm's employees (Squicciarini and Le Mouel, 2012).

CHS (2009) refer to microdata evidence by Abowd (2005) suggesting that organisational practices (proxied by firm-level distributions of human capital) are strongly related to outcomes such as revenue per worker and market valuation. Chen (2012) discusses the question to what extend organisational capital can be seen to be embodied either in people or in firms. Because of the strong relation between organisational capital and the firms' outcome, he relies on the firm specific aspect of organisational capital.

The capital value of a team We concentrate in this study on a specific element of organisational capital. This we call the "team value". We assume a capital value for a team, which is determined by the knowledge on the behaviour of the other members of the team as part of the societal knowledge (Corrado et al., 2015) in a firm. The interaction between the team members creates a capital value that develops from *"..the match between employees working in teams"* as

Prescott and Visscher noted in 1980. Since then, other authors have emphasized that the capital value of a team represents a dominant part of organisational capital (O'Mahony et al., 2014). It is part of the own account produced assets of a firm. If such a team value exists, it is related to the employees who constitute the team. We understand that the capital value of a team is more than the sum of capital values of the individuals in the team. For instance, the team value of a soccer team is not the sum of the individual transfer values of the players. Moreover, the team value is part of the competitive power, which resides in the people who constitute the team that is governing the unit in question. This section follows the basic concept of Squicciarini and Mouel (2012) in assuming that a loss in the team value of a production unit will occur if members of the management team are leaving it. The capital value of the team will be reduced twofold.

- *First: the societal knowledge of the quitting team member gets lost.*
- *Second: the societal knowledge of the other members of the team with respect to the leaving member becomes obsolete.*

We calculate unit specific quit rates that describe the loss of the capital value of a team. Hence, these quit rates can be taken as proxies for the depreciation rate of the team value. In the simplest model, the quit rate is calculated as number of employees leaving the unit related to the stock of employees in the unit. In more demanding models we use wage weighted quit rates.

The Eukleed database

Eukleed is a comprehensive integrated micro data set on employment, investment, and output for about 1.6 million German establishments, with around 40 million employment cases per year. The Eukleed database has originally been applied in the Innodrive project (Piekkola et al., 2011) to assess organisational capital for the market sector. Here, the analysis is extended to cover also the units of the SPINTAN related industries. Its panel structure allows that for every unit the exact entry and exit days for each individual employee is available. The main source for Eukleed is a linked employer employee data set (LEED) derived from the German social insurance system (SIS). It supplies firm level [49] information with respect to employment, employment characteristics, labour compensation by type of labour, and establishment characteristics. To calibrate the firm level information with the aggregated data of the National

[49] If not noted otherwise, firm is used synonymously with establishment, the local production units.

Accounts two additional sources are used: The National Accounts data for 70 industries and 16 Federal States.

The German Social Insurance System (SIS)

SIS is based on the register for all persons obliged to pay social security contributions. It supplies a nearly complete coverage of all German employees. Merely some governmental personnel and a number of low-income recipients are excluded. For each employee, information is available for the day a particular job began and when it has been finished, including the income received during that period. Among others, information is supplied upon the type of the job performed and the educational skill of the person doing the job and the establishment where the person is employed. This implies that the industry where a person is working is available. A full overview of SIS is given by Fritsch and Brixy (2004).

The micro data of SIS are subject to very restrictive disclosure rules. In recent years, access has increasingly been made possible by the Research Data Centre (http://fdz.iab.de) of the Federal Employment Agency (BA) at the Institute for Employment Research (IAB), which prepares individual datasets developed in the sphere of social security and in employment research and makes them available for research purposes - primarily for external researchers. An overview on the current situation with respect to data availability from this source can be found in Bender and Mller (2009). SIS data are collected for administrative purposes. This implies that they are not necessarily in line with statistical rules for surveys. For the purpose of the Eukleed database, the SIS data had to be corrected by eliminating erroneous entries or entries that are induced by corresponding labour market laws. For example, employees with no income are registered because women on maternity leave are defined in SIS according to the law as employees.

Number of employees

ESA describes employment as the average stock of employed persons over the year. In the Eukleed database for each person, information is available on the first day and on the last day of the persons? employment. Here, this fact is called employment case. An employment case can be a person that works only for one day or it could be a person that works all the days of the year (Figure 30,). The same person may consist of several employment cases. From these facts, we can calculate employment days for each employee. In figure 30, person A is an employment case working the full observation period of 5 years. Person B constitutes two employment cases working with interruptions in the same unit/establishment. Person C covers three employment cases working in three different units/ establishments. Principally, the same person can constitute several employment cases at the same time. To make this information comparable, the employment cases are converted into individual employment days, which can be summed up to higher aggregates. This can be the units/establishments in question or the SPINTAN related industry levels. Calculations have been made separately for employees, who entered the unit during the year, left the unit before the end of the year, entered and left the unit during the year, and those who stayed in the unit for all the days of the year.

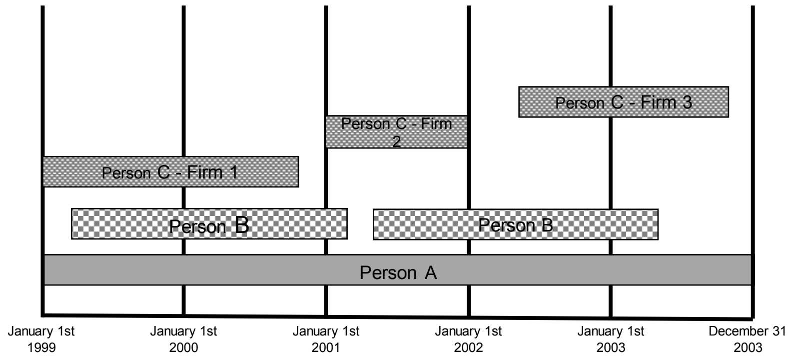


Figure 30: Employment patterns over the year

In the abstract figure 30, we have no quits in 1999 and in 2002, 1 quit in 2000, 2 quits in 2001, and 2 quits in 2003. Quit rates per unit cannot be calculated, since no information is given on the units/establishment. Divergences between Eukleed and National Accounts data with respect to the industry's employment figures are caused by the fact that National Accounts data refer to enterprises, the legal units as the smallest entity; SIS data are only available for establishments, which are comparable to the local KAU (Kind of Activity Unit) in ESA (1.56). For some industries, the number of employees in establishments is higher than in the enterprises of these industries because these industries consist mainly of local establishments of enterprises, whose main activity is in other industries. Eukleed does not cover:

- *certain types of civil servants in institutional sectors S.14/S.15 with an impact for Nace 2 industries O, P, and Q*
- *self-employed*
- *very low-income recipients (i.e. less than* 400 *per month)*

Furthermore, we are not able to distinguish between market and non-market sector. With respect to all employed people, the coverage is around 70%. A relation that is valid within certain margins also for the income data. For the public sector, the degree of coverage is lower, since certain types of civil servants who do not pay social security contributions are not included.

2001	Labour force survey	National accounts²
	mill. persons³	
Total	36.8	38.9
Self-employed	4.1	4.1
Employed	32.7	34.8
Civil servants	2.3	2.3
Others	30.5	32.6
SIS members	27.1	27.1
Minor income jobs etc.[1]	3.4	5.5

[1] Residual: Less than 400 € per month, less than 15 working hours per week, temporary jobs - ² Based on the definitions of ESA'95 in 2001. - ³ Differences in the sums due to rounding. - *Sources:* National Accouts, Labour Force Survey.

Table 20: Coverage of SIS compared with Labour Force Survey and National Accounts

Quits Quits can be calculated with the Eukleed database from those employed persons who have been observed during the year and are not anymore observable in the end of the year. All employment cases of a year can be described either as pure entries ($EntryDays_{(j,i)}$), pure exits ($ExitDays_{(j,i)}$), entries and exits ($TempDays_{(j,i)}$), or permanent staff ($PermDays_{(j,i)}$). A units'i total employment in a year then is given as:

$$E_i = \sum_{j,t} EntDays_{j,i,t} + \sum_{j,t} ExDays_{j,i,t} + \sum_{j,t} TempDays_{j,i,t} + \sum_{j,t} PermDays_{j,i,t} \tag{22}$$

t indicating the days of a year, i. e. 365 days, or 366 days in the leap year 2002. The quit rate δ_i for a unit/establishment i then is calculated as

$$\delta_i = (\sum_{j,t} ExDays_{j,i,t} + \sum_{j,t} TempDays_{j,i,t})/E_i \tag{23}$$

The not weighted industry specific quit rate is the mean of the quit rates of all units in the industry i. The weighted industry I specific quit rate δ_I is calculated as

$$\delta_I = (\sum_{j,t} ExDays_{j,i,t} + \sum_{j,t} TempDays_{j,i,t})/\sum_{i} E_i \tag{24}$$

Both rates will differ if the quit rates are different by size of the units in question.

Wage expenditures

Wages in the SIS database do not include social security contributions completely. Furthermore, they are censored for low incomes and for high incomes depending on the region and the year considered. To be more precise, in this sample we do not have sufficient information on employees with a monthly wage below 400 Euro. The coverage for this type of employees is very low in some cases. The number of people covered has varied over time due to changes in the respective legislation. At the upper end, the wage income reported is censored according to the law for the social insurance contributions. All other characteristics of employees in the SIS are available also for these employees. A wage function is applied to estimate all wages outside the upper wage limits given by the data set, using fixed effect regressions with about 20 different explaining variables. Since the LEED data set is very big, comprising about 140 million employment cases for the period considered, a multitude of explaining variables could be included both of the firm-specific and person-specific type (Grzig, 2011). Grossing up wages and days worked to the industry levels as given by the National Accounts, we can calculate average wages per day for each industry. The average wage per day of SIS is adapted to the respective value in the National Accounts. Multiplying daily wages for all employees in the firm by the days worked results in total wage expenditures of the firm, which is a central variable for the subsequently described estimates. The coverage of wage expenditures is with 80% higher than the findings for employment, since the very low income employees are not covered in the SIS database.

Industries Eukleed data are available in the 2-digit Nace 1 industry classification. Using the 5-digit Nace 1 classification of SIS, a conversion table at the level of the 2-digit Nace 2 SPINTAN related industries can be calculated.

Activities	EU KLEMS Nace 2	(AO)	I	K	L	M	N	O	All industries (EU KLEMS)
"All other activities"	(AO)	100.0	99.6	89.2	1.6	-	0.5	85.7	76.6
Scientific research and development	MB	-	-	4.8	-	-	-	-	0.5
Public administration, defence; compulsory social security	O	-	-	-	96.4	-	-	-	6.3
Education	P	-	0.4	6.0	-	100.0	-	0.8	4.5
Human health activities	QA	-	-	-	-	-	58.8	-	6.7
Residential care, social work activities	QB	-	-	-	0.1	-	40.7	-	4.6
Creative, arts, entertainment activities; libraries, archives museums, other cultural	R (1)	-	-	-	1.9	-	-	6.0	0.4
Gambling, betting activities; sports, amusement, recreation	R (2)	-	-	-	-	-	-	7.5	0.3
All industries (Nace 2)		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Sources: Eukleed, Own calculations.

Table 21: Concordance table Nace 1 to Nace 2 for SPINTAN related industries - employment averages 1999-2003

Observation period Eukleed is a true panel. It covers all days between 1999 and 2003. The first day is January 1st 1999 and the last day is December 31th 2003. Note that 2002 is a leap year and has 366 days instead of 365 days.

Team definition The management employees (basic staff) as defined in the INNODRIVE project (Piekkola et al., 2011) are taken as a starting definition for the team. For each employee, a number of personal characteristics are reported in the SIS database. From this, a combination of kind of occupation based on the 3-digit BA key with more than 350 different occupations and 2 different types of education has been chosen to distinguish between management and non-management employees. All employees, who are working in one of the occupations described in Table 22, by BKdl88, are principally producers of organisational capital if they have a higher education. A higher education is assumed if these employees have visited a secondary school with vocational training, or if they have a college or university degree. Exemptions from this are agricultural engineers and administrators, and chief executives, consultants, tax advisers, and similar occupations, where all employees are treated as management staff. All other employees are assumed non-management staff.

Results Calculations are made for all 300 thousand units that are covered by the SPINTAN related industries (Corrado et al., 2015, table 1), applying the same methodology as for the 1.5 mill. units of the Non-SPINTAN related industries. Note that although it can be assumed that

BKdl88[1]	description[2]	Management staff
31-32	Agricultural engineers and administrators, a.s.	All
601-612	Engineers, physicists, mathematicians, a.s.	High
681	Wholesale, retail trade agents, purchasing agents, a.s.	High
682-688	Sales assistents, a.s.	High
691-692	Banker, a.s.	High
703	Advertising specialists, a.s.	High
751-763	Chief executives, consultants, tax adviser, a.s.	All
771-773	Financial officers, chief accountants, a.s.	High
781-782	Office executives, a.s.	High
784-794	Office clerks, a.s.	High
862-863	Chief executives, consultants of social institutions, a.s.	High
911	Directors of hotels, restaurants, a.s.	High
921	Home economy administrators, a.s.	High
[1]German classification of occupations (IAB 2008; chapter 5). - [2]Translated from *Sources:* IAB 2008, INNODRIVE 2011		

Table 22: Basic Team - management staff definition in INNODRIVE

the share of non-market sector units is above average in the SPINTAN related industries, the results can only be a proxy for the public sector. The average employment number in the units in the SPINTAN related industries is 19, which is more than 50% higher than in the Non-SPINTAN related industries. The share of management employees on the other hand is with 8% only 2/3 of the value in the Non-SPINTAN related industries (10). In the average, the (employment) weighted quit rate of the team value for the units of the SPINTAN related industries results in 13%. This is the same magnitude as for the Non-SPINTAN related industries. With 18%, the non-weighted quit rate is higher since in general smaller firms have higher quit rates. Note that this paper only deals with own account produced assets and does not include purchased assets. Therefore, the results are not fully comparable with other findings, which include also the purchased parts of organisational capital. The rates found, are considerably lower than depreciation rates for organisational capital in the market sector by INTAN-Invest (Corrado et al., 2012, table 6: 40%) or in INNODRIVE (Piekkola et al., 2011, table 1: 25%). Rooijen-Horsten (2008) assumes for the Netherlands a service life of 5 years for all organisational capital. This implies a depreciation rate between the values of INNODRIVE and those of INTAN-Invest.

The quit rate of the team value varies considerably with respect to the industry in question. It is rather high in P (17%) and low in O (10%) and QA (10%). The difference between the weighted and not-weighted quit rates is rather high in MB and R-1 and low in O and in QB (Figure 31). This indicates that the level of the quit rate in MB and R-1 depends to some extend on the size of the units, as measured by the number of employees and that the variation of the quit rate in these industries is comparatively high

Figure 32 displays the quit rates by Nace 1 industries. Significant differences between the

	Averages 1999-2003	SPINTAN related industries[1]	All other industries
Establishments	million	0.301	1.473
Employees	million	5.641	18.492
Management staff[2]	million	0.462	2.259
Management quits	million	0.059	0.295
Average establishment size	employees	19	13
Average management share	per cent	8	12
Average management quit rate	per cent	13	13

[1] Nace 2 industries MB, O, P, Q, R. - [2] As defined in INNODRIVE (see table 5). - *Sources:* Eukleed, Own calculations.

Table 23: Aggregated results

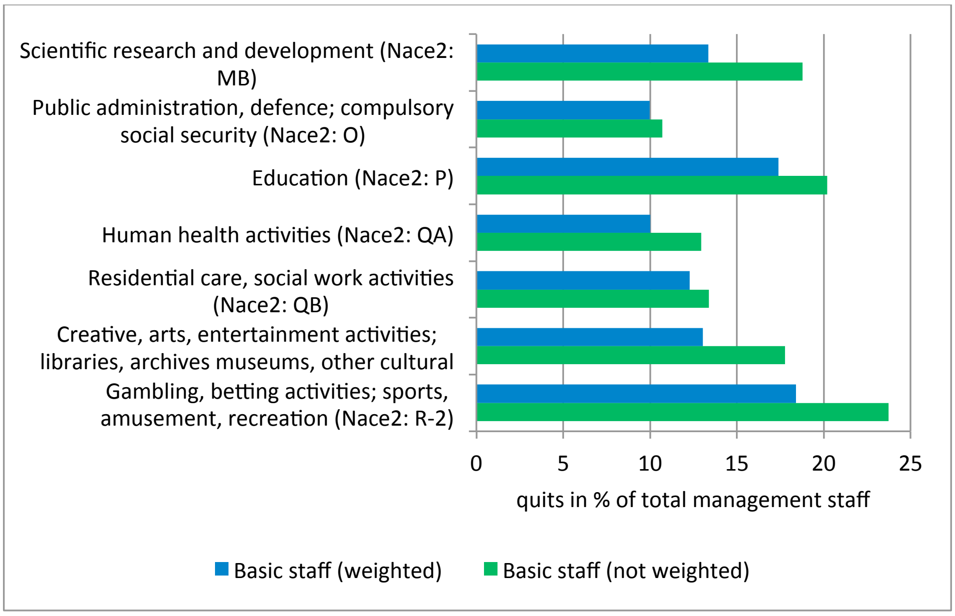


Figure 31: Aggregated results

industries can be observed. High quit rates in hotel and restaurants and low rates in transport equipment can be identified.

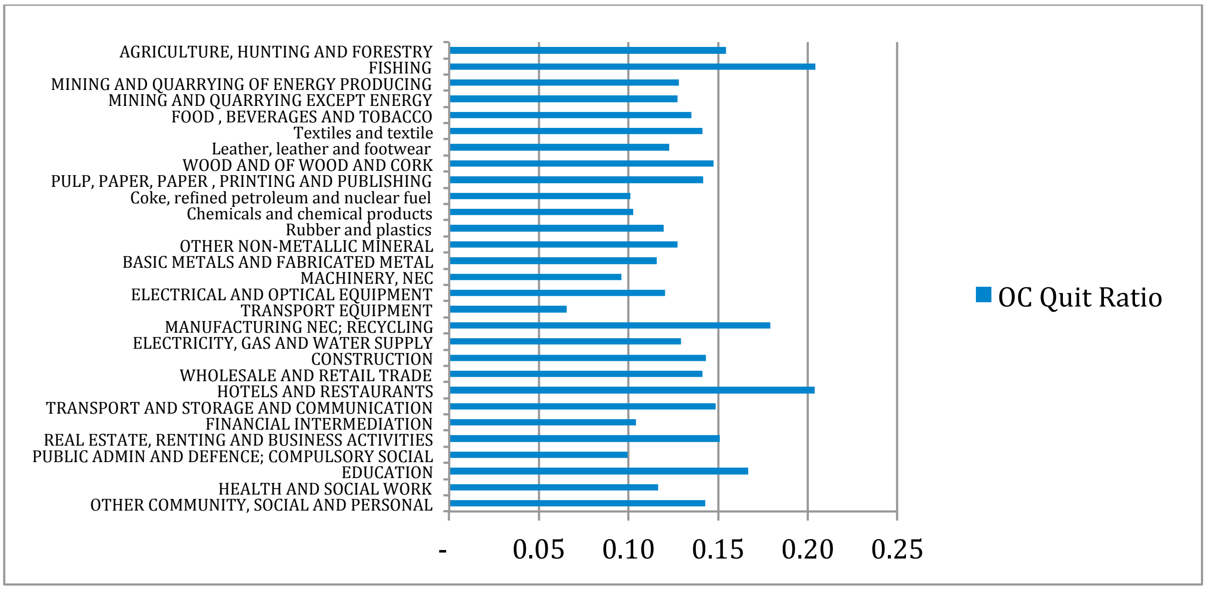


Figure 32: Quit rates for Nace 1 industries

In the average, management wages per head are 20% higher compared with those employees who are not managers. However, it is worth to note that there is wide variation of the unit specific quit rates across all the units of the SPINTAN related industries (Figure 33). This supports the assumption that depreciation rates of organisational capital are to a high extend firm specific and any fixed rate used in modelling it can only be seen as a mean value across the wide spread of firm level depreciation rates. One could expect a scaling down of the observed spread if one could distinguish between several types of organisational capital.

Many employees who are member of the management staff have a wage income per head below that of non-management employees as can be seen in Figure 34). Non-management wage rate is much more concentrated than the management wage rate. Nevertheless, the peak of the distribution of the management wages is just a bit to right compared with the non-management distribution of wage rates. This suggests that not all employees, which have been formally defined as management people in INNODRIVE can be classified as members of a team that is governing the unit in question. Therefore, it may make sense to reduce the team definition to those employees who get a wage rate above the average. Another important result from the micro data analysis is that more than 5% of the management staff consists of people that stay only less than a year in the same unit. Many small units do not have any management

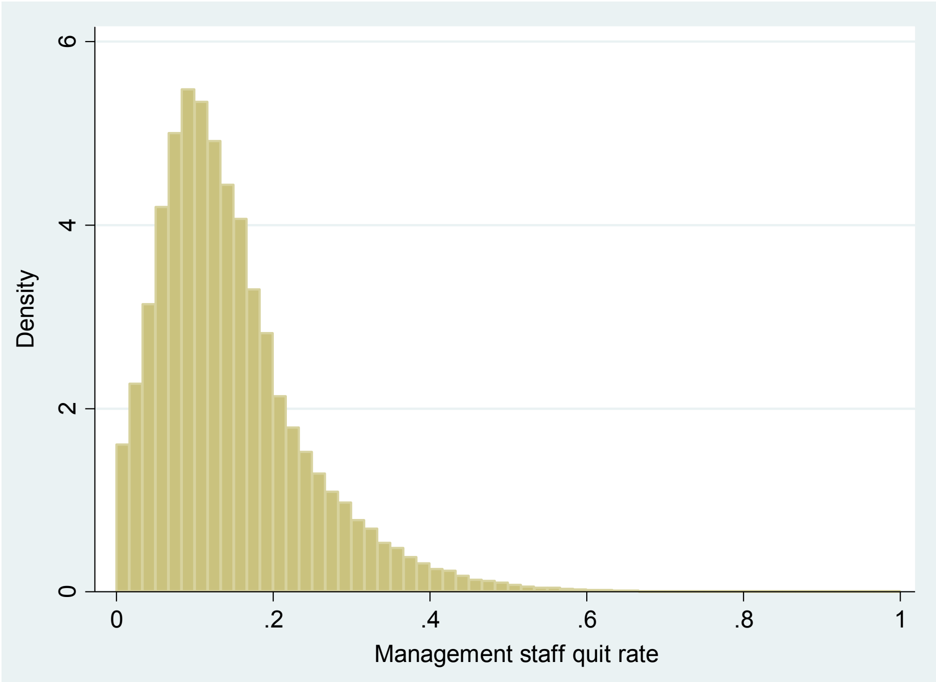


Figure 33: Density distribution of quit rates in SPINTAN related industries, 1999-2003

employees at all and do not exist over the total observation period. We therefore tried another team definition where only employees are seen as members of the management team that stay at least one year in the unit in question. We define additional constellations of the management team.

- *Only those "basic" staff members that earn a higher income per day than the average daily income (High wage staff)*
- *Only those "basic" staff members that work for more than one year in an establishment (High tenure staff)*

Assuming, that employees with higher income contribute more to the team value we also investigated whether the results change if the team is defined either by employment or by income shares.

The impact from these revised definitions on the average quit rate is rather small. Defining the management staff to consist only by those employees who have an above average wage rate will reduce the quit rate from 13% to 12%. The same happens if the employees are weighted with their income. Including in the management team only those employees, who have stayed more

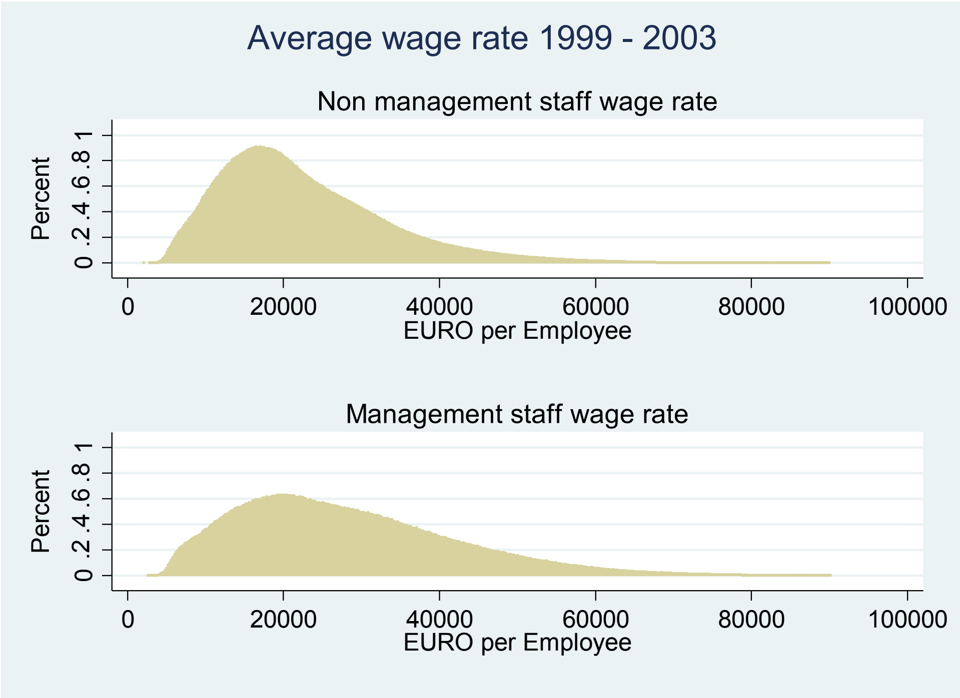


Figure 34: Density distribution of annual wage rates

than a year in the team results in a stronger reduction of the quit ratio (10%) in the average. There are distinct differences in the results if we look at the SPINTAN related industries. Both alternative team definitions result in a strong effect in R-2, an industry where one can expect a higher share of private sector units.

Results for the US published by Squicciarini and Le Mouel (2012) are displayed in an industry breakdown according to the US-NAICS classification. This classification is not directly comparable with the NACE 2 classification applied on the German data. According to Eurostat (2010), a rough concordance at the 2-digit level is possible if the primary links between these two classifications are considered. In Table 25, results for both countries are displayed side by side for the SPINTAN related industries, considering all primary links between these two classifications, except for Nace industry 72, which covers only part of the primary links for US-NAICS industry 54. Considering the well-known differences in labour market organisation between Germany and the US higher depreciation rates in the US are not a surprise. The higher depreciation rates for Germany in Education and Public administration can be explained that in SIS an important fraction of civil servants with a principally high tenure is not covered. Apart from this it should be considered that the applied database are different in structure.

Conclusion

	Employees	Wage sum
	million	million €
Management staff		
Basic management staff[1]	0.462	17 020
High wage staff[2]	0.297	12 176
High tenure staff[3]	0.426	15 912
Quits		
Basic management staff	0.059	2 008
High wage staff	0.034	1 367
High tenure staff	0.044	1 566
Quit rates		
Basic management staff	0.13	0.12
High wage staff	0.12	0.11
High tenure staff	0.10	0.10

[1] As defined in INNODRIVE (see table 5). - [2] Basic management employees with an income above the average. - [3] Basic management employees who work more than a year in the same unit. - *Sources:* Eukleed, Own calculations.

Table 24: Results for alternative team definitions

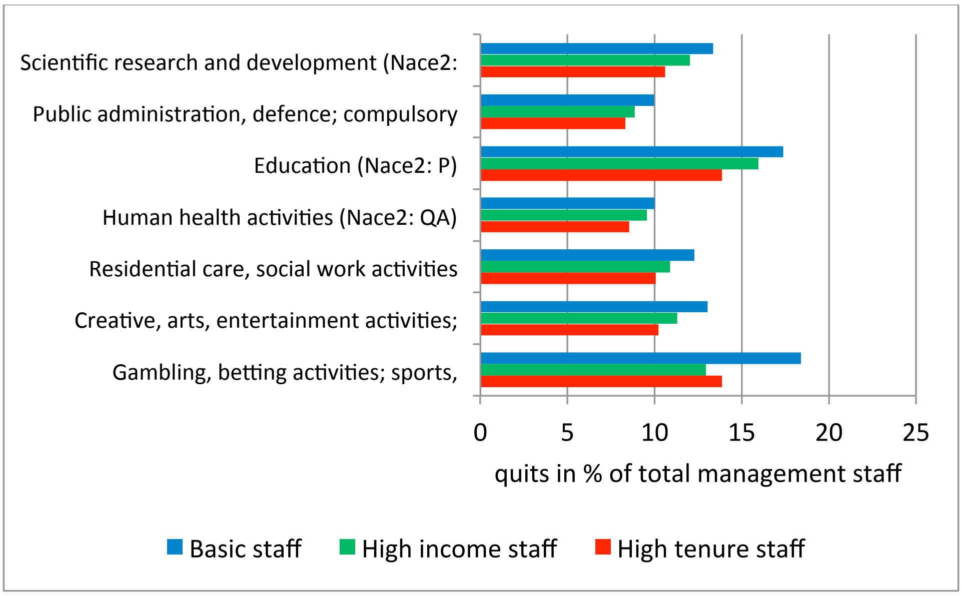


Figure 35: Quit rates for high tenure and high income staff

SPINTAN related industries - Nace 2		Depreciation rates in % of the team value		US NAICS 2007 - NACE Rev. 2 CORRESPONDENCE TABLE AT TWO-DIGIT LEVEL - primary links only[2]	
		Ger-many	US[1]		
Scientific research and development	72	19	20	54	Professional & technical services
Public administration, defence; compulsory social security	84	11	9	92	Public administration
Education	85	20	18	61	Educational services
Human health activities	86	13	17-18	62	Heath care services, hospitals, and social asistance
Creative, arts, entertainment activities; libraries, archives museums, other cultural, gambling, betting activities; sports, amusement, recreation	90-93	24	25	71	Arts, entertainment & recreation

[1] Squicciarini/Le Mouel (2012), table 5. - [2] Commission of the European Communities (2010).- Own calculations.

Table 25: Comparisons of depreciation rates for SPINTAN related industries

Following ESA, service lives of assets are a prerequisite to determine depreciation. This is independent from the methodology applied to estimate the level of net stocks. The question whether one has to assume different service lives for public intangibles in comparison with the service life assumption of private intangibles lastly is a question of the degree of breakdown by type of asset. If the asset breakdown can be deep enough in a way that the individual types of assets can be considered as a homogeneous goods, then there would be no further need to distinguish between private and public assets. If we want to transfer the experience collected for tangible assets on intangible assets we have to consider that according to most researchers many types of intangible assets are much more firm specific than tangible assets are assumed to be. From this, we would expect an even bigger variation of the service lives for intangible assets. One of the reasons for this is that product prices develop differently across firms, such that even with the same cost prices a given type of asset will have diverging service lives. Therefore, the assumed service lives for intangible assets in Corrado et al. (2015) can only be understood as a mean value of the factual values. The case study for organisational capital also lets hypothesize that depreciation rates might be lower than assumed in this study.

5.4 Rates of return

Carol Corrado, Kirsten Jäger, and Matilde Mas

This chapter reviews (i) The leading options for imputing a return to public and non-market capital; (ii) Why imputing a return to public and non-market assets matters for productivity calculations; and (iii) Why many typical calculations of the ex post rate of return for many industry sectors are likely to be inaccurate. It starts presenting in Section 5.4.1 the main methodological issues concerning the measurement of both tangible and intangible capital. It continues considering the social rate of time preference (SRTP) as a coherent solution for the imputation. The SRTP is the rate at which a society abstains from current consumption. Its theoretical underpinnings are reviewed—and results presented—in section 5.4.2. The estimated SRTPs consist of annual time series for 22 SPINTAN European countries, the EU-27, and the United States (US) based on data in AMECO database (as of April 2015). Section 5.4.3 provides a summary and section 5.4.4 concludes.

5.4.1 Methodological problems

From a methodological perspective the distinction between private and public capital stocks is not relevant for individual assets (as long as the information is available). The main difference is with respect to capital services, which comes from the user cost expression that transforms a volume index of capital (a stock) into a value of its capital services (a flow). From an economic point of view, the flow of capital services includes owners' net return to investment plus compensation for the asset's loss in value and productive efficiency as it ages (economic depreciation). Both concepts are naturally embedded in the gross operating surplus (GOS) of national accounts (NA) for the private (or market) sector. For the public (or nonmarket) sector, which SPINTAN treats as including non-profit institutions acting in the public interest and unable to charge economically significant prices (as well as general government), NA must estimate a value for GOS. The problem is that NA do not assign a net return to the flow of services provided by public capital. The only recognized flow is public fixed capital consumption. The main implications of this procedure are twofold. First, NA Gross Operating Surplus figures are underestimated because the value of the capital services provided by public capital is not fully considered; and second, consequently, the value of output is also underestimated in NA figures, affecting both its level and its rate of growth. Five different but related issues are discussed in this section: (i) rate of return of public vs. private capital; (ii) exogenous vs endogenous calculations; (iii) business taxes and ex-post returns; (iv) user cost expression(s) and (v) some additional issues related to intangible capital

Assume that the ownership of $K_{j,t}$ (Volume Index of Capital for asset j) is divided between the private ($K^{p}_{j,t}$) and the public ($K^{g}_{j,t}$) sector at time t. The superscripts p and g refer to private

(p) and public (g) capital, respectively. The value of the capital services ($VCS_{j,t}$) provided by asset j at time t can be computed as:

$$VCS_{j,t} = cu_{j,t}K_{j,t-1} = cu_{j,t}K^{p}_{j,t-1} + cu_{j,t}K^{g}_{j,t-1} \tag{25}$$

Or, alternatively, as

$$VCS^{*}_{j,t} = cu^{p}_{j,t}K^{p}_{j,t-1} + cu^{g}_{j,t}K^{g}_{j,t-1}.... \tag{26}$$

where $cu_{j,t}$= user cost of the capital services.

Equation 25 assumes that the user cost is the same for private and publicly owned assets. An example of this approach is Nordhaus's (2006) basic principle for measuring non-market activities: "Non-market goods and services should be treated as if they were produced and consumed as market activities. Under this convention, the prices of non-market goods and services should be imputed on the basis of the comparable market goods and services" (p. 146). Alternatively, equation 26 assumes that the rates of return are different. Examples of this second approach are Moulton(2004), Jorgenson and Landfeld (2006); and OECD Manual (2009). According to Jorgenson and Landfeld (2006), "For government, the imputed rate of return is set equal to the average of corporate, non-corporate, and household rates of return?" (p. 79). The OECD Manual (2009) makes a similar recommendation to Jorgenson and Landfeld (2006) but only when full information on rates of return for the market and the household sector is available. When this information is not available it recommends using the household rate of return measured by the social rate of time preference. It also suggests borrowing rates for government bonds as an alternative (pp. 142-144). Note that the last two are both exogenous rates of return. Moulton (2004), following Slater and David (1998), proposes four general ways of estimating the rate of return of government fixed capital: i) by means of an econometric estimation; ii) using a pre-determined rate such as the rate set by the US Office of Management and Budget (OMB); iii) the rate of return for comparable private business activities; or iv) the interest rate at which governments borrow.

Endogenous vs. exogenous calculations Two approaches are used for the rate of return in the user cost expression: endogenous (ex post) or exogenous (ex ante). The endogenous, ex post approach rate of return is obtained using the Jorgenson and Griliches (1967) and Hall and Jorgenson (1967) approach. This approach is in accordance with the standard neoclassical model (and also the neoclassical growth accounting framework), which assumes perfect competition and constant returns to scale. The endogenous approach imposes the same rate of return for all asset types within an industry (or larger sector for which it might be calculated). It is computed by equating capital income (including capital related taxes on production and subsidies) to the gross per period return on capital assets, or user cost of capital services.

An alternative is the exogenous, ex ante approach. Instead of using the actual, average rate of return, this approach uses an estimate of the required rate of return for each industry or country. An exogenous rate is chosen independently of the operating surplus since it is taken from exogenous information, such as the interest rate on corporate bonds. It is unlikely that, as in the ex post approach, the resulting values of capital services will add up to capital income as reported in national accounts. The choice of the rate of return is an important element in the construction of user cost and can have an impact on the resulting volume series for capital input. There is no consensus in literature on which of the two approaches is superior. In fact, both methods have advantages and drawbacks, and depending on parameters and accounting structure of the available data, the endogenous or the exogenous method could yield results closer to "truth." The pros and cons of both approaches have been widely discussed in the literature given its relevance for the measurement of capital input (Berndt and Fuss 1986; Diewert 2001; OECD 2009; and many others). The rates of return stemming from the ex post approach are theoretically more consistent for productivity analysis (Berndt 1990) and therefore this approach is frequently used in empirical research. Understanding the realized contribution of capital rather than the expected contributions is prioritized in growth accounting. The consistency with the neoclassical theory of the endogenous model is clearly recognized as an advantage, but at the same time these assumptions seem incompatible with economic reality, especially given the rapid technological progress (van den Bergen et al. 2008; Mas, 2008). Mas (2008) summarizes the advantages and disadvantages of the exogenous approach in a very comprehensive way. It does not require restrictive assumptions (especially with regard to returns to scale and perfect competition), it can easily deal with the presence of public goods, and it allows modeling the rate of return as an expected rate of return. Finding a suitable interest rate is the main difficulty of this approach. Oulton (2007) suggests a hybrid method that makes use of elements of both approaches as an alternative. An ex post, endogenous rate is computed first and then the ex ante rate is chosen as the trend of the ex post rate of return. This approach has the advantage that it preserves the ex ante nature of the calculation while it avoids the problem of selecting an exogenous rate of return.

According to the OECD (2009), "There are at least two situations when the exogenous approach ... is a useful choice. First, when the stock of assets considered is incomplete ... [such as for] land for which information may not be available or at least not with reliable quality ... Second, *when no empirical distinction can be made between the market sector and the government sector* [our italics] computations with an endogenous approach will imply a downward bias of the rate of return because there is no net operating surplus for government assets so that the market sector's operating surplus will be brought into relation with an asset base that comprises assets in the total economy and is therefore too big" (p. 139). Let us assume that we chose the endogenous approach. Then, according to National Accounts practice, total gross operating surplus will equal the gross operating surplus for the private sector plus public capital consumption:

$$GOS^{NA} = GOS^{NA,p} + \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP^g_{j,i,t-1} \tag{27}$$

where GOS = Gross operating surplus; NA = National Accounts; δ = depreciation rate; P = price; and j, t, and i indicate assets, time and industries. From an analytical perspective GOS (private, p) equals the value of private capital services:

$$GOS^{NA,p} = \sum_j \sum_i cu_{j,t} KP^p_{j,i,t-1} \tag{28}$$

According to the standard computation of the internal rate of return:

$$GOS^{NA} = \sum_j \sum_i cu^{NA}_{j,t} [KP^p_{j,i,t-1} + KP^g_{j,i,t-1}] \tag{29}$$

$$cu^{NA}_{j,t} = cu^{NA}_{j,t}(r^{NA}_t, q_{j,t}, \delta_{j,t})$$

with $q_{j,t}$ representing potential gains or losses. According to (29) the internal rate of return r^{NA}_t is computed taking into account the aggregated private and public capital but only the

GOS of the private sector plus the consumption of public capital. However, in order to obtain a consistent computation only the private sector should be considered when computing the internal rate of return:

$$GOS^{NA,p} - \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP^{g}_{j,i,t-1} = \sum_j \sum_i cu^{R}_{j,t} KP^{p}_{j,i,t-1} \tag{30}$$

$$cu^{R}_{j,t} = cu^{R}_{j,t}(r^{R}_{t}, q_{j,t}, \delta_{j,t})$$

where R stands for Revised.

Bear in mind that in order to use the endogenous approach consistently we need a clear distinction between assets belonging to the market and those belonging to the non-market sector. Only under this condition can a consistent measure of the rate of return be obtained. Once the internal rate of return is computed, we can obtain the revised Gross Operating Surplus (GOS) by adding up the GOS figures provided by National Accounts and the value of public capital services, and deducting the consumption of public capital provided by National Accounts in order to avoid double counting:

$$GOS^{R}_{t} = GOS^{NA}_{t} + \sum_j \sum_i cu^{R}_{j,t} KP^{g}_{j,i,t-1} - \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP^{g}_{j,i,t-1} \tag{31}$$

$$cu^{R}_{j,t} = cu^{R}_{j,t}(r^{R}_{t}, q_{j,t}, \delta_{j,t})$$

Once we have revised figures for GOS we can compute the revised nominal Value Added which will include the imputed value of public capital services that considers not only the consumption of capital but also its imputed remuneration:

$$(PQ)^{R}_{i,t} = (PQ)^{NA}_{i,t} + \sum_j cu^{R}_{j,t} KP^{g}_{j,i,t-1} - \sum_j \delta_{j,t} p_{j,t-1} KP^{g}_{j,i,t-1} \tag{32}$$

Business taxes and ex post returns. The private sector contains notably different entities according to legal tax status. These include (i) corporations subject to corporate income taxes, (ii) unincorporated businesses subject to personal income taxes, and (iii) non-profit institutions that charge economically significant prices but are not subject to taxation (NPIPP).[50] Thus we

[50] As previously indicated, there also are non-profit institutions serving households (aka the public interest), denoted NPISH in national accounts. Therefore total non-profit organizations, NPI, equals NPISH + NPIPP.

have,

$$cu_j^{NPIPP} = (r_i + \delta_j)p_j \tag{33}$$

whereas the user cost for the same asset in the same industry used in an organization subject to corporate income taxation is

$$cu_j^{P-Corp} = T_j(r_i + \delta_j)p_j + p_j b_j \ . \tag{34}$$

In this equation b_j is the tax levy on business property (where j is a property type asset) and T_j is the Hall-Jorgenson (1967) corporate income tax adjustment given by

$$T_j = (1 - uz_j - \phi_j)/(1 - u) \tag{35}$$

where z_j is the net present discounted value of depreciation allowances, ϕ_j is the investment tax credit, and u is the marginal corporate income tax rate.[51]

Equations (34) and (35) show how capital income taxes and property taxes enter productivity accounting. Property taxes reduce the net after-tax return (r_i), whereas investment tax credits boost it, and the impact of the business income tax depends on the value for z_j. Three key points regarding Hall-Jorgenson tax term are as follows: First, with regard to intangible asset types, the values of T_j for individual intangible asset types tend to be very different from one another. This is because expenditures on R&D and mineral exploration usually enjoy favourable tax treatment, leading to a situation in which T_j for these assets is less than one, which boosts the after-tax rate of return.[52] Other intangible investments usually are fully expensed, in which case Tj equals one.

Second, with regard to tangible assets, T_j differs substantially according to broad asset type, i.e., according to whether j is equipment or structures whereas T_j for individual equipment types and structures types generally do not vary much within the broad category. Furthermore, the present value of depreciation charges for many equipment types is such that z_j approximately

Note that all non-profit organizations serving business are assumed to be NPIPPs and included in the private (market) sector because typically they are able to charge economically significant prices for their services.

[51]The user cost formula for businesses subject to personal income taxation, which owes to Christensen and Jorgenson (1969), is not discussed here; see also Jorgenson and Landefeld (2006).

[52]The OECD's "B-index" (OECD 2013) summarizes the tax advantages for R&D.

equals one, in which case T_j also equals one. By contrast, the z_j for expenditures on nonresidential structures is often significantly less than one, creating a situation in which T_j for structures is notably greater than one; in the United States, for example, T_j averaged 1.32 averaged over 12 types of structures for the years 1987 to 2008 (business sector only).[53] Third, with regard to whether accounting for taxes in the estimation of user cost "matters" for the estimation of productivity change, studies have concluded that the bias of ignoring taxes in the user cost estimation is very small (Baldwin and Gu 2007; Erumban 2008) although it should be noted that Erumban added the qualification, "except for some service sector industries" (p. 26).[54]

The view that accounting for taxes "doesn't matter very much" is pervasive in the empirical productivity literature (see again the OECD capital services manual [2009], where the topic is relegated to Chapter 18). The concern of the SPINTAN project is somewhat different, however. As previously discussed, it is sometimes argued that the ex post calculated private r is the appropriate rate for imputing returns to public assets—this is listed as the first of three alternatives in the OECD capital manual. Apart from conceptual issues why this may not be appropriate (discussed below), ex post measures of the private return to unsubsidized business capital are in fact very difficult to recover from SNA-compliant industry accounts that blend private and publicly subsidized enterprises and record values at basic prices (Corrado, Haskel and Jona-Lasinio 2014).[55]

This is particularly germane to SPINTAN industries of interest, i.e., the five "nonmarket" industries spelled out in Chapter 1. Each industry reflects a mix of private entities by legal form, which creates a need to also account for business income taxation according to legal form to obtain an appropriate ex post rate of return. NPIs are typically not identified in industry data, and accounting for differential rates of business income taxation within industries is rarely done.[56]

[53] Based on the underlying estimates used for productivity figures reported in Corrado and Hulten (2010). For detailed information on T_j by asset and industry for the U.S., see http://www.bls.gov/mfp/mprdload.htm.

[54] Baldwin and Gu (2007) based their conclusion on an analysis of the aggregate Canadian business sector. Erumban (2008) arrived at his conclusion based on an analysis of 26 industries in the United States and four EU countries (Netherlands, France, Germany, and the UK).

[55] Accounting for subsidies to production and investment grants, either by adding them to capital compensation or having disaggregate data that would permit calculating two ex-post returns, one for the unsubsidized sector and another for the subsidized one, are ways to circumvent this problem. Such information is not readily available at the industry level.

[56] An exception is the work of Jorgenson and associates, which exploits the fact that (a) U.S. industry data generally are for private industries only, i.e., U.S. industry data do not follow the SNA in this regard, and (b) major sector and industry information on capital by corporate and non-corporate legal form is available. Note

All told, although the potential for peril in using pre-tax rental prices in aggregating capital services in industry-level growth accounting exercises generally seems low, the ex post rates of return so computed are of little value as a guide for imputing returns to public assets when calculated over (or for) industries with a mix of activity by institutional sector, e.g., many services industries, including transportation and communication.

User cost expression for the market economy. In practice, the user cost expression can adopt different versions. Ignoring taxes, production subsidies, and investment grants, the general expression for the user cost based on market GOS^{NA} was given by equation 30, which can be written as:

(36)

$$GOS^{NA}-\sum_j\sum_i \delta_{j,t}p_{j,t-1}KP^{g}_{j,i,t-1}=\sum_j\sum_i cu^{R}_{j,t}KP^{p}_{j,i,t-1}=\sum_j\sum_i (i^{R}_{t}+\delta_{j,t}-q_{j,t})p_{j,t}KP^{p}_{j,i,t-1}$$

Mas, Prez and Uriel (2005), following Harper, Berndt and Wood (1989), consider the four different specifications for calculating i^R, shown below in table 26.

Procedure	Rate of return (i)	Capital gains/losses (q)
M1	Endogeneous (see equation 12)	Current variations in prices $q_{jt}=\dfrac{p_{j,t}-p_{j,t-1}}{p_{j,t-1}}$
M3	Exogeneous r = 4% $i_t = r+\pi^e_t$ π = inflation (CPI) $\pi^e_t=\dfrac{\pi_{t-1}+\pi_t+\pi_{t+1}}{3}$	Expected variations $(q^e_{j,t})$ $q^e_{j,t}$ (expected) = $\dfrac{q_{j,t-1}+q_{j,t}+q_{j,t+1}}{3}$
M4	Endogeneous (see equation 12)	Expected variations $(q^e_{j,t})$ as M3
M5	Exogeneous π^e_t as M3 Long-term government bond yields	Expected variations $(q^e_{j,t})$ as M3

Table 26: Four procedures to compute user cost. Market Economy

Source: Mas, Prez and Uriel (2005).

The four specifications consider two in which the internal rate of return is computed endogenously (M1 and M4) while the other two (M3 and M5) use the exogenous approach as expressed

further that the 2008 SNA contains the following paragraph: . . . [T]he SNA assigns NPI to different sectors according to whether they produce for the market or not, regardless of motivation, status of employees or the activity they are engaged in. However, there is increasing interest in considering the full set of NPI as evidence of "civil society" so it is recommended that NPI within the corporate and government sectors be identified in distinct subsectors so that supplementary tables summarizing all NPI activities can be derived in a straightforward manner as and when required (para. 4.35).

in table 26. They also use two different specifications for the capital gains and losses term: contemporaneous vs expected. Figure 36 offers the profiles shown by the four specifications using Spanish data for the period 1970-2009. The profiles are quite similar from the first half of the eighties until the beginning of the new century. As expected the two exogenous specifications provide the less volatile profile, especially the one which uses the long-term government bond yields.

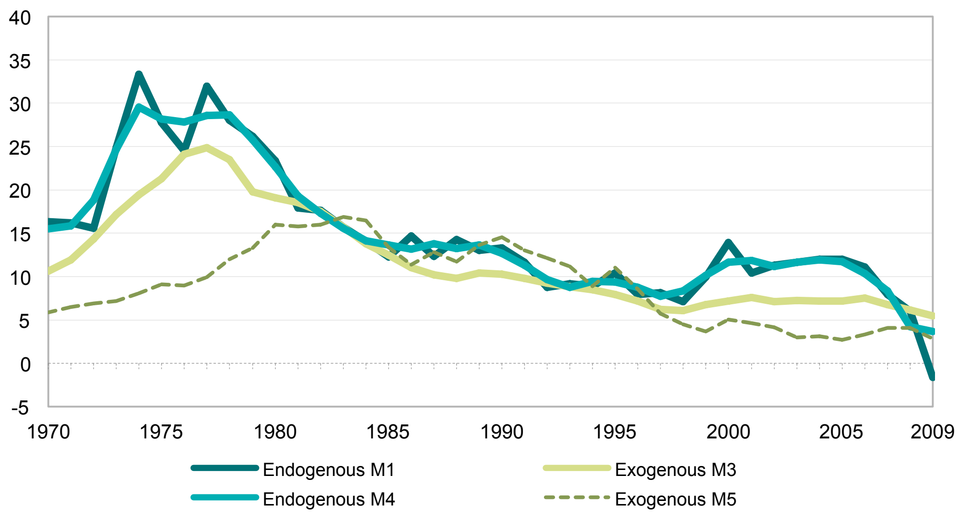


Figure 36: Nominal rate of return. Market Economy. Spain (1970-2009) (percentage)

Source: BBVA Foundation-Ivie and own elaboration.

From a productivity perspective, i.e., the perspective of SPINTAN, the most relevant result associated to the measurement of the rate of return and the user cost expression is its implication in the computation of the value of the capital services. Figure 37 provides this computation for the asset software in the market economy based on the Spanish data for this asset. In order to test the implication of the four specifications in quantitative terms table 2 reports the deviations from the M1 (endogenous) specification considering, both levels in panel a) and growth rates in panel b). The main results are as follows. First the differences are higher for the two exogenous measures (M3 and M5) than for the other endogenous expression (M4). Second, the higher differences appear when comparing M1 (endogenous) and M5 (which uses government bonds as the rate of return). Third, the discrepancies between the four specifications widen during the period of recession. In 2005 the M5 measures gave a level for the value of capital services provided by the asset software that was 18% lower than that provided by M1. In 2009, the (also exogenous) M3 measure gave a level that was 17% higher. In terms of growth rates, panel

b) indicates than the higher discrepancies occurred in the period 2005-2009, when the economy turned from a strong expansion to a deep recession. Note that the differences with respect to M1 were very high. The origin of this result could already have been anticipated by observing the severe downturn of the nominal rate of return as measured by M1 in the first two years of the recession (2008 and 2009) shown in figure 1 and the corresponding drop in the value of its capital services in figure 37.

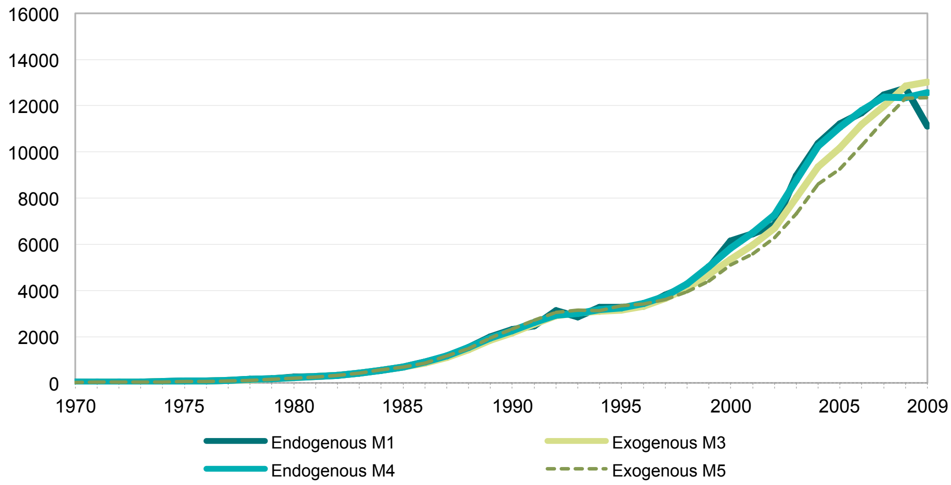


Figure 37: Capital services. Market Economy. Spain. Software (1970-2009) (millions of euros)

Source: BBVA Foundation-Ivie and own elaboration.

a) Levels (percentage over M1)

	1970	1980	1990	2000	2005	2009
M3	0.92	0.91	0.94	0.87	0,91	1.17
M4	1.00	0.96	0.98	0.95	0.99	1.13
M5	0.84	0.86	1.01	0.83	0.82	1.11

b) Average annual rates of growth (percentage points difference)

	1970-1980	1980-1990	1990-2000	2000-2005	2005-2009	1970-2009
M3	-0.16	0.37	0.78	0.82	6.44	0.62
M4	-0.41	0.18	0.34	0.78	3.37	0.30
M5	0.20	1.70	2.01	-0.14	7.42	0.72

Table 27: Value of Capital Services. Market Economy. Spain. Software - Differences from the endogenous M1 assumption

Source: BBVA Foundation-Ivie and own elaboration.

5.4.2 SRTP and the public sector rate of return

For almost half a century, the choice of an appropriate social discount of public projects has been subject to intense debate among economists. The question is whether the future cost and benefits of public projects should be discounted by a marginal rate of return on private investment or a social discount rate. Two types of social discount rates have been advocated in the literature: (i) the social opportunity cost (SOC) and (ii) the social rate of time preference (SRTP).

The SOC measures the value to society of the next best alternative use to which funds employed in the public project might otherwise have been put. The model assumes that the private sector and the government compete for the same pool of funds given the scarce resources in an economy. Thus, the marginal source of funds for any government project is from borrowing in the capital market and a project should only be undertaken if its return is higher than the available return on alternative projects (Burgess and Zerbe 2011). In other words, the social benefit of a project needs to exceed the loss resulting from the removal of resources from the private sector. In practical terms, the opportunity cost of these funds is represented by the market interest rate or ex post calculated rate of return for the market economy.

A number of governments, for example in Germany, France, and the UK, have already switched from using a SOC-based recommended value of the social discount rate to an SRTP-based value over the last decade. SOC based rates are typically higher than SRTP based rates. While many economists favour the SOC method (e.g., Baumol 1968; Hirshleifer 1972; Harberger 1972; Burgess and Zerbe 2011) favour the SOC method, most favour the SRTP as an appropriate way to discount future consumption. Contributions to the SRTP approach go back to Ramsey (1928) and have been widely discussed in the economics literature (e.g., Marglin 1963; Feldstein 1964; Bradford 1975). One argument for the choice of the social rate of time preference (SRTP) is the fact that consumption by future generations can be regarded as public goods. Public projects displace current consumption, and streams of costs and benefits to be discounted are essentially streams of consumption goods either postponed or gained. The SRTP has the practical advantage of straightforward calculation and demonstrated empirical applicability.

The fundamental goal in welfare economics is to maximize the utility (or happiness) of society or of a representative individual, where utility depends on per capita consumption in present and future time periods. Public and private consumption goods and services are traditionally taken into account. The SRTP is a normative function reflecting society's evaluation of the relative desirability of consumption at different points in time. It measures a society's willingness to postpone a unit of current consumption in exchange for more future consumption. Future consumption can be increased at the expense of current consumption, either through savings that lead to investment in human or physical capital, or in the generation of new ideas. Two alternative methods have come up for empirical estimation of the SRTP. One is to approximate it by the after-tax rate of return on government bonds while the second option is the Ramsey (1928) model used in this section [57].

The basic equation for the SRTP according to Ramsey (1928) is the sum of two components:

$$SRTP = \rho + eg = (w - \pi) + eg \tag{37}$$

The first term in equation 37 is the rate at which utility is discounted or rate of time preference ρ; it comprises two elements, the "pure" time preference w which is related to individual's impatience or myopia, and the survival risk or Weberian notion of life chance π. The second term is the product of the elasticity of marginal utility of consumption e and the trend rate of growth of per capita consumption g. The rationale behind g is that the rate of substitution between the present and the future society is reflected by the growth rate of consumption over long periods. Taking the subcomponents of ρ into account, and adopting the definitions as in OECD (2009), the SRTP can be equivalently expressed as:

$$SRTP = (1 + g)^e (1/\pi^w) - 1 \tag{38}$$

Estimating g is straightforward, and the data can be drawn from the national accounts. The parameters w, π and e are harder to quantify and have been a subject of debate in the economics literature because they require some normative value judgments. For example, the rate of time preference captures the degree of selfishness of present generation vis--vis future generations.

A value for w = 1 implies that current generations do not consider future generations, whereas w = 0 stands for no selfishness at all, and w = 0.5 suggests an intermediate degree of consideration of generations to follow OECD (2009). Even though zero time preference implies a savings rate that is much higher than normally observed, thus contradicting actual behaviour,

[57] Note that the US Bureau of Labor Statistics total economy productivity estimates use a government bond rate; see Harper et al. (2009) for further details.

a zero rate has been chosen in some empirical studies. On balance, ω ranges between zero and 0.5 in the literature (Pearce and Ulph 1999; OECD 2009). As previously noted, the parameter π is related to life chance. It also has been taken to mean survival risk. The UK Treasury (2003) deemed it catastrophe risk, which is the risk of a devastating event that eliminates all returns from projects, programs, or policies. Natural disasters or wars are examples of such an event. It can also be defined as the increasing risk of death for an individual that is aging (Evans and Sezer 2004). We follow Pearce and Ulph (1999) and OECD (2009) and define π as the survival probability of an individual, which can be measured as

$$\pi = 1 - (deaths/population) \tag{39}$$

This measure reflects the risk that the average individual will not gain the benefits from future returns to investments.

The elasticity of marginal utility of consumption e captures the percentage change in utility from an additional percentage point change in consumption. In other words, it measures the preference of a society for reducing inequality in per capita consumption over time (Moore, Boardman and Vining 2013). Higher values of e reflect a higher tendency of a society to discount unit of consumption received in the (richer) future, reflecting an overwhelming desire to equalize per capita consumption over time. Theoretically, e could range between zero and infinity, but it is usually treated as constant (e = 1) in empirical studies.[58] The classic source of estimates of e is Stern (1977). He surveyed a number of studies that suggested a range for e from 0 to 10, but with a concentration of estimates around a value of 2. Pearce and Ulph (1999), in their survey of the evidence, estimate a range for e from 0.7 to 1.5, with a value of 1 being defensible. Oxera (2002), based on their survey of relevant studies, as well as OECD (2009) regard a range of 0.5 to 1.2 as reasonable.

Without a preference for present over future happiness (ρ=0) and a zero elasticity of marginal utility of consumption (e = 0), a society would value each unit of consumption received in the future as equal to the value of a unit of consumption in the present. This can be interpreted as a complete lack of concern for temporal inequality in consumption. Consumption should be discounted by the SRTP to maximize the present value of utility from its current and future consumption per capita flows. Society would arrive at the optimal growth rate of consumption,

[58] Setting e = 1 implies that the marginal utility of a society's consumption per capita equals the inverse of its per capita consumption in each time period (Moore, Boardman and Vining 2013).

if investment continues until the real return to investment were equal to the SRTP. That is why the method of deriving the social discount rate is sometimes referred to as the optimal consumption model (Moore, Boardman and Vining 2013).

Social rate of time preference for EU countries and the US. Before we focus our attention on the SRTP results, we examine the annual growth rate consumption per capita. Figures 38 - 40 show the growth of total consumption per capita and the contribution of the government to total consumption growth in the EU-15, the US, and the EU-12. Comparing figures 38 and 39, the growth of total consumption per capita and government's contribution to it are both rather more volatile in the US than in the EU-15. The impact of the initial phase of the recent financial crisis was also more severe in the US than in Europe, but, after the initial phase, patterns diverged with the "double-dip" in Europe and recovery (albeit subdued) in the US. Consumption growth in the EU-12 during the financial crises exhibits a similar pattern to that in the EU-15. Reliable and coherent rate of returns for the public sector are needed to

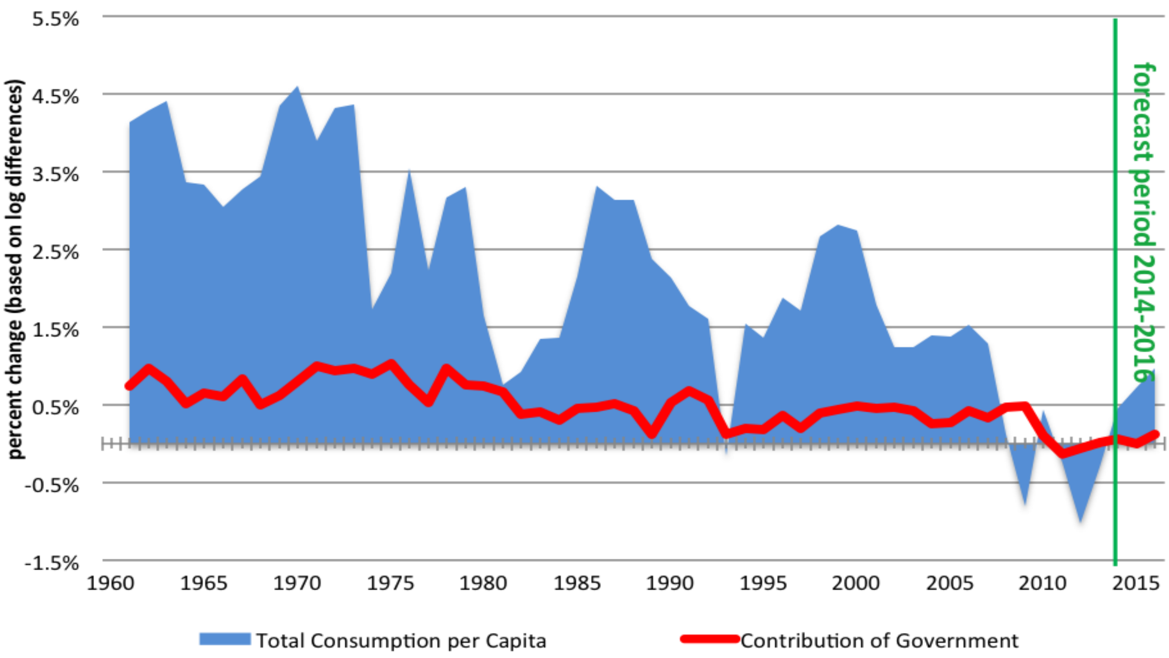


Figure 38: Annual Growth Rate of EU-15* Consumption per capita, 1961 to 2016

*Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, the Netherlands and UK.
Source: Authors' elaboration of data from the AMECO database.

guarantee the international comparability of the results within the SPINTAN project. Therefore,

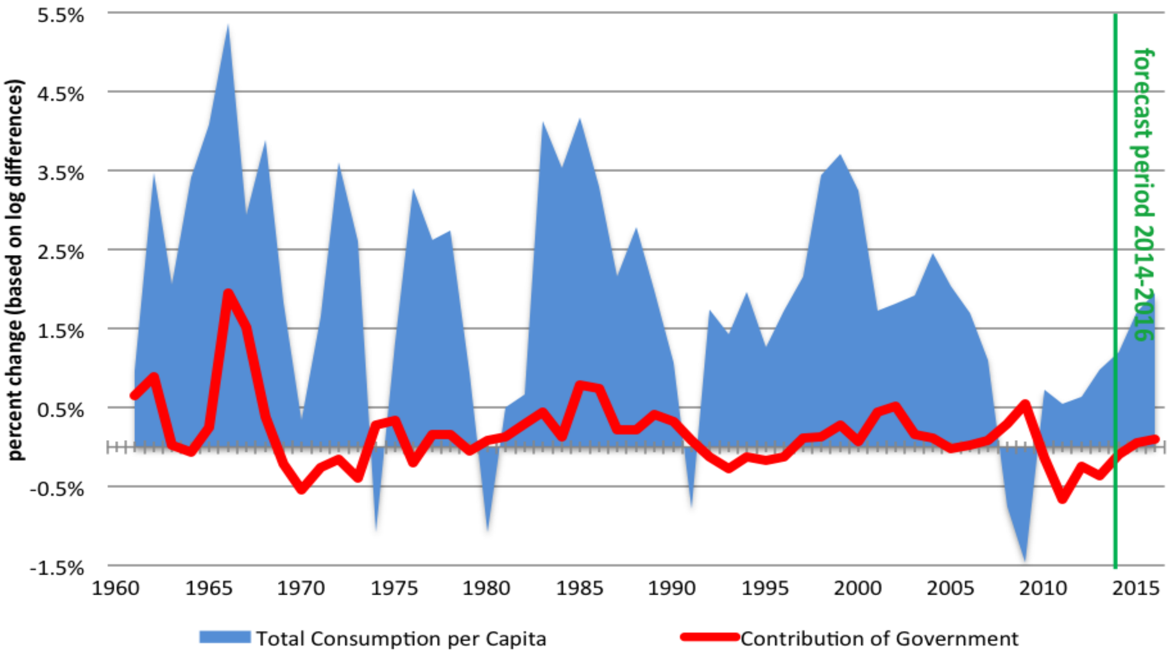


Figure 39: Annual Growth Rate of US. Consumption per capita, 1961 to 2016

Source: Authors' elaboration of data from the AMECO database

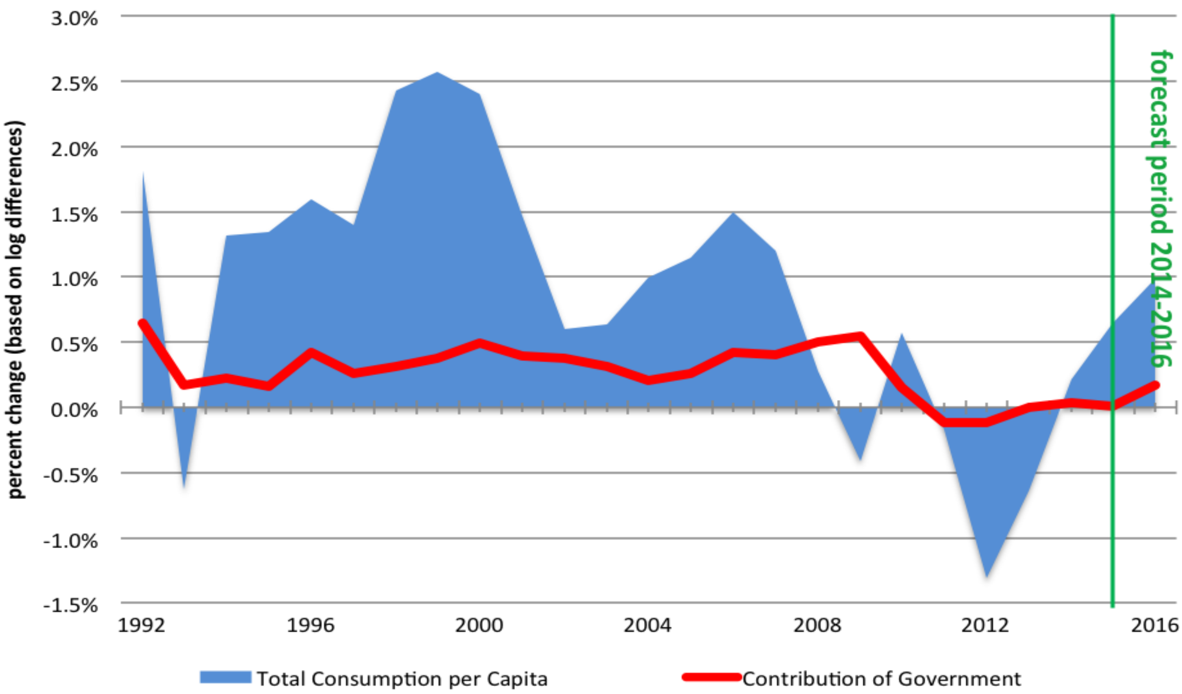


Figure 40: Annual Growth Rate of EU-12*. Consumption per capita, 1992 to 2016

* Bulgaria, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Romania, Slovakia and Slovenia.
Source: Authors' elaboration of data from the AMECO database.

we calculate individual SRTPs for 22 European countries, as well as aggregates EU-27 and EU-12, and the US from 1961-2013. The OECD capital manual (2009) published calculations for the social rate of time preference based on household consumption for 24 OECD countries for the period 1970-2005. Our estimates are not only an update of the SRTP for many countries for the longer period 1961-2013, but also a refinement of the OECD estimates because we also compute the SRTP based on total consumption per capita. Our primary data source is the AMECO database that comprises not only macroeconomic data through 2013 for EU Member States, candidate countries, and other OECD countries, but also forecasts for the years 2014 to 2016.

Table 28 shows the SRTP estimates based on private consumption per capita and table 4 shows the estimates based on total consumption per capita. Our preferred approach is the calculation of SRTPs based on total per capita consumption became it includes all services consumed by households regardless of source of supply (or nature of services). Besides the average growth rates of per capita consumption, both tables show the survival probability in the third column, and thereafter six versions of SRTPs using different combinations of the parameters w (consumption preferences of individuals) and e (elasticity of marginal utility of consumption). The preferred parameter combination SRTP is highlighted with a grey shading. It combines the common settings of w and e in the empirical literature as described in the previous section, assuming intermediate consideration of following generations and a unitary elasticity of the marginal utility of consumption. The average SRTP1 based on household consumption per capita is 0.08 percentage point (2.43 vs. 2.35) higher than SRTP1 based on total consumption per capita, implying that the inclusion of public consumption leads to a better consideration of future generations. The largest difference occurs for the US. Sweden, Germany, and Belgium exhibit the smallest difference between both methods.

Portugal, Poland, Bulgaria, and Slovakia have the highest SRTP1 - above 3 percent in table 2 - which implies the lowest willingness to postpone private consumption now in order to consume later among all sample countries. A high willingness to refrain from current consumption can be observed in Sweden, Hungary, and the Czech Republic. Current generations in the US appear to have a higher preference for current consumption compared with counterparts in European countries.

Finally, we note that the SRTP can vary over time although a common practice in empirical studies is to assume the SRTP is constant within a given generation. SRTP practice then suggests that essentially a single value for the SRTP could be used as the return to public assets. A time series approach is more relevant for national accounts and productivity analysis, however. We therefore generated a time series for SRTP2 using a *trend value* for the growth in consumption per capita. The trend was determined via the Hodrick-Prescott filter ($\lambda = 100$), and results for the main aggregates are shown in figure 41. As may be seen, the results hover about 2 percent from the mid-1980s to the early 2000s but then drop down and move back up slightly after that. Individual EU country results based on trend consumption per capita as well as tables for the SRTP based on the last 30 years of data (i.e., 1983 to 2013) are shown in the appendix E.

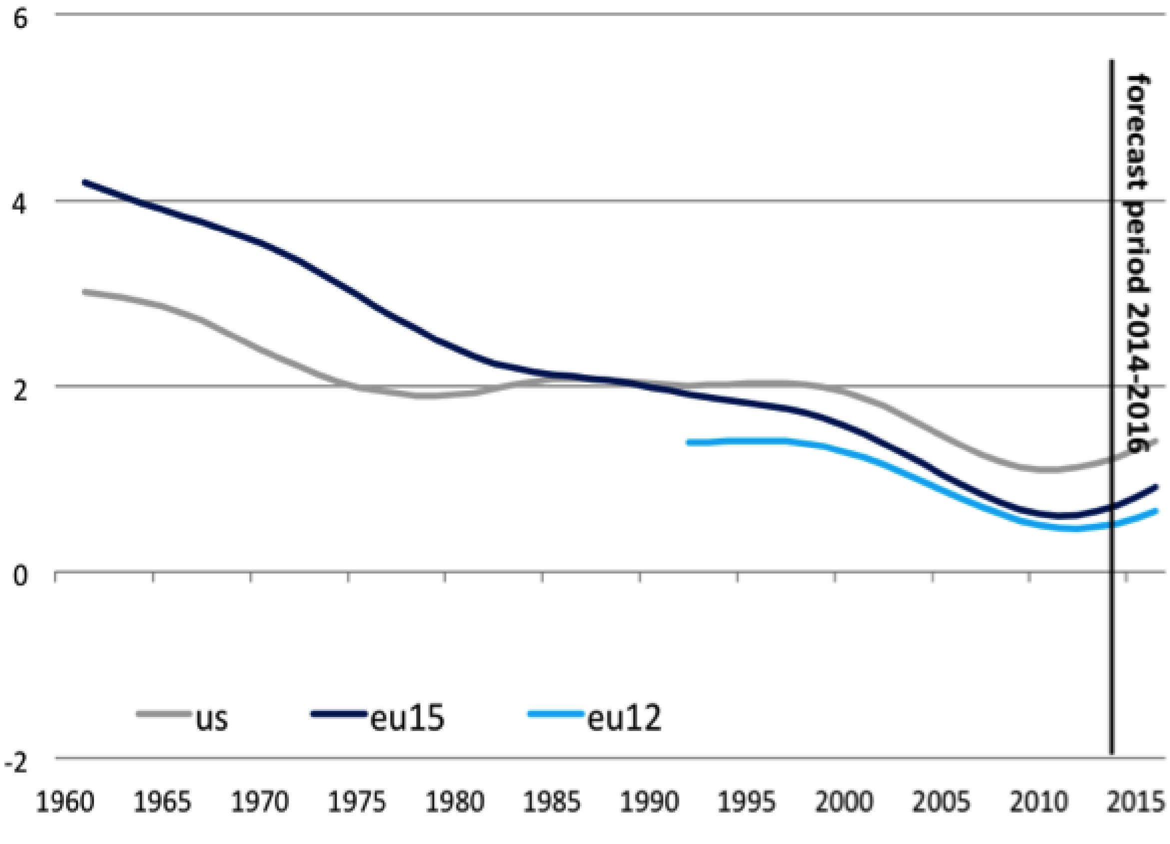


Figure 41: SRTP based on HP-filtered Growth of Total Consumption per capita, 1961 to 2016

Source: Authors' calculations.

5.4.3 Rates of Return for Public Capital: Summing-up

The computation on public intangible capital poses additional problems to those presented in section 5.4.1. For the assets already recognized by national accounts, we need to distinguish

Country	Private Consumption per capita (%) g	Survival probability π	Social rate of time preference (%) SRTP1 $w = 0.5$ $e = 1$	SRTP2 $w = 1$ $e = 1$	SRTP3 $w = 0.5$ $e = 0.5$	SRTP4 $w = 1$ $e = 0.5$	SRTP5 $w = 0.5$ $e = 1.2$	SRTP6 $w = 1$ $e = 1.2$
AT	2.28	0.97770	2.32	2.35	0.83	0.85	3.21	3.25
BE	2.09	0.97798	2.12	2.16	0.78	0.80	2.91	2.95
DK	1.73	0.97883	1.76	1.79	0.67	0.69	2.37	2.41
FI	2.64	0.98102	2.67	2.71	0.93	0.94	3.76	3.80
FR	2.18	0.98060	2.21	2.25	0.80	0.82	3.05	3.09
DE	2.27	0.97726	2.31	2.35	0.83	0.85	3.20	3.25
GR	2.63	0.98193	2.66	2.69	0.92	0.94	3.73	3.78
IE	2.34	0.98148	2.37	2.40	0.85	0.86	3.29	3.33
IT	2.30	0.98053	2.33	2.37	0.83	0.85	3.23	3.27
LU	2.27	0.97977	2.30	2.34	0.83	0.85	3.19	3.23
NL	1.90	0.98331	1.92	1.95	0.72	0.73	2.62	2.65
PT	2.98	0.97943	3.02	3.07	1.02	1.04	4.31	4.36
ES	2.39	0.98309	2.42	2.45	0.86	0.87	3.37	3.40
SE	1.65	0.97902	1.67	1.70	0.64	0.66	2.25	2.28
UK	2.18	0.97791	2.22	2.25	0.80	0.82	3.06	3.10
HU*	1.86	0.97453	1.90	1.94	0.71	0.74	2.58	2.63
CZ*	1.45	0.97711	1.48	1.51	0.58	0.60	1.96	2.00
PL*	3.92	0.98147	3.97	4.02	1.24	1.26	5.84	5.90
RO*	3.53	0.97858	3.58	3.63	1.15	1.18	5.20	5.27
BG*	2.92	0.97638	2.97	3.01	1.00	1.03	4.21	4.28
SK*	3.63	0.98101	3.67	3.72	1.17	1.19	5.35	5.41
SL*	1.79	0.98063	1.82	1.85	0.69	0.70	2.46	2.49
US	2.22	0.98262	2.25	2.28	0.81	0.83	3.10	3.14
EU-27	2.33	0.97951	2.36	2.40	0.84	0.86	3.28	3.32
EU-15*	2.18	0.98382	2.21	2.23	0.80	0.81	3.04	3.07
Average (individual countries)	2.40	0.97966	2.43	2.47	0.86	0.87	3.40	3.45

Table 28: Social rate of time preference, based on private consumption per capita 1961-2013

Note: * Shorter time period. Grey shading indicates preferred SRTP.
** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, the Netherlands and UK.
Source: AMECO database, Eurostat.

Country	Total Consumption per capita (%)	Survival probability	Social rate of time preference (%)					
	g	π	SRTP1 $w = 0.5$ $e = 1$	SRTP2 $w = 1$ $e = 1$	SRTP3 $w = 0.5$ $e = 0.5$	SRTP4 $w = 1$ $e = 0.5$	SRTP5 $w = 0.5$ $e = 1.2$	SRTP6 $w = 1$ $e = 1.2$
AT	2.23	0.97770	2.26	2.30	0.82	0.84	3.12	3.17
BE	2.12	0.97798	2.16	2.19	0.79	0.81	2.96	3.01
DK	1.86	0.97883	1.89	1.92	0.71	0.73	2.57	2.61
FI	2.62	0.98102	2.65	2.69	0.92	0.94	3.72	3.77
FR	2.26	0.98060	2.29	2.32	0.82	0.84	3.16	3.21
DE	2.27	0.97726	2.31	2.34	0.83	0.85	3.19	3.24
GR	2.60	0.98193	2.63	2.67	0.92	0.93	3.70	3.74
IE	2.33	0.98148	2.36	2.39	0.84	0.86	3.28	3.32
IT	2.19	0.98053	2.22	2.25	0.80	0.82	3.06	3.10
LU	2.41	0.97977	2.45	2.48	0.87	0.89	3.41	3.45
NL	1.99	0.98331	2.02	2.04	0.74	0.76	2.76	2.79
PT	3.18	0.97943	3.23	3.27	1.07	1.09	4.63	4.68
ES	2.61	0.98309	2.64	2.68	0.92	0.93	3.71	3.75
SE	1.70	0.97902	1.73	1.76	0.66	0.68	2.33	2.36
UK	2.01	0.97791	2.05	2.08	0.75	0.77	2.80	2.84
HU*	1.69	0.97453	1.72	1.76	0.66	0.68	2.32	2.36
CZ*	1.13	0.97711	1.16	1.18	0.48	0.50	1.51	1.54
PL*	3.71	0.98147	3.76	3.80	1.19	1.21	5.48	5.55
RO*	3.20	0.97858	3.25	3.29	1.07	1.09	4.66	4.72
BG*	2.08	0.97638	2.12	2.16	0.78	0.80	2.91	2.96
SK*	3.41	0.98101	3.46	3.50	1.12	1.14	5.00	5.05
SL*	1.84	0.98063	1.86	1.89	0.70	0.72	2.53	2.56
US	1.94	0.98262	1.96	1.99	0.73	0.74	2.67	2.71
EU-27	2.32	0.97951	2.36	2.39	0.84	0.86	3.27	3.31
EU-15**	2.18	0.98382	2.20	2.23	0.80	0.81	3.04	3.07
Average (individual countries)	2.32	0.97966	2.35	2.39	0.83	0.85	3.28	3.32

Table 29: Social rate of time preference, based on total consumption per capita 1961-2013

Note: * Shorter time period. Grey shading indicates preferred SRTP.
** Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Portugal, Spain, Sweden, the Netherlands and UK.
Source: AMECO database, Eurostat.

if they are owned, or not, by the market sector. In the first case, its consideration will not change the Gross Value Added (GVA). These assets should be treated by NA as any other tangible asset. But, if they are owned by the non-market sector, GVA will increase since NA only recognizes the consumption of fixed capital as has already been highlighted in section 5.4.1. For the intangible assets not yet recognized by NA their capitalization will cause a symmetric increase of both Gross Fixed Capital Formation (GFCF) and GOS, regardless the ownership by the market or the non-market sector. Thus GVA will increase in both cases.

As explained above, the user cost of capital for both non-market tangible and intangible assets can be computed by using an endogenous or an exogenous rate of return. The following alternatives are open:

1. Ex post rate of return computed only for tangible assets in the market sector
2. Ex post rate of return for both tangible and intangible assets in the market sector
3. A selection of market rates of interest for different assets
4. Financing costs of government projects (proxy by Government long term bonds)
5. The social rate of time preference (SRTP)
6. Others

The social time preference rate (SRTP) reflects the value that society attaches to present, as opposed to future, consumption, while the remaining rates (with the obvious exception of option 6) reflect the opportunity cost for investment in the private sector. Figure 42 presents the evolution followed by : (i) Ex post rate of return computed only for tangible assets in the market sector (M1 in figure 36); (ii) Financing costs of government projects (proxy by Government long-term bonds) (M5 in figure 36); (iii) The time-varying social rate of time preference (SRTP) for the Spanish economy presented in the appendix E ; and (iv) An average of the last two options which represent the opportunity costs for private consumption (SRTP) and investment (long-term government bonds) since public spending could have crowded out both.

Figure 8 shows that the three alternative exogenous rates of return provide similar results for the value of the capital services corresponding to the asset software in the non-market sector of the Spanish economy. Regarding the only endogenous measure M1, the differences are noticeable and have widened since the beginning of the last cyclical expansion around the middle of the nineties. As before, the severe downturn experience by the M1 measure in the first years of the recession is also remarkable. Table 30 computes the differences of the three exogenous measures with respect to M1, both in levels and in growth rates. Regarding levels, panel a) indicates that the differences oscillate between a low 82% in 2005 and a high 111% in 2009 for M5 in both cases. Concerning the differences in terms of annual growth rates, panel b) shows, again, important deviations from the M1 measure during the period 2005-2009 which can be attributed to the strong downturn shown by the nominal rate of return shown in figure 1 for years 2008 and 2009.

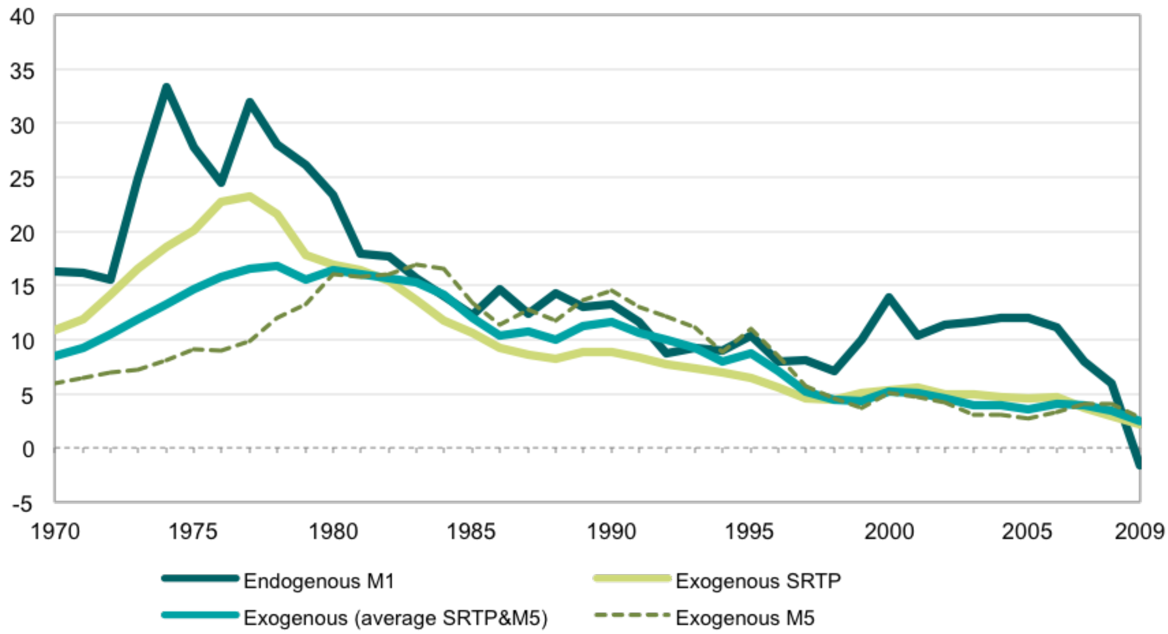


Figure 42: Nominal rate of return. Non-Market Economy. Spain (1970-2009) (percentage)

Source: BBVA Foundation-Ivie and own elaboration

5.4.4 Concluding Remarks

This chapter has reviewed the main statistical and methodological issues associated with measuring returns to non-market and public capital. For our purpose the distinction between the two definitions is not relevant because the problems addressed are common to both.

The main conclusions to be drawn are the following. First, the lack of statistical data providing cross-referenced information for both industrial and institutional sectors is a major

a) Levels (percentage over M1)

	1970	1980	1990	2000	2005	2009
SRTP	0.93	0.87	0.91	0.84	0.86	1.09
M5	0.84	0.86	1.01	0.83	0.82	1.11
Average SRTP&M5	0.88	0.86	0.96	0.83	0.84	1.10

b) Average annual rates of growth (percentage points difference)

	1970-1980	1980-1990	1990-2000	2000-2005	2005-2009	1970-2009
SRTP	-0.60	0.47	-0.89	0.50	6.06	0.42
M5	0.20	1.70	-2.01	-0.14	7.42	0.72
Average SRTP&M5	-0.21	1.10	-1.46	0.19	6.73	0.57

Table 30: Value of Capital Services. Non-Market Economy. Spain. Software (differences from the endogenous M1 assumption)

Source: BBVA Foundation-Ivie and own elaboration.

hurdle to appropriate measurement of public capital. The availability of this information has worsened rather than improved in the last years and there is little hope that things will change in the near future.

Second, it is now commonly accepted by researchers but not, or at least not yet, by the National Statistical Institutes that public capital should be assigned a net return that goes beyond the National Accounts practices of considering only the depreciation component measured by the consumption of fixed capital.

There is less agreement on how this rate of return should be computed, however. The four main questions are:

1. Should the imputation consider the same rate of return for private and public capital, or should it be different?

2. Should the non-market sector follow the endogenous (ex post) or endogenous (ex ante) approach?

3. Should the rate of return used for public capital calculations be selected taking into account only the consequences of public GFCF on private investment or also in private consumption?

4. Does this discussion have practical consequences or is it irrelevant from the practical perspective?

The answers to these questions can be summarised as follows. First, from the SPINTAN perspective, the reasons outlined in section 5.4.1 recommend using a rate of return for the non-market economy that is different from the market economy. Second, in principle both endogenous and exogenous approaches could be used for both market and non-market economies. However, the consistent use of the former requires statistical information that clearly distinguishes between the investment made by industries and institutional sectors, market and non-market, or public and private. Because this information is not readily available for the great majority of countries, the most consistent alternative is to use the exogenous approach. Third, since public investment crowds out both private consumption and private investment, at least in principle, one logical choice is to use a combination of the opportunity cost of both of them. Fourth, selecting one of the various alternatives proposed indeed has some practical consequences when the economy is going through phases of strong cyclical movements as the Spanish data shows for the most recent economic crisis.

All told, our suggestion is to use the time-varying social rate of time preference (SRTP) as the return to public and nonmarket assets in SPINTAN analysis. As a conceptual matter (ignoring inflation and taxes), the SRTP and government bond yields should be capturing the same inter-temporal preferences. Furthermore, the information for the Spanish economy indicates that, at least for the most recent period, there are no significant differences between them. As a consequence, from the practical perspective the measurement of the capital services is not affected. Therefore, the selection of the time-varying SRTP as the most appropriate rate of return for non-market or public assets is backed by both conceptual and practical reasons.

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A Estimating Investment in Training: annex1

This appendix reports all questions which were exploited in the methodological section of this study.

- **FE12:** "Did you attend any formal training activity in 12 previous months?" (*Yes/No*). Derived variable.
- **B_Q02B:** "What is the level of the qualification you are currently studying for?" (*choose one of 6 ISCED categories*)
- **B_Q04A:** "During the last 12 months, have you studied for any formal qualification, either full-time or part-time?" (*Yes / No*)
- **B_Q05A:** (in reference to question B_Q04A) "What was the level of this qualification?" (*choose one of 6 ISCED categories*)
- **B_Q10A:** "In the last 12 months, while studying for this qualification, were you employed at any time, either full-time or part-time? (*Yes / No*)
- **B_Q10B:** (in reference to question B_Q10A) "Did this study take place..? (*Only during working hours; Mostly during working hours; Mostly outside working hours; Only outside working hours*)
- **B_Q10C:** (in reference to question B_Q10A) "How useful were your studies for this qualification for the job or business you had at that time? Would you say they were" (*Not useful at all; Somewhat useful; Moderately useful; Very useful*)
- **B_Q11:** (in reference to question B_Q10A) "Did an employer or prospective employer pay for tuition or registration, exam fees, expenses for books or other costs associated with your studying for this qualification?" (*Yes, totally; Yes, partly; No, not at all; There were no such costs; No employer or prospective employer at that time*)
- **NFE12:** "Did you attend any non-formal training activity in 12 previous months?" (*Yes/No*). Derived variable.
- **B_Q15B:** (in reference to variable NFE12) "Did this study take place?" (*Only during working hours; Mostly during working hours; Mostly outside working hours; Only outside working hours*)
- **B_Q15C**: (in reference to variable NFE12) "How useful was this training for the job or business you had at that time or still have? Would you say it was" (*Not useful at all; Somewhat useful; Moderately useful; Very useful*)
- **B_Q16:** (in reference to variable NFE12) "Did an employer or prospective employer pay for tuition or registration, exam fees, expenses for books or other costs resulting from your participation in this activity? Would that be" (*Yes, totally; Yes, partly; No, not at all; There were no such costs; No employer or prospective employer at that time*)
- **B_Q17:** (in reference to variable NFE12) "Now let's look at the total amount of time you have spent in the past 12 months on all types of courses, training, private lessons, seminars or workshops. What is the easiest way to describe the total time you spent on all these activities: would that be in whole weeks, in whole days or in hours? Exclude time spent on homework or travel." (*Weeks; Days; Hours*)
- **B_Q18A, B_Q19A, B_Q20A:** "How many whole (weeks; days; hours) did you spend in these activities?" (*Number*)
- **C_Q07**: "Please look at this card and tell me which ONE of the statements best describes your current situation." *(Full-time employed; Part-time employed; Unemployed; Pupil, student; Apprentice, internship; In retirement or early retirement; Permanently disabled; In compulsory military or community service; Fulfilling domestic tasks or looking after children/family; Other)*
- **D_Q03**: "In which sector of the economy do you work?" *(Private sector; Public sector; Non-profit organisation)*

- **D_Q06A:** "How many people work for your employer at the place where you work? Would that be" (*1-10 people; 11-50; 51-250; 251-1000; more than 1000 people*)
- **D_Q07A:** "Do you have employees working for you? Please include family members working paid or unpaid in the business." (*Yes/No*)
- **D_Q07B:** "How many people do you employ? Would that be" (*1-10 people; 11-50; 51-250; 251-1000; more than 1000 people*)
- **D_Q09**: "What kind of employment contract do you have?" *(Indefinite; Fixed term; Temporary employment agency contract; Apprenticeship or other training scheme; No contract)*
- **D_Q10:** "How many hours do you usually work per week in this job? Include any usual paid or unpaid overtime, but exclude lunch breaks or other breaks." (*Number of hours*)
- **D_Q13A:** "In your own job, how often do you learn new work-related things from co-workers or supervisors?" (*Never; Less than once a month; Less than once a week but at least once a month; At least once a week but not every day; Every day*)
- **D_Q13B**: "How often does your job involve learning-by-doing from the tasks you perform?" (*Never; Less than once a month; Less than once a week but at least once a month; At least once a week but not every day; Every day*)
- **D_Q13C:** "How often does your job involve keeping up to date with new products or services?" (*Never; Less than once a month; Less than once a week but at least once a month; At least once a week but not every day; Every day*)

B Estimating Investment in Training: annex2

Estimation of the average number of hours per day spent in informal learning The objective of this section is to provide an estimates of hours per day employees spend in training, on the basis of Loewenstein and Spletzer (2000) for the U.S., Kurosawa (2001) for Japan, and Nelen and de Grip (2009) for the Netherlands. These papers report different estimates of the length of training in a year, which are here made comparable. In particular, both Loewenstein and Spletzer (2000) and Kurosawa (2001) distinguish between newly hired employees and all other employees. Loewenstein and Spletzer (2000), however, report the length of training in number of hours per year, Kurosawa (2001) does so in days per year, while Nelen and de Grip do so in hours per week. These figures are reported in the first three rows of Table 31, in bold. The number of hours of informal learning per day for the U.S. is then obtained by dividing the number of hours per year (*Hours/Year*) by the average number of working days in 1993 and 1994 (250.5, not reported in Table A3). For Japan, the number of days per year is transformed in hours per year using *Working Hours/Day*, then divided by the number of working days in 1994 (248, not reported in Table 31). Finally, for the Netherlands, the number of hours of training per week (*Hours/Week*) is divided by the average number of working hours in a week as reported in the Life Long Learning survey used by Nelen and de Grip (2009) (i.e. 41.9); the result is then multiplied by the number of hours actually worked in a day (*Working Hours/Day*).

	US (1993-94)				Japan (1994)		Netherlands (2007)
	Newly Hired		*Others*		*Newly Hired*	*Others*	*Full Time N*
	Supervisor	*Co-worker*	*Supervisor*	*Co-worker*	*Total*	*Total*	*Total*
Days/Year					**28.7**	**12.5**	
Hours/Year	**49.8**	**78.4**	**22**	**30.9**			
Hours/Week							**11.9**
Working Hours/Day	7.3	7.3	7.3	7.3	7.7	7.7	5.6
Hours/Day	0.20	0.31	0.09	0.12	0.89	0.39	1.56

Table 31: Average number of hours per day spent in informal learning, country comparisons
Source: : Loewenstein and Spletzer (2000) for the U.S., Kurosawa (2001) for Japan, and Nelen and de Grip (2009) for the Netherlands. The numbers in bold are taken from these articles directly and elaborated by the authors for the present study, yielding the remaining figures which populate the table. The number of working hours per day is calculated from the average hours worked per employee ("Total Employment") in the reference year, from the OECD. The figures for the U.S. are averaged between 1993 and 1994, as in Loewenstein and Spletzer (2000).

C Appendix: Data Sources for Own-account Organizational Capital

To apply the cost based approach to measure OAOC we need data on the number of managers and their average compensation. The main sources are the following:
a) Structure of Earnings Survey (SES) represents EU-wide, harmonized structural data on gross earnings, hours paid and annual days of paid holiday leave that are collected every four years. Years available from Eurostat's website: 2002, 2006 and 2010. Variables of interest (from SES 2010 release): Mean annual earnings by economic activity and occupation and Number of employees by economic activity and occupation. Sector and Industry coverage: according to the Eurostat Metadata about the 2010 survey. The statistics cover all economic activities defined in NACE Rev. 2 sections B to S. NACE Section O (Public administration and defense; compulsory social security) is optional, however covered by most countries. Data from Eurostat are available only at the level of 1 digit of ISCO classification of occupation. At the level of 1 digit it is possible to identify only the general category "Managers", more detailed data have to be requested to Eurostat or NSI. SES info are not cross classified by industry and sector. (we need to think about an alternative source, see below for sector O).

b) Labour Force Survey (LFS) is the main source of information for the composition and trends in the labour market in the EU. The survey's target population is all persons in private households aged 15 years or older. Data for all member states are mostly available from 1999 or 2000 onwards. Data relating to the former EU-15 are available from 1995 onwards and those relating to the former EU-12 are available from 1987 onwards. Results for the candidate countries date back to 2002 and for the EFTA countries to 1995. Variable of interest: Number of employees by occupation. LFS does not collect data on compensation. Sector and industry coverage: LFS is an households survey, but respondent are asked the industry in which they work and also if they work in the public sector or not (probably here public sector must be interpreted as government sector, S13). It is possible to generate data disaggregated by industry, profession and sector (public sector vs non-public).

c) OECD Survey on Compensation of Employees in Central/Federal Governments. Some results are reported in the "Government at a Glance 2013", OECD. This survey aims at collecting information on annual compensation of employees for a sample of occupations in central/federal/national government. The purpose is to build a database on compensation levels for typical positions in central government that contributes to a better understanding of the salary structures and pay levels in the public service. Sector and industry coverage: the survey focuses on central/federal government level and excludes states, regional and local levels and social security institutions. The survey excludes all public and quasi-public corporations at all government levels. The survey doesn't cover the subordinated offices/organizations of central government ministries, often referred to as ?agencies?. It also focuses on employees working full-time, excluding consultants and short-term staff. In terms of official classification, is seems that the survey covers a subset (central/federal government) of industry O. Occupational groups: top managers, middle managers, professionals, and secretaries.

D Appendix: Classification Systems

Table B1: **NACE 2 Intermediate Structure**

The table below presents the “intermediate SNA/ISIC aggregation A*38”:

	A*38 code	ISIC Rev. 4/ NACE Rev. 2	Divisions
1	A	Agriculture, forestry and fishing	01 to 03
2	B	Mining and quarrying	05 to 09
3	CA	Manufacture of food products, beverages and tobacco products	10 to 12
4	CB	Manufacture of textiles, apparel, leather and related products	13 to 15
5	CC	Manufacture of wood and paper products, and printing	16 to 18
6	CD	Manufacture of coke, and refined petroleum products	19
7	CE	Manufacture of chemicals and chemical products	20
8	CF	Manufacture of pharmaceuticals, medicinal chemical and botanical products	21
9	CG	Manufacture of rubber and plastics products, and other non-metallic mineral products	22 + 23
10	CH	Manufacture of basic metals and fabricated metal products, except machinery and equipment	24 + 25
11	CI	Manufacture of computer, electronic and optical products	26
12	CJ	Manufacture of electrical equipment	27
13	CK	Manufacture of machinery and equipment n.e.c.	28
14	CL	Manufacture of transport equipment	29 + 30
15	CM	Other manufacturing, and repair and installation of machinery and equipment	31 to 33
16	D	Electricity, gas, steam and air-conditioning supply	35
17	E	Water supply, sewerage, waste management and remediation	36 to 39
18	F	Construction	41 to 43
19	G	Wholesale and retail trade, repair of motor vehicles and motorcycles	45 to 47
20	H	Transportation and storage	49 to 53
21	I	Accommodation and food service activities	55 + 56
22	JA	Publishing, audiovisual and broadcasting activities	58 to 60
23	JB	Telecommunications	61
24	JC	IT and other information services	62 +63
25	K	Financial and insurance activities	64 to 66
26	L	Real estate activities*	68
27	MA	Legal, accounting, management, architecture, engineering, technical testing and analysis activities	69 to 71
28	MB	Scientific research and development	72
29	MC	Other professional, scientific and technical activities	73 to 75
30	N	Administrative and support service activities	77 to 82
31	O	Public administration and defence, compulsory social security	84
32	P	Education	85
33	QA	Human health services	86
34	QB	Residential care and social work activities	87 + 88
35	R	Arts, entertainment and recreation	90 to 93
36	S	Other services	94 to 96
37	T**	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	97 + 98*
38	U**	Activities of extra-territorial organisations and bodies	99*

* including imputed rents of owner-occupied dwellings

** All of U and part of T (division 98) are outside the SNA production boundary, and will be empty for SNA data reporting, but are included for completeness.

Table B2: **Classification of the Purposes of Nonprofit Institutions**

- 01 - Housing
  - 01.0 - Housing
- 02 - Health
  - 02.1 - Medical products, appliances and equipment
  - 02.2 - Outpatient services
  - 02.3 - Hospital services
  - 02.4 - Public health services
  - 02.5 - R&D Health
  - 02.6 - Other health services
- 03 - Recreation and culture
  - 03.1 - Recreational and sporting services
  - 03.2 - Cultural services
- 04 - Education
  - 04.1 - Pre-primary and primary education
  - 04.2 - Secondary education
  - 04.3 - Post-secondary non-tertiary education
  - 04.4 - Tertiary education
  - 04.5 - Education not definable by level
  - 04.6 - R&D Education
  - 04.7 - Other educational services
- 05 - Social protection
  - 05.1 - Social protection services
  - 05.2 - R&D Social protection
- 06 - Religion
  - 06.0 - Religion
- 07 - Political parties, labour and professional organizations
  - 07.1 - Services of political parties
  - 07.2 - Services of labour organizations
  - 07.3 - Services of professional organizations
- 08 - Environmental protection
  - 08.1 - Environmental protection services
  - 08.2 - R&D Environmental protection
- 09 - Services n.e.c.
  - 09.1 - Services n.e.c.
  - 09.2 - R&D Services n.e.c.

Source: United Nations Website, `http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=6&Lg=1`, accessed July 30, 2014.

Table B3: **SPINTAN Data *Desideratum***

1.	Nonmarket output measurement methods in SPINTAN topic areas by country
2.	Industry detail for NACE 72, and possibly 90–91 vs 92–93 in Section R
3.	Mapping of FOGs to NACE industries
	a. Final consumption
	b. Final investment
	c. Investment grants
	d. Subsidies
4.	Capital compensation by industry including subsidies and relevant transfers
5.	Disaggregation of industry data by institutional sector in our topic areas
	a. Value added and major components
	b. Employment and investment by asset type
6.	Estimates of E and P^{ES} from JF-style human capital accounts
7.	Estimates of the real net return to nonmarket capital
8.	Public R&D spending by industry
9.	Ownership of R&D output funded by the public sector, criteria by SPINTAN country

Source—This paper.

Entirely cultural divisions
Cultural Services - GF0802 - Provision of cultural services; administration of cultural affairs; supervision and regulation of cultural facilities; - operation or support of facilities for cultural pursuits (libraries, museums, art galleries, theatres, exhibition halls, monuments, historic houses and sites, zoological and botanical gardens, aquaria, arboreta, etc.); production, operation or support of cultural events (concerts, stage and film productions, art shows, etc.); - grants, loans or subsidies to support individual artists, writers, designers, composers and others working in the arts or to organizations engaged in promoting cultural activities.
Broadcasting and publishing - GF0803 -Administration of broadcasting and publishing affairs; supervision and regulation of broadcasting and publishing services; -Operation or support of broadcasting and publishing services; -Grants, loans or subsidies to support: the construction or acquisition of facilities for television or radio broadcasting; the construction or acquisition of plant, equipment or materials for newspaper, magazine or book publishing; the production of material for, and its presentation by, broadcasting; the gathering of news or other information; the distribution of published works.
Partly cultural divisions
R&D Recreation, culture and religion - GF0805 -Administration and operation of government agencies engaged in applied research and experimental development related to recreation, culture and religion; -Grants, loans and subsidies to support applied research and experimental development related to recreation, culture and religion undertaken by non-government bodies such as research institutes and universities.
Recreation, culture and religion n.e.c. - GF0806 -Administration, operation or support of activities such as formulation, administration, coordination and monitoring of overall policies, plans, programmes and budgets for the promotion of sport, recreation, culture and religion; preparation and enforcement of legislation and standards for the provision of recreational and cultural services; production and dissemination of general information, technical documentation and statistics on recreation, cultural and religion.

Table B4: Content of culture related COFOG divisions

E Appendix: SRTP Estimates

Country	Total Consumption per capita (%)	Survival probability	Social rate of time preference (%)					
	g	Π	SRTP1 w=0.5 e=1	SRTP2 w=1 e=1	SRTP3 w=0.5 e=0.5	SRTP4 w=1 e=0.5	SRTP5 w=0.5 e=1.2	SRTP6 w=1 e=1.2
at	1.43	0.97974	1.45	1.48	0.57	0.59	1.93	1.96
be	1.21	0.97939	1.23	1.25	0.50	0.52	1.61	1.64
dk	1.15	0.97817	1.17	1.20	0.48	0.50	1.53	1.56
fi	1.74	0.98094	1.77	1.79	0.67	0.69	2.38	2.42
fr	1.29	0.98199	1.31	1.33	0.53	0.54	1.72	1.75
de	1.40	0.97836	1.43	1.46	0.57	0.58	1.90	1.93
gr	1.00	0.98103	1.02	1.04	0.43	0.44	1.33	1.35
ie	2.18	0.98395	2.21	2.23	0.80	0.81	3.04	3.07
it	0.94	0.98054	0.96	0.98	0.41	0.42	1.23	1.26
lu	1.80	0.98176	1.83	1.86	0.69	0.71	2.48	2.51
nl	1.32	0.98296	1.34	1.37	0.54	0.55	1.78	1.80
pt	2.17	0.97993	2.21	2.24	0.80	0.82	3.04	3.08
es	1.73	0.98291	1.76	1.78	0.67	0.68	2.37	2.40
se	1.15	0.97894	1.17	1.19	0.48	0.50	1.53	1.56
uk	2.16	0.97897	2.20	2.23	0.80	0.82	3.03	3.07
hu*	1.69	0.97291	1.72	1.76	0.66	0.68	2.32	2.36
cz*	1.13	0.97755	1.16	1.18	0.48	0.49	1.51	1.54
pl*	3.71	0.98014	3.76	3.81	1.19	1.21	5.49	5.55
ro*	3.20	0.97658	3.25	3.30	1.07	1.10	4.66	4.73
bg*	2.08	0.97303	2.13	2.17	0.78	0.80	2.92	2.97
sk*	3.41	0.98023	3.46	3.50	1.12	1.14	5.00	5.06
sl*	1.84	0.98087	1.86	1.89	0.70	0.72	2.53	2.56
us	1.82	0.98313	1.85	1.87	0.69	0.71	2.50	2.53
eu27	1.59	0.97977	1.61	1.64	0.63	0.64	2.16	2.19
eu15	1.45	0.98431	1.47	1.49	0.58	0.59	1.96	1.98
Average (individual countries)	1.81	0.97974	1.84	1.87	0.68	0.70	2.51	2.55

Table B5: Social Rate of Time Preference, based on total consumption per capita, 1983-2013

Note: *Shorter time period. Grey shading indicates preferred SRTP.
Data sources: AMECO Database, Eurostat

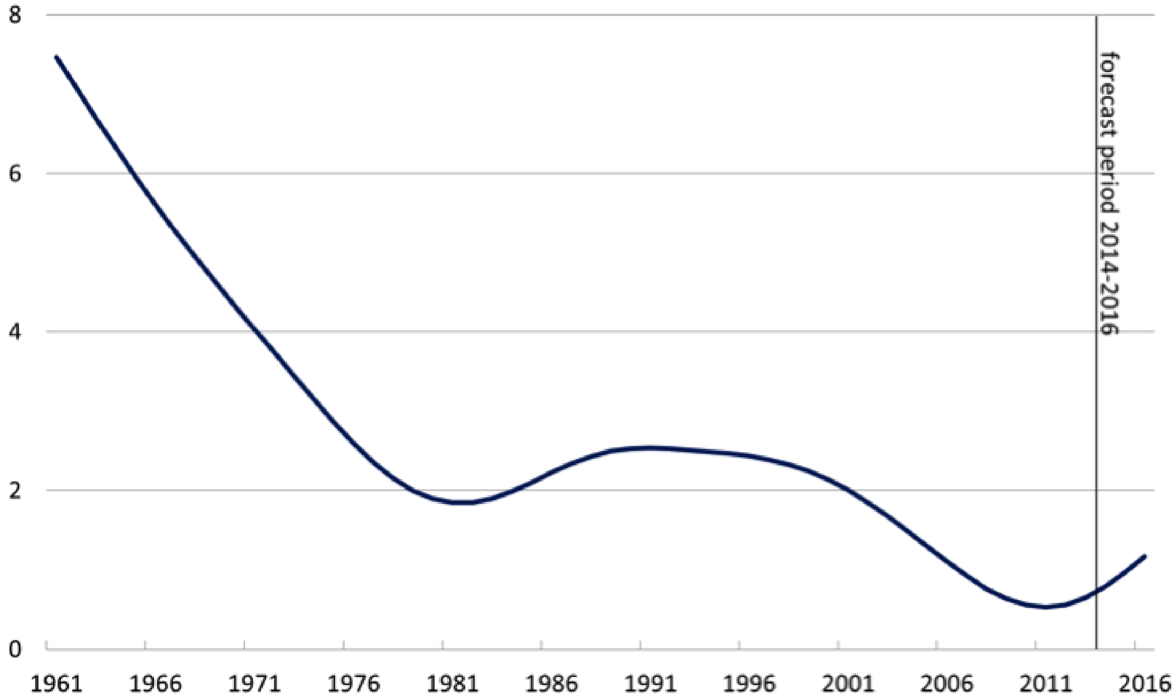

Figure 43: Social rate of time preference based on Total consumption , HP-filtered, Spain 1961-2016

Source: Authors' calculations.