SPINTAN
smartpublicintangibles

Working Paper Series No. 11

ESTIMATES OF INTANGIBLE INVESTMENT IN THE PUBLIC SECTOR: EU, US, CHINA AND BRAZIL

F. Bacchini
C. Corrado
J.Hao
J.Haskel
R. Iannaccone
M. Iommi
K. Jager
C. Jona Lasinio

SPINTAN Project: Smart Public intangibles. This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no: 612774.

Version: April 2016

Published by:

Instituto Valenciano de Investigaciones Económicas, S.A.

C/ Guardia Civil, 22 esc. 2 1º - 46020 Valencia (Spain)

DOI: http://dx.medra.org/10.12842/SPINTAN-WP-11

SPINTAN
smartpublicintangibles

SPINTAN Working Paper Series No. 11

ESTIMATES OF INTANGIBLE INVESTMENT IN THE PUBLIC SECTOR: EU, US, CHINA AND BRAZIL[1]

F. Bacchini*
C. Corrado**
J.Hao**
J.Haskel°
R. Iannaccone°°
M. Iommi°°
K. Jager**
C. Jona Lasinio°°

Abstract

The paper illustrates the methods used to generate measures of public intangible investment for 22 European countries in 1995-2011 and for US, China and Brazil over the period 1995-2013. We propose an estimation strategy that is consistent with National Accounts principles and with the theoretical framework developed in (Corrado, Haskel, Jona-Lasinio, 2015). The methodology is organized into two different steps depending on whether the intangible assets are capitalized in National Accounts or are accounted as intermediate costs. The paper offers also an overview of the main characteristics of the SPINTAN database. Finally, we provide some preliminary evidence on the dynamics and intensities of public intangible investment in the EU economies, US, China and Brazil.

[1] This paper was developed as part of Deliverable 2.2 - SPINTAN.

* ISTAT

** The Conference Board

° Imperial College

°° LUISS Lab on European Economics and ISTAT

1) Introduction

The main goal of SPINTAN is to produce harmonized measures of intangible investment in the public sector coherent with National Accounts Principles (System of National Accounts (2008)).

During the past two years the activity of Work Package 2 (WP2) has been focused on the analysis of the existing data sources, the collection of official data and the construction of a database containing harmonized estimates of intangible investment in the nonmarket industries identified in Work Package 1 (WP1).

This paper provides an overview of the estimation strategy adopted to generate measures of intangible investment in the public sector of 22 European countries (Table 1) in 1995-2011 and in the US, Brazil and China over the period 1995-2013. The estimation strategy is consistent with the theoretical framework developed in WP1 (Corrado, Haskel, Jona-Lasinio, 2014) and it is organized into two different steps depending on the intangible assets being capitalized or not in the National Accounts. The paper offers also some preliminary evidence for the EU economies, US, China and Brazil.

The paper is organized as follows: section 2 illustrates the estimation strategy adopted to generate measures intangible investment in the European economies while section 3 shows some empirical findings. Section 4 is focused on the estimation methods for US, China and Brazil and some results. Section 5 describes the architecture of the database and section 6 concludes.

Table 1 – Country coverage

Eurostat code	Eurostat name		Institution
AT	Austria		WIIW
BE	Belgium		LUISS
DK	Denmark		FORES
FI	Finland		FORES
FR	France		LUISS
DE	Germany		ZEW
EL	Greece		LUISS
IE	Ireland		LUISS
IT	Italy		ISTAT
LU	Luxembourg		LUISS
NL	Netherlands		TCB
PT	Portugal		LUISS
ES	Spain		IVIE
SE	Sweden		FORES
UK	United Kingdom		IC/NIESR
US	United States		TCB
HU	Hungary		WIIW
CZ	Czech Republic		WIIW
PL	Poland		WIIW
RO	Romania		WIIW
BG	Bulgaria		WIIW
SK	Slovakia		WIIW
SI	Slovenia		WIIW
CN	China		TCB
BR	Brazil		TCB
IN	India		TCB

2. Measuring intangible investment in the Public sector

As illustrated in (Corrado, Haskel, Jona –Lasinio (2015)) 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 sectors. Second, we must now capitalize intangibles for each industry mix according to institutional sector. Within this second task, we must 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 second covering estimates for all other non-national accounts intangibles.

To split industries into institutional units as well as capitalize new categories of intangibles for the SPINTAN 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 2. We will refer to this collection of industries as the "nonmarket" sector. We do this because these industries cover most of the public production we are interested in and because this allows us to blend our new work under the SPINTAN project with INTAN-Invest estimates for other industries.

Table 2 – SPINTAN industries of interests

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.

Source: Corrado, Haskel, Jona-Lasinio (2015)

The EU countries and the US adopt different industry classifications that have been harmonized to generate comparable SPINTAN estimates across countries. Section 4 illustrates the method we followed to guarantee the comparability between the EU and the US estimates.

2.1 - Defining the boundaries of public/nonmarket sector

The fundamental units identified in the SNA are the economic units that can engage in the full range of transactions and are capable of owning assets and incurring liabilities on their own behalf. These units are called institutional units (SNA 2008 par 2.16). The institutional units are grouped together to form institutional sectors, on the basis of their principal functions, behavior and objectives. The first step to measure public intangible investment is to identify the boundaries of what it is defined as the nonmarket sector in the NA.

In the National Accounts (ESA/SNA) the non-market sector is composed by the following institutional sectors: the Government Sector consisting of institutional units that, in addition to fulfilling their political responsibilities and their role of economic regulation, produce services (and possibly goods) for individual or collective consumption mainly on a non-market basis and redistribute income and wealth (as S13 in ESA 2010 chapter 2 and in the SNA 2008 par 2.16) and the Non Profit Institutions Serving households (NPISH) Sector (identified as sector S.15 in ESA 2010, chapter 2 and in the SNA 2008 par 4.30) including Non

Profit Institutions engaged in nonmarket production that are controlled by government units or social security funds.

A main goal for SPINTAN is to produce estimates of intangible investment performed by the nonmarket sector cross-classified by industry and by institutional sector. But in the System of National Accounts, units are classified by *industry* according to the activity they carry out being they market or nonmarket producers (SNA 2008 par 5.47). Therefore, each *industry* can (potentially) consist of a mix of market and nonmarket producers. In SPINTAN the *Nonmarket* industries consist of the following NACE Rev. 2 sections: (1) public administration and defense (2) education and (3) human health and social work activities; (4) scientific research and development and (5) arts, entertainment and recreation (Corrado, Haskel, Jona-Lasinio, 2015). Besides Public administration and defense, that is entirely nonmarket in nature, the other industries of interest for SPINTAN contain a mix of producers.

2.2 Estimation strategy

Our estimation strategy is mostly based on National Accounts (NA) principles to generate measures of Public sector intangible investment coherent with other NA aggregates (output, tangible gross fixed capital formation, intermediate costs) and with the business sector estimates of intangibles developed by INTAN-Invest[1] (Corrado, Haskel, Jona-Lasinio, and Iommi, 2012).

We adopt an expenditure-based approach to produce measures of harmonized intangible investment that satisfy the following criteria:

- **Exhaustiveness.** A comprehensive measure of intangible investment incorporates the estimate of two components: own-account and purchased intangible investments.

- **Consistency with national accounts**. NA consistency is guaranteed by the use of NA as the main data source of information.

- **Reproducibility and international comparability**. Reproducibility and international comparability, is assured by the adoption of official data sources homogeneous across countries.

[1] INTAN-Invest is an unfunded research collaboration that maintains and extends work done under the EU FP7 funded project COINVEST and INNODRIVE.

The estimates of intangible investment follow two different approaches depending on the inclusion/exclusion of the asset in the NA boundaries. If the assets are already included in the NA they are identified as "National Account Intangible Asset" (NAIA) if they are excluded they are labeled as " New Intangible Assets" (NIA).

National Account Intangible Asset refer to R&D, Software, Entertainment and artistic originals; while New Intangible Assets are Design, Brand Equity, Organizational Capital and Training.

Measures of intangible assets (R&D, Computer software and databases, Mineral exploration and Artistic originals) already included in the NA (NAIA) are gathered directly from the NA since they include both the own account and the purchased component of intangible investment. However, very often NA data cross-classified by asset, industry and institutional sector are not available, so that there are two different possibilities: National Statistical Institutes (NSI) provide GFCF by industry and by sector but not the cross classification (industry-sector), or alternatively, NSI release only GFCF data by industry without any detail by institutional sector (see appendix 1 for the estimation details).

The basic information about expenditures performed to purchase NIA are classified as intermediate costs in NA. Thus the estimate of the purchased component of intangibles is rather straightforward involving the following steps: *i)* the estimate of the total expenditure in intangible assets; *ii)* the identification of a capitalization factor to compute the share of total expenditure that can be classified as gross fixed capital formation[2]. The estimate of the own account component is rather more complicated because NA data includes only information about final output for own final use[3].

2.2.1 - Measuring investment in New Intangible Assets in the European economies

Purchased intangibles

The *Use table at current prices (NACE Rev. 2),* containing intermediate costs for 40 *industries* and 64 CPA products, is the main information source used to generate measures of purchased

[2] See equation 4) in (Corrado, Haskel, Iommi, Jaeger and Jona-Lasinio, D1.3 May 2015).
[3] The main source used to estimate the own account component of intangible investment are employment and labor cost data (e.g. from Labour Force Surveys and Structure of Earning Surveys) for the occupation that are likely to be more connected with the production of each type of intangible asset. For almost all assets it is necessary to obtain detailed employment data that are not freely available from EUROSTAT (microdata from EUROSTAT LFS and SES).

NIA. The products of interest for SPINTAN are: Advertising and Market Research Services (CPA M73), Architectural and engineering services, technical testing and analysis services (CPA M71) and Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70), Education Services (CPA P85). The information about the expenditure for these products has to be elaborated to match the definition of the SPINTAN industries and assets and to generate measures of intangible investments over the period 1995-2013.

The estimation procedure involves the following steps:

- Mapping the CPA products to the CHS intangible assets using alternative indicators[4].
- Back-casting expenditure data when time series of the USE tables are not available.
- Identifying the amount of market and nonmarket intangible expenditure by industry and product.
- Capitalizing a share or all the estimated intangible expenditure with a proper capitalization factor (Corrado, Hulten and Sichel, 2009).

Table 3 below shows the mapping between the CPA products and NIA, the information used to split the CPA (when needed) and the capitalization factor for each intangible expenditure.

[4] As an example, the CPA (M69-M70) Legal and accounting activities; activities of head offices; management consultancy activities does not map one to one to the definition of Organizational capital corresponding to Management consultancy services (CPA 70). To obtain the correct correspondence we use the information about turnover from the Structural Business Statistics (SBS) to split the CPA_M69_M70 into M_69 and M_70.

Table 3 – Capitalizing intangible expenditure for CPA products

Asset	Product (CPA)	USE table disaggregation	Product disaggregation	Capitalization factor
Organizational capital	Management consulting services (CPA 70.2)	Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70)	V12110 - Turnover or gross premiums written in Structural Business Statistics	.8
Design	Architectural and engineering services (CPA 71.1)	Architectural and engineering services (CPA 71.1)		.5
Brand Equity	Advertising Services (CPA 73.1), Market research services (CPA 73.2)	Advertising and market research services (CPA 73)		.6
Training	Education Services (CPA P85)	Education Services (CPA P85)		1

The nest step involves the identification of the share of intangible expenditure to the nonmarket sector in each industry of interest. Besides Public administration and defense, that is entirely nonmarket in nature, the other industries of interest for SPINTAN contain a mix of producers. Table 4 offers an example of the multiple characteristics of a unit potentially purchasing consultancy services in the Health industry[5]. The unit can be public or private, profit or non-profit and market or nonmarket.

Table 4 – An example of the characteristics of institutional sector- units in the Health industry

Dimension	characteristics
Type of unit	Corporation, NPI, Government unit
Ownership	public, private
Legal form	for profit, nonprofit
Type of producer	Market/ non market
SNA sector	S11, S13, S15

The main challenge is to identify expenditure data of the units engaged in **nonmarket production** (Government sector (S.13) and Non Profit Institutions Serving Households (NPISH) Sector (S.15)) excluding the expenditures of the units engaged in the **market production** (Corporations, either non-financial or financial, and Household (S11+S12+S14)).

Besides few exceptions[6], publicly available information does not allow to split the expenditure between market and nonmarket production. To solve this problem we applied following indicators to the USE expenditure data (current prices and NACE Rev. 2):

Share of nonmarket output over total output by industry (NA)

Share of nonmarket employees over total employees by industry (Labor Force Survey)

Share of non-market intermediate consumption over total intermediate consumption by industry (NSIs). The main limitation of this approach is that the above indicators are industry specific but not product specific, thus we need to assume that the share of each institutional sector is the same across all products (although different in each industry). Table A4 in the appendix provides a summary of the basic indicators.

[5] As an example, assume that we need to measure the nonmarket expenditure for consultancy services made by the Health industry. The use table provides total expenditure for consultancy services of the Health industry as a whole. But, the consultancy services can be purchased by both market and nonmarket producers inside the Health industry.

[6] Seven European countries made this information accessible to SPINTAN: Italy, UK, Austria, Finland, Sweden Czech Republic and Hungary. Comparable information is available for the US from National Income and Product Accounts.

Finally, nonmarket intangible investment by industry and by product is generated applying a capitalization factor to the expenditure obtained as above (Table 3).

Own account intangibles

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). At this stage of the project, own account calculations have been developed only to generate measures of organizational capital for a subset of countries (Austria, Belgium, Finland, France, Germany, Italy, Spain, Sweden and United Kingdom)depending on data availability.

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 for the moment[7]. The method is described in appendix A2.

2.2.2 - Measuring investment in National Accounts Intangible Assets in the European economies

The estimate of nonmarket investment in NA intangibles in the industries of interest follows the criteria stated in the SNA2008 and ESA2010.

Intangible gross fixed capital formation (GCFC) cross-classified by industry, sector and by asset is rarely released by NSIs since this level of detail is not required by the ESA2010 Transmission program. Few exceptions are:.

Besides Sweden and Hungary, for which data are available, for the remaining EU economies investment in Computer software and databases and in Research and Development cross-classified by industry and by sector are generated adopting two approaches depending on GFCF data availability:

1. data are available by industry and by sector but not cross-classified;
2. data are available by industry only (not by sector)

Table 5 shows investment in a given asset cross-classified by industries (rows refer to the SPINTAN industries of interest) and by sectors (columns). Ideally we need the information contained in each cell of the matrix but generally this data are not accessible, so that to the

[7] Measures for own account training are under development.

value in each cell of table 5 has to be estimated using alternative data sources and then constrained to national account totals (by rows and or by columns).

Both methods are fully described in appendix A3. Here we report only a short description of method 2 widely used in SPINTAN. Assume that GFCF data by industry are available from National Accounts for Software ($GFCF^{SW}_j$) and Total Intellectual Property Products ($GFCF^{IPP}_j$) but not for investment in R&D ($GFCF^{R\&D}_j$).

Thus we need first to measure R&D investment by industry and split the estimated value between market and nonmarket sectors (Government and NPISH).

Table 5 – The ideal information set to measure NA intangibles

	Sectors			
Industries	**Market**	**Government**	**NPISH**	**Industry totals**
M72	$GFCF_{M72,MKT}$	$GFCF_{M72,GOV}$	$GFCF_{M72,NPISH}$	$\mathbf{GFCFI_{M72} = \sum_s GFCF_{M72,s}}$
O84	0	$GFCF_{O84,GOV}$	0	$\mathbf{GFCFI_{O84} = GFCF_{O84,GOV}}$
P85	$GFCF_{P85,MKT}$	$GFCF_{P85,GOV}$	$GFCF_{P85,NPISH}$	$\mathbf{GFCFI_{P85} = \sum_s GFCF_{P85,s}}$
Q86	$GFCF_{Q86,MKT}$	$GFCF_{Q86,GOV}$	$GFCF_{Q86,NPISH}$	$\mathbf{GFCFI_{Q86} = \sum_s GFCF_{Q86,s}}$
Q87-Q88	$GFCF_{Q87\text{-}88,MKT}$	$GFCF_{Q87\text{-}88,GOV}$	$GFCF_{Q87\text{-}88,NPISH}$	$\mathbf{GFCFI_{Q87\text{-}88} = \sum_s GFCF_{Q87\text{-}88,s}}$
R90-R92	$GFCF_{R90\text{-}92,MKT}$	$GFCF_{R90\text{-}92,GOV}$	$GFCF_{R90\text{-}92,NPISH}$	$\mathbf{GFCFI_{R90\text{-}92} = \sum_s GFCF_{R90\text{-}92,s}}$
Sector Totals	$\mathbf{GFCFIS_{MKT}}$	$\mathbf{GFCFIS_{GOV}}$	$\mathbf{GFCFIS_{NPISH}}$	$\mathbf{GFCF = \sum_j \sum_s GFCF_{j,s}}$
	$\mathbf{= \sum_j GFCF_{j,MKT}}$	$\mathbf{= \sum_j GFCF_{j,GOV}}$	$\mathbf{= \sum_j GFCF_{j,NPISH}}$	

The algorithm to generate NA measures of intangibles in the nonmarket sector consists of three steps:

1. estimate totals by sector (total by column in table 5) for the industries of interest;
2. approximate the industry distribution of the estimated sectoral values computed in step 1;
3. for each industry (row) rescale the market, government and NPISH components to the NA totals by industry.

Software market and nonmarket investment shares are generated on the basis of output based indicators. R&D investment by industry is gathered from NA, when this is not available it is estimated as follows.

Investments in intellectual property products (IPP) are defined as the sum of R&D, Software and Originals and Mineral Explorations, assuming that, in the industries of interest, the share of investment in Originals and Mineral Explorations is negligible, R&D by industry can be approximated as the difference between intellectual property products (IPP) and software (SW) that is: IPP-SW=R&D. The R&D amount is then split between market and nonmarket investment on the basis of the ANBERD[8] and NA R&D data by source of funds[9].

2.3 - Backcasting

The introduction of the ESA 2010 and the adoption of the NACE Rev. 2 classification reduced the accessibility to long time series of expenditure data for most of the EU countries. Thus it is necessary to retropolate the nonmarket expenditure data over the years 2007-1995 to generate longer time series for sources of growth analysis. We adopted two different approaches depending on data availability.

Method 1

This approach assumes that the dynamics of intangible expenditure by asset can be approximated by the rate of growth of total intermediate expenditure by industry (G_r^j where j = M72, O84, P85, Q86, Q87-88, R90-92) as shown in (Table 6) times the average expenditure share by asset over the period 2008-2010, A_s^j. Then expenditure by asset for the years 1995-2007 is obtained as: $G_r^j * A_s^j$.

[8] ANBERD is the OECD's Analytical Business Enterprise Research and Development database. It presents annual data on enterprise R&D expenditures disaggregated by industry.

[9] At the moment we have implemented the method described above to estimate GFCF for Belgium, Denmark, Finland, France, Germany, Italy, Netherlands, Poland, Slovenia. Slovakia, Spain and UK. For Portugal and Sweden NA data about Computer software and databases and R&D by industry are split into market, government and NPISH components using the output based indicators from Eurostat. Finally, information about Austria, Czech Republic and Hungary has been provided directly by the partners.

Table 6 – Backcasting information set

Growth Rate between year t and year t-1						
	M72	O84	P85	Q86	Q87-Q88	R90-R92
Organisational Capital						
Advertising						
Design						
Training						
Total						

Method 2

The second approach is based on the information of the World Input-Output Database (WIOD). WIOD makes available long time series of the USE tables back to 1995. This information is used to retropolate intermediate expenditure by industry and CPA products contained in the ESA2010 USE tables taking into account the differences between ESA1995 and ESA2010 industry classification systems (see table A4 in the appendix).

The comparison between the two approaches revealed that there are pros and cons in both cases: the first is based on the assumption that industry dynamics is invariant across the assets while the second is rather sensitive to the presence of outliers.

Methods 1 and 2

Robustness checks of the two methods reveal that when the information set is limited a mixed approach is relatively more efficient. The mixed approach consist of 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 data free from outliers. The specification is as follows:

$$y^{I}_{p,t} = \alpha_1 x^{I}_{t,Wiiw} + \alpha_2 x^{\dot{I}}_{\dot{p},t,Wiod} + \varepsilon_t \quad (1)$$

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;
- $x^{I}_{t,z,Wiiw}$: is the growth rate of total intermediate consumption and industry I, and country z from National accounts;

– $x^{\dot{I}}_{\dot{p},t,z,Wiod}$: is the growth rate of intermediate expenditure for product $\dot{p}$ and industry $\dot{I}$ from of country z from the WIOD[10]

Figure 1 shows a comparison between the estimates of training expenditure generated by equation (1) and the national account values.

Figure 1 - Training (P85) expenditure in the Italian Public administration (O84)
(yearly rates of growth 2001-2010)

Figure 1 suggests that the mixed approach generates a good approximation of the dynamics of the official time series figures.

2.4 - Volume measures of intangibles

Intangible investment in real terms is a particular 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 large amount is produced on own account. The choice of the best price measure to deflate intangible investment in the nonmarket sector is closely related to the availability of industry sector price indices.

Purchased intangible assets, independently of the sector performing the investment, are usually deflated resorting to average price indices since sector specific price information is not available. Own account intangibles in real terms instead are obtained with an input based

[10] 1. 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.

approach allows accounting for the market and nonmarket characteristics. The input based price measures are estimated on the basis of cost indices varying across sectors (since the cost structure might be different across industries and 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 (NIA), since the case of sold copies is unlikely for these assets while both original for sale and for own-use are standard practice. Thus there are two alternative price indexes to generate volume measures of purchased NIA: Service Producer Price Index (SPPI) and Market Sector Value Added Deflator (MSVAD). The SSPIs is methodologically correct and consistent across countries but the availability of SPPIs data is still limited across countries[11] and time. Additionally, the collection of service output price indices poses a number of statistical problems since 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).

National account output (or value-added) deflators, on the other hand, are available for almost all countries and years. Moreover, national account deflator should be based on SSPsI when available and thus contain the same information[12]. The major concern about national accounts deflators is that the availability of updated information on sources and methods used by NSIs for price and volume decomposition is limited.

Available information to deflate purchased intangible investment is shown in Table 7 comparing the dynamics of the Service Producer Price Index (SPPI) and the Market Sector Value Added Deflator (MSVAD) for the following service industries: Legal, accounting and

[11] The countries for which no SPPI for the industries of our interest is available are Bulgaria, Greece, Italy, Portugal, Sweden and Slovakia.

[12] Actually, the *Eurostat-OECD Methodological Guide for Developing Producer Price Indices for Service* mentions their usage as deflators in national accounts as one of the main reasons to develop SPPIs.

management consultancy activities, Architectural and engineering activities and technical testing and Advertising and market research. The dynamics are rather different across countries revealing both cross-country differences in industry productivity and dissimilarity of SPPI compilation methods.

SPPIs are generated taking into account quality adjustments and they are rather heterogeneous across countries and industries and are asset specific. Thus we assume, that at the time of this writing, they are valuable price measures to deflate purchased intangible assets not included in the SNA asset boundary[13]. But the identification of the most appropriate price measure to deflate intangible investment in the nonmarket sector deserves further investigation.

Up to now estimates of GFCF in volume terms for Organizational capital, Design and Brand Equity are generated using value-added deflators because they are available for a larger number of countries. Volume measures for training are obtained resorting to the deflator of the Education industry (P85) since SPPIs for Education services are not available.

Volume measures of Computer software and databases and R&D are obtained using National accounts deflators. However, the identification of a price measure for R&D is not straightforward since most EU countries do not deliver R&D investment by industry. Available information allows to compute price measures for R&D (R&D=IPP-SW) by industry based on IPP and SW National account deflators. Thus we assume that price measures derived for the difference between IPP and SW are a good proxy of the R&D deflator by industry. The only exception might be industry R, where the deflator likely includes also Entertainment, literary and artistic originals.
When industry details are not available we use the asset deflators of GFCF by industry. For Sweden and Denmark data availability is scant deserving a deeper investigation of alternative sources.. For the moment, we use the aggregate software deflator available from Intan-Invest to deflate software and R&D in the above countries. Table A3.2 reports a detailed description of data sources for all the countries for which we have already produced volume measures of software and R&D investments.

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

Table 7- Service producer price index (SPPI) vs market sector value added deflator (MSVAD), 2007-2013

	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

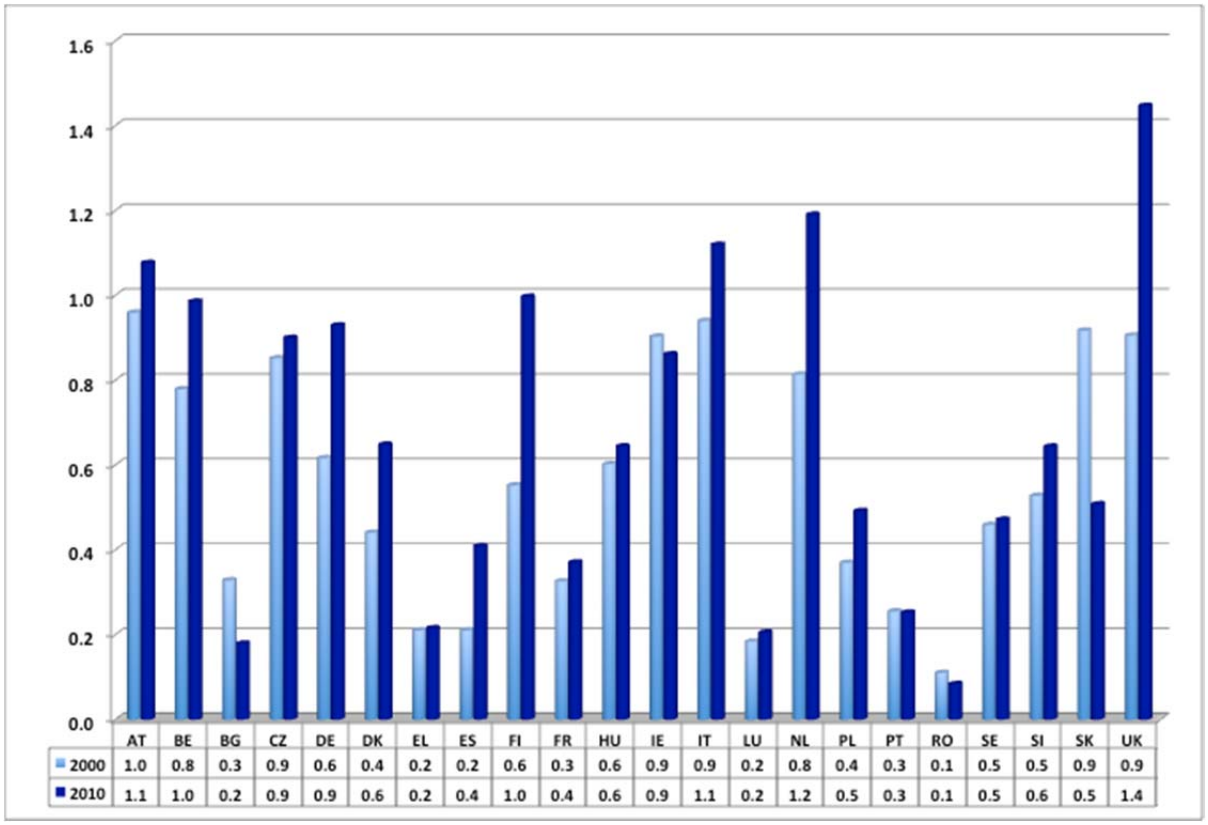
(1) 2010-2013 (2) 2009-2012

An alternative approach is suggested by Corrado, Goodridge and Haskel (2011) for market sector R&D investment based on the calculation of a price deflator for R&D accounting for 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.

3. Intangible investment in the European countries

For the industries listed in table 2—to which, we reiterate, we refer to as the nonmarket sector— SPINTAN has generated measures of intangible investment for the CHS asset types (Corrado, Haskel, Jona Lasinio 2014) for 22 EU countries from 1995 to 2010. Figure 2 shows the GDP shares of intangible investment in 2000 and 2010.

Figure 2 – Public sector intangibles in the EU economies (GDP shares*)*



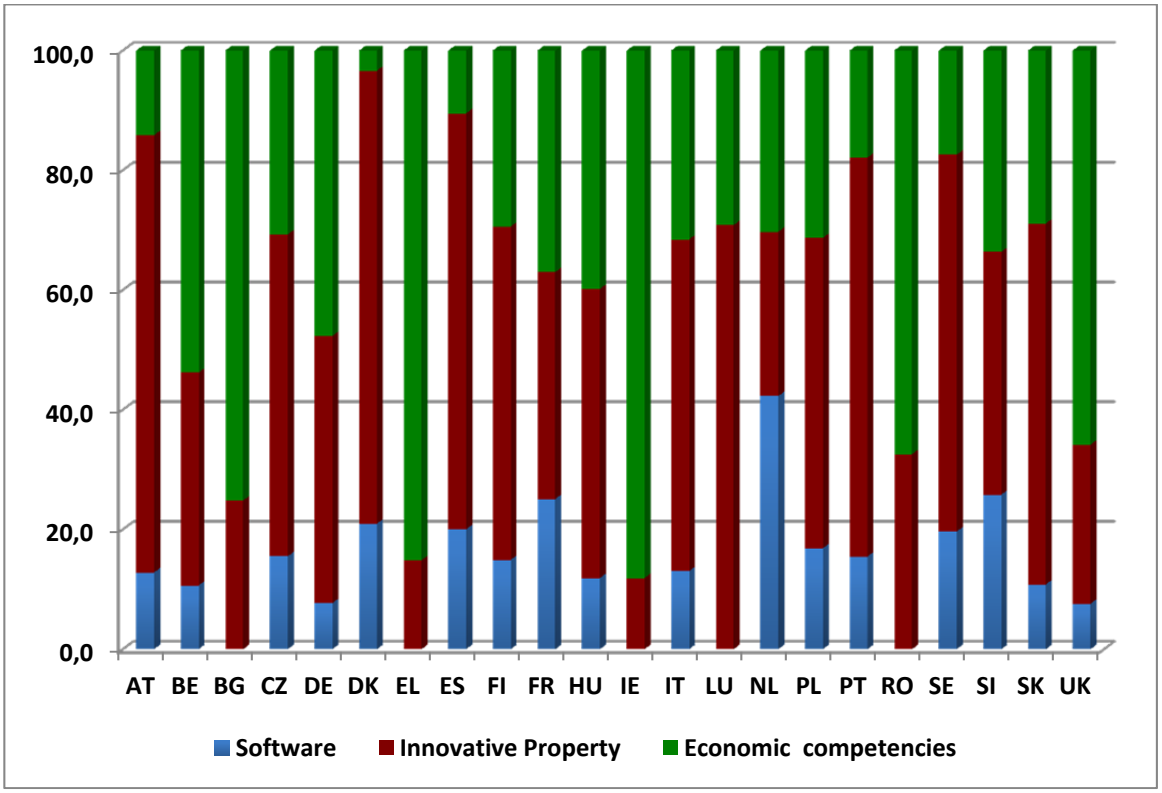
	AT	BE	BG	CZ	DE	DK	EL	ES	FI	FR	HU	IE	IT	LU	NL	PL	PT	RO	SE	SI	SK	UK
2000	1.0	0.8	0.3	0.9	0.6	0.4	0.2	0.2	0.6	0.3	0.6	0.9	0.9	0.2	0.8	0.4	0.3	0.1	0.5	0.5	0.9	0.9
2010	1.1	1.0	0.2	0.9	0.9	0.6	0.2	0.4	1.0	0.4	0.6	0.9	1.1	0.2	1.2	0.5	0.3	0.1	0.5	0.6	0.5	1.4

Source: SPINTAN estimates

Data suggest that GDP share of intangible investment in the nonmarket sector increased in most of the EU countries accounts on average for 1 percent of GDP in 2010 (from 0.5 on average in 2000).

Figure 3 breaks down intangible investment into its major asset categories in 2010. The relative importance of each asset category varies considerably across countries. Innovative property is the largest category in many of the most intangible-intensive economies, namely Denmark, Austria and Spain, where it accounts for more than 70 percent of intangible investment. Economic competencies are the major driver of nonmarket intangible investment in UK and Ireland accounting for more than 60 percent of total intangibles.

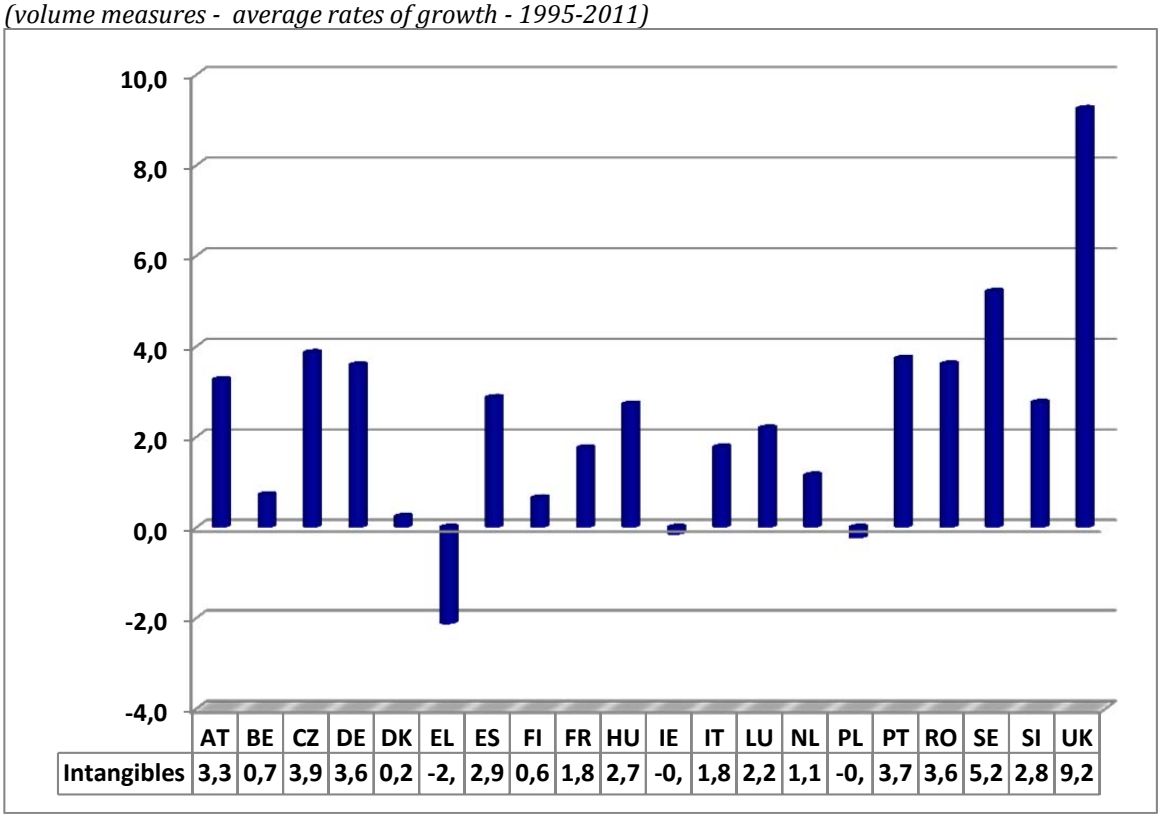
Figure 3 – Public sector intangibles in the EU economies (composition)



Source: SPINTAN estimates.
Software data for BG, EL, IE, LU and RO are not available from National Accounts.

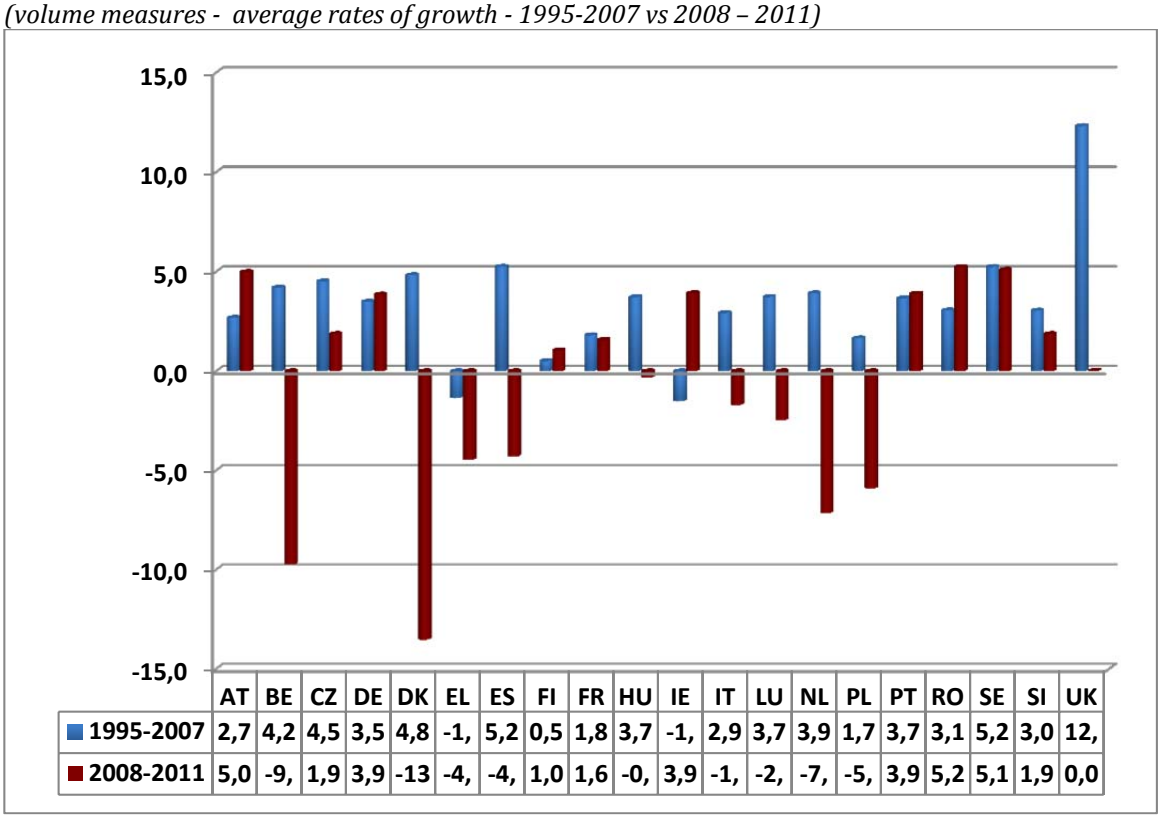
Figure 4 illustrates the dynamics of intangible investment in the nonmarket sector of 20 EU countries over the years 1995-2011. The evidence suggests that the most knowledge intensive economies, UK and Sweden experienced faster accumulation of intangibles in the nonmarket sector compared to most of the other EU countries. Most of the other countries show positive rates of growth above 2 percent with Denmark and Finland showing rates below 1 percent. Greece and Ireland experienced decreasing growth rates. In Figure 5 we decompose the time period into two sub-periods, 1995-2007 and 2008-2011, to check for the sensitivity of nonmarket intangible investment to the financial crisis downturn. In 1995-2007, the accumulation of nonmarket intangibles was very fast in UK (12.3 percent) and between 3 and 5 percent in ten out of twenty EU countries, while less than 2 percent in Finland, France and Poland. Over the crisis, eight countries out of twenty recorded a significant decline of intangible investments. In the remaining EU economies, the dynamics of nonmarket intangibles has been somewhat counter cyclical.

Figure 4 – Nonmarket intangible investment in the EU economies –
(volume measures - average rates of growth - 1995-2011)



	AT	BE	CZ	DE	DK	EL	ES	FI	FR	HU	IE	IT	LU	NL	PL	PT	RO	SE	SI	UK
Intangibles	3,3	0,7	3,9	3,6	0,2	-2,	2,9	0,6	1,8	2,7	-0,	1,8	2,2	1,1	-0,	3,7	3,6	5,2	2,8	9,2

Figure 5 – Nonmarket intangible investment in the EU economies –
(volume measures - average rates of growth - 1995-2007 vs 2008 – 2011)



	AT	BE	CZ	DE	DK	EL	ES	FI	FR	HU	IE	IT	LU	NL	PL	PT	RO	SE	SI	UK
1995-2007	2,7	4,2	4,5	3,5	4,8	-1,	5,2	0,5	1,8	3,7	-1,	2,9	3,7	3,9	1,7	3,7	3,1	5,2	3,0	12,
2008-2011	5,0	-9,	1,9	3,9	-13	-4,	-4,	1,0	1,6	-0,	3,9	-1,	-2,	-7,	-5,	3,9	5,2	5,1	1,9	0,0

4. Measuring intangible investment in US, China and Brazil

4.1 Intangible Investment in the United States

4.1.1 Industries, sectors, and functions of government

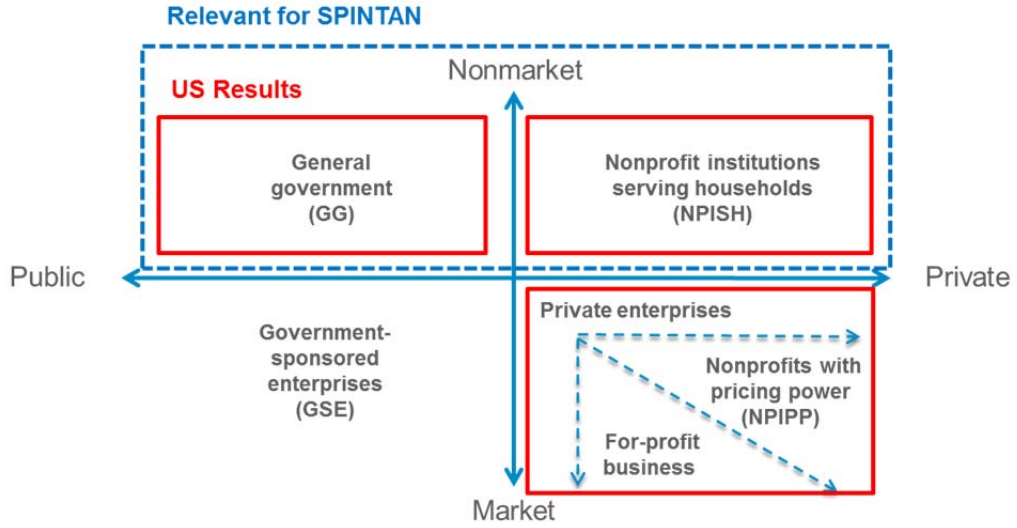
One of the main differences between national accounts data by industry in the United States and Europe is the industry classification. The North American Industry Classification System (NAICS) provides common industry definitions for Canada, Mexico, and the United States and differs substantially from the industry classification ISIC Rev. 4/NACE Rev. 2 (in the following NACE 2) that is common in Europe. Unlike NACE 2 which is based on activities, NAICS is developed on the basis of a production-oriented conceptual framework and classifies units. Despite the different structures, it is possible to aggregate the very detailed NAICS industries to NACE 2 sectors in a way that the comparability of data is ensured. This exercise is mainly useful for the private industries, but also needed for the public industries, since the NACE 2 sectors Q (Health and social work), P (Education), and R (Arts, entertainment and recreation), and O (Public administration and defence; compulsory social security) have private and public segments. The two-digit level of NACE 2 is sufficient to estimate public intangible investment within the scope of the SPINTAN project and to include these public intangibles in extended growth decompositions. The relevant NACE 2 industries for SPINTAN are shown in table 2 in section 2.1.

The measurement of public intangibles for the "non-market sector" needs another dimension since some of the SPINTAN industries of interest in table 2 have a public and private component. Figure 2 illustrates that the "non-market sector" is found above the horizontal line and consists of the general government (GG, S.13) and nonprofit institutions serving households (NPISH, S.15). The "non-market sector" is used as synonym of the public sector in SPINTAN.

The coverage of the US results is not entirely comparable to results for the European countries. The main reason is that SPINTAN strictly defines intangibles for the **non-market sector**, whereas the US results are for **"non-market" industries**, specifically, the SPINTAN industries of interest (as shown in table 2). We could not reliably split out nonprofit vs for-profit activity in the private US health sector and therefore investment in the private "non-market sector" (upper right quadrant in figure 6) comprises some minor investments from the private "market sector" (lower right quadrant in figure 6). This is less an issue for

education since the private US education sector is mostly nonprofit, although the share of for-profit higher educational institutions has been rising lately.

Figure 6: Defining the Non-market Sector



All but one of the industries that we work with (NACE 84, public administration and defence) consist of a mix of institutions: business (whether for-profit or nonprofit), nonprofit institutions serving households, and general government. To capture all relevant "non-market" intangible investments for SPINTAN above the vertical line in figure 6, national accounts data need to be complemented. To ensure comparability with EU-SPINTAN countries, we break the US general government into function of governments and combine them with their private "non-market" counterparts. The Bureau of Economic Analysis (BEA) publishes national income and product accounts (NIPA) by functions of government. Government receipts and expenditures are classified according to their purpose, i.e. their function. These functions were crafted to be comparable with the functions used in the international classifications of the functions of government (COFOG). The classifications that are used in the new NIPA functions are designed to be comparable with the functions used in the international classifications of the functions of government (COFOG).

4.1.2 Sources and methodology

We added the COFOG production accounts to relevant industries and internationally comparable sectors P, Q and R (table 8) to complement the missing public part of the national accounts. The NACE 2 class "O - Public administration and defence; compulsory social

security" is no longer kept separately in our system as it consists basically of the FOGs general public service, national defense, public order and safety, income security, economic affairs, and housing and community services. Instead, the aggregate public NMS which equals the government covers all FOGs.

Table 8: SPINTAN Aggregates – combination of NACE sectors and FOGs:

Aggregate	NACE sector (private)	FOG (public)
Total Education	P - Education	• Public Education
Total Health	Q - Health and social work	• Public Health
Total Recreation and culture	R - Arts, entertainment and recreation	• Public Recreation and Culture
Public NMS (Government)		• General public service • National defense • Public order and safety • Income security • Economic affairs • Housing and community services • Public Education • Public Health • Public Recreation and Culture

Regarding the measurement of intangibles assets, it is also necessary to distinguish between two groups of intangibles as shown in table 9: intangible assets that are already included in the national accounts (NA) and additional intangibles that are not part of the national accounts (non-NA). Software, research and development, entertainment, literary and artistic originals, and Mineral Explorations are already included in the current fixed asset boundary. Thus, gross fixed capital formation for private "non-market" intangibles are taken from the NIPA productivity accounts and are complemented by FOG data for the public sector as mentioned above. Brands, design, organizational capital, and training together build the group of non-national accounts intangibles. Private non-NA intangibles stem from the use tables of commodities by industries tables published by BEA. Public non-NA intangibles include only the purchased component. Investment for the general government also stems from the use tables and the split of the general government into its sub functions is based on FOG data from BEA. Open data and cultural asset are further intangible assets that are not part of the national accounts for the public sector. General measurement methods are currently developed and they will be added to the final intangible investment numbers that will be released in November 2016.

Table 9: National accounts and non-national accounts intangible in the United States

National accounts intangibles	Non-national accounts intangibles
• Entertainment & Artistic originals • Mineral Exploration • New financial product development • Research and Development • Software	• Brands • Design • Organizational Capital • Training • (Culture) • (Open Data)

Further variables are needed for the growth decomposition. Detailed data for fixed assets and consumer durable goods by industry and by type of asset from BEA are the source for nominal and real investment (including NA intangibles) in private nonresidential fixed assets, as well as the corresponding capital stocks and depreciation rates. We aggregated the 96 US asset types to nine rather standard asset types to obtain comparable results with the remaining SPINTAN countries and the EU KLEMS database. The public part stems from BEA's FOG data or was calculated using on this source.

- IT Computing equipment
- CT Communications equipment
- Soft Software
- TraEq Transport Equipment
- OMach Other Machinery and Equipment
- OCon Total Non-residential structure
- Min Mineral exploration
- AO Entertainment & Artistic originals
- RD Research and Development

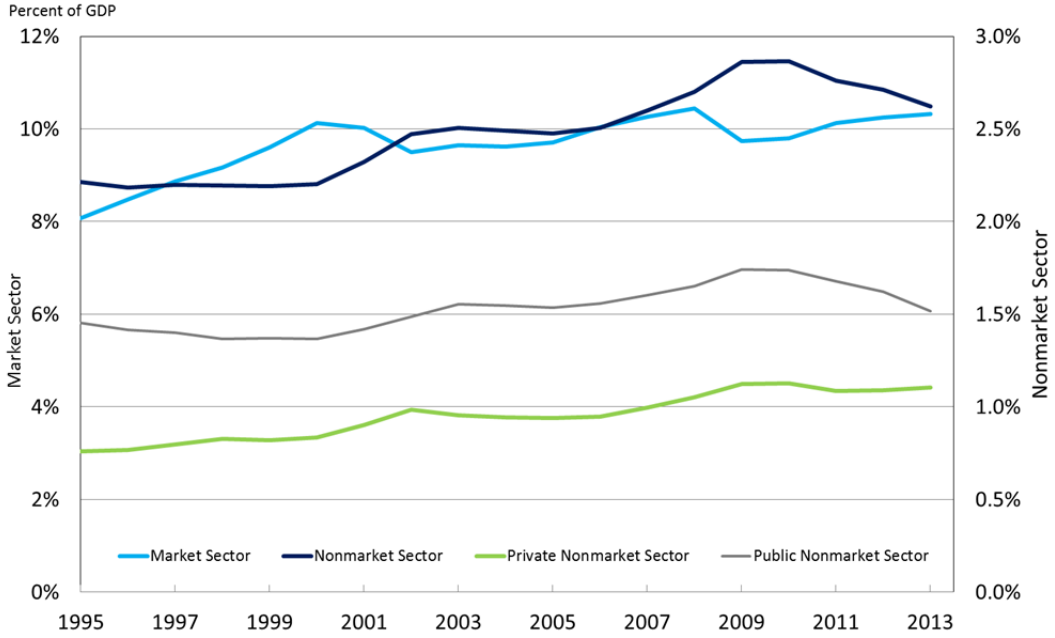
Basic variables like nominal VA, real VA, deflators, etc. for the private "non-market sector" are derived from the industry economic accounts from BEA whereas the basic variables for the public sector come from FOG data. Labor related variables stem from the Integrated Industry-Level Production Account for the United States.

4.2 US Results

Figure 7 illustrates how much the US "market sector" and "non-market sector" invested in intangibles from 1995-2013. The "non-market sector" is furthermore split into its public and private components as described above. Intangible investment in the "market sector" grew at an average annual growth rate of 1.4 percent from 8.1 percent to 10.36 percent between 1995 and 2013 while total public intangible grew slower at 0.9 percent on average from 2.2 percent to 2.6 percent at the same time. "Non-market" intangible investment was mainly driven by the

public “non-market sector” and only to a lesser extent by private “non-market sector”. It is interesting to see that “market sector” intangible investment declined during the financial crises and continued to rise afterwards whereas “non-market” intangible investment kept growing until 2010 and fell strongly thereafter. The behavior of the “non-market” sector was dominated by the public “non-market sector”.

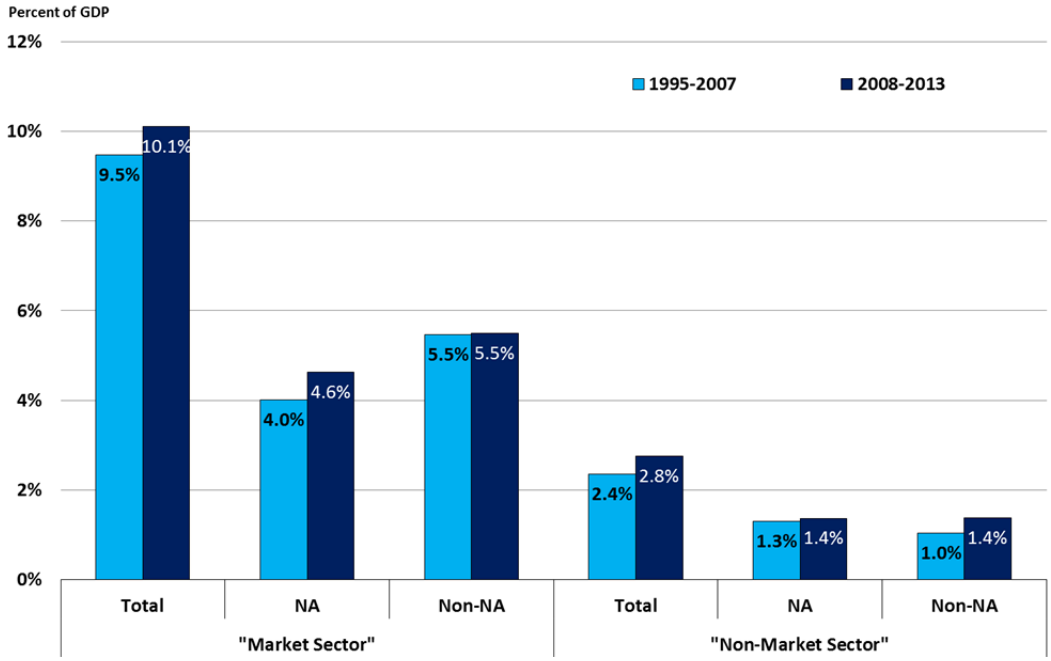
Figure 7: Intangible Investment in the United States 1995-2013



Data source: BEA and Rosenthal et al. (2014).

A split of total “market sector” and “non-market sector” public intangible investment into NA intangibles and non-NA intangibles in figure 8 reveals that “market sector” intangibles are mainly investments in software, R&D, artistic originals, mineral exploration, NFPD in 1995-2007 and 2008-2011. Public intangibles are rather evenly distributed among NA intangibles and non-NA intangibles, especially in the second period.

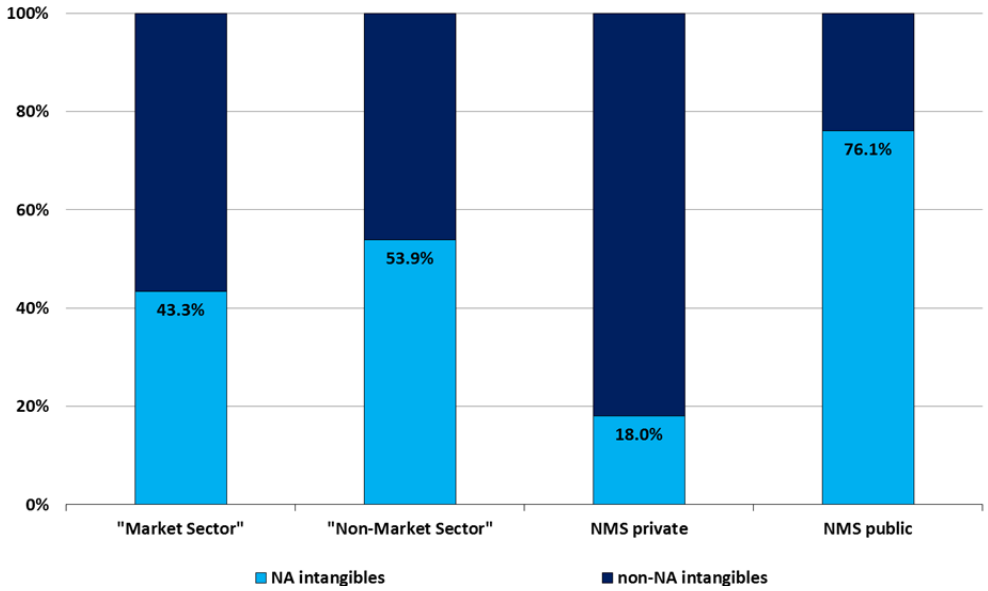
Figure 8: Investment in NA and non-NA intangibles, United States, 1995-2013



Data source: BEA and Rosenthal et al. (2014).
Note: NA=National Accounts Intangibles: AO, Mineral Exploration, NFPD, R&D, Software
Non-NA=National Accounts Intangibles: Brands, Design, Organizational Capital, Training

Even though NA and non-NA intangibles score similarly in the total "non-market" sector, the distribution of these two groups in in the private and public "non-market sectors" differs (figure 9). Intangible investment in the public "non-market sector" consists only to 23.9 percent of NA intangibles and 76.1 percent are investments in brands, design, organizational capital, and training. 82 percent of private "non-market sector" investment is related to non-NA intangible investment.

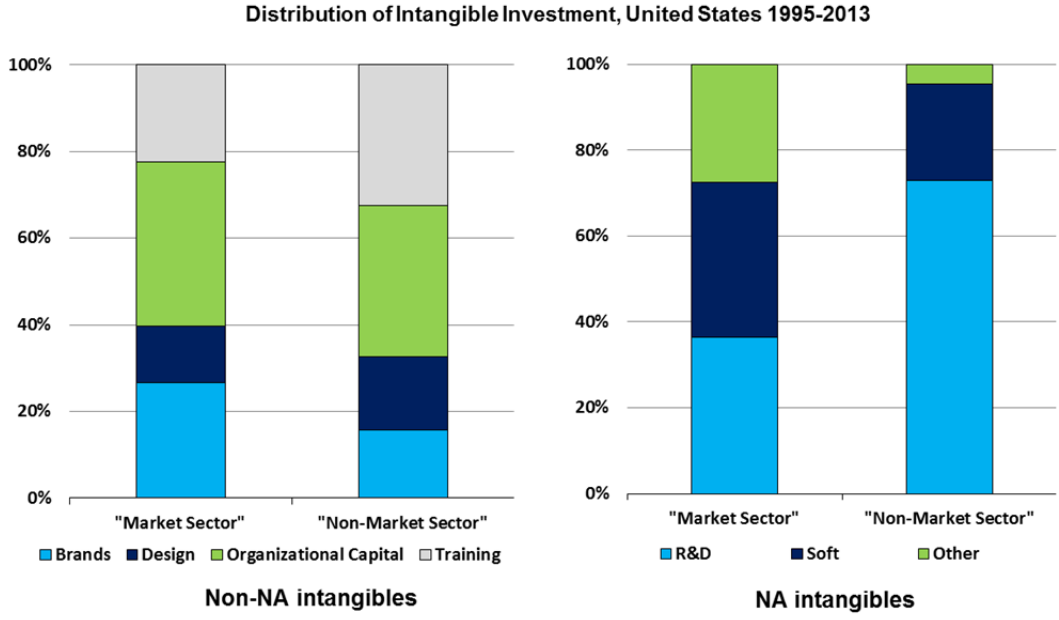
Figure 9: Distribution of NA and non-NA intangibles, United States 1995-2013



Data source: BEA and Rosenthal et al. (2014).

A further breakup into the components of NA and non-NA accounts intangibles in the "market sector" and "non-market sector" in figure 10 shows that organizational capital is the main driver of non-NA intangibles in both sectors. The picture is somewhat mixed when it comes to NA intangibles. R&D has with 73 percent of total "non-market sector" investment the largest share, followed by software with 22 percent. The "market sector" invested 36.5 percent of total NA in R&D and 35.9 percent in software on average between 1995 and 2013.

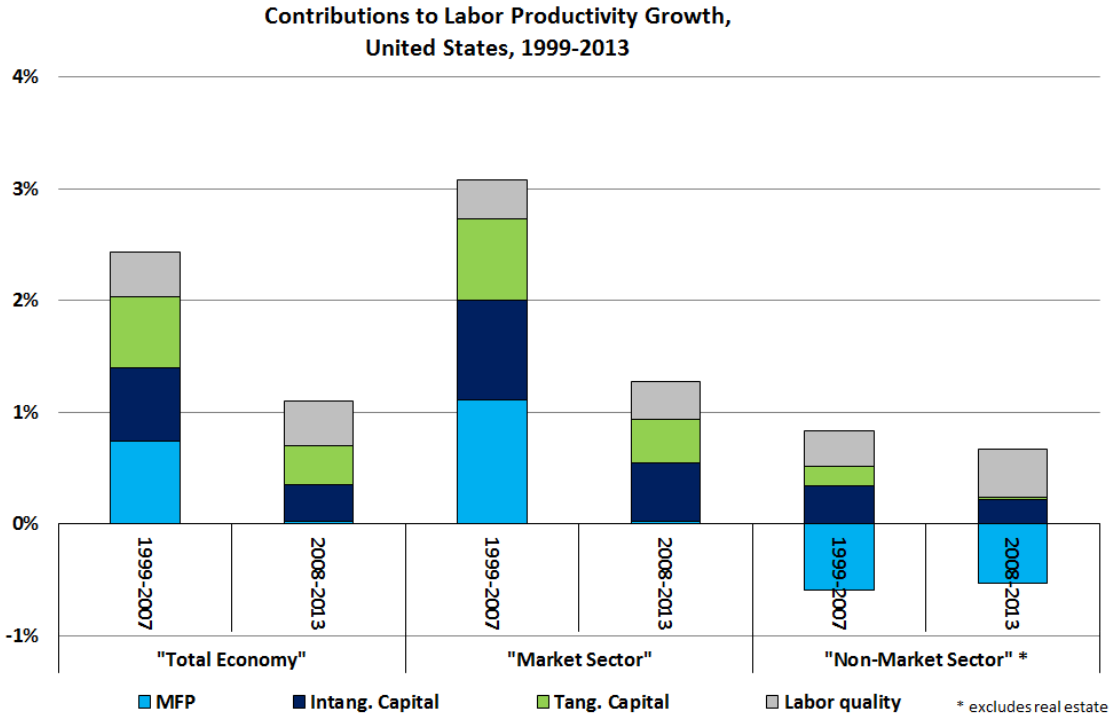
Figure 10: Org. Capital and R&D are main drivers of NMS intangibles



Data source: BEA and Rosenthal et al. (2014).

Figure 11 shows the contributions of labor quality, MFP and tangible and intangible capital to labor productivity growth for the total economy, the "market sector" and the "non-market sector" from 1999 to 2007 and 2008 to 2013. Given the data availability for several variables from the industry economic accounts and also the integrated industry-level production accounts, growth accounts prior to 1999 cannot be carried out. The most important and expected result is that intangible capital contributes positively to labor productivity in all sectors and periods, only to a different degree. Leaving MFP aside, intangibles are the largest contributor to labor productivity growth in the total economy, the "market sector", and the "non-market sector" in 1999 to 2007. While the contribution of intangibles to LP growth in the total economy is only marginally higher than the contribution of tangible capital in 1999-2007, the picture reverses in 2008-2013. Intangibles remain the main driver of labor productivity growth in the 'market sector" in the second period. Tangible capital plays only a minor role in the 'non-market sector" and the relative contribution of labor quality is higher compared to the total economy and the "market economy". Labor quality is the main positive contributor to labor productivity growth in the "non-market sector" from 2008-2013 and MFP is a drag on labor productivity in both periods.

Figure 11: Labor Productivity Growth Decomposition 1999-2013



Data source: BEA and Rosenthal et al. (2014).

4.3 Intangible Investment in China

Intangible investment in the whole economy of China is relatively high according to international comparison, but it only amounts for about a quarter of tangible investment, implying that China is still a typical developing economy that relies mostly on tangible rather than intangible assets and thus probably not a knowledge-intensive economy. Hulten and Hao (2015) estimate that the whole economy of China spent 8.5% of GDP on intangibles in 2010. It is less than that of the U.S. (market sector, 10.5% of GDP in 2010) but more than that of Japan (the whole economy, 7.3% of GDP in 2008). While China spends heavily on intangibles, it spends much more on machines, equipment and structures which (excluding residential housing) amounted to 36% of GDP in China in 2010 (Hulten & Hao, 2015), more than three times of investment in intangibles. In contrast in the U.S., intangible investment exceeded tangible investment in the 1980s. The contrast shows that China is still a typical developing economy and a "Factor of the World" that is not knowledge-intensive.

In order to understand the important role that the Chinese government plays in building China into an innovative economy, we would need to break down intangible investment of the whole economy into public and non-public investment. The Chinese government is deeply involved in investment related to innovation, setting innovation as one of the core strategies of economic development in the Twelfth Five-year-plan and the recently published Thirteenth Five-year-plan.[14] The innovation strategy includes innovation in science and technology, improvement on the education system, and the supply of sufficient skilled labor to facilitate the Chinese economy to climb up the value chain. The government directly invests in innovation such as public R&D spending in universities, or indirectly promotes innovation in the market sector using tax incentives, innovation industrial parks, and so on.

Our estimate of China public spending on intangibles is based on Hao and Wu (2015). Hao and Wu (2015) revised the national estimates of Hulten and Hao (2015) with newly found data sets and break down intangible investment of the whole economy into 37 industries. They estimate that the whole economy of China spent7.3% of GDP on intangible assets in 2010. Here are their estimates of intangible spending in SPINTAN-related industries. The

[14]The Twelfth Five-Year-Plan. 国民经济和社会发展第十二个五年规划纲要(全文)
http://www.gov.cn/2011lh/content_1825838.htm.
The Thirteenth Five-Year-Plan. 中共中央十三五规划建议全文
http://lwjgdgw.longwan.gov.cn/art/2015/11/12/art_8241_332980.html

industry of public administration and defense spent 0.19% of GDP on intangibles, the education industry, 0.32%, and health and social security services, 0.12%. Hao and Wu (2015) do not provide estimates of intangible spending in the other three SPINTAN industries, and provide only estimates of more aggregate industries. Using data on the more aggregate industries, we estimate that Industry MB (Scientific R&D Services) spent 0.31% of GDP on intangibles, and the industry of Recreation, Culture, Sports and Residential Services, 0.023% of GDP in 2010.

Then we estimate the public shares of intangible spending in SPINTAN industries. The government funds 100% of spending (intangibles and others) in Public Administration and Defense, over 80% of spending in the R&D service industry (industry MB of SPINTAN industries), 60% to 80% of spending in the education industry, and 15% to 30% of spending in the health industry over the period of 1995 to 2010. As to recreation, culture, sports and residential services, the government is estimated to fund about a quarter of the spending. We use those percentages to estimate public spending on intangibles.

In addition, we measure public spending outside of the SPINTAN industries. The list of SPINTAN industries may not apply to China. SPINTAN chooses six industries to account for most of the public spending on intangibles, based on the composition of government spending in the U.S., but that does not perfectly apply to China. While the U.S. government spends 93% of total budget on education, health, social security and employment, and general government and public safety (BEA, 2015), the Chinese government spends only 53% of total budget on those functions and allocate the other 47% of budget on a wide variety of functions such as agriculture, forestry and water conservancy, environment protection, transportation, business services, financial regulation, land and resources, and grain and oil supplies reserve (NBS, 2015). So the SPINTAN industries are likely to miss substantial public spending in China.

We convert intangible spending into investment following the method of Corrado, Hulten and Sichel (2005). 60% of advertisement spending, 80% of organizational structure spending, and 100% of the spending on the other intangibles are considered investment.
We estimate that public investment on intangibles increased from 0.39% of GDP in 1995 to 0.81% of GDP in 2010 (investment in SPINTAN industries accounted for 0.70% of GDP in 2010) (Figure 12). That public investment more than doubled in those 15 years indicates that

the Chinese government might have gotten more involved in promoting innovation and other knowledge aspects of the economy over the years. Indeed, the Chinese government for decades has considered S&T as a key driver of economic development and has rapidly increasing R&D spending, and the government decides to expand its focus from R&D to innovation services in the recent Thirteenth Five-Year-Plan.

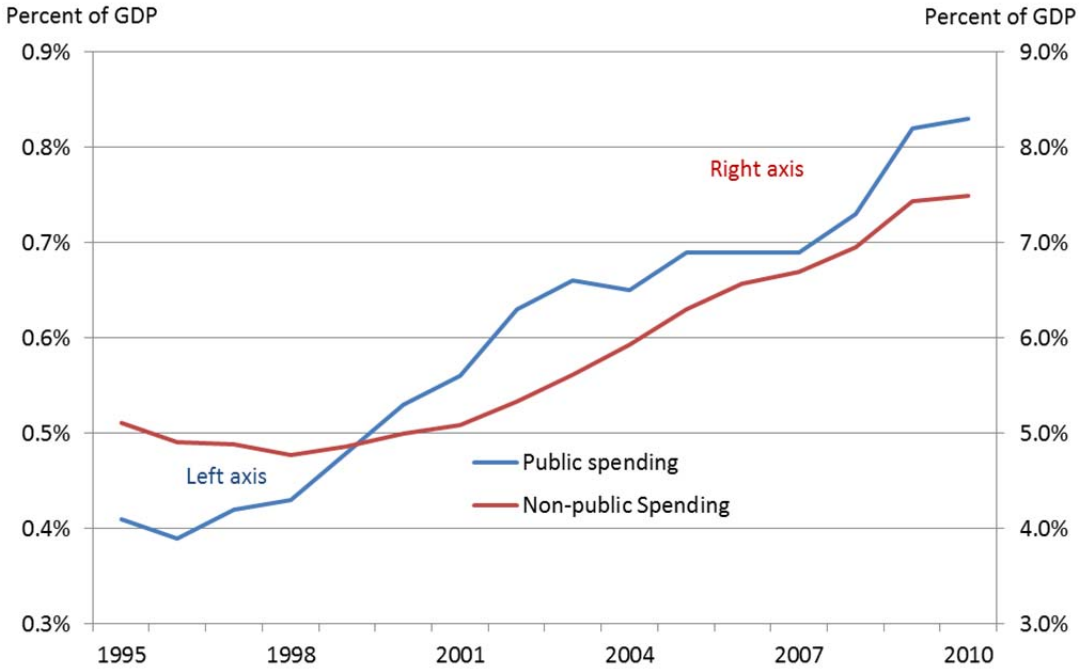
Among the SPINTAN industries, the government accounted for most or all of the intangible investment in Education Services, Scientific R&D Services, and Public Administration and Defense. In contrast, non-public investment dominated the industries of Health and Social Security Services, Recreation, Culture, Sports, and Residential Services (Figure 13).

Figure 14 shows the composition of intangible spending in SPINTAN industries as a whole. R&D is the largest component accounting for 50% of public intangible spending in 2010, followed by software and database, 16%, organizational structures, 14%, human capital, 10%, mineral exploration, 5%, architectural design, 3%, brand equity, 2% and copyright and licenses, 1%. The composition of intangible spending in SPINTAN industries differs from that of the national aggregate. Compared with the national aggregate, SPINTAN industries tend to invest less in brand equity and invest more in R&D. The Chinese government, as part of the S&T policy, spends heavily on R&D in universities and in R&D institutes—both of them belong to the SPINTAN industries. The case is reversed for brand equity. Industries that invest the most in brands do not belong to the of SPINTAN industries. The products and services that spend the most in brand equity are chemicals and allied products, food and kindred products, motor vehicles and real estate services—none of them are SPINTAN industries.

The Chinese government invested 0.81% of GDP in 2010, less than the U.S. government (1.74% of GDP) and more than the Brazilian government (0.31% of GDP). It is not surprising that China spent less than the US, given that the budget of the US government reached 37% of GDP in 2010, while the Chinese budget was only 22% of GDP in the same year, and that China is a less knowledge-intensive economy than the U.S. which requires less investment in intangibles. When comparing China with Brazil, a major difference is that the Chinese government allocated 50% of its intangible spending on R&D (Figure 14), while the Brazilian government allocated less than 20% on R&D. The difference becomes even larger considering that the Chinese government spends a larger share of GDP on intangibles than the Brazilian government. Another difference between the two governments is that the Brazilian

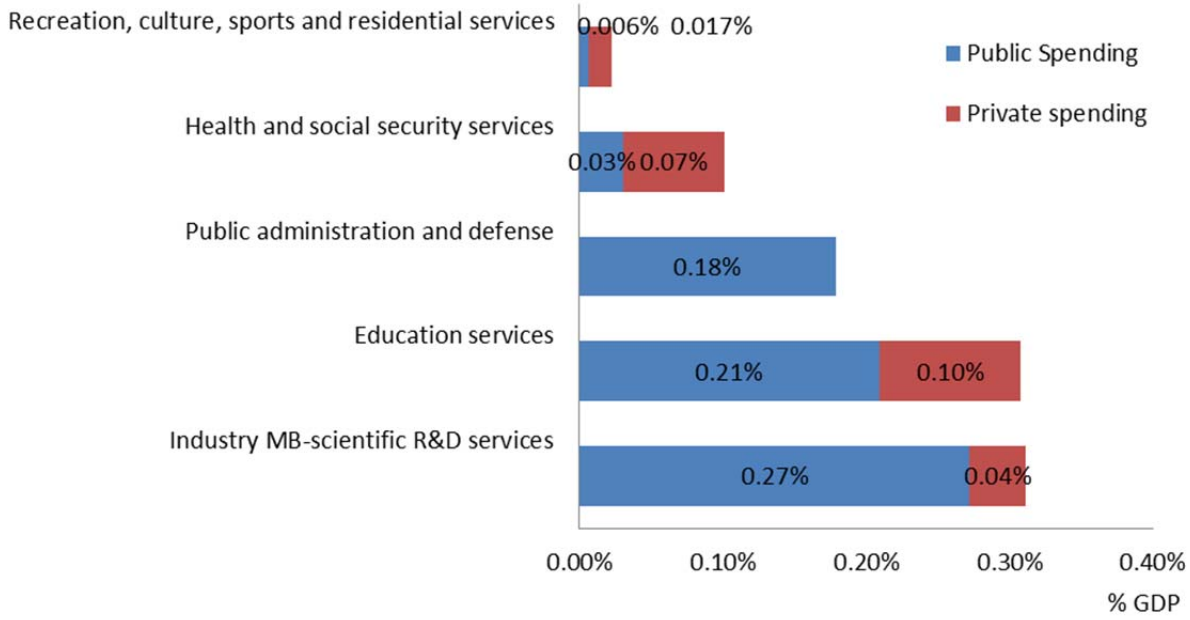
government allocated about 40% of its intangible spending on brands and design, while the Chinese government allocated less than 5% of intangible spending on those two types of intangible assets. That is consistent with the fact that brands and design are not competitive advantages of China in general.

Figure 12: Public and nonpublic intangible spending in China 1995-2010



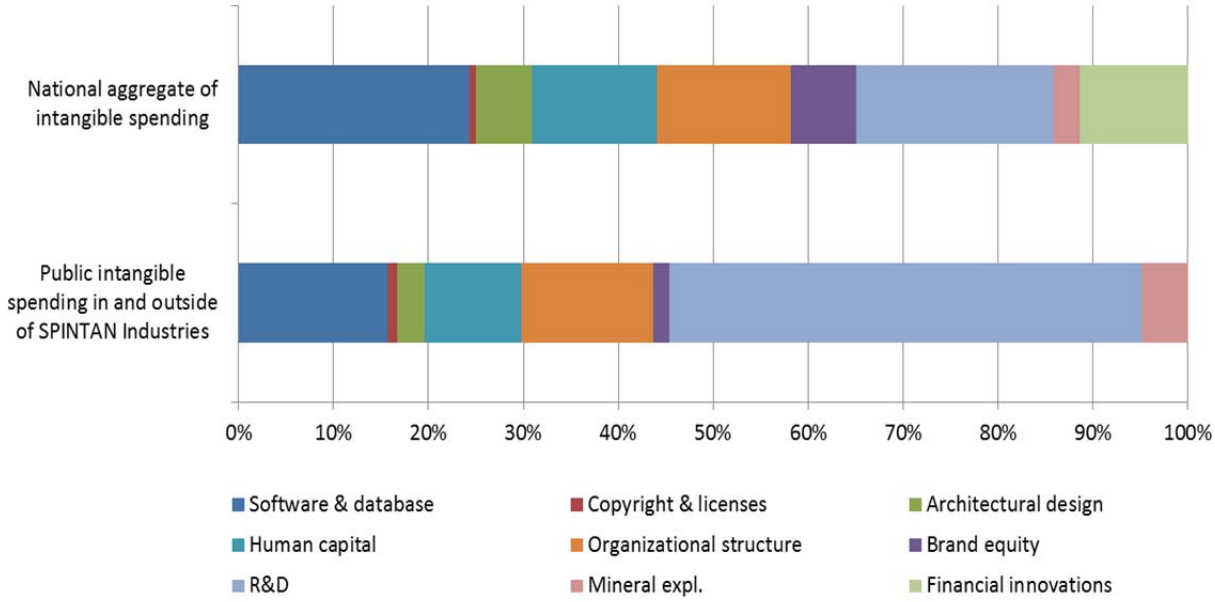
Sources: NBS, CEIC, Hulten & Hao (2015), and Hao & Wu (2015).

Figure 13: Public v.s. Non-public Intangible Investment in SPINTAN Industries in 2010,% GDP.



Sources: NBS, CEIC, Hulten & Hao (2015), and Hao & Wu (2015).

Figure 14: Composition of intangible spending of the whole economy and intangible spending funded by the government, 2010.



To sum up, the public spending on intangibles in China is relatively large compared with other countries, it increased rapidly from 1995 to 2010, and half of the public spending is on R&D.

Still, intangible spending accounts for a very small fraction of total government budget, 0.83% out of 22% of GDP in 2010.

Our measurement faces problems of data quality, as most economists would do when they research on the Chinese economy. More specifically, because we base our estimates on Hao and Wu (2015), their data problems affect the accuracy of our estimates. Hao and Wu (2015) do not have raw data on investment by industry for software and organizational structures, so they have to make assumptions and roughly estimate the spending by industry for those intangibles. In order to allocate software investment into 37 industries, Hao and Wu (2015) create the weights among industries assuming that the ratio of software investment to gross output in a certain industry is the same in China and in the U.S., and for organizational structures, they create industry weights assuming that the relationship between organizational structure and equipment investment and workers' education attainment is the same in the U.S. and in China. Finally, for the other types of intangible assets, Hao and Wu (2015) have to make some assumptions, too. For example, they allocate spending on architectural designs using fixed asset investment in structures in each industry, assuming that the ratio of design spending to the total spending of structures is the same across industries.

4.4 Intangible Investment in Brazil

4.4.1. Sources and methodology

Detailed information on public intangible expenditures or investment in Brazil is sparely available and datasets released from statistical agencies or other official sources are not comparable to what we found for the United States or most European countries. The Brazilian statistical office Instituto Brasileiro de Geografia e Estatística (IBGE) and other official source often release their data on public finances with a time lag of several years. For example, expenditures of the public sector were not released since 2002 in the download area from IBGE. In addition, public expenditures from various sources were often not sufficiently broken down to cover public intangible assets as required for the SPINTAN project. The federal government, the state, and the municipalities build the three levels of the general government in Brazil. Detailed information on public intangibles for all three levels or alternatively for the general government as a whole is not available and we had to estimate the missing parts.

The Brazilian General Government publishes very detailed data on spending of the federal government by economic activity from 2004 to the current year. These 22 main economic activities (table 10) are broken down in further 169 sub-activities. To be consistent with the other countries, we allocate these expenditures to the set of public intangibles assets that has been defined for this project and kept the split into national accounts and non-national accounts intangibles. We estimate how much the Brazilian federal government spent on organizational capital, training, design, brands, software, R&D, and other intangibles in current Brazilian Real and as percentage of GDP.

Table 10: Economic activities of the Brazilian federal government

	Economic activity
1	Public administration, defense, and social security
2	Agriculture, livestock, forestry production, fisheries and aquaculture
3	Water, sewage, waste management activities and decontamination
4	Accommodation and Food
5	Arts, culture, sport and recreation
6	Administrative activities and additional services
7	Financial activities, insurance and related services
8	Real estate activities
9	Professional activities, scientific and technical
10	Trade, repair of automotive and motorcycles
11	Construction
12	Education
13	Electricity and gas
14	Processing industries
15	Extractive industries
16	Information and Communication
17	Organizations and territorial bodies
18	Other service activities
19	Human health and social services
20	Domestic services
21	Transport, storage and mail
22	Information protected by secrecy, under the law, to ensure the security of society and the state.

Source: Federal Government, Brazil

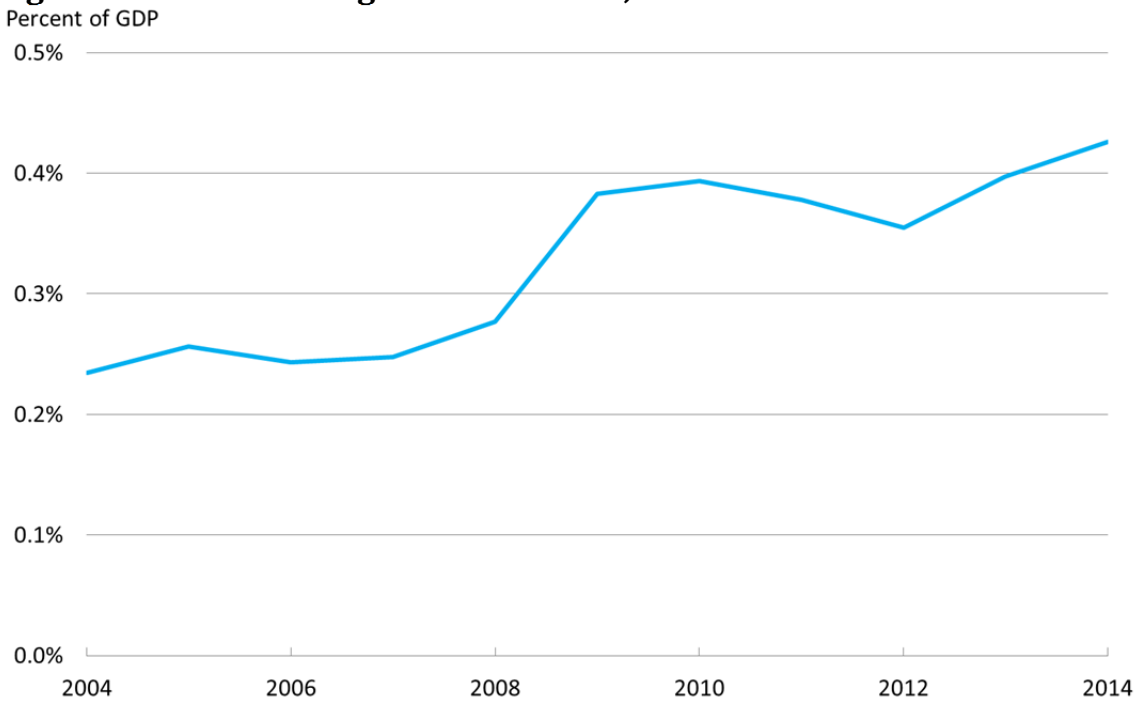
The next step is to estimate spending on these public intangible assets by the other two levels of the Brazilian general government. Intangible spending of the state and the municipalities was added to the federal government's expenditures on public intangibles based on their average shares in total general government expenditures from 2010 to 2013 as published by the Instituto Brasileiro de Geografia e Estatística IBGE (in the public finances and intermediate accounts).

Spending was converted into investment following the widely accepted CHS rule that 60% of spending on advertisement, 80% of spending on organizational capital, and 100% of spending on the other intangibles are considered to be investment. The resulting Brazilian investment figures are not entirely comparable to the results for the United States and EU-SPINTAN countries due to our data limitation and the assumptions we had to make. Nevertheless, they give us an understanding how much the Brazilian public sector invested in public intangibles. We aim at improving our estimates as soon as better datasets are available and accessible.

4.4.2. Results for Brazil

Brazil invested on average 0.33 percent of GDP in public intangibles from 2004 to 2014. Intangible investment grew at an average annual growth rate of 6 percent from 0.23 percent to 0.43 percent in this period. Public investment did not decline and continued to grow during the financial crisis like in the United States and most European countries. Interestingly, investment dropped in the United States and Brazil after 2010. Brazil's investment rose again from 2012 onwards and continued to decline in the United States until 2013.

Figure 15: Public intangible investment, Brazil 2004-2011

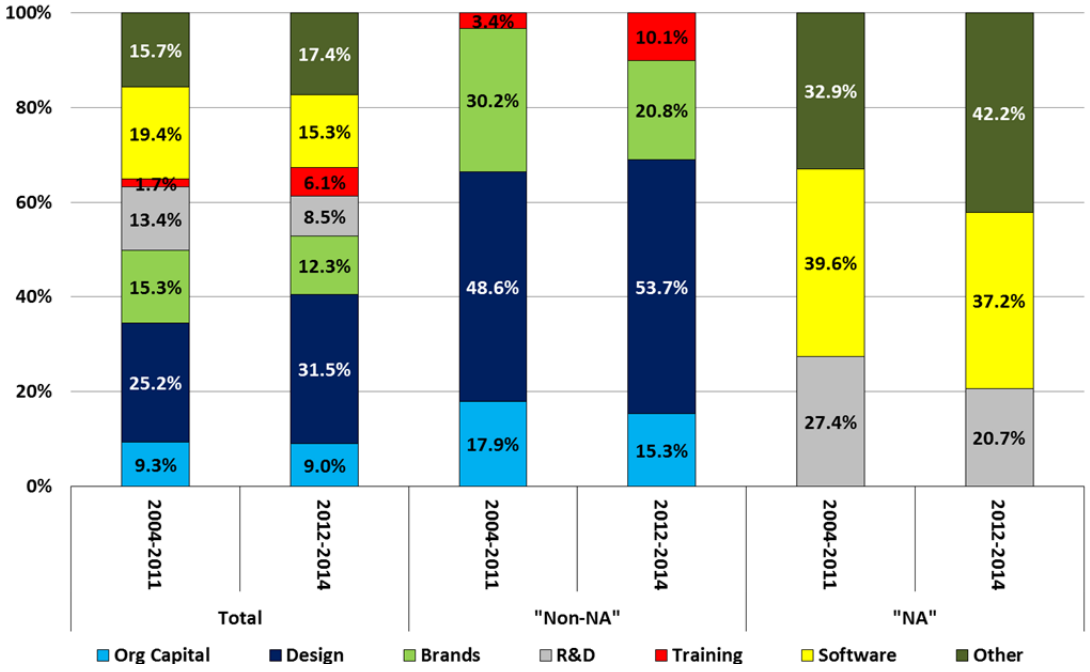


Data source: Federal Government, Brazil

Figure 16 shows the distribution of all public intangible assets in total investment from 2004-2011 and 2012-2014 first before it illustrates the distribution of assets in what is considered as non-national accounts and national accounts intangibles for the European countries and the United States. Brazil's "non-market sector" invested most on design and least on training. This is not unusual since high public investments in design can also be observed in the United States. The share of investments in design in total investment increased from the first to the second period by 6.3 percent. Software investments scored on the second rank in total investment and on rank one in the so called national accounts intangibles in 2004-2011 and

fell back in 2012-2014 because the Brazilian government invested more in other intangibles like mineral exploration and artistic originals. The share of brands and organizational capital fell likewise from 2004-2011 to 2012-2014, while investment in training gained ground.

Figure 16: Distribution of intangible investment, Brazil 2004-2014



Data source: Federal Government, Brazil

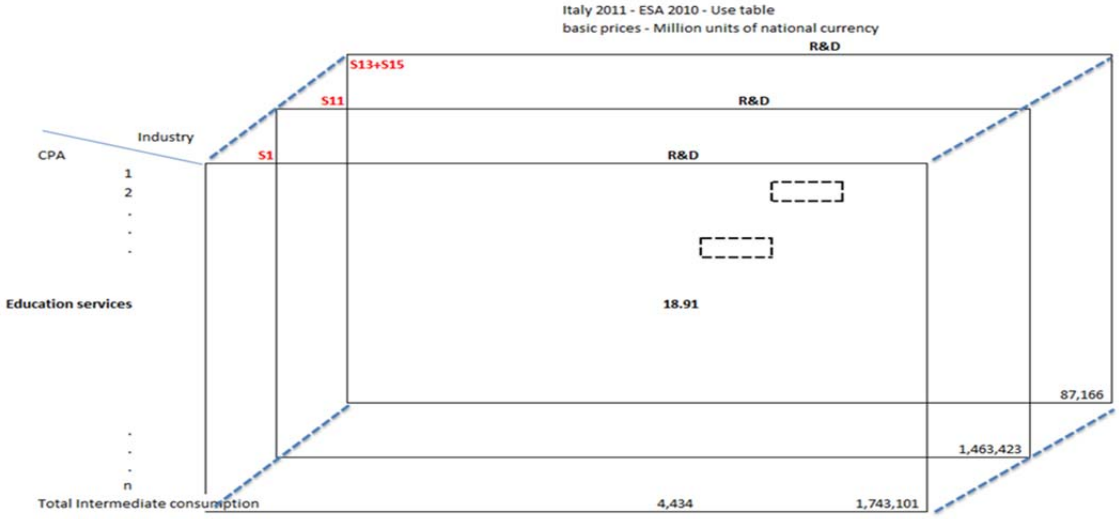
5. The SPINTAN database

The SPINTAN DB is designed as a flexible environment where it is possible to explore quickly the data along several dimensions, such as the category of intangible assets or the number of industries, and to update them on a rolling basis. The structure of the DB mirrors the multiple relationships existing between the elementary entities (sources, variables, asset characteristics).

As already mentioned above, the estimate of public intangible investment has been done for two different sets of assets: New intangible assets (NIA) and the National account intangible assets (NAIA).

Figure 17 shows the structure of the main information set necessary to generate measures of purchased nonmarket intangible investment (NIA) disaggregated by industry (column), products (row) and institutional sector (the third dimension). The structure of the information set mirrors the structure of the database.

Figure 17: The information set to measure purchased NIA



Unfortunately, the availability of the intermediate expenditure data by industry and institutional sector is rather scant across countries[15].

The SPINTAN database is structured as a relational database (DB) queried by the Structured Query Language (SQL) in an R environment. A relational DB is a rather flexible environment where data queries can be used to retrieve large amounts of records quickly and efficiently. It is in a flexible structure allowing efficient data managing, where the addition of extra data, the update and the elimination of the information are easily implemented.

In particular, the database and the related script is organized along five main areas:

- Back-casting: correction of the outliers, regression estimates and mixed method.
- Estimation: there are two procedures according if the estimates is done for the NIA or the NIAI.
- Robustness check of the estimation procedure based on auxiliary information;
- Deflation and chain linking calculation;
- Final output.

Basic information to estimate purchased NIA is stored in a template containing the following variables: Expenditure by Asset, by Country; and by Industry and time. The other inputs are:

[15] The main reasons are: the European statistical regulation does not preview the collection of the USE tables by institutional sector and secondly, the adoption of European system of accounts 2010 (ESA2010) generated a break in the classification system (from NACE 1.1 to NACE 2) and extended the asset boundaries to include R&D.

- a table containing the Structural Business Statistics (SBS) shares of turnover for the products CPA M_69 and M_70 over the whole CPA_M69_M70, by country;
- a table containing the share of market and nonmarket output at basic prices for all industries of interest contained in the supply table.

The main input to measure software and research and development investments are national account data on gross fixed capital formation by 38 branches at current prices. This information is supplemented by country specific data provided by the partners.

6. Next steps

This paper provides an overview of the empirical methods used to generate measures of intangible investment in 22 European countries, the US, China and Brazil and a first set of preliminary results.

The estimates have been uploaded on the SPINTAN website and will be revised in the following months to integrate country specific information.

In the following months the activity of WP2 will be focused on the estimates of net stocks of intangible assets in the public sector and on the refinement of the nominal and real figures already produced. Finally, we will generate real time estimates for all the sample countries up to 2013.

Appendix A1 - Defining market and nonmarket sectors

In the SNA producers are defined according to the type of output they produce. Market producers are establishments, for which all or most output is market production. Non-market producers consist of establishments (owned by government units or NPISHs) that supply goods or services free, or at prices that are not economically significant, to households or the community as a whole. These producers may also have sell secondary market output whose prices are intended to cover their costs or earn a surplus: for example, sales of reproductions by non-market museums (SNA 2008 par 6.133).

Non-profit institutions serving households (NPISHs) consist of those NPIs that are non-market producers and are not controlled by the government. They provide goods and services to households free or at prices that are not economically significant (SNA 2008 par 4.93).

General government consists of institutional units that, in addition to fulfilling their political responsibilities and their role of economic regulation, produce services (and possibly goods) for individual or collective consumption mainly on a non-market basis and redistribute income and wealth (SNA 2008 par 2.16). In addition to Government units, it includes Non Profit Institutions engaged in non-market production that are controlled by government units or social security funds (SNA 2008 par 4.30).

Note two important implications of this classification criteria: i) institutional units included in the Government sector can potentially be engaged in the production of whatever product (goods and services); public enterprises (e.g. enterprises that are controlled by the Government but sell their output at economically significant prices) are not included in the General Government sector but in the Financial Corporations or in the Non-Financial Corporations sectors.

The classification of producers into different industries, instead, is based on different criterion. In practice, an industry consists of a group of establishments engaged in the same, or similar, kinds of activity (SNA 2008 par 5.1). Note that all establishments engaged in the same kind of production are classified in the same industry, whether the institutional units to which they belong are market producers or not. Because the distinction between market and non-market production is based on a different criterion from the nature of activity itself, it is possible to cross-classify establishments by type of activity and by whether they are market producers, non-market producers, or producers for own final use (SNA 2008 par 5.47).

In other words, each industry can (potentially) consist of a mix of market and non market producers. For instance, in National Accounts data classified by industry all the three hospital of the example above are grouped in the Health Industry (see table 1for a broader list of examples).

One of the few exception is the industry "Public administration and defense; compulsory social security" (Nace Section O), that include only units belonging to sector S13: but it must be clear that the industry O is only a subset (although a very large one) of the Government sector.

Appendix A2 – Measuring own account organizational capital

Data sources

In order to estimate total compensation of managers we need data on the number of managers and their average compensation. The main data sources for these variables are the following:

1) Structure of Earnings Survey

- SES represents EU-wide, harmonised 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.
- Variable of interest for our estimates: *Mean annual earnings by economic activity and occupation* and *Number of employees by economic activity and occupation*
- Sector and Industry coverage: according to Eurostat Metadata for 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". The 2006 and 2002 surveys referred to the NACE Rev.1 classification. Results for the variable of our interest from the 2002 survey are available only at the aggregate level, without industry details.
- Data available from Eurostat provide data only at the level of 1 digit of ISCO classification of occupation. At the level of 1 digit only a general category "Managers" is identified. Availability of data at the level of 2 or 3 digit would be of great help to identify profession that are involved in the creation of organisational capital. Moreover, data available from Eurostat do not allow to cross-classify data by industry and sector.

2) Labour Force Survey

- It is the main source of information about the situation 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. Data 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 for our estimates: *Number of employees by occupation*. LFS does not collect data on compensation.
- Sector and industry coverage: LFS is a household survey, but respondents are asked the industry in which they work. Then it is possible to produce data disaggregated by industry and occupation. In several countries respondents are also asked if they work in the public sector or not, but this information is not available from Eurostat database.

3) OECD Survey on Compensation of Employees in Central/Federal Governments. Some results are reported in the OECD publication "Government at a Glance 2013". 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. The reference year is 2011.

- 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 does not cover the subordinated offices/organisations 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.

4) National accounts by industry

- Variable of interest for our estimates: *Compensation of employees, Market output (P11), Non-market output (P13)*

Estimation method: outline

- Estimate the *gross earnings of managers* and *gross earnings of all employees* by multiplying the mean annual earnings for the number of employees (from SES).
- Calculate the share of gross earnings of managers as

manager_comp_share = Gross earnings of managers / Gross earnings of all employees.

- Estimate the total expenditure for management compensation consistent with national accounts data by applying the share of gross earnings of managers to the total compensation of employees:

*manager_comp = manager_comp_share * Compensation of employees (from National Accounts).*

- Make an assumption about what proportion of spending is to be considered investment (*inv_share*). Following Corrado, Hulten and Sichel (2005), we have assumed *inv_share*=20%.
- Estimate the value of total own-account investment in organisational capital (*own_orgcap*) by applying the investment share to the total manager's compensation:

*own_orgcap= manager_comp * inv_share.*

- Estimate the value of the non-market component of own-account investment using output based indicators:

*own_orgcap_nonmkt= own_orgcap * (P13/ (P11+P13))*

Estimation method: implementation issues

The method outlined above has been implemented at the industry level for the industries of interest in SPINTAN.

The SES does not cover NACE Section O (Public administration and defense; compulsory social security) in all countries. When section O is not available, we have estimated the share of gross earnings of managers from the OECD Survey on Compensation of Employees in Central/Federal Governments (reference year 2011) and we have held the value constant for the whole period 1995-2011.

Industry level data from SES are available only for 2006 and 2010. The share of gross earnings of managers for the other years has been estimated as follows:

- 2007-2009: linear interpolation of the values estimated from SES for 2006 and 2010.
- 2002: the value for 2002 has been estimated estimation the change beween SES2002 and SES2006 at the aggregate level and applying the change to the shares estimated at the industry level from SES2006 (then the same dynamic is imposed to each industry).
- 2003-2005: linear interpolation of the values estimated for the year 2006 and 2002.
- 1995-2001: the estimate for the year 2002 have been retropolated using the dynamic on the share of manager in total employment (source LFS) as indicator. LFS data for the years before 2008 are avaialble with any industry disaggregation, then we had to apply the same dynamic (computed using aggregate data) to each industry.
- 2011: we have held the share constant to the value for the year 2010

Appendix A3 – Methods for estimating Software and R&D investment cross-classified by industry and sector

The goal of SPINTAN is to produce estimates of expenditure in intangible assets (i.e. investment) cross classified by industry and institutional sector (for a selection of industries of interest). In other words, for each intangible asset, our task is to fill all the cells of table 1. With respect to the intangible assets already included in the asset boundary of National Accounts data consistent with

SNA2008/ESA2010 (i.e. R&D, Computer software and databases, Mineral exploration and Artistic originals), SPINTAN's estimation strategy is to be consistent with existing official data.

In the ideal case, National Statistical Institutes (NSIs) provide gross fixed capital formation (GCFC) cross-classified by industry and sector and, obviously, we do not have to produce any estimate by our own. Unfortunately, it is unlikely that NSIs release official estimates of GFCF cross-classified by asset, industry and sector (because such level of detail is not required in the ESA2010 Transmission program) and for many countries, SPINTAN estimates needs to be produced.

In this note, we propose alternative estimation methods to produce estimates of GFCF in Computer software and databases and in Research and Development cross-classified by industry and by sector that are consistent with the available national accounts data on GFCF. We consider two situations: one where NSI provide GFCF by industry and by sector but not the cross classification and another one where only GFCF by sector is available (but not by sector)

Table A3.1 -

	Sectors			
Industries	**Market**	**Government**	**NPISH**	**Industry totals**
M72	$GFCF_{M72,MKT}$	$GFCF_{M72,GOV}$	$GFCF_{M72,NPISH}$	$\mathbf{GFCFI_{M72} = \sum_s GFCF_{M72,s}}$
O84	0	$GFCF_{O84,GOV}$	0	$\mathbf{GFCFI_{O84} = GFCF_{O84,GOV}}$
P85	$GFCF_{P85,MKT}$	$GFCF_{P85,GOV}$	$GFCF_{P85,NPISH}$	$\mathbf{GFCFI_{P85} = \sum_s GFCF_{P85,s}}$
Q86	$GFCF_{Q86,MKT}$	$GFCF_{Q86,GOV}$	$GFCF_{Q86,NPISH}$	$\mathbf{GFCFI_{Q86} = \sum_s GFCF_{Q86,s}}$
Q87-Q88	$GFCF_{Q87-88,MKT}$	$GFCF_{Q87-88,GOV}$	$GFCF_{Q87-88,NPISH}$	$\mathbf{GFCFI_{Q87-88} = \sum_s GFCF_{Q87-88,s}}$
R90-R92	$GFCF_{R90-92,MKT}$	$GFCF_{R90-92,GOV}$	$GFCF_{R90-92,NPISH}$	$\mathbf{GFCFI_{R90-92} = \sum_s GFCF_{R90-92,s}}$
Sector Totals	$\mathbf{GFCFIS_{MKT}}$	$\mathbf{GFCFIS_{GOV}}$	$\mathbf{GFCFIS_{NPISH}}$	$\mathbf{GFCF = \sum_j \sum_s GFCF_{j,s}}$
	$\mathbf{= \sum_j GFCF_{j,MKT}}$	$\mathbf{= \sum_j GFCF_{j,GOV}}$	$\mathbf{= \sum_j GFCF_{j,NPISH}}$	

Notation and variables definition

Let A the set of all industries, S the subset of A including only the industries of interest in the Spintan project, X the subset of S including only the mixed industries (NACE divisions 72, 85, 86, 87-88 and 90-92) and N the subset of S including only industries entirely non-market (actually only the division 84, that is entirely composed by units belonging to the Government sector). Then S=X U N. GFCF refers to gross fixed capital formation (from national accounts or SPINTAN estimates). $P11_j$ and $P13_j$ are, respectively, market output and non-market output in the industry j. $ANBERD_j$ refers to Business enterprise R&D expenditure (BERD) by economic activity for industry j from the OECD's Analytical Business Enterprise Research and

Development database. GOVERD, NPERD and HEERD are total R&D performed, respectively, by Government, Private non-profit and Higher Education (from R&D surveys conducted in accordance with the recommendations of the OECD Frascati Manual).

Case 1)

Data availability from National Accounts (according to ESA2010/SNA2008): GFCF by industry for the industries of interest ($GFCFI_j$) and total GFCF by sector (GFCFSi, i=S11,…,S15) both for software and R&D.

Method (to be applied independently to Software and to R&D): Industry totals (rows total in table 1) are available from NA. First we estimate sector totals for the set of industries of interest (column totals in table 1) consistent with total GFCF by sector (available from NA); then we estimate the split of total GFCF in each mixed industry into the market, S13 and S15 components consistent with industry and sector totals.

Detailed estimation procedure (points 1.1-1.5 are the same for R&D and for Software):

1.1) Compute total gross fixed capital formation of market sector $GFCFS_{mkt}=GFCFS_{S11}+GFCFS_{S12}+GFCFS_{S14}$, and total gross fixed capital formation of mixed industries $GFCFIx=\sum_{j\epsilon X}GFCFI_j$

1.2) Rescale $GFCFS_{s13}$ and $GFCFS_{s15}$ to exclude residual non market activity included in other industries not included in SPINTAN list of mixed industries (i.e., to get columns total of table 1 for Government and NPISH sectors):

1.2.1) $GFCFIS_{GOV}= GFCFS_{s13}* (\sum_{j\epsilon S}P13_j / (\sum_{j\epsilon A} P13_j- P13_{94}))$, where $P13_{94}$ is non-market output of NACE 94 (Activities of membership organisations) that usually is almost entirely composed of units belonging to the NPISH sector.

1.2.2) $GFCFIS_{NPISH}= GFCFS_{s15} – GFCFI_{94}$ where $GFCFI_{94}$ is gross fixed capital formation of NACE 94 (we assume that NACE 94 is the only industry besides the industries of interest for SPINTAN where the amount of GFCF made by NPISH is not negligible).

1.3) Compute total GFCF of Government sector component in the mixed industries as $GFCFIx\_s13 = GFCFIS_{GOV}- GFCFI_{85}$, where $GFCFI_{85}$ is GFCF in the Public administration and defense industry (NACE section 85).

1.4) Note that for the NPISH sector, $GFCFIS_{NPISH}$ is equal to total GFCF in the mixed industries (GFCFIx_s15), because $GFCF_{O84,NPISH}$ is equal to zero by definition.

1.5) Compute total GFCF of market sector component in the mixed industries as GFCFIx_mkt = GFCFIx - GFCFIx_s13 – $GFCFIS_{NPISH}$. Note that GFCFIx_mkt=$GFCFIS_{mkt}$ because $GFCF_{O84,mkt}$ is equal to zero by definition.

1.6) For Software:

1.6.1) Disaggregate total industry GFCF into the market and non market component using the shares of market and non market output (or employment based indicators):

$GFCFI_{j,MKT} = GFCFI_j * (P11_j / (P11_j+P13_j))$, for j∈X

$GFCFI_{j,NMKT} = GFCFI_j * (P13_j / (P11_j+P13_j))$, for j∈X.

1.6.2) For every mixed industry, disaggregate estimated non-market GFCF ($GFCFI_{j,NMKT}$) into Government and NPISH components using Government and NPISH shares in total mixed industries by industry total GFCF of NPISH sector component in the mixed industries, GFCFIx_s15:

$GFCFI_{j,GOV} = GFCFI_{j,NMKT} * (GFCFIS_{GOV} / (GFCFIS_{GOV} + GFCFIS_{NPISH}))$, for j∈X.

$GFCFI_{j,NPISH} = GFCFI_{j,NMKT} * (GFCFIS_{NPISH} / (GFCFIS_{GOV} + GFCFIS_{NPISH}))$, for j∈X.

1.6.4) Rescale $GFCFI_{j,GOV}$, $GFCFI_{j,NPISH}$ and $GFCFI_{j,MKT}$ (i.e. our initial estimates of the cells of table 1) to make them consistent with industry totals (i.e. rows total provided by NA) and sector totals (i.e. column total estimated at points 1.1-1.5). One available method is the RAS (or Iterative Biproportional Fitting).

1.6 bis) Alternative for Software if no output or employment based indicators for splitting industry totals into market and non market components are not available:

1.6.1) Disaggregate by industry total GFCF of Government sector component in the mixed industries, GFCFIx_s13:

$GFCFI_{j,GOV} = GFCFI_j * (GFCFIx\_s13 / GFCFIx)$, for j∈X.

1.6.2) Disaggregate by industry total GFCF of NPISH sector component in the mixed industries, GFCFIx_s15:

$GFCFI_{j,NPISH} = GFCFI_j * (GFCFIx\_s15 / GFCFIx)$, for $j \epsilon X$.

1.6.3) Disaggregate by industry total GFCF of Market sector component in the mixed industries, GFCFIx_mkt, by industry:

$GFCFI_{j,MKT} = GFCFI_j * (GFCFIx\_mkt / GFCFIx)$, for $j \epsilon X$.

1.6.4) Rescale $GFCFI_{j,GOV}$, $GFCFI_{j,NPISH}$ and $GFCFI_{j,MKT}$ (i.e. our initial estimates of the cells of table 1) to make them consistent with industry totals (i.e. rows total provided by NA) and sector totals (i.e. column total estimated at points 1.1-1.5). One available method is the RAS (or Iterative Biproportional Fitting).

1.7) For R&D:

1.7.1) Disaggregate total GFCF of Government sector component in the mixed industries, GFCFIx_s13, by industry using data on Government final consumption expenditure from old national accounts series (consistent with ESA95/SNA1993) assuming that the COFOG function is a proxy for the industry that made the expenditure.

1.7.2) Disaggregate total GFCF of NPISH sector component in the mixed industries, GFCFIx_s15, by industry using country specific indicators if available or assumptions

1.7.3) Disaggregate total GFCF of market sector component in the mixed industries, GFCFIx_mkt, using industry distribution of ANBERD as indicator

1.7.4) From steps 1.7.1-1.7.3 we obtain initial estimates of $GFCFI_{j,GOV}$, $GFCFI_{j,NPISH}$ and $GFCFI_{j,MKT}$ (i.e. initial estimates of the cells of table 1). The final step is rescaling $GFCFI_{j,GOV}$, $GFCFI_{j,NPISH}$ and $GFCFI_{j,MKT}$ to make them consistent with industry totals (i.e. rows total provided by NA) and sector totals (i.e. column total estimated at points 1.1-1.5). One available method is the RAS (or Iterative Biproportional Fitting).

Case 2)

Data availability from National Accounts (according to ESA2010/SNA2008): GFCF by industry for Software ($GFCFI^{SW}_j$) and Total Intellectual Property Products ($GFCFI^{IPP}_j$). This should be standard data availability according to ESA2010 transmission program.

In this case, our problem is twofold: i) we need to estimate R&D GFCF by industry; ii) for software and for R&D we need to split total GFCF in each industry into the market, Government and NPISH components.

Method: Industry totals (rows total in table 1) are available from NA. As in case 1), first we estimate sector totals for the set of industries of interest (column totals in table 1) but in this case there is no information on total GFCF by sector available from NA and we deem these as preliminary estimates and not as constraints. Second step is to estimate the industry distribution of the (estimated) total GFCF for each sector; finally, for every industry we rescale the market, government and NPISH components to make them consistent with industry total from national accounts.

For software, our approach is to produce the industry and sector disaggregation using employment based or output based indicators.

For R&D, our approach is to produce the industry and sector disaggregation using ANBERD data, data on R&D expenditure by source of funds and data on General Government final consumption expenditure (COFOG classification) from old National Accounts data consistent with ESA95/SNA1993. The main issue is that there is no one-to-one relationship between R&D surveys and SNA sectors. R&D surveys consider the following sectors: Business enterprise, Government, Private non-profit and Higher Education. While Business enterprise is included in the Market sector (S11+S12+S14) and Government is included in the Government sector (S13), Private non-profit and Higher Education correspond to more than one SNA sector (and are a mix of market and non-market units).

Assumption 1: for the industries of interest, Originals and Mineral Explorations are negligible, then in each industry SW+R&D=IPP.

Assumption 2: Unless there are some country specific information that we can use to split R&D surveys data into national accounts sectors, we need to make assumptions on the mapping between R&D surveys sectors and SNA sectors:

i) Business enterprise -> 100% Market sector (S11+S12+S14)

ii) Government -> 100% Government sector (S13)

iii) Private non-profit -> 50% NPISH (S15) and 50% Market sector (S11+S12+S14)

iv) Higher Education -> 45% NPISH (S15), 45%Government sector (S13) and 10% Market sector (S11+S12+S14)

Assumption 3: Unless there are some country specific information that we can use to estimate the sector that is the actual owner of the R&D results (i.e., the sector that has actually made the investment), we need to make assumptions on the mapping between funders and owners:

i) Market sector (S11+S12+S14) -> 100% Market sector (S11+S12+S14)

ii) Government sector (S13) -> 75% Government sector (S13) and 25% Market sector (S11+S12+S14)

iii) NPISH (S15) -> 75% NPISH (S15) and 25% Market sector (S11+S12+S14)

Detailed estimation procedure:

1.1. For every mixed industry j, disaggregate total GFCF in software, $GFCFI^{SW}_j$, into the market, government and NPISH component using employment based or output based indicators.
1.2. Compute total R&D GFCF in each industry, $GFCFI^{RD}_j = GFCFI^{IPP}_j - GFCFI^{SW}_j$
1.3. Compute total R&D GFCF in mixed industries, $GFCFIx^{RD} = \sum_{j \epsilon x} GFCFI^{RD}_j$
1.4. Compute total R&D GFCF in Spintan industries, $GFCFIs^{RD} = \sum_{j \epsilon s} GFCFI^{RD}_j$
1.5. We use ANBERD data as a proxy for GFCF in R&D (i.e. for R&D produced for own final use or purchased from other industries). It is likely that for industry 72 (Research and Development) the share of R&D output produced to be sold to other industries is much larger than for the other industries. For this reason, estimating industry disaggregation of GFCF in R&D using ANBERD data is likely to produce overestimation of GFCF in industry 72. In order to minimize the bias, we reduce the value of $ANBERD_{72}$ using country specific information on the share of market output in total output of the industry or a priori assumptions (e.g., assume that the share of market output is 50% and then multiplying the value of $ANBERD_{72}$ by .5).
1.6. Compute total R&D business expenditure in all industries, $ANBERDa = \sum_{j \epsilon A} ANBERD_j$
1.7. Compute R&D business expenditure in mixed industries, $ANBERDx = \sum_{j \epsilon x} ANBERD_j$.

1.8. Compute the share of mixed industries in total R&D business expenditure
ANBERDx_share=ANBERDx/ANBERDa

1.9. Compute R&D founded by enterprises in mixed industries
ENTERDx=ANBERDx_share*ENTERD

1.10. Compute total R&D expenditure founded by SPINTAN industries,
TERDs= ENTERDx + GOVERD + NPERD + HEERD

1.11. Compute the share of market sector (S11+S12+S14) in TERDs,
mktshare= (ENTERDx +.5* NPERD+.1*HEERD)/TERDs

1.12. Compute the share of government sector (S13) in TERDs,
govshare= (GOVERD +.45*HEERD)/TERDs

1.13. Compute the share of NPISH (S15) in TERDs,
npshare= (.5* NPERD+.45*HEERD)/TERDs

1.14. Estimate R&D GFCF in Spintan industries made by market sector,
$GFCFIS_{MKT}^{RD}$= (mktshare* $GFCFIs^{RD}$) + (.25* govshare* $GFCFIs^{RD}$) + (.25* npshare* $GFCFIs^{RD}$)

1.15. Estimate R&D GFCF in Spintan industries made by government sector,
$GFCFI_{GOV}^{RD}$= .75*govshare* $GFCFIs^{RD}$

1.16. Estimate R&D GFCF in Spintan industries made by NPISH sector,
$GFCFI_{NPISH}^{RD}$= .75*npshare* $GFCFIs^{RD}$

1.17. Estimate industry distribution of R&D GFCF in Spintan industries made by market sector, $GFCFI_{j,MKT}^{RD}$, using industry distribution of ANBERDx as indicator to split $GFCFIS_{MKT}^{RD}$.

1.18. Estimate industry distribution of R&D GFCF in Spintan industries made by government sector, $GFCFI_{j,GOV}^{RD}$, using COFOG as indicator to split $GFCFI_{GOV}^{RD}$.

1.19. Estimate industry distribution of R&D GFCF in Spintan industries made by NPISH sector, $GFCFI_{j,NPISH}^{RD}$, using employment based or output based indicators to split $GFCFI_{NPISH}^{RD}$ (or relying on assumptions).

1.20. For every industry rescale the market, government and NPISH components so that:
$GFCFI_{j,MKT}^{RD} + GFCFI_{j,GOV}^{RD} + GFCFI_{j,NPISH}^{RD} = GFCFI_{j}^{RD}$

However, the mapping between available R&D information and SNA/ESA sectors is not straightforward since

i) there is not a one-to-one correspondence between R&D surveys and the SNA sectors. R&D surveys refer to the following sectors: Business enterprise, Government, Private non-profit and Higher Education. But while Business enterprise is included in the Market sector (S11+S12+S14) and Government is included in the Government sector (S13), Private non-profit and Higher Education correspond to more than one sector in the SNA (and are a mix of market and non-market units).

ii) there is not a one-to-one association between funders of R&D expenditures (the information that we have from R&D statistics) and the actual owner of the asset (. In national accounts, the industry distribution of GFCF in R&D is made on an ownership base (i.e. GFCF is attributed to the industry in which the actual owner of the result of the R&D activity is classified). Usually who founds the R&D expenditure is also the final owner of the asset generated by the corresponding R&D activity. Nevertheless, this is not always the case. Consider, for instance, when business R&D activity is founded with free grants from the Government. In this case, the Government sector appears as the funder of the R&D activity in the R&D statistics but is not the owner of the asset in national accounts data.

iii) the functions of Government defined in the COFOG do not match unequivocally to the industries of interest.

Table A3.2 summarizes the assumptions we made to map R&D surveys by sector to the SNA/ESA sectors, table A3.3 shows the hypothesis about the correspondence between founding and ownership .

Table A3.2 Mapping between R&D surveys and SNA/ESA sectors.

	SNA/ESA sectors		
R&D survey sectors	**Market (S11+S12+S14)**	**Government (S13)**	**NPISH (S15)**
Business enterprises	1.0	0.0	0.0
Government	0.0	1.0	0.0
Non-profit institutions	0.5	0.0	0.5
Higher Education	0.1	0.45	0.45

Table A3.3. Mapping between founding and ownership.

	Owner		
Funder	**Market (S11+S12+S14)**	**Government (S13)**	**NPISH (S15)**
Market (S11+S12+S14)	1.0	0.0	0.0
Government (S13)	0.25	0.75	0.0
NPISH (S15)	0.25	0.0	0.75

Table A.3.4– Correspondence table between assets and industries in Cpa, 2002 and Nace 1.1 vs Cpa 2008 and Nace 2

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

Table A 3.5 – Availability of price indexes: Software and R&D

Country	***Software***			***R&D***		
	Asset	*Industry detail*	*Source*	*Asset*	*Industry detail*	*Source*
AT	software	yes	Eurostat	Other_IPP	yes	Eurostat
BE	software	yes	Eurostat	Other_IPP	yes	Eurostat
BG	software	no	Eurostat	Other_IPP	no	Eurostat
CZ	software	yes	Eurostat	Other_IPP	yes	Eurostat
DE	software	yes	Eurostat	Other_IPP	yes	Eurostat
DK	software	no	Intan-Invest	software	no	Intan-Invest
EL	na	na	na	Na	na	Na
ES	software	yes	Eurostat	Other_IPP	yes	Eurostat
FI	software	yes	Eurostat	Other_IPP	yes	Eurostat
FR	software	yes	Eurostat	Other_IPP	yes	Eurostat
HU	software	yes	Eurostat	Other_IPP	yes	Eurostat
IE	Software	no	NSI	R&D	no	NSI
IT	software	yes	Eurostat	Other_IPP	yes	Eurostat
LU	na	na	na	na	na	Na
NL	software	yes	Eurostat	Other_IPP	yes	Eurostat
PL	na	na	na	na	na	Na
PT	na	na	na	na	na	Na
RO	na	na	na	na	na	Na
SE	software	no	Intan-Invest	software	no	Intan-Invest
SI	na	na	na	na	na	Na
SK	na	na	na	na	na	Na
UK	software	yes	Eurostat	Other_IPP	yes	Eurostat

Appendix A4 – National accounts data availability

Table A.4.1 – Use table: data availability

Country	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Split
AT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
BE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	**No**
BG	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**No**
CZ	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
DE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	**No**
DK	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	1	**No**
EL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	**No**
ES	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	**Yes**
FI	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	**Yes**
FR	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	**No**
HU	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
IE	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	**No**
LU	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1	1	**No**
IT	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	**Yes**
NL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**No**
PL	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	**No**
PT	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1	**No**
RO	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**No**
SE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
SI	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
SK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
UK	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	**Yes**
Legend: 1 Missing; 0 Not Missing																			

Table A.4.2 – Gross Fixed Capital Formation: Data availability

	IPP Distribution						Computer Software and Databases						Research and Development					
	Industry		Institut. Sector		Cross		Industry		Institut. Sector		Cross		Industry		Institut. Sector		Cross	
	Source	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*	*Source*	*Time*
AT	E	1995-2013	Na	na	na	na	E	1995-2013	na	Na	na	na	na	na	na	na	na	na
BE	E	1995-2013	Na	na	na	na	E	1995-2013	na	Na	na	na	na	na	na	na	na	na
BG	na	na	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
CZ	E	1995-2013	Na	na	na	na	E	1995-2013	na	Na	na	na	na	na	na	na	na	na
DE	T	1995-2013	Na	na	na	na	na	na	na	Na	na	na	T	1995-2013	T***	1995-2013	T***	1995-2013
DK	T	1995-2013	T	1995-2013	T	1995-2013	E	1995-2010	na	Na	na	na	na	na	na	na	na	na
EL	E	1995-2013	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
ES	T*	1995-2012	Na	na	na	na	T	1995-2012	na	Na	na	na	na	na	na	na	na	na
FI	T	1995-2013	T	1995-2013	T	1995-2013	E	1995-2013	na	Na	na	na	na	na	na	na	na	na
FR	E	1995-2013	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
HU	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013	T	1995-2013
IE	na	na	Na	Na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
IT	NSI	1995-2012	Na	na	na	na	NSI	1995-2012	na	Na	na	na	NSI	1995-2012	na	na	na	na
LU	E	2000-2013	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
NL	E	1995-2012	Na	na	na	na	E	1995-2012	na	Na	na	na	na	na	na	na	na	na
PL	na	na	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
PT	E	1995-2011	NSI	1995-2011	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
RO	na	na	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na
SE	na	Na	Na	na	na	na	T***	1995-2012	T***	1995-2012	T***	1995-2012	T***	1995-2012	T***	1995-2012	T***	1995-2012
SI	E*	1995-2012	Na	na	na	na	E*	1995-2012	na	Na	na	na	na	na	na	na	na	na
SK	T	2004-2013	T	2004-2013	T	2004-2013	T	2000-2013	T	2000-2013	T	2000-2013	T	2000-2013	T	2000-2013	T	2000-2013
UK	E**	1995-2013	Na	na	na	na	na	na	na	Na	na	na	na	na	na	na	na	na

* not available for M72, Q86 and Q87-88 (only aggregated for M and Q) ** only available for Q86, Q87-88 and R90_92,*** only S13 E=Eurostat T=Template

References

Corrado, C., J. Haskel, C. Jona-Lasinio, and M. Iommi (2012). Intangible capital and growth in advanced economies: Measurement and comparative results. Working paper, The Conference Board and IZA. Available at http://repec.iza.org/dp6733.pdf and http://www.conference-board.org/publications/publicationdetail.cfm?publicationid=2377.

Corrado, C., C. Hulten, and D. Sichel (2005). Measuring capital and technology: An expanded framework. In C. Corrado, J. Haltiwanger, and D. Sichel (Eds.), Measuring Capital in the New Economy, Volume 66 of NBER Studies in Income and Wealth, pp. 11–46. Chicago: University of Chicago Press.

Corrado, C., J. Haskel, and C. Jona-Lasinio, (2014), "Smart Public Intangibles: SPINTAN Framework and Measurement Guidelines", available on SPINTAN website (www.spintan.net)

J¨ager, K. and M. Iommi (2014). New intangible assets: Information assets and cultural assets. (forthcoming).

Rosenthal, Steven, Matthew Russell, Jon D. Samuels, Erich H. Strassner, Lisa Usher (2014): Integrated Industry-Level Production Account for the United States: Intellectual Property Products and the 2007 NAICS" presented at the The Third World KLEMS Conference, Tokyo, Japan, May 19-20, 2014.