Private and Public Intangible Capital: Productivity Growth and New Policy Challenges

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(Preliminary and not for quotation)

Abstract

The paper summarizes the measurement framework for the analysis and generation of data on public intangible investments developed in the SPINTAN EU funded project. We do this in a manner that is, broadly speaking, within the current scope of GDP and makes possible the generation of new empirics on the evolution of productivity in the total economy, as well as the analysis of policies supporting economic growth through public intangible investments. We then combine SPINTAN newly developed measures of "public" intangibles with INTAN-Invest's industry-level estimates of "private" intangibles and review their implications for the rate and trajectory of intangible investment in the EU in recent years. We also evaluate the role of public and business sector intangibles as sources of growth in a sample of five EU member countries over the period 1995-2009. Finally, we evaluate how economic policy settings can be readjusted to favour intangible investment (where appropriate) and to stimulate efficient reallocation of resources to new sources of growth.

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Analysis of an economy's performance requires data on public investment and estimates of how these investments impact private sector outcomes. The SPINTAN project aims at discovering the theoretical and empirical underpinnings of public intangible investments and public policies towards those investments. It widens work carried out in previous FP7 projects by including the nonmarket sector in the Corrado, Hulten, and Sichel (2005, 2009, hereafter CHS) framework for analyzing the contribution of intangible capital to economic growth.[1] The CHS framework was developed for application to the market (or business) sector, and thus considerations that arise in a public context require extension and modification.

The primary purpose of this paper is to review and analyse key issues with regard to the boundaries of public intangibles and to offer a general accounting framework that facilitates the estimation and analysis of public sector activity consistently across countries. Our goal is to measure public investments in intangibles at the level and detail needed for economic analysis of a wide set of public policies. We also provide new descriptive evidence on the dynamics and intensity of intangible investments in the nonmarket sector of a sample of European countries in 1995-2010 and assess the impact of intangible capital on productivity growth in market and nonmarket sectors of five European economies before and during the financial crisis.

This paper has four major sections. In the first, we review the scope, goal, and other preliminaries, including terminology. In the second, we set out two broad categories of assets we propose to measure (1) information, scientific, and cultural assets and (2) societal competencies; and we also include a list of components for each major category. In the third section, we illustrate newly developed measures of public intangible investment in Europe and in section 4 we analyse the impact of intangible capital on private and public sector productivity growth in a sample of five EU countries. A final section provides some policy implications and concludes.

[1] COINVEST, EUKLEMS, INDICSER, and INNODRIVE.

1 Scope, Goals, and Challenges

The conceptual framework for the measurement of public intangibles is formulated with the analysis of certain topics in mind. These topics are: health and education, culture and the arts, science and the economy, and information and the economy (i.e., not the environment, not mass transport, etc.). Even so, because the impact of public investment in a particular asset type, scientific R&D, say, depends on other public investments (e.g., education), other types of private investment (physical, human, and intangible), as well as framework conditions (e.g., intellectual property policies), the subject matter we are dealing with is wide-ranging.

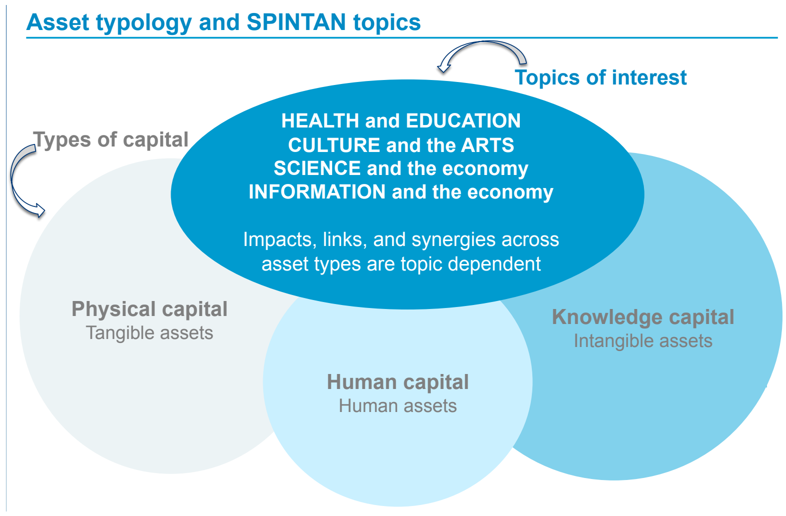


Figure 1: SPINTAN Topics of Interest and Types of Capital

The overlaps and synergies among capital types and topics are illustrated in a general fashion in figure 1 for ready reference. The key point to keep in mind is that considering impacts of investment in the arts vs. health vs. education vs. science vs. information deals with very different types and very different aspects of capital. Understanding synergies across capital asset types and links to spending policies, i.e., where what we call a public investment can be tied to a line item in the budget of a government or quasi-public institution, is an important consideration in SPINTAN's planned analysis of public intangibles. This implies that we need to aim for sufficient detail in our measures to generate meaningful results on our topics. At the same time we need to be sufficiently general so that all topics can be analyzed using the same framework.

Measurement Goal. What is the nature and scope of the measures we aim to develop? As we proceed to expand the existing intangibles framework, broadly speaking we continue to treat the current scope of GDP as our production possibilities frontier. In other words, while we consider nonmarket production by public and nonprofit institutions, *nonmarket production by households is excluded.*

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

Finally, the limitations of the currently available data on *real* public outputs (e.g., public safety, education, health care) constrain our ability to reliably estimate the impact of public investments on the wider economy.[2]

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

[2] An understanding of how real output measurement methods differ across the EU and other countries will be a component of the comparative productivity analysis of SPINTAN, e.g., as provided for health care spending by Schreyer and Mas (2013)

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

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

groupings of industries is thus not precise because an industry can reflect activity carried out by a mix of producers, as is evident with NACE Section R and the larger section of which NACE Section MB is a part.[5]

Table 1: **SPINTAN Industries of Interest**

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

NOTE—NACE Rev. 2.

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

Industries vs. Institutional Sector. National accountants classify economic activity according to institutional sectors, not industries. Figure 2 illustrates the relationship between national account sectors and the nonmarket/market conceptual distinction in a simplified way. The national accounts *nonmarket* sector is found above the horizontal line in figure 2 and consists of general government (GG) and nonprofit institutions serving households (NPISH). The *public* sector is found to the left of the vertical line in figure 2 and consists of general governments and government sponsored enterprises (GSEs).

Investment activities of the general government and nonprofit institutions (NPI) are the focus of SPINTAN. It is important to recognize that many nonprofit institutions are considered market producers according to the System of National Accounts (SNA) because they are able

[5]Appendix table A1 (page 32) shows the full intermediate structure of NACE Rev. 2.

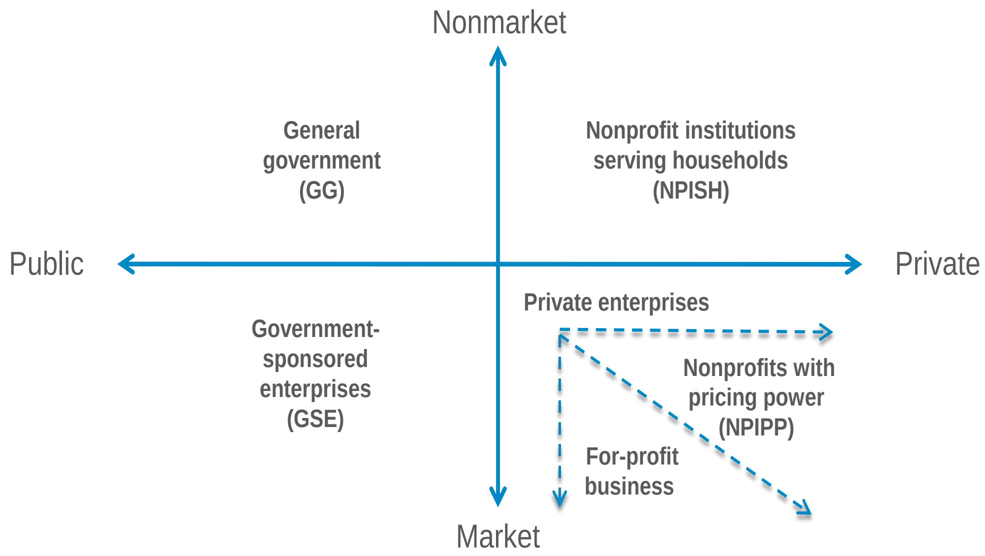


Figure 2: Enterprise types in the SNA: Groups according to control (private, public) and ability to charge economically significant prices (market, nonmarket)

to charge "economically significant" prices.[6] In other words, such institutions are not NPISH but rather are NPIPP (nonprofit institutions with pricing power) where NPI=NPISH+NPIPP. Educational institutions, for example, can be public or private, and among the latter, while most are nonprofit institutions, some are classified as market producers, i.e., they are in the NPIPP segment of the lower right quadrant of figure 2. The arts and entertainment industry is equally diverse in terms of its institutional composition, as is health and social services in certain countries. All told, all but one of the industries that we work with (NACE 84, public administration and defence) consists of a mix of institutions: business (whether for-profit or nonprofit), nonprofit institutions serving households, and general government.[7] The distinction between institutional sector and industry is very important because the information provided by the available data is quite different. We elaborate on this issue in section 2 below.

Finally, we note that because of the societal focus of our topic areas, in SPINTAN we do not

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

[7]Note that the United States and Canada follow a different convention in that the general government and government sponsored enterprises sectors are kept as separate industries in industry and input-output accounts, with the result that other industries largely pertain to private enterprises, i.e., activity to the right of the vertical line in figure 2. This means that U.S. public schools and universities, Veterans Administration hospitals and the like are *not* included in the U.S. education and health industry; the postal system is *not* in the transportation sector, etc., whereas such organizations would be spread across industries based on homogeneity of production process if European conventions were followed.

concern ourselves with GSEs even though these tend to be companies traditionally associated with public infrastructure investment, e.g., rail and power companies. And to be perfectly clear, we also do not concern ourselves with segments of nonprofits outside our topic areas, e.g., religious organizations, or membership organizations serving business.[8]

Functions of Government. The functions of government, according to economics textbooks, include maintaining legal and social framework, providing public goods and services, maintaining competition, redistributing income, correcting for externalities, and stabilizing the economy. This is formalized in national accounting as a system called "classification of the functions of government," or COFOG.

Table 2: **Functions of Government**

	Function
1.	General public services[1]
2.	Defense
3.	Public order and safety
4.	Economic affairs[2]
5.	Environmental protection
6.	Housing and community amenities
7.	Health
8.	Culture and recreation[3]
9.	Education
10.	Social protection[4]

1. Includes interest payments.
2. Transportation affairs, general economic and labor affairs, agriculture, energy and natural resources.
3. Also includes religion.
4. Disability and retirement income, welfare and social services, unemployment and other transfers to persons.

Table 2 above shows a list of the ten COFOG categories used to classify government expenditures. The categories are largely self-explanatory except the first, general public services. This category includes expenses related to executive and legislative organs, financial and fiscal affairs, external affairs, foreign economic aid, general services, general R&D, and interest payments on debt. The category excludes, however, expenditures on such items specifically related to one of the other functions, e.g., R&D related to defense is included in defense, R&D related to health is included in health, etc.

Looking at the list of items in table 2, the three functions circled, health, education, and culture and recreation correspond rather directly to three of the SPINTAN topics (see again

[8]The two-digit classification structure for the purposes of NPI is shown as Appendix table A2 (page 33), in which it can be seen we cover three of the nine one-digit categories.

figure 1, page 2); they also correspond to certain of our industries (see again table 1, page 4). R&D, as just noted, is an activity that tends to be sprinkled across several COFOGs, but all told each activity in table 2 involves the provision (or funding) of a service activity. COFOG data then are a breakdown of government expenditure according to service type, and as such, COFOG data may be mapped to NACE industries as well as to income and final demand.

Government Expenditure. Government expenditure includes payments for all government consumption and investment, as well as for payments for subsidies, transfers, and interest on public debt. In national accounting the acquisition (or production) of goods and services for community use by the government is classified as final consumption expenditure because it is spending aimed at satisfying current collective needs. Government acquisition (or production on own-account) of goods and services intended to create future benefits, such as infrastructure or research spending, is government investment (or capital expenditure). These two types of final spending by governments, consumption and investment, are components of GDP.

Transfers and subsidies are excluded from GDP because they are goods and services (payments) supplied without any transformation. As a consequence, when one hears statements such as "government spending is 50 percent of GDP in the EU"—a generally accurate metric (see figure 3)—it must be borne in mind that a significant portion of government expenditure is not final spending that is included in GDP, and thus private final spending is *not* the remainder. A framework for capitalising public intangibles requires a more refined view on how to think about the contribution of public spending to production, income generation, and consumption.

Transfer payments may be distinguished according to whether they are current or capital transfers. Current transfers directly affect the level of disposable income for the purpose of influencing consumption. Indeed the bulk of the EU's government expenditure—nearly 40 percent of GDP (2002–2012 average)—is for maintenance of household income. The comparable U.S. figure is less than 25 percent, and broadly speaking, this difference accounts for the difference between the EU and US figures for government expenditures as a percent of GDP.

Capital transfers, assuming for the moment these are domestically bound, primarily are investment grants, which are payments to market producers for the acquisition of fixed assets. They differ from subsidies, which are not tied to the purchase of an asset, but which have a similar economic impact in that they both subsidize the return to capital, a matter discussed

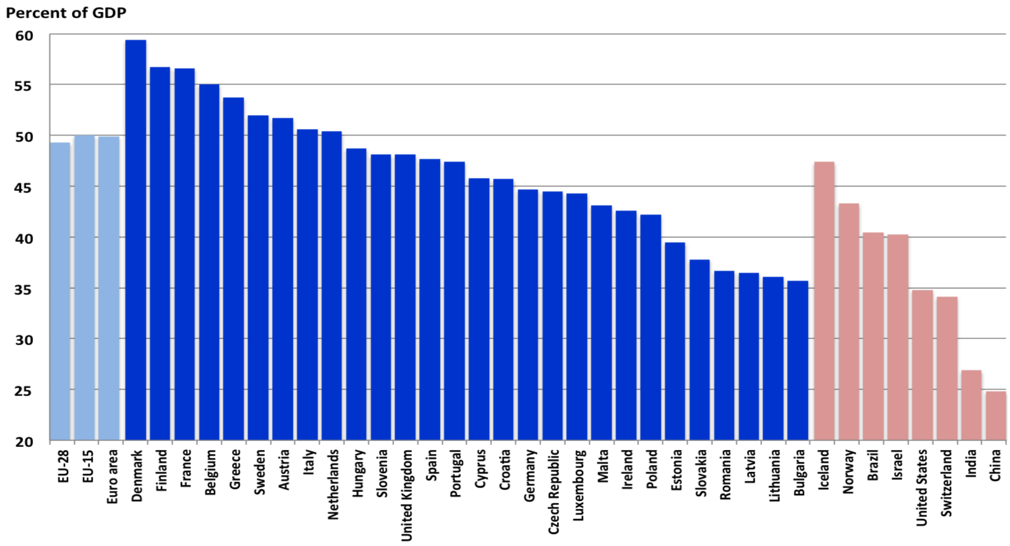


Figure 3: Government Expenditure, EU-27 and Selected Countries, 2012: Percent of GDP. Source: Eurostat, U.S. BEA, IMF

more extensively in section A below. The objectives and recipients of investment grants vary across countries and time. For instance funds may be used to offset the difficulty that SMEs have obtaining capital given the risk-averse nature of financial markets, or they may be used for the revitalization of a rural area, or they may be for explicit agricultural, transportation, energy, or housing investment projects.

From a conceptual point of view, one might think that investment financed from the budgets of public entities is public investment. But under SNA/ESA guidelines, gross fixed capital formation (GFCF) by general government *excludes* investment grants and all investment by GSEs; see again figure 2. This means that when, say, GSE-run power companies receive public funds for expansion of the electric grid, or certain universities receive public funds to build new science education facilities, the investment *may* not appear as government gross fixed capital formation in national accounts. In this sense, general government GFCF potentially excludes a significant portion of publicly-financed investment.[9]

The rate of government investment (i.e., investment relative to GDP) in the European Union and United States is shown in figure 4. The red triangles include investment grants and the blue bars show gross fixed capital formation. All told, for most of the countries plotted, the public investment rate (i.e., including investment grants) ranges from 2 to 4 percent of GDP, i.e., public investment is very small relative to total public expenditure.

[9]Government GFCF also excludes changes in public financial ownership of private companies and nonproduced assets, but these tend to be rather small compared with investment grants.

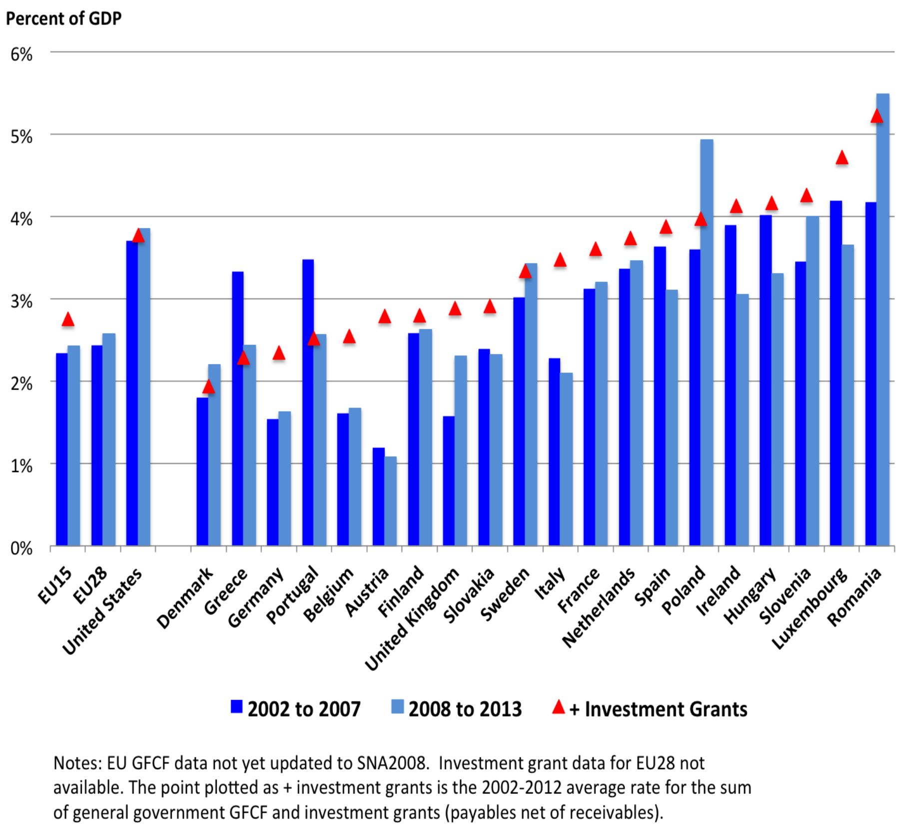


Figure 4: Government Investment in the European Union and United States, 2002–2012: Percent of GDP. Sources: Eurostat, U.S. BEA (SNA table)

A very important first point to make regarding this figure is that, as of this writing, data for the European Union do not yet reflect R&D capitalization whereas data for the United States do. After updating the EU data to reflect R&D capitalization, EU government investment rates will move closer to the rate for the United States. Another point regarding figure 4 is that including investment grants raises the rate for the EU15 aggregate by .4 percentage points, whereas the U.S. rate is unchanged.

The most striking feature of figure 4 is the variation in relative importance of investment grants across EU countries; they range from small negatives or nil for some to 1+ percentage points for others (Austria, Italy, and UK). One source of these differences is simply governance structures, i.e., central government investment grants may be administered by other levels of government (in which case the transfer nets out in general government, and the investment appears as government GFCF) or by private industry (in which case a sectoral transfer occurs, and the investment is recorded as private GFCF). These are matters that loom large in national accounting but are of little consequence when assessing the size and direction of a country's rate of public investment. Moreover, information on the industry distribution of investment grants is not readily available, and thus we do not yet know if they loom large in the capital expenditure of FOGs in our topic areas.

A final point is that the likely substantial impact of R&D capitalization on the rate of public investment underscores the relevance of SPINTAN's work to identify and estimate non-R&D public intangibles. R&D capitalization added more than 1 percentage point to the U.S. government investment rate, thereby presenting a very different picture of the relative size of government investment in the overall economy. Will this also be the case for non-R&D public intangibles after SPINTAN? In the next section we lay the conceptual groundwork for the analysis we pursue to answer that question.

2 Measuring Public Intangibles

The development of a framework for productivity analysis that covers the total economy in a coherent manner by placing public capital on the same footing as private capital requires two main steps: first the identification and measurement of intangible investments undertaken by government and nonprofit producers; second the imputation of a real net return to public capital as has long been done in the work of Jorgenson & Associates and recently implemented in official total economy productivity measures for the United States. We start with the definition of the asset boundary to identify knowledge capital in the total economy. Then we move to the nonmarket capital rate of return.

2.1 CHS-type Assets

Table 3 summarizes the CHS list of intangibles assets (on the left) and maps them to the public or nonmarket sector (on the right). As may be seen, two broad categories of public intangible assets are proposed. One consists of information, scientific, and cultural assets, and the second is societal competencies. Before we discuss what's different across the two columns, let us make a few points about the similarities. First, while the character of some assets are rather different when produced by public institutions, e.g., R&D, organizational, and mineral exploration, one may still draw a correspondence between these assets across sectors. For example, Jarboe (2009) defines public investments in brand as expenditures for export promotion, tourism promotion, and consumer product and food and drug safety (i.e, investments in product reputation). The

Table 3: **Knowledge Capital in a Total Economy**

Market Sector		Nonmarket Sector	
Computerized Information		Information, Scientific, and Cultural Assets	
1	Software	1	Software
2	Databases	2	Open data
Innovative Property			
3	R&D, broadly defined to include all NPD costs	3	R&D, basic and applied science
4	Entertainment & artistic originals	4	Cultural and heritage, including arch. & eng. design
5	Design		
6	Mineral exploration	5	Mineral exploration
Economic Competencies		Societal Competencies	
7	Brands	6	Brands
8	Organizational capital	7	Organizational capital
	(a) Manager capital		(a) Professional and manager capital
	(b) Purchased organizational services		(b) Purchased organizational services
9	Firm-specific human capital (employer-provided training)	8	Function-specific human capital (employer-provided training)

NOTE—NPD=New Product Development, including testing and spending for new financial products and other services development not included in software or conventional science-based R&D.

correspondence for computer software, purchased investments in organizational capital, and function-specific worker capital (employer-provided training) is of course far closer.

The circled items are rather different in a public sector context. Open data refers to information assets in the form of publicly collected data issued and curated for public use. This runs the gamut from patent records to demographic statistics and national accounts to geographic information and local birth/death records.[10] After asking the question, What are public sector intangible assets in the United Kingdom? Blaug and Lekhi (2009, p. 53) concluded that "perhaps the most important . . . is information assets." Jarboe (2009) includes government information creation as a high-level category in his estimates of U.S. federal government intangible investments. The category includes spending on statistical agencies, the weather service, federal libraries, nonpartisan reporting and accounting offices, and the patent office, which suggests information assets loom large in the United States as well. Indeed, it has long been held that the U.S. Census Bureau's release of its TIGER (Topologically Integrated Geographic Encoding and Referencing) dataset—in 1991—bootstrapped the country's booming geospatial industry.

Cultural assets are public intangible assets whose services are used in production in cultural

[10]Appendix table A3, page 34, reports an extensive list compiled for the MEPSIR (Measuring European Public Sector Information Resources) project.

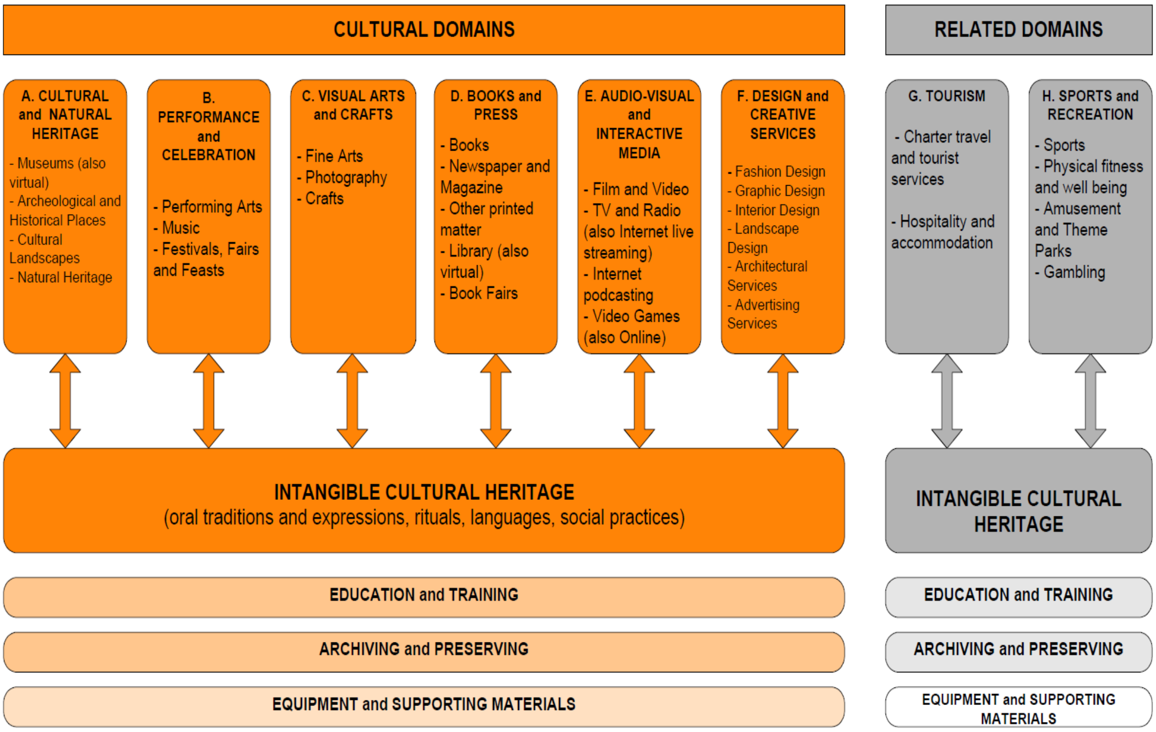


Figure 5: UNESCO Framework for Statistics on Cultural Domains

domains dominated or influenced by the public and nonmarket sectors; cultural domains as defined by the UNESCO Framework for Cultural Statistics are shown in figure 5. The capital used in many domains is included in existing estimates of private capital (tangible and intangible), but public investments (or funding) for new asset creation (especially in domains A, B, and C) needs to be identified and newly capitalized.[11] Note that cultural assets are notionally grouped with public architectural and engineering design, on the grounds that the British Museum's tessellated glass ceiling or the Louvre Pyramid are as valuable (and as incalculable) as the museums' contents although of course their correspondence to the private CHS counterparts is apparent. Cultural assets also would include the value of curative activities not normally capitalized in national accounts (a form of humanities R&D, if you will). An in-depth analysis and review of sources and methods used to estimate information assets and cultural assets is forthcoming (Jäger and Iommi, 2015). Finally, organizational investments on own-account (professional and

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

manager time devoted to organizational innovation) take on a somewhat different character in a public setting (O'Mahony, 2012; Squicciarini and Le Mouel, 2012).

2.2 Measurement Method

SPINTAN is a three year EU-funded project started December 2013, whose main goal is to develop harmonized measures of intangible investment in the public sector for 22 European countries and the U.S. from 1995 to 2013. This paper reports work-in-progress at the time of writing. For example, we confine ourselves here to intangibles as knowledge stocks *used* in public production. As described in Corrado, Haskel, and Jona-Lasinio (2014b), the treatment of schooling as a public asset, and the general subject of societal intangibles *produced* by public production, will be an activity of SPINTAN in the coming two years.

As the previous section makes clear, there are broadly two main tasks involved in documenting the scope of intangible assets used by the public sector. First, because some industries span institutional sectors, we must split these industries into their respective sectors. Second, we must now capitalize intangibles for all industries in the economy (as well as for each industry's mix according to institutional sector). Within this second task, 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 new industries, whilst keeping to an national accounts framework, we proceed in distinct steps. Consider first the industry dimension, and in particular, our industries of interest as listed in table 1. We will refer to this collection of industries as the "nonmarket" sector (even though we have seen of course from figure 2 that this is not precise language). We 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 (see previous discussion on page 3).

Henceforth in this paper, which concerns developing data and estimates of productivity for the total economy, when we refer to the nonmarket and market sectors, we mean industry groups split according to table 1 and, in keeping with these purposes, public intangibles are identified as the assets these industries use in their production. Figure 6 thus sets out the scope of the measurements we report in this paper.

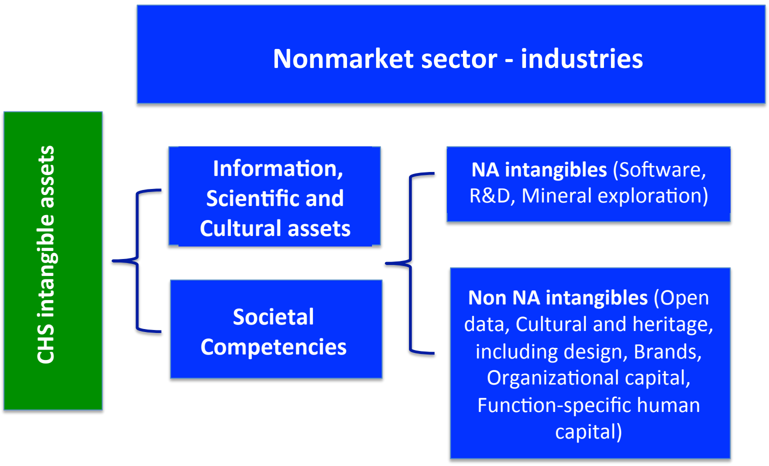


Figure 6: Measurement Dimensions of Public Intangibles

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

Although we have split our industries of interest into institutional components, we have yet to do the same for industries included in the "market-dominated" grouping, such as transportation. For reasons that will become clear in the following section, the splits are needed for productivity analysis so that a rate of return can be ascribed to public capital. This will be done in SPINTAN in the fullness of time, but we are not yet at the appropriate point to do so. As a result, we do not report (or use) information on institutional splits in this paper, except to say that, indeed, the industries listed on table 1 are dominated by nonmarket (i.e., either government or NPISH) organizations.

To obtain data on intangibles, we use the framework for estimating nominal expenditure as set out in Corrado, Haskel, Jona-Lasinio, and Iommi (2012), which may be summarized as follows:

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

where $P^N N_t$ is nominal expenditure, i is a subscript for industries, and s is a subscript for sectors. $OwnCost$ and $Purchased$ are time-series indicators of the own-account and purchased components of intangible investment, respectively. The other symbols, which though fully subscripted (i.e., by industry, sector, and time), are parameters: The parameter λ indicates the adjustment to the time-series indicator that is needed to transform it to a sector-industry gross output (own-account) or gross spending measure.[12] The parameter γ is the capitalization factor, namely, a parameter that adjusts a spending measure to a measure of investment—a fraction of revenues or employee time, say, devoted to long-lived activities.

With regard to the purchased component of non-national accounts CHS intangibles, our time series for $Puchased^{Indicator}$ are obtained from use tables in current prices (NACE Rev. 2 basis), available from most national statistical offices (NSOs) from 2002 on; for earlier years, tables generated from the WIOD project are used. Use tables provide intermediate purchases by industry (columns) and by product (rows) according to Classification of Products by Activity (CPA) codes. For the four CHS purchased assets, design, brands, organizational capital, and training, we use the following codes: Architectural and engineering services, technical testing and analysis services (CPA M71); Advertising and market research services (CPA M73); Legal and accounting services, services of head offices and management consulting services (CPA M69 and M70); and Education services (CPA P85). That these codes are used is strictly dependent on data availability; for some codes, the indicator requires usings a λ much less than one.[13] Once intangible expenditure by our nonmarket industries was identified, we followed the CHS methodology to capitalize each series (Corrado et al., 2005).[14]

Estimates of the own-account components of non-national account intangibles are still under development; as noted previously, organizational capital takes on a somewhat different character

[12]To place own-account estimates on the same footing as purchased components, for market sector industries, it is also necessary to account for industry margins. This aspect of analysis is ignored in equation (1).

[13]For example, for purchased organizational capital, we wish to obtain purchases of management consulting services (not also legal and accounting services), so the indicator is adjusted accordingly. The source of the λ adjustment may differ according to country, though detailed surveys by industry are the usual source. A detailed explanation of all these measurement steps we is in the SPINTAN document, Report on Data Collection (December 2014), available from the authors upon request.

[14]These are: design .5; advertising and market research .6; organizational capital .8; and training 1.

in a public/nonprofit setting. Next year's SPINTAN estimation activities will focus on this topic with special reference to health and educational institutions.

With regard to national accounts intangibles, we rely on our own R&D estimates. Although R&D is, in principle, currently capitalized in the national accounts of most countries, the guidelines set for European countries do *not* call for R&D investment to be published by industry. We expect the new R&D investment time series to be available by industry in the near future for a sample of European countries, however, but at the time of this writing it is not yet possible to know the precise availability. The remaining national account intangibles have been gathered from NSOs, but the level of industry disaggregation required for our analysis requires additional estimation for some countries. Official data for the United States by industry and by asset (software, artistic and entertainment originals, R&D, and mineral exploration) are readily available from 1901 to 2013.

2.3 Return to Nonmarket Capital

Once we have capitalised public intangibles, our primary objective is to evaluate their contribution to productivity growth. But to achieve this goal we need to impute a net return to public investments. For market producers, the value of production is based on industry revenues, and the return attributed to capital is obtained as revenues less current expenses. Because nonmarket producers offer their products at a price that covers only part or none of the costs of production, revenues cannot serve as a measure of the value of production for nonmarket producers. National accounts therefore use the sum of costs incurred in production to value output. For governments and NPISH, capital costs are measured as the value of economic depreciation (capital consumption), thus ignoring that part of capital compensation reflecting the real net return.

The main reason for the national accounts convention lies in the fact that (a) to include a net return requires imputation, and that (b) any such imputation directly affects GDP and national income, and that (c) there is a broad spectrum of possible imputations. The imputation of a return to public investments is discussed in the OECD capital services manual (OECD, 2009), where a key point, also made earlier by Moulton (2004, p. 169), is that aiming to create a production account for the government sector—especially one that includes its contribution to total economy multifactor productivity—necessitates estimation of a net return to public capital formation. This was done, for example, in Mas, Pérez, and Uriel (2006) in their study of the contribution of infrastructure capital to economic growth in Spain where such capital is largely held by government entities.[15]

To illustrate the issue from a productivity perspective, let i be a NACE services industry or NACE section with institutionally-mixed producers, in which case i's industry gross output and value added is the sum of activity by governments, NPISH, and market sector producers:

$$P_i^Q Q_i = \sum_S P_i^Q Q_i^S \quad ; \quad P_i^V V_i = \sum_S P_i^V V_i^S \;\; ; \;\; \Delta ln V_i = \sum_S \overline{\omega}_{S,i}^V \Delta ln V_i^S \tag{2}$$

$$P_i^V V_i = \sum_S P_i^Q Q_i^S - \sum_S P_i^{II} II_i^S = \sum_S P_i^L L_i^S + \sum_S P_i^K K_i^S \tag{3}$$

where S is an index of sectors within industry i and $\overline{\omega}_{S,i}^V$ is a given sector's Divisia share weight in total industry value added. Now *for each* S, let capital payments be fully articulated and determined residually:

$$P_i^{K^S} K_i^S = P_i^V V_i^S - P_i^L L_i^S \;\; , \tag{4}$$

in which case industry value added productivity change $\Delta ln A_i$ can be expressed in the following equivalent ways:

$$\begin{aligned} \Delta ln A_i &= \Delta ln V_i - \overline{\nu}_i^L \Delta ln L_i - \overline{\nu}_i^K \Delta ln K_i \\ &= \sum_S \overline{\omega}_{S,i}^V \Delta ln V_i^S - \sum_S \overline{\nu}_{S,i}^L \Delta ln L_i^S - \sum_S \overline{\nu}_{S,i}^K \Delta ln K_i^S \\ &= \sum_S \overline{\omega}_{S,i}^V \Delta ln A_i^S \end{aligned} \tag{5}$$

where $\overline{\nu}_{S,i}^K$ is capital's Divisia share for sector S in industry i based on (4). Note we assume that the technology for producing i makes no material use of intermediate inputs produced elsewhere in industry i.

Consider now $\Delta ln A_i^G$ for the nonmarket sector portion of total industry i. Adding a net return to nonmarket capital adjusts value added and capital compensation equally, and real output and capital contribution quantity change *within the sector* equally too, with the result

[15] Imputing a return to government capital is a common move by productivity researchers interested in total economy performance measures, e.g., as in the many works of Jorgenson and associates conducted for the United States. More recently, the imputation also is made for official U.S. total economy multifactor productivity estimates issued by the BLS (Harper et al., 2009). From 2002–2006, the adjustment averages 3.9 percent of GDP (calculated using table 5 of Harper et al., 2009).

Besides Mas et al. (2006), we are unaware of European productivity studies that have imputed a net return to capital used in nonmarket production.

that estimated ΔlnA_i^G is unaffected. But as equation (5) also makes clear, the measured contributions of ΔlnA_i^G, ΔlnK_i^G, and ΔlnV_i^G to their respective industry i aggregates *are* affected. All told, both for industries and the total economy, *the contribution of nonmarket activities will be understated* (as in under-weighted) unless a net return to capital is imputed.

A dataset that (1) cross-classifies industry-level information by institutional sector based on national accounts data, (2) imputes a return to capital compensation in the general government and NPISH subsectors, and (3) recomputes relevant economic aggregates circumvents the above-described problems. A forthcoming SPINTAN background paper explores using the social rate of time preference (Feldstein, 1964; OECD 2009) as a relevant alternative for imputing a rate of return to government capital (Corrado and Jäger, 2015). At this stage, as previously indicated, we have stuck to the national accounts assumption of a zero nonmarket sector rate of return.

3 Results

For the industries listed in table 1—to which, we reiterate, we refer to as the nonmarket sector—SPINTAN has generated measures of purchased intangible investment for four CHS asset types (brands, organizational capital, design, and training) for 10 of the 22 EU countries (Spain, Germany, Italy, UK, Finland, Netherlands, Belgium, Sweden, France, Austria) from 1995 to 2010.

3.1 The New Data and Trends

Figure 7 shows the value added shares of the table 1 (nonmarket-dominated) industries in total industry value added (which includes the impact of capitalizing intangibles), ranked from the highest (Netherlands) to the lowest (Germany). In this sample of 10 countries, nonmarket industry value added accounts for 17 to 20 percent of total value added in Netherlands, Sweden, France, and Finland and for a rather smaller share in Spain, Austria, and Germany (just over 10 percent). Market sector-dominated industries cover the remaining 80–85+ percent of economic activity.

Figure 8 shows the 1995–2010 average rate of intangible investment across the 10 EU economies when existing estimates of intangibles for market sector industries are augmented by the intangible asset components listed above for nonmarket-dominated industries. In the sample

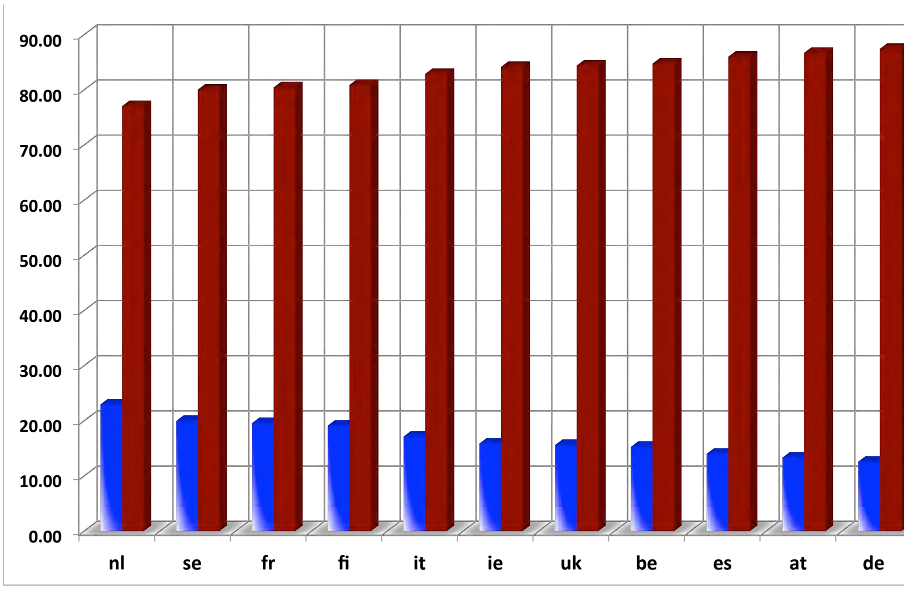


Figure 7: Market and Nonmarket Shares of Total Value Added, 1995–2010

economies, the resulting intangible investment rate ranges from nearly 6 percent to just below 3 percent of total value added, with investment in the market- versus the nonmarket-dominated industries accounting for 4 percent and 0.7 percent of value added, respectively.[16] The UK, the Netherlands, Belgium, and France have relatively high rates of intangible investment, while Spain, Italy, and Austria have relatively low rates of investment in intangibles.

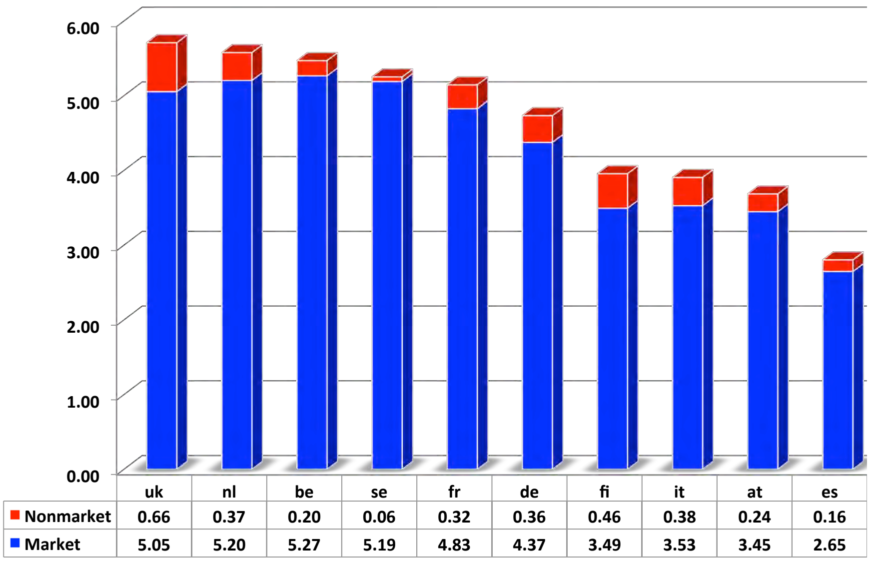
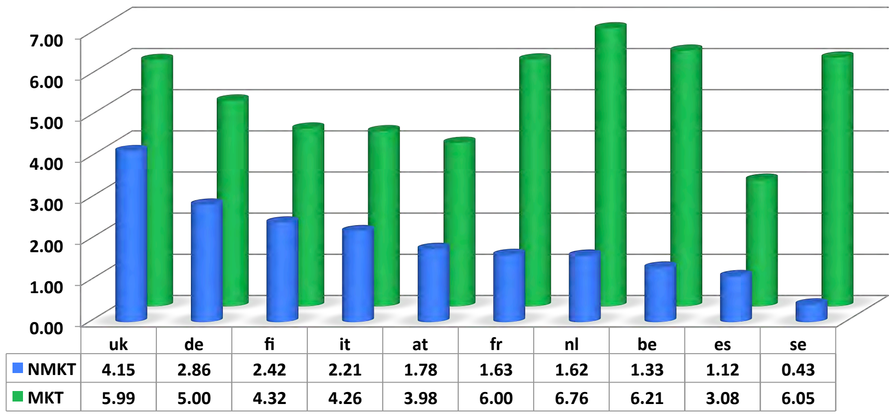


Figure 8: Intangible Investment, Share of Total Value Added, 1995–2010

Figure 9 shows the average rate of intangible investment on a sector basis, i.e., in contrast

[16]Note of course that this disparity stems in part from the still incomplete coverage of public intangibles in nonmarket-dominated industries.

to figure 8, each sector's intangible investment is shown as a share of the sector's value added. In all countries the market sector rate exceeds the nonmarket sector rate (i.e. the green bars are higher than the blue bars). But there is also interesting variation between countries. The UK, for example, has high investment rates in both the market and nonmarket sectors, while Sweden, which has a relatively high share of nonmarket activity in total activity (see again figure 7), has a high rate of intangible investment in the market sector but a very low rate in the nonmarket sector: France, the Netherlands and Belgium are similar.



	uk	de	fi	it	at	fr	nl	be	es	se
NMKT	4.15	2.86	2.42	2.21	1.78	1.63	1.62	1.33	1.12	0.43
MKT	5.99	5.00	4.32	4.26	3.98	6.00	6.76	6.21	3.08	6.05

Figure 9: Intangible Investment, Shares of Nonmarket and Market Value Added, 1995–2010

Finally, table 4 breaks down intangible investment into its major non-national accounts asset types for the two sectors in 2008. So, for example, the top row shows, for Austria, shares of four asset types for both the nonmarket and market sector, where the shares for each sector sum to 100 percent. The relative importance of each asset category varies considerably across countries and sectors with a higher degree of heterogeneity in nonmarket sector. Training is the largest component in many of the most intangible-intensive nonmarket economies, namely UK and Germany, where it accounts for more than 60 to 70 percent of non-national accounts intangible investment. As reported in previous comparative studies, e.g., van Ark, Hao, Corrado, and Hulten (2009), organizational capital and brands are the main components of intangible investment in the market sector. It will be of interest to see if this picture remains when we capitalize all intangible assets for all countries.

	Nonmarket Intangibles					Market Intangibles				
	BRAND	DES	TRAIN	ORGC		BRAND	DES	TRAIN	ORGC	
Austria	15,4	30,3	17,3	37,0	100	25,9	22,8	27,1	24,1	100
Germany	2,9	14,1	71,2	11,8	100	20,9	22,5	30,1	26,4	100
Spain	32,4	53,3	7,6	6,6	100	35,8	35,2	17,0	12,0	100
Belgium	10,6	14,1	1,4	73,9	100	38,4	20,2	13,2	28,2	100
Finland	6,8	31,2	36,6	25,3	100	24,9	33,5	19,5	22,1	100
France	11,3	26,1	22,2	40,4	100	17,9	27,2	24,7	30,2	100
Italy	6,6	39,6	16,8	37,0	100	29,5	27,9	19,9	22,7	100
Netherlands	18,4	7,2	25,0	49,4	100	23,0	19,8	20,8	36,5	100
Sweden	14,5	37,8	22,3	25,4	100	16,2	29,4	18,2	36,2	100
UK	9,5	16,6	63,7	10,2	100	21,3	24,4	25,2	29,2	100

Table 4: Non-national Accounts Intangible Investment by Asset Type, 2008

3.2 Growth Accounting with Public Intangibles

To the data on new assets presented in the previous section, we add the national accounts intangibles (R&D, software, and artistic and entertainment originals plus mineral exploration). We are thus able to look at a fairly complete picture of intangible inputs to total production across a sample of advanced countries.[17] We currently are able to present a sources-of-growth analysis for these intangibles for five European countries: Finland, Germany, Italy, Spain, and the United Kingdom.

To carry out the growth accounting, in addition to exploiting the newly-developed SPINTAN measures of public intangibles described and our databases of national accounts intangibles by industry for the total economy and of non-national accounts intangibles for market sector industries (INTAN-Invest), we also require information on tangible assets from EUKLEMS. Due to the lack of availability of EUKLEMS data on tangible assets by industry after 2009, however, the estimates we now present span the years 1995 to 2009.[18]

The sources-of-growth estimates for market and nonmarket sectors (defined as a collection of industries dominated by one type of activity or the other as previously described) are set out in table 5. The top line shows average percent changes in labor productivity, and subsequent rows show contribution, with the highlighted lines for capital deepening showing subtotals aggregated over asset type. Looking at the top line, the performance of advanced economies differs widely according to market versus nonmarket sector for these five European countries. Market sector labor productivity growth in the UK and Finland (see the last two pairs of columns) averaged 2.2 and 2.5 percent per year, respectively, over the entire 1995–2009 period; Germany posted an annual gain of 1.5 percent, while in Spain and Italy averaged just 0.8 and 0.4 percent,

[17] As of this writing we have not completed our estimates for the United States, nor have we prepared estimates for non-national accounts own-account components, or for the new assets, open data and cultural & heritage assets.

[18] The results presented in this section were developed in collaboration with M. Iommi.

respectively. At the same time, nonmarket sector productivity growth in Spain, Germany and UK averaged just over 1 percent per year; in Italy it was 0.7 percent, while in Finland it decreased by -0.03 percent per year.

	es mkt	es nmkt	demkt	de nmkt	it mkt	it nmkt	uk mkt	uknmkt	fi mkt	fi nmkt
Labor Productivity Growth	**0,77**	**1,00**	**1,47**	**1,16**	**0,37**	**0,67**	**2,18**	**1,02**	**2,49**	**-0,03**
Tang Capital Deepening	**0,92**	**0,41**	**0,57**	**-0,02**	**0,54**	**0,17**	**0,81**	**0,66**	**-0,21**	**-0,65**
Tang ICT Capital Deepening	0,23	0,21	0,24	0,05	0,16	0,14	0,49	0,19	0,11	0,03
Tang noICT Capital Deepening	0,68	0,19	0,33	-0,07	0,38	0,02	0,33	0,47	-0,33	-0,67
Intang Capital Deepening	**0,29**	**0,18**	**0,29**	**0,65**	**0,17**	**-0,02**	**0,64**	**0,34**	**0,63**	**0,25**
Software	0,13	0,06	0,07	0,03	0,06	0,03	0,20	0,07	0,15	0,05
Innovative Prop	0,11	0,10	0,12	0,46	0,06	-0,03	0,13	0,06	0,31	0,19
R&D	0,05	0,09	0,07	0,44	0,01	-0,06	0,03	0,03	0,22	0,16
Arch_Des	0,05	0,02	0,03	0,02	0,04	0,03	0,08	0,03	0,08	0,03
NFP	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,00	0,00	0,00
Min_Art	0,01	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,01	0,00
Econ Competencies	0,05	0,02	0,10	0,17	0,05	-0,02	0,31	0,20	0,17	0,01
Advert+Mkt_Res	0,02	0,01	0,01	0,00	0,02	0,00	0,03	0,01	0,05	0,01
Org_Cap	0,03	0,00	0,07	0,02	0,04	0,02	0,22	0,02	0,12	0,02
Train	0,00	0,01	0,02	0,15	-0,01	-0,04	0,06	0,17	0,00	-0,01
TFP Growth	**-0,43**	**0,42**	**0,61**	**0,53**	**-0,34**	**0,52**	**0,73**	**0,02**	**2,08**	**0,36**

Table 5: Contributions to Sectoral Labor Productivity Growth:1995–2009

Finland seems to be somewhat of a special case, with very low (or negative) contributions from tangible capital deepening in both sectors. Italy and Spain, two slow-growth economies, also both have relatively low intangible capital deepening contributions in both sectors, but relatively healthy contributions from tangible capital deepening. Their poor market sector productivity in Spain and Italy is accounted for by low (or negative) TFP in their market sectors. Interestingly, however, they have comparatively good TFP growth in their nonmarket sectors. The UK stands out in that it has the poorest nonmarket TFP performance.

All told, tangible capital deepening and TFP are the main drivers of nonmarket sector productivity in the slow-growing countries (Italy and Spain) where intangible capital provides only a small or negative and negligible contribution (0.2 percent per year in Spain and -0.02 percent per year in Italy). By contrast, in Germany and Finland, intangible capital provides a relatively strong contribution to productivity growth in the nonmarket sector; in these economies, this result is mostly driven by R&D. Thus the analysis supports the idea that intangible capital is an important source of growth for the *public* sectors of certain advanced economies.

Now we look at the sources of growth results that distinguish the period before the global financial crisis from its starting years. The distinction enables us to evaluate the contribution of intangible capital in the market and nonmarket sectors before and after the financial shock. The results are shown in figure 10.

From 1995 to 2007, all sample countries experienced increases in labor productivity, on balance, even with different degrees of performance in the two sectors across countries. The

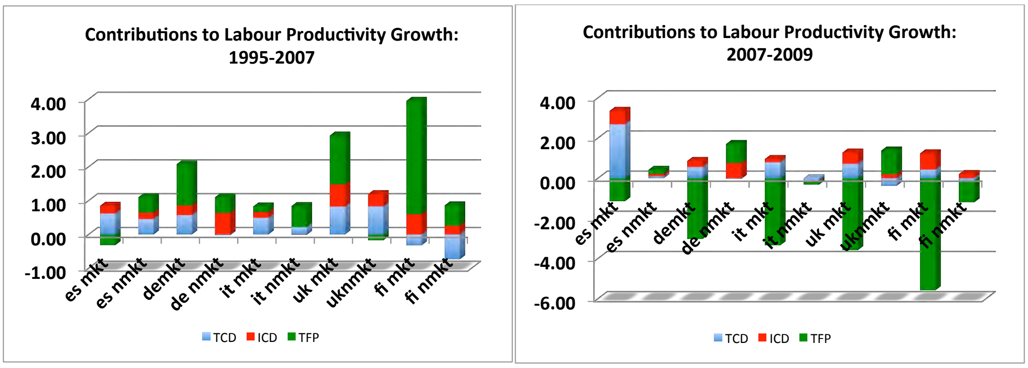


Figure 10: Contributions to Labour Productivity Growth:1995-2007 vs 2007-2009

international comparative intangible capital literature (e.g., van Ark et al., 2009; Corrado et al., 2013) has established that capital deepening is the main driver of market sector productivity growth even though the nature of the accumulation, i.e., whether it reflects the contribution of tangible or intangible capital, varies considerably across countries. Slow-growing economies are more tangible capital-intensive compared with fast-growing countries where intangible capital and TFP are the primary sources of growth. In our expanded exercise, we find that the main drivers of growth in nonmarket-dominated industries are rather different across countries. TFP is the main source of nonmarket productivity growth in Italy, Spain and Finland, whereas tangible and intangible capital are the main drivers in UK and Germany, respectively.

At the onset of the financial crisis, market sector productivity decreased sharply in all sample economies except Spain. Nonmarket sector productivity slowed in Italy and Finland but remained positive in Spain, Germany, and the UK. Interestingly, intangible capital deepening provided a positive and significant contribution to nonmarket productivity growth in UK, Finland, and Germany—a contribution that in all cases outweighed the contribution of tangible capital.

All told, our analysis suggests that besides the well known contribution of intangible capital to private sector productivity growth, intangible capital also is a relevant source of growth in the public sector of advanced economies. The main drivers of the contribution of public intangible capital are R&D (Germany and Finland) and organizational capital (UK). Finally, at the very beginning of the financial crisis, intangible capital positively supported labor productivity growth in both the market and nonmarket sectors of our sample of advanced economies.

In the fullness of time we wish to understand the relation between the various components of a total economy growth analysis that includes intangibles. As a first look at whether intangible

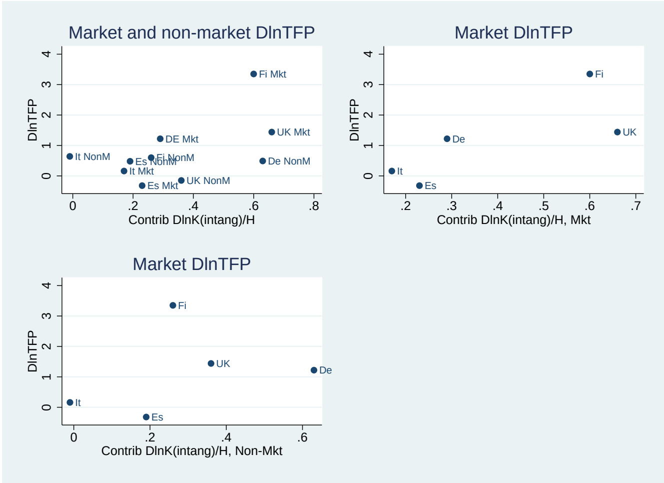


Figure 11: Total Factor Productivity Growth (1995-2007) and market and nonmarket intangible capital deepending contributions

capital accumulation might generate productivity spillovers, consider figure 11 (which uses data 1995–2007 to avoid possible measurement issues in the recession). The top left panel shows TFP growth for our 5 countries, for both market and nonmarket sectors, plotted against the contribution of intangible capital deepening. There is a broadly positive relation. The other panels plot *market*-sector TFP growth against the contribution of intangible capital deepening for the *market* sector, top right panel, and *market*-sector TFP growth against the contribution of intangible capital deepening for the *nonmarket* sector, bottom left panel. There are of course only five observations, but the broad upward-sloping line is suggestive of spillovers from market sector intangibles to market sector TFP (we have in fact shown this for a broader sample of countries in another paper; see Corrado, Haskel, and Jona-Lasinio, 2014a) and also, perhaps, from nonmarket sector intangibles to market sector GDP. If the latter spillover holds up to in-depth investigation, this may be potentially of policy significance.

4 Conclusion and Policy Challenges

This paper has reviewed the implications of measuring public sector intangible investment. The challenges are considerable and consist of a number of basic issues to overcome. First, existing industry datasets are typically a mixture of market and nonmarket activity (e.g. education is both public and private) and so existing data must be separated out. Second, to the extent that some intangible assets are already capitalised in national accounts (e.g. software and some R&D), one must also separate those out. Third, if one wishes to capitalise new non-national accounts intangible assets, e.g. public information goods, these assets must be decided and data must be collected separated between market and nonmarket sectors. Fourth, one must decide on what returns, if any, to attribute to nonmarket sector capital (current conventions assign a rate of return of zero).

We have tried in this paper to provide some first steps along this path. For all 22 EU countries, we have split the economy into its market and nonmarket sectors, using current data, which capitalizes intangible software, mineral exploration and artistic originals. For 10 EU countries out of 22 (Spain, Denmark, Italy, UK, Finland, Netherlands, Belgium, Sweden, France, Austria), we have generated measures of purchased intangible investment in four CHS type of assets (brands, organizational capital, design and training) in the nonmarket sector. For five countries (Spain, Germany, Italy, UK and Finland) we have managed to generate growth accounting results using all CHS asset types (but yet not including the asset types that take on a very different character in the public sector context). We have therefore presented two sets of results: (a) for 10 countries we present results that include the four newly capitalized CHS purchased assets, (brands, organizational capital, design and training) for nonmarket-dominated industries (scientific R&D, public administration, education, health and social work, and creative, arts and entertainment activities) (b) for five countries we present growth accounting for all the national accounts and non-national accounts CHS assets in the market and nonmarket sectors.

We have found that, the restricted group of intangible assets in 10 countries accounts for about 0.7% of total value added. For the growth accounting results, we have different effects in different countries. Spain and Italy have relatively strong nonmarket sector productivity growth, associated with relatively strong TFP growth but in Spain (Italy) a high (low) intangible contribution.

In future work we hope to extend the dataset and take up a series of policy questions. For example, a primary finding with regard to intangible capital, widely supported by growth accounting exercises and macroeconomic studies (Corrado et al., 2005, 2009, 2013, 2014a), is that it is growth-promoting. Intangible investments, R&D and non-R&D alike, appear to generate spillovers to the economic system owing to their non-rival and possibly non-excludable, characteristics. Such spillovers, if they exist, might be within the private sector and/or between the public and private sector. In light in particular of the claims and counter-claims around public sector austerity and fiscal policy in Europe, it would be vital to know which, if any, public sector intangibles had positive spillovers to the rest of the economy.

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A Appendix: GDP and Income Impacts of New Assets

Here we consider three central measurement questions, namely:

1. Reclassification of a current input (intermediate purchase or own-produced service): What is the change to GDP and national saving that arises when a new asset type used in nonmarket production (and nonmarket production only) is introduced?

2. Reclassification of final consumption: What is the change to GDP and national saving that arises when a nonmarket final consumption service is regarded as a societal investment, i.e., as in social infrastructure?

3. Reclassification of a production subsidy to a payment for a public asset: What changes at the industry and aggregate level?

We proceed by first setting out key macroeconomic variables in terms of their nonmarket and market components, and then turn to analyzing these questions. Specifically, we consider adjustments to GDP in market prices (consumption and investment), net expenditure (NE), national income (NI), and national saving (NS). National saving is the increment to wealth, or future consumption, and thus changes to it reflect changes to the measured increment to wealth from current production. (Wealth also increases due to revaluation, which is not discussed.) All variables are in nominal terms.

First, we assume that services supplied by nonmarket producers are uniquely produced by the domestic nonmarket sector and are not traded. This is not far from reality, but it is not the same as saying the total supply of each i flows entirely from domestic nonmarket producers or that the sector buys only domestically-supplied investment goods and services. In the next subsection we move to consider the total supply of i and of investment goods and services used in the production of i, in which case the subscript i comes to be used to distinguish industries. For the task at hand, distinguishing among institutional units supplying i is for the most part not necessary, and we drop the i subscript when we can and use it only when we need to say something about industries in particular.

The superscript "N" will be used to reflect nonmarket activity, technically, by governments and NPISH (but again, to look ahead, we will eventually look at the production of each i by all producers, and this should be borne in mind). Now, let "H" denote market activity by households, "M" market activity by market sector producers (i.e, mostly business, but also NPIPP), and "ROW" rest-of-world "sector" activity. ROW activities here consist of two magnitudes: "BOT" balance of trade (net exports) and "NFI" net factor income from abroad (i.e., the difference between GDP and GNP), and which together with international capital transfers comprise the current account balance.

For GDP and national income, the following identities hold:

$$GDP = \underbrace{P^C C^N \ + \ P^I I^N}_{Nonmarket\ C\&I} \ + \ \underbrace{P^C C^H + P^I I^M + BOT}_{Market\ C\&I} \tag{6}$$

$$NI + Sb - TxPI = P^L L + \underbrace{P^K K^N + P^K K^M - (\delta P^I K^N + \delta P^I K^M) + NFI^{ROW}}_{NetPropertyIncome} \tag{7}$$

As all expressions are in nominal terms, net expenditures equals national income, and national saving is given by total income available for consumption $NI + Tr$ less total consumption $P^C C^N + P^C C^H$ and total taxes paid $Taxes$:

$$NS = NI + Tr - P^C C^N - P^C C^H - Taxes \tag{8}$$

Household capital formation (e.g., housing) is not explicit in the above relations, nor are business transfer payments.[19]

Reclassification of nonmarket intermediate consumption. We follow Fraumeni and Okubo (2005) in their sketch of the impact of capitalizing R&D in national accounts.[20] With regard to GDP, note from the first term in (6) that nonmarket final spending is either consumption or investment. Note further from (**??**), page **??**, that if a purchased intermediate input, R&D services, say, is reclassified as investment, total *actual outlays* by nonmarket organizations do not change but via (**??**) measured consumption decreases by the amount of the purchased intermediate service and increases by the measured gross income earned on the new asset $P^K_{a+}K^N_{a+}$, where the subscript $a+$ denotes the new asset. If the new asset has a counterpart in the sector's own nonmarket activities, e.g., R&D funded and conducted within the organization, the gross returns will be larger because the corresponding net stocks are larger.

These impacts and their consequences are summarized as follows:

(9) $$\text{Adj.} - \text{Orig. Consumption} = -P_{a+}II^N_{a+} - P_{a+}IOwn^N_{a+} + P^K_{a+}K^N_{a+}$$

(10) $$\text{Adj.} - \text{Orig. Investment} = P_{a+}IPur^N_{a+} + P_{a+}IOwn^N_{a+}$$

which implies the following for GDP:

(11) $$\text{Adj.} - \text{Orig. GDP} = \underbrace{-P_{a+}II^N_{a+} - P_{a+}IOwn^N_{a+} + P^K_{a+}K^N_{a+}}_{ConsumptionChange} + \underbrace{P_{a+}IPur^N_{a+} + P_{a+}IOwn^N_{a+}}_{InvestmentChange} .$$

Noting that $P_{a+}IPur^N_{a+} = P_{a+}II^N$, the overall GDP change simplifies to:

$$= \underbrace{P^K_{a+}K^N_{a+}}_{GrossReturntoNewAsset}$$

which says that GDP increases by the imputed gross income accruing to the new asset.

The change to national income reflects only the imputed *net* income accruing to the new asset:

(12) $$\text{Adj.} - \text{Orig. National Income} = \underbrace{P^K_{a+}K^N_{a+} - \delta P_{a+}K^N_{a+}}_{NetReturntoNewAsset} .$$

And the change in national savings NS is then:

(13) $$\text{Adj.} - \text{Orig. NS} = \underbrace{P^K_{a+}K^N_{a+} - \delta P_{a+}K^N_{a+}}_{NationalIncomeChange} - \underbrace{(-P_{a+}II^N_{a+} - P^{IOwn}_{a+}IOwn^N_{a+} + P^K_{a+}K^N_{a+})}_{ConsumptionChange} .$$

Noting again $P_{a+}IPur^N_{a+} = P_{a+}II^N$ and also $P_{a+}I^N_{a+} = P_{a+}IPur^N_{a+} + P_{a+}IOwn^N_{a+}$, the above expression reduces to:

(14) $$= \underbrace{P_{a+}I^N_{a+} - \delta P_{a+}K^N_{a+}}_{NetInvestmentChange}$$

which says that the change to national savings equals the change in net investment resulting from the capitalization of the new asset. In the general case, this is sufficient to offset the

[19] To complete the accounting of saving and investment flows under these assumptions, note that we also have:

$$NS \equiv \underbrace{P^I I^N + P^I I^B + P^I I^{ROW}}_{Total\ Investment} - \underbrace{(\delta P^I K^N + \delta P^I K^B)}_{Depreciation}$$

where

$$P^I I^{ROW} \equiv CAB = \underbrace{P^{BOT}BOT}_{Net\ Exports} + \underbrace{NFI^{ROW}}_{Net\ Factor\ Income} + \underbrace{CTr^{ROW}}_{Capital\ Transfers}$$

where "CAB" is current account balance, and all statistical discrepancies are ignored.

[20] Unlike Fraumeni and Okubo (2005), we concern ourselves here with the reclassification of intermediate consumption by *nonmarket producers* only.

decrease in consumption so that the change in net expenditure (NE), the sum of the change in consumption and change in the increment to future consumption (or NS) is positive. We have then for NE

$$\text{(15)} \qquad \text{Adj.} - \text{Orig. NE} = \underbrace{-P_{a+}II^N_{a+} - P^{IOwn}_{a+}IOwn^N_{a+} + P^K_{a+}K^N_{a+}}_{ConsumptionChange} + \underbrace{P^I I^N_{a+} - \delta P_{a+}K^N_{a+}}_{NetSavingChange}$$

$$\text{(16)} \qquad = \underbrace{P^K_{a+}K^N_{a+} - \delta P_{a+}K^N_{a+}}_{NetReturntoNewAsset}$$

because as previously indicated we are in nominal terms, and NE = NI.

All told then, we see that GDP increases by the gross return to the new asset, and net expenditure increases by the net return. Although this increase in NE might be regarded as fairly small, it reflects two rather larger, partially offsetting mechanisms, namely, lower current consumption that is more than offset by current and future net returns to the investment. National saving increases, of course, by the full value of the new net investment.

Reclassification of nonmarket final consumption. As may be seen via equation (**??**), the algebra of these impacts is the same as the foregoing after substituting a final service component $P_{a+}C^N_{a+}$ for an intermediate input component $P_{a+}II^N_{a+}$. This would be case where spending on a portion of health care services, say, is reclassfied as investment.

Reclassification of subsidies to payments for public assets. Note first that the logical implication of equation (**??**) is that the "usual" expression for market sector industry output becomes

$$\text{(17)} \qquad \begin{aligned} P^Q_i Q^M &= P^L_i L_i + (P^K_i K_i - SbQ_i) + P^{II}_i II_i \ . \\ &= Sales^{FD}_i + P^{IO}_i IOwn_i + Sales^{i,S\neq i}_i \end{aligned}$$

where $Sales^{FD}_i$ is industry i sales to final demand and

$$\text{(18)} \qquad P^K_i K_i \equiv P^Q_i Q^M + SbQ_i - P^{II}_i II_i - P^L_i L_i$$

When a production subsidy is reclassified as a payment for a public asset, SbQ_i is reduced and $P^Q_i Q_i$ (via sales revenue) increases by the same magnitude. Capital compensation in market sector industries thus does not change (but the previously overstated return to tangible capital is reduced).

In the purchasing industry (the nonmarket industry, specifically government), capital compensation increases by the gross return on the new asset, and thus total industry gross value added at factor costs changes by this amount $P^K_{a+}K^G_{a+}$. GDP at market prices includes, however, an additional effect, namely, whether built from industry data as expressed in equation (**??**) or built from expenditure data as in equation (6), GDP also increases by the value of the new investment purchases $P_{a+}I^G_{a+} = P_{a+}IPur^G_{a+}$.

All told we have the change to GDP as

$$\text{(19)} \qquad \text{Adj.} - \text{Orig. GDP} = \underbrace{P^K_{a+}K^G_{a+}}_{ConsumptionChange} + \underbrace{P_{a+}I^G_{a+}}_{InvestmentChange}$$

and for national income as

$$\text{(20)} \qquad \begin{aligned} \text{Adj.} - \text{Orig. NI} &= P^K_{a+}K^G_{a+} - \delta P_{a+}K^G_{a+} - (-Sb_{a+}) \\ &= \underbrace{P^K_{a+}K^G_{a+} - \delta P_{a+}K^G_{a+}}_{NetReturntoNewAsset} + \underbrace{P_{a+}I^G_{a+}}_{InvestmentChange} \quad . \end{aligned}$$

The change in national savings is given by

$$\text{Adj.} - \text{Orig. NS} = \underbrace{P^K_{a+}K^G_{a+} - \delta P_{a+}K^G_{a+} + P_{a+}I^G_{a+}}_{NationalIncomeChange} - \underbrace{(P^K_{a+}K^G_{a+})}_{ConsumptionChange}$$

$$= \underbrace{P_{a+}I^G_{a+} - \delta P_{a+}K^G_{a+}}_{NetInvestmentChange} \quad . \tag{21}$$

For net expenditure, we have of course

$$\text{Adj.} - \text{Orig. NE} = \underbrace{P^K_{a+}K^G_{a+}}_{ConsumptionChange} + \underbrace{P^I I^G_{a+} - \delta P_{a+}K^G_{a+}}_{NetSavingChange} \tag{22}$$

$$= \underbrace{P^K_{a+}K^G_{a+} - \delta P_{a+}K^G_{a+}}_{NetReturntoNewAsset} + \underbrace{P_{a+}I^G_{a+}}_{InvestmentChange} \quad . \tag{23}$$

This scenario provides a sketch of how public sector funds that support the conduct of R&D by for-profit and nonprofit producers might be treated in national accounts after R&D capitalization *if* ownership of publicly-funded, privately-produced R&D assets is determined to be the public sector. This situation reflects our current understanding of how most countries will treat public R&D spending.[21]

To sum up, when a production subsidy is regarded instead as a purchase of an asset, GDP increases by the gross return to the new asset *plus* the value of investment in the new asset, and net expenditure increases by the net return to the new asset *plus* the value of investment in the new asset. Owing to the fact that expenditures previously classified as non-transformative (or nonproduction), are now considered production of a long-lived asset, the results (per unit of spending involved) are rather more dramatic than the two previous cases.

[21] Note that it is not necessary for NSOs to have previously treated publicly-funded R&D as a subsidy to production for our observations to be valid because the transferred funds would have boosted GOS in reality (and statistically, with allowance for discrepancies) and thereby operated as a subsidy.

Note further that if ownership of publicly-funded, privately-conducted R&D is determined to be the private sector, which we understand is the determination for the United Kingdom, then GDP increases by the newly capitalized *private* own-account R&D investment paid for by the public sector. The public funding is recorded as a production subsidy, and then via (18), capital compensation in the market sector does not change.

B Appendix: Tables

Table A1: **NACE 2 Intermediate Structure**

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

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

* including imputed rents of owner-occupied dwellings

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

Table A2: **Classification of the Purposes of Nonprofit Institutions**

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

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

Table A3: **MEPSIR Information Types and Sub-types**

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

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

Table A4: **SPINTAN Data *Desideratum***

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

Source—This paper.