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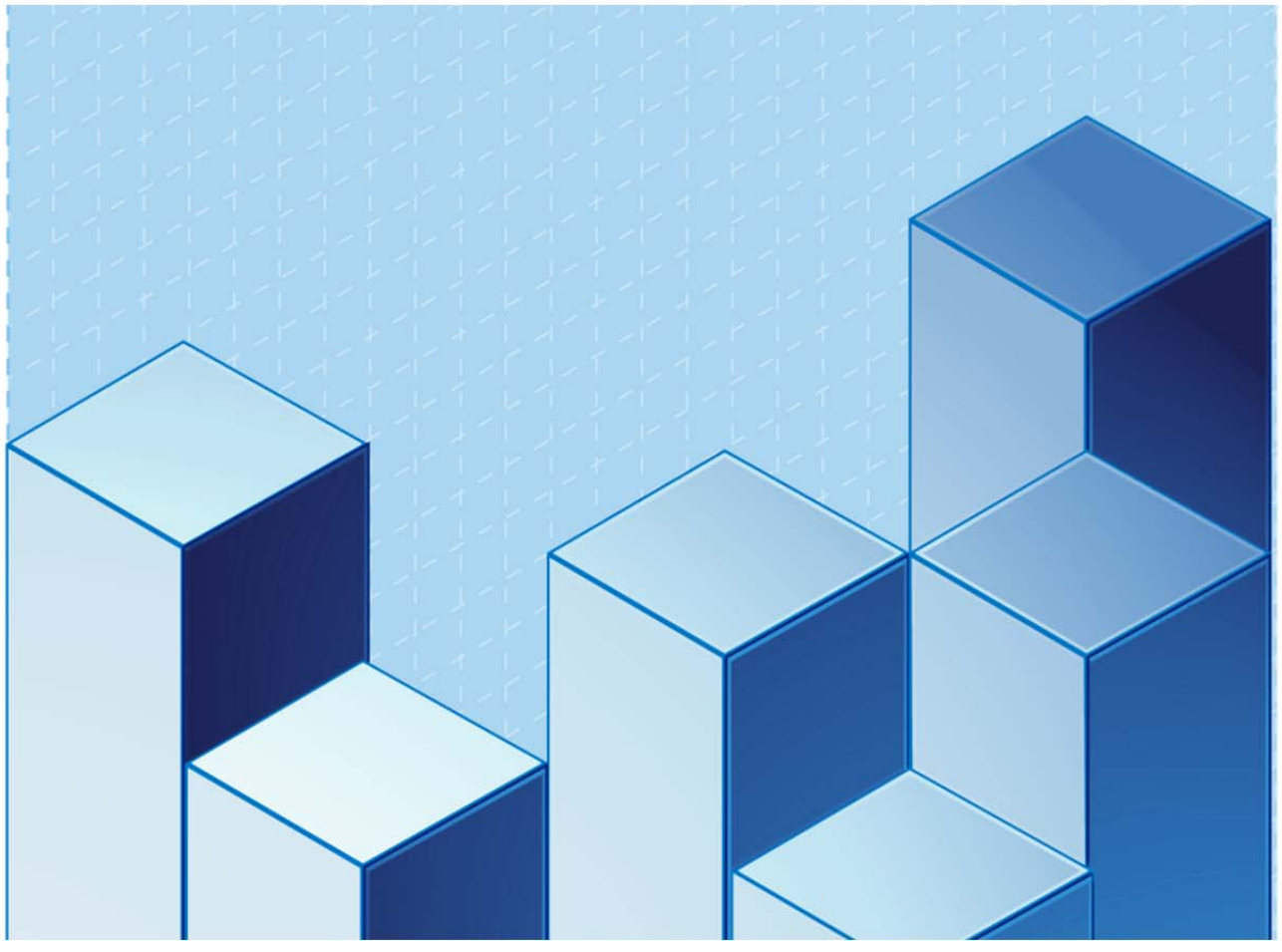
Working Paper Series No. 2

PUBLIC CAPITAL. MEASUREMENT ISSUES

Matilde Mas



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Matilde Mas†

Abstract

This paper takes two complementary perspectives to review the main issues arising from the measurement of public capital. Firstly, it presents the most relevant statistical issues related to measuring public/non-market investment. Second, it highlights some methodological problems associated with the measurement of the value of capital services, namely, i) the use of a rate of return for public capital; ii) the endogenous vs. exogenous approach and the consistency requirements when the former is used; and iii) the selected user cost expression and its consequences for measurement. Third, it refers explicitly to intangible capital. Finally, the paper also shows the implications for the value of capital services —levels and growth rates— of the different options open for both tangible and intangible public capital.

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This paper reviews the main issues arising from the measurement of public capital from two complementary perspectives. First, it presents the most relevant statistical issues raised by the use of available statistics. Second, it highlights some methodological problems associated with the user cost expression in general, and with the meaning and measurement of the rate of return in the public capital context in particular. From the statistical side the three main issues covered are: i) the implications of the existence of three tiers of government; ii) the difficulty of distinguishing between market and non-market industries; and iii) the relation between assets and public function classifications for government activities. From the methodological side it highlights some problems associated with the measurement of the value of capital services, namely, i) the use of a rate of return for public capital; ii) the endogenous *vs.* exogenous approach and the consistency requirements when the former is used; and iii) the selected user cost expression and its consequences for measurement. Third, it makes an explicit reference to intangible capital. Finally, the paper also shows the implications for levels and growth rates of the different options open for both tangible and intangible public capital. The paper begins by presenting both perspectives —statistical and methodological— for tangible public capital since most of the problems faced by the newly developed framework of intangible capital are common to both types of assets.

I. Issues from the statistical side

The main issues from the statistical side are the existence of different levels of government; the distinction between market and non-market industries; and the classification by assets *vs.* public functions.

1. **The existence of different levels of government**. The problem from the statistical standpoint is that the organisation by tiers of government (central, regional or local) can differ between countries, making it difficult to have information for all of them with the required level of disaggregation and detail. Furthermore, it is futile to draw conclusions on the effectiveness of public actions taken by different levels of government since the same type of investment —for instance, the building of a motorway— may be the responsibility of the central government in one country and the regional government in another.[1]

2. **Market vs. non-market industries**. Gross Fixed Capital Formation (GFCF) data is usually split by industry, but not by institutional sector. Industry classifications have changed over time, and also across countries (NACE Rev. 2, ISIC, Rev. 4, NACE Rev.1.1, NAICS, etc.) requiring a prior process of homogenisation. In addition, analysis of the public/non-market sector also requires disaggregation by institutional sectors (Non-financial corporations (S11), Financial corporations (S12), General government (S13), Households (S14) and Non-profit Institutions Serving Households (NPISH) (S15)), information which is not generally available for all countries and time periods.

   The subject of analysis must also be defined previously, since it can focus either on the non-market sector or on the public sector. According to the ESA 2010 definition, “The public sector consists of all institutional units resident in the economy that are controlled by government. The private sector consists of all other resident units”. Table 1 sets out the criteria for distinguishing between public and private and between market and non-market sectors.

[1] See, for instance, Bom and Lightheart (2014) as an example of what should not be concluded when using international data.

Table 1. Public Sector *vs.* Non-market Sector

Criteria	Controlled by government (public sector)	Privately controlled (private sector)
Non-market output	General government	NPISH
Market output	Public corporations	Private corporations

The SPINTAN project defines the public sector as Government sector (S13) plus NPISH (S15). The reason for choosing this definition is because both EUKLEMS and the INTAN-Invest initiative have adopted this criteria and SPINTAN is designed to be both compatible with and complementary to these databases.

Non-market/public activities are generally concentrated in a few industries: 1) Scientific research and development (NACE Rev. 2 M72); 2) Public administration and defence; compulsory social security (O84); 3) Education (P85); 4) Human health activities (Q86); 5. Social work activities (Q87-Q88); and 6. Creative, arts and entertainment activities, gambling and betting activities (R92-R92).

The problem lies in the difficulty of separating the market and non-market part of these industries with the available statistical information. This is because recently (at least since 2008) National Statistical Institutes (NSI) and international databases tend not to split these industries between market and non-market components (or public-private). As a consequence, cross-classified National Accounts data by industry and institutional sector are not available for the majority of countries. As we will see in section II, this common practice has relevant methodological implications for measuring public capital.

In the case of Spain, INE (*Instituto Nacional de Estadística*, Spanish Statistical Office) offered this information in the input-output framework up to 2007 (Spanish National Accounts. 2000 Base). Since then, it no longer includes the distinction within each industry by institutional sector in its official publications. In order to overcome this limitation, the BBVA Foundation-Ivie database for Spain uses complementary public budget data to estimate public GFCF, since this distinction is not included in National Accounts for all industries.

Related to this there are two additional problems. The first is that investments made by the public sector through capital transfers to private firms will not be recorded either by National Accounts or by COFOG (*Government Expenditure by Function*) data. The second problem is that public GFCF figures coming from public budgets do not follow National Accounts criteria.

3. **Assets vs. public functions.** The information needed for the estimation of capital stocks is the GFCF in terms of asset categories. However, the budgetary information provides the information classified by functions of government (COFOG). The first classification is provided by National Accounts, which publishes information on GFCF by asset category and industry, while public budgetary data are usually classified by functions of government. The COFOG classification shows the purpose for which expenditure transactions are undertaken. This classification describes government expenditure according to ten major functions (Table 2), and according to two additional levels of increased detailed breakdown (not presented here). As an example, the second level is necessary in order to gather information on research and development expenditure.

Table 2. COFOG, the 10 functions of government

Code	Function
01	General public services
02	Defence
03	Public order and safety
04	Economic affairs
05	Environmental protection
06	Housing and community amenities
07	Health
08	Recreation, culture and religion
09	Education
10	Social protection

International statistical databases —Eurostat, OECDStats, etc.— offer information on government expenditure by COFOG, as do many NSI. In the case of Spain, the IGAE (*Intervención General del Estado*, General State Comptroller) provides information on GFCF by COFOG functions and sub-functions and by level of government. The BBVA Foundation-Ivie series for the Public Sector are based mainly on this information.

The main international sources of information are:

Eurostat: public GFCF by COFOG, GFCF and fixed assets (stocks) by industry and asset, total GFCF by institutional sector (industry and institutional sector cross-classified data are not available)

OECD: public expenditure by COFOG, GFCF by industry and asset, total net and gross capital stock (data by institutional sector are not available)

AMECO: total, private and general government GFCF, total GFCF by asset, total GCF by institutional sector (but S15 (Non-profit Institutions Serving Households (NPISH) aggregated with S14 (Households)), total net capital stock (data by industry are not available)

EU KLEMS (WORD KLEMS): GFCF by industry and asset, real fixed capital stock by industry and asset (data by institutional sector are not available)

WIOD (Socio-economic accounts): GFCF by industry, real fixed capital stock by industry (data by institutional sector and by asset are not available)

APO Productivity Database: total GFCF and total net capital stock (data by institutional sector, asset and industry are not available).

Public capital estimates: two examples from Spanish sources

1. BBVA Foundation-Ivie: "*Historical series on public capital and its territorial distribution*". This database provides in-depth information on public GFCF and public capital stock from 1900 to 2012, classified according to government functions and according to region and province (data are obtained from public accounts, NA data, yearbooks about infrastructures, etc.). It considers the three tiers of government but the NPISH sector is not included. Data are provided by function of government and infrastructure type (data by asset are not available). The public sector investment series are classified by expenditure function and investing agent. The capital stock series follow the same classification by function but do not take into

account the breakdown by investing agent because of the constant change in capital ownership over the long period analysed. It uses OECD (2001) methodology to estimate capital stock. The estimations focus exclusively on net capital. It does not provide information for the productive capital since the information for asset types is not available.[2]

2. BBVA Foundation-Ivie: "*Capital stock in Spain and its distribution by territories (1964-2013*)". This database covers three variables: investment, capital stock and capital services. It follows OECD (2009) methodology. Data are classified by asset and industry: at a national level, 18 different asset types and 31 industries are considered, following the NACE-2009 classification. Public infrastructures have been retained in the asset breakdown (which was a distinctive characteristic of the BBVA Foundation-Ivie series). It also distinguishes between the public and private sector for two industries: Education (P85) and Health and Social Services (Q86-Q88) (besides Public Administration (O84)). In addition, data are provided by regions and provinces with disaggregation by 18 types of assets, and 25 and 15 industries, respectively.[3]

II. Methodological problems

From the methodological perspective the distinction between private and public capital is not relevant for individual assets (as long as the information is available). The main difference with respect to private capital services comes from the user cost expression which transforms the volume index of capital of an asset into the value of its capital services. The problem is that National Accounts do not assign a net return to the flow of services provided by public capital. The only recognised flow is public fixed capital consumption.

The main implications of this procedure are twofold. First, NA Gross Operating Surplus figures are underestimated because the value of the capital services provided by public capital is not fully considered; and second, as a consequence the value of output is also underestimated in NA figures, affecting both its level and its rate of growth.

Three different but related issues are discussed in this section: i) rate of return of public *vs.* private capital; ii) exogenous *vs.* endogenous calculations; and iii) user cost expression.

1. Rate of return of public vs. private capital

Assume that the ownership of $K_{j,t}$ (Volume Index of Capital for asset *j*) is divided between the private ($K^p_{j,t}$) and the public ($K^g_{j,t}$) sector at time *t*. The superscripts *p* and *g* refer to private (*p*) and public (*g*) capital, respectively. The value of the capital services ($VCS_{j,t}$) provided by asset *j* at time *t* can be computed as:

$$VCS_{j,t} = cu_{j,t} K_{j,t-1} = cu_{j,t} K^p_{j,t-1} + cu_{j,t} K^g_{j,t-1} \quad [1a]$$

Or, alternatively, as

$$VCS^*_{j,t} = cu^p_{j,t} K^p_{j,t-1} + cu^g_{j,t} K^g_{j,t-1} \quad [1b]$$

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

[2] More details can be found on these links: http://www.ivie.es/en/banco/stock/banco3.php and http://www.fbbva.es/TLFU/tlfu/ing/areas/econosoc/bbdd/index.jsp

[3] More details can be found on the links: http://www.ivie.es/en/banco/stock/banco2.php and http://www.fbbva.es/TLFU/tlfu/ing/areas/econosoc/bbdd/index.jsp.

Equation [1a] assumes that the user cost is the same for private and publicly owned assets. An example of this approach is Nordhaus's (2006) *basic principle for measuring non-market activities*: "Non-market goods and services should be treated as if they were produced and consumed as market activities. Under this convention, the prices of non-market goods and services should be imputed on the basis of the comparable market goods and services" (p. 5).

Alternatively, equation [1b] assumes that the rates of return are different. Examples of this second approach are Jorgenson and Landfeld (2006); OECD Manual (2009); or Moulton (2004). According to Jorgenson and Landfeld (2006), "For government, the imputed rate of return is set equal to the average of corporate, non-corporate, and household rates of return…" (p. 35).

The OECD Manual (2009) makes a similar recommendation to Jorgenson and Landfeld (2004) but only when full information on rates of return for the market and the household sector is available. When this information is not available it recommends using the household rate of return measured by the social rate of time preference. It also suggests borrowing rates for government bonds as an alternative (ps. 142-144). Note that the last two are both exogenous rates of return.

Moulton (2004), following Slater and Davies (1998), proposes four general ways of estimating the rate of return of government fixed capital: a) by means of an econometric estimation; b) using a pre-determined rate such as the rate set by the U.S. Office of Management and Budget (OMB); c) the rate of return for comparable private business activities; or d) the interest rate at which governments borrow.

2. Endogenous vs. Exogenous calculations

Two approaches are used for the rate of return in the user cost expression: endogenous (ex-post) or exogenous (ex-ante). According to the OECD (2009), "There are at least two situations when the exogenous approach […] is a useful choice. First, when the stock of assets considered is incomplete [… such as for] land for which information may not be available or at least not with reliable quality […]. Second, *when no empirical distinction can be made between the market sector and the government sector* [our italics], computations with an endogenous approach will imply a downward bias of the rate of return because there is no net operating surplus for government assets so that the market sector's operating surplus will be brought into relation with an asset base that comprises assets in the total economy and is therefore too big" (p. 139).

Let us assume that we chose the endogenous approach. Then, according to National Accounts practices: $GOS^{NA} = GOS^{NA,p}$ (private) + Public Capital Consumption

$$GOS^{NA} = GOS^{NA,p} + \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP^{g}_{j,i,t-1} \qquad [2]$$

GOS = Gross operating surplus; ^{NA} = National Accounts; δ = depreciation rate; p = price; j assets, t time and i industries.

From an analytical perspective GOS (private, p) equals the Value of Private Capital Services:

$$GOS^{NA,p} = \sum_j \sum_i cu_{j,t} KP^{p}_{j,i,t-1} \qquad [3]$$

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

$$GOS_t^{NA} = \sum_j \sum_i cu_{j,t}^{NA} \left[KP_{j,i,t-1}^{p} + KP_{j,i,t-1}^{g} \right]$$
$$cu_{j,t}^{NA} = cu_{j,t}^{NA}(r_t^{NA}, q_{j,t}, \delta_{j,t}) \qquad [4]$$

with $q_{j,t}$ representing potential gains or losses. According to [4] the internal rate of return r_t^{NA} is computed taking into account the aggregated private and public capital but only the GOS of the private sector plus the consumption of public capital.

However, in order to obtain a consistent computation only the private sector should be considered when computing the internal rate of return:

$$GOS_t^{NA} - \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP_{j,i,t-1}^{g} = \sum_j \sum_i cu_{j,t}^{R} KP_{j,i,t-1}^{p}$$
$$cu_{j,t}^{R} = cu_{j,t}^{R} \left[r_t^{R}, q_{j,t}, \delta_{j,t} \right] \qquad [5]$$

where *R* stands for Revised.

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

$$GOS_t^{R} = GOS_t^{NA} + \sum_j \sum_i cu_{j,t}^{R} KP_{j,i.t-1}^{g} - \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP_{j,i,t-1}^{g} \qquad [6]$$

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

$$(PQ)_{i,t}^{R} = (PQ)_{i,t}^{NA} + \sum_j cu_{j,t}^{R} KP_{j,i,t-1}^{g} - \sum_j \delta_{j,t} p_{j,t-1} KP_{j,i,t-1}^{g} \qquad [7]$$

3. User cost expression for the market economy

In practice, the user cost expression can adopt different versions. Let us consider the general expression for the market GOS^{NA} given by [5] and assume that

$$cu_{j,t}^{R} = (r_t^{R} + \delta_{j,t} - q_{j,t}) p_{j,t} \qquad [8]$$

where $i_t^R \equiv$ revised nominal rate of return; and, as before, $\delta \equiv$ depreciation rate; $q \equiv$ capital gains/losses term; $p \equiv$ price; $j \equiv$ asset; $i \equiv$ industry.

So that [5] transforms into

$$GOS_t^{NA} - \sum_j \sum_i \delta_{j,t} p_{j,t-1} KP_{j,i,t-1}^{g} = \sum_j \sum_i cu_{j,t}^{R} KP_{j,i,t-1}^{p}$$
$$= \sum_j \sum_i \left[r_t^{R} + \delta_{j,t} - q_{j,t} \right] p_{j,t} KP_{j,i,t-1}^{P} \qquad [9]$$

Mas, Pérez and Uriel (2005), following Harper, Berndt and Wood (1989), consider the four different specifications appearing in Table 3.

Table 3. Four procedures to compute user cost. Market Economy

Procedure	Rate of return (i)	Capital gains/losses (q)
M1	Endogenous (see equation 9)	Current variations in prices $q_{jt} = \frac{p_{j,t} - p_{j,t-1}}{p_{j,t-1}}$
M3	Exogenous r = 4% $i_t = r + \pi_t^e$ $\pi \equiv$ inflation (CPI) $\pi_t^e = \frac{\pi_{t-1} + \pi_t + \pi_{t+1}}{3}$	Expected variations $(q_{j,t}^e)$ $q_{j,t}^e$ (expected) = $\frac{q_{j,t-1} + q_{j,t} + q_{j,t+1}}{3}$
M4	Endogenous (see equation 9)	Expected variations $(q_{j,t}^e)$ as M3
M5	Exogenous π_t^e as M3 Long-term government bond yields	Expected variations $(q_{j,t}^e)$ as M3

Source: Mas, Pérez and Uriel (2005).

The four specifications consider two in which the internal rate of return is computed endogenously (M1 and M4) while the other two (M3 and M5) use the exogenous approach as expressed in Table 3. They also use two different specifications for the capital gains and losses term: contemporaneous *vs.* expected.

Figure 1 offers the profiles shown by the four specifications using Spanish data for the period 1970-2009. The profiles are quite similar from the first half of the eighties until the beginning of the new century. As expected the two exogenous specifications provide the less volatile profile, especially the one which uses the long-term government bond yields.

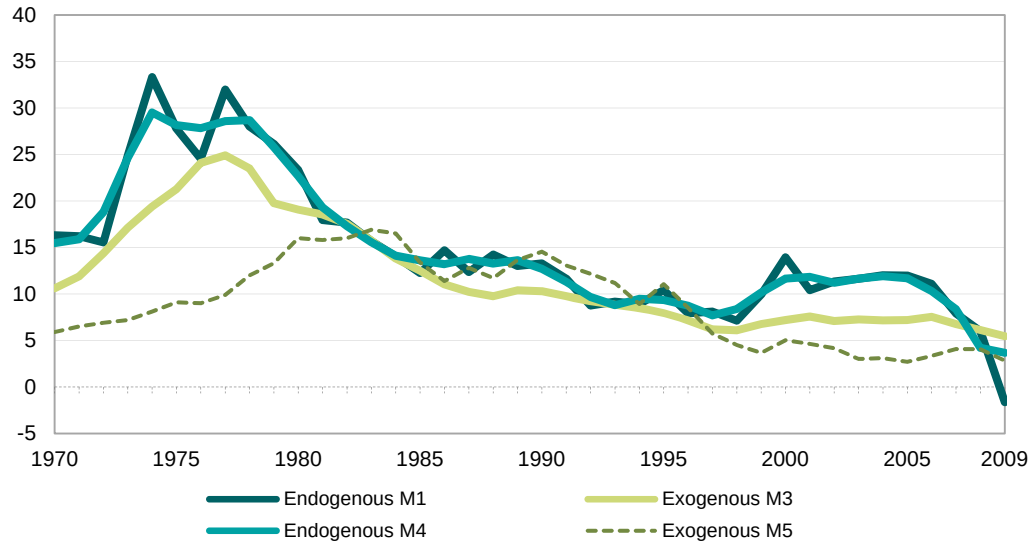
However, the most relevant fact associated to the measurement of the rate of return and the user cost expression is its implication in the computation of the value of the capital services. Figure 2 provides this computation for the asset software in the market economy based on the Spanish data for this asset.

In order to test the implication of the four specifications in quantitative terms Table 4 reports the deviations from the M1 (endogenous) specification considering both, levels in panel a) and growth rates in panel b). The main results are as follows. First the differences are higher for the two exogenous measures (M3 and M5) than for the other endogenous expression (M4). Second, the higher differences appear when comparing M1 (endogenous) and M5 (which uses government bonds as the rate of return). Third, the discrepancies between the four specifications widen during the period of recession. In 2005 the M5 measures gave a level for the value of capital services provided by the asset software that was 18% lower than that

provided by M1. In 2009, the (also exogenous) M3 measure gave a level that was 17% higher. In terms of growth rates, panel b) indicates than the higher discrepancies occurred in the period 2005-2009, when the economy turned from a strong expansion to a deep recession. Note that the differences with respect to M1 were very high. The origin of this result could already have been anticipated by observing the severe downturn of the nominal rate of return as measured by M1 in the first two years of the recession (2008 and 2009) shown in Figure 1 and the corresponding drop in the value of its capital services in Figure 2.

Figure 1. Nominal rate of return. Market Economy. Spain (1970-2009)

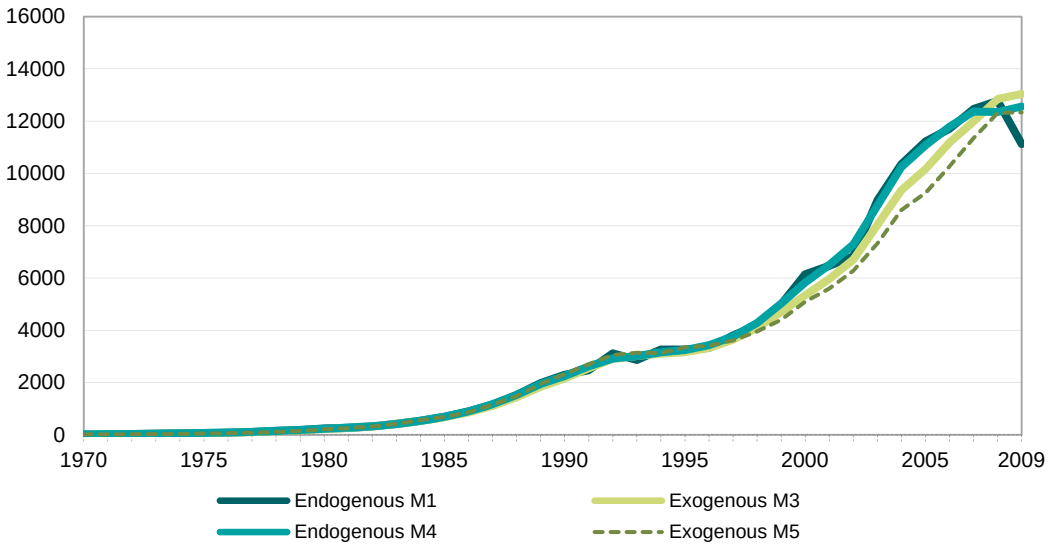
(percentage)



Source: BBVA Foundation-Ivie and own elaboration.

Figure 2. Capital services. Market Economy. Spain. Software (1970-2009)

(millions of euros)



Source: BBVA Foundation-Ivie and own elaboration.

Table 4. Value of Capital Services. Market Economy. Spain. Software
Differences from the endogenous M1 assumption

a) Levels (percentage over M1)

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

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

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

Source: BBVA Foundation/Ivie and own elaboration.

III. Intangible capital

The previous section presented three interrelated methodological problems which affect the measurement of tangible and intangible capital in both the market and the non-market economies. It used software —a form of intangible capital now recognised by National Accounts — to illustrate the practical consequences of choosing different methodological alternatives.

The seminal work for intangible capital is Corrado, Hulten and Sichel (2005, 2009). These authors developed a proposal to expand National Accounts (NA) boundaries to include a selected group of intangible assets. Instead of following the NA practice of treating intangibles as intermediate consumption goods and services they argue that "any use of resources that reduces current consumption in order to increase it in the future […] qualifies as investment". Thus, all types of capital —tangible and intangible— should be treated symmetrically.

Their work was initially applied to USA data. Two projects funded by the 7th Framework Programme (COINVEST and INNODRIVE) addressed similar issues from the European perspective. Following them, the INTAN-Invest initiative (Carol Corrado, Jonathan Haskel, Cecilia Jona-Lasinio and Massimiliano Iommi) provided a database for 27 EU countries plus Norway and the USA for the 1995-2010 period and a level of disaggregation of nine industries belonging to the market economy.

The SPINTAN project, also funded by the 7th Framework Programme, focuses on the non-market sector. The methodological framework is provided by Corrado et *al.* (2015). Its goal is to produce estimates on intangible investment and capital of the non-market sector disaggregated by industry and by institutional sector. The public sector is used as a synonym for the non-market sector, which refers to two institutional sectors: Government sector (S13) and NPISH (S15). It pursues consistency with National Accounts principles and it is coherent with INTAN-Invest market-sector intangibles estimates. In this way, SPINTAN is designed to complete the coverage of intangible investment, thus making it possible to generate total economy growth accounts with public intangibles as additional productive assets.

The SPINTAN classification of intangible assets takes as a reference the INTAN-Invest classification, but slightly modified to include more assets specific to the public sector. Table 5 presents the intangible assets included in the market and non-market sectors.

Table 5. Classification of Intangible Assets. Market vs. Non-Market

Private/Market	Public/Non-Market
Computer software	Computer software
Databases	Open data (information assets that can be leveraged by market)
R&D (broadly defined)	R&D
E&A originals	Cultural assets
Design	
Mineral exploration	Mineral exploration
Brands	Brand
Organisational capital - Manager capital - Purchased org. services	Organisational capital - Manager capital - Purchased org. services
Firm-specific human capital (employer-provided training)	Function-specific human capital (employer-provided training)

From the industry disaggregation perspective, SPINTAN focuses on industries containing significant non-market production:

- Scientific research and development (NACE Rev. 2 M72)
- Public administration and defence; compulsory social security (O84)
- Education (P85)
- Human health activities (Q86)
- Residential care and social work activities (Q87-Q88)
- Creative, arts and entertainment activities, gambling and betting activities and amusement and recreation activities (R92-R93)

The main data sources for intangible assets are the USE tables; Statistics on Government expenditure by function (COFOG); Employment and labour cost data (LFS, SES, etc.); Budgetary information; Other national specific sources (national surveys, country specific studies, etc.)

The public intangibles data present similar problems to those explained in section I for assets already recognised by NA. Some problems that arise when looking for cross-referenced information on expenditures by industry and institutional sector should also be taken into account.

The USE tables usually report total expenditure made by each industry, but they do not generally provide information regarding institutional sectors. Thus, for mixed industries, additional indicators are needed to estimate the share of total expenditure made by units belonging to Government and NPISH sectors. Furthermore, USE table disaggregation of products is not detailed enough to estimate intangible assets. Additional indicators (SBS, national surveys, etc.) are therefore needed. Note also that USE tables compiled according to NACE Rev.2 and ESA 2010 are not yet available for all countries.

COFOG data provides a breakdown of government expenditure according to service type, and as such, COFOG data may be mapped to NACE. A correspondence between industry classification and COFOG divisions and groups (first and second level categories) is available but it needs to be worked out carefully. However, this type of information is not available with the most detailed breakdown for all the countries. Moreover, General government GFCF

potentially excludes a significant portion of publicly-financed investment (grants, subsidies, and so on). This portion varies from one country to another.

Budget or administrative data and other national sources are also needed. This type of information is specific to each country, so analysis of these data needs to be country specific. As previously mentioned, another problem arises from the fact that budgetary information does not follow NA criteria or industry classifications. For these reasons, as with the previous sources it is not easy to centralise the update of the information each year in a multi-country project.

IV. Rates of Return for Public Capital. Summing up

The computation on public intangible capital poses additional problems to those presented in section I. In the case of intangible assets we must distinguish between those assets already included in National Accounts (ESA 2010): software, mineral exploration, entertainment and artistic originals, and R&D, from those not (yet) included in National Accounts.

This distinction is relevant also for the selection of the rate of return. For the assets already recognized (such as software and R&D), we need to distinguish if they are owned, or not, by the market sector. In the first case, its consideration will not change the Gross Value Added (GVA). These assets should be treated by NA as any other tangible asset. But, if they are owned by the non-market sector, GVA will increase since NA only recognizes the consumption of fixed capital as has already been highlighted in section I.2.

For the remaining intangible assets —not yet recognized by NA— its inclusion will cause a symmetric increase of both, Gross Fixed Capital Formation (GFCF) and GOS, regardless the ownership by the market or the non-market sector. Thus GVA will increase in both cases.

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

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

The theoretical background for the social rate of time preference (SRTP) —or consumption rate of interest— (option 5) was developed by Marglin (1963), Feldstein (1964) and Kula (1984). Today it is a well-established concept to determine the discount rates for government projects[4].

As for the user cost expression, the SRTP can adopt different specifications. The OECD (2009) suggests the following one:

$$SRTP = \frac{(1+g)^e}{\Pi^w} - 1 \qquad [10]$$

where *g* is the trend growth in real per capita household consumption; *e* captures the elasticity of marginal utility of consumption; Π is the survival probability of an individual. It is intended to capture the risk that an individual in society will not be able to benefit from future returns on an

[4] For a detailed discussion see OECD (2009) and Corrado and Jäger (2015).

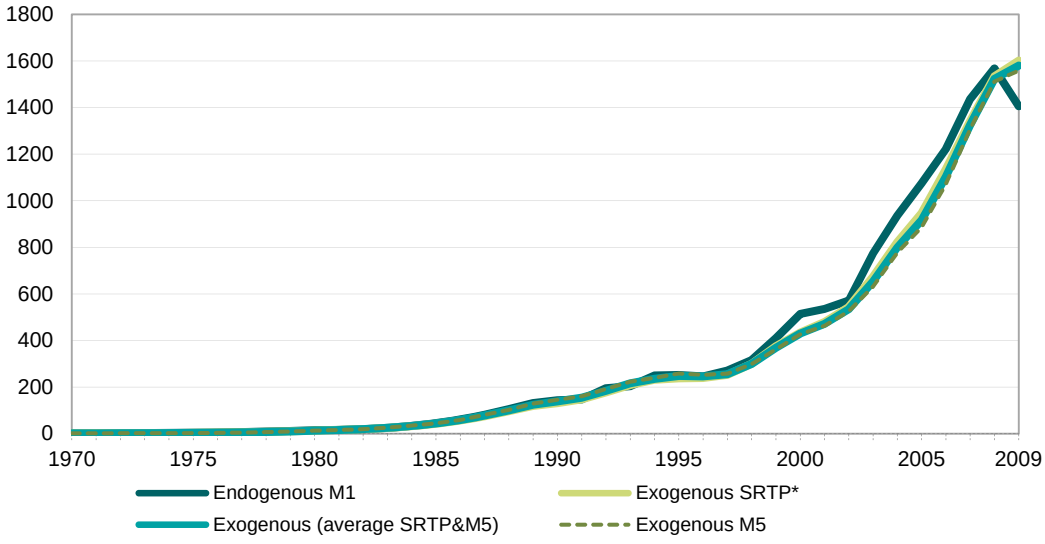
investment; and *W* reflects the degree of "selfishness" of present generations *vis-à-vis* future generations.

The OECD (2009, Table 16.1) offers the SRTP for OECD countries considering different values of the parameters *W* and *e*. However, based on the literature it concludes that *W* = 0.5 and *e* = 1 is the best option. For Spain the SRTP assigned a value of 3. The social time preference rate (SRTP) reflects the value that society attaches to present, as opposed to future, consumption, while the remaining rates (with the obvious exception of option 6) reflect the opportunity cost for investment in the private sector.

Figure 3 computes de Value of Capital Services of software owned by the Spanish non-market sector under three of the six alternatives considered: i) Ex-post rate of return computed only for tangible assets in the market sector (M 1 in Figure 1); ii) Financing costs of government projects (proxy by Government long-term bonds) (M5 in Figure 1); iii) The social rate of time preference (SRTP) for the Spanish economy, which amounts to a value of 3; and iv) An average of the last two options which represent the opportunity costs for private consumption (SRTP) and investment (long-term government bonds) since public spending could have crowded out both.

Figure 3 shows that the three alternative exogenous rates of return provide similar results for the value of the capital services corresponding to the asset software, now for the non-market sector, of the Spanish economy. Regarding the only endogenous measure M1, the differences are noticeable and have widened since the beginning of the last cyclical expansion around the middle of the nineties. As before, the severe downturn experience by the M1 measure in the first years of the recession is also remarkable.

Figure 3. Capital services. Non-market economy. Spain. Software (1970-2009)
(millions of euros)



* Exogenous SRTP = 3.0.

Source: BBVA Foundation-Ivie and own elaboration.

Table 6 computes the differences of the three exogenous measures with respect to M1, both in levels and in growth rates. Regarding levels, panel a) indicates that the differences oscillate between a low 82% for M5 in 2005 and a high 115% for the SRTP in 2009. Concerning the differences in terms of annual growth rates, panel b) shows, again, important deviations from

the M1 measure during the period 2005-2009 which can be attributed once more to the strong downturn shown by the nominal rate of return in Figure 1 for years 2008 and 2009.

Table 6. Value of Capital Services. Non-Market Economy. Spain. Software
Differences from the endogenous M1 assumption

a) Levels (percentage over M1)

	1970	1980	1990	2000	2005	2009
SRTP	0.90	0.89	0.92	0.85	0.89	1.15
M5	0.84	0.86	1.01	0.83	0.82	1.11
Average SRTP&M5	0.87	0.87	0.97	0.84	0.86	1.13

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

	1970-1980	1980-1990	1990-2000	2000-2005	2005-2009	1970-2009
SRTP	-0.15	0.36	-0.80	0.84	6.43	0.62
M5	0.20	1.70	-2.01	-0.14	7.42	0.72
Average SRTP&M5	0.02	1.04	-1.41	0.36	6.91	0.67

Source: BBVA Foundation/Ivie and own elaboration

V. Concluding Remarks

The paper has revised the main statistical and methodological issues associated with measuring non-market, or public, capital. For our purpose the distinction between the two definitions is not relevant since the problems addressed are common to both. Section I presented the main statistical problems common to both tangible and intangible capital. This was followed, in section II, by three aspects related to measuring the user cost of capital when publicly owned assets are present. Section III presented some specific issues related to intangible public capital. Section IV provided a summary of the main problems posed by the measurement of public capital. The paper also reported the computation of the value of capital services for software using the data available for Spain. This asset has the characteristic of being an intangible asset but one now recognised by National Accounts. Thus, it allows us to focus on the market and non-market distinction which is central in our analysis.

The main conclusions to be drawn are the following. First, the lack of statistical data providing cross-referenced information for both industrial and institutional sectors is a major hurdle to appropriate measurement of public capital. The availability of this information has worsened rather than improved in the last years and there is little hope that things will change in the near future.

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

However, there is less agreement on how this rate of return should be computed. The four main questions are: i) Should the imputation consider the same rate of return for private and public capital, or should it be different? ii) Should the non-market sector follow the endogenous (ex-post) or endogenous (ex-ante) approach? iii) Should the rate of return used for public capital calculations be selected taking into account only the consequences of public GFCF on private

investment or also in private consumption? iv) Does this discussion have practical consequences or is it irrelevant from the practical perspective?

The answers to these questions can be summarised as follows. First, from our perspective the reasons outlined in section II recommend a different rate of return for the non-market economy. Second, in principle both endogenous and exogenous approaches could be used for both market and non-market economies. However, the consistent use of the former requires statistical information which clearly distinguishes between the investment made by industries and institutional sectors, market and non-market, or public and private. Since this information is not readily available for the great majority of countries, the most consistent alternative is to use the exogenous approach. Third, our preferred alternatives would be to use the social rate of time preference (SRTP) or a combination of SRTP and the long-term government bond yields. And fourth, selecting one of the various alternatives proposed indeed has practical consequences when the economy is going through phases of strong cyclical movements as the Spanish data shows for the most recent economic crisis.

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