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The productivity of the public sector: a Classical view

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1. Introduction

In the face of the ongoing financial and economic crisis, in several European countries austerity-prone governments are dramatically cutting public expenditure, as if it was a deadweight burden upon society, or a luxury that we can only afford in good times.[1] In several countries, in particular the role of the public sector as a producer of useful public goods and services is under attack, as evidenced by the large share of public sector wages and employment reductions within the fiscal retrenchment plans.[2]

In this paper we claim that the production of public goods is instead a constituent component of any well-functioning capitalist economy. Specifically, public sector output carries economic worth despite there being no adequate way to quantify it yet.

We define public administrations (PAs) as productive units, and analyse the recent trends in PAs' productivity. To carry out such an analysis, we apply Sylos Labini's productivity function, a model of the determinants of growth at both the micro and macro levels inspired by British classical economists.[3] Such a framework is especially useful as a reference growth model that does not rely on marginalist hypotheses, especially concerning the contested notions of aggregate capital and the neoclassical production function, and it is specifically well suited to capture the relevance of innovation processes (Corsi *et al*., 2006).[4]

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[1] Kregel (2011); D'Ippoliti and Roncaglia (2011).

[2] See Bettio *et al*. (2012); Glassner (2010).

[3] For a detailed analysis of British classical economists' thought, see Roncaglia (2005).

[4] For a full description of Sylos Labini's productivity function, see Corsi and Guarini (2007).

The aim of the paper is thus twofold: at the microeconomic level, we propose a model of government action for the production of public goods; at the macroeconomic level, we set out to underline the relevance of distinguishing the public and the private sectors in growth accounting exercises, and to show that the former contributes to economic growth too.

In the empirical part, we apply a modified version of the productivity function model to the estimation of the impact of e-Government processes on PAs' productivity, for a number of OECD countries. In accordance with the economic and organisational literature, by e-Government we mean a set of processes of reorganisation and modernisation of the public administrations led by the adoption of Information and Communication Technologies (ICT). E-Government was selected as a relevant case study both for its 'horizontal' impact, across the whole public sector, and for its special role in driving innovation, which in our model is one of the main determinants of productivity growth. To this end, we employ a unique dataset, estimating the value and structure of public expenditure for ICT-led reorganisation of PAs.[5]

Such an analysis, however, incurs the major limitation that the mainstream definition of economic growth currently only takes the variation in GDP as an indicator. It thus limits itself to the changes in the sum total of the exchange value of the goods and services exchanged in the market, with a narrow view that has been repeatedly criticized.[6] What is most relevant from the point of view of PAs' productivity is that publicly produced goods and services are not exchanged in the market, they frequently cannot be assigned an exchange value and, when they can, any such value is most likely an underestimation of the real worth of such output to society.

Thus, as will be shown, the analysis proposed here is to be understood as a rather conservative test of the model. Specifically, data limitations severely limit the application of the model to disaggregated or

[5] The dataset was developed within the e-Government Economics Project – eGEP, carried out within the European Commission's MODINIS Programme and managed by the e-Government unit of the DG Information Society and Media (see the final report: Corsi *et al*., 2006). Full documentation is available from the authors upon request.

[6] Most notoriously by the so-called Stiglitz-Sen-Fitoussi Commission's *Report*: see Stiglitz *et al*. (2011).

microeconomic data, and it constrains the time span for which even aggregate data can meaningfully be used. However, while future improvements in the standards of data estimation and collection in the public sector will allow a clearer and more precise picture to be drawn, we believe that the current widespread drive towards the compression of the public sector makes such an analysis, even if preliminary by necessity, extremely relevant.

2. A model of productivity growth

The economic model employed here constitutes an adaptation to the public sector of the productivity function model developed by Paolo Sylos Labini (1984; 1985; 2004) to describe economic growth in the private sector.[7]

Let Y_{PS} denote the aggregate value of production in the public sector – the sum of the value of the goods and services supplied – calculated in monetary terms. Accordingly, average labour productivity in the public sector, π_{PS}, can be defined as the value of production in the public sector divided by the number of employees in that sector:

Public sector output Y_{PS}	=	Labour productivity in public sector π_{PS}	×	Number of public sector employees L_{PS}

Since π_{PS} is *average* productivity, as opposed to marginal labour productivity, it constitutes a synthetic measure of the productivity of the

[7] See the documents produced within the eGEP Project for an extensive illustration of the model and discussion of the problems involved in transposing it to the public sector: Corsi *et al*. (2006).

public sector as a whole.[8] For example, average labour productivity may grow as a consequence of capital accumulation. As is true in the case of marginal productivity, variations in average productivity can be generated by different dynamics. First, they may arise from changes in the price (or average value) of product per employee, given quantities: in such a case we will refer to changes in the *efficacy* of public administrations. Second, they may reflect changes in the quantities produced, given prices; or third, they may follow a shift in the composition of output, for example towards the production of goods and services with higher added-value: in these cases we refer to variations in PAs' *efficiency*.

In our theoretical model, both PA's efficiency and efficacy vary due to five mechanisms: three originally identified by Sylos Labini (1984) – the "Smith effect", the "Ricardo effect" and the "Investments effect" (also named "Schumpeter effect") – and two new effects meant to capture the specificities of innovation processes in the public administration – the "Back-Office effect" and the "Take-Up effect".

The Smith effect: in the private sector, the Smith effect connects labour productivity with the market size of a firm (it is thus an effect defined at the microeconomic level): in particular, it summarizes the impact of dynamic economies of scale on labour productivity.[9] With variations in firm size, the efficiency with which the endowment of fixed and circulating capital is used varies: following Adam Smith and a long tradition in economics, Sylos Labini assumed increasing economies of scale to generally prevail. In other words, the Smith effect is expected to exhibit a positive sign, if only due the possibility of amortising a firm's fixed costs over a larger output.

Adapting this concept to the public sector proves far from simple or direct. In fact, in their activity of supplying services to the community, the PAs have no market for their products. In many cases there is no 'demand' for public goods, in the sense of an evident readiness to pay for

[8] See Sylos Labini (1995) for a clear exposition of the reasons for this choice and for a theoretical critique of the neoclassical production function and related empirical applications. Most of Sylos Labini's works are freely available at http://dspace.unitus.it/handle/2067/163/.

[9] Sylos Labini's *Smith effect* is similar to what is known in the literature as the *Verdoorn-Kaldor effect*.

them, and production decisions are guided by the supply side. At the same time, effectively achieving improvements in efficiency often implies launching reorganisation processes. Since most PAs enjoy a monopoly over their specific product, the deployment of such reorganisations cannot be considered automatic, given the lack of a competitive stimulus.

Moreover, if increasing economies of scale hold, then in the private sector one also expects a reverse relationship to hold, i.e. from increases in productivity to increases in scale. This is due to the possibility of setting lower prices at larger scales, on the strength of higher productivity. Again, such an effect cannot be considered automatic in the case of the PAs. In fact, the need is for the greater potential supply of public goods and services to be effectively demanded by users and citizens; otherwise, the technically feasible increases in productivity will remain unfulfilled, unless through staff reductions. At the aggregate level, for this reverse effect to hold it implies efficacious planning of the broad mix of public goods and services supplied, by 'efficacious' we mean that it effectively answers to the needs of the citizens.

In relation to the public sector, the Smith effect can be broken down into two effect typologies: microeconomic and macroeconomic. The former applies to the benefits strictly achieved by the individual PAs, many of which take the form of gains in financial terms. In particular, increases in productivity will result in one or more of the following: savings in terms of reduction of the cost of services as a whole and/or of single transactions; reallocation of human and financial resources in favour of those services that are of the greatest utility to users (increase in efficacy);[10] greater integration, customisation and speed in the supply of goods and services; supply of "new generation" services, and potentially corresponding new revenues. At the macroeconomic level, over and above the aggregation of the micro-effects, it is at least worth noting the increased speed and coverage capacity of tax revenues.

[10] See Danziger and Viborg Andersen (2002), Grönroos and Ojasalo (2004) and Berman and Vasudeva (2005) for examples of in-depth examination of the efficacy and quality of public services provision.

In conclusion, the application of the Smith effect to the public sector allows us to implicitly test a number of hypotheses on the PAs' capacity to innovate and increase their efficacy and efficiency, despite the lack of competition in their output markets.

In symbols, indicating with a circumflex accent the rate of variations, the Smith effect can be indicated as

$$\hat{\pi}_{PS} = b\hat{Y}_{PS}$$

where *b* represents the elasticity of productivity variations to changes in aggregate output.

The Ricardo effect: according to Sylos Labini's productivity function model, in the private sector there may or may not be a certain static substitutability among production inputs, but there certainly is a dynamic substitutability, associated with process innovation and the modification of production technologies. In particular, in response to variations in the prices of labour and capital goods and services, firms will be stimulated to adopt organisational and technological innovations, reducing the relative use of the inputs that become more costly. Thus, while the Smith effect relates a firm's productivity to the size of its output market, the Ricardo effect relates it to prices in its inputs markets.

The theorisation of the Ricardo effect within the public sector is even more problematic than the Smith effect, because – again, due to the non-market logic of the public sector – PAs' efficient response to price signals cannot be taken for granted. Indeed, PAs are subjected to far more stringent constraints than private firms with regard to the expediency of variations in the staff employed, especially when it is a matter of shedding staff (although staff increases are also increasingly difficult in the current climate of austerity). Thus, it seems very likely that variations in wages and factor prices will lead to increased efficiency, if at all, due to the integration and relative increase of innovative processes with traditional ones, rather than their immediate substitution.[11]

[11] This process could be also described as an *organizational effect*, analysed by Sylos Labini (1984).

There are two variables to consider in estimating the Ricardo effect: the rate of change in the average wages of public employees (w), and the investment goods price index, with specific attention to the intermediate goods and services acquired by the public sector ($P_{I,\,PS}$). Indicating with c the sensitivity of variations in productivity to changes in relative prices, productivity changes can thus be expressed as a function of the Smith and the Ricardo effects:[12]

$$\hat{\pi}_{PS} = b\hat{Y}_{PS} + c\left(\hat{w}_{PS} \Big/ \hat{P}_{I,PS}\right)$$

The Schumpeter effect (or effect of investments in innovation): in the private sector, there are two reasons why investments increase potential output, but also the efficiency and/or the efficacy in the supply of goods and services. First, they are sometimes made for this precise purpose. Second, even if they are made simply to increase the volume of production, thus with a proportional increase of employees, or when the aim is to replace obsolete or old capital, the introduction of new machinery generally leads to improvements in operations, thanks to embodied technical progress (Lucidi and Kleinknecht, 2010).

Both such effects can reasonably be expected to work in the PAs too, if we disregard the hypothesis that public managers waste expenditure on useless or misguided investments (i.e. with no impact on PAs' efficiency or efficacy) by public managers. Thus, when applying the model to the public sector, the ex-ante predicted sign of the Schumpeter effect is more clearly positive.13

Obviously, not only the acquisition of physical goods should be considered as investment. Especially in relation to ICT-led reorganisation

[12] Before variations in the relative prices lead to the adoption of different technologies there is a certain time lag, just as the impact of these innovations on productivity will not be immediate: the effective temporal dimension of the lag is a matter of empirical nature, and we have therefore omitted time indexes in our general formulation of the model.

[13] In his productivity function Sylos Labini distinguishes between current and past investments. The latter have a positive effect while the former, according to Sylos Labini, have a negative effect, called "disturbance effect" (Sylos Labini, 1984).

processes four cost items can be distinguished: spending on hardware (generally greater in the initial stages of reorganisation processes), spending on software (also greater at the stage of introduction of ICTs, but fairly steady in the subsequent stages), spending on external consulting, and on staff training plans (both greater at the more advanced stages of the innovation process).[14]

Thus, indicating with I the investment expenditure in the public sector,[15] and with d the elasticity of changes in productivity to public investments, we obtain the following productivity function:

$$\hat{\pi}_{PS} = b\hat{Y}_{PS} + c\left(\hat{w}_{PS} \Big/ \hat{P}_{I,PS}\right) + dI_{PS},$$

From a theoretical point of view, transposing the productivity function model to the public sector entails at least two further considerations. Broadly speaking, the social environment influences the efficacy of e-Government programmes, i.e. their impact on the productivity of the public sector: both on the demand side, e.g. with greater receptivity of the potential users, and on the supply side, e.g. with better-prepared staff in the PAs. The resulting two further effects, respectively the Take-Up effect and the Back-Office effect, are likely to be multiplicative in relation to the previous effects, in that they afford greater or lesser effectiveness to the dynamics so far defined.

However, identifying these effects empirically proves all too formidable a task, given the lack of much of the relevant data and the considerable difficulties involved in measuring the variables of interest. Thus, the two effects will not be taken into account in the following econometric analysis.

The *Take-Up effect* can be defined as a set of environmental conditions that enable e-Government implementation and determine its efficacy. For example, concerning the technological scenario one may

[14] Although – strictly speaking – expenditure incurred due to the reorganisation of processes and services should also be calculated among the investments in innovation, rating them is empirically far harder, and they will therefore be omitted from the following analysis.

[15] Again for simplicity ignoring the temporal lags of the individual effects.

assume that the citizens demand for public services exploiting ICTs increases with the private supply of ICT-related services and products. Similarly, the competition of private services could drive the public sector to greater efforts to achieve a more rapid and efficient supply of services, as well as the education and training level of the staff employed in the public sector and of the entire population being decisive for the supply of knowledge-based services.

The *Back-office effect* includes the impacts on reorganisation processes induced by ICT implementation initiatives, taking into consideration the potentially greater rigidity of the public sector towards modernisation phenomena in comparison with the private sector.[16] In order to completely achieve the benefits of e-Government in terms of efficiency and effectiveness, PAs are obliged to accomplish high levels of integration among their various organisational areas and units. Re-engineering the back-office functions is a primary factor to be considered for the creation of an e-Government structure able to provide integrated and efficient public services, and it appears all the more important when we recall the minimal impact of the first e-Government projects carried out up to a few years ago (Corsi *et al*., 2006). As they focused solely on a simple and rapid transfer of the very same traditional public services online, without any concrete reorganisation of the productive processes, they mostly failed.

Indicating with φ the set of context variables affecting the efficiency of the effects considered, and with ψ the capacity of the policy-makers to reorganise the public sector as a whole in response to the incentives considered, we may sum up the productivity function thus:

$$\hat{\pi}_{PS} = (\varphi,\psi)\left[b\hat{Y}_{PS} + c\left(\hat{w}_{PS} \Big/ \hat{P}_{I,PS} \right) + dI_{PS} \right]$$

In section 5, we will empirically test the applicability of the productivity function model to the public sector, looking at the recent

[16] See Bertschek and Kaiser (2004).

experience of a number of OECD countries. A specific focus will be devoted to the impact of ICT-led processes on the reorganisation of PAs, which have so far been studied only at the microeconomic level. Before such an exercise, the next section briefly reviews the organisational and economic literature on e-Government, while the subsequent section discusses the main difficulties related to the collection of output data for most PAs.

3. ICT, efficiency and efficacy in the public sector

In the last decade, several studies have been conducted to identify the benefits of ICT investments in terms of productivity, especially in the private sector (see e.g. Brynjolfsson and Hitt, 1998; Lehr and Lichtenberg, 1999; Triplett, 1999; Dewan and Kraemer, 2000; van Ark, 2000; Pohjola, 2001; Inklaar *et al.*, 2003; van Ark and Piatkowski, 2004).

In section 5, we will indirectly test the general assumption that e-Government processes can contribute to economic growth too. Such an impact can be highlighted by variations in the efficiency and/or the efficacy of PAs, leading to increases in labour productivity in the public sector. Given the number of public sector employees, productivity increases are assumed to result in an increase in the aggregate value of the public output.[17]

However, as shown by Corsi *et al*. (2006), e-Government may also have a direct impact on the private production of goods and services. For example, macroeconomic multiplier and accelerator mechanisms can arise from both the public demand for investment goods and the accumulation of publicly provided economic capital. Moreover, e-Government may exert a direct impact on private sector productivity growth too. For example, public procurement oriented towards markedly innovative, high value-added goods and services can stimulate the creation of production capacity by innovative firms. Similarly, the

[17] That is to say, we assume that increases in productivity will be followed by no or less than proportional reductions of staff.

provision of an increasing number of public goods and services through ICT-enabled channels can contribute to the overall competitiveness of the economic system, e.g. by contributing to the 'e-readiness' of society as a whole (e.g. by stimulating citizens to broaden their ICT skills). By design, the economic model presented in the previous section only allows us to consider the first effect mentioned above, i.e. the direct impact of e-Government on PAs' productivity. Though limited in its scope, to our knowledge this is the first such exercise to use macroeconomic data.

At the microeconomic level, the increasing adoption of ICTs as a channel for interaction between citizens or firms and PAs has spawned several empirical studies seeking to size up the potential and key areas of impact of e-Government, especially in the OECD countries.

Concerning the efficiency of PAs, particular attention to measurement issues in examining trends on ICT usage and their effect on public sector productivity is given by Lehr and Lichtenberg (1996) and Lichenberg (1996). Focusing on the USA, these works use data from the Bureau of Labour Statistics (BLS) Federal Productivity Measurement Program on productivity growth and PAs' computer assets. However, due to a lack of relevant aggregate data, our study will not consider the USA.

With regard to the efficacy of public services, the survey carried out by Capgemini yearly since 2001 represents a major contribution.[18] Adopting a "benchmarking" methodological approach, the study analyses twenty basic public e-Services, supplied by the PAs of Europe to citizens and firms, on the basis of two main indicators: full online availability (in the sense of the number of services that can be fully provided on electronic platforms) and level of online sophistication of the service (in particular, five levels are distinguished, from non-availability of online service to a stage at which the procedures forming the service are characterised by perfect integration between PA and user). Immediately prior to the outbreak of the economic crisis, the reports show significant advances in both indicators: in the 27 EU countries, on average nearly 50% of public services are available through the internet (and the figure is growing), with a fairly high level of sophistication (level 4).

[18] See for example Capgemini (2006).

Also based on a benchmarking methodology is UNDERSTAND,[19] a project promoted in 2006 with the aim to compare the degree of development of e-Government at the regional level in Europe, as well as to define and apply a set of common indicators. The study confirms considerable advances in the innovation processes of the regional PAs, but at the same time it reveals certain limitations. As the complexity of the services increases, their online availability decreases; multi-channel supply remains at the primordial stage and efforts must be made to reduce the negative relationship there is between a PA's size and their development of e-Government initiatives.

With regard to the evaluation of the efficiency and efficacy of public services, it is worth citing a work published in 2004 by Cisco Systems,[20] containing interviews with over 1400 people responsible for investment choices in relation to the supply of electronic public services (at both the technological and organisational level) working in the central, regional and local PAs of eight European countries. The study determines a series of factors of critical importance in achieving increases in the efficiency of e-services supply, such as the average time taken to complete a procedure, the average cost of a procedure, the total number of procedures concluded within a given timespan, etc.

The bulk of the literature on efficiency and efficacy in PAs is of the organisational-management type, and based on sample surveys of best practices and/or benchmarking (for a full review, see Corsi *et al*., 2006). Most of these works assume as their main objective the issue of reducing the weight of bureaucracy on firms and citizens. However, as we have already mentioned, the model proposed here assumes the increasing efficiency in the PA as a precondition for the supply of more and better products and services, rather than as an intermediate objective on the way to downsizing the role of the public sector in the economy. It thus seeks to determine how the public sector can, on the strength of innovations guided by ICT implementation, actively enhance its own capacity and generate a positive impact on economic growth.

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[19] The documents produced over the course of the project are available on the website http://www.understand-eu.net/. For a summary of the results, see Mancini (2006).
[20] Momentum Research Group (2004).

4. Limitations of the estimates of public sector output

Public intervention in the economy is not a one-dimensional phenomenon: given the multiplicity of objectives it pursues and of the instruments it applies, it clearly merits a multidisciplinary approach, plural in both the methods and objects of examination. Thus, economic analysis of the productivity of the public sector, as sought in the present paper, inevitably provides us with a partial picture. Moreover, the objectives of public intervention − of an essentially political nature − are neither constant over time nor necessarily uniform between countries, which sets limits to the interpretation of international comparisons as attempted here.

However, the most serious limitation to any quantitative evaluation of the economic role of the public sector lies in the statistical practice related to the measurement of the public sector's inputs and output. Yet, if we were to abstain from any quantitative analysis only because it is to be expected that its results would underestimate the actual phenomena, we would incur the more dangerous risk of implying that what cannot be measured does not count. For this reason, we expose here some of the major limitations of any quantitative analysis of the public sector in order to then be able to proceed whilst keeping such limits in mind.

For example, in the specific case of e-Government, it is to be pointed out that a series of potential consequences stemming from its implementation are not taken into account in the estimates presented in the next section, although they may have a significant impact on the social fabric. Among these, we may draw particular attention to: increases in the level of responsibility and transparency within PAs, improvements in the diffusion and circulation of information deriving from public sources, greater participation in the performance of democratic processes, enhanced efficacy of public policies.

As was the case with studies on e-Government (see previous section), most existing analyses of public sector productivity are defined at the microeconomic level, in relation to an individual organisational unit or PA. Occasionally, analyses of the outcomes of public sector production are defined or estimated at the aggregate level, as are most of

the feasible measures of efficacy (based, for example, on socio-economic development indicators concerning, for example, social inclusion or health).[21]

Although the aggregate measures derive *ex-post* from the sum of microeconomic variables, this distinction takes on a certain significance, since *ex-ante* the macro magnitudes can differ considerably from a simple sum. In fact, all the economic activities are connected and a change within one organisational unit cannot occur without producing effects within other, associated units. For example, if a PA shows increased levels of efficiency, the benefits deriving from it are very likely to also be absorbed to some extent by the administrations interacting with it.

Furthermore, the operation to aggregate diverse magnitudes – in our case a miscellany of goods and services – implies the need to adopt a common unit of measurement. For the private sector, international accounting standards use market prices and aggregate their value. However, the public sector has no market in which to sell its products and services, which makes measurement problematic. Above all, many public goods and services have no market value.

The conceptual implications are indeed considerable. With regard to the former type of problem, it is to be noted that many PAs do not engage in the supply of services to final users, interacting solely with other administrations (government-to-government activities). Thus, their place in the capitalist economy is only on the side of input acquisition. Many PAs charge no price for the services they supply, or they charge only very small amounts (fees) aimed at rationing demand (thereby selecting among a great number of consumers those who really need the services in question) rather than covering, even partially, the costs borne.

As for the second type of problem, it should be noted that a number of PAs have the precise aim to *not* supply a certain service: for example, the PAs operating at the level of prevention of certain behaviours and actions on the part of the citizens, of natural events, or even of threats from without.

Furthermore, economic theory has long since developed the concept

[21] For a review, see Giordano and Tommasino (2011).

of public goods, i.e. goods distinguished by collective and/or non-rival consumption, the consumption of which cannot be excluded for any individual user (as in the case of infrastructures). Such goods too are generally provided at no charge.

Finally, no less significant is the lack of a clear and commonly accepted definition of public sector output, and of a value attributable to it. It is, indeed, precisely the many conceptual difficulties and problems of definition that make measurement such a formidable task. The solution most often adopted involves classifying as public sector "market" activities, these are aggregated as such on the basis of the payment ("price") made by users for the individual transactions, that part of the supply of goods and services to final users which is acquired at a price amounting to at least 50% of the unit production cost. Conversely, those that are considered "non-market", and thus valued at the cost of production, are all the remaining activities, namely those that do not imply individual transactions, imply transactions only between PAs, or for which the charge effectively paid is less than 50% of the average cost.

Such practice proves to be rather in contrast with the main aim of the empirical analysis to be performed here, in that imposing a condition of equality between the costs borne (i.e. the value of inputs) and the value of output is tantamount to implicitly assuming constant average productivity. For example, when employing this method a pay rise in certain PAs would be evaluated *sic et simpliciter* as a proportional increase in their respective output.

In the last decades, several economists have attempted to assess the performance of PAs through microeconomic productivity indices that compare aggregate output to aggregate input use (O'Mahony and Stevens, 2003; Dawson *et al*., 2005; Stevens *et al*., 2006). The use of direct output measures is naturally easier in some cases, among those being the healthcare sector. Besides Dawson *et al*. (2005), reviews of the economic studies focussing on this sector are to be found in Cutler and McClellan (2001) and Cutler and Berndt (2001).

From a methodological point of view, the so-called *Atkinson Report* (NSO, 2005) has impressed on national statistical institutes worldwide, but especially in OECD countries, the need to address the definition of

common public sector output measurement criteria with all due commitment. The aim of these efforts is to estimate this magnitude through direct output measures, or in other words direct measurements of variations in the volume of output at the micro level (variations in the volume of activities and tasks pursued are often used as a proxy). With regard to progress towards this goal, the report pointed out the pioneering position of the United Kingdom within the EU, with its estimation of about two thirds of the total economic activities in the public sector by applying direct output measures.

After the publication of the *Atkinson Report*, efforts by the national statistical institutes to more adequately estimate the value of the public sector's output have increased, often with corrections of the estimations for the previous years. However, the more we look back into the past, the more the share of public sector output estimated through inadequate input-based indexes grows. Thus, reasons of prudence induce us to only consider data starting from the year 2000 in the next section. For the same reason, only a select number of countries will be considered, those in which more resources are traditionally devoted to the production and refinement of statistical estimates.

5. Public sector productivity dynamics in some OECD countries

For the reasons mentioned in the previous section, constructing a public sector productivity database is not an easy task. However, even with the inevitable limits involved in the necessary approximations of the theoretical variables, some interesting results may be achieved by considering the OECD countries, where more statistical efforts have been made to address some of the major issues. As noted in the aforementioned *Atkinson Report*, these countries exhibit considerable improvements in the quality of data on public sector production in recent years, especially in terms of the share of public sector output measured directly or through some indirect measures that do not exclusively or mechanically rely on the value of inputs.

The database considered includes 24 OECD countries[22] observed from 1998 to 2006: we do not consider the most recent years (from 2007 onwards) because of the lack of updated data on ICT-related expenditure, and above all in order to avoid the perturbation effects, especially strong in the public sector, of the financial and economic crisis and the ensuing austerity programs. To further improve the international comparability of data, the formulation of the productivity function adopted here does not consider first differences but rather rates of change (both of labour productivity and for the Smith and Ricardo effects).

As a measure of public sector output, we adopt the value of general government output, that is to say the sum of the aggregate added value of central, regional and local administrations, in order to prevent institutional differences affecting the estimates. The same aggregate considers the dynamics of public sector average wages and number of full-time equivalent employees (i.e. adjusted for the hours worked).[23] Public sector investments are expressed in the form of gross fixed capital formation. Direct ICT expenditure, i.e. excluding the expense incurred in reorganising production, is obtained from the WITSA database and the above-mentioned eGEP project.[24] Descriptive statistics of the resulting database are reported in table 1.

The variation of public sector output (Smith effect) is considered with a one-year time lag, in order to avoid potential spurious correlation with productivity dynamics, especially given possible rigidity of employment. The Ricardo effect and the investment in innovation effect are considered with a one-year lag too, for theoretical reasons (i.e. to better capture the whole reorganisation processes involved, see section 2). Concerning the latter effect, in order to mitigate potential multicollinearity issues, public investments are expressed as a percentage of public sector output, while e-Government expenditure is expressed as a percentage of GDP.

[22] Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Holland, Hungary, Ireland, Italy, Mexico, Norway, New Zealand, Poland, Portugal, Slovakia, Spain, Sweden, Switzerland and Turkey.

[23] With the exception of the UK, for which the OECD only provides a complete series for the relevant period on the number of public sector employees and the number of public sector jobs (the former has been selected for the present analysis).

[24] For a description, see WITSA (2006).

Table 1 – *Descriptive statistics of the main variables in the dataset*

	$\hat{\pi}_{PS}$	$\hat{P}_{I,PS}$	$\hat{W}_{PS}$	Smith effect	Ricardo effect	e-Gov expenditure	I_{PS}
			yearly % variation			*% GDP*	*% PS output*
Observations	189	256	214	190	199	144	205
Average	4%	4%	6%	4%	2%	1%	17%
Standard deviation	13%	10%	17%	13%	15%	0%	7%
Median	3%	2%	4%	3%	2%	1%	16%
			2-year % variation				
Observations	165	232	190	144	175		
Average	9%	10%	13%	9%	5%		
Standard deviation	23%	25%	31%	24%	25%		
Median	7%	5%	7%	4%	4%		
			3-year % variation				
Observations	141	208	166	96	151		
Average	15%	17%	21%	5%	7%		
Standard deviation	30%	47%	48%	27%	33%		
Median	19%	7%	11%	-4%	5%		
			4-year % variation				
Observations	117	184	142	48	127		
Average	21%	26%	29%	-1%	9%		
Standard deviation	35%	81%	60%	23%	32%		
Median	18%	9%	16%	-7%	7%		

In order to fully exploit the longitudinal character of our data, productivity growth is considered both on a yearly and a long-period basis, through repeated cross-section estimates (i.e. jointly considering variations across all countries and all years) that control for both heteroskedasticity of the error terms and the correlation of the repeated observations for a same country. For all estimates, we first report a standard OLS estimation that only includes PS investments as an indicator of the investments in innovation effect.

Then, we report an OLS estimation that also separately includes the expenditure on e-Government ("eGov") and the residual of a first-stage regression of eGov on a number of instruments. We denote such estimates as 2-stage OLS, or 2SLS. In the first stage, eGov is instrumented through the distribution of ICT expenditure in the four categories identified in section 2: software, hardware, services and

consultancy, and communication, plus a residual "other" component. These variables, expressed as percentages of total ICT expenditure, are closely correlated with e-Government spending (due to the different average cost of these forms of expenditure) but they are not significantly correlated with productivity dynamics or with the other public investments, as shown in table A1 in the Appendix. Thus, together with the quota of public expenditure for ICT over total national expenditure for ICT, they prove good instruments to estimate the impact of e-Government on productivity (see table A2 in the Appendix).[25]

In the second-stage regression, the inclusion of the first-stage residuals is necessary to control for the potential emergence of endogeneity: small *p*-values of the coefficient of the first-stage regression errors would indicate that the OLS estimate is not consistent (Davidson and MacKinnon, 1993).[26]

Finally, for each estimate we report an instrumental variables regression (IV), using the same first-stage regression adopted in the 2SLS estimation. As is well known, when the usual hypotheses of linear regressions apply, the OLS estimate is both consistent and efficient, and we will therefore refer to it. However, when necessary the use of IV regressions allows for consistent estimates, and we will refer to these when endogeneity or multicollinearity issues arise. However, since for IV regressions the R^2 is not significant, we report the AR statistic, a minimum distance test that simultaneously tests for weak instruments and for the exogeneity of the chosen instruments.[27]

[25] The expenditure for consultancy and "other" ICT-related costs are not included as instruments within the "services" cost items, in order to prevent the shares of e-Government expenditures to total 1.

[26] To further control for possible multicollinearity, in these estimates we also report the average variance impact factor (VIF): a VIF of 5 or 10 and above is generally understood to indicate a possible multicollinearity problem (however, see O'Brien, 2007).

[27] The test has been chose due to its robustness to heteroskedasticity and clustered error terms (Finlay and Magnusson, 2009).

5.1. Main results

Considering the model in its simplest form (tables 2 to 5, columns denoted by OLS) it emerges that the productivity function can empirically explain between 48% of productivity growth, on an annual basis, and 91% on a triennial basis (4-year estimates are necessarily based on very few observations, due to the small size of our database).

The significance of the Ricardo and Schumpeter effects increases with the increase in the time span considered, even if the sample size is correspondingly reduced, which implies a reduction in the width of the confidence intervals. In estimates of one-year productivity growth, public sector investments exhibit a negative sign, a result also found by Sylos Labini (1984; 1985), while it becomes significantly positive as longer time spans are considered. In our case, such a finding is hardly surprising when we consider that public investments are not necessarily aimed at enhancing the productivity of public employment. However, both these observations (on the R^2 and the significance of two major theoretical components of the model) suggest that the model is better equipped to capture the determinants of productivity growth in the medium-to-long run than in the short run.

Besides statistical significance, the sign and size of the coefficients of the Ricardo and Investment in innovation effects also increase with the increase of the time span considered. This suggests that in the medium term PAs show an efficient response to market signals, despite the lack of competition in the public supply of many goods and services.

It is to be noted that all the coefficients show marked variance, indicative of a certain heterogeneity at the national and, in some cases, temporal level. In particular, the high variance causes the Smith effect to be often not statistically significant at the traditional confidence levels. When running separate estimations of international cross-sections for each year, as shown in tables 3 to 5, it emerges that the Smith effect has a variable influence on productivity over time. Especially when considering the short-term, the Smith effect becomes significantly positive in almost all estimates.

Table 2 – *Productivity growth in the public sector, years 2000-2006*

	Yearly productivity growth			2-years productivity growth			3-years productivity growth			4-years productivity growth		
	OLS	2SLS	IV	OLS	2SLS	IV	OLS	2SLS	IV	OLS	2SLS	IV
Smith effect	0.235	0.522	0.519	-0.224	-0.232	-0.232	-0.184	-0.118	-0.239	-0.222	-0.288	-0.156
	(0.186)	*(0.174)***	*(0.177)***	*(0.182)*	*(0.215)*	*(0.21)*	*(0.16)*	*(0.191)*	*(0.184)*	*(0.34)*	*(0.384)*	*(0.347)*
Ricardo effect	0.161	-0.069	-0.082	0.598	0.618	0.609	0.96	1.101	0.954	0.999	0.996	1.007
	(0.173)	*(0.161)*	*(0.166)*	*(0.161)***	*(0.166)***	*(0.163)***	*(0.126)***	*(0.212)***	*(0.115)***	*(0.204)***	*(0.187)***	*(0.189)***
PS Investments	-0.223	-0.122	-0.148	-0.355	-0.176	-0.219	-0.303	0.287	-0.258	1.465	0.486	0.759
	*(0.056)***	*(0.056)***	*(0.061)***	*(0.179)**	*(0.151)*	*(0.176)*	*(0.249)*	*(0.311)*	*(0.273)*	*(0.457)***	*(1.023)*	*(0.814)*
e-Government		-1.408	-0.749		-6.323	-3.733		13.829	-5.121		13.78	10.043
		(2.197)	*(1.962)*		*(5.439)*	*(5.103)*		*(4.978)***	*(3.969)*		*(13.542)*	*(13.587)*
Residuals e-Gov		7.887			10.203			-20.041			-41.402	
		(4.649)			*(8.718)*			*(15.182)*			*(31.904)*	
Observations	158	117	117	115	108	108	69	69	69	25	25	25
Countries	24	24	24	24	24	24	22	22	22	16	16	16
R-squared	*0.48*	*0.6*		*0.72*	*0.74*		*0.91*	*0.86*		*0.77*	*0.79*	
Mean VIF		*4.73*			*4.46*			*2.49*			*4.56*	
AR: $\chi^2(4)$			*5.94*			*16.19***			*18.63***			*7.25*

*: significant at 10%; **: significant at 5%; ***: significant at 1%

Notes: Standard errors robust to heteroskedasticity and self-correlation in brackets. The estimates include annual dummies as control variables.

Thus, in the medium-to-long term the public sector as a whole seems in general unable to achieve economies of scale as it grows in size. Several explanations may account for this finding: technological conditions, with constant returns to scale prevailing in the sector; an inability to reorganise the PAs with due efficiency at the microeconomic level; or the inability to shift, as the size of the sector increases, towards the production of those goods and services that are most demanded by the citizens.

The inclusion of e-Government expenditure in the Investments in innovation effect implies certain modifications to the results (reported in the columns denoted by 2SLS and IV in tables 2 to 5). For short-term estimates (annual changes in productivity), the Smith effect becomes consistently significantly positive, whereas it is confirmed that the Ricardo effect takes on greater relevance over the medium-to-long run. As opposed to the aggregate of public sector investments, e-Government programmes are usually specifically aimed at increasing public sector efficiency. Thus, we may read the fact that – similarly to PS investments – they exhibit higher and more often statistically significant coefficients when considering longer time spans as a sign that PAs' reorganization takes time to implement and/or to become evident in output statistics.

6. Implications for economic policy

The analysis presented in this work shows that the public sector can be fruitfully represented in terms of the sum total of several public productive units. A vision of public administrations as a productive sector of the economy, side by side with the private sector, can be given a meaningful quantitative representation through a theoretical model, and an empirical estimation, not unlike those applicable to the private sector. Truly, the social value of public action should be understood as wider and possibly more important than simply a production-increasing effort, but still conceiving the public sector as a productive unit provides a further economic rationale in support of its preservation, in the face of current retrenchment plans.

Table 3 – *Cross-section estimates of productivity growth*

Yearly productivity change

	2001			2002			2003		
	OLS	2SLS	IV	OLS	2SLS	IV	OLS	2SLS	IV
Smith effect	0.923	1.382	1.348	0.046	0.16	0.253	0.54	0.212	0.195
	*(0.491)**	*(0.626)***	*(0.548)***	*(0.276)*	*(0.301)*	*(0.346)*	*(0.315)*	*(0.303)*	*(0.289)*
Ricardo effect	-0.568	-0.477	-0.525	0.572	0.47	0.368	0.102	0.298	0.326
	(0.459)	*(0.375)*	*(0.372)*	*(0.396)*	*(0.397)*	*(0.435)*	*(0.33)*	*(0.306)*	*(0.286)*
PS Investments	0.21	-0.269	-0.224	0.362	-0.077	0.016	0.65	0.029	0.031
	(0.162)	*(0.238)*	*(0.186)*	*(0.102)****	*(0.193)*	*(0.153)*	*(0.186)****	*(0.17)*	*(0.162)*
e-Government		12.611	11.504		8.086	6.982		13.597	13.619
		(8.667)	*(7.117)*		*(3.827)***	*(3.569)**		*(3.205)****	*(3.140)****
Residuals e-Gov		-8.258			-11.574			-6.306	
		(18.331)			*(9.618)*			*(8.544)*	
Observations	24	24	24	24	24	24	24	24	24
R-squared	*0.25*	*0.36*		*0.52*	*0.61*		*0.75*	*0.85*	
Mean VIF		*4.26*			*5.61*			*3.93*	
AR: $\chi^2(4)$			*16.17****			*5.48*			*33.41***

*: significant at 10%; **: significant at 5%; ***: significant at 1%

Notes: Standard errors robust to heteroskedasticity in brackets.

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Table 3 – *Cross-section estimates of productivity growth*

Yearly productivity change

	2004			2005		
	OLS	2SLS	IV	OLS	2SLS	IV
Smith effect	0.37	0.427	0.41	0.64	0.745	0.759
	*(0.124)***	*(0.193)**	*(0.200)**	*(0.175)****	*(0.195)****	*(0.236)****
Ricardo effect	0.078	0.055	0.041	-1.235	-1.36	-1.317
	(0.298)	*(0.359)*	*(0.367)*	*(0.535)***	*(0.571)***	*(0.583)***
PS Investments	0.19	0.273	0.208	-0.248	-0.19	-0.225
	(0.113)	*(0.115)***	*(0.108)**	*(0.177)*	*-0.182*	*(0.206)*
e-Government		-2.283	-1.017		-1.939	-1.788
		(3.036)	*(3.116)*		*-1.661*	*(1.86)*
Residuals e-Gov		10.853			9.624	
		(6.792)			*-5.864*	
Observations	24	24	24	20	20	20
R-squared	*0.8*	*0.82*		*0.28*	*0.32*	
Mean VIF		*5.19*			*6.69*	
AR: $\chi^2(4)$			*7.82**			*6.22*

*: significant at 10%; **: significant at 5%; ***: significant at 1%

Notes: Standard errors robust to heteroskedasticity in brackets.

Table 4 – *Cross-section estimates of productivity growth*

Two-years productivity change

	2002			2003			2004			2005		
	OLS	2SLS	IV	OLS	2SLS	IV	OLS	2SLS	IV	OLS	2SLS	IV
Smith effect	-0.51	-0.234	-0.309	-1.081	-0.787	-0.683	-0.209	-0.176	-0.166	0.308	0.315	0.332
	(0.39)	*(0.425)*	*(0.359)*	*(0.347)***	*(0.361)***	*(0.423)*	*(0.242)*	*(0.22)*	*(0.225)*	*(0.071)****	*(0.075)****	*(0.063)****
Ricardo effect	1.1	1.218	1.123	0.902	0.776	0.748	0.946	0.83	0.825	-0.728	-0.733	-0.751
	*(0.531)**	*(0.430)***	*(0.533)***	*(0.190)****	*(0.207)****	*(0.222)****	*(0.538)**	*(0.462)**	*(0.443)**	*(0.493)*	*(0.52)*	*(0.504)*
PS Investments	0.289	-0.21	0.008	0.696	0.205	0.186	1.407	0.36	0.316	0.262	0.338	0.313
	(0.201)	*(0.317)*	*(0.211)*	*(0.257)***	*(0.243)*	*(0.235)*	*(0.289)****	*(0.261)*	*(0.214)*	*(0.181)*	*(0.217)*	*(0.215)*
e-Government		10.15	6.567		12.088	13.504		19.431	20.266		-1.238	-1.59
		(7.672)	*(5.916)*		*(6.513)**	*(7.011)**		*(4.782)****	*(4.380)****		*(2.88)*	*(2.723)*
Residuals e-Gov		-37.325			-11.598			-3.535			9.401	
		(24.851)			*(13.898)*			*(13.944)*			*(9.909)*	
Observations	22	22	22	24	24	24	24	24	24	20	20	20
R-squared	*0.47*	*0.55*		*0.82*	*0.84*		*0.75*	*0.86*		*0.7*	*0.71*	
Mean VIF		*3.9*			*4.1*			*3.51*			*3.89*	
AR: $\chi^2(4)$			*9.42**			*8.09**			*35.38****			*11.17***

*: significant at 10%; **: significant at 5%; ***: significant at 1%

Notes: Standard errors robust to heteroskedasticity in brackets.

Table 5 – *Cross-section estimates of productivity growth*

Three-years productivity change

	2004			2005		
	OLS	OLS	IV	OLS	OLS	IV
Smith effect	-0.826	-0.52	-0.469	-0.08	0.171	0.186
	*(0.414)**	*(0.385)*	*(0.36)*	*(0.336)*	*(0.351)*	*(0.343)*
Ricardo effect	1.61	1.43	1.411	1.038	0.738	0.718
	*(0.325)****	*(0.317)****	*(0.293)****	*(0.540)**	*(0.538)*	*(0.514)*
PS Investments	1.073	0.405	0.351	1.45	0.449	0.372
	*(0.357)****	*-0.295*	*(0.272)*	*(0.403)****	*(0.351)*	*(0.304)*
e-Government		15.961	17.617		19.468	20.91
		*(5.390)****	*(4.861)****		*(6.776)***	*(6.597)****
Residuals e-Gov		-4.581			1.003	
		(18.146)			*(13.383)*	
Observations	22	22	22	20	20	20
R-squared	*0.89*	*0.92*		*0.81*	*0.87*	
Mean VIF		*3.12*			*3.02*	
AR: $\chi^2(4)$			*29.74****			*18.89****

*: significant at 10%; **: significant at 5%; ***: significant at 1%

Notes: Standard errors robust to heteroskedasticity in brackets. Only regressions with more than 20 observations are reported.

According to our analysis, contrary to stereotypical expectations voiced from time to time, the PAs seem to respond efficiently to market incentives in terms of the prices of inputs, especially over the long period. This finding suggests substantial dynamic efficiency in the public sector, pointing to the expediency of further empirical investigation. Although the public sector is subject to political pressures that often do not apply to the private sector (for example in the field of staff management), and although it is not subject to competitive conditions, the average productivity of public employees appears to an appreciable extent to be determined by similar dynamics to those in the capitalistic sector of the economy.

However, our analysis highlights the need for further research in the field of public sector efficacy, since increases in output are not significantly correlated with increases in productivity (apart from in the short period). Specific inquiry needs to be made into the respective extent to which this piece of evidence may be due to the production technology of the public sector exhibiting constant economies of scale or the incapacity to reorganise production at the micro or macroeconomic level (i.e. in the composition and nature of the goods and services supplied).

Finally, we show that investments in the enhancement of public sector efficiency and efficacy bring about positive economic outcomes. The reorganisation of the public administrations prompted by the adoption of ICT promises to increase the production and diffusion of information, making the PAs more transparent and responsible towards the citizens and policy-makers, reducing the scope for corruption and enhancing opportunities for all citizens and firms. e-Government represents an opportunity for radical transformation of PAs, both in terms of goods and services supplied to citizens and of their capacity to satisfy needs not adequately met by the market (public sector efficacy), as well as in terms of efficiency in the supply of these services and in the support of the services supplied by the market and the family (where the public sector constitutes a factor of production). According to our estimates, investments in ICT may have contributed positively to productivity growth in the public sector, and may have done so more effectively and significantly than other public investments have. As one would expect, both forms of investment seem more relevant in the medium-to-long run.

In conclusion, the analysis of productivity trends in the public sector seems very useful not only to better account for the actual value of the economic transactions engaged in within a certain economy (i.e. to have better estimates of a country's GDP), but also for the implied reconsideration of PAs as productive units, and not as deadweight burdens on taxpayers. Though the present study necessarily exhibits limitations, especially in the geographical and temporal range of the dataset analysed, it is our hope that it further demonstrates the need to redouble the efforts to produce ever better estimates of the economic value of the public sphere of the economy.

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Appendix

Table A1 – *Simple correlations: e-Government, public investments and productivity of the public sector*

	e-Government expenditure	PS Investments	Yearly productivity variation	2-year productivity variation	3-year productivity variation	4-year productivity variation
PS Investments	-0.0133	1	-0.0745	-0.0917	-0.1174	-0.1393
	(0.8782)	-	*(0.3125)*	*(0.2441)*	*(0.1673)*	*(0.1357)*
e-Government exp.	1	-0.0133	-0.0092	-0.0469	-0.1171	-0.2045*
	-	*(0.8782)*	*(0.9208)*	*0.6137*	*0.2106*	*(0.0329)*
Hardware share	-0.1563*	-0.1838*	0.0284	-0.1034	-0.2354*	-0.2262*
	(0.0613)	*(0.0329)*	*(0.7600)*	*0.2653*	*0.011*	*(0.018)*
Software share	0.5788*	-0.0464	0.0932	0.1269	0.1044	0.0242
	(0.0000)	*(0.5932)*	*(0.3152)*	*0.171*	*0.2646*	*(0.8027)*
Services share	0.6973*	-0.1154	0.0057	-0.0055	-0.0603	-0.1551
	(0.0000)	*(0.1827)*	*(0.9512)*	*0.9528*	*0.5202*	*(0.1073)*
Communications share	-0.5741*	0.1383	-0.0365	-0.0023	0.0766	0.1601*
	(0.0000)	*(0.1097)*	*(0.6946)*	*0.9803*	*0.414*	*(0.0964)*
PS share of ICT exp.	0.7800*	0.1212	-0.0325	-0.0455	-0.097	-0.2072*
	(0.0000)	*(0.1613)*	*(0.7269)*	*(0.6245)*	*(0.3004)*	*(0.0306)*

*: statistically significant at least at 10%

Table A2 – *First stage regressions: e-Government expenditure in relation to the instruments*

	Annual Expenditure	Biennial Expenditure	Triennial Expenditure	Quadrennial Expenditure
Hardware share	-0.0402	-0.0409	-0.0329	-0.0189
	(0.0081)	*(0.0081)*	*(0.0103)*	*(0.0249)*
Software share	0.0176	0.0194	-0.0004	-0.0179
	(0.0142)	*(0.0139)*	*(0.0176)*	*(0.0309)*
Services share	0.0255	0.0259	0.0302	0.0292
	(0.0071)	*(0.0069)*	*(0.0088)*	*(0.0191)*
Communications share	0.0072	0.0089	(0.0087)	0.0034
	(0.0019)	*(0.002)*	*(0.0027)*	*(0.0054)*
Public Sector share	0.0388	0.0377	0.0347	0.0438
	(0.008)	*(0.0079)*	*(0.0098)*	*(0.0203)*
Smith effect	0.0004	-0.0018	-0.005	-0.0034
	(0.0036)	*(0.0018)*	*(0.0021)*	*(0.0027)*
Ricardo effect	0.0007	5.59e-06	0.0011	0.0004
	(0.0042)	*(0.0017)*	*(0.0021)*	*(0.0023)*
Investments effect	-0.0044	-0.0051	-0.0033	0.0023
	(0.0035)	*(0.0035)*	*(0.0046)*	*(0.0113)*
Observations	*93*	*91*	*65*	*25*
R^2	*96,75%*	*96,94%*	*96,88%*	*97,13%*

Notes: Standard errors robust to heteroskedasticity and self-correlation in brackets. All estimates include annual dummies as control variables.