The productivity of the public sector in OECD countries: eGovernment as driver of efficiency and efficacy

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This article aims at illustrating a theoretical approach to the analysis of the dynamics of productivity in the public sector, and at presenting a preliminary application of it to the estimation of the impact on productivity of the recent development of e-Government processes in a number of OECD countries.[1]

Our analysis serves a twofold purpose: at the microeconomic level, we set out to provide individual public administrations (PAs) with an instrument to evaluate the benefits, in terms of output, of alternative projects, particularly through a more efficient organisation of the relevant information. At the macroeconomic level, the aim is to highlight a significant relationship between e-Government and economic growth, as an indicator of social wellbeing.

To begin with we must point out the limits of any analysis of productivity in the public sector, at least within the terms in which the concepts of efficiency and efficacy have been developed and utilised for the specific analysis of the private sector in a capitalist economy[2]. In the first place, intervention in the public sector of the economy does not take the form of a one-dimensional phenomenon: attributable to a multidimensional world, given the multiplicity of objectives it pursues and instruments applied, it clearly merits a multidisciplinary approach, plural in both methods and objects under examination. Thus economic analysis of the productivity of the public sector inevitably provides us with a partial picture, while 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 in this case) or shared by all the populations of the individual countries.

In the specific case of e-Government, it is to be pointed out, for example, that a series of further effects stemming from its implementation are not taken into account in the estimates presented here although they have significant impact on the entire social fabric. Among them, we can distinguish: increases in the level of responsibility and transparency within the public administrations, improvements in the diffusion and circulation of information deriving from public sources, greater participation in the performance of democratic processes, enhanced efficacy for public policies.

On output and productivity of the public sector: methodological notes

Analysis of public sector productivity, and most of the effects that e-Government has on it, are mainly defined at the microeconomic level, in relation to an individual organisational unit within the PA, while some effects of the adoption of ICT on GDP – for example, the indirect

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[1] 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).

[2] See Corsi *et al.* (2006). The documents produced in the course of the eGEP project are available on the website www.rso.it/eGEP. Carried out under the European Commission's Modinis Programme, and managed by the e-Government unit in DG Information Society and Media, the e-Government Economics Project (eGEP) focused on producing a measurement framework for the evaluation of e-Government impacts and outcomes.

stimulus for productivity growth in the private sector and the direct impact of investments on GDP – are defined at the aggregate level, as are most of the feasible measures of efficacy (based, for example, on social-economic development indicators as social inclusion or health).

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 (e.g., if a public administration shows increased levels of efficiency, the benefits deriving from it are very likely to 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 the national accounting standards take market prices as a reference, aggregating their value. However, the public sector has no market to sell its products and services, which makes measurement problematic, and 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 public administrations 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 charge no price for the services supplied, or charge only minimal amounts, in order to ration 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 concerns the second type of problem, it should be noted that a number of public administrations have the precise aim *not* to 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, for instance, or natural events, or even threats from without). Furthermore, we are all well acquainted with the issue of "public goods" – goods distinguished by collective and/or non-rival consumption, consumption of which cannot be excluded for any individual user (as in the case of infrastructures): such goods are generally provided without any charge.

No less significant, finally, is the lack of a clear and commonly accepted definition of the 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 "market" activities, and so aggregated on the basis of the payment ("price") made 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, they are considered "non-market", and thus valued at the cost of production, 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 quite in contrast with the main aim of the empirical analysis here to be performed, in that imposing a condition of equality between costs borne and value of output produced is tantamount to implicitly assuming constant average productivity.[3]

The recent *Atkinson Report* (NSO, 2005) has impressed on national statistical institutes worldwide the need to address the definition of common public sector output measurement criteria with all due commitment. The aim is to estimate this magnitude through direct output measures, or in other words direct measurements of variations in the volume of output, proxied by variations in the volume of activities and tasks pursued. With regard to progress

[3] For example, a pay rise in certain PAs of the public sector is evaluated *sic et simpliciter* as a proportional increase in the respective production.

towards this goal, the Atkinson Report points up the pioneering position of the United Kingdom within the EU, with estimation of about two thirds of the total economic activities in the public sector applying direct output measures, while many OECD countries are lagging in the implementation of this methodology with all the consequent problems when it comes to comparing results.

In recent years, several economists have attempted to assess the performance of the public sector trough productivity indices that compare aggregate output to aggregate input use (O'Mahony and Stevens, 2003; Dawson *et al*., 2005; Stevens et al., 2006; Prior, 2006). The use of direct output measures is naturally easier in some industries, among which the health-care sector. Beyond the cited 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). Finally, concerning the USA, 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). In these papers the authors use data from the Bureau of Labour Statistics' (BLS) *Federal Productivity Measurement Program* on productivity growth and computer assets. However, due to a lack of relevant aggregate data, our study will not consider the USA.

ICT, efficiency and efficacy in the Public Sector

The recent development of the Information Society, and in particular the increasing use of ICT as a channel for interaction between citizens or firms and the public administrations, has spawned a great many studies, seeking to size up the potential and key areas of impact of e-Government, thus offering policymakers a better understanding of its benefits in terms of efficiency and efficacy. It is worth recalling here some of the most significant studies recently carried out on the subject of e-Government.

With regard to the efficacy of public services, the sample survey carried out annually by Capgemini[4] since 2001 represents a major contribution. Taking a methodological approach of the benchmarking type, the study analyses twenty basic public e-Services, supplied by the public administrations 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). The findings of the last available report show significant advances in both indicators: in the 27 EU countries, on average nearly 50% of the services are available through the Internet, in comparison with the 40% of the year before, with a fairly high level of sophistication (level 4).

Also based on a benchmarking methodology is UNDERSTAND,[5] a project promoted and coordinated by the Regione Emilia Romagna, concluded in 2006, the aim of which is to compare the degree of development of the Information Society (and in particular e-Government) at the regional level in Europe, defining and applying a set of common indicators. The long-period results expected are substantiated in supplying the twelve regions involved in the project with instruments to evaluate the impact in terms of efficacy of investments in ICT, in the ambits of both the public administrations and the social environment in general (firms, schools, citizens, etc.). The surveys carried out confirm

[4] Capgemini (2006).

[5] The documents produced in the course of the project are available on the website www.understand-eu.net. For a summary of the results see Mancini (2006).

advance in the innovation processes of the regional PAs, but at the same time reveal certain limits. As the complexity of the services increases, their availability electronically decreases; multi-channel supply remains at the primordial stage; and efforts must be made to reduce the negative relationship there is between PA dimension and the development of e-Government initiatives.

With regard to evaluation of the efficiency and efficacy of public services, it is worth citing a work published in 2004 by Cisco Systems[6], 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 public administrations of eight European countries. The study determines a series of factors of critical importance in achieving increases in the efficiency of e-services supply (for example, the average time taken to complete a procedure, average cost of a procedure, total number of procedures concluded within a given span of time, etc.), so as to identify, on the basis of these key aspects a series of best practices to imitate.

It hardly needs pointing out that much of the literature on efficiency and efficacy in the public administrations is of the organisational-management type and based on sample surveys of best practices, often characterised by considerable use of methodologies of the benchmarking type. The eGEP Economic Model (Corsi *et al*., 2006) marks a break in the line of the literature, in that it addresses the complexity of the subject systematically (i.e. analysing the entire public sector) while strictly grounded on economic theory.

The points developed there also underlie the model presented here, the subject of which – as we have seen – is evaluation of the *efficiency* shown by the public administrations in the supply of goods and services, which are assumed to be comparable on the basis of market or estimated value. It will also emerge from the analysis that this approach affords some general indications for a preliminary evaluation of the *efficacy* of the PAs. The reason for researching aspects associated with efficiency lies mainly in the lesser complexity of an empirical survey, thanks to the (relatively) greater measurability of the variables involved.

A final point to note is the new viewpoint taken – pre-analytic, in the terminology of Schumpeter (1954) – which makes comparison of the model here proposed with the economic and organisational literature on PA somewhat difficult, in that the main assumption adopted sees increasing efficiency in the PA as precondition for the supply of more and better products and services, rather than intermediate objective on the way to downsizing the role of the public sector in the economy. Actually, the model presented here also takes account of the issue of reducing the bureaucracy weighing on firms and citizens, but it goes further, seeking 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. Here the key assumption is that the objective of arriving at public administrations able to supply services conceived in terms of the users' needs, can in the first place be achieved by boosting productivity through reorganisation, professional training and ICT, or in other words through e-Government.

Productivity in the Public Sector and e-Government Processes

The economic model presented here constitutes extension and adaptation to the public sector of the productivity function model by Paolo Sylos Labini (1984 and 1985) for description of economic growth in the private sector (recently revised and estimated on Italian

[6] Cisco Systems-Momentum (2004).

data by Sylos Labini (2004), which is also the source for denomination of the individual effects)[7].

Let Y_{PS} denote the value of production in the public sector – the sum of the goods and services supplied – calculated in monetary terms, which by definition represents a portion of the Gross Domestic Product ($Y_{PS} = \alpha GDP$). Thus the productivity of labour in the public sector can be defined as the overall 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 this is an average productivity – the value of the goods and services produced on average by every public employee – π_{PS} constitutes a synthetic measure of the productivity of the public sector as a whole, and not only of the labour factor, as in the case of marginal productivity[8], being in combination with other production inputs. Variations in productivity per employee can be generated by variations in price or average value of product per employee, given the physical quantities supplied of each good or service (in which case, within the framework of the model it will be a matter of variations in the efficacy of the public administration), or by an increase in the physical quantities per employee, given their prices and values (variations in efficiency), or by both quantities.

We assume that e-Government processes contribute to GDP growth along three channels:

1. Direct variations of the efficiency and efficacy of the public administration, leading to increases in labour productivity in the public sector (π_{PS}). Given the number of employees in the Public Sector (L_{PS}), the consequent increase in value of the public output (Y_{PS}) will translate as growth in GDP (or, it is hypothesised that increases in productivity will be followed by less than proportional reductions of staff).

2. Direct impact on the private production of goods and services, thanks to multiplier and accelerator mechanisms connected with the public demand for investment goods and services (full employment is assumed not to obtain) and the creation of public capital in the form of material and immaterial infrastructures, assumed at least partially to constitute positive inputs also for production in the private sector.

3. Direct impact on growth in the private sector generated by the stimulation to innovate, and by the contribution to the competitiveness of the economic system stemming from the changed composition of public demand, oriented (in the case of e-Government processes) towards markedly innovative, high value added goods and services.

[7] See, the documents produced within the eGEP project for extensive illustration of the model and discussion of the problems involved in transposing it to the public sector. A preliminary econometric estimate applied to panel data for 19 EU countries is provided in Corsi *et al*. (2006).

[8] See Sylos Labini (1995) for clear exposition of the reasons for this choice and for theoretical critique and empirical applications based on the neoclassical production function.

The theoretical model we look to refers to the first of these three channels, distinguishing five mechanisms by means of which variations in efficiency and efficacy lead to variations in productivity – three originally identified by Sylos Labini (1984) – the Smith Effect, the Ricardo Effect and the Investments Effect (here renamed Schumpeter Effect) – and two more effects introduced by Gumina (2006) with specific reference to innovation processes in the public administration – the Back-Office Effect and the Take-Up Effect.

The productivity function

The Smith Effect. At the private level, the Smith Effect connects labour productivity with the market size of an individual firm (thus an effect defined at the microeconomic level): in particular, it summarizes the impact of dynamic economies of scale on labour productivity. In fact, with variations in firm size the efficiency with which the endowment of fixed and circulating capital is used also varies: generally there will be increasing economies of scale, or in other words the Smith Effect is expected to exhibit a positive sign, at least through the possibility of amortising the fixed costs over a larger set of goods and services.

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 public administrations have no market (in the sense of traditional microeconomics) for their products. In many cases there is no "demand" for public goods, in the sense of evident readiness to pay for them, and production decisions are guided, rather, by the supply side. At the same time, effectively achieving improvements in efficiency means launching reorganisation processes that cannot be considered automatic, given the lack of competitive stimulus of an objective of monetary gain.

Finally, the reverse relationship, from increases in productivity to increases in scale, which can be hypothesised in the private sector, thanks to the possibility of setting lower prices at larger scales on the strength of higher productivity, but it 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 matched by demand of users and citizens; otherwise, the technically feasible increases in productivity will remain unfulfilled, unless through staff reduction. At the aggregate level this reverse effect implies efficacious planning of the broad mix of public goods and services supplied, meaning by efficacious that it effectively answers to the needs of the citizens, which may be considered a sort of demand for public services and goods.

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 public administrations, many of which take the form of gains in financial terms. In particular, e-Government is able to produce the following intermediate results: 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[9]); greater integration, customisation and speed in the supply of goods and services; services supply of new design, and potentially corresponding new revenues.

At the macroeconomic level, over and above aggregation of the micro-effects, which does not correspond to their sum it is at least worth noting the increased speed and coverage capacity of tax revenues.

Indicating with a circumflex accent the rate of variations of the individual variables in period t, the Smith effect can be indicated in symbols as

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

$$\hat{\pi} = b\,\hat{Y}_{SP},$$

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

The Ricardo Effect – or the Substitution/Integration 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 modification of production technologies. In particular, in response to variations in the prices of labour and capital goods, firms will be stimulated to adopt organisational and technological innovations reducing the relative use of the input that has become more costly.

The public administrations are subjected to far more stringent constraints than are private firms with regard to the expediency of or needs for variation in the staff employed, especially when it is a matter of shedding staff. Thus, it seems very likely that variations in prices can lead to increased efficiency thanks to the integration (and relative increase) of innovation processes and e-Government with traditional processes, rather than their immediate substitution.

There are two variables to consider in estimating the Ricardo effect: variation in the average wages of public employees (*w*), and the index number of the prices of investment goods acquired by the public sector ($P_{I,PS}$). Thus, indicating with *c* the sensitivity of variations in productivity to variations in relative prices, the variations in productivity can be expressed as a function of the Smith effect and the Ricardo effect:

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

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.

The Schumpeter Effect – or the effect of investments in innovation. In the last decade, many studies have been conducted to identify the benefits of ICT investments in terms of productivity, especially in the private sector.[10] Basically, there are two reasons why investments increase not only the potential output, but also efficiency and/or efficacy in the supply of goods and services. Firstly, they are sometimes made for this precise purpose; on the other hand – even if they are made simply to increase the volume of production, thus with a proportional increase of employees, productivity being equal, or when the aim is to replace capital either obsolete or old – the introduction of new machinery generally leads to improvement in operations, thanks to the "embodied" technical progress.

Obviously, not only the mere acquisition of physical goods can be considered investment: in relation to reorganisation processes and the introduction of forms of e-Government, there are four items to be distinguished: spending on hardware (generally greater in the initial

[10] For a review of the works in the economic literature see Brynjolfsson and Hitt, 1998; Lehr and Lichtenberg, 1999; Triplett, 1999; Dewan and Kraemer, 2000; Van Ark, 2000; Pohjola, 2001; Inklaar et al., 2003; Piatkowski and Van Ark, 2004-2006; Anderson et al., 2006

stages of e-Government processes), spending on software (also greater at the stage of introduction, but fairly steady in the subsequent stages), spending on external consulting and on staff training plans (greater at the more advanced stages of the innovation process)[11].

Indicating with *I* expenditures on investment in the public sector, and again adopting the convention of ignoring the temporal dimension of the individual effects, we obtain the following productivity function:

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

where d represents the elasticity of variations in productivity generated by public investments.

The Back-Office Effect and the **Take-Up Effect**. Transposing the productivity function model to the public sector entails at least two other types of considerations. The two effects introduced by Corsi et al. (2006) are multiplicative in relation to the previous effects, in that they afford greater or lesser effectiveness to the dynamics so far defined. In any case, identifying them empirically proves all too formidable a task, given the lack of much of the relevant data and the considerable difficulties involved in measuring the interest variables: the two effects will not be taken into account in the following econometric analysis.

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 (Bertschek and Kaiser, 2004). 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. As they focused solely on a simple and rapid translation online of the very same traditional public services, without any concrete reorganisation of the productive processes, they mostly failed.

The Take-Up effect can be defined as a set of environmental conditions that enable e-Government implementation and determine its efficacy. Here there are at least two significant aspects to distinguish:

- The technological scenario: one may assume that the demand of citizens for public services exploiting ICT increases with the supply of private ICT – related services and products.
- The competition of private services could drive the public sector to greater efforts to achieve a more rapid and efficient supply of services.
- The educational/training level of the staff employed in the public sector and of the entire population is decisive for the supply of knowledge-based services.

Broadly speaking, the social environment influences the efficacy of e-Government programmes – or in other words their impact on the productivity of the public sector – on both

[11] Although - strictly speaking - expenditure borne indirectly on the reorganisation of processes and services should also be calculated among the investment in innovation cost items, rating them is empirically far harder, and they will therefore be omitted from the following analysis.

the demand side, with greater receptivity of the potential users, and on the supply side, with better-prepared staff in the public offices.

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, thus we may sum up the productivity function:

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

Public sector productivity dynamics in some OECD countries

For the reasons mentioned above, constructing a public sector productivity database is no easy task. Indeed, as for the Atkinson Report, the urgent need for real political commitment to the production and diffusion of relevant information is among the main implications of this paper at the level of economic policy. In any case, even with the inevitable limits involved in the necessary approximations of the theoretical variables, some interesting results may be achieved.

The database considered includes 24 OECD countries[12] observed from 1998 to 2005 though with considerable attition. Public sector output is proxied with the value of the production of the Central, Regional and Local Administrations (since institutional differences do not affect the estimates); the same productive units are considered for the dynamics of the average wages and the number of full-time equivalent employees in the public sector (i.e. adjusted for the hours worked). Investments are expressed in the form of gross fixed capital, that is before accrued depreciation. Direct ICT expenditure, i.e. excluding the expense incurred in reorganising production, is provided by the WITSA database [13].

The formulation adopted considers rates of change, with regard to both labour productivity and the Smith and Ricardo effects, for the sake of better international comparability of the data, as compared to e.g. first differences, given the partially different accounting standards across countries.. The variation of public output (Smith Effect) is taken with a one-year time lag to avoid possible spurious correlations with the productivity dynamics, given the possible rigidity of employment. The Ricardo Effect is also considered with a lag for theoretical reasons. Public investments are expressed as percentages of public output, and e-Government expenditure as a percentage of GDP: the former with one lag, the latter with two. The model is firstly estimated in its basic form, then including e-Government. Productivity growth is considered on both a yearly and a long-period basis. Pooled estimates are conducting jointly considering variation across all countries and all years at the same time, with proper corrections of the standard errors considering correlation across observations regarding each country and heteroskedacity of errors across countries.

Considering the model in the simplest form (Table 1, columns OLS), it emerges that the productivity function accounts for 52% of productivity growth on an annual basis, and for an eve greater proportion of variance in the case of long-run growth, up to 83% on a triennial

[12] 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, Turkey.

[13] WITSA (2006).

basis. The significance of the Ricardo Effect and of investments increases with the increase in the time span considered, although the sample size is correspondingly reduced (implying a reduction in the width of the confidence intervals). Both observations clearly indicate that the model is better equipped to capture productivity growth determinants in the medium-to-long run than in the short run.

Table 1. Productivity growth in the public sector, 2000-2005

	Annual var.		**Biennial var.**		**Triennial var.**		**Quadrennial var.**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Smith	0.239	0.262	0.034	-0.047	-0.169	-0.047	-0.222	-0.159
	(0.164)	*(0.112)**	*(0.084)*	*(0.134)*	*(0.197)*	*(0.228)*	*(0.340)*	*(0.346)*
Ricardo	0.178	0.201	0.468	0.512	1.131	1.046	0.999	1.005
	(0.178)	*(0.124)*	*(0.138)***	*(0.135)***	*(0.230)***	*(0.250)***	*(0.204)***	*(0.188)***
Investments	-0.016	-0.056	0.285	0.068	0.957	0.131	1.465	0.776
	(0.081)	*(0.094)*	*(0.174)*	*(0.168)*	*(0.285)***	*(0.196)*	*(0.457)***	*(0.824)*
E-Government		0.975		8.738		12.815		9.803
		(1.368)		*(4.766)*		*(4.912)**		*(13.818)*
Observations	158	93	115	91	69	65	25	25
R^2	0.52		0.68		0.83		0.77	

Notes: Standard errors robust to heteroskedacity and self-correlation in brackets. The estimate includes annual dummies as control variables.

** significance 5%; ** significance 1%*

With more prolonged time spans, the coefficients of the two variables (Ricardo and Investments) increase, showing a positive role for public investments in the medium run – not observed in the short run – and 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 not significant at the traditional confidence levels. Furthermore, the respective coefficient decreases on average, and in the minimum and maximum, as longer time spans are considered. The conclusion this brings us to, is that the public administrations are unable to achieve economies of scale when they grow in size. Behind this incapacity there may lie a technological impossibility (associated with the technical conditions of goods and services supply), or inability to reorganise the overall organisation with due efficiency, or it may depend on the typology of the goods and services supplied efficiently (i.e. effectively demanded by the citizens). It is also to be pointed out, however, that the Smith Effect has a substantially variable influence on productivity over time, as it emerges from the separate estimation of cross-sections for the various years (shown in the Appendix): in the sample of countries considered a positive trend emerges – albeit more notably in short-period growth than over the medium-long term – thanks to which the Smith Effect proves significantly positive in most of the formulations referring to years 2004 and 2005.

Introduction of e-Government expenditure in the model considered, appears empirically problematic given the high correlation between e-Government expenditure and public

spending on investments, despite the different normalisation of the two magnitudes. Thus estimations were made, pooled and individually for each year, with the instrumental variable method (IV columns in Table 1). In fact, the database considered offers details of the distribution of ICT expenditure in the four categories of software, hardware, services and consultation, and communication. These variables, expressed as percentages of national ICT expenditure, together with the quota of public expenditure for ICT over the total national ICT expenditure, are closely correlated with e-Government spending, but not with productivity dynamics, nor with public investments as a whole (see Table A2 in the Appendix): they thus prove excellent instruments to estimate the impact of e-Government on productivity.

In all the specifications, estimation of e-Government expenditure in relation to the five instruments described accounts for 88% to 98% of the variance; on the other hand, R^2 does not prove a significant measure in relation to the second stage of estimation. Explicit consideration of e-Government implies certain modifications to the preceding results. While the Smith Effect becomes significantly positive in estimation of the annual variation in productivity, the Ricardo Effect shows greater relevance over the medium-to-long run, growing in magnitude and significance. At the same time, the Investments coefficient diminishes as the period under consideration is prolonged, without a corresponding reduction in variance (which, moreover, increases in some cases). This tends to downsize the role of public investments in the increase of public sector productivity, in favour of expenditure specifically going into e-Government programmes, which likewise loom gradually larger. This finding is hardly surprising when we consider that, unlike e-Government programmes, public investments are not necessarily channelled into enhancing the productivity of public employment (as in the case of building infrastructures, for example, or when directed to an increase in productive capacity and not in productivity). Nevertheless, the fact that their contribution to the growth of productivity in the public sector appears not only modest but statistically insignificant, signals the need for further research in analysing the efficacy of public investments.

Implications for Economic Policy

At the socio-political level, the reorganisation of the public administrations prompted by the adoption of ICT promises to increase the production and diffusion of information, making the public administrations more transparent and responsible towards the citizens and policy-makers, reducing the scope for corruption and enhancing opportunities for all citizens and firms. From a strictly economic point of view, no less potential is shown by the e-Government initiatives: indeed, e-Government represents an opportunity for radical transformation of the PAs, both in terms of goods and services supplied to the citizens and of capacity to satisfy needs not adequately met by the market or the informal sector (public sector efficacy), as well as in terms of efficiency in the supply of these services and in support for the services supplied by the market and the family (where the public sector constitutes a factor of production).

Focussing on the impact of e-Government on public sector productivity and defining the results in terms of GDP growth, our analysis appears to yield some encouraging preliminary findings. In many OECD countries investments in ICT have contributed positively on productivity growth in the public sector, more effectively and significantly than have public investments as a whole. As one would have expected, both forms of investment show more importance in the dynamics of the medium-to-long run than on the short run.

Contrary to expectations voiced from time to time, the public administrations seem to respond efficiently to market incentives in terms of the prices of inputs, especially over the

long period. Moreover, although the public sector is subject to dynamics that often do not apply to the private sector, for example in the field of staff management, the average productivity of public employees appears to an appreciable extent to be determined by the dynamics of the capitalistic sector of the economy. This is an interesting finding since it suggests substantial dynamic efficiency in the public sector, pointing to the expediency of further empirical investigation in the face of repeated calls for the minimisation of public intervention in the economy on the grounds of its alleged inefficiency.

Finally, 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 the short period), specific inquiry needs to be made into the extent to which this limit may be due to the production technology of the public sector – which would rule out economies of scale – rather than to incapacity to reorganise production at the micro (Back-Office) level, or the macroeconomic level (in the composition and nature of the goods and services supplied).

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APPENDIX

Table A1. Cross-section estimates of productivity variance

Annual Variation

	2002		2003		2004		2005	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Smith	0.046	0.210	0.540	0.189	0.370	0.414	0.640	0.754
	(0.276)	*(0.330)*	*(0.315)*	*(0.282)*	*(0.124)***	*(0.201)*	*(0.175)***	*(0.234)***
Ricardo	0.572	0.355	0.102	0.327	0.078	0.036	-1.235	-1.312
	(0.396)	*(0.434)*	*(0.330)*	*(0.278)*	*(0.298)*	*(0.370)*	*(0.535)**	*(0.580)**
Investments	0.362	0.028	0.650	0.033	0.190	0.211	-0.248	-0.228
	*(0.102)***	*(0.151)*	*(0.186)***	*(0.158)*	*(0.113)*	*(0.108)*	*(0.177)*	*(0.203)*
eGovernment		6.867		13.461		-1.147		-1.663
		(3.599)		*(3.071)***		*(3.219)*		*(1.838)*
Obs	24	24	24	24	24	24	20	20
R-sq	0.52		0.75		0.80		0.28	

Biennial Variation

	2002		2003		2004		2005	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Smith	-0.510	-0.323	-1.081	-0.663	-0.209	-0.157	0.308	0.331
	(0.390)	*(0.358)*	*(0.347)***	*(0.405)*	*(0.242)*	*(0.223)*	*(0.071)***	*(0.064)***
Ricardo	1.100	1.104	0.902	0.740	0.946	0.814	-0.728	-0.750
	(0.531)	*(0.530)*	*(0.190)***	*(0.216)***	*(0.538)*	*(0.441)*	*(0.493)*	*(0.503)*
Investments	0.289	0.011	0.696	0.170	1.407	0.296	0.262	0.308
	(0.201)	*(0.221)*	*(0.257)**	*(0.233)*	*(0.289)***	*(0.222)*	*(0.181)*	*(0.213)*
eGovernment		6.469		13.831		21.034		-1.468
		(6.219)		*(6.693)*		*(4.646)***		*(2.742)*
Obs	22	22	24	24	24	24	20	20
R-sq	0.47		0.82		0.75		0.70	

Triennial Variation

	2002		2003		2004		2005	
	n.d.	n.d.	OLS	IV	OLS	IV	OLS	IV
Smith			-0.375	0.015	-0.826	-0.454	-0.080	0.188
			(0.483)	*(0.439)*	*(0.414)*	*(0.351)*	*(0.336)*	*(0.337)*
Ricardo			1.318	1.168	1.610	1.415	1.038	0.704
			*(0.304)***	*(0.318)***	*(0.325)***	*(0.290)***	*(0.540)*	*(0.508)*
Investments			0.915	-0.073	1.073	0.310	1.450	0.349
			*(0.349)**	*(0.285)*	*(0.357)***	*(0.281)*	*(0.403)***	*(0.298)*
eGovernment				19.194		18.778		21.291
				*(7.329)**		*(5.088)***		*(6.527)***
Obs			17	17	22	22	20	20
R-sq			0.82		0.89		0.81	

Note: Standard errors robust to heteroskedacity in brackets. ** significance 5%; ** significance 1%*

Table A2. Simple correlations: e-Government, public investments, productivity of the public sector, instruments adopted

	Hardware Share	Software Share	Services Share	Communic. Share	Public Share
E-Government Expenditure	-20,89%	57,89%	69,27%	-56,98%	78%
Investments	-18,38%	-4,64%	-11,54%	13,83%	12,12%
Productivity annual var.	2,84%	9,32%	0,57%	-3,65%	-3,25%
Productivity biennial var.	-10,34%	-12,69%	-0,55%	-0,23%	-4,55%
Productivity triennial var.	-23,54%	10,44%	-6,03%	7,66%	-9,7%
Productivity quadrennial var.	-22,62%	2,42%	-15,51%	16,01%	-20,72%

Table A3. e-Government expenditure estimates 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	0.0004	-0.0018	-0.005	-0.0034
	(0.0036)	*(0.0018)*	*(0.0021)*	*(0.0027)*
Ricardo	0.0007	5.59e-06	0.0011	0.0004
	(0.0042)	*(0.0017)*	*(0.0021)*	*(0.0023)*
Investments	-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 heteroskedacity and self-correlation in brackets. The estimate includes annual dummies as control variables.