

The role of ICT, skills and organizational change in public sector performance

di Paolo Seri e Antonello Zanfei*

Abstract

This paper accounts for recent developments in the literature on public sector innovation and offers some insights on the conceptual and empirical issues that are raised to evaluate the complementarity between ICT adoption and performance in the case of public administrations. From this perspective, three separate sets of conceptual and empirical issues need be tackled. First, one has to address the analytical problem of measuring performance in the case of public sector. Second, one needs to evaluate the specific role of ICT in modernizing the public sector. Third, the interactions between ICT, organizational change and skills should be examined more explicitly to assess their joint impact on public sector performance.

JEL classification: O14 O33 O38 L32.

Keywords: Public Sector Innovation, ICTs, Organizational Change, Skills.

Il ruolo di ICT, skill e cambiamento organizzativo nelle performance del settore pubblico

Sommario

Questo lavoro illustra gli sviluppi recenti nella letteratura sull'innovazione nel settore pubblico e si sofferma su alcune questioni chiave sul piano concettuale e empirico che riguardano la complementarità fra adozione delle ICT e le performance delle Amministrazioni Pubbliche. Tre sono gli aspetti chiave esaminati. Innanzitutto, vanno affrontati i problemi riguardanti la misurazione delle performance del settore pubblico. In secondo luogo, occorre valutare il ruolo specifico che svolgono ICT nella modernizzazione del settore pubblico. In terzo luogo, vanno esaminate più esplicitamente le interazioni fra ICT, cambiamento organizzativo e competenze, al fine di valutarne l'impatto congiunto sulle performance delle Amministrazioni Pubbliche.

Classificazione JEL: O14 O33 O38 L32.

Parole chiave: Innovazione settore pubblico, ICTs, cambiamento organizzativo, competenze.

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Introduction

An extensive empirical literature over the past decades has shown that the adoption of ICTs can affect economic performance only if it is combined with improvements in organizational practices and in labor skills. In the absence of such a combination of complementary factors one can observe an insignificant, or even negative, impact of ICT diffusion on the firm or sector competitiveness and productivity, giving rise to the well known Solow Paradox (Brynjolfsson et alii, 1997; Bocquet et al 2007; Caroli, 2001; Jorenson et al. 2005; Bartel et al.2007, Pencarelli et al. 2015).

Such investigations, however, remain largely confined to private sectors. While important insights can be drawn from this relatively wide range of studies, to the best of our knowledge there is very limited systematic evidence on the complementarity story in the case of Public Administrations (PAs thereafter).

The lack of research on the links between ICT, organizational change, skill structure, and performance of the public sector is due inter alia to the conceptual and analytical problems encountered when estimating output for non-market sectors. Moreover, proper proxies of skill composition and organizational change are even harder to obtain for PAs than for private sectors. The result is that scant attention has been devoted to the investigation of the ICT effects on PA productivity, and to the accompanying changes taking place among the organizational structures and skills composition of PA.

Recent research has indeed highlighted different aspects of the complementarity puzzle in the case of PAs. This effort is reflected in the more comprehensive measures of public sector performance that account for the quality of inputs or innovativeness of outputs. Moreover there is a growing number of qualitative and quantitative analyses of the complexities of ICT adoption in the public organizations. Going deeper along this line has also led to explicitly evaluate the co-evolution of ICTs, skills and organization and their effect on public sector productivity, thus helping explore the specificities of the Solow paradox in the case of PAs (Seri and Zanfei 2013).

This paper accounts for such developments and offers some insights on the conceptual and empirical issues that are raised when moving in this direction of research.

To examine the role of ICT, skills and organizational change in public sector performance, three separate sets of conceptual and empirical issues need be tackled. First, one has to address the serious analytical problem of measuring performance in the case of public sector. Second, one needs to

evaluate the specific role of ICT in modernizing the public sector. Third, the interactions between ICT, organizational change and skills should be examined more explicitly to assess their joint impact on public sector performance.

1. The measurement of public sector performance

The analysis of performance in service sectors has traditionally posed a number of conceptual and methodological problems (Griliches 1984). In the case of public sector the issue of efficiency has increased in importance in a context of increasing budget constraints, which have become even tighter in the aftermath of the world financial crisis (Pini 2014). However, measuring public sector performance is a hard task to tackle. One may mention at least three specific sets of largely unresolved difficulties (Baxter 2000, Oecd 1999, Djellal and Gallouj 2008). First, public services are commonly provided free of charge or at modest prices that do not cover the costs of production. Hence, price and tariffs, when they exist, are not reliable measures of the unit value of output. Second, assessing public sector output in terms of quantities is a hard job as standard units of analysis and measures are seldom available. Indeed, one can hardly single out universally recognised tasks to be accomplished for each individual public function, associate volume measures to each individual task, and aggregate them into consistent sets of data to allow comparative analyses across countries. Third, even in the presence of comparable measures of output quantities (or values, when prices are available), evaluating quality is even harder. In fact the perceived quality of public sector output depends on social and economic objectives which differ across countries and depend on the actors being considered, whether they are providers or users of public services. Significant differences also exist across actors along the supply chain (e.g. the ministry of health vs. the director of a hospital vs. individual doctors) and across user categories (e.g. tax payers indirectly taking advantage from externalities created by a hospital, vs. patients directly using health services). The quality of output is thus undetermined unless one adopts the viewpoint of a specific set of actors.

A survey of extant literature (Worldbank, 2011; Jorgenson, 2010; Simpson 2009; Dean, 2009; Murray, 2010; Djellal and Gallouj, 2008, EC2013) makes it possible to distinguish between the following families of empirical strategies to tackle the above mentioned sets of problems:

Use of inputs as a proxy of output

One way of dealing with the difficulties of measuring output quantities and values is to rely on inputs, which can be more easily quantified and priced. In most international comparisons input data are used as a proxy for output of non market services. This procedure has long been used in many publications, including Dean (2009) and World Bank (2011). A major limitation is that this method implicitly assumes that PAs are equally productive in utilizing inputs. In line with this criticism, Dean (2009) maintains that “the use of input ratios to compute output ratios, with no adjustment for productivity differences and no other adjustment, is incorrect. It is surely time to end this procedure, for which no defensible rationale can be presented”.

A more acceptable variant of this method would then be to consider input costs and correct them for some proxy of differences in efficiency of PAs. Some scholars propose to use labor productivity data as calculated for market sectors —where labor productivity is measured as output per employee— to estimate outputs in non market sectors (see e.g. Dean, 2009 and Simpson 2006). More direct proxies of PA efficiency would be desirable but are often difficult to find. One procedure that has been followed (see e.g. Linna et alii, 2010) is to adjust input costs for some measure of quality of service activities, which would allow to better differentiate public sectors in terms of their actual performance.

Measuring output in terms of service activities

Indicators of public sector output have been introduced by several countries into their national accounting systems. However the shift to substitute input based measures with output indicators is a relatively recent one, with the partial exception of the UK which has started producing activity based statistics for public services in the mid 1980’s (Ashaye 2001). As mentioned earlier, the generalized introduction of output indicators and their use for comparative analyses across countries would require an effort to standardize units of analysis and measurement procedures (OECD 1999, Pritchard 2003, Handler et al. 2005). This effort is complicated by the heterogeneity of activities composing a given public service both within and across countries, and by the absence of reliable price indexes to assign a value to such activities¹. The fact that comparable data are not always

¹ An agreement needs to be found on: which service activities should be covered (e.g. no universally accepted standards exist in terms of tasks to be performed by government servants); which volume-based measures should be used (e.g. number of hospital beds provided, number of pupils per school class, number of documents processed); which weights should

available for a large set of public sector activities constitutes a serious hindrance to the use of this type of indicators. Even in case service activities can be considered relatively good proxies of public sector output as a whole, one may question whether and to what extent such indicators actually capture the performance of PAs. Indeed, the interpretation of changes in output levels measured in terms of service activities will depend on the (technological and/or organizational) context in which such changes occur. For instance, shorter hospital stays could be considered as a reduction of output, but this could be result of improved organization and hence reveal an improvement of performance. This would also be the case of the introduction of ICTs leading to a lower number of paper-documents processed by a public administration: this reduction of output should be interpreted as a sign of better performance as well. While measuring output and performances is per se a hard job to accomplish in the case of public services, the fact that indicators of increasing (decreasing) output may be interpreted as worsening (improving) performance adds further complexity to the analysis of public sector activities.

Capturing the quality of public sector activities

This is a hard exercise in general, and it is even harder in the absence of market prices as proxies of quality. Eurostat (2001) has identified three methods of taking quality into account in the case of non market services. The first such method is based on ad hoc measures of the quality of output produced by means of surveys on how effective services are perceived to be by either users, providers or inspecting/regulatory institutions. A major limitation is that data collected from these surveys often reflect a specific point of view (the one of the evaluator), and are more effective at assessing the quality of the production process than the quality of output (see e.g. the Atkinson Review 2011 of the UK Office for National Statistic).

A second method to approximate the quality of output consists in measuring the quality of inputs. From this perspective, workers' qualification and wages are taken as measures of output quality. Much like the first family of approaches recalled earlier (using inputs as a proxy of output), this method is based on the heroic hypothesis that all changes in input quality will translate into output quality.

The third method addresses the issue of quality by investigating outcomes, i.e. by assessing the ultimate results of public sector activities. Of

be adopted to aggregate different volume based activities (e.g. costs of individual cases treated).

course the closer indicators get to the outcome end, the more controls are necessary for additional factors, other than public sector characteristics or decisions, that may affect them. To illustrate, the number of students graduating from university in a given year might be considered as a good outcome indicator, but this will depend inter alia on the quality of students which is not only affected by teaching activities (e.g. the income level of their families will also play a role).

An important variant of this line of empirical research is to consider measures of innovation to account for the quality of public sector output. Arundel and Huber (2013) identified 17 studies using large scale datasets to evaluate public sector innovation in developed economies distinguishing between using three methodological approaches: 1) An object based method examining specific innovations (the object), 2) Business practice surveys asking public sector managers about their use of specific innovative business practices and technologies, and 3) Innovation surveys asking about a range of innovation activities and types of innovations implemented over a defined time period. Over time, the focus has shifted from the first two approaches to the use of innovation collecting data on a wider range of data than object-based and business practice surveys with a greater interest in external information sources, incentives, sources of innovative ideas, and outcomes (see EC 2013 for a recent survey on these methods).

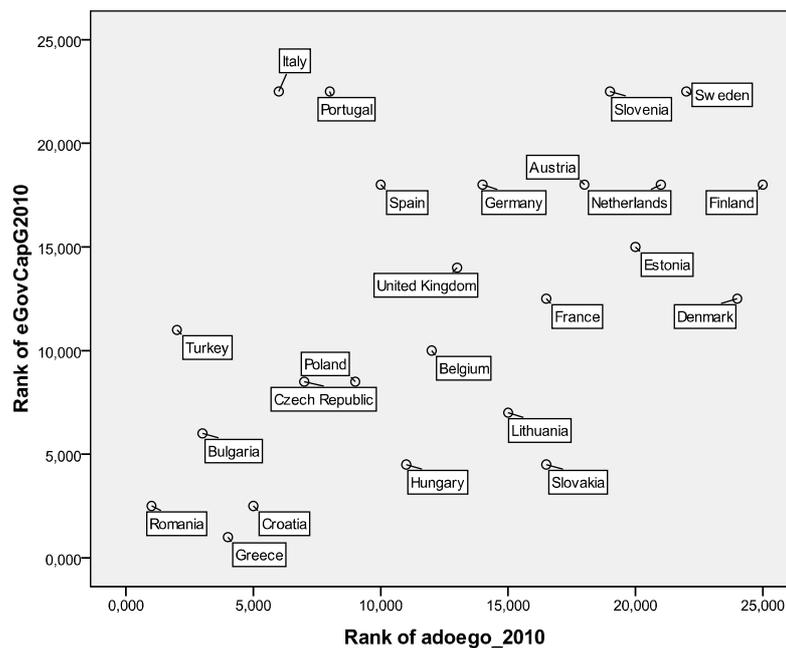
Apart from a general criticism on the use of input based estimation in the absence of some control for PA efficiency, at present there is no clear agreement on the methodology one should follow to carry out empirical studies on public service performance. To carry out analyses of output and productivity in the public sector across a relatively large number of countries, we are forced to exclude the second (activity based) approach. As observed, only a few countries have been producing activity based statistics covering an extensive set of services and using comparable classification criteria.

2. The complexities of ICT adoption in public sector

The second set of analytical issues to be dealt with when analyzing determinants of public sector performance has to do with the role of ICT in the case of PAs. ICT has long been considered as a trigger of modernization in public administrations (Van de Donk and Stellen, 1998). From this perspective, information and communication technologies can be expected to: i) facilitate adoption of modern techniques and methods in public manage-

ment; ii) contribute to enhancing accountability, openness, and transparency; iii) promote government–citizen interactions. Indeed, Van Reenen et al. (2010) show that public institutions are among the largest adopters of ICT, with an average of 1.32 computers per employees in 2005-2008, as opposed to 0.64 in manufacturing and 1.18 in business services (differences are significant at the 1% level).

Fig. 1 - eGovernment use vs. availability, ranking 2010



Source: our elaboration on Eurostat data.

Within the public sector, the most ICT intensive sectors are by far Education (SIC 82) and National Security (SIC 92), while the least ICT intensive are Health services (SIC 80). These broad averages hide considerable variation across European regions and countries, with the highest overall intensity in Northern Europe (1,75 computers per employees in the public sector) and the lowest in Eastern and in Southern Europe as expected (1.00 and 1.01 respectively). At the country level, the ICT intensity of the Education sector ranges from a minimum of 0.60 computers per employee in Poland and Slovenia, to a maximum of 7 computers per employee in Austria (Van Reenen et al. 2010). In a similar vein, Ebbers and Dijk (2007) and

Seri, Bianchi and Matteucci (2014) illustrate an extreme variety of patterns of e-government development and Cepparulo et al (2013) observe an extremely high heterogeneity in the diffusion of several categories of public e-services.

While the digitalization of PAs and the subsequent availability of public e-services is generally making strong progress, the actual use of the latter lags behind in many countries. Figure 1 orders the relative scores of European countries based on Eurostat data on eService availability and adoption.

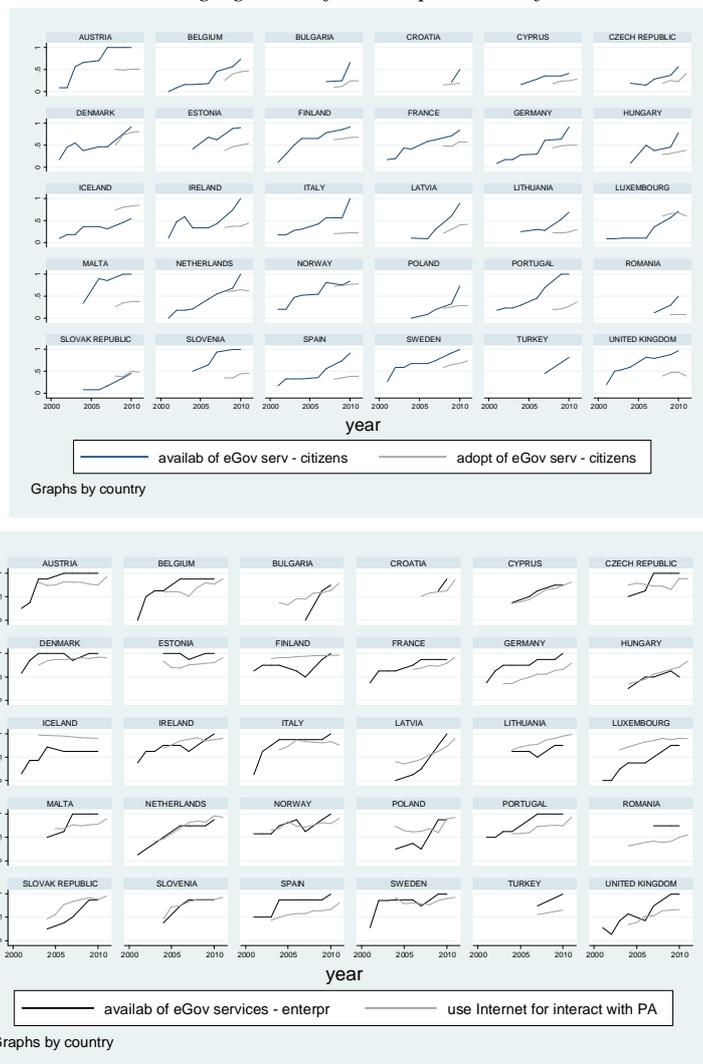
The case of countries positioned in the high-left area in this chart reflects a general rule that applies *inter alia* to the diffusion of eGovernment in Europe: “You can lead a horse to water, but you can't make it drink”. In other words, PAs are most likely to have devoted more resources to ‘opening up the e-shop’, than to organisation design, skill development, back office support, digital literacy, interface friendliness, and consideration of user needs.

The two sets of charts below (fig. 2) show the more specific indicator of availability and use of e-government services for citizens and enterprises (Eurostat 2003-2012). A gradual convergence of the two lines indicates the global effectiveness of delivered e-services, while strong separation of the two lines can be interpreted as a lack of effectiveness, thus revealing that the Solow paradox is in action in the case of PAs. In some circumstances, abrupt separation of the two lines can also indicate a measuring problem (the level of availability might be overstated by governments for the sake of “marketing” reasons).

Italy exhibits a strong bifurcation between the formal availability and the actual use by firms and citizens of public e-services. This emerges also from more detailed data produced by Istat (2013)², which carried out two surveys in 2009 and 2012 on ICT equipment and use in Italian local PAs. Comparing data between surveys highlights that Italian PAs have significantly increased the introduction of most ICT devices, but the presence of internal bodies and staff specialized in ICT is still very limited and low (and decreasing) resources are devoted to ICT training of personnel. Twenty per cent of local PAs have organized training courses in 2012, and only 6.3% of employees have received training in this field over the past year (it was 7.7% in 2009).

² <http://www.istat.it/en/archive/91815>.

Fig. 2 - EGov indexes diverging trends for enterprises and for citizens



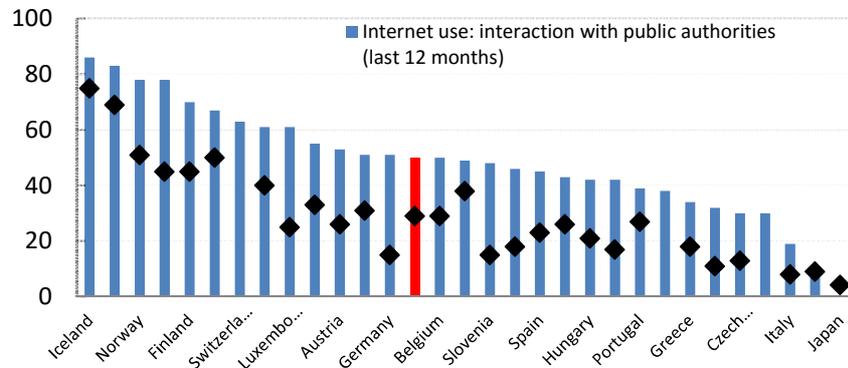
Source: our elaboration on Eurostat data.

Remarkable differences exist between institutions according to their size. Most Regions and Autonomous Provinces (21 out of 22) and 80 out of 100 Municipalities with more than 60,000 inhabitants have this office compared to 6 per cent of Municipalities with no more than 5.000 inhabitants. For some activities such as the management of accounts, payments, tributes and, only for Municipalities, Registry of marital status and Population Reg-

istry, a good level of digitalization and integration between different software applications is reached. Other activities, such as the management of contracts and tenders still poorly networked. The “basic” technological equipment are used by almost all local administrations but the adoption of more sophisticated technologies such as mobile ones is once again limited to large PAs: 70 out of 100 largest Municipalities and only 8 out of 100 smallest ones use mobile devices (tablets, smartphones, netbooks, etc..). Almost all local PAs offer web-services to the users, but the possibility of submitting forms on-line is circumscribed to 36% of PAs, and completing the whole administrative process electronically is limited to 19%, even less in the case of on-line payment procedures.

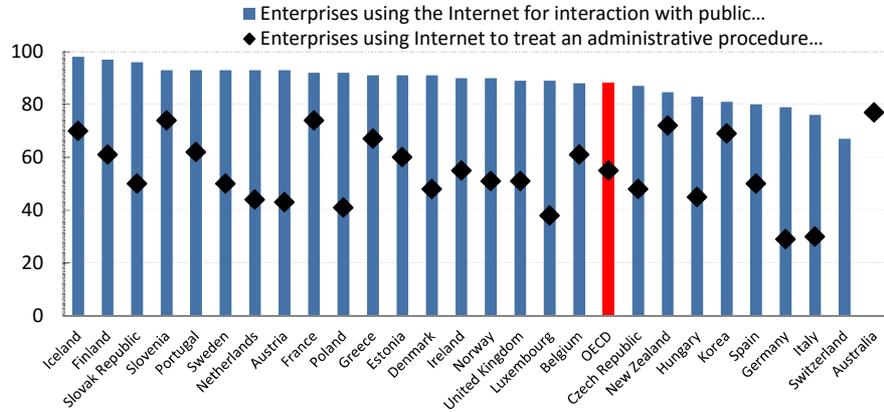
This scenario is consistent with the evidence offered in Figures 3 and 4. Here Italy, notwithstanding its high performance in e-services availability, ranks very low in the effective use of e-services by citizens and firms. More generally speaking, these figures confirm that a significant gap exists between availability and actual adoption of public eServices, especially when usage by citizens is considered, with numerous countries exhibiting percentages well below the OECD average.

Fig. 3 - Citizens using the Internet to interact with public authorities by type of activity (2012)



Source: Eurostat Information Society Statistics (database).

Fig. 4 - Firms using the Internet to interact with public authorities by type of activity (2011)



Source: Eurostat Information Society Statistics (database).

When it comes to examining how effective the introduction of ICT is in public organizations, the scenario is quite blurred. Sorrentino (2004), examines 138 co-financing proposals put forward by numerous Italian public bodies within the context of a national e-government plan, and concludes that these types of initiatives are not really likely to improve organizational performance. Shaun Goldfinch (2007) shows that the majority of information systems developments in public administrations are unsuccessful. This is especially the case of large ICT investment projects which have a higher complexity and are often harder to manage. He argues that, despite the persistence of this problem for decades and the expenditure of considerable amounts of money, computer failure has received surprisingly little attention in the public administration literature. The portrait of public officers that emerges from Goldfinch's analysis is that of a recalcitrant, suspicious, and skeptical adopter of information technologies who is most likely to act as a barrier to, rather than a promoter of, innovation in PAs.

Consistently with the abundant empirical literature on ICT adoption in business sectors, it is often held that, also in the case of the public sector, the successful exploitation of these technologies requires the presence of a wide range of skills and organizational practices. Dunleavy et al. (2006) highlight four main challenges which might hinder the efficiency impact of ICT in the public sector. First, due to their sheer size and complexity combined with exposure to political pressure, public administrations generally exhibit what has been dubbed *organizational inflexibility*. This consists in a greater resistance to absorb labour saving technology and in a generalized

tendency of public institutions to overcome barriers to the introduction of ICT by means of large scale investment programs rather than piecemeal, cumulative changes (the "big-bang cycle" approach). Second, growing pressures on governments to increase their market orientation as to achieve greater cost-efficiency, have induced PAs in many countries to outsource a large fraction of ICT activities. This has determined an additional layer of *technical inflexibility* to the already rigid organisational features we have just recalled. Third, while the development of digital network services and defence related technologies allowed the public sector to attract large numbers of highly skilled ICT specialists in the 1960s and 70s, private firms and ICT system companies have thereafter gradually overtaken governments in terms of ICT and digital technology innovation. This has significantly reduced the attractiveness of public sector for qualified workers and caused an endemic *lack of skilled ICT specialists*, further increasing the costs of adapting new systems to the specific characteristics of public organisations. Fourth, the shortage of in-house specialized ICT and the increasing outsourcing trends mentioned above are often coupled with a *lack of competition in the ICT supply for public organisations*. This is likely to generate distortions in the quality or quantity of ICT supplied to the government hence reducing the effectiveness of ICT within the public sector.

3. How the interactions between ICT, skills and organization affect public sector performance

The empirical relevance of these constraints to the exploitation of ICT in the public sector can hardly be evaluated with robust statistical methods due to scarcity of data on output, organizational practices and skill composition in the public sector (Van Reenen et al.2010). A few works have been able to overcome these constraints and provide a convincing analysis of the role played by ICT, although this has been done mainly with reference to specific public sector activities, and most often focusing on individual countries.

Machin et al. (2007) examine whether the adoption of computers in UK schools over the 1999-2003 period have increased students' educational outcomes. In sharp contrast with most previous studies across US and European schools, Manchin et al. (2007) find a strong relationship between ICT investments and educational performance in primary schools, especially in the teaching of English and science (not of mathematics). To over-

come endogeneity problems they use a quasi-experimental setting and observe students' performance before and after a major change in the rules about how ICT funds were allocated to different Local Educational Authorities (LEAs). Unfortunately, since this paper is based on area-level variation, the authors are not able to provide any direct insight on the key characteristics of the schools which were most affected by ICT adoption, or whether significant school organisational or skills complementarities may have impacted the ultimate effect of ICT on performance. Nevertheless, they find more indirect evidence of the impact of skill levels within schools, as they observe that LEAs benefiting the most from the policy change were those with lower overall expenditure per pupil, but better educational standards (as measured by exam pass rates and truancy rates). It thus appears to be the joint effect of large increases in ICT funding and a fertile background for making an efficient use of it, that led to positive effects of ICT expenditure on educational performance.

Garicano and Heaton (2010) examine the relationship between ICT, organizational change and productivity across some 8,600 US police departments using a panel data set that covers the 1987–2003 period. They find that when considered alone, increases in ICT are not associated with reductions in crime rates, increases in clearance rates, or other productivity measures. These results persist across various samples, specifications, and ICT tools (PCs, mobile data terminals, mainframes and servers). ICT investments are, however, linked to improved productivity when they are complemented with particular organizational and management practices.

They first show that ICT adoption is associated with a variety of organizational changes within a department, including an expansion of personnel (primarily in technical support roles as opposed to field operations), an increased use of special units, and enhanced training and educational requirements. Thus, departments that expanded ICT use have also modernized their own activities in other important ways. They next identify agencies that simultaneously implemented high levels of ICT, specialization, and education. In panel regressions that control for underlying organizational and ICT measures, they illustrate that agencies implementing this combined set of practices experienced statistically significant drops in crime rates. To further test the complementarity hypothesis, they also study the impact of ICT when it is adopted together with management techniques characteristic of Compstat, including skilled officers, new problem-solving techniques, extensive use of "output" information in evaluation and deployment of officers, and a geographic-based structure. Although the data available for testing this hypothesis are much shorter and more limited,

they clearly endorse this hypothesis. Overall results are also confirmed by a number of robustness checks.

A few papers carry out in-depth cross-country studies on how the diffusion of digital network technology affects performances of public organizations. Caldas et al. (2005) provide perhaps one of the most extensive analyses of the effects of ICT on general government activities in 8 European countries, capturing the interplay of technology adoption, organizational change and performances of PAs. The authors exploit a large and very detailed dataset based on a survey of more than a thousand public sector organizations, which was conducted in 2003. First, they find that while larger PAs have easier access to budgetary and technical resources, thus favoring digital network technology adoption, size per se may not explain their performance. Caldas et al. (2005) identify clusters of public organizations with different characteristics in terms of territorial distribution and hierarchical positions in the decision making processes which are associated to different technological profiles, largely independent of size. Second, they analyze a sub-sample of public organizations and compute a measure of performance that combines the relationship between their adoption and mode of utilization of e-network technologies, on the one hand, and, on the other hand, the rates of improvement that their managers perceived had occurred in the average number of cases resolved per employee. They obtain approximate estimates of the implied rate of growth in the sector-wide average number of “cases resolved per employee” during the period 2003-2008.

While Caldas, David and Ormanidhi develop an extremely rich and promising line of research, they can shed only a limited light on the complementarity issue in the case of PAs. In fact, they provide very detailed data and analyses on how technology adoption interacts with PAs’ ability to “resolve cases”. In order to do so, however, they are forced to focus on a subsample of organizations that do perceive a change of performances, thus reducing the possibility of generalizing their results.

Other cross-national analyses address the links between ICT and public sector performance with reference to specific areas of service activity. A number of such studies focus on education, due to the availability of extensive surveys carried out for OECD countries within the Programme for International Student Assessment (PISA) administered since year 2000 (Oecd 2009). Nevertheless, in most cases experimental and quasi-experimental analyses are not feasible and instrumental variables are not available, due to data limitations, so that analyzing correlation relationships is often the only feasible strategy. This is the case of Fuchs and Wößmann (2005), Notten &

Kraaykamp (2009), and Luu & Freeman (2011) who find a positive and significant correlation between the availability of computers at school and students' performance in PISA tests, although the estimated correlation is reduced when additional variables are brought into the regression as controls. In a study that uses the 2006 PISA ICT familiarity questionnaire, Spiezia (2010) tries to go beyond a simple correlation analysis and, controlling for the potential endogeneity of treatment, finds that a greater frequency of computer use is positively associated with higher PISA test scores in science in all countries (with large cross-country differences in the estimated coefficients). He also offers indirect evidence on the role of skills and organizational factors by controlling for where computers are used (home vs school). In fact according to computer location, one might infer both how ICT based training is organized (dispersion vs. concentration of educational services) and how skilled users are (as home usage implies a higher acquaintance than usage at school only). Spiezia (2010) shows that the positive relationship between intensity of use and the PISA science test score is much stronger for those who use computers intensively at home than for those who use them intensively at school (the association between test scores and intensity of computer use at school is not significant for many countries). While these results point at the low efficacy of ICT policies directed solely at schools, one may also suggest that they provide insights on the importance of organizational innovation and skill accumulation as a complement to ICT investment.

Biagi and Loi (2013) exploit the possibility offered by the 2009 wave of PISA to evaluate students' performances not only as a function of computer usage but also as a function of the breadth of learning activities. After having categorised computer use into a set of different activities according to the skills they involve, the authors correlate students' PISA test-scores with an index capturing the intensity of use for each of these activities and with the total number of learning activities they perform. Overall, Biagi and Loi find that students' PISA test scores in reading, mathematics and science increase with the intensity of computer use for Gaming activities while they decrease with the intensity of computer use for activities that are more related with school curricula (i.e. Communication and Collaboration activities; Technical Operations/Info Retrieval activities; Creation of Content and Knowledge Problem Solving activities). However, the number of learning activities (and hence the diversification of these activities), irrespective of the intensity of computer use, is positively correlated with students' proficiency in all three PISA domains in the vast majority of the 23 countries examined. This is consistent with a framework in which the different activi-

ties are complementary in building competences that are relevant for the PISA tests. It remains that Biagi and Loi's analysis cannot be considered as a proper impact assessment based on counterfactual evaluation, as the PISA test scores obtained by students using ICT cannot be compared with test scores obtained by students of an appropriate control group. Indeed, finding such a control group is almost impossible, especially in countries (such as Nordic countries) where most students declare having access to and using computers both at home and at school.

To summarise, some of the studies we have reviewed do provide rich evidence on the complementarity between ICT, skills and organizational change. However, the more analyses are extensive in terms of public services and country coverage, the less conclusive is the extant evidence of the actual impact of ICT on public sector performance.

4. Beyond traditional approaches to ICT and performance in public sector

An attempt to overcome these limitations has been carried out by Seri and Zanfei (2013). Different from the extensive stream of research on individual sub-sectors of PAs, they conduct a cross-country analysis on the aggregate of PAs (net of Defense). Moreover, they integrate different data-sources that allow to evaluate patterns and determinants of performance for all public sector organizations in the examined countries, and not only the ones that innovate in their practices (different from Caldas et al. 2005). Seri and Zanfei (2013) propose an index-based approach to the measurement of PA performance relying on the adoption of public e-services as a proxy of revealed output quality, and provide an econometric analysis of how the co-evolution of ICT, skills and organizational factors affects Government effectiveness. This implies correcting the traditional approach of measuring output in terms of inputs (first family of empirical strategies illustrated in section 2) by taking into account differences of effectiveness of PAs (consistent with the third family of empirical strategies). More precisely, their *quality adjusted index of output* combines two country level indicators: (a) per-capita PA expenditures net of Defense (PA_SPENDING)³; (b) a meas-

³ EU-KLEMS (<http://www.euklems.net/>) provides data on Gross Output measured in terms of input costs at current prices (in millions of Euros) by country from 1970 to 2007 for all sectors. Data supplied under the label: "PUBLIC ADMIN AND DEFENCE; COMPUL-

ure of e-service adoption. The second set of data (b), which they use to qualify input costs, is a combination of four indicators of actual utilization (by citizens and enterprises) of public e-services by country, as supplied by Eurostat (eSERV_ADOPTION)⁴. The authors consider this proxy of *public e-service adoption* as an indicator of public service quality. On the one hand, it denotes the ability of PAs to introduce new services that are per se innovative. In fact, the deployment of public e-services requires: a non trivial effort to adapt existing services, and design new ones, in order to deliver them though the Web; an overall restructuring of both back-office and front-office activities; and a fundamental change in the approach to customers/users (Serrano Cinca et al. 2003, Arduini et al. 2010). On the other hand, adoption indicators reveal that the introduction of these relatively new services has survived a selection which is not only based on their cost-effectiveness but also on the satisfaction of user needs. In other words, the transformation of existing services into web based government activities will be associated with a sunk cost that users will have to bear in case of adoption. It is assumed that, especially in a pre-paradigmatic phase of e-services development, users will only adopt “high quality” services, i.e. services that are really worth bearing this extra cost.

The *quality adjusted output index* PA_ADJ_OUTPUT, is thus obtained as PA_SPENDING * eSERV_ADOPTION. As such, it reflects the amount

SORY SOCIAL SECURITY” include all public sector activities except health and education. The SIPRI Military Expenditure Database (<http://www.sipri.org/databases>) provides data on Defense sector costs expressed both in terms of US \$ values at constant and current prices and as a percentage of gross domestic product. To check the consistency of the SIPRI dataset with EU-KLEMS, Seri and Zanfei (2013) computed an additional proxy of defense expenditures by calculating the percentage provided by SIPRI on EU-KLEMS Output values. They were thus able to compute two measures of PA expenditure net of Defense, by alternatively subtracting the one of two measures of Defense expenditures from EU-KLEMS Gross Output values for public sector. They ran the same regressions illustrated in section 4 using either measure of PA spending net of defense as a basis to calculate the dependent variable and obtained similar results, which are available from the authors upon request.

⁴Data are drawn from http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database. See the folder “Computers and the Internet in households and enterprises” in “Information society statistics”. One of the four indicators refers to individuals using the internet to interact with PAs; and three other indicators capture different aspects of enterprise usage of the internet to obtain information or interact with PAs. The measure used by Seri and Zanfei (2013) is a weighted means of the four indicators, calculated with alternative weights to check the robustness of empirical relations tested.

of input costs sustained by Public Administrations (in terms of capital services, labour services and intermediate inputs, either purchased from domestic industries or imported), but will turn out to be higher the greater the level of public e-service adoption. PA_ADJ_OUPUT is used as dependent variable in the econometric exercises.

Due to crossed missing values between the sources utilized to construct the two sets of measures – (a) PA expenditures net of defense and (b) public e-service adoption – the analysis needs be restricted to 16 European countries (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Netherland, Portugal, Slovenia, Spain, Sweden, United Kingdom) for which a full panel of consistent data are available over the 2003-2007 period.

Tab. 1 - List of e-services considered by the EU e-government benchmark

Citizens	1 Income taxes
	2 Job search services
	3 Social security benefits
	3,1 Unemployment benefits
	3,2 Child allowances
	3,3 Medical costs
	3,4 Student grants
	4 Personal documents
	4,1 Passports
	4,2 Drivers licence
	5 Car registration
	6 Application for building permission
7 Declaration to the police	
8 Public libraries	
9 Birth and marriage certificates	
10 Enrolment in higher education	
11 Announcement of moving	
12 Health-related services	
Businesses	13 Social contribution for employees
	14 Corporate tax
	15 VAT
	16 Registration of a new company
	17 Submission of data to statistical offices
	18 Customs declarations
	19 Environment-related permits
	20 Public procurement

20 eServices for

Source: CapGemini et al 2010.

In order to examine the complementarity issue in the case of public sector in Europe data on ICT investments, human capital and organizational change were also collected.

Data on ICT investment (PA_ICT) and on skill levels of employees (PA_SKILL) are drawn from the EU-KLEMS dataset. While information on the first two sets of variables can be derived under reasonable assumptions from EU-KLEMS's data (see Seri and Zanfei, 2013 on this), measuring organizational change is by far the most complex task to accomplish. In fact, public sector activities involve a variety of organizational levels – within individual PAs, across PAs and between PAs and users of services – all of which interact with human capital accumulation and ICT investments. Since direct (and homogeneous) measures of all of these organizational dimensions in non market sectors do not exist at the country level, the authors use an indirect measure based on the availability and sophistication of e-services.

Their measure of organizational change (PA_ORG) is obtained as the weighted average of Public e-service Online Availability Index computed by Capgemini et al. (2010) for the European Commission, where weights are represented by the degree of sophistication of services provided according to a 5-stage maturity model (see Capgemini et al. 2010). See Table 1 for the complete list of e-services monitored by Capgemini et al. (2010). The idea is that, much more than the provision of standard services, the introduction of web-based services imply an overall change in the organizational structure of PAs; and organizational change required will be even deeper the higher the level of “sophistication” (i.e. the degree of interactivity) of such e-services. As suggested in the recent UN “e-Government Survey 2012” :

“Small-scale ICT activity – development of a website as an additional information channel – may not require complex supporting changes. Far reaching organizational change will be required when:

- 1) *The website begins to offer deeper, more complex services.*
- 2) *Agencies are asked to work together to deliver services according to the needs of citizens and not their structure.*
- 3) *New work styles - tele-working, virtual teams - emerge.*
- 4) *With increased data-sharing and communication:*
 - _ particular data holdings become redundant*
 - _ more decisions are made at the lower organization levels*
 - _ special units are established for government-wide projects” (UN 2012)⁵.*

⁵ <http://unpan1.un.org/intradoc/groups/public/documents/un/unpan048065.pdf>

The introduction of e-services is generally associated to all four circumstances listed by the UN. By using PA_ORG as a proxy of organizational change, it is thus assumed that, once controlled for ICT investments and human capital composition, a higher provision of sophisticated e-services reveals that PAs will have undergone a profound change in its organizational structure and behavior.

Seri and Zanfei (2013) extensively discuss limitations of these assumptions on the role of both eService adoption and provision as indicators of service quality and organizational innovation respectively, and address different technical issues including complementarity tests, controls for endogeneity of variables used, robustness checks and tests on fixed vs. random effect models.

They regress their quality adjusted measure of PA output (PA_ADJ_OUTPUT) on their key explanatory variables (ICT investments, skill composition and our proxy of organizational change), and other controls (per capita GDP, infrastructural endowments and educational attainment of population).

Tab. 2 shows the results of regressions with one of the specifications of the dependent variable, i.e. the one wherein the output quality adjustment is calculated in terms of a simple means of the four indicators of eService adoption (see Seri and Zanfei, 2013, for other specifications and robustness checks). In column 1 we test how the three explanatory variables of our baseline model – investment in skilled personnel, organizational change and ICT spending – singularly taken, influence our PA quality adjusted output measures. It is shown that the proxies for human capital and for organizational change significantly affect our measures of output. Although the proxy of organizational change used is quite rough, adding a control on the delivery of sophisticated e-services for any given level of ICT expenditure and labor qualification (and other contextual factors such as per capita GDP and broadband penetration) should capture PAs' ability to introduce significant changes in its organizational structure and behavior. ICT expenditure *per se* does not significantly impact on PA performance. This is consistent with what has long been observed in the extensive literature on business sector (and in the scantier works on PAs reviewed in section 3), i.e. the effect of investment in these technologies can hardly be seen in productivity statistics also in the case of public sector.

Similar to what has been found in extant literature focusing on business sectors, one may also assume that ICT expenditure will eventually translate into PA output changes only in the presence of key complementary factors, such as organizational change and a qualified human capital. This hypothe-

sis is tested in columns 2, 3 and 4 of Table 2, where the following interactions are added respectively: the interacted term PA_SKILL* PA_ICT, which allows us to capture the impact of joint investment in ICT and human capital sustained by PAs in the observed countries; the interacted term PA_ORG * PA_ICT, which should highlight the impact of joint investment in ICT and organizational change; and the interactive effect generated by all of the three factors together: PA_SKILL* PA_ORG * PA_ICT (independent variables are centered on the mean as suggested in Jaccard and Turrisi, 2003).

Tab. 2 – The impact of ICT, skills and organizational change on PAs' performance

VARIABLES	(1) PA_ADJ_ OUTPUT	(2) PA_ADJ_ OUTPUT	(3) PA_ADJ_O UTPUT	(4) PA_ADJ _OUTPUT
PA_SKILL (L)	32.36*** (10.99)	32.70*** (10.85)	20.87** (9.112)	25.29** (10.15)
PA_ORG (O)	0.251** (0.124)	0.250** (0.122)	-0.995*** (0.278)	0.0294 (0.131)
PA_ICT (I)	-0.132 (0.421)	-0.281 (0.428)	-0.384 (0.341)	-0.0546 (0.380)
L*I		0.0895 (0.0625)		
I*O			0.0370*** (0.00771)	
L*I*O				0.00442*** (0.00139)
CONTROLS	Yes	Yes	Yes	Yes
TIME DUMMIES	Yes	Yes	Yes	Yes
Observations	64	64	64	64
R-squared	0.760	0.772	0.850	0.810
Adjusted R squared	0.612	0.622	0.752	0.685
Number of countries	16	16	16	16

Note: Standard errors in parentheses; *** p ≤ .01; ** p ≤ .05; * p ≤ .10.

Source: Elaborations on Seri and Zanfei (2013).

The results show that the last two interacted terms turn out positive, and add significance to the model, with respect to the factors taken singularly. This can be interpreted as a partial confirmation of the complementarity thesis. This procedure is broadly consistent with the one followed by Brynjolfsson et al. (1987) in the case of the impact of ICT on the performance of US manufacturing industry; and by Antonioli et al. (2010) who examine how the links between ICT, training activities, and organisational change – including the introduction of labour flexibility and changes in industrial re-

lations – affect the economic performance of small and medium sized manufacturing firms in Northern Italy. Using a terminology that mirrors the one adopted by Antonioli, et al. (2010), we can thus posit that interacting ICT with organizational and human capital variables “compensates” for the insignificant impact of ICT on our PA effectiveness indexes. More specifically, we show that while ICT does not *per se* have any effect on public sector performance, its combination with organizational change does (column 3). Furthermore joint investments in ICT, organizational change and skills appear to positively affect public sector performance as well (see column 4).

In other words, it is not ICT investment alone, but its combination with qualified labor and far reaching organizational change, that affects PA performance. It is worth noting that this appears to be the first explicit test of the complementarity issue in the case of PAs, across a large number of countries and with reference to a broad set of public sector activities.

What seems to be specific of Public Sectors with respect to the business sectors, as shown in the data, is the role of both labor qualification and organizational change, that have a strong and significant impact on performance also when considered in isolation from investments ICT. One may interpret the importance and significance of these variables as confirming that performance is heavily affected by the ability of Public Sector organizations to qualify their labor forces and effectively handle complex relationships within individual PAs, across PAs and between PAs and users.

Conclusion

Public sector activities in general appear to be significantly ICT intensive, and even more so than their private sector counterparts. However, there are relatively few studies analysing how ICT affects public sector performance with rigorous statistical methods. Some of them do provide rich evidence on the complementarity between ICT, skills and organizational change. The most comprehensive and robust analyses of these complementarities have been carried out with a narrow focus in terms of public sector establishments and activities (e.g. primary schools or police departments) and in terms of country coverage (normally individual countries). Due to data shortage, the more analyses are extensive in terms of public services and country coverage, the less conclusive is the extant evidence of the actual impact of ICT on public sector performance.

To overcome these analytical limitations we have introduced novel measures of public sector performance and regressed them on indicators of ICT adoption, organisational innovations and skill intensity of PAs. Our results suggest that PAs performance is largely driven by human capital and organizational change. This is likely to reflect the extreme complexity of information flows and decision making levels that characterize the provision and adoption of public services. The key implication is that the ability to improve the quality of labor force and handle organizational challenges is a distinctive factor affecting the performance of Public Administrations, over and above their investments in ICT. In a way, ICT might be seen as a factor that both stimulates investment in human capital and organizational change, and moderates their impact on PAs performance, as its introduction imposes new challenges and compelling requirements in the management of public sector activities.

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