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PUBLIC SECTOR E-INNOVATIONS. E-GOVERNMENT AND ITS IMPACT ON CORRUPTION

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**PUBLIC SECTOR E-INNOVATIONS.
E-GOVERNMENT AND ITS IMPACT ON CORRUPTION⁴**

The paper aims at assessing indicators and individual elements of e-government of selected countries in 2009-2010, and the interrelation of e-government with corruption in the public sector. The authors explore possible causal and dependency relations of the established interlink between e-government and public sector corruption.

Although it is universally acknowledged that corruption is an evil, there is much debate over which determinants of corruption are important. Using econometric analysis for sizeable country samples the authors verified the closeness of interrelation between e-government indicators and ICT Development Index indicators, such as online services quality and ICT usage, on one hand, and the level of perceived public sector corruption, on the other hand. The major research papers were analyzed, along with international rankings and databases of international organizations.

Based on the analysis recommendations for overcoming international e-government measurement constraints are put forward, as well as suggestions for future studies of the topic.

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Introduction

Corruption and its manifestations, such as administrative barriers, is a well-described barrier to advancing any innovations (OECD, 2010). Technological, process and organizational novelties introduced by government agencies, referred to as ‘innovations in the public sector’⁵, are at the same time a solution to curb corruption and a very specific type of sectoral innovations.

Innovations in public services are widely viewed as necessary for improvement in performance and meeting the challenges of the budget constraints which many countries faced as a result of the economic downturn of 2008-2009. E-government⁶ is one type of innovation in the public sector, which gained supporters among national governments and spread across economies at various stages of development. It is not only a way to make public services less expensive and more accessible, but is now viewed as underpinning innovation and change (OECD, 2009a: 24).

The rapid pace of technological development inspired the creation of increasingly advanced ICT solutions that are capable of radically transforming both public institutions and private organizations (Yigitcanlar, Baum, 2006). ICT offers tools for innovative interactions between a government and its citizens and smart ways to provide public services. Literature argues that e-government can bring the government closer to citizens, overcoming the hurdles of bureaucracy, curbing corruption and making decision-makers more responsive to people’s needs. The rationale behind its introduction, however, is most commonly that e-services are usually characterized by greater efficiency and transparency.

The global economic crisis became a challenge for e-government. The crisis has not only increased national budget deficits, but also deficits of sub-national governments: while tax revenues plummeted, demand for social welfare grew (among other factors, related to unemployment). The financial difficulties of sub-national administrations will most likely affect the regular ways of delivery of public goods and services⁷. Moreover, in countries with

⁵ The OECD defines innovation in the public sector as “new or significantly improved deliverables, ways of working or other initiatives that seek to improve or create new public sector activities”.

⁶ The World Bank definition of e-government “refers to the use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that have the ability to transform relations with citizens, businesses, and other arms of government”. The OECD also notes that the term “e-government” may be applied to the full range of government functions (OECD, 2002).

⁷ On average, 56% of public investment is done by sub-national governments of developed states, and about 16% of their expenditures are linked with welfare services and transfers. To tackle existing and possible difficulties, central governments have introduced new discretionary, transitory mechanisms to facilitate co-ordination. In the sphere of public services these include, for instance, simplifying procedures and regulatory measures. Many of

substantial regional autonomy these difficulties may hamper the stimulus plans introduced at the national level (OECD 2009b: 25). At the same time, the crisis challenge may turn out as an opportunity, creating a good stimulus for advancing e-government as a cheaper and more effective option for providing state services to people and businesses.

Almost all OECD countries report that e-government may serve as a contribution to the economic recovery in 2009-2010, whether or not they have decided to include it as a formal part of their crisis response and recovery packages. According to an OECD survey, many of its member states have chosen to seize this occasion to accelerate the speed of its implementation (Ubaldi, 2011). Similarly, in early 2010, the United Nations published a global survey on leveraging e-government at a time of financial and economic crisis. This went on to point to the importance of regulation and monitoring, restoring trust, moving from transparency to participation, data access and civil society, and improving international cooperation (United Nations, 2010).

Besides the economic crisis, a number of previously known risks are associated with the introduction of e-government, including information security issues (i.e. vulnerability to cyber attacks, which may lead to misuse of personal information); unwanted intrusion of governments into personal life of citizens; and the social exclusion caused by 'digital divide'. Both economically advanced and less advanced countries are prone to these risks.

This paper has the ambition to contribute to better understanding of the impact of specific public sector innovations (advancement of certain e-government aspects) upon greater, systemic changes (better control of corruption). The quantitative analysis below is made with sizeable country samples of 138 and 173 countries.

The scope and methodology

The study is aimed at assessing innovations in the public sector, which were introduced by selected countries by 2009-2010 in the sphere of e-government, and the interrelation of certain e-government aspects with control of corruption. We presume that supply (e-government infrastructure) and demand sides (use of e-services by citizens and business) of e-government have an impact on good governance and corruption.

Based on the study objectives, the following methodology was applied. First, major international ICT and e-government rankings were reviewed and analyzed to identify the data sources. Selected indicators of these rankings, listed below, were identified for further

these innovative instruments appeared through regional development policy arrangements, which serve to prioritize public investment in regions through co-funding arrangements

statistical and econometric analysis. The main data sources used in this study are single and composite indicators produced by the international governmental and non-governmental organizations that use them for international comparative studies in the sphere of ICT and e-governance. These sources have reasonably up-to-date information, and time series. Authors concentrated on the 3 groups of indicators:

- E-government supply side: UN E-government Readiness Index and its subindexes: Online Services Index and Telecommunications Infrastructure Index [United Nations, 2010], WEF Networked Readiness Index [Dutta, Mia, 2011];
- E-government infrastructure: UN Online Services Index, WEF Networked Readiness Index; ITU ICT Development Index [ITU, 2010];
- Governance and corruption indicators: Transparency International Corruption Perceptions Index [Transparency International, 2010], Freedom House Political Freedom Index [Freedom House, 2011];
- Other variables: GDP per capita in int. dollars⁸.

Second, to identify the link between ICT infrastructure and ICT use by citizens and business, on one hand, and perceived level of corruption, on the other hand, a correlation analysis was done for 138 countries and 4 aggregate indicators: the 3 subindexes of the WEF Networked Readiness Index [Dutta, Mia, 2011] and the Transparency International Corruption Perceptions Index [Transparency International, 2010].

Third, to establish the relationship between public sector corruption and e-government use, a regression analysis was made for Transparency International Corruption Perceptions Index (CPI) and United Nations' Index of Online Services (OSI) for the year 2010 for a sample of 173 countries. In order to refine the analysis we made some cross-section estimates of corruption levels as measured by the Transparency International CPI-index in 2010 on measures for the quality of e-government implementation (OSI and E-Government Readiness Index, EGOVRI), the Freedom House Political Freedom Index (POLFREE) (Freedom House, 2011) and the (log of) real GDP per capita in 2005 int. dollars. As a first attempt to reduce possible reverse causality problems, we regressed current CPI-levels in 2010 on OSI and EGOVRI-levels in 2005. To mitigate further the reverse impact of corruption on economic wealth and democratic freedom, we use the year 2000 levels of POLFREE and GDPpc. In the

⁸ GDPpc from the Penn World Tables 7.0

process of further refinement of methodology UN Telecommunications Infrastructure Index (INFRASTRUCTURE) was matched against the CPI.

The study has some limitations. To a large extent, the authors had to rely on existing measurement frameworks for a number of reasons. First of all, the desired individual indicators (i.e. the use of sophisticated e-services) were unavailable from open sources for countries outside EU and OECD. Secondly, these international organizations have continuously advanced and sharpened their measurement methodologies over the past years.

International measurements of e-government

The European Union (EU) has arguably advanced the most in forming its measurement framework for systematic gathering of performance information that can help identify and evaluate sources of effective and innovative e-governance practices. Since 2004 Eurostat⁹ has been collecting statistical data on e-government usage by business and household (demand side), and consulting company Capgemini on behalf of the European Commission has since 2001 been collecting data on e-government service availability (supply side). More specifically, Eurostat's and other European Commission surveys of public services provide reliable data for the number of "basic public services" fully available online; the share of individuals using the Internet for interacting with public authorities by purpose: obtaining information, obtaining forms, returning filled-in forms; the percentage of enterprises using the Internet for interacting with public authorities (by purpose) [European Commission, 2006].

The OECD is another international center, which has advanced e-governance research and, more generally, public innovation measurement. Its experts work on the metrics on public sector innovations, measuring performance, output or quality of public services, with a view to come up with the Guidelines on approaches to Public Sector and Service Innovation Measurement. The outcomes of this work are still not available.

Other international organizations, such as the International Telecommunication Union¹⁰, the World Bank¹¹ and UN agencies¹² study and promote e-governance as part of

⁹ The Statistical Office of the European Community

¹⁰ Calculates ICT Development Index and gather most of the world statistics on ICT.

¹¹ For example, the World Bank Group calculates its Governance Indicators and sustains its Information and Communications for Development Online Database.

¹² For example, annual E-Government Readiness Report prepared by the UN Department of Economic and Social Affairs.

good governance and public sector innovations¹³. The aim is to root out inconsistency in definitions, methodology, reporting and monitoring of e-government development across countries and levels of government, while supporting international benchmarking efforts.

Monitoring the efficacy of e-government development faces substantial challenges. Most of the statistics is derived from supply side indicators, sometimes by website assessments alone. Little data is yet available on the demand side of e-government. Few surveys exist that would indicate ‘how’ citizens appreciate and use these services and ‘what’ they see as maximizing public value. Measurement experts are to define the scope of governmental agencies’ responsibility, consider the issue of outsourced government functions, and accommodate heterogeneity among national and local institutions. The pace of technological innovation also needs to be taken into consideration when designing a framework for measuring e-government and monitoring its effects.

Taking into account the described limitations, a review of the 2010 editions of international rankings in the sphere of ICT, e-government and corruption is made below.

The E-government Development Index (EGDI)¹⁴ allows for a comparative performance assessment of national governments (see Figure 1), although it is not intended for measuring the level of e-government in absolute sense [United Nations, 2010]. One of the three EGDI components - Online Service Index (OSI) – measures the scope and quality of online services. It attempts to capture a country’s performance in a single internationally-comparable value using a four-stage model of online service maturity: emerging, enhanced, transactional and connected services. It assesses the supply side: how useful are online services and how often they are provided to citizens. Within the OSI similar number of

¹³ An international task force on e-government indicators was established in 2006 through the Partnership on Measuring ICT for Development, of which the United Nations Department of Economic and Social Affairs is a member. The task force will recommend a core set of measures to be collected by governments.

In May 2010 the OECD started discussions with the major global e-government survey owners, academic research groups and OECD member-states, and suggested launching new e-government indicators with a focus on public sector performance. E-government rankings have been calculated for over a decade and laying the grounds for more advanced indicators, based on objective assessments (hard data). The idea is not to combine existing methodologies and indicators, but to develop completely new ones to be developed by a ‘virtual taskforce’. The work will feed into the OECD’s bi-annual report *Government at a Glance*¹³. Currently, the Report and its web-resource provide access to raw data, as well as composite indexes that regroup the key elements of public administration in human resource management, budgeting and regulation.

¹⁴ The maximum possible value of Index is one, the minimum is 0. The E-government Readiness measurement in EGDI is complemented by an E-participation Index. As of 2009-2010, in line with the updated methodology, EGDI consists of three subindexes: Online Service Index, Telecommunication Infrastructure Index and Human Capital Index. E-Participation Index attempts to bring some order to measurement of e-governance by positing the relevance of three factors in citizen engagement: electronic information dissemination, electronic consultation and electronic participation in decision-making.

services provided through each country's national website as well as the websites of the ministries of education, labour, social services, health and finance were assessed.

While the second EGDI measure, Telecommunication Infrastructure Index¹⁵, may be helpful in verification of our hypothesis, the Human Capital Index¹⁶ is less relevant for a number of advanced and mid-income countries like Canada, Russia, and the UK.

The UN E-Government Survey is published annually as E-Government Readiness Report [United Nations, 2010]. The 2010 Report covered 191 countries and ranked them by e-government readiness and e-participation. The top-5 countries are the developed countries: Republic of Korea, the United States, Canada, the United Kingdom and the Netherlands. Looking at the demand side, the leaders in EGDI E-participation Index are Republic of Korea, Australia and Spain. The national leaders in e-government within each World region were also pointed out. Of the World regions EGDI regional average is highest for Europe.

Most international e-government surveys encompass various ICT measurements, as positive e-government developments are possible with a wide and universal ICT diffusion. Therefore, we looked into the level of ICT development in different countries around the globe as measured by the ICT Development Index¹⁷ [ITU, 2009; ITU, 2010].

The latest results of ICT Development Index (IDI) published in 2010, testify to the remaining almost 10 fold sizeable gap in ICT development between high- and lower-income countries (ITU, 2010). The top ranking countries are Sweden, Luxemburg, Republic of Korea, Denmark, Netherlands, Iceland, Switzerland, Japan, Norway and Great Britain (see Figure 2). All these countries, with the exception of two, are located in Europe, which is a leading region in the World in terms of ICT infrastructure and e-services.

The IDI sub-indexes allow revealing countries' relative strengths. For instance, Russia is doing especially good in ICT Skills sub-index, while in ICT Use the country is far behind, ranking 59th, and in the level of access and use of ICT Russia comes only 45th and 59th respectively.

The digital divide at international scale, illustrated above in ICT Development Index 2010 results, is a relative concept, which seeks to compare the level of ICT development in a

¹⁵ The Telecommunication Infrastructure Index is a composite of 5 indicators that uses ITU primary data.

¹⁶ A composite of two indicators: Adult Literacy Rate and the Combined Primary, Secondary, and Tertiary Gross Enrollment Ratio. Adult literacy – 2/3, number of enrolled students -1/3.

¹⁷ ICT Development Index is composed of 11 indicators, grouped by the three sub-indices: ICT infrastructure and access, ICT use, and ICT skills. Sub-indices were computed by summing up the weighted values of the indicators included in the respective subgroup. After normalizing the data, the individual series were all rescaled to identical ranges, from 1-10. For the final index computation, the ICT access and ICT use sub-indices were given 40 per cent weight each, and the skills sub-index (based on proxy indicators) 20 per cent weight. The final index value was then computed by summing up the weighted sub-indices.

country (group of countries) with that in another country (group) at a certain point in time. The digital divide may be defined as the relative difference in a measurement of a country's digital divide (i.e. by Orbicom Infostate Index), benchmarked against the simple average of all countries included in analysis [Orbicom, 2003]. Above-average performing countries were assigned a positive number, and below-average performing countries were identified by a negative number [ITU, 2010: 40].

The analysis of IDI 2010 results showed the prevailing, although slightly shrinking, digital divide between those countries with very high ICT levels and those with lower levels. This may be partly explained by the decelerating of ICT growth in the most advanced countries. At the same time, the top ranking countries have been advancing at a high rate thus increasing the gap with those ranking lowest. Moreover, ICT indicators have a relatively short time lag as compared to other development indicators. This increases the probability for countries at the bottom of the scale to catch up relatively fast, under the condition of due policy attention to their ICT sectors [ITU, 2010: 42-43].

Our analysis of international rankings and individual indicators, available for some countries, testifies that the digital divide remains to be one of the major obstacles to the wide profusion of e-government not only in the developing world, but also in fast growing economies and in the economically advanced countries.

The wider introduction and use of ICT is influenced by the cost of ICT services. For assessing this factor a special measure – price basket of ICT services – was formed. The price basket provides information on the cost and affordability of ICT services in absolute values and as a percentage of income (GNI per capita). The ten countries and territories with most affordable prices of ICT services are Macao (China), Hong-Kong (China), Singapore, Kuwait, Luxemburg, USA, Denmark, Norway, Great Britain and Iceland. The data testifies to a faster spread and application of ICT in developed countries. It is probable that lowering of ICT service costs would allow for their wider application, thus bridging the digital divide between countries [ITU, 2010: 99-100].

Based on the above analysis, we may note that the top ten countries in E-government Development Index and ICT Development Index cover the same five: Republic of Korea, Denmark, Netherlands, Norway and Great Britain. We also note the following tendency. Despite the fact that countries ranking high in ICT development are gradually losing their positions, they are gaining in e-government ranking. A possible explanation is that the digital divide between countries is reducing and the developing world is gaining better positions. It is also probable that in the areas of infrastructure and ICT skills the advanced countries are

ready to pass on to the new level of communications, including the interaction between national governments and their citizens. The indicators analyzed above are briefly compared in Table 1.

Although there are some limitations to the existing international e-government measurements as described above, the data provided by the international organizations that stand behind these measurements is valid and, for the most part, verifiable. Most individual indicators are based on the statistical data of ITU and the UN. For calculation of those indicators that are based on opinion polls large representative samples are used. For those indicators that are derived from the assessment of the quality of e-services as per national and ministerial web-sites unified procedures and multilingual staff are put in place to assure validity. Moreover, the international organizations have continuously advanced and sharpened their measurement methodologies over the past years to close the data gaps and sustain validity, on one hand, and to increase the comparability across multiple countries, on the other hand.

Unfortunately the individual indicators or primary data, which are used to calculate the indexes described above are, in most cases unavailable (not published in the reports or available from organizations' web-sites). For instance such individual indicators as the use of sophisticated e-services are unavailable from open sources for countries outside EU and OECD. As this study was intended to cover countries across various world regions, the authors used aggregate indicators available from international measurements as described above.

At present the international organizations, owners of ICT and e-government international rankings, make very little use of official statistics in certain countries and rely on own sources: expert assessments, databases, questionnaire surveys, own studies of national web-sites. These limitations may lead to incomplete and partial information, which, in turn, may lead to inconsistency of ranking studies results. For instance, due to difficulties with data collection, EGDI 2010 was not able to encompass such aspects as cross-country differences in user-friendly design of services for various population groups; and share of service requests processed electronically and online in the total number of requests. The low response rate of national partners in multinational comparative studies (i.e. approx. 30% in EGDI 2010 Online Service Index) lead to a number of challenges, including language, with assessing national sources centrally (i.e. official web-sites).

Additional incentives are needed for countries to introduce various e-government indicators in their statistical practice. For instance, the European Union, which shows best

practice here, has developed a benchmarking framework to track the progress towards its i2010 strategic goals. The sets of indicators, among other, cover availability and usage of online services by population and enterprises broken down by purpose, as well as issues of inclusion: computing disparity indices with household connectivity and usage indicators, e-accessibility, and measuring digital literacy.

E-government and corruption: a cross-country analysis

As it becomes clear with the international rankings, there are many features and functional components of e-government, and countries differ in their preference towards particular components, such as e-infrastructure, e-services, and access to public information, all of which have a rationale for an anti-corruption effect. Among the debated arguments are that e-government may help increase the transparency of procurements system, make public services more accessible and clear, and ensure a universal citizens' access to information [Norris and Zinnbauer, 2002].

Ensuring easy citizen e-access to government information is another important good governance tool in ensuring the execution of state obligations and raising the accountability to citizens [Bellver and Kaufmann, 2005; Lederman, 2004]. Information allows the society to know, assess and demand the improvement of government performance on issues of social importance such as public safety, education, healthcare and more. Undoubtedly close public scrutiny limits public sector corruption [Kolstad and Wiig, 2008].

A vital, if not the central motivation to implement e-government applications is to improve the quality of public services. This overall goal includes a number of very different improvements, all of which are related to curbing public sector corruption. They range from a faster delivery of certain services (e.g. licenses or permissions) to citizens, better access to public information and information exchange procedures, to cost savings in the government sector. In general, the relation between input and output/outcome of public service supply should be improved by a more efficient government management, i.e. with the use of technological public sector innovations, such as e-government applications.

Today bureaucratic barriers still hinder the adoption of a consistent and unified position, aligned among all government agencies (whole-of-government approach) to service delivery [Christensen and Læg Reid, 2006; Halligan, 2006]. This approach requires a balance between efficiency and effectiveness, service quality and speed of delivery, user-friendly procedures and budget constraints.

The New Public Management approach views citizens as customers [Boston et al., 1996; Kaboolian, 1998; Nagel, 1997]. Certain countries have gone beyond this approach to treat citizens as partners in lay out, provision and evaluation of services. The presumption here is that greater efficiency in delivery of public services will depend on stronger collaborations with citizens and will result in reduction of costs, as well as savings of untapped resources, such as user time [OECD, 2009b]. However, much of the theoretic results within the New Public Management school have been achieved at micro-level and they very much rely on a national social, economic and political context [Pollitt, 1998: 65], for instance, changes at micro-level (i.e. specific changes in management practice) resulting in systemic changes in the public management. There were very few evaluations at macro level focusing on impact assessment [Jones et al, 2001].

Effective and efficient e-government may indeed produce desirable effects on the overall social and economic situation in a country. Bureaucratic discretion may be reduced through higher decision making transparency and information openness attained by standardized rules and procedures. Automated processes should limit opportunities of government employees to extort money from citizens. Information delivered to citizens in a more timely manner is expected to increase the transparency of government and empower citizens to monitor government performance more effectively. Moreover, a reduction of personal interactions between public employees and citizens may also contribute to a reduction in the number of corrupt transactions [e.g. Bhatnagar, 2003; Clift, 2004; Andersen, 2009; Kim et al., 2009; Shim, Eom, 2009; Garcia-Murillo, 2010].

The authors' hypothesis, tested in the paper, is that e-government has an effect on the control of corruption. To prove the interlink between ICT infrastructure and ICT use, on one hand, and perceived level of public sector corruption, on the other hand, we performed a statistical correlation analysis of the Transparency International Corruptions Perception Index [Transparency International, 2010] and the WEF Networked Readiness Index [Dutta, Mia, 2011] 3 sub-indexes: infrastructure environment, individual ICT usage and business ICT usage¹⁸. The choice of indexes was based on availability of comparable data on indicators, characterizing advancement of e-government. Figures 3.1-3.3 illustrate the distribution of 138 countries by CPI and the NRI subindexes.

¹⁸ The NRI subindexes are: Infrastructure environment; Individual usage; and Business usage. For details see: <http://reports.weforum.org/global-information-technology-report/>.

The analysis shows a rather close linkage between the four composite indicators. Of the 20 top ranking countries in WEF NRI infrastructure environment, individual usage and business usage, 14, 15 and 13, accordingly, were among the top 20 in CPI. The 20 countries with highest level of corruption perception, 10, 8 and 9, accordingly, are the lowest ranking in the WEF NRI subindexes under consideration.

The closest connection was established between the level of corruption perception and infrastructure environment and individual ICT usage with the correlation coefficient 0,87 (see Table 2).

These results are an important step in proving the interlink between the level of ICT development, especially on the user side, with perceived level of public sector corruption. Clearly, ICT is the necessary precondition for e-government and the source of public sector technological innovations. At the same time the ICT infrastructure and usage indicators may only serve as proxy of the level of e-government advancement.

To advance and substantiate our analysis of the possible relationship between public sector corruption and e-government use, figure 4 plots the Transparency International Corruption Perceptions Index for the year 2010 against United Nations' 2010 E-Government Readiness Index of online services for a sample of 173 countries. The CPI measures the perceived levels of public sector corruption based on a number of different sources. The CPI lies in a range from 0 to 10, higher values indicating less corruption. The UN online service-index (OSI) attempts to capture a country's e-government performance using a four-stage model of online service maturity. It thereby takes into account the degree of user-friendliness and the amount of content offered on the government websites, following a 'citizen-centered approach'. The online service index is standardized on a 0-1-scale. Higher index scores illustrate more sophisticated and user-friendly services.

Figure 4 shows a highly significant relation between online service qualities on the one hand and perceived corruption levels on the other. Improved e-government services are associated with higher CPI-levels and, thus, lower perceived levels of public sector corruption.

A simple bi-variate OLS¹⁹ regression describes the relationship between CPI-level and Online Service Index (OSI) by (p-values in parentheses)

$$CPI_i = 2.0 (0.000) + 6.6 (0.000) \cdot OSI_i, \quad R^2 = 0.45$$

¹⁹ Ordinary least squares

These results are in line with our hypothesis about e-government mitigating corruption, but they are hardly definitive. The highly significant positive correlation does not imply causality; either of the parameters could be the independent variable influencing the other; they might be linked in a virtuous circle; or both could be (more or less independent) products of some unmeasured structural features. The possible relations here may be explored further, for example, that higher corruption levels per se could well be a decisive factor for worse online service quality. If government officials are responsible for the implementation of e-government, we should expect such a positive correlation between CPI and OSI, as corrupt officials tend not to introduce technologies that they expect would reduce their discretionary freedom. At best, we would suppose them to introduce bad and ineffectual e-government services, which will weaken or even destroy the link between service quality and corruption levels.

Further problems arise if we take into account that both public sector corruption and e-government implementation almost certainly depend on the level of democracy and the income level. For instance, Lederman et al. [2001] state that political institutions—such as democracy, political stability and other — are crucial in determining the prevalence of corrupt activities and lowering corruption. Van Dijk and Hacker [2003] found that such factors as income, education, and employment are strongly associated with higher possession of hardware for internet access and are thus responsible for gaps in Internet access (e.g. access to e-government).

Based on these studies we may presume that less democratic regimes are usually also more corrupt *and* are probably also less inclined to implement new technologies for improved communication with their citizens. Hence, a lower level of democracy will be associated with both more corruption and worse e-government services. Moreover, we would expect predominantly rich countries to provide the necessary telecommunications infrastructure which is a prerequisite for the introduction of online services. A country's economic wealth will therefore almost certainly play a decisive role for the implementation of e-government. Finally, the quality of human capital, as measured by adult literacy rate or schooling level, will also be a determinant for the use of the internet in general and in particular for the implementation of the government online services (and their utilization). Both variables are commonly associated with GDP per capita, which, however, may in turn be influenced by corruption levels.

Indeed the empirical literature on the determinants of e-government implementation shows clear associations in line with this discussion. In a large cross-country sample, Kim

(2007) finds a positive relation of education level, economic wealth, urbanization rate, civil liberties and government effectiveness to e-government performance. These results are very much in line with the works of Chinn and Fairlie [2007], who examine the determinants of global computer use and internet penetration patterns. This is exactly what we would expect: factors that are supposed to be conducive to the world-wide spread of the internet use are also conducive to the implementation of e-government services. In a more recent study, Bussell [2011] finds that the adoption of e-government technologies depends on initial corruption levels. Politicians in countries with established high corruption are more likely to resist to the introduction of e-government services.

Hence, when testing the relationship between corruption and the use of e-government we observe a number of considerable and complex reverse causality and endogeneity problems. In this context, simple OLS estimates of the relationship between current corruption levels and online services will be biased even if additional controls are added to the specification. Thus, we switch to multivariate analysis - to Two-Stage-least-Squares (2-SLS)-regressions, looking for instrument variables that are on the one hand strongly related to the adaptation of high-quality e-government, and, on the other, not related to corruption levels [e.g. Wooldridge, 2005, ch. 15].

Table 3 displays the results of some cross-section estimates of corruption levels as measured by the Transparency International CPI-index in 2010 on measures for the quality of e-government implementation in 2005, as well as the 10-year-lagged values of the Freedom House Political Freedom Index (POLFREE, re-coded on a 0-10-scale, with higher values showing more political liberties) and the (log of) real GDP per capita (in 2005 int. dollars (from the Penn World Tables 7.0).

We use two different measures of e-government quality. The Government Online Service Index (OSI) is measured as described above, to account for the degree of user-friendliness and the amount of content offered on the government websites. The E-government Readiness Index (EGOVRI), also from the United Nations [2010], additionally takes into account the quality of a country's telecommunication infrastructure and its human capital (school enrollment and adult literacy). EGOVRI therefore provides a more comprehensive picture of e-government availability.

As a first attempt to reduce possible reverse causality problems, we regressed current CPI-levels in 2010 on OSI and EGOVRI-levels in 2005. This is similar to say that the quality of services has an impact on subsequent corruption levels, less on contemporary corruption. A lag of 5 years is justified further by the fact that the impact of better e-government service

availability on corruption does usually not lead to an immediate reaction of perceived corruption. To mitigate further the reverse impact of corruption on economic wealth and democratic freedom, we use the year 2000 levels of POLFREE and GDPpc. Results are qualitatively and quantitatively almost unchanged if we use the 2005 values of POLFREE and GDPpc.

Columns (1) and (2) show results of simple OLS estimates. Both Online Service Index and e-Government Readiness Index in the year 2005 have a positive and significant relation to the Corruption Perceptions Index (CPI) in 2010. Better services are therefore associated with less corruption. EGOVRI includes measures for telecom infrastructure quality as well as human capital. The coefficient (+4.84) is more than twice as high as the coefficient of OSI (+2.33). This results points to the high relevance of a good infrastructure. In order to separate these effects, we simply added in columns (3) the UN Telecommunications Infrastructure Index (INFRASTRUCTURE) (United Nations, 2010) as an additional infrastructure variable to the OSI-base equation (1). INFRASTRUCTURE is coded on a 0-1-scale, higher values reflecting better infrastructure. While the INFRASTRUCTURE index (for the year 2005) is highly significant and positively related to the CPI, the OSI loses its positive relationship to the CPI. This is partly due to collinearity, but it may also show that an extremely high relation of EGOVRI to the CPI is driven primarily by infrastructure quality and not by the quality of provided online services.

In equations (4) to (6) we re-estimated (1) – (3) by 2SLS, and modeled the e-government variables OSI and EGOVRI as endogenous. We only used one excluded instrument, i.e. the (log of) population size in the year 2000. There is no reason to believe that population size and corruption levels are systematically related. A simple correlation test confirms this ($r = -0.12$). But we examine this variable because it could be argued that adoption of e-government online services is especially helpful in populous countries (because of the increasing returns to scale that could be expected). The first stage regressions clearly confirm this assumption. In all estimates the (logged) population variable is significant and positively related to the OSI. The partial R^2 of the excluded instrument is around 0.3 in (4) and (6) and still 0.14 in (5). F-test values above 10 are also an indication that the first stage instrument is valid. Using only one instrument and one endogenous variable, the equation is exactly identified.

The results show a somewhat different picture as compared to simple OLS. In (4) and (5) the e-government indicators are negatively related to the CPI, though the coefficients are not significant. Hence, there is no indication that the adoption of e-government services is

related to a reduction in corruption levels. Adding the infrastructure control variable in (6), the coefficient of OSI even turns its sign and becomes negative at a 1 percent confidence level, while INFRASTRUCTURE is strongly positively related to the CPI. Again, this is an indication that not the introduction of online services but, instead, a better telecommunications infrastructure is associated with a better corruption performance.

Thus, we found no stable relation between the quality of e-government services and the corruption level as measured by the Transparency International CPI measure.²⁰ We suspect that the often found positive relation between government adoption of e-services and corruption containment mainly works through the infrastructure channel. Hence, measures that assess the quality of e-government services inclusive of infrastructure variables may lead to misleading results. The extremely optimistic view about the anti-corruption effects of e-government should be seen with more skepticism.

Conclusion

In the paper we have first reviewed international measurements of e-government and selected the most appropriate indicators, having briefly outlined the strengths, as well as shortages of aggregate e-governance measures. We then attempted to explore possible causal and dependency relations of the established interlink between e-government and public sector corruption. As a result of econometric analysis we found no stable relation between the quality of e-government services and the corruption level as measured by the Transparency International CPI measure. At the same time it was demonstrated in the paper that the often found positive relation between government adoption of e-services and corruption containment may work through the infrastructure channel.

Thus for further research into the subject it would be beneficial to use, where possible, individual (not aggregate) indicators, possibly in cooperation with the international organizations, the primary data owners and data holders. It may be of use to look at time series, adding the new data as it becomes available, as well as explore other aspects of e-government as variables. The presumption that needs to be verified is that different e-government components have a different, at times divergent, impact upon containment of corruption in the public sector.

²⁰ The results hold if we use the World Bank's "Control of Corruption" measure (data were available for 2009 instead of 2010).

Acronyms

CCTV - closed-circuit television

CPI – Transparency International Corruption Perceptions Index

EGDI – UN E-government Development Index

EGOVRI – UN E-Government Readiness Index

GOL – Canada’s Government On-Line Initiative

ICT – Information and Communication Technologies

IDI - ICT Development Index of the International Telecommunication Union

ITU – International Telecommunication Union

NESTI – OECD Group of National Experts on Science and Technology Indicators

NRI - Network Readiness Index of the World Economic Forum and INSEAD Business School

OECD – Organization for Economic Cooperation and Development

OSI – EGDI Online Service Index

POLFREE - Freedom House Political Freedom Index

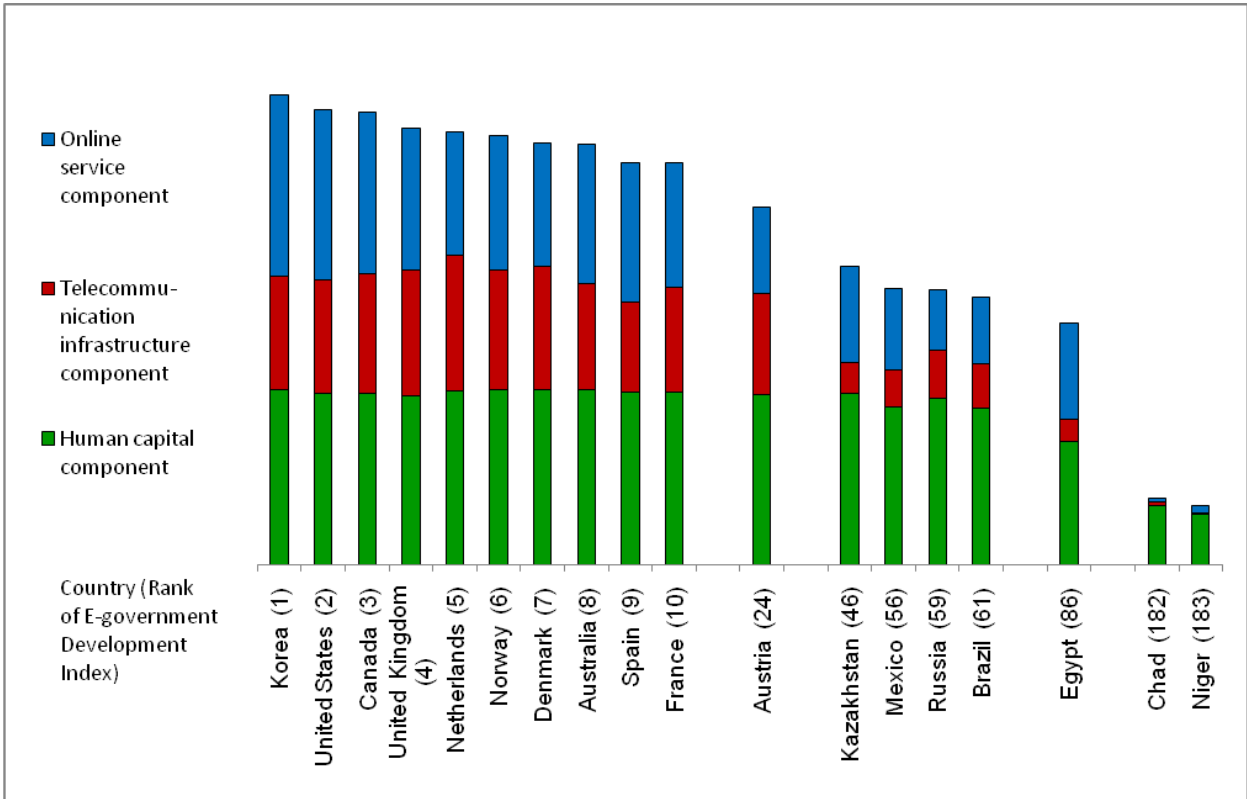
RFID - radio frequency identification

TI – Transparency International

UN – United Nations

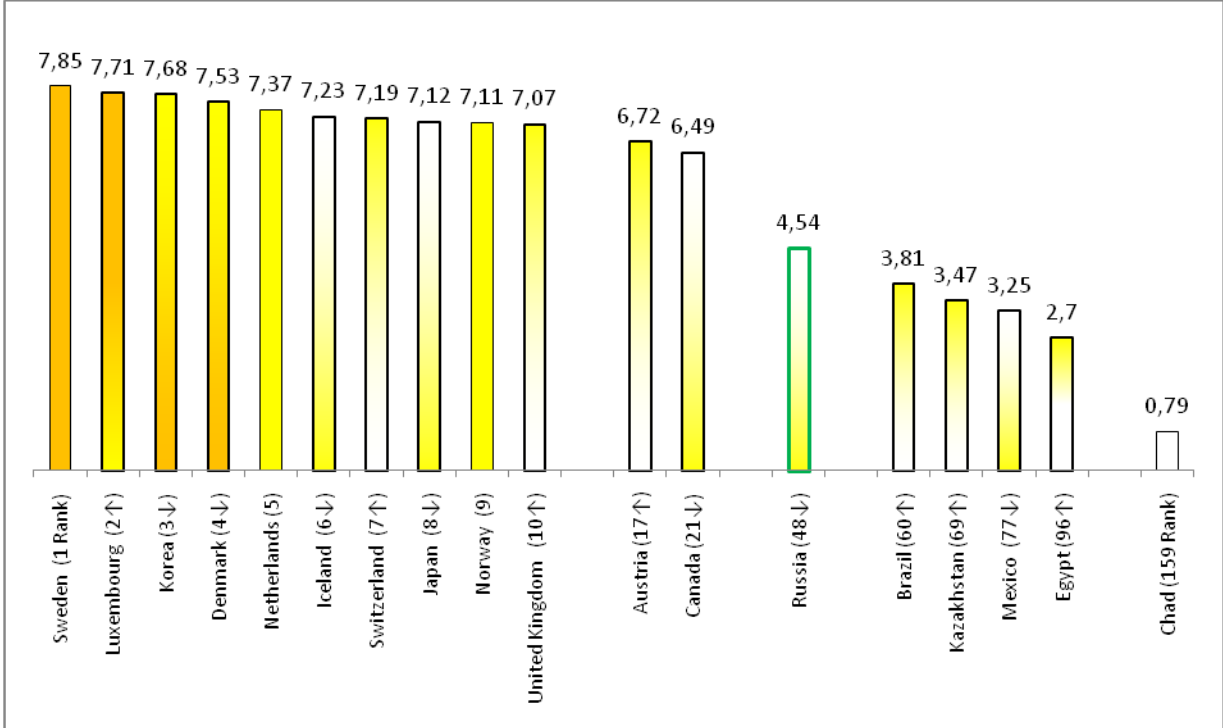
WEF – World Economic Forum

Figure 1. Ranking results E-government Development Index, 2010



Source: United Nations, 2010.

Figure 2. Countries ranking by level of ICT development, 2010



Source: ITU, 2010.

Table 1. Comparison of various international measures of e-government

Indexes	Subindexes	Potentials	Limitations
E-Government Development Index (EGDI) (formerly E-government Readiness Index)		Attempts to capture various aspects of e-government, characterize the infrastructure, as well as citizen's ability to use the e-services	Not intended for measuring the level of e-government in absolute sense
	Human capital index	Based on statistical data of adult literacy and gross enrolment	Less relevant for developed countries
	Telecommunication Infrastructure Index	Based on verifiable ITU primary data. Measures a variety of infrastructure components used by population: personal computers, Internet, telephone lines, etc.	
	Online Service Index (OSI)	Measures the scope and quality of online services. Attempts to capture a country's performance in a single internationally-comparable value using a four-stage model of online service maturity. The only subindex that is composed of indicators directly relevant for e-government.	Subjective assessment of a number of services provided through each country's national website, as well as the websites of the ministries of education, labour, social services, health and finance. This measure also has language limitations.
WEF Networked Readiness Index		The index is calculated on the basis of statistical data of a variety of international organizations	The data for 39 indicators is also derived from the opinion polls of some 13 000 chief executives across different countries. This subjective data is used to characterize not only quantitative,

Indexes	Subindexes	Potentials	Limitations
			but also quantitative indicators in case of absence of statistical data
ITU ICT Development Index (IDI)		The Index is based only on verifiable official data of the national statistical offices. Illustrates the demand-side of e-government and the digital divide. Offers cross-country comparisons by means of price basket of ICT services	The indicators were selected based on availability of statistical data in all countries, including the developing world. In case of data absence estimates are used (i.e. extrapolation).
	ICT Access	The most representative from the viewpoint of number of indicators (5 out of 11). Assesses the use of ICT by various groups: households, organizations, population	
	ICT Use	Assesses the intensity of Internet use	Of all ICT focuses only on the Internet use
	ICT Skills		Due to limited data on Internet use, especially for the developing countries, the subindex is calculated based on indirect indicators – literacy and education

Figures 3.1-3.3. Distribution of countries by CPI ranking and 3 subindexes of WEF Networked Readiness Index, characterizing ICT infrastructure, individual and business usage of ICT

Figure 3.1

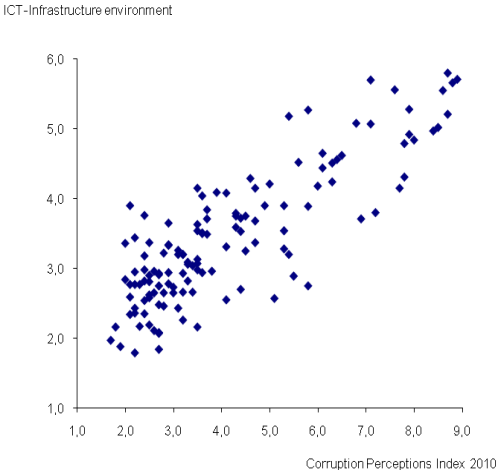


Figure 3.2

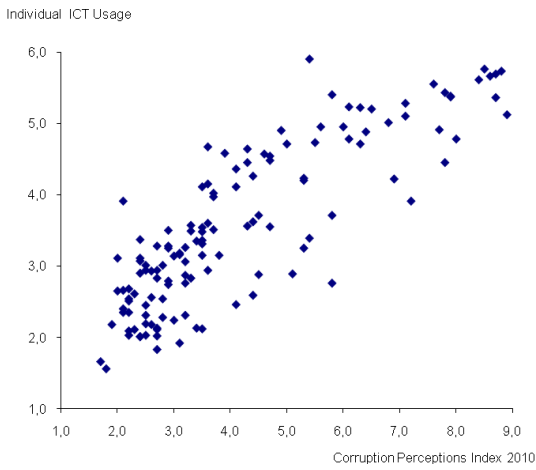
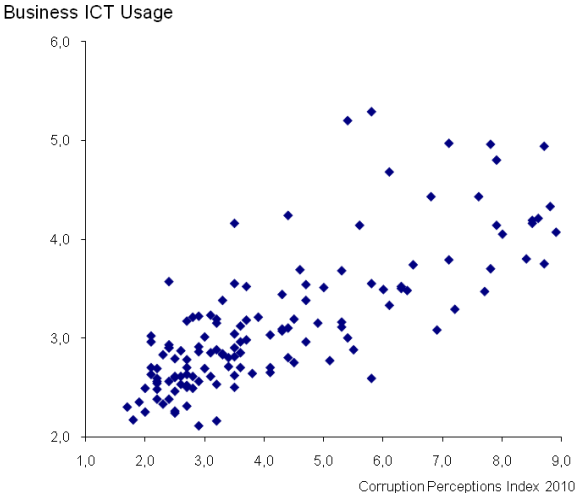


Figure 3.3



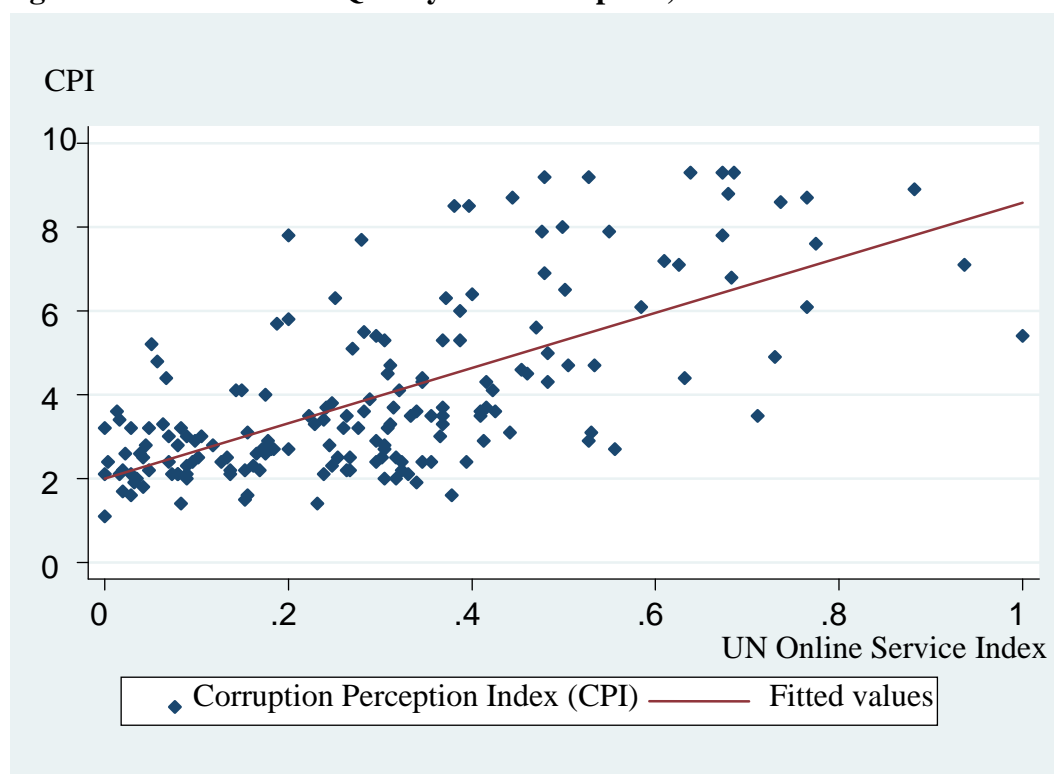
Sources: data from Dutta, Mia, 2011; CPI 2010.

Table 2. Correlation coefficients* between WEF NRI subindexes (2010-2011) and CPI (2010), 138 countries

	WEF NRI Infrastructure environment subindex	WEF NRI Individual usage subindex	WEF NRI Business usage subindex
Corruption Perceptions Index 2010	0,87	0,87	0,80

* Note: the following coefficient formula was applied: $\rho_{X,Y} = \frac{Cov(X,Y)}{\sigma_X \cdot \sigma_Y}$, whereby x and y are sample average AVERAGE(array1) and AVERAGE(array 2).

Figure 4. Online Service Quality and Corruption, 2010



Sources: data from United Nations, 2010; CPI 2010.

Table 3. E-government services as determinants of corruption

	(1)	(2)	(3)	(4)	(5)	(6)
	OLS	OLS	OLS	2SLS	2SLS	2SLS
OSI (t-5)	2.33 (0.001)		-0.37 (0.472)	-1.16 (0.223)		-2.88 (0.001)
EGOVRI (t-5)		4.84 (0.000)			-2.55 (0.257)	
GDPpc (t-10)	0.61 (0.000)	0.39 (0.001)	0.20 (0.008)	0.96 (0.000)	1.08 (0.000)	0.29 (0.000)
POLFREE (t-10)	0.11 (0.000)	0.09 (0.004)	0.05 (0.058)	0.18 (0.000)	0.19 (0.000)	0.07 (0.010)
INFRASTRUCTURE (t-5)			7.44 (0.000)			9.22 (0.000)
Constant	-2.55 (0.024)	-1.89 (0.012)	0.84 (0.090)	-4.65 (0.000)	-5.04 (0.001)	0.53 (0.305)
Observations	170	170	170	170	170	170
R2 (adj.)	0.638	0.676	0.802	0.544	0.489	0.765
First stage regression:						
Partial R2 of excluded instrument				0.296	0.138	0.306
F-stat.				71.86	24.11	60.94

Note: Robust p-values (two-tailed-tests) in parentheses.

Dependent variable: Transparency International Corruption Perceptions Index (2010).

Endogeneous variables: OSI (eq. 4 and 6) and EGOVRI (eq. 5). Excluded instrument: (log of) population size (in 1,000) in 2000.

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