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Does E-Government Improve Government Capacity?

Evidence from Tax Administration and Public Procurement

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Abstract

Using a cross-country data set on e-government systems, this paper analyzes whether e-filing of taxes and e-procurement adoption improves the capacity of governments to raise and spend resources through the lowering of tax compliance costs, improvement of public procurement competitiveness, and reduction of corruption. The paper finds that information and communications technology can help improve government capacity, but the impact of e-government varies by type of government activity and is stronger in more developed countries. Implementation of e-filing systems reduces tax compliance costs as measured by the number of tax payments, time required to prepare and pay taxes, likelihood and frequency of firms being visited by a tax official, perception of tax administration as an obstacle, and incidence of bribery. The effects of e-procurement are weaker, with the number of firms securing or attempting to secure a government contract increasing with e-procurement implementation only in countries with higher levels of development and better quality institutions. The paper finds no systematic relationship between e-procurement and bureaucratic corruption.

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Does E-Government Improve Government Capacity? Evidence from Tax Administration and Public Procurement*

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1. Introduction

Economic development requires a government that can successfully implement policies, protect property rights, and deliver public goods and services. A necessary prerequisite is the ability to raise and spend fiscal resources effectively. But many governments, particularly in low- and middle-income countries, lack these capacities (Besley and Persson, 2010). High tax compliance costs due to cumbersome regulations and harassment by tax officials deter investment, encourage tax evasion, and undermine economic growth (Hindriks et al., 1999; Djankov et al., 2006; Coolidge, 2012; Alm et al. 2015; Jerbashian and Kochanova, 2016a). The public procurement of goods and services is often rife with collusive practices and corruption, resulting in the misallocation or waste of resources and poor quality infrastructure (Auriol, 2016; Center for Global Development, 2014).

This paper investigates whether the use of information and communications technology (ICT) by government, or "e-government," can strengthen governments' capacity to raise and spend resources effectively. Most countries have invested heavily in ICT over the past two decades to improve revenue mobilization, budget preparation, and budget execution, and to deliver a variety of services to citizens.[1] However, very little is known about the impact of these investments on government efficiency. We aim to fill this gap by empirically examining the effects of two aspects of e-government: the electronic filing and payment of taxes (e-filing) on tax compliance costs and corruption; and electronic procurement (e-procurement) on the competitiveness of public procurement and corruption. We employ novel cross-country data on e-government implementation, as well as country- and firm-level data on the business environment.

E-filing should, in theory, reduce tax compliance costs. Taxpayers have more flexibility about when to file taxes, are less prone to errors while filing standardized forms, and, ideally, do not need to spend time with tax officials in face-to-face interactions, which also reduces opportunities for corruption. Similarly, implementation of e-procurement should reduce costs to firms of participating in government tenders, attract more bidders, and decrease corruption associated with collusive behavior. However, the investments in e-government might not bring the expected results if countries lack the skills, capacity, and institutions to fully exploit the advantages of ICT (Yilmaz and Coolidge, 2013; World Bank, 2016). We test this conjecture using the interaction between e-government implementation and a country's level of development, which we proxy by the GDP per capita, number of Internet users per capita, gross secondary school enrollment, and measures of the rule of law, government effectiveness, and business freedom.

[1] Almost all countries have some form of automated financial management system in place. According to the World Bank's *Global e-Government Systems Database*, which is used in this paper and described in detail in Section 2, 94 percent of countries have automated e-customs systems and 84 percent have automated tax management systems.
Governments also tend to use more ICT than the private sector. Van Reenen et al. (2010) report that public sector establishments in 2005–2008 used on average 1.32 computers per employee as compared to 0.64 in the manufacturing and 1.18 in the services sector.

We find that the adoption of e-filing reduces tax compliance costs as measured by the number of tax payments, the time required to prepare and pay taxes, the probability of being visited by tax officials, the number of visits by tax officials, and the perception of tax administration as an obstacle to firms' operation and growth. It also reduces solicitation of bribes to public officials. The overall effects of e-filing are generally stronger in countries with higher levels of development, and remain qualitatively the same if we also control for measures reflecting the ease of doing business in a country.

The impact of e-government on public procurement, by contrast, is much weaker. The implementation of e-procurement systems, regardless of system functionality, does not directly increase public procurement competitiveness, measured by the propensity of firms to apply for tenders, nor does it reduce the incidence to bribe to secure a government contract. However, in more developed countries e-procurement increases the likelihood that firms will bid. One explanation of the absence of strong effects of e-procurement is that it has more limited potential to automate processes than e-filing and e-payment of taxes. Public procurement often requires public officials to evaluate qualitatively different bids and, therefore, to exercise considerable discretion. It is therefore more susceptible than tax filing to collusive behavior between firm managers and government officials.

Our findings shed light on the potential and limitations of ICT to improve government capacity. First, the varying impacts of e-filing and e-procurement suggest that technology can increase capacity in certain areas more than others, depending on the extent to which tasks can be automated. Second, the interaction effects of development measures on our variables of interest suggest that the quality of institutions, infrastructure, technology, and human capital condition the impact of e-government. In particular, more developed countries are more likely to have the capacity to undertake the regulatory and organizational changes that complement investments in technology. This is consistent with the literature on ICT and firm productivity, which emphasizes the importance of complementary organizational changes within firms to reap the benefits of ICT (Bresnahan et al., 2002; Brynjolfsson and Hitt, 2000), and with the few studies of the impact of ICT on public sector performance (Garicano and Heaton, 2010; Seri and Zenfei, 2013). The absence of accompanying institutional changes may also explain the poor returns on ICT investments, particularly in large and complex ICT systems, in developing countries (Heeks, 2008; World Bank, 2016).[2]

While there have been an increasing number of studies on the impact of ICT on various aspects of development (Aker and Mbiti, 2010), health (Qiang et al., 2011), financial inclusion (Jack and Suri, 2014), industry competition (Jerbashian and Kochanova, 2016b) and aggregate economic performance (Ketteni et al., 2011), empirical research of e-government is scarce.[3] The theoretical literature on taxation emphasizes the importance of tax enforcement on compliance (Kopczuk and Slemrod, 2006; Gordon and Li, 2009), and a few empirical studies suggest ICT can help. Ali et al. (2014) and Eissa and

[2] According to Heeks (2008) about 30 percent of government ICT projects fail being abandoned before completion; and another 50 – 60 percent has significant budget and time overruns.
[3] For an assessment of the state of research on e-government see, for example, Heeks and Bailur (2007).

Zeitlin (2014) find that the introduction of electronic machines to record sales transactions of firms improved tax compliance and revenue mobilization in Ethiopia and Rwanda, respectively. Yilmaz and Coolidge (2013) demonstrate that e-filing significantly reduced tax compliance costs for firms in South Africa, but not in Ukraine or Nepal. However, these studies are country specific or compare a few cases at best. Our paper is the first to systematically examine the effects of e-filing cross-nationally and shows that government investments in e-filing systems could substantially increase tax revenue and improve the business climate by encouraging and facilitating tax compliance.[4]

Empirical studies of the impact of e-procurement are country-specific or limited to small samples of relatively homogenous cases. For example, Nepelski (2006), using data from several European countries, finds that e-procurement increases the amount of market transactions and improves supply chain management. Lewis-Faupel et al. (2014) find that e-procurement in India and Indonesia improved the quality of public infrastructure projects through the increase in competition among bidders. In this paper, we analyze the effects of e-procurement implementation on public procurement competitiveness for a large sample of low- and middle-income countries.

This paper is also related to the literature on the impact of ICT on corruption. Muralidharan et al. (2014) and Barnwal (2014) show that biometric registration, authentication, and payment systems significantly reduced corruption and inefficiencies in government workfare and fuel subsidy programs in India by automating tasks and improving monitoring. Banerjee et al. (2014), using the evidence from a large field experiment, conclude that e-government reduces fiscal leakages, but does not necessarily improve outcomes of public programs. This paper, by contrast, finds only weak evidence of a reduction in petty corruption attributable to e-government adoption.

The reminder of the paper is structured as follows. The next section describes the data sources and variables. Section 3 outlines the empirical strategy. Section 4 discusses the results and their implications and presents the robustness checks. And Section 5 concludes.

2. Data

This paper relies on a number of data sets collected by the World Bank. Our primary variables of interest, e-filing and e-procurement adoption dates and system functionality, are taken from the *Global e-Government Systems Database (GeGSD)*, which was prepared for the *World Development Report 2016: Digital Dividends.* Data were compiled by World Bank experts by visiting government websites and consulting World Bank project documents, national legislation and implementation reports, and validated by country economists and government officials.[5] These data cover 198 countries, comprising

[4] Quantifying the effects of e-filing on tax revenue, however, is beyond the scope of this paper.

[5] The *Global e-Government Systems Database* was prepared by a World Bank team comprising Cem Dener, Sophiko Skhirtladze, and Irene H. Zhan for the *World Development Report 2016: Digital Dividends*. It is updated annually in August. Data and summary statistics can be accessed at http://data.worldbank.org/data-catalog/pfm-systems-eservices-dataset. A related dataset focused on digital identification can be found at http://data.worldbank.org/data-catalog/id4d-dataset.

variables related to management information systems for public finance, tax administration, customs, procurement, and human resources, as well as digital identification schemes.

Our explanatory variables of interest are indicators showing when e-government systems were adopted by the central government of each country and the type of the functionality of the adopted systems. The e-filing implementation year refers to the year in which the country first introduced an e-filing system at the given level of functionality. Typically, this occurs after core tax administration systems are in place. Given that e-filing is a relatively new e-government technology, countries have only one iteration of an e-filing system at a given level of functionality. System upgrades that do not constitute an upgrade in system functionality are not recorded in the data set. E-filing functionality is assessed at three levels: 1) informational systems, which provide policy guidance and forms for download; 2) transactional systems, which allow taxes to be filed electronically; and 3) transactional systems with e-payment, which allow for electronic filing and payment of taxes. In the empirical analysis, we distinguish between transactional and transactional with e-payment functionalities. We do not have countries that implemented basic informational systems during our sample period.

The e-procurement implementation year refers to the year in which the most recent iteration of a country's e-procurement system was introduced. E-procurement functionality is also assessed at three levels: 1) informational systems, which provide information about tenders and the results of bid evaluations; 2) transactional systems, which also allow tenders and supporting documents to be submitted and evaluated electronically; and 3) connected systems, in which the transactional system is integrated with other financial management information systems so that budgets, contractual commitments, and payments to vendors are automated. In our analysis we distinguish between informational and transactional systems. Four countries had adopted connected systems by 2014, but data on procurement competitiveness is not available for them, and they are excluded from our analysis.

Figure 1 shows the total number of e-filing and e-procurement systems adopted each year, by functionality. Overall, 125 countries implemented e-filing systems and 73 countries did not implement any system; 142 countries implemented e-procurement systems and 56 countries did not implement any system during the period 1990–2014.

To estimate the impact of e-government, we focus on tax compliance costs, public procurement competitiveness, and corruption measures at the country and firm levels. Tax compliance costs at the country level are the number of tax payments and the time required to prepare and pay taxes, which are available on an annual basis from the *Doing Business* (DB) database.[6] These costs are estimated for a "typical" medium-sized manufacturing firm by in-country experts based on existing regulations and

[6] One caution is that the number of tax payments might be somewhat endogenous with respect to e-filing implementation, as according to its definition "the number of payments takes into account electronic filing. Where full electronic filing and payment is allowed and it is used by the majority of medium-size businesses, the tax is counted as paid once a year even if filings and payments are more frequent." (Source: http://www.doingbusiness.org/methodology/paying-taxes). For completeness, we nevertheless consider this variable in the analysis.

their professional experience. The data are available for 2005–2014. We exclude countries with populations below 500,000, since they can be very different from the rest of the countries. Country-level data related to public procurement competitiveness are not available.

Measures of firm-level tax compliance costs are from the *World Bank Enterprise Surveys* (WBES) conducted during 2006-2014.[7] We use four variables: whether the firm was visited or inspected by tax officials; the frequency of such visits; whether a gift or informal payment was expected or requested in any of the inspections or meetings with tax officials; and the extent to which tax administration is an obstacle to business operations. Firm-level procurement practices and costs are also taken from the WBES. The two variables of interest are: whether the firm has secured or attempted to secure a government contract over the last year; and whether the firm had to pay a bribe to get the contract. We restrict the sample of countries to those that are present in at least two survey waves.

Our main country-level controls comprise: GDP per capita, expressed in terms of purchasing power parity (PPP) from the *World Development Indicators* (WDI) database and the overall polity score, from the *Polity IV* database, which measures political competitiveness, executive recruitment, and constraints on executive action. To measure the level of development we use also gross secondary school enrollment; the number of Internet users from WDI; measures of the rule of law and government effectiveness from the *Worldwide Governance Indicators* (WDI) database; and a measure of business freedom from the Heritage Foundation. In addition we use the time to enforce a contract, the time and number of procedures to start a business, and the time and number of procedures to register a property from DB database to construct a measure of the ease of doing business in a country.

Our firm-level controls are taken from the WBES and comprise firm productivity (real sales per employee) and a vector of indicator variables for whether a firm exports; is publicly traded; has foreign or state ownership; is of medium or large size; communicates with customers using e-mail or website; and has been in operation for less than five years.

Table 1 displays summary statistics of the main variables of interest. A full list of the variables with definitions is provided in Appendix A. Tables A.1–A.3 in the Online Appendix present additional statistics and correlations between the variables.

3. Empirical strategy

To assess the impact of e-filing implementation at the country level, we employ a difference-in-difference (DID) approach in a fixed effects estimation framework. The treatment is the year of e-filing implementation, which varies across countries. Countries that adopted e-filing systems during the sample period are the treated group, and countries that had implemented an e-filing system before 2005 or had not adopted a system by the end of the sample period are the control group. The inclusion in the

[7] The *Enterprise Surveys* are also known as the *Business Environment and Enterprise Performance Surveys* (BEEPS) in the Europe and Central Asia (ECA) region.

control group of countries that have and have not implemented e-filing systems helps to ensure that the treated and control groups are similar to each other on average (Costa 2014).[8]

An important identification assumption for DID estimation is that the control and treated groups have similar trends in the dependent variable prior to treatment. For country-level analysis, we test this assumption by analyzing the effects in the years prior to e-filing implementation date (lags). In addition we estimate the effects in the years subsequent to e-filing implementation date (leads) to observe the evolution of the impact over time. The country-level empirical specification is the following:

$$y_{ct} = \sum_{n=-5}^{5} \alpha_{1,n} \, Egov2_{n_{ct}} + \sum_{n=-5}^{5} \alpha_{2,n} \, Egov3_{n_{ct}} + \beta X_{ct} + \eta_c + \lambda_t + \nu_r \times \lambda_t + \varepsilon_{ct} \quad (1)$$

The outcome variable y_{ct} is either the logarithm of number of taxes or the logarithm of the time required to prepare and pay taxes in country *c* at time *t*; $Egov2_{n_{ct}}$ is an indicator for an observation taking place *n* years before and after the adoption of a transactional e-filing system; and $Egov3_{n_{ct}}$ is an indicator for an observation taking place *n* years before and after the adoption of a transactional e-filing system with e-payment functionality. Since all countries have only one iteration of e-filing, we can include $Egov2$ and $Egov3$ jointly in one regression equation. We make the 5 year cut-off, with observations before and after 5 years of the introduction of the e-filing system merged into categories $Egov2_{-5_{ct}}$ and $Egov3_{-5_{ct}}$, and into $Egov2_{5_{ct}}$ and $Egov3_{5_{ct}}$respectively. The reference groups in this regression are $Egov2_{-1_{ct}}$ and $Egov3_{-1_{ct}}$, which are observations in the last year prior to the adoption of an e-filing system and e-filing system with e-payment functionality respectively, as we expect to see the effects immediately in the year of adoption. X_{ct} is a vector of control variables that includes the logarithm of GDP per capita (PPP) and Polity index; η_c stands for country fixed effects that remove time-invariant country characteristics; λ_t captures the year fixed effects and allows for DID estimation;[9] ν_r is the set of dummy variables indicating the country's geographical region, so that $\nu_r \times \lambda_t$ is a full set of region-year fixed effects that removes region-specific shocks (direct region effects are not included, since they are subsumed by country fixed effects); and ε_{ct} is the error term that satisfies the usual assumptions.

The set of coefficients of interest are $\alpha_{1,n}$ and $\alpha_{2,n}$. Each of them represents the expected difference in the outcome variables between treated and control groups at time *n* relative to the reference year -1 (one year before e-government implementation). Negative signs of the coefficients $\alpha_{1,n}$ and $\alpha_{2,n}$, where $n \in [0; 5]$ would indicate a reduction of tax compliance costs after the adoption of the e-filing systems. The coefficients $\alpha_{1,n}$ and $\alpha_{2,n}$, where $n \in [-5; -2]$ allow us to test the DID identifying assumption—the similarity of pre-trends in outcome variables for treated and control groups. Since our dependent

[8] Countries that already adopted e-government are on average richer, while countries that have not adopted are poorer than those that implemented e-government during the sample period. Combing these two sets of countries therefore makes the treated and control groups more similar.

[9] Without year fixed effects the identification would come only from within-country variation for countries that switched e-government status during the sample period. Countries that never changed e-government status would not be taken into account when estimating $\alpha_{1,n}$ and $\alpha_{2,n}$.

variables are restricted to zero from the bottom, we estimate specification (1) using tobit models.[10] We cluster standard errors at the country level.

We use data from the WBES to evaluate the impact of e-filing on tax compliance costs and e-procurement on public procurement competitiveness at the firm level. Since we have only two time periods for each country, it is not appropriate to estimate the pre- and post-implementation effects from specification (1) as we do at the country level. Therefore, we estimate the following regression:

$$y_{ict} = \alpha_1 Egov2_{ct} + \alpha_2 Egov3_{ct} + \beta X_{ct} + \gamma Z_{ict} + \mu_s + \eta_c + \lambda_t + \varepsilon_{ict} \quad (2)$$

The outcome variable y_{ict} is an indicator of whether a firm was visited by a tax official, the number of such visits, whether a bribe was requested or expected during the visits, or firms' perception of tax administration as an obstacle to conducting business. The outcome variables y_{ict} to test the effect of e-procurement adoption are the indicator of whether a firm secured or attempted to secure a government contract in the previous year and whether a firm offered a bribe to secure the contract. In the case of e-filing, $Egov2_{ct}$ is an indicator for whether a transactional system is in place at time *t* and $Egov3_{ct}$ is an indicator for whether a transactional system with e-payment is in place at time *t.* In the case of e-procurement, $Egov2_{ct}$ is an indicator for whether an informational system is in place at time *t* and is $Egov3_{ct}$ is an indicator for whether a transactional system is in place at time *t*.

We add a vector of firm-specific characteristics, Z_{ict}, to the set of country-level control variables X_{ct}. These variables are described in Section 2 and defined in details in Appendix A. In contrast to specification (1), we control for sector fixed effects μ_s, and do not control for the region-specific shocks ($\nu_r \times \lambda_t$), since our sample includes only a few countries outside of Europe and Central Asia (ECA) and Sub-Saharan Africa (SSA) regions. The WBES database for the ECA region also allows us to explore the panel structure of the data and control for firm fixed effects. We use a probit model for all specifications that involve binary dependent variables, and we use a tobit model when the dependent variable is the number of tax visits.[11] In all cases we cluster standard errors at the industry-country levels.

Finally, we are interested in whether the effects of e-government vary with a country's level of development. To explore this question, we combine leads and lags of e-government implementation, as well as levels of system functionality, since we are interested in general effects. The country-level specification is:

$$y_{ct} = \alpha Egov_{ct} + \theta Egov_{ct} \times Dev_{ct} + \beta X_{ct} + \eta_c + \lambda_t + \nu_r \times \lambda_t + \varepsilon_{ct} \quad (3)$$

$Egov_{ct}$ is an indicator of whether e-government is in place in country *c* at time *t*. Dev_{ct} is the proxy for development in country *c* at time *t*. Proxies assessed include GDP per capita (PPP), gross secondary

[10] In addition, we remove 99th percentile of the distribution of the dependent variables as outliers. For robustness check we estimate (1) using OLS, and confirm that the results remain the same.

[11] In addition, for this variable we remove the 95th percentile of its distribution as outliers. For robustness check, we estimate (2) using OLS.

school enrollment, Internet use, rule of law, government effectiveness, and business freedom. Since these development measures are highly correlated, we estimate separate regressions for each of them. The vector X_{ct} includes Dev_{ct}. We build firm-level specifications in a similar way. The coefficient of interest is θ.

4. Results and discussion

4.1. Tax compliance and e-filing

4.1.1. Country-level evidence

The coefficients $\hat{\alpha}_{1,n}$ and $\hat{\alpha}_{2,n}$ from specification (1) are depicted in Figure 2, and the complete estimates are presented in Appendix B. Each dot on the graph shows the estimated coefficient, which is the difference in the outcome variable between the treated and control groups at year *n* compared to the difference in outcome variables for these groups in the reference year (one year prior to e-filing system implementation). Dashed lines show the 95 percent confidence intervals.

Our estimates suggest that transactional e-filing systems that do not feature e-payment functionality do not significantly reduce tax compliance costs in the short or medium run, as the number of tax payments and the time required to prepare and pay taxes are not statistically different between the treated and control groups (Figure 2, left parts). In the year of adoption and the years following, the effects gradually increase, and become statistically significant only in the long run, after year five. Moreover, in the 2 to 4 years prior to e-filing implementation, tax compliance costs in the treated group were actually lower (at the 5 or 10 percent level of significance) than in the control group. This observation suggests a violation of the assumption about common pre-trends in the control and treated group. Ignoring the lags in specification (1) (*n = -4, -3, -2*) would lead to a positive bias in the estimated impact of transactional e-filing system implementation, at least in the short run, when the impact is actually not statistically significant.

In contrast, the implementation of transactional e-filing systems with e-payment functionality significantly reduces tax compliance costs, as measured by both the number of tax payments and the time required to prepare and pay taxes (Figure 2, right parts). The effects are almost immediate and become stronger in subsequent years. The assumption about common pre-trends is not violated, as the effects estimated at *n = -5, -4, -3, -2* are not statistically significant.

The results suggest that only the adoption of the more advanced e-filing system that includes an e-payment option significantly reduces tax compliance costs. Using the coefficients from regressions, we can estimate the economic impact of introducing such systems. Compared to one year prior to implementation, the average number of tax payments are reduced by 12 percent in the year of implementation, by 17 percent in the first year following implementation, and by 39 percent in the second year following implementation. Similarly, compared to one year prior to implementation, the average time required to prepare and pay taxes are reduced by 5 percent, 10 percent, and 16 percent

respectively in the year of implementation through to the second year following implementation.[12] These are economically sizable numbers.[13]

One potential problem with our analysis is confounding policy reforms that coincide with the adoption of e-filing. To address this concern, we use two variables to proxy for reforms and the overall business climate in a country. One measure is the first principle component of the time to enforce a contract, the time and number of procedures to start a business, and the time and number of procedures to register a property (denoted as the "doing business" variable in the Table B.1.). We take these components from the *Doing Business* database. Higher values of the constructed variable reflect a larger burden on business. The second measure is the business freedom index from the Heritage Foundation, where higher values represent more economic freedom for businesses. If these variables capture country-level reforms, and e-filing implementation is only a consequence of these reforms, then the effects of e-filing should be much lower after controlling for either of these proxies. Table B.1 in the Online Appendix reports the results of estimating specification (1) without lags and leads. In columns (I) and (II) only standard controls are includes, in columns (III) and (IV) the first principal component of the set of doing business indicators is added, and in columns (V) and (VI) the business freedom index is included. Both proxies are highly correlated with our tax compliance costs measures; however, the coefficients on the e-filing dummy variables remain qualitatively the same. This suggests that e-filing implementation has an effect independent of policy reforms and the business environment.

4.1.2. Firm-level evidence

Table 2 shows the results of the estimation of specification (2). According to column I, the coefficients α_1 and α_2 on the e-filing indicator variables are negative and highly significant. The probability of being inspected by a tax official, therefore, drops by 9 percent and 8 percent respectively when a transactional e-filing or a transactional e-filing with e-payment is adopted. The impact on the number of tax visits is statistically significant at only 10 percent and only when transactional e-filing is adopted (column II). In that case, the number of visits drops by 4 percent.

Overall, our results suggest that e-filing implementation directly decreases tax compliance costs. Remarkably, our results from firm-level analysis are consistent with country-level estimates, despite using different measures of the same concept. These findings are also supported by the fact that firm managers are less likely to perceive tax administration as an obstacle to firms' operation and growth when transactional e-filing with e-payment is adopted (column III). We also find that the adoption of transactional e-filing reduces the probability of paying bribes to tax officials by 5 percent (column IV). These results remain qualitatively the same if we also control for overall business environment in a

[12] To derive the estimated effect, we compute: $1 - \exp(\hat{\alpha}_{1,n})$ and $1 - \exp(\hat{\alpha}_{2,n})$.

[13] Since no cross-national data are available on expenditures on e-government we are unable to provide any cost-benefit analysis of these investments in e-government. Clearly these returns also depend on whether governments adequately maintain the ICT infrastructure, and on data integrity and cyber-security.

country using the constructed measure of doing business and the business freedom index (Table B.2 in the Online Appendix).

One interesting observation from the Table 2 is that higher GDP per capita (PPP) is associated with a higher number of visits by tax officials and a more common perception of tax administration being an obstacle to business operations and growth. This signals that richer developing countries also have a more cumbersome tax administration bureaucracy. We also find that more productive and larger firms and those that export face a higher tax compliance burden.

4.2. Competitiveness of public procurement and E-procurement

We next analyze the impact of e-procurement implementation on competitiveness of public procurement and the probability that firms had to pay bribes to secure a government contract. Table 2, Columns V and VI present the results. Although we expect the adoption of e-procurement to increase the likelihood that firms participate in public tenders and to limit corruption, our estimates demonstrate this is not the case. We obtain insignificant coefficients on both informational and transactional e-procurement systems. When we control for a country's overall business environment the results remain insignificant (and we therefore we do not report them). The results also show that firms with higher productivity, state ownership, larger size, publicly traded, or web-presence tend to participate more often in government tenders. Firms with lower productivity, smaller size, higher export shares, or which are not publicly traded are more likely to pay bribes to secure a government contract.

Our results suggest that automation may be less effective in public procurement. By its nature, public procurement requires more discretion from government officials than tax administration, particularly for complex activities where evaluating bids for technical compliance or value for money requires considerable judgment. Public procurement also involves decisions over potentially much larger sums of money than tax returns, thereby increasing the opportunities and incentives for corruption. Given that far fewer firms bid for government contracts than file taxes, it is more susceptible to collusive relationships between bureaucrats and firms. In addition, more transparent information about government contracts may itself encourage collusion (Center for Global Development, 2014). Another explanation is that implementation of relatively unsophisticated informational or transactional e-procurement systems might not be enough to improve public procurement competitiveness. Only four high-income countries have adopted connected e-procurement systems, but they are not considered in our firm-level analysis given lack of data for our outcome variables. Finally, it is possible that firms' reports of securing or attempting to secure a government contract from the WBES database may not adequately capture public procurement competitiveness. More research is therefore needed to assess the impact of e-government on public procurement competitiveness.

4.3. Development and E-government

Finally, we examine whether the relationship between tax compliance costs, public procurement competitiveness, and the adoption of e-government systems depends on countries' level of development. We expect that countries with higher income, stronger institutions, better technology, and more skilled workers experience greater returns from e-government. Our main proxy for development is GDP per capita (PPP); we also consider other measures such as rates of gross secondary school enrollment and Internet use and measures of the rule of law, government effectiveness, and business freedom. The higher values of these measures correspond to higher level of development.

4.3.1. Country-level evidence

Table 3, columns I and II, presents the results of estimating specification (3) for e-filing at the country level. The coefficient on the interaction term between the e-filing indicator and GDP per capita (PPP) is negative and significant for the number of tax payments, but is not significant for the time required to prepare and pay taxes. For the other measures of development we again obtain negative signs on the interaction terms (Table B.3 in the Online Appendix). The effects are particularly strong for the number of Internet users per capita, government effectiveness, and business freedom index. These results confirm our expectations and suggest that a country needs to have the necessary human capital, regulatory environment, and institutions to fully exploit investments in ICT. More developed countries also tend to have greater resources to design and implement advanced e-filing systems with e-payment functionality, which contributes to greater reductions in tax compliance costs. The estimates also allow us to calculate, for example, the level of GDP per capita at which e-filing implementation reduces tax compliance costs. When GDP per capita (PPP) exceeds approximately $3,200, the adoption of e-filing leads to the reduction of the number of tax payments and the time to prepare and pay taxes.

4.3.2. Firm-level evidence

Table 3, columns III and VI, and Table B.4 in the Online Appendix present the results of estimating specification (3) using the firm-level data for e-filing. We find a negative and significant effect on the e-filing and income interaction term only for the number of tax visits. With respect to other development measures (Table B.4), we find that higher gross secondary school enrollment and the number of Internet users in a country significantly reduces the number of visits by tax officials, perception of tax administration as an obstacle, and the incidence to bribe tax officials when e-filing is adopted. In the case of the business freedom index, we also find negative and significant coefficients on the interaction terms when estimating the impact on the perception of tax administration as an obstacle and the incidence of bribery. Only for the rule of law indicator as a proxy for the level of development do we find a negative and significant coefficient on the interaction term for the probability of being visited by a tax official. These results, in general, are in line with the country-level evidence. However, they also show that for a sample of developing countries proxies for development and institutions are more heterogeneous.

Table 3, columns VII and VIII, and Table B.5 display the results of estimating specification (3) for e-procurement implementation. We find that e-procurement increases the probability that firms bid on government contracts only in relatively richer countries with incomes approximately above $11,300 per capita (PPP). We also find that the competitiveness of public procurement is strongly increasing with the other proxies of development after e-procurement is implemented (Table B.5). This finding is consistent with our earlier discussion of the more discretionary nature of public procurement and its vulnerability to collusion, control of which requires strong institutions that are more likely to prevail in higher-income countries. Finally, we do not find a significant effect for the interaction term on the probability to pay bribes to secure a government contract.

4.4. Robustness checks

We conduct several tests to check the robustness and sensitivity of our findings.[14] First, we check how the results change if we drop region-specific shocks from specification (1). We combine leads and lags, so that $Egov2$ and $Egov3$ indicators equal one if e-government is implemented, and zero otherwise. Since these shocks absorb a part of country-level variation we expect to obtain large effects. Table B.6, columns I and II, in the Online Appendix show that the coefficients on $Egov3$ are larger in absolute value for both dependent variables: the number of tax payments and the time required to prepare and pay taxes. In our main analysis, we thus report the conservative estimates.

Second, we check whether our results hold on a "balanced" sample. We restrict the sample of countries to those that implemented e-filing systems during the 2007–2012 period, and exclude those that implemented in 2005–2006 and 2013–2014. Using this "balanced" sample we can observe tax compliance costs at least two years before and two years after the adoption of e-filing systems, which allows for a better DID comparison. Table B.6, columns III and IV, 6 report the results. The coefficients on $Egov3$ increase in absolute value, which indicates that the actual impact of e-filing might be larger than that presented in our main analysis. The coefficients on $Egov2$ remain insignificant.

Third, we check if the results from Section 4.1 hold if we restrict the sample of countries to those that are included in the firm-level analysis (64 developing countries). Given that the impact of e-filing increases with the level of development, we expect to obtain weaker results. For both outcome variables, the magnitude of the coefficients on $Egov3$ drops by one-third relative to the full sample, and are not significant even at the 10 percent level (Table B.6, Columns V and VI, Online Appendix). This is consistent with the observation from Section 4.3 that the impact of e-government is weaker in less developed countries.

Next, we conduct placebo tests, by randomly assigning years of e-government implementation to a group of random countries. We keep the number of randomly treated countries the same as the actual treated countries: 25 percent for country-level analysis, 27 percent for firm-level analysis and e-filing. We find

[14] Due to the space limitation the results from robustness checks are available in the Online Appendix.

that previously negative effects of e-filing adoption are insignificant when we use placebo treatments (Table B.6, columns VII and VIII, and Table B.7 in the Online Appendix). We thus confirm that the results presented in Section 4.1 are not random, and that e-filing implementation does indeed reduce tax compliance costs. We do not conduct similar tests for public procurement, as the direct effects on e-procurement are not significant in the main analysis.

Our firm-level data for the ECA region allows us to control for firm fixed effects. Therefore, we repeat firm-level analysis on the sub-sample of firms from the ECA region and compare estimates from two different sources of variation: within country and sector and within firm (Tables B.8 and B.9 in the Online Appendix).[15] The estimated coefficients for this sub-sample generally have the same sign and significance level as those for the full sample of developing countries. The magnitudes of the coefficients, however, are often different, which reflects region-specific differences in the impact of e-government implementation. Importantly, for the number of visits by a tax official, the coefficient on $Egov3$ increases in absolute value and becomes highly significant when firm fixed effects are taken into account. Similarly, for the likelihood to pay bribes to secure a government contract, the coefficient on $Egov3$ is not positive or significant when firm fixed effects are taken into account, in contrast to the estimation with year, sector, and country fixed effects that had suggested e-procurement resulted in more corruption. These observations highlight the importance of controlling for firm fixed effects in firm-level analysis, as they help to remove unobservable firm specific characteristics that can bias estimates. Unfortunately, the paucity of WBES data limits the cases in which firm fixed effects can be applied.

Finally, we confirm that in all cases we get similar results if we use OLS methods instead of tobit and probit. For firm-level analysis, we also confirm that the results remain qualitatively the same if we do not control for the labor productivity measure, which increases the sample size by 15 percent, and if we use a categorical measure of the tax administration obstacle instead of a binary variable.

5. Conclusion

This paper is the first attempt to assess the impact of e-government adoption on public sector capacity cross-nationally. We exploit the new *Global e-Government Systems Database*, developed by the World Bank, and the measures of tax compliance and public procurement competitiveness from the *Doing Business* and *Enterprise Survey* databases. Our results show that e-government can substantially improve government capacity, but the estimated effects vary by the type and functionality of e-government systems adopted, government activity and country context.

E-filing systems can significantly reduce the number of tax payments and the time required to prepare and pay taxes. They can also reduce the likelihood and frequency of visits by tax officials, thereby lowering tax compliance costs. Since these costs are frequently cited as a major impediment of the business climate, investments in e-filing can have potentially significant economic returns. However,

[15] We estimate all regressions for the ECA region using OLS method.

the benefits often occur with the adoption of more advanced, and therefore costlier, e-filing systems that feature an e-payment option. Moreover, the gains often are conditional on a country's level of development, suggesting the returns to e-government are partly a function of human capital and institutional quality.

In contrast, we do not find a significant direct impact of e-procurement on the competitiveness of public procurement, which points to the limitations of technology in addressing major governance problems. One possible explanation is that the scope for automation in improving performance differs across activities. Tax filing is highly amenable to automation, as it follows a standardized set of procedures that can be digitized. Doing so reduces or eliminates travel time to tax offices, limits the number of forms and discrete actions that taxpayers must complete, and greatly reduces bureaucratic discretion and face-to-face contact between public officials and businesses. In contrast, procurement of complex or high-value works, goods, or services requires considerable discretion of officials in evaluating different bids. E-procurement can make information about tenders and contracts widely available, and can automate bid submission, but it cannot automate the actual evaluation of bids. It is therefore not surprising that the adoption of e-procurement significantly improves public sector competitiveness only in countries with higher incomes, better rule of law, and more effective governments.

Notably, we find only weak association between e-government and corruption. The incidence to bribe tax officials is reduced only with the adoption of simpler transactional e-filing systems that do not have an e-payment option. None of the other e-filing or e-procurement systems produced this effect. This suggests that government officials can find ways to illicitly profit in spite of e-government innovations. In particular, the payoffs from collusive or corrupt practices in public procurement are often very high, especially in lower-income countries. This creates strong vested interests that resist competition and transparency. It is unlikely that e-procurement can overcome rent-seeking behavior of firms and public officials in the absence of complementary institutional reforms.

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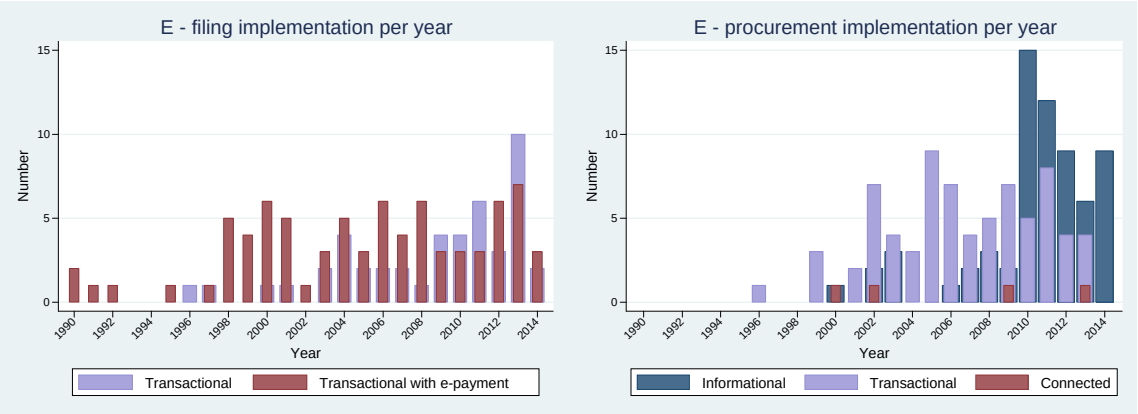
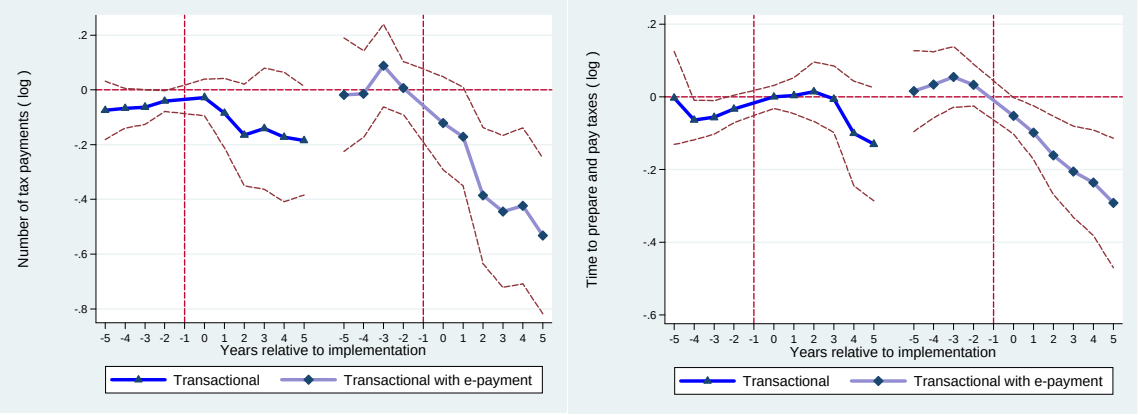
Figures and Tables

Figure 1: Timing of e-government adoption, by system functionality (1990–2014)



Note: These figures show the number of countries that adopted e-filing and e-procurement systems each year by the level of system functionality. For example, in 2000 one country implemented transactional e-filing and six countries implemented e-filing with e-payment.

Figure 2: The impact of e-filing on tax compliance costs



Note: These figures plot the coefficients on indicator variables for the years before and after the adoption of the e-filing system, estimated from specification (1). The reference group is year -1, one year before the adoption. Left parts of the graphs show the effects of transactional e-filing system implementation, while right parts show the effects of transactional with e-payment system implementation. Dashed lines indicate 95% confidence intervals.

Table 1: Summary statistics of main variables

Variable	N obs.	Mean	SD
For country-level data			
E-filing2	1494	0.11	0.31
E-filing3	1494	0.31	0.46
Tax number	1388	3.19	0.76
Tax time	1388	5.54	0.69
For firm-level data			
E-filing2	72830	0.13	0.34
E-filing3	72830	0.35	0.48
E-procurement2	72830	0.17	0.37
E-procurement3	72830	0.39	0.49
Tax visit	71882	0.61	0.49
Tax visit number	42159	1.24	0.65
Tax obstacle	72830	0.67	0.47
Tax bribe	42357	0.17	0.38
Procurement	40041	0.19	0.39
Procurement bribe	20515	0.25	0.44

Table 2: The impact of e-government adoption on tax compliance costs and public procurement

	Tax visit	Tax visit number	Tax obstacle	Tax bribe	Procurement	Procurement bribe
	(I)	(II)	(III)	(IV)	(V)	(VI)
E-filing2	-0.093***	-0.032*	-0.061	-0.054***		
	(0.029)	(0.018)	(0.047)	(0.016)		
E-filing3	-0.078***	0.008	-0.168***	0.018		
	(0.025)	(0.022)	(0.022)	(0.017)		
E-procurement2					0.000	-0.041
					(0.025)	(0.036)
E-procurement3					-0.014	0.042
					(0.017)	(0.038)
GDP	-0.046	0.224***	0.226**	-0.019	0.056	-0.261
	(0.073)	(0.080)	(0.102)	(0.070)	(0.071)	(0.169)
Polity	-0.012	0.377***	-0.011	-0.069**	-0.059	0.024
	(0.031)	(0.041)	(0.034)	(0.030)	(0.037)	(0.074)
Productivity	0.013***	0.006***	-0.000	-0.000	0.007***	-0.013***
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.003)
Exporter	0.032***	0.033***	0.032***	0.003	-0.011	0.026**
	(0.007)	(0.009)	(0.006)	(0.006)	(0.008)	(0.012)
Foreign	0.016**	-0.009	-0.008	0.002	-0.022***	0.007
	(0.008)	(0.009)	(0.007)	(0.008)	(0.007)	(0.014)
State	-0.011	0.011	-0.009	-0.012	0.079***	0.003
	(0.020)	(0.021)	(0.017)	(0.014)	(0.019)	(0.029)
Medium	0.089***	0.036***	0.029***	0.009*	0.058***	-0.008
	(0.006)	(0.007)	(0.005)	(0.005)	(0.006)	(0.009)
Large	0.192***	0.076***	0.037***	-0.003	0.069***	-0.064***
	(0.008)	(0.010)	(0.007)	(0.007)	(0.010)	(0.013)
Internet use	0.004	-0.005	0.023***	0.008	0.092***	0.012
	(0.008)	(0.008)	(0.007)	(0.006)	(0.007)	(0.010)
Listed	0.011	-0.009	0.004	-0.034***	0.041***	-0.060***
	(0.012)	(0.012)	(0.011)	(0.009)	(0.010)	(0.016)
N obs.	59,720	33,418	60,124	35,694	32,683	18,428
N countries	64	64	64	64	40	64
R2 pseudo	0.116	0.181	0.074	0.175	0.100	0.159

Note: This table reports the results from the estimation of specification (2) for the dependent variables identified in the headline using firm-level data. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. E-procurement2 equals 1 if an informational e-payment system is in place. E-procurement3 equals 1 if a transactional e-procurement system is in place. Marginal effects are reported after probit estimation. Definitions of the variables are in Appendix A and in Section 2 of the text. All regressions include country, industry, and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table 3: The impact of e-government at different levels of development

	Tax number (I)	Tax time (II)	Tax visit incident (III)	Tax visit (IV)	Tax obstacle (V)	Tax bribe (VI)	Procurement (VII)	Procurement bribe (VIII)
E-filing	1.376***	0.426	-0.400**	0.274*	-0.014	-0.155		
	(0.522)	(0.293)	(0.166)	(0.140)	(0.216)	(0.111)		
E-filing*GDP	-0.171***	-0.053	0.037*	-0.033**	-0.012	0.016		
	(0.061)	(0.033)	(0.021)	(0.016)	(0.024)	(0.014)		
E-procurement							-0.448***	0.148
							(0.125)	(0.268)
E-procurement*GDP							0.048***	-0.017
							(0.014)	(0.030)
GDP	-0.160	-0.345**	-0.047	0.239***	0.194**	0.013	0.101	-0.317*
	(0.187)	(0.160)	(0.074)	(0.079)	(0.098)	(0.067)	(0.068)	(0.171)
N obs.	1,478	1,480	59,720	33,418	60,124	35,694	32,683	18,428
N countries	152	151	64	64	64	64	40	64
R2 pseudo	1.047	1.556	0.116	0.181	0.074	0.175	0.101	0.159

Note: This table reports the results from the estimation of specification (3) for the dependent variables identified in the headline using country-level data (columns I and II) and firm-level data (columns III–VIII). E-filing equals 1 if an e-filing system is in place. E-procurement equals 1 if an e-payment system is in place. GDP per capita (PPP) is a proxy for the level of development in a country. Marginal effects are reported after probit estimation. Definitions of the variables are in Appendix A and Section 2 of the text. All regressions include country, industry, and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Appendix

Appendix A: Description of variables

Variable	Description
Main Country-level variables	
E-filing2	Indicator variable that equals 1 if a transactional e-filing system is in place. Source: GeGSD.
E-filing3	Indicator variable that equals 1 if a transactional e-filing system with e-payment is in place. Source: GeGSD.
E-procurement2	Indicator variable that equals 1 if an informational type e-procurement system is in place. Source: GeGSD.
E-procurement3	Indicator variable that equals 1 if a transactional e-procurement system is in place. Source: GeGSD.
Tax number	Logarithm of the number of tax payments. Source: Doing Business Indicators.
Tax time	Logarithm of time required to prepare and pay taxes (hours). Source: Doing Business Indicators.
GDP	Logarithm of GPD per capita (PPP) in international 2011 constant dollars. Source: WDI.
Polity	Polity2 index divided by 10. Source: Polity IV dataset.
Other Country-level variables	
Enrollment	Gross secondary school enrollment (% of school-age population) divided by 100. Source: WDI.
Internet	Internet users per capita. Source: WDI.
Rule of law	Index measuring the perception of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence. Source: WGI.
Government effectiveness	Index measuring the perception of the quality of public and civil services and the degree of their independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Source: WGI.
Business freedom	Index of the efficiency of government regulation of business. Source: The Heritage Foundation
Doing business	The first principle component of the time to enforce a contract, the time and number of procedures to start a business, and the time and number of procedures to register a property. Source: DB.
Firm-level variables	
Tax visit	Indicator variable that equals 1 if respondent replies “yes” to the following question: “Over the last 12 months, was this establishment visited and or inspected by tax officials?” Source: WBES.
Tax visit number	Logarithm of the number of tax visits, derived from the question: “Over the last 12 months, how many times was this establishment either inspected by tax officials or required to meet with them?” Source: WBES.
Tax obstacle	Indicator variable that equals 1 if respondent replies “Major Obstacle” or “Very Severe Obstacle” to the following question: “As I list some of many factors that can affect the current operations of a business, please look at this card and tell me if you think that each factor [tax administration] is No Obstacle, a Minor Obstacle, a Major Obstacle, or a Very Severe Obstacle to the current operations of this establishment.” Source: WBES.
Tax bribe	Indicator variable that equals 1 if respondent replies “yes” to the following question: “In any of these inspections or meetings was a gift or informal payment expected or requested?” Source: WBES.
Procurement	Indicator variable that equals 1 if respondent replies “yes” to the following question: “Over the last 12 months, has this establishment secured a government contract or attempted to secure a contract with the government?” Source: WBES.
Procurement bribe	Indicator variable that equals 1 if respondent reports a positive amount replying to the following question: “When establishments like this one do business with the government, what percent of the contract value would be typically paid in informal payments or gifts to secure the contract?” Source: WBES.
Productivity	The share of real sales in USD over number of employees. Source: WBES.
Exporter	Indicator variable equal to 1 if a firm exports. Source: WBES.
Foreign	Indicator variable equal to 1 if a firm has any amount of foreign ownership. Source: WBES.
State	Indicator variable equal to 1 if a firm has any amount of state ownership. Source: WBES.
Medium	Indicator variable equal to 1 if a firm has more than 20 employees but less than 99. Source: WBES.
Large	Indicator variable equal to 1 if a firm has more than 100 employees. Source: WBES.
Internet use	Indicator variable equal to 1 if a firm uses e-mail or a website to communicate with customers and suppliers. Source: WBES.
Listed	Indicator variable equal to 1 if a firm is listed on the stock exchange. Source: WBES.

Appendix B: The impact of e-filing adoption on tax compliance costs at the country level

	Tax number (I)	Tax time (II)
E-filing2$_{-5}$	-0.075	-0.003
	(0.054)	(0.065)
E-filing2$_{-4}$	-0.067*	-0.064**
	(0.037)	(0.028)
E-filing2$_{-3}$	-0.063*	-0.056**
	(0.032)	(0.024)
E-filing2$_{-2}$	-0.041**	-0.033*
	(0.019)	(0.019)
E-filing2$_{0}$	-0.028	0.000
	(0.034)	(0.016)
E-filing2$_{+1}$	-0.085	0.004
	(0.064)	(0.025)
E-filing2$_{+2}$	-0.165*	0.014
	(0.095)	(0.042)
E-filing2$_{+3}$	-0.142	-0.006
	(0.113)	(0.047)
E-filing2$_{+4}$	-0.173	-0.101
	(0.120)	(0.073)
E-filing2$_{+5}$	-0.185*	-0.130
	(0.101)	(0.080)
E-filing3$_{-5}$	-0.018	0.016
	(0.106)	(0.057)
E-filing3$_{-4}$	-0.015	0.034
	(0.080)	(0.046)
E-filing3$_{-3}$	0.088	0.055
	(0.077)	(0.043)
E-filing3$_{-2}$	0.006	0.033
	(0.050)	(0.029)
E-filing3$_{0}$	-0.122	-0.052**
	(0.087)	(0.026)
E-filing3$_{+1}$	-0.171*	-0.098***
	(0.092)	(0.038)
E-filing3$_{+2}$	-0.386***	-0.161***
	(0.127)	(0.055)
E-filing3$_{+3}$	-0.444***	-0.206***
	(0.141)	(0.064)
E-filing3$_{+4}$	-0.423***	-0.236***
	(0.145)	(0.074)
E-filing3$_{+5}$	-0.533***	-0.292***
	(0.145)	(0.091)
GDP	-0.139	-0.300*
	(0.193)	(0.162)
Polity	-0.008	0.038
	-0.075	-0.003
N observations	1,478	1,480
N countries	152	151
R2 pseudo	1.073	1.599

Note: This table reports the results from the estimation of specification (1) for the dependent variables identified in the headline. Detailed definitions of the variables are provided in Appendix A and Section 2 of the text. Both regressions include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country level. *** p<0.01, ** p<0.05, * p<0.1.

Online Appendix

Online Appendix A: Additional summary statistics

Table A.1: Summary statistics and pairwise correlations of country-level variables

		Summary statistics			Correlations				
		N obs.	Mean	SD	1	2	3	4	5
1	Tax number	1553	3.17	0.78					
2	Tax time	1553	5.51	0.69	0.40*				
3	E-filing2	1640	0.12	0.32	-0.00	0.09*			
4	E-filing3	1640	0.32	0.47	-0.45*	-0.13*	-0.25*		
5	GDP	1562	9.06	1.25	-0.60*	-0.32*	0.09*	0.44*	
6	Polity	1597	0.38	0.63	-0.14*	0.04	0.13*	0.35*	0.17*

Note: * p<0.01.

Table A.2: Summary statistics and pairwise correlations of country-level measures of development

		Summary statistics			Correlations					
		N obs.	Mean	SD	1	2	3	4	5	6
1	GDP	1562	9.06	1.25						
2	Enrollment	1512	0.76	0.30	0.81*					
3	Internet	1610	0.30	0.28	0.79*	0.75*				
4	Rule of law	1620	-0.19	0.99	0.72*	0.65*	0.81*			
5	Government effectiveness	1619	-0.12	1.00	0.76*	0.70*	0.83*	0.96*		
6	Business freedom	1572	0.63	0.18	0.62*	0.62*	0.70*	0.75*	0.78*	
7	Doing business	1540	-0.10	1.62	-0.44*	-0.50*	-0.59*	-0.57*	-0.59*	-0.67*

Note: * p<0.01.

Table A.2: Summary statistics of firm-level variables

	N obs.	Mean	SD
Tax visit	71882	0.61	0.49
Tax visit number	42159	1.24	0.65
Tax obstacle	72830	0.67	0.47
Tax bribe	42357	0.17	0.38
Procurement	40041	0.19	0.39
Procurement bribe	20515	0.25	0.44
E-filing2	72830	0.13	0.34
E-filing3	72830	0.35	0.48
E-procurement2	72830	0.17	0.37
E-procurement3	72830	0.39	0.49
GDP	72830	8.84	0.94
Polity	72830	0.53	0.46
Productivity	60981	9.59	2.14
Exporter	71591	0.22	0.42
Foreign	72020	0.11	0.31
State	72039	0.02	0.14
Medium	72456	0.33	0.47
Large	72456	0.17	0.38
Internet use	72643	0.71	0.45
Listed	72830	0.05	0.23

Table A.3: Pairwise correlations of firm-level variables

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Tax visit																			
2	Tax visit number	0.21*																		
3	Tax obstacle	0.07*	0.08*																	
4	Tax bribe	-0.01	0.15*	0.14*																
5	Procurement	0.03*	0.01	0.03*	0.00															
6	Procurement bribe	0.10*	0.11*	0.13*	0.39*	-0.01														
7	E-filing2	-0.03*	-0.08*	0.001	-0.03*	-0.03*	-0.05*													
8	E-filing3	-0.09*	0.01	-0.07*	-0.13*	0.04*	-0.18*	-0.29*												
9	E-procurement2	0.03*	-0.01	0.007	-0.00	-0.02*	-0.04*	0.05*	-0.04*											
10	E-procurement3	-0.08*	0.01*	-0.02*	-0.15*	0.01*	-0.17*	-0.07*	0.46*	-0.36*										
11	GDP	-0.19*	-0.08*	-0.07*	-0.23*	0.06*	-0.26*	0.11*	0.49*	-0.22*	0.52*									
12	Polity	-0.07*	0.06*	0.04*	-0.20*	0.01	-0.16*	0.11*	0.09*	-0.12*	0.34*	0.31*								
13	Productivity	-0.03*	0.02*	-0.03*	-0.14*	0.05*	-0.13*	0.07*	0.13*	-0.27*	0.13*	0.29*	0.27*							
14	Exporter	0.04*	0.02*	0.05*	-0.05*	0.02*	-0.05*	0.07*	0.06*	0.01*	0.04*	0.10*	0.12*	0.10*						
15	Foreign	0.04*	0.03*	0.01*	-0.03*	0.01*	-0.02*	-0.00	-0.07*	0.02*	-0.04*	-0.05*	0.03*	0.12*	0.19*					
16	State	0.02*	0.01	-0.00	0.01	0.04*	-0.01	0.03*	-0.04*	0.07*	-0.07*	-0.01*	-0.09*	-0.06*	0.06*	0.11*				
17	Medium	0.02*	-0.00	0.02*	-0.01	0.06*	-0.02*	0.00	0.02*	-0.02*	0.03*	0.05*	0.01*	0.04*	0.04*	0.02*	0.00			
18	Large	0.10*	0.04*	0.05*	-0.04*	0.08*	-0.10*	0.01	0.07*	-0.05*	0.07*	0.08*	0.02*	0.09*	0.30*	0.18*	0.08*	-0.32*		
19	Internet use	-0.04*	-0.03*	-0.00	-0.13*	0.15*	-0.15*	0.09*	0.21*	-0.10*	0.25*	0.36*	0.24*	0.30*	0.23*	0.12*	-0.01	0.15*	0.24*	
20	Listed	0.02*	-0.00	0.00	-0.03*	0.05*	-0.06*	-0.02*	0.04*	-0.04*	0.03*	0.06*	-0.02*	0.03*	0.06*	0.09*	0.14*	0.00	0.18*	0.06*

Note: * p<0.01.

Online Appendix B: Additional results and robustness checks

Table B.1: The impact of e-filing on tax compliance costs at the country level

	Tax number	Tax time	Tax number	Tax time	Tax number	Tax time
	(I)	(II)	(III)	(IV)	(V)	(VI)
E-filing2	0.008	0.061	-0.002	0.053	-0.010	0.047
	(0.069)	(0.038)	(0.068)	(0.038)	(0.072)	(0.040)
E-filing3	-0.262***	-0.129***	-0.253**	-0.130***	-0.261***	-0.133***
	(0.101)	(0.041)	(0.098)	(0.040)	(0.101)	(0.040)
Doing business			0.072**	0.027		
			(0.033)	(0.021)		
Business freedom					-0.595***	-0.225*
					(0.204)	(0.131)
GDP	-0.196	-0.344**	-0.121	-0.280*	-0.119	-0.277*
	(0.191)	(0.158)	(0.201)	(0.151)	(0.205)	(0.162)
Polity	-0.063	0.014	-0.079	0.008	-0.079	0.005
	(0.062)	(0.045)	(0.063)	(0.046)	(0.064)	(0.046)
N observations	1,478	1,480	1,465	1,467	1,455	1,457
N countries	152	151	150	149	152	151
R2 pseudo	1.046	1.569	1.061	1.590	1.047	1.586

Note: This table reports the results from the estimation of specification (1) (when leads and lags of the treatment effects are combined) for the dependent variables identified in the headline. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. All regressions include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.2: The impact of e-filing on tax compliance costs at the firm level

	Tax visit	Tax visit number	Tax obstacle	Tax bribe	Tax visit	Tax visit number	Tax obstacle	Tax bribe
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
E-filing2	-0.083***	-0.036**	-0.064	-0.053***	-0.088***	-0.025	-0.061	-0.048***
	(0.029)	(0.018)	(0.047)	(0.017)	(0.030)	(0.018)	(0.047)	(0.017)
E-filing3	-0.059**	0.001	-0.174***	0.018	-0.081***	0.005	-0.168***	0.020
	(0.026)	(0.022)	(0.024)	(0.017)	(0.024)	(0.022)	(0.022)	(0.017)
Doing business	0.031***	-0.021**	-0.011	0.021***				
	(0.008)	(0.009)	(0.012)	(0.007)				
Business freedom					0.139	0.270***	0.002	0.231***
					(0.104)	(0.100)	(0.100)	(0.086)
Other Controls	YES	YES	YES	YES	YES	YES	YES	YES
N obs.	59,720	33,418	60,124	35,694	59,470	33,248	59,874	35,506
R2 pseudo	0.117	0.181	0.075	0.176	0.116	0.181	0.075	0.175

Note: This table reports the results from the estimation of specification (2) for the dependent variables identified in the headline. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. All regressions include country, industry and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.3: Development and the impact of e-filing at the country level

	Tax number (I)	Tax time (II)	Tax number (III)	Tax time (IV)	Tax number (V)	Tax time (VI)
			Panel A			
	GDP		Enrollment		Internet	
E-filing	1.376***	0.426	0.322*	0.078	0.115	0.068
	(0.522)	(0.293)	(0.165)	(0.106)	(0.088)	(0.049)
E-filing*Dev	-0.171***	-0.053	-0.604**	-0.161	-1.011***	-0.438***
	(0.061)	(0.033)	(0.235)	(0.131)	(0.300)	(0.139)
Dev			0.455*	0.085	-0.189	-0.121
			(0.244)	(0.179)	(0.319)	(0.201)
GDP	-0.160	-0.345**	-0.208	-0.347**	-0.149	-0.334**
	(0.187)	(0.160)	(0.198)	(0.164)	(0.170)	(0.150)
N obs.	1,478	1,480	1,415	1,427	1,472	1,474
N countries	152	151	145	145	151	150
R2 pseudo	1.047	1.556	1.033	1.564	1.067	1.571
			Panel B			
	Rule of law		Government effectiveness		Business freedom	
E-filing	-0.244***	-0.071**	-0.207***	-0.067**	1.085***	0.361***
	(0.081)	(0.035)	(0.074)	(0.033)	(0.227)	(0.098)
E-filing*Dev	-0.268***	-0.072	-0.297***	-0.097**	-1.930***	-0.649***
	(0.074)	(0.046)	(0.083)	(0.044)	(0.382)	(0.148)
Dev	0.001	0.126*	-0.068	0.059	0.150	0.010
	(0.110)	(0.074)	(0.109)	(0.076)	(0.217)	(0.140)
GDP	-0.209	-0.416**	-0.143	-0.385**	-0.156	-0.301*
	(0.202)	(0.169)	(0.206)	(0.167)	(0.213)	(0.165)
N obs.	1,478	1,480	1,478	1,480	1,455	1,457
N countries	152	151	152	151	152	151
R2 pseudo	1.051	1.559	1.056	1.558	1.077	1.585

Note: This table reports the results from the estimation of specification (3) for the dependent variables identified in the headline using country-level data. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing equals 1 if an e-filing system is in place. In Panel A, proxies for development are GDP per capita (PPP), gross secondary school enrolment, and the number of internet users per capita. In Panel B, proxies for development are the rule of law, government effectiveness, and business freedom index. All regressions include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.4: Development and the impact of e-filing, firm-level data

	Tax visit	Tax visit number	Tax obstacle	Tax bribe	Tax visit	Tax visit number	Tax obstacle	Tax bribe
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
				Panel A				
		GDP				Enrollment		
E-filing	-0.400**	0.274*	-0.014	-0.155	-0.273***	0.087*	0.167***	0.029
	(0.166)	(0.140)	(0.216)	(0.111)	(0.055)	(0.046)	(0.063)	(0.039)
E-filing*Dev	0.037*	-0.033**	-0.012	0.016	0.215***	-0.145**	-0.363***	-0.077
	(0.021)	(0.016)	(0.024)	(0.014)	(0.069)	(0.056)	(0.077)	(0.054)
Dev	-0.047	0.239***	0.194**	0.013	0.284**	0.466***	0.749***	0.195
	(0.074)	(0.079)	(0.098)	(0.067)	(0.144)	(0.153)	(0.141)	(0.124)
N obs.	59,720	33,418	60,124	35,694	58,625	32,728	59,025	34,957
R2 pseudo	0.116	0.181	0.074	0.175	0.117	0.183	0.076	0.176
				Panel B				
		Internet				Rule of Law		
E-filing	-0.128***	0.044	-0.014	0.023	-0.126***	-0.004	-0.059	-0.030
	(0.037)	(0.027)	(0.035)	(0.027)	(0.024)	(0.021)	(0.037)	(0.021)
E-filing*Dev	0.165	-0.259**	-0.377***	-0.246***	-0.079***	0.013	0.142***	0.010
	(0.128)	(0.101)	(0.126)	(0.094)	(0.030)	(0.026)	(0.049)	(0.036)
Dev	0.094	0.344***	-0.401***	0.214***	0.116**	-0.001	0.178***	0.147***
	(0.125)	(0.111)	(0.119)	(0.071)	(0.058)	(0.050)	(0.057)	(0.050)
N obs.	59,720	33,418	60,124	35,694	59,720	33,418	60,124	35,694
R2 pseudo	0.116	0.181	0.076	0.175	0.116	0.181	0.076	0.175
				Panel C				
		Government effectiveness				Business freedom		
E-filing	-0.093***	0.002	-0.091***	0.006	-0.230**	-0.019	0.295**	0.125
	(0.024)	(0.021)	(0.031)	(0.023)	(0.111)	(0.088)	(0.119)	(0.089)
E-filing*Dev	-0.038	0.035	0.084	0.075	0.226	0.016	-0.652***	-0.222*
	(0.038)	(0.035)	(0.053)	(0.046)	(0.168)	(0.132)	(0.191)	(0.126)
Dev	-0.065	0.026	-0.039	0.025	0.047	0.276**	0.224*	0.319***
	(0.061)	(0.052)	(0.063)	(0.044)	(0.127)	(0.115)	(0.132)	(0.098)
N obs.	59,720	33,418	60,124	35,694	59,470	33,248	59,874	35,506
R2 pseudo	0.116	0.181	0.074	0.175	0.117	0.181	0.075	0.175

Note: This table reports the results from the estimation of specification (3) for the dependent variables identified in the headline using firm-level data. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing equals 1 if an e-filing system is in place. In Panel A, proxies for development are GDP per capita (PPP) and gross secondary school enrolment. In Panel B, proxies for development are the number of internet users per capita and the rule of law index. In Panel C, proxies for development are the government effectiveness and business freedom indexes. All regressions include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.5: Development and the impact of e-procurement at the firm level

	Procurement	Procurement bribe	Procurement	Procurement bribe	Procurement	Procurement bribe
	(I)	(II)	(III)	(IV)	(V)	(VI)
			Panel A			
	GDP		Enrollment		Internet	
E-procurement	-0.448***	0.148	-0.297***	0.056	-0.028	-0.001
	(0.125)	(0.268)	(0.090)	(0.080)	(0.021)	(0.040)
E-procurement*Dev	0.048***	-0.017	0.311***	-0.062	0.097**	0.013
	(0.014)	(0.030)	(0.091)	(0.106)	(0.046)	(0.146)
Dev	0.101	-0.317*	0.245	0.082	-0.242**	-0.003
	(0.068)	(0.171)	(0.171)	(0.216)	(0.099)	(0.164)
N obs.	32,683	18,428	31,594	18,256	32,683	18,428
R2 pseudo			0.102	0.160	0.101	0.159
			Panel B			
	Rule of Law		Government effectiveness		Business freedom	
E-procurement	0.003	0.012	-0.014	0.020	-0.115*	-0.214
	(0.016)	(0.037)	(0.015)	(0.036)	(0.067)	(0.134)
E-procurement*Dev	0.050***	0.010	0.075***	0.014	0.156*	0.336
	(0.017)	(0.040)	(0.018)	(0.045)	(0.093)	(0.225)
Dev	-0.038	0.204***	-0.171***	0.160**	-0.019	0.554***
	(0.060)	(0.068)	(0.050)	(0.076)	(0.118)	(0.182)
N obs.	32,683	18,428	32,683	18,428	32,434	18,333
R2 pseudo	0.101	0.160	0.101	0.159	0.098	0.160

Note: This table reports the results from the estimation of specification (3) for the dependent variables identified in the headline using firm-level data. Definitions of the variables are in Appendix A and Section 2 of the text. E-procurement equals 1 if an e-procurement system is in place. In Panel A, proxies for development are GDP per capita (PPP) and gross secondary school enrolment. In Panel B, proxies for development are the number of internet users per capita and the rule of law index. In Panel C, proxies for development are the government effectiveness and business freedom indexes. All regressions include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.6: Robustness check: the impact of e-filing on tax compliance costs at the country level

	Tax number	Tax time	Tax number	Tax time	Tax number	Tax time	Tax number	Tax time
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
	Without region-specific fixed effects		Balanced sample		Sample of developing countries from WBES		Placebo effects	
E-filing2	-0.043	0.043	-0.033	0.059	-0.020	0.067	0.018	0.008
	(0.073)	(0.035)	(0.095)	(0.044)	(0.089)	(0.054)	(0.022)	(0.013)
E-filing3	-0.332***	-0.133***	-0.335***	-0.161***	-0.151	-0.074	0.016	0.003
	(0.108)	(0.042)	(0.127)	(0.045)	(0.125)	(0.054)	(0.017)	(0.007)
GDP	0.006	-0.271*	-0.107	-0.339**	0.272	-0.404	-0.343*	-0.405***
	(0.192)	(0.153)	(0.236)	(0.146)	(0.347)	(0.349)	(0.206)	(0.157)
Polity	-0.008	0.036	-0.092	-0.042	0.137*	0.189***	-0.074	0.006
	(0.068)	(0.043)	(0.077)	(0.052)	(0.076)	(0.067)	(0.069)	(0.050)
N observations	1,478	1,480	1,215	1,213	622	634	1,478	1,480
N countries	152	151	125	124	64	64	152	151
R2 pseudo	1.000	1.527	1.072	1.649	0.972	1.621	1.029	1.551

Note: This table reports the results from the estimation of specification (1) (when leads and lags of the treatment effects are combined) for the dependent variables identified in the headline. Columns I and II exclude region-specific shocks; Columns III and IV exclude countries that implemented e-filing in 2005–2006 and 2013–2014; Columns V and VI include only developing countries from WBES; Columns VII and VIII randomly distribute treatment (implementation of e-filing) across years and countries. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. All regressions, besides Columns I and II, include country and year fixed effects, and interactions between region and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.7: Robustness check: placebo tests for the impact of e-filing

	Tax visit	Tax visit number	Tax obstacle	Tax bribe
	(I)	(II)	(III)	(IV)
E-filing2	-0.009	0.003	0.004	-0.001
	(0.006)	(0.007)	(0.006)	(0.006)
E-filing3	0.001	0.011*	0.001	0.000
	(0.004)	(0.005)	(0.004)	(0.004)
GDP	-0.092	0.238***	0.012	0.138
	(0.075)	(0.080)	(0.070)	(0.107)
Polity	0.019	0.381***	-0.060**	0.017
	(0.032)	(0.041)	(0.030)	(0.039)
Productivity	0.012***	0.006**	-0.001	-0.002
	(0.002)	(0.002)	(0.001)	(0.002)
Exporter	0.032***	0.034***	0.004	0.032***
	(0.007)	(0.009)	(0.006)	(0.006)
Foreign	0.017**	-0.009	0.003	-0.007
	(0.008)	(0.009)	(0.008)	(0.007)
State	-0.009	0.012	-0.012	-0.007
	(0.019)	(0.021)	(0.014)	(0.017)
Medium	0.089***	0.036***	0.008	0.030***
	(0.006)	(0.007)	(0.005)	(0.005)
Large	0.192***	0.075***	-0.004	0.038***
	(0.008)	(0.010)	(0.007)	(0.007)
Internet use	0.003	-0.005	0.008	0.023***
	(0.008)	(0.008)	(0.006)	(0.007)
Listed	0.013	-0.008	-0.032***	0.005
	(0.012)	(0.012)	(0.009)	(0.011)
N obs.	59,720	33,418	35,694	60,124
N countries	64	64	64	64
R2 pseudo	0.115	0.181	0.175	0.072

Note: This table reports the results from the estimation of specification (2) for the dependent variables identified in the headline. Treatment (implementation of e-filing) is randomly distributed across years and countries. Definitions of the variables are in Appendix A and Section 2 of the text. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. All regressions include country, industry, and year fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.8: Robustness check: the impact of e-filing on tax compliance costs at the firm level in the ECA region

	Tax visit	Tax visit	Tax visit number	Tax visit number	Tax obstacle	Tax obstacle	Tax bribe	Tax bribe
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
E-filing2	0.006	0.048	-0.049	-0.005	0.080*	0.047	-0.013	-0.007
	(0.024)	(0.034)	(0.031)	(0.051)	(0.045)	(0.056)	(0.024)	(0.036)
E-filing3	-0.186***	-0.148**	-0.075	-0.288***	-0.141***	-0.130**	0.045	-0.047
	(0.030)	(0.062)	(0.056)	(0.101)	(0.038)	(0.058)	(0.032)	(0.048)
GDP	0.013	0.008	0.228**	-0.148	-0.301*	-0.477**	-0.441***	-0.005
	(0.086)	(0.125)	(0.096)	(0.190)	(0.160)	(0.220)	(0.127)	(0.155)
Polity	0.182*	-0.310**	0.039	-0.138	0.218	-0.352*	0.212**	0.044
	(0.107)	(0.151)	(0.111)	(0.240)	(0.151)	(0.189)	(0.100)	(0.311)
Productivity	0.003	-0.012	0.001	0.009	0.000	-0.004	0.003	0.010
	(0.003)	(0.008)	(0.003)	(0.016)	(0.003)	(0.008)	(0.003)	(0.013)
Exporter	0.038***	0.070**	0.064***	0.140**	0.048***	0.107***	0.012	0.123***
	(0.010)	(0.033)	(0.012)	(0.057)	(0.010)	(0.032)	(0.008)	(0.040)
Foreign	-0.022*	-0.072*	0.023	-0.010	-0.019	-0.079	0.021**	-0.104***
	(0.013)	(0.038)	(0.015)	(0.074)	(0.013)	(0.048)	(0.010)	(0.039)
State	0.028	0.058	0.078***	-0.007	0.003	0.108**	-0.009	0.067
	(0.027)	(0.056)	(0.027)	(0.105)	(0.024)	(0.054)	(0.019)	(0.058)
Medium	0.098***	0.069**	0.033***	0.097**	0.030***	0.004	0.004	0.002
	(0.009)	(0.027)	(0.012)	(0.043)	(0.010)	(0.037)	(0.008)	(0.036)
Large	0.197***	0.120***	0.047***	0.150*	0.032***	0.049	0.005	-0.068
	(0.013)	(0.038)	(0.015)	(0.089)	(0.010)	(0.054)	(0.010)	(0.055)
Internet use	-0.020*	0.004	0.010	0.085	0.010	-0.093***	0.025**	-0.022
	(0.012)	(0.034)	(0.012)	(0.053)	(0.012)	(0.033)	(0.011)	(0.046)
Listed	0.019	-0.016	-0.045***	-0.085	0.012	0.040	-0.027**	0.057
	(0.013)	(0.039)	(0.016)	(0.077)	(0.013)	(0.044)	(0.013)	(0.054)
Firm FE	NO	YES	NO	YES	NO	YES	NO	YES
N obs.	20,687	20,687	10,761	10,761	20,836	20,836	11,698	11,698
N countries	30	30	30	30	30	30	30	30
R2/R2 within	0.130	0.027	0.125	0.054	0.097	0.129	0.127	0.053

Note: This table reports the results from the estimation of specification (2) for the dependent variables identified in the headline using firm-level data from the ECA region. Definitions of the variables are in Appendix A and in Section 2 of the text. E-filing2 equals 1 if a transactional e-filing system is in place. E-filing3 equals 1 if a transactional e-filing system with e-payment is in place. Odd columns include year, sector, and country fixed effects; even columns include year and firm fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.

Table B.9: Robustness check: the impact of e-procurement on public procurement competitiveness and corruption at the firm level in the ECA region

	Procurement	Procurement	Procurement bribe	Procurement bribe
	(I)	(II)	(III)	(IV)
E-procurement2	-0.071***	-0.065*	-0.059	0.042
	(0.021)	(0.036)	(0.050)	(0.096)
E-procurement3	-0.003	-0.027	0.091***	-0.060
	(0.016)	(0.025)	(0.033)	(0.082)
GDP	0.010	0.027	-0.447***	0.331
	(0.062)	(0.120)	(0.144)	(0.276)
Polity	0.356***	0.183	0.186	0.316
	(0.087)	(0.176)	(0.210)	(0.269)
Productivity	0.012***	0.007	-0.000	-0.040
	(0.002)	(0.007)	(0.005)	(0.036)
Exporter	0.004	0.037	0.038**	-0.123
	(0.010)	(0.029)	(0.017)	(0.075)
Foreign	-0.034***	-0.026	0.039*	-0.053
	(0.011)	(0.036)	(0.021)	(0.052)
State	0.083***	0.050	-0.046	0.032
	(0.025)	(0.043)	(0.032)	(0.090)
Medium	0.058***	0.026	-0.013	0.088
	(0.007)	(0.029)	(0.015)	(0.102)
Large	0.090***	-0.002	-0.049**	0.090
	(0.011)	(0.037)	(0.021)	(0.127)
Internet use	0.089***	0.030	0.022	-0.081
	(0.010)	(0.024)	(0.027)	(0.100)
Listed	0.043***	0.055*	-0.091***	-0.033
	(0.011)	(0.032)	(0.020)	(0.066)
Firm FE	NO	YES	NO	YES
N obs.	20,633	20,633	3,680	3,680
N countries	30	30	30	30
R2/R2 within	0.094	0.017	0.112	0.171

Note: This table reports the results from the estimation of specification (2) for the dependent variables identified in the headline using firm-level data from the ECA region. Definitions of the variables are in Appendix A and in Section 2 of the text. E-procurenent2 equals 1 if an informational e-payment system is in place. E-procurement3 equals 1 if a transactional e-filing system with e-payment is in place. Odd columns include year, sector, and country fixed effects; even columns include year and firm fixed effects. Standard errors are clustered at the country-industry level. *** p<0.01, ** p<0.05, * p<0.1.