Can Electronic Procurement Improve Infrastructure Provision? Evidence from Public Works in India and Indonesia

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Abstract

Poorly functioning, and often corrupted, public procurement procedures are widely faulted for the low quality of infrastructure provision in developing countries. Electronic procurement, which increases information availability and reduces personal interaction between bidders and procuement officials, is thought to help ameliorate these problems. In this paper we develop a unique micro-dataset on public works procurement from two fast-growing economies, India and Indonesia, and use regional and time variation in the adoption of electronic procurement across both Indian states and Indonesian provinces to examine the impact of electronic procurement. We find no statistically significant changes in prices paid by the government in response to electronic procurement. We do, however, observe improvements in the quality of public good provision. In India, where we observe an independent measure of construction quality, e-procurement improves the average road quality, and in Indonesia, e-procurement reduces delays in completion of public works projects. Bidding data suggests that an important channel of influence is a broader distribution of winners, with (better) winning bidders more likely to come from outside the region where the work takes place. On net, the results suggest that e-procurement may work by facilitating entry from higher quality contractors.

JEL Codes: H57, O12, O53

I Introduction

Contestable government procurement of goods and services is estimated at over 6% of world GDP (OECD 2002), with the incidence rising in emerging economies: For instance, in 2007, the Indian government spent over US $21 billion ($18 per capita) on the procurement of external goods and services, over double what it spent in 2000 (IMF). Yet, both the quantity and quality of recently constructed public infrastructure often remains low (Briceo-Garmendia et al. 2004). A limited supply of local qualified contractors, collusion among contractors, and corruption among public officials have each been cited as important reasons (Kenny 2007).

A number of governments have responded by adopting electronic procurement (henceforth: e-procurement) (World Bank 2007). E-procurement entails the use of electronic media, such as the internet, for some or all of the process of acquisition of goods or services. E-procurement is thought to address potentially three common concerns with manual procurement practices: lack of access to bid information, collusion among bidders, and corruption. E-procurement can increase the number of bidders by lowering the costs of obtaining information about a tender process, thus increasing the number of firms who can bid. Likewise, e-procurement can reduce collusion among bidders by providing information about tenders to firms outside a local cartel, allowing non-cartel firms to participate and breaking up local bidding cartels. E-procurement can also potentially mitigate corruption by reducing the degree to which government officials selectively withhold information or refuse to take bids from non-favored bidders. Moreover, by ensuring public access to all procurement data, e-procurement enhances transparency and the possibility of public oversight.

However, it is also plausible that in low income settings, where information technology coverage and other aspects of state capacity remain low, e-procurement can only effect limited change, and can potentially make things worse. Potential contractors (who are currently not in the system) may continue never to learn about available tenders, and cartels and corrupt officials may continue to use strong-arm tactics to prevent entry by such contractors. If many small firms have limited access to the internet, requiring electronic bids could actually harm competition.

In this paper we examine the impact of electronic procurement on public works projects in two large emerging economies: India and Indonesia. In India, we examine procurement practices between 2000 and 2009 for a federally funded rural road construction program which is implemented

by state road departments, the *Pradhan Mantri Gram Sarak Yojana* (PMGSY) program. Under this program, roughly 145 road packages are tendered per state per year. In Indonesia, we examine contract data from the national Ministry of Public Works for both construction and consulting (e.g. engineering management and design) contracts each year. On average, 88 packages per province were issued per year. Our evaluation exploits the fact that in both countries e-procurement was gradually rolled out at the state (India) or province (Indonesia) level. This allows for a difference-in-difference strategy: we compare outcomes in states/provinces before and after the adoption of e-procurement, as well as in those continuing under manual procurement practices, allowing us to quantify the benefits or costs of the practice in both countries.

For both countries, we obtained administrative data on the complete universe of contracts from before and after e-procurement by scraping publicly available information from respective government websites. All told, this leaves us with a dataset of over 20,000 contracts in India and over 14,000 tenders in Indonesia.

We first show that, in both India and Indonesia, e-procurement increases the probability that the winning bidder comes from outside the region where the contract takes place. This is consistent with e-procurement decreasing the costs of submitting bids for those not physically present. We next examine the impact on the ultimate outcomes the government cares about: price, quality, and timeliness. We find no systematic evidence that electronic procurement lowers prices paid by the government. In Indonesia, the point estimates are consistent with small (2-5 percent) reductions in prices, but these are not statistically significant. In India, we do not find that e-procurement reduces initial government estimated costs or that final prices are affected. Overall, we can statistically rule out (at the 5% level) declines in contract value of more than 2.7 percent in India, of more than 6.6 percent for Indonesian consulting projects, and of more than 14 percent for Indonesian works contracts.

In contrast, e-procurement led to quality improvements. A first measure of quality is time-overrun in project completion. Reports of corruption of procurement in India typically focus on cases where works are abandoned halfway through or completed in a very tardy manner. In our data we see that 77 percent of road projects in India and over 95 percent of public works projects in Indonesia are completed late. In India, we observe no statistically signficant changes in late works, while in Indonesia these declines are large and significant – whereas only 5 percent of conventionally

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procured construction projects in Indonesia are completed on schedule, 20 percent of electronically procured construction projects are on time. Moreover, we also see a decline in works projects that are very delayed (as in taking more than twice the expected time) from 44 percent to 18 percent with the use of e-procurement.

A separate indicator of quality, only available for India, is an independent audit report on construction quality, which was conducted identically in roads completed under both e-procurement and traditional procurement. According to this measure, we find that e-procurement leads to higher quality roads, with the quality grades rising by about 13 percent in e-procurement projects compared to other projects.

We then explore the degree to which the results are driven by improving outcomes among already winning bidders, as opposed to changing who wins. To see whether the changes in outcomes we observe are driven by changes in selection of who wins, for the key variables of interest – price, delays, and quality – we estimate a fixed effect for each contractor, and then examine how the average quality characteristics of winning contractors (i.e., the fixed effects of who wins) change with e-procurement. We find that after e-procurement, winning contractors in India tend to be those who have higher quality on average. In Indonesia, we find evidence that those contractors who win after e-procurement are systematically less likely to be late. This suggests that a key mechanism for e-procurement is allowing higher quality contractors to enter and win projects, rather than encouraging better performance from an existing set of contractors.

This paper is related to several economic literatures. In the corruption literature, a number of recent papers use procurement data to examine corruption (Di Tella and Shargrodsky 2003, Ferraz and Finan 2008, Bobonis, Fuertes, and Schwabe 2009, Bandeira, Prat, and Villetti). While there is also a growing economics literature on procurement (Bandiera et al. 2009, Krasnokutsaya and Seim 2006), much of the literature has focused on the rules governing the action (i.e. scoring auctions vs. lowest-price auctions, etc) (Tran 2008). This paper suggests that an important component, at least for ensuring quality, can be in the implementation of the procurement auction, holding the rules fixed.

Second, this paper is part of a recent, broader agenda that documents the role of communication technology in development. While there are several studies that document the impact of cell phone technology on market access (Jensen 2007, Aker 2010) and education (Aker et al. 2012). This

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paper represents one of the first studies to examine the impact of the internet on governance issues.

One advantage of our approach is that we use the same methodology to study two different e-procurement programs, in two different countries. To the extent the findings from both countries are similar, this helps give credence to the external validity of the results. To the best of our knowledge, this study represents one of the first microeconomic studies that uses differences-in-differences to simultaneously evaluate a new program in multiple countries, allowing for more careful conclusions with respect to external validity.[1]

The paper is structured as follows: In Section II we describe the institutional details relating to procurement practices and road construction in India and Indonesia. In Section III we describe the data and empirical strategy. In IV and V we report the findings. Section VII concludes.

II   Background

We start by describing the public works programs in our two study countries, and then the nature of e-procurement adopted in these two settings. We conclude the section with a brief description of likely channels of influence of e-procurement.

A   Public Works Program and Procurement

A.1   India

In the year 2000, India launched a large-scale rural road construction scheme called *Pradhan Mantri Gram Sarak Yojana* (PMGSY). The federal government provided funding for this scheme, but full executional responsibility lies with state governments. While implementation of this program is coordinated at a national level, each state has an independent rural roads department which decides the schedule for road construction and manages procurement. PMGSY roads follow a uniform criteria for road construction in terms of material usage and quality for all Indian states.

In PMGSY, all states use the same procurement rules and standardized bidding document, provided by the national roads agency. The procurement process for PMGSY roads is a cost-based auction procedure. Specifically, conditional on meeting a pre-specified set of technical qualifications

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[1]The other study of this nature we are aware of is Gruber and Mullainathan (2005), which evaluates the impact of state and provincial cigarette tax changes in the US and Canada.

intended to ensure a contractor is capable of completing the project, the contract is awarded to the lowest bidder. Importantly, these rules are identical with and without electronic procurement.

During construction, PMGSY has a multi-tier quality monitoring system, with local, state, and national monitoring. National monitoring is conducted by National Quality Monitors (NQM), who are retired engineers from other states. The package choice for NQM monitoring and assignment of monitor to the project is randomized, and therefore is conducted similarly in places both with and without electronic procurement.[2] Since it is randomized and thus identical accross locations, we focus on the outcomes of this national monitoring (NQM) as our quality outcome.

A.2 Indonesia

We examine the national Indonesian Ministry of Public Works (MPW). The MPW procurement process covers mainly two types of contracts, works and consulting. Works contracts refer to projects such as the building or repairing of roads and bridges, where physical services or construction work are conducted by the contract winner. Consulting contracts entail the provision of professional expertise by the winning bidder in planning or supervision services such as design and management. Depending on the project, procurement takes place either at the national headquarters in Jakarta or at the provincial offices of the MPW.

Works contracts are generally assigned to the low bidder conditional on meeting minimum administrative and technical qualifications, as in India. Consulting contracts involve a pre-qualification phase in which potential bidders first submit a document containing administrative, financial, and work experience information. The 5 to 7 top-rated firms are typically then identified and allowed to submit bids. The winning bidder is assigned using a formula based on a combination of technical score and price. For both types of contracts, a minimum of 3 bid submissions are required, otherwise the processes are repeated. The overall pool of bidding firms consists of both private firms and state-owned construction firms, with state-owned competing against the private sector without any special preferences.

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[2]The NQMs are given the letter of request once every two months for carrying out inspection for the forthcoming two months. The NQMs are required to inspect three districts in a single visit in one state in each of the two months. The letter of request allocates a mix of works in progress and completed works. The letter indicates the specific location of works to be inspected and which are in-progress or completed works. Within a block (the administrative unit below district), projects to be inspected are chosen on a random basis.

B   Issues with Manual Procurement

B.1   India

Anecdotally, public procurement in India is rife with corruption, and claims of impropriety exist throughout the contracting process. Contractors have reported being physically intimidated or barred from submitting bidding documents. The handling of bidding documents after submission has also been called into question with claims of altered bids, inspection of bids prior to technical reviews, and intentional loss of submissions. There is also concern that technical qualifications are used to unreasonably exclude certain firms from the bidding process. The implication of many of these reports is that government officials collect rents in exchange for some advantage in the bidding process.

As a case study, we examined the tendering process for manual procurement for a random sample of 190 road contracts issued between 2001 and 2006 in the Indian state of Uttar Pradesh. As Figure 1 shows there is very little competition in PMGSY contracts. In 95 percent of cases, the financial bid of only one firm was evaluated; that is, there was only one bid submitted or all other bids were disqualified based on technical requirements. When we observe multiple bids here, over three quarters of the time all but one bid are disqualified. In the case of any technical disqualification, all but one bidder are disqualified 100 percent of the time. Prima facie this pattern of disqualifications is consistent with corrupt officials enforcing a desired winner.

B.2   Indonesia

Public procurement is generally understood to be "one of the most corruption-ridden sectors" (Freedom House, 2012) in Indonesia. For example, the 2009 Global Enterprise Survey of Indonesia (IFC and World Bank) sampled 1,444 firms comprising a representative sample of the non-agricultural formal private economy in the country. In the survey, 38.1% of respondents who had attempted to secure a government contract in the previous year indicated that firms with characteristics similar to theirs make informal payments or give gifts to public officials to secure such contracts, though the average value given for these bribes was only 1.8% of the total contract value. A separate survey of 792 randomly sampled construction, consulting, and supplier firms conducted in 2010 by the Indonesia Procurement Watch provides further suggestive evidence of corruption in the government

procurement process, with 92.7% of respondents answering that they thought their firm had ever given bribes to the government officials involved in managing procurement. Additionally, 97.3% of respondents believed that it was not possible to win the contract tender without bribery and more than 95% indicated that the typical value of a bribe was more than 10% of the contract value. Beyond survey results, of the 196 cases considered by the Corruption Eradication Commission (KPK) of the Government of Indonesia between 2004 and 2010, 86 dealt with bribery and graft related to the procurement of goods and services and every such case resulted in a conviction (New York Times, 2011).

Anecdotal evidence suggests that the manual procurement process contributes to the corruption problem in much the same ways discussed in India. For example, government officials may not make the detailed documents required to prepare a bid available to non-favored firms or purposely them about the proper submission process (UNAFEI, 2008). Alternatively, there could be physical intimindation to firms that are not part of the cartel from submitting bids.

C   E-Procurement

C.1   India

In 2000, when the program began, all Indian states used a manual paper-based procurement system to bid out contracts to private contractors. This process involved obtaining internal approval of the project, publishing a Notice Inviting Tenders (NIT) in several media outlets (typically newspapers), having suppliers obtain detailed bid preparation materials from the government, receiving bid submissions by suppliers, receiving bid evaluations by buyers, and finally, the awarding of the procurement order and signing of agreements. The complete process required a long chain of internal authorizations (at times involving several departments), several visits by suppliers to departments, and the generation of reams of paper-based statements and evaluations.

The Indian IT Act of 2000 provided legal recognition to electronic transactions. Since then, several Indian states have passed legislation enacting e-procurement, and the rural roads department in several states followed by adopting e-procurement practices for road construction. We exploit this variation across time and states for our empirical analysis. Figure 2a shows the dates when e-procurement rules were adopted in various states through 2009. Our sample covered all major

Indian states for which consistent data on e-procurement was available. During this period, 9 out of 21 Indian states for which we have data adopted a system of electronic procurement. The first state to adopt, in 2004, was Andhra Pradesh, which (along with Karnataka) is one of the technological leaders of India. (Note that in some states (Chattisgarh, Gujarat, and Orissa), contracts which are below a state-specified cost threshold do not go through the electronic procurement process and are processed on paper. We use these cutoffs to classify projects as eproc where applicable.)

C.2 Indonesia

Indonesia began rolling out a "semi-electronic procurement" (SEP) system in 2004 in the central ministry in Jakarta, and expanded across the 33 provincial offices in approximately concentric circles from Jakarta over the next 5 years, as shown in Figure 2b. Under SEP, firms are able online to register expressions of interest, download bidding and technical qualification documents, and submit questions and complaints. However, due to a regulatory constraint, the submission of bids was still required to be conducted manually (hence the term "semi") throughout the period we study. The SEP process thus covers the entire procurement process except the final submission of bids. There was no change in procurement rules associated with the switch to SEP; procurement still followed the Presidential guidelines issued in 2003.

Prior to the adoption of SEP in a province, procurement was in a "copy to internet" (CTI) phase where the acquisition of bidding and technical qualification documents and the submission of bids were carried out manually, but the contract details (bids of each firm and the winner) were posted to the internet ex-post to be publicly available. Crucially for our analysis, the data made public during the copy-to-internet and semi e-procurement systems are identical, and in fact use the same electronic platform; the only difference is that procurement actually takes place electronically on the SEP system, whereas in copy-to-internet, information is just released publically ex-post. We discuss the data in more detail below.[3]

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[3]The number of officials sitting on the procurement committee for a given project also shifts from three to five members for estimated costs greater than Rp. 500 million and Rp. 200 million for works and consulting projects, respectively. We plan to explore the potential impacts of this threshold in subsequent analysis.

D E-procurement: Channels of Influence

The price and quality effects of the adoption of e-procurement is ex-ante theoretically ambiguous. We outline several number of potential channels of influence below.

Benchmark: Efficient corruption where quality matters: For a given price/quality tradeoff, the most efficient firm (in terms of the ratio of the quality delivered to price received) is able to pay the highest bribes. Corruption should therefore lead to higher prices paid by the government to cover additional bribes to government officials, but not necessarily a reduction in quality, since the most efficient firm still wins. If e-procurement reduces the ability of corrupt officials to allocate a contract to a given firm, then a reduction in prices should be observed, but quality and the identity of the winning firm should not be affected.

For example, in several different contexts, from Asian procurement of electrical equipment (Tran 2008) to stamp auctions in New York (Asker 2010), economists have noted that such pre-auctions exist. In the case of electrical equipment, the secret pre-auction identified the bidder who could supply the specified equipment at the lowest cost, and who could hence offer the highest combination of bribe to the corrupt official at the lowest price the lowest price to the government; the corrupt official subsequently arranged with other cartel members to ensure that the firm so identified would win. If such an environment was operating here, eliminating corruption would not change the identity of the winning bidder or their ability to deliver a high quality road; instead, the firm with the largest surplus should still win, but the prices paid by the government should fall since they are no longer inflated to provide rents to the corrupt official.

Alternative 1: Inefficient corruption on the quality dimension when lowest price always wins.

Suppose that corruption means that the procurement officer has connections with certain firms. After seeing bids, he uses private personal connections to firms to choose one bidder, and then allows that firm to resubmit at just under the equilibrium price. Rules require that the winning bidder must submit the lowest price, but the firm can then extract rents by providing low quality works, not finishing the work and/or charging for extra costs later. In this environment corruption leads to low quality (delayed work or poor construction) and potentially higher prices. If e-procurement compels procurement officials to follow the rules and such resubmission is no longer possible, then

this mechanism can be eliminated–firms need to compete on costs and quality. This can lead to average quality improvements and/or lower prices.

Alternative 2: Non-corrupt inefficiency.

Even in the absence of corruption, e-procurement may yield improvements in quality and prices. In a setting of onerous regulations and shirking on the part of procurement officials, who need not be engaging in illegal activity to increase their own rents but rather may be hindered by overly complicated procurement rules or exert less than full effort while behaving legally, e-procurement may streamline the procurement process and increase the observability of government officials. This in turn can lead to the exertion of more effort and to greater returns for a given level of effort, potentially improving quality and price outcomes. Also, in an environment of limited bidder information, where it is difficult for firms to determine the full set of contracts available for bidding or to obtain the bidding materials in person, e-procurement may reduce these costs and increase the pool of firms bidding on projects. The asssociated increase in competition may then improve quality or lower costs. [2] document such practicies in the context of Italy.

III   Data and Empirical Strategy

In this section we describe the Indian and Indonesian datasets we use, followed by our empirical strategy.

A   Data

A.1   India

We obtain administrative data on costs, quality, and delays associated with each PMGSY contract issued between 2000 and 2009 from several PMGSY websites for the years 2000 to 2009. The dataset covers 21 Indian states. For PMGSY, packaging of multiple road contracts into a single package, tendered at once, is allowed, so a package consists of one or more specific contracts. Our final dataset covers over 24,669 packages and the associated 26,622 contracts.

A first set of outcomes are the cost outcomes associated with each contract. The estimated cost is the amount budgeted by the national authority for construction of a specific road or set of roads in a package. A contract or payment above this amount can only occur with permission from the

national offices. The contract value is the amount the government agrees to pay the winning firm for the relevant work. The final payment records the total amount paid out for each package, which as discussed above may be distributed among multiple contacts, and includes any ammendments to the contract that occur during construction.

We have measures of both timeliness and actual project quality. For timeliness, we track the time to execution. We use "late completion," which is an indicator variable taking value one if road construction work is not completed by the date agreed to in the initial contract. We also construct the indicator variable "2x Late Completion", which is an indicator variable for whether the work takes more than twice the agreed upon amount of time to be finished. Finally, we have a continuous "time overrun ratio" variable, which is the ratio of actual to agreed upon time to completion.

To measure the quality of project implementation, we use quality reports submitted by the National Quality Monitors. As discussed above, these National Quality Monitors come from different states, are randomly allocated, and are not affected by the shift to e-procurement.These evaluate each part of the work for material and workmanship as per the format for Inspection Report of National Quality Monitors, indicating the tests carried out and the test results obtained. Overall grading includes management issues, contract management, and quality of work. We use a binary assessment (satisfactory/unsatisfactory) of the technical fitness of the road after completion.

A.2   Indonesia

We scraped data from the CTI and SEP websites of the Indonesian Ministry of Public Works, capturing the complete universe of procurement from 2004 through 2008. Over 14,000 contracts from the MPW national headquarters and the 33 provincial offices are covered. Each entry in the data is at the contract level and specifies the estimated cost, which is, as in India, the maximum amount allowed by the MPW to be paid for a given contract. Limited information on type of project is available, as are all bidder names, bid amounts, disqualifications, and final contract values.

We also have the dates on which the notice and details for each contract were first posted online (and concurrently in traditional media), as well as the dates of bid opening and contract award. For road projects (which represent a subset of all projects covered by the Ministry of Public Works), we have a separate database from the road division that tracks the start dates and expected and actual completion dates for the services associated with each contract. As with India, we construct

"late completion", "2x late completion", and "time overrun" variables. No direct quality measure is available for Indonesia. For regressions which consider as an outcome variable the above measures of the timeliness of completion, the number of firms expressing interest, or the number of firms bidding, we trim the top and bottom 1 percent of sample observations.

B Descriptive Statistics

In the first two columns of Table 1, we present a set of basic descriptive statistics about our data from India, and in the remaining columns we present statistics from Indonesia. All monetary variables are in logs, which is how they will be used in the regressions below.

Examining the Indian data, in an average year, the typical state sanctioned almost 145 packages worth 9.61 log lakh rupees (US$27+ million; 1 lakh is 100,000 rupees) covering over 6.74 log kilometers (525 miles) of road. At the package level, the average log estimated cost of completion over the period observed is 5.211 log lakh rupees, or about US$345,000 at current exchange rates. In the subset of auctions for which we have data (as discussed above, these are from 4 states), there are an average of 2.7 total bids and 1.7 qualified bids.

One contract per package is the mode but a long right tail is observed. On average, a package is associated with 1.6 contracts for which we have data. Roads contracts generally come in below estimated cost (most likely because exceeding estimated cost requires an additional bureaucratic process). However, cost overruns relative to the contracted price appear to be relatively common post-contracting. The average payment on completed projects exceeds the average contract value by about 46%.

Turning to delays and quality, completion before the contracted due date was rare, with more than three quarters of contracts finished after the assigned deadline and an average delay of 244 days. There was heterogeneity in quality, with 72 percent percent of projects received a satisfactory quality rating on first inspection.

Examining the Indonesian data in Table 1, between 2004 and 2008 the average Indonesian province auctioned about 88 contracts per year, with nearly twice as many works as consulting projects, for a province-level average log total budget of 25.67 log rupiah (US$14+million). This implies that the total annual budget for all contracts in our data averages 29.61 log rupiah (US$740+million). At the project level, the average log estimated cost for works projects is 20.95

log rupiah (~US$130,000) and for consulting projects is 19.78 log rupiah (~US$40,000). The final contract value for a given project is on average 10 percent lower than the official estimated cost provided by the government prior to bidding. Firms winning contracts are typically based in the same province as the contract, more than 80 percent so for works projects. As with the data from India, delays are common; nearly all works projects (95 percent) and more than half of consulting projects (55 percent) are completed later than the initially agreed upon date.

C   Empirical Strategy

We estimate impacts separately for India and Indonesia. In both cases, we make use of a difference-in-difference strategy, but our implementation differs slightly across countries, as described below.

In India, for road package i in state s which began in year t we estimate the following OLS specification:

$$y_{ist} = \alpha_s + \beta_t + \mu EPROC_{st} + X'_{ist}\gamma + \epsilon_{ist}$$

where i is a package, s is a state, and t is a year, and $EPROC_{st}$ is a dummy for e-proc adoption by state s as of year t. Controls X_{ist} are log estimated cost and log road length. All regressions include state (α_s) and year (β_t) fixed effects. In some cases we collapse the package-level data to the state level and estimate regressions using annual state-level data. In all cases we cluster standard errors by state.

In Indonesia, the availability of e-procurement at the province level does not necessarily imply that all projects within a province will be contracted using the system.[4] To obtain the average impacts of the use of e-procurement, we instrument for actual e-procurement use with the adoption of e-procurement in the province, as follows. The regression of interest (i.e. the second stage) is:

$$y_{ist} = \alpha_s + \beta_t + \theta EPROCPACKAGE_{ist} + \delta X_{ist} + \epsilon_{ist}$$

where $EPROCPACKAGE_{ist}$ is a dummy for e-procurement use in project i in province s as of year t. The project level e-procurement variable $EPROCPACKAGE_{ist}$ is instrumented with $EPROC_{st}$, which is a dummy for whether $EPROC_{st}$ has been adopted by provicne s as of time t.

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[4]It is possible that this is true for India as well, but for India we do not observe what fraction of packages actually used e-procurement in a given year.

The control variable X_{ist} is the log estimated cost (since we have many different types of projects and there is no metric available in the data other than estimated cost, we cannot control for road length as for India). Standard errors are clustered by province.

In our regression tables we typically report results for the India sample as Panel A. In Panel B we report results for Indonesia works projects and in Panel C for Indonesia consulting projects.

D   Identification Check

An important potential concern with our empirical strategy is that, since the adoption of e-procurement is not randomly assigned, we need to ensure that the timing of e-procurement adoption is not correlated with differential trends in procurement that would have occurred in the absence of e-procurement.

To examine this, we begin by checking whether, overall, the adoption of e-procurement is adopted with a change in the volume (total budget for procurement) or structure (i.e. how many contracts that procurement is broken into) in a given province. Column (1) of Table 2 reports regressions where the dependent variable is log total estimated cost at the state-year level and the explanatory variable of interest is an indicator for any contract being awarded under e-procurement, with log of road length included as a control for India. Column (2) repeats the exercise using number of projects as the dependent variable, controlling for log total state-year estimated project cost. In neither case do we see a significant impact of e-procurement adoption on the total budget allocations (column 1) or the number of projects they are broken into (column 2) at state/province-level, suggesting that e-procurement was not coincident with major changes in the amount or structure of contracts being procured.

Second, we examine whether the year of official adoption of e-procurement at the state level[5] is significantly related to the difference in log average contract value between 2001 and 2000 for India (Appendix, Panel A) and between 2005 and 2004 for Indonesia (Appendix, Panels B and C), the first two years of our datasets in each country. We see no correlation between change in state-level contract value and the timing of e-procurement for either India or Indonesia.

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[5]Conditional on adoption occurring after 2005 for Indonesia and after 2001 for India

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IV Did E-procurement Change the Contracting Process?

A Contracting Execution

In Table 3 we first examine whether the introduction of e-procurement has an impact on the duration of the project contracting phase. In columns (1) and (2) we consider the time elapsed between tender notice and contract award and between bid opening and contract award. Both variables are available only for the Indonesia sample. While neither variable is significantly impacted for works projects, we find an increase of 54.13 days (statistically significant at the 1% level), a more than 50 percent increase, in the time elapsed between the tender notice and awarding of contract is observed for consulting projects. In conjunction with the absence of an effect in column (2) on the amount of time between bid opening and award, this implies that period of time between the tender notice and the opening of bidding, in which firms can learn about potential contracts and prepare their bid documents, becomes signficantly longer for consulting projects with the use of e-procurement.

B Who Bids and Who Wins?

We next consider indicators of changing contractor identity. In column (3) of Table 3 we investigate the impact of e-procurement on the number of firms who fill out the initial form expressing an interest in bidding. These data are only available for Indonesia. For nearly every works project, this process entails registering to be allowed to participate in bid submission and download the detailed bid documents. For all consulting projects and a small subset of works projects, expression of interest involves the submission of a pre-qualification document on which firms are scored and a subset of those passing are chosen to submit bids. We observe a significant more than doubling in the number of firms expressing interest in the case of works projects.

In column (4) we examine the number of firms actually submitting a complete bid. This number is relatively low in India with the average manual procurement contract receiving roughly 2.7 bids. This number is higher for Indonesia at over 7 bids per works project and 3.1 per consulting project. However, in no instance do we see a significant increase in the average number of bids.

Column (5) examines whether e-procurement changes the likelihood that the winning firm is registered in the same area as where we first observe the contractor in the data in the pre-period,

which we take a proxy for the firms default location.[6] In general, as with most construction projects, where moving equipment is quite costly and where there is often a need for local sources of, e.g. hot asphalt, there is a strong tendency to be to be local: over 60 percent of winning bids come from firms located in the same district in India, over 80 percent of works contracts are in the same province in Indoneisa as where the contract is to be executed, and over 65 percent of consulting projects are from the same province in Indonesia as where the contract is to be executed.

We observe a significant 10 percentage point decline in this variable in India and a 23 percentage point decline for consultancy projects in Indonesia. Given that it is much easier to move engineers geographically than to move heavy equipment and asphalt plants, it is not surprising that the impacts for Indonesia – where cross-provincial distances are much greater than the cross-district distances we observe in India – are concentrated among consulting projects.

Finally, we examine whether e-procurement changed entry of new firms. Specifically, we examine whether the winning bidder was in present in the first year of our data (2000 or 2001 for districts or in 2004 for provinces in Indonesia). This regression is restricted to observations which fall in years subsquent to these initial years. We observe a highly significant increase of 41 percentage points for consultancy projects in Indonesia, showing that e-procurement leads to more contracts being won by pre-existing winning firms. Combined with column 5, this suggests that e-procurement leads to projects being won by pre-existing firms from other provinces.

One consistent explanation for these findings is that e-procurement improves access to information for firms outside the area where procurement is taking place. This is a relative larger benefit for firms that are farther away, and also potentially favors pre-existing firms with a documented record of success.

V   Did E-Procurement Change Procurement Outcomes?

There are three main outcome variables about which the government cares when procuring for the provision of a service/construction of a project: the price it pays for the contract, the timeliness with which the contract is executed, and the quality of work undertaken. In this section we examine the impact of e-procurement on each of these three dimensions.

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[6]Note that this variable is only defined for firms we can match to a firm that we observe in the first year of the data.

A   Prices

Before turning to prices, in column (1) of Table 4 we consider the log of estimated cost, the reference value provided by the government prior to bidding, to confirm that there are no major changes in the budgets announced for projects. Bids are officially required to be lower than this value in Indonesia, but this is not the case in India. Panel A shows the absence of a significant effect in India, with a point estimate of -0.062 and associated 95 percent confidence interval of -0.138 to 0.014. Panel B and C report IV estimates at the project level in Indonesia, where the independent variable is the use of electronic procurement, instrumented by the official adoption of electronic procurement at the state level. No impact on estimated cost is found for either works or consulting projects.

To examine the impact on prices paid, we first consider impacts in each country on the contract value agreed upon between the winning bidder and the government. Column (2) shows no statistically significant impact in India on log contract value, conditional on the log length of the road and the log estimated cost of the road. The point estimates are quite small – 0.02 – and the 95 percent confidence interval ranges from -0.026 to 0.064. This means that we can reject the hypothesis that there were more than 2 percent cost savings associated with e-procurement, based on the original contract value. For Indonesia, conditional on the log estimated cost, for both works and consultancy projects, the point estimates suggest a small reduction in log contract value, though it is not statistically significant. The confidence intervals suggest that, at 95 percent confidence, we can rule out price declines in Indonesia of more than 14 percent for works projects and of more than 6.6 percent for consulting projects.

Of course, the government does not care about the contract value per se; rather, the more important measure is the actual amount paid to the contractor. Cost overruns are frequent, so as discussed above, the amount paid is typically higher than the contract value. Column (3) examines the impact on the final amount actually paid by the government, including any overruns or contract ammendments. Values for this variable are only available for India. Note that the observation count falls substantially here since not all packages were complete at that time[7]. Again, no significant impact is observed. The point estimate for India is -0.031, with the 95 percent confidence interval

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[7]As we show subsequently that the date to completion is unaffected by e-procurement, this sample selection is unlikely to be an issue.

ranging from -0.105 to 0.043. Given the negative point estimate and the slightly larger standard errors, the confidence interval is somewhat larger than with the original contract value, so the lower end of the confidence interval implies we can reject the hypothesis that there was more than about an 10.5 percent cost savings. On net, the evidence in this section suggests that there was no statistically detectable impact on prices paid for projects, and to the extent there are effects we cannot detect, they are relatively modest in size.

B   Project Timeliness

We next examine delays in the execution of projects. In column (4) of Table 4 we consider late completion – a dummy taking value 1 if a project is finished after the contracted completion date. Late completion is very common in both countries. More than three quarters of projects in India are completed late, while more than 95 percent of works projects and 60 percent of consultancy projects in Indonesia are not finished on time. In the case of Indonesian works projects, we see a significant 15 percentage point decline in this variable associated with the adoption of e-procurement. The impact of e-procurement on extreme lateness is examined in column (5) with the variable 2x late completion, a dummy for the project taking more than twice as long as contracted. While this is a rare occurrence for Indonesian consulting projects, such delays take place at a greater than 40 percent frequency for Indonesian works projects and more than 30 percent of the time in India. No effect of eprocurement on extreme lateness is found in India, but a large and statistically significant decline of 26.6 percentage points is shown for Indonesian works projects.

We then consider the time overrun ratio in column (6). This is the actual time to completion divided by the contracted time to completion. For both India and Indonesian works projects we observe high levels of overrun – on average, actual time to completion is double the contracted time. In neither country do we see a significant decline associated with adoption of e-procurement, however.[8]

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[8]Note that for Indonesian works, the point estimate on the time over-run ratio is positive while the dummies on late completion are negative. This is due to a few extreme outliers. If we trim the bottom and top 2 percent of observations, the coeffients and statistical significance in columns 4 and 5 are essentially unchanged, but the point estimate in column 6 becomes -0.04.

C   Quality

In the final four columns of Table 4 we turn to package-level quality measures from a nation-wide auditing process. As described above, these data only exist for the India sample. The Indian National Quality Monitoring process is coordinated centrally, and inspectors audit a randomly selected bundle of roads (both in progress and complete to audit). Specifically, for auditing roads grade in a given season the national monitor is told how many of each type of project (complete and ongoing) to sample and from which districts in a state. He then separately randomly samples these from the list of projects provided by the state road department. In addition, inspectors are allocated follow up audits for roads and here poorly graded roads are oversampled.

Thus, only the first quality grade is randomly selected. We examine two variables: the first quality grade and the minimal quality grade for the road project given by the national monitor. The minimum quality grade is the lowest quality grade given during any of the inspector evaluations across all contracts in the package.

The quality score is measured as either 0 (unsatisfactory) or 1 (satisfactory). We consider quality outcomes for works in progress and completed roads separately.

In columns (8) and (10) we find highly significant impacts on both the first and minimum quality grades for completed roads. E-procurement associated increases of 10.7 and 17.7 percentage points in the first quality grade and worst quality grade, respectively. In contrast, we dont see any significant impacts on incomplete works (columns 7 and 9) which possibly reflects greater measurement error in evaluating quality of ongoing road projects.

VI   Selecting Better Contractors, or Making Existing Contractors Better?

We observe significant impacts of e-procurement on road quality in India and evidence of reductions in delays in Indonesia. We also find that winning contractors are more likely to come from outside areas. We now explore a potential channel of influence: whether e-procurement changed the pool of contractors who bid and caused better contractors to be selected.

To the extent that e-procurement improves outcomes, an important question is whether it

does so by selecting better contractors, or by encouraging existing contractors to perform better. Selection effects would occur if the effects were primarily by allowing new entrants, and if those new entrants won; treatment effects on existing contractors could occur if increased competition or lower corruption led these incumbent firms to submit higher quality bids.

To investigate these possibilities, we conduct a two-stage strategy where we first estimate a firm fixed effect for each firm in the data. This measures each firm's average quality. We then examine whether e-procurement leads to the selection of firms with higher average quality. If it does – and if these coefficients match the overall effects documented above – we can then conclude that selection effects are playing a large role. On the other hand, if e-procurement does not lead to changes in average firm quality, then the quality and delay effects documented above must be arising through increased performance from a given set of incumbent firms.

For each outcome of interest y, we initially estimate the following regression:

$$y_{icst} = \tau_c + \alpha_t + \alpha_s + X'_{ist}\gamma + \epsilon_{ist}$$

where τ_c is a winning contractor fixed effect. The first stage sample is restricted to observations from years prior to the presence of e-procurement in a state or province. We generate a full set of contractor fixed effects from this regression and then use them as the outcome variable in the following regression:

$$\tau_{cist} = \alpha_t + \alpha_s + \beta EPROC_{st} + X'_{ist}\gamma + \epsilon_{ist}$$

where τ_{cist} is the estimated τ_c from the initial regression for the contractor that won project ist. The estimation is weighted by the inverse variance of τ_c (as estimated from the first stage). This regression asks how e-procurement affected the choice of which contractors won a given package.

Examining prices in columns (1) and (2) of Table 5, we find evidence suggesting that the introduction of e-procurement was accompanied in India the selection of winning firms which tend to win smaller contracts. In Indonesia, we find that e-procurement was associated with firms that tend to bid lower amounts for a given estimated cost on consulting projects.

We then examine delays. In column (4), we see that in Indonesia, e-procurement was associated with firms that tended to be less late being more likely to win. The magnitude of the coefficient –

0.05 – is about one-third the equivalent magnitude in column (4) of Table 4 – 0.15 – which suggests that one-third of the effect is driven by changes in selection, while two-thirds of the effect is driven by existing contractors performing better.

Turning to quality, we find substantial impacts on the average quality of contractors, as shown in columns (6) and (7). The magnitudes are comparable to the overall quality effects in Table 4 – in fact if anything the magnitudes are higher in the two stage regressions here. This suggests that the entire quality effect is driven by selecting higher quality contractors, rather than the impact of increased competition being to improve the quality of existing contractors.

VII Conclusion

This paper provides some of the first rigorous evidence on the impact of e-procurement on contractual choice and subsequent contract outcomes. All told, the results present a consistent story. E-procurement appears to have led to increased ability of firms from outside the home region to win contracts. These firms, in turn, tended to be higher quality firms in general, as measured by their average delay times (in Indonesia) and average quality (in India). This led to improvements in quality of roads and timeliness, but no detectable changes in price.

Following the increase in competition among firms for contracts brought about by the adoption of e-procurement, a reduction in the rents accruing to winning firms may be expected to occur either through an increase in quality for a given price or a decrease in price for a given level of quality. In both the Indian and Indonesian settings examined here, we see evidence in support of improvements in quality for a given price. The fact that we observe changes on the quality margin, and that it occurs through changing which contractors win, rather than the performance of a given set of winning contracts, suggests that the system prior to e-procurement was not necessarily selecting the most efficient firms, and that e-procurement may have improved efficient even if it did not necessarily lower prices paid. It also suggests that the practice of giving contract to the lowest price bidder likely contributed to greater inefficiencies on the quality margin.

Overall, our findings provide qualified support to the view that e-governance can improve governance. E-procurement was a partial reform which changed the application process but neither the rules for technical qualification nor the requirement that the lowest price bidder receive the

contract. Case-study evidence suggests that official discretion in determining technical disqualification is often an important way of limiting competition. Equally, emphasizing price over quality(as occurs when lowest price bidder always wins) implies that bidders build in their profit margins by cutting back on quality. E-procurement facilitated entry but left significant discretion with officials in determining qualification and the bidding rules continued to prioritize low price over quality. Thus, it appears that the main impact we see can be attributed to gains from trade associated with having reduced barriers to entry. It is an open question whether a reform package which changes both the application process and also the process of selecting among bidders could lead to even larger gains in economic efficiency.

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Appendix: Webscraping process

The data were obtained from eight webpages hosted by the national PMGSY offices, each one containing different information on contracts and packages (i.e. technical details, contractors, quality, etc.). We first cleaned by removing clearly erroneous contract values, dates, etc. and standardizing formatting/labelling for the approximately 30,000 projects listed on each of the eight websites. The data from the eight sites were then merged into one master dataset. No unique identifier was available for projects, so sites which shared the most variables were merged first to reduce unmatched duplicates in later merges. Projects that could not at first be merged across sites were compared on increasingly smaller sets of variables using an automated process of elimination to narrow down possibilities until all unmatched sites were the result of multiple indiscernible projects. Ultimately, 87% of projects were matched across all of five of the most important sites and most of the data from the remaining three sites were matched to the five-site set.

VIII   Bidding

The Bidding process Qualification of the Bidder

To qualify for award of the Contract, each bidder should have in the last five years achieved in any one year a minimum financial turnover volume of construction work of at least the amount equal to the estimated cost of works and satisfactorily completed, as prime Contractor, at least one similar work equal in value to one-third of the estimated cost of work.

Each bidder must demonstrate availability for construction work, of the key equipment; availability for construction work for this work of technical personnel; liquid assets and/or credit facilities determined by each EA. The bidder must not have in his employment the near relations of certain departmental officers or any person who retired as gazetted officer within the last two years from the departments determined by the EA without Government permission.

Bidders who meet the minimum qualification criteria will be qualified only if their available bid capacity for construction work is equal to or more than the total bid value. The available bid capacity will be calculated using a formula that takes into account the maximum value of civil engineering works executed in any one year during the last five years, the number of years prescribed for completion of the works for which bids are invited, the value of existing commitments

and on-going works to be completed during the period of completion of the works for which bids are invited (this one enters negatively).

Even though the bidders meet the above qualifying criteria, they are subject to be disqualified if they have made misleading or false representations; and/or record of poor performance or participated in the previous bidding for the same work and had quoted unreasonably high or low bid prices and could not furnish rational justification for it to the Employer. Each Bidder may submit only one Bid for one work. The Bid is submitted in two separate parts: the Technical Bid and the Financial Bid. The first one includes the qualification information and the Earnest Money; the Financial Bid includes the priced bill of quantities. Bid Prices The Contract has to be for the whole Works, based on the priced Bill of Quantities. The rates and prices quoted by the Bidder are fixed for the duration of the Contract and are not be subject to adjustment. Bid Opening and Evaluation Evaluations of the technical bids are completed within five working days of opening the bids, and a list will be drawn up of the responsive bids whose financial bids are eligible for consideration. The financial bid of only these bidders will be considered. Evaluation of technical bid will determine if each Bid meets the eligibility criteria defined before and if it is substantially responsive to the requirements of the bidding documents. During the detailed evaluation of the Ã'Financial BidsÃ", the responsiveness of the bids will be further determined with respect to the remaining bid conditions, i.e., priced bill of quantities, technical specifications and drawings. A substantially responsive Ã'Financial BidÃ" is one which conforms to all the terms, conditions, and specifications of the bidding documents, without material deviation or reservation. A material deviation or reservation is one (a) which affects in any substantial way the scope, quality, or performance of the Works; (b) which limits in any substantial way, inconsistent with the bidding documents, the EmployerÃ•s rights or the BidderÃ•s obligations under the Contract; or (c) whose rectification would affect unfairly the competitive position of other bidders presenting substantially responsive bids. If a Ã'Financial BidÃ" is not substantially responsive, it will be rejected by the Employer. Award Criteria The Employer will award the Contract to the Bidder whose Bid has been determined: i. to be substantially responsive to the bidding documents and who has offered the lowest evaluated Bid price, provided that such Bidder is eligible and qualified; ii. to be within the available bid capacity adjusted to account for his bid price which is evaluated the lowest in any of the packages opened earlier than the one under consideration. Details of contracts entered into

are entered into database. At the District level, the Program will be coordinated, and implemented through a dedicated Program Implementation Unit (PIU). The relevant projects would be executed by the PIUs and completed within a period of 9 months from the date of issue of the Work order.

Table 1: Summary Statistics

	India		Indonesia					
	All		All		Works		Consulting	
	Mean (SD)	Obs.	Mean (SD)	Obs.	Mean (SD)	Obs.	Mean (SD)	Obs.
State/Province-year level								
Total projects	144.8 (184.9)	158	88.3 (89.1)	166	57.9 (40.3)	164	32.2 (61.2)	160
Log total budget	9.609 (1.469)	158	25.674 (0.944)	166	25.610 (0.918)	164	22.886 (1.156)	160
Package Level								
Log estimated cost	5.211 (0.846)	24669	20.540 (1.311)	14657	20.952 (1.350)	9502	19.780 (0.799)	5155
Contracts in package	1.616 (3.739)	24669						
Log total value of contracts in package	4.786 (1.760)	24669						
Satisfactory quality at first inspection	0.723 (0.447)	13222						
Contract level								
Log contract value	4.530 (2.044)	26622	20.433 (1.322)	14623	20.826 (1.381)	9491	19.706 (0.799)	5132
Log final payment	4.914 (0.903)	14813						
Completion delay (days)	244.2 (345.4)	13781						
Number of firms expressing interest			30.027 (36.559)	14665	35.104 (43.389)	9508	20.666 (13.955)	5157
Number of firms bidding	2.756 (3.075)	1628	6.031 (5.276)	14665	7.586 (5.904)	9508	3.165 (1.492)	5157
Time notice to award			98.513 (105.286)	10410	83.579 (97.552)	6802	126.668 (113.281)	3608
Time bid open to award			29.066 (17.648)	9194	27.175 (17.394)	5973	32.572 (17.581)	3221
Winner won in first year	0.239 (0.427)	35227	0.282 (0.450)	9578	0.212 (0.408)	6896	0.463 (0.499)	2682
Winner from same district/prov.	0.303 (0.460)	12871	0.734 (0.442)	6102	0.817 (0.387)	4152	0.556 (0.497)	1950
Time overrun ratio	2.262 (3.017)	13628	1.876 (0.992)	4162	2.172 (0.996)	2996	1.114 (0.397)	1166
Late	0.766 (0.423)	13628	0.833 (0.373)	4162	0.945 (0.229)	2996	0.547 (0.498)	1166
Late 2x	0.325 (0.469)	13628	0.307 (0.461)	4162	0.415 (0.493)	2996	0.03 (0.171)	1166

Table 2: Identification Check

	State-year level	
	(1)	(2)
	Log (total estimated cost at state-year)	Number of projects in state-year
Panel A: India		
E-procurement	-0.057	-65.5
	(0.089)	(64.1)
Mean Dep. Var. (Non-Eproc)	9.82	161.2
	(1.26)	(196.3)
Obs.	131	131
Panel B: Indonesia - Works Projects		
E-procurement (IV)	0.187	-3.559
	(0.151)	(7.069)
Mean Dep. Var. (Non-Eproc)	25.211	45.102
	(0.774)	(28.803)
Obs.	164	164
Panel C: Indonesia - Consultancy Projects		
E-procurement (IV)	0.374	7.641
	(0.226)	(8.486)
Mean Dep. Var (Non-Eproc)	22.306	15.831
	(0.888)	(10.009)
Obs.	160	160

India: Column (1) reports estimates from an OLS regression of log total estimated cost at the state-year level on an indicator for any contract being awarded under e-procurement. Column (2) does the same using number of packages as the dependent variable. Log of road length and log of estimated cost are included as controls when not on the LHS.

Indonesia: Columns (1) and (2) give results from OLS regressions at the state-year level, where the dependent variable is given in the table and the independent variable is the official adoption of electronic procurement at the state level. Column (2) includes a control for log total state-year estimated project cost.

The state-year regressions include year fixed effects. Robust standard errors are in parentheses below estimates. Means for each dependent variable are also reported, with standard deviations in parentheses. *Significant at 10 percent. **Significant at 5 percent. ***Significant at 1 percent.

Table 3: Contract Process

	(1)	(2)	(3)	(4)	(5)	(6)
	Time elapsed notice to award	Time elapsed bid open to award	Number of firms expressing interest	Number of firms bidding	Winner from same province/ district	Winner in first year
Panel A: India						
E-procurement				0.284	-0.104***	0.0356
				[0.648]	(0.028)	(0.0223)
Mean Dep. Var. (Non-Eproc)				2.76	0.62	0.589
				(3.08)	(0.492)	(0.196)
Obs.				1406	6335	25146
Panel B: Indonesia - Works Projects						
E-procurement (IV)	43.26	1.94	24.735*	0.453	-0.036	0.070
	(37.20)	(5.40)	(13.657)	(1.340)	(0.057)	(0.060)
Mean Dep. Var. (Non-Eproc)	65.47	25.33	17.456	7.082	0.816	0.245
	(74.45)	(29.43)	(21.460)	(5.031)	(0.387)	(0.430)
Obs.	6798	5972	9323	9292	4151	6895
Panel C: Indonesia - Consultancy Projects						
E-procurement (IV)	54.13***	5.13	-3.489	-0.242	-0.233*	0.414**
	(19.81)	(3.50)	(2.561)	(0.281)	(0.133)	(0.183)
Mean Dep. Var. (Non-Eproc)	98.14	26.13	11.069	3.178	0.65	0.446
	(101.31)	(48.53)	(6.174)	(1.468)	(0.447)	(0.497)
Obs.	3607	3220	5078	5107	1944	2682

Winner in first year is an indicator for the winner having been awarded a contract in 2000 or 2001 for India or in 2004 for Indonesia. This regression is restricted to observations after the first year. Column (6), for India, defines the district a contractor is from as the mode district of the contractor's observed contracts prior to e-procurement starting anywhere in the country (this regression is therefore restricted to contracts won by the cohort of contracts who were awarded contracts prior to e-procurement). For Indonesia, home province is where the contractor is based.

India: All columns report OLS estimates from a regression at the contract level of the listed variable on an indicator for the contract being awarded using e-procurement. This is done only for subset of contracts for which we have bidding data. State and year fixed effects as well as controls for log of road length and log of estimated cost are included.

Table 4: Prices and project execution

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Prices			Delays			Quality			
	Log estimated cost	Log contract value	Log final payment	Late Complete	2x Late Complete	Time overrun ratio	First quality grade	First quality grade (cond. on completion)	Minimum across quality grades	Minimum across quality grades (cond. on completion)
Panel A: India										
E-procurement	-0.062	0.019	-0.031	0.008	0.003	0.149	0.009	0.107**	0.051	0.177***
	(0.039)	(0.023)	(0.038)	(0.067)	(0.044)	(0.245)	(0.031)	(0.042)	(0.044)	(0.039)
Mean Dep. Var. (Non-Eproc)	5.200	5.210	4.970	0.776	0.337	2.345	0.724	0.836	0.588	0.779
	(0.800)	(0.850)	(0.790)	(0.417)	(0.473)	(3.175)	(0.447)	(0.370)	(0.492)	(0.415)
Obs.	21625	20988	15430	12880	12880	12880	10824	1683	10824	1683
Panel B: Indonesia - Works Projects										
E-procurement (IV)	0.001	-0.049		-0.156*	-0.266*	0.129				
	(0.299)	(0.047)		(0.087)	(0.158)	(0.231)				
Mean Dep. Var. (Non-Eproc)	20.880	20.766		0.953	0.441	2.169				
	(1.300)	(1.329)		(0.212)	(0.497)	(0.982)				
Obs.	9502	9485		2995	2995	2995				
Panel C: Indonesia - Consultancy Projects										
E-procurement (IV)	0.102	-0.023		0.170	-0.068	-0.083				
	(0.137)	(0.022)		(0.193)	(0.081)	(0.187)				
Mean Dep. Var. (Non-Eproc)	19.554	19.502		0.635	0.047	1.180				
	(0.844)	(0.841)		(0.482)	(0.212)	(0.527)				
Obs.	5155	5130		1166	1166	1166				

The first quality grade is earliest quality report (satisfactory [1] or unsatisfactory [0]). The worst quality grade is the lowest quality grade given at any time (across all contracts in the package). Award delay is the number of years after funds were allocated that a contract is awarded. Time overrun ratio is the actual time to completion divided by the contracted time to completion. Late completion is a dummy for the project completion occurring after the contracted completion date. 2x late completion is a dummy for time to completion taking more than twice as long as the contracted time to completion.

India: All columns report OLS estimates from a regression of the listed variable on an indicator for e-procurement. Column (1) also includes controls for complete at first inspection, first inspection year, and inspector. Column (2) includes controls for first inspection year, and inspector. Columns (2) and (4) condition on project complete at time of inspection.Columns (4) and (6) are at the contract level and use an indicator for the contract being awarded under e-procurement. Columns (3) and (5) are at the package level and use an indicator for any contract in the package being awarded under e-procurement. State and year fixed effects as well as controls for log road length and log estimated cost are included.

Indonesia: All columns report IV estimates at the project level, where the dependent variable is given in the table and the independent variable is the use of electronic procurement, instrumented by the official adoption of electronic procurement at the state level. All regressions include state and year fixed effects and a control for log estimated project cost. Standard errors are clustered at the state level. Non-e-procurement project means for each dependent variable are also reported, with standard deviations in parentheses. *Significant at 10 percent. **Significant at 5 percent. ***Significant at 1 percent. XXfor Indonesia note this is a subset of data from roads divisionXX

Table 5: Two-Stage Contractor FE Regressions

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Log estimated cost	Log contract value	Log final payment	Late	Time overrun ratio	First quality grade (cond. on completion)	Minimum across quality grades (cond. on completion)
Panel A: India							
E-procurement	-0.0530*	0.00223	-0.0000463	0.0196	0.197	0.145**	0.179***
	(0.0256)	(0.01188)	(0.0118)	(0.0390)	(0.154)	(0.052)	(0.057)
Obs.	18344	17902	10111	9494	9494	1631	1631
Panel B: Indonesia - Works Projects							
E-procurement (IV)	-0.208	-0.045		-0.051*	0.0975		
	(0.264)	(0.034)		(0.028)	(0.205)		
Obs.	8590	8585		4122	4122		
Panel C: Indonesia - Consultancy Projects							
E-procurement (IV)	0.123	-0.029*		-0.00004	0.00002		
	(0.157)	(0.016)		(0.0005)	(0.0003)		
Obs.	4592	4586		2479	2479		

Observations are at the project level. The first stage is an OLS estimate, where the dependent variable is given in the table and regressed on a set of winning-contractor fixed effects. The second stage is an IV estimate, where the dependent variable is the winning-contractor coefficient from the first stage and the dependent variable is the use of e-procurement, instrumented by the official adoption of electronic procurement at the state level. Observations are analytically weighted by the inverse of the winning-contractor estimate squared standard errors in the second stage. All regressions include state and year fixed effects in both stages. India regressions also include log road length and log estimated cost controls in the first stage. In India, all regressions are restricted to packages with one contract.

Standard errors are clustered at the state level. Non-e-procurement project means for each first-stage dependent variable are also reported, with standard deviations in parentheses.

*Significant at 10 percent. **Significant at 5 percent. ***Significant at 1 percent.

Appendix

	State level
	(1)
	Difference in log contract value
Panel A: India	
E-procurement	2.87E-05
	(4E-05)
Mean Dep. Var. (Non-Eproc)	0.202
	(0.697)
Obs.	20
Panel B: Indonesia - Works Projects	
E-procurement (IV)	-0.084
	(0.115)
Mean Dep. Var. (Non-Eproc)	-0.039
	(0.538)
Obs.	30
Panel C: Indonesia - Consultancy Projects	
E-procurement (IV)	0.017
	(0.235)
Mean Dep. Var (Non-Eproc)	-0.491
	(0.725)
Obs.	28

India: Column (1) reports OLS estimates at the state level, where the dependent variable is the difference in log average contract value between 2000 and 2001. The independent variable is the year of official adoption of electronic procurement at the state level, conditional on adoption occurring after 2001.

Indonesia: Column (1) reports OLS estimates at the state level, where the dependent variable is the difference in log average contract value between 2005 and 2004. The independent variable is the year of official adoption of electronic procurement at the state level, conditional on adoption occurring after 2005.

The state-year regressions include year fixed effects.

Robust standard errors are in parentheses below estimates. Means for each dependent variable are also reported, with standard deviations in parentheses.

*Significant at 10 percent. **Significant at 5 percent.

***Significant at 1 percent.

Figure 1: Number of contracts by number of technical disqualifications and number of bidders

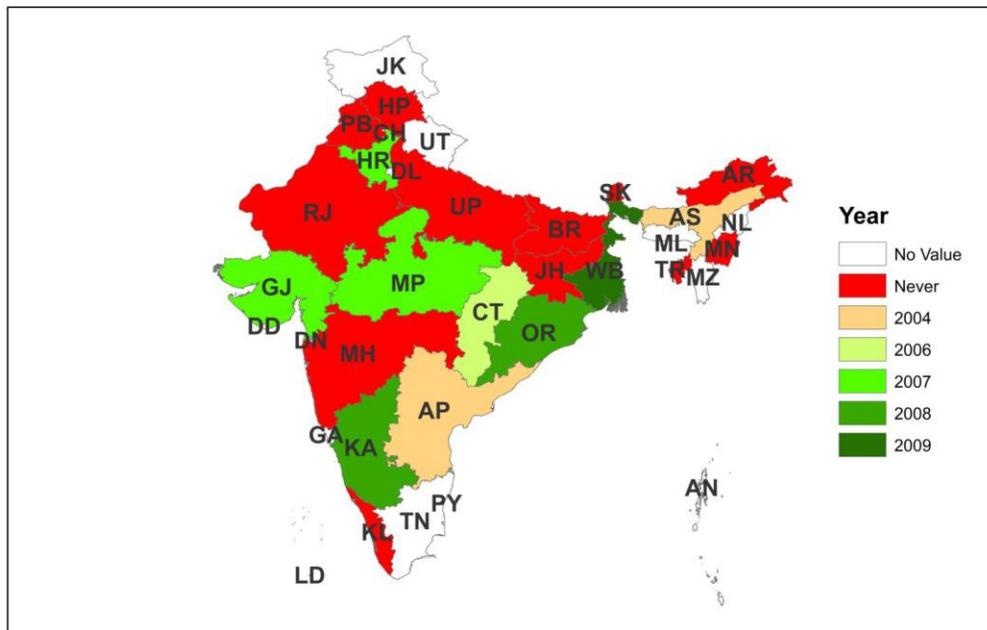| Number of bidders	Number of technical disqualifications				
	0	1	2	3	4
1	155				
2	4	15			
3	1		5		
4	3			4	
5					1
Total	163	15	5	4	1

Figure 2a: E-procurement Adoption – India

Figure 2b: E-procurement Adoption – Indonesia