Bribes, Bureaucracies, and Blackouts: Towards Understanding How Corruption Impacts the Quality of Electricity Supply to End-Users in Transition and Developing Economies

Jacquelyn Pless*

Submission for the Dennis J. O'Brien USAEE/IAEE Best Student Paper Award

February 2014

Abstract: The main purpose of this paper is to empirically estimate the impacts of corruption on the quality of electricity supply in emerging markets and developing economies. The research is important because poor electricity service delivery has critical implications for economic growth, particularly for developing countries. With a better understanding of the causes of "non-technical" electricity losses, findings can contribute to dialogue on effective policy measures seeking to improve electricity supply and its related institutions. An unbalanced pseudo-panel covering survey data from firms in 121 countries over the time period of 2006 to 2010 is used. Results indicate that when firms in an economy offer informal gifts or payments in return for an electricity connection, the overall quality of electricity supply decreases as measured by increased monthly power outages, higher percentages of electricity coming from back-up generators, and higher percentages of total sales lost to electricity outages. We also find that female participation in firm ownership decreases the chance that a firm will decide to offer a bribe for an electrical connection, and that market competition decreases the magnitude of bribes offered to public officials in order to 'get things done'.

Acknowledgements: This research was undertaken with funding support from the Joint Institute for Strategic Energy Analysis (JISEA), National Renewable Energy Laboratory (NREL), located in Golden, Colorado. I am incredibly thankful for the opportunity. I would like to thank my supervisors Doug Arent and Morgan Bazilian of JISEA/NREL for their invaluable guidance and insights. I would also like to thank my academic adviser, Harrison Fell, for his ongoing and helpful feedback on this project. All mistakes herein are solely those of my own.

* MS Candidate in Energy Economics, Colorado School of Mines, Division of Business & Economics, Golden, Colorado. Contact: japless@mymail.mines.edu.

I Introduction

In the year 2000, roughly a fourth of all electricity produced in low-income countries was lost during transmission and distribution (Kenny and Søreide, 2008).[1] Despite efforts to reduce electricity losses (particularly those that are non-technical[2]), they appear to be increasing overall and are most significant in countries characterized by relatively high economic, social, and political risk (Smith, 2004).[3] Power outages to the detriment of end-users result, potentially impeding the ability of firms to operate efficiently.[4] The quality of electricity supply has important implications for economic and social development,[5] and thus improving reliability remains a priority but one characterized by vast complexities. Although an impressive set of literature on the topic exists (as detailed in the next section), the determinants of non-technical losses, as well as their implications, are still not entirely well understood as they transcend the boundaries of strictly the electricity sector itself.

Understanding the roles of governance and corruption has emerged as a critical element in explaining electricity sector performance, and more generally, patterns of development. As infrastructure operations remain particularly vulnerable to corrupt activities (Bergara, Henisz, and Spiller, 1998; Dal Bó 2007; Estache and Trujillo, 2009), researchers, decision-makers, and policymakers have become increasingly interested in exploring how to reduce its impacts on infrastructure performance (Estache and Wren-Lewis, 2011). Corruption is a problem that takes on many forms with varying degrees of incidence and damage. But the word corruption can mean many things in various contexts, most often (and generally) referring to the use of public office for private

[1] Some regions—such as parts of India—have been shown to experience losses as high as 50 percent (Bhalla, 2000).
[2] Definition is forthcoming.
[3] For example, see Dollar et al. (2005) who use firm-level enterprise data to find that power losses have a significantly negative effect on productivity, confirming the importance of electricity provision in poor countries for productivity and growth.
[4] NTL overload generation units, which can result in over-voltage, impacting the quality of supply and leaving utilities with no estimate about the true quantity of electricity to supply to true and illegal customers (Depuru et al., 2011). High NTL could trip the generation unit and interrupt power supply (Sullivan, 2002), leading to brownouts and blackouts. Electricity theft and other forms of NTL is a serious concern for many utilities as they are threatened by significant economic losses, often losing large portions of total revenue. Sometimes, this leads to utilities imposing additional tariffs in order to compensate for the lost revenues (Depuru et al., 2011).
[5] See, for instance, Andersen and Dalgaard (2013) which examines the impact of power outages on economic growth in Sub-Saharan Africa (SSA) from 1995 to 2007, finding that weak power infrastructure in SSA leads to a substantial growth drag. See World Bank (1994) for an overview of the role of infrastructure in economic development, and Gramlich (1994) for a survey of literature on quantification of infrastructure contributions to income and growth. Furthermore, Dethier, Hirn, and Straub (2008) survey the literature that examines the impact of business climate variables on productivity and growth, including infrastructure and corruption impacts on firm performance. They highlight how good business climate drives growth by encouraging investment and higher productivity, noting how various infrastructure variables have been shown to significantly impact firm performance.

gain (Bardhan, 1997). In this context, many have studied how governance and corruption influence firm efficiency, some of which have focused on infrastructure provision, and a few have specifically explored the impacts on electricity losses (to be discussed in Section II). However, a robust understanding of how non-technical losses and their causes impact the *quality* of service provision—measures reflecting the impacts on end-users, such as through power outages and commercial losses—is still lacking. Furthermore, there is minimal research to date that explores firm characteristics that influence a firm's decision to bribe.

Overall, there remains an opportunity to explore the linkages between corruption, the quality of electricity supply, and firms' (end-users) capacity utilization. Such relationships have important implications for economic development in the context of weak infrastructure impeding growth, particularly for developing countries, and the impact of corruption on infrastructure quality. The main objective of this paper is to empirically investigate the impacts of corruption (as measured by bribery at the firm level) on the quality of electricity supply to end-users (as measured by monthly power outages, losses as a percentage of annual sales, and the percentage of electricity firms use from back-up generators) in emerging markets and developing economies. We explore three related questions: 1) how bribery directly impacts the quality of electricity supply provided to end-users, 2) the determinants of bribery, and 3) how corruption impacts firm capacity utilization.

The remainder of this paper is organized as follows. Section II provides an overview of existing research focusing on corruption and electricity with a focus on developing countries, and Section III explores the economic theory motivating our research question. Section IV describes our data, methodology, and empirical models, and in Section V we detail our identification strategy. In Section VI we discuss our findings, and we conclude in Section VII.

II Background

Generally, losses refer to the electricity injected into a transmission and distribution grid that is not paid for by final end-users (World Bank, 2009). In other words, they represent electricity generated that does not reach the customer. However in the context of this research, losses refer to financial losses (as opposed to electrons) due to poor power supply. Some losses are technical (physical) in nature (caused by losses in transmission or deficiencies in operations or physical infrastructure), but others (and the majority, in some cases) are widely assumed to reflect non-technical inefficiencies (commercial losses) resulting from actions outside of the physical power system. Common causes of non-technical losses (NTL) can include electricity theft, non-payment, and poor recordkeeping (World Bank, 2009).

Although practitioners and academics have sought to tackle this issue through various channels, significant electricity losses persist. One attempt, mostly introduced in the 1990s, was privatization; however, despite its success in some countries, performance of the industry fell short of (mostly poorly conceived) expectations, in some cases due partially to corruption (Kenny and Soreide, 2008)—but largely due to many other aspects of power sector reform. Some of these challenges can be associated with insufficient institutional and regulatory capacity (Estache, 2006; Kessides, 2004; Laffont, 2005), and the more general concern of governance (Kenny and Soreide, 2008).

In general, corruption can worsen productivity, increase the size of the informal economy, increase inequality, and reduce growth, investment, and income (Bardhan, 1997; Lambsdorff, 2005; Friedman et al., 2000; Li et al., 2000; Mauro, 1995; Murphy et al., 1993). It also entails 'fiscal leakage', reducing the ability of poorer countries to supply critical public services, such as electricity (Reinikka and Svensson, 2004; World Development Report, 2004). Petty corruption—bribes for service delivery in which utilities offer illegal connections in return for payment—is a significant obstacle in many cases (Kenny and Soreide, 2008). For instance, billing irregularities are often caused by corrupt practices and a lack of commitment by utility employees to control illegal electricity consumption (Gulati and Rao, 2006).

Studies on corruption and the resulting rent seeking were pioneered in the 1960s and 1970s (Becker, 1968; Becker and Stigler, 1974; Krueger, 1974; Leff, 1964; Rose-Ackerman, 1978), with a focus mostly on understanding the incentives of corrupt agents and their rent-seeking behavior (see, for instance, Rose-Ackerman, 1978; Shleifer and Vishny, 1993; Krueger, 1974). They addressed how government agents control access to markets as monopolists who can charge rents, and they highlighted how competition or regulation could help deter corrupt activity. The notion that corruption is an obstacle to growth and development is not new, and a detailed account of its influence on economic development does not need repeating.

More recently, however, the focus has been on the causes and economic consequences of corruption, particularly as they impact developing countries. Studies have shown that weak infrastructure (for instance, insufficient electric grids that provide poor electricity service delivery) can lead to a substantial growth drag (Andersen and Dalgaard, 2013), and that the contributions from infrastructure to income and growth are quantifiable and significant (World Bank, 1994). However, infrastructure operations—such as electricity provision—are particularly vulnerable to corruption (Bergara, Henisz, and Spiller, 1998; Dal Bó, 2006; Estache and Trujillo, 2009) thus drawing increasing interest from researchers, decision-makers, and policymakers to explore mechanisms for reducing its impacts on infrastructure performance (Estache and Wren-Lewis, 2011).

Some have focused on quantifying losses in power systems due to non-technical causes (Gulati and Rao, 2006). Others have specifically looked at how governance and corruption impact losses, but most work has focused on country-level losses and macro-level governance indicators. For instance Estache, Goicoechea, and Trujillo (2006) show how perceived corruption is correlated to lower energy use, finding interaction effects between sector policies and the impact of corruption, but the analysis relies on general measures of corruption perceptions at the country-level. Similarly, Estache, Goicoechea, and Trujillo (2009) explore the impact of corruption on country-level measures of access, quality, and affordability. A handful of papers have focused on the determinants of bribery. Findings have generally suggested that companies pay more bribes when they need to spend more time dealing with government or when they face other business climate restrictions (Gaviria, 2002; Henderson and Kuncoro, 2006; Renikka and Svensson, 2006). Clarke and Xu (2004) consider the impacts of reforms on petty bribery to utility firms using firm-level data, focusing on how characteristics of bribe-takers and payers affect bribes to utilities. However, they do not directly explore impacts on electricity supply quality, such as outages.

Perhaps most closely aligned with our current research, Bó and Rossi (2007) study how corruption is the most explanatory factor in firm efficiency when examining 80 electricity distribution firms in 13 Latin American countries from 1994 to 2001. They focus on how corruption impacts the efficiency of electricity distribution firms, but they note the need for a focus on the quality of service provision. Following Bó and Rossi (2007), Wren-Lewis (2013) explores the interaction between governance and corruption within the electricity sector, but again, there isn't a specific investigation into the quality of service provision. Lastly, Cubbin and Stern (2006) study the impacts of regulatory governance on electricity outcomes as measured by efficiency.

Dethier, Hirn, and Straub (2008) provide an overview of the literature that uses survey data on corruption and infrastructure. Particularly relevant, Dollar et al. (2005) use the World Bank's Enterprise Surveys to find that power losses have a significantly negative effect on productivity, confirming the importance of electricity provision in poor countries for productivity and growth. Reinikka and Svensson (2002) show how deficient public services impact private investment based on a 1998 Ugandan Industrial Enterprise Survey. Aterido et al. (2007) find that power outages decrease employment growth for medium sized firms. Commander and Svenjnar (2007) find that more competitors within the market impacts firm revenue. Fisman and Svensson (2005) provide evidence for the impact of corruption on growth. And Escribano and Guasch (2005) show that the size of bribe payments actually increases productivity.

Still, while corruption and governance and some of their impacts have been studied, a focus on how corruption at the firm level impacts the *quality* of electricity supply to end-users will provide valuable insights into the channels through which corruption can travel in the electricity sector and its impacts. Therefore, there remains an opportunity to investigate the impacts of bribery on the quality of electricity supply provided to end-users as measured by commercial losses, power outages, and the percentage of electricity used from a generator, which is the focus of this paper.

III Economic Theory & the Pervasive Nature of Corruption

There are essentially four components of economic theory that can help to explain corruption in electricity service provision at various levels: incentive theory (at the individual level), the theories of industrial organization (at the firm level), regulation theory (at the sector level), and political economy and rent-seeking theory (at the government level) (Kenny and Søreide, 2008).

At the individual level, agents consider the option to bribe (for an electricity connection, for instance). Incentive theory implies that those bribing—as well as those being bribed—will compare potential rewards relative to potential consequences of such an action (see Bardhan (1997) or Aidt (2003)), performing cost-benefit analyses at the individual decision-making level. Thus, if the punishments for such behaviors are perceived as being more harsh and enforceable, one will be less likely to bribe, whereas individuals will be inclined to bribe when the benefits exceed the costs.

At the firm level, the theories of industrial organization suggest that less competitive pressure within the industry will increase business corruption, and thus more corruption within an industry may exist within less competitive markets.[6] When there are market opportunities in for power, we would expect more corruption to exist. Furthermore, when an informal market exists or is perceived to exist—a 'competitive fringe' of informal producers in a market shared by 'formal firms' (Murphy et al., 1989)—then a government often oversees the formal firms. In this case, bribes are often requested (as an entry cost) so that firms and those that can pay receive the benefit of being in an imperfectly competitive market in which positive economic profits are realized (Emerson, 2006).

Corruption can also enter the picture at the sector level. Consider the case of service provider selection where such services will operate under a concession contract. This process typically takes

[6] See Beato and Laffont (2002) for a review of competition and corruption in regulated industries. For information on market concentration in utility sectors, see Benitez and Estache (2005). Lastly, see Ades and Di Tella (1999), Bliss and Di Tella (1997), and Shleifer (2004) for more on the relationships between corruption and competition.

place through a competitive bidding process, while the concession contract will contain many regulatory elements to meet other jurisdiction-wide welfare objectives (Kenny and Søreide, 2008). Regulation theory suggests that the extent and impact of grand corruption will depend on the nature of how the industry is regulated, as well as the strength of regulatory institutions (Kenny and Søreide, 2008). For instance, the independence of regulatory institutions has been shown to influence the impact of corruption (see Wren-Lewis, 2011). Politicians may try to influence regulatory decisions for patronage or other motivations. However, an independent regulatory may only change the structure rather than the extent of corruption, unless sufficient transparency exists within the regulatory structures and there is well-managed, effective oversight (Kenny and Søreide, 2008).

Lastly, corruption and the quality of governance at the country-level cannot be ignored. In regions where public power is often exercised for private gain, the quality of public services is poor (including the government's commitment to policy enforcement), and agents do not have confidence in the rules of society. Corruption is therefore likely to be more of an issue at the sector level when its present at the national level as perceptions often lead to an initial set of assumptions for corruption risk (World Bank, n.d.). In this context, countrywide governance and corruption may have implications for the incidence of corrupt activities within the electricity sector. Furthermore, higher-level corruption can encourage businesses to operate within the informal sector, thus we may suspect that country-level governance and corruption measures could influence a firm's decision to bribe or to participate in the informal sector.

IV Data, Methodology, and Empirical Models

4.1 The Data

The empirical analysis presented is based on firms (of various sectors, such as manufacturing, services, textiles, etc.) in emerging markets and developing economies from 2006 to 2010. Three different data sources are used to form a repeated cross-section dataset of 73,330 firms in 121 countries from 2006 to 2012. A pseudo-panel is created as described in the following section.

Country-level data on corruption and governance are obtained from the World Bank's Governance Indicators Database,[7] and data for all other country-level controls are from the World Bank's Development Indicators Database.[8] Firm-level data correspond to firms that participated in the World Bank's Enterprise Surveys between 2006 and 2010. The Enterprise Surveys provide the most comprehensive firm-level data in developing and emerging economies, covering 130,000 firms in 135 countries as representative samples of economies' private sectors. They cover a range of business environment topics including infrastructure, corruption, competition, and performance measures.

4.2 Methodology: A pseudo-panel approach

Following Verbeek (2007), we start by setting up a simple linear model for i firms over t periods with individual (firm) fixed effects given by

$$y_{it} = \beta x_{it}' + u_i + \varepsilon_{it}\,, \quad t = 1, \ldots, T, \tag{1}$$

where x_{it} is a matrix of explanatory variables, u_i are individual (firm) fixed effects, and ε_{it} is the disturbance term. Since the dataset is a series of independent cross-sections, so that observations on N firms are available each period, different firms are observed in each time period, implying that i does not follow from 1 to N for each period t (Verbeek, 2007).

This model can be consistently estimated from repeated cross-sections with OLS by pooling observations, treating $u_i + \varepsilon_{it}$ as a composite error term, but only if the firm effects u_i are uncorrelated with the other explanatory variables. In our case, it is likely that firm effects will be correlated with some or all of the explanatory variables, and thus some of the moment conditions that could be exploited in the OLS case would not be valid (Verbeek, 2007). On the other hand, a fixed effects approach treating u_i as fixed unknown parameters could be implemented if we had genuine panel data. When estimating β, this approach would be the same as using the within-transformed explanatory variables $x_{it} - \bar{x}_i$ as instruments for x_{it} in (1), where $\bar{x}_i = T^{-1} \sum_{t=1}^{T} x_{it}$.

[7] Available at http://info.worldbank.org/governance/wgi/index.aspx#home.
[8] Available at http://data.worldbank.org/data-catalog/world-development-indicators.

Clearly, this cannot be used though when repeated observations on the same firms are not available, which is the case for our present data. The Enterprise Surveys are based on large samples of firms in countries across time, but firms are not identified over time. Rather, the raw data consist of repeated cross-sections of large samples of firms' survey responses over time.

In order to obtain consistent estimators with this repeated cross-section data, Deaton (1985) suggests the use of cohorts even if u_i is correlated with one or more explanatory variables. More recent developments on the methodology include Bourguignon, Goh, and Kim (2004) and Artman and McKenzie (2007). This means-based pseudo-panel approach in which cohorts of firms with similar characteristics are tracked over time has been exploited when facing data limitations similar to those that we face in our current study, such as demonstrated in Antman and McKenzie (2006), Warunsiri and McNown (2010), and Cuesta et al. (2011).

We apply the pseudo-panel method and define C cohorts as groups of individuals (or firms) that share common characteristics, where each firm or individual is a member of only one cohort, which does not change over periods (Verbeek, 2007). Cohorts therefore must have fixed membership and must be based on characteristics that are observed for all observations within the sample. This rules out time-varying variables (such as earnings) (Verbeek, 2007).

Once all observations are aggregated to the cohort level, we calculate the mean values for the variables associated with each cohort, which become the units of observation in the pseudo-panel (Verbeek and Nijman, 1992: Verbeek and Nijman, 1993). The resulting model is written as

$$\bar{y}_{ct} = \beta \bar{x}'_{ct} + \bar{u}_{ct} + \bar{\varepsilon}_{ct}\ ,\ \ c = 1, \dots, C;\ \ t = 1, \dots, T, \tag{2}$$

where $\bar{y}_{ct}$ is the average value of all observed y_{it}'s within cohort c in period t, and likewise, the other variables are also averages of observed values within cohort c in period t. What results is a pseudo panel (or synthetic panel) with repeated observations for C cohorts over T periods (Verbeek, 2007).

When estimating β from (2) we face the problem that $\bar{u}_{ct}$ is unobserved, depends on t, and is likely correlated with $\bar{x}_{ct}$. Treating $\bar{x}_{ct}$ as part of the disturbance term, therefore, will lead to inconsistent estimators (Verbeek, 2007). An alternative approach is to treat $\bar{u}_{ct}$ as fixed unknown parameters with the assumption that variation over time can be ignored and thus $\bar{u}_{ct} = u_c$. If cohorts consist of a large number of individual observations, then the assumption seems reasonable and the estimator for β is the within estimator on the pseudo panel, given by (Verbeek, 2007) as

$$\hat{\beta}_W = \left(\sum_{c=1}^{C} \sum_{t=1}^{T} (\bar{x}_{ct} - \bar{x}_c)(\bar{x}_{ct} - \bar{x}_c)' \right)^{-1} \sum_{c=1}^{C} \sum_{t=1}^{T} (\bar{x}_{ct} - \bar{x}_c)(\bar{y}_{ct} - \bar{y}_c) \ , \qquad (3)$$

where $\bar{x}_c = T^{-1} \sum_{t=1}^{T} \bar{x}_{ct}$ is the time average of the observed cohort means.

There are two additional dimensions to consider: the number of observations within each cohort n_c and the number of cohorts C. Three possibilities are most common (Verbeek, 2007):

1. $N \to \infty$ and C is fixed so that $n_c \to \infty$;
2. $N \to \infty$ and $C \to \infty$ so that n_c is fixed.
3. $T \to \infty$ and C, N are fixed (and thus n_c is also fixed).

Type 1 asymptotics are the reasonable choice for our data (which are employed in Moffitt (1993), and Verbeek and Vella (2005)) in which the fixed effects estimator based on the pseudo panel, $\hat{\beta}_W$, is consistent for β if

$$\operatorname*{plim}_{n_c \to \infty} \frac{1}{CT} \sum_{c=1}^{C} \sum_{t=1}^{T} ((\bar{x}_{ct} - \bar{x}_c)(\bar{x}_{ct} - \bar{x}_c)' \qquad (4)$$

is finite and invertible (Verbeek, 2007), and if

$$\operatorname*{plim}_{n_c \to \infty} \frac{1}{CT} \sum_{c=1}^{C} \sum_{t=1}^{T} (\bar{x}_{ct} - \bar{x}_c)\bar{u}_{ct} = 0. \qquad (5)$$

This essentially says that cohort averages exhibit genuine time variation even when very large cohorts exist (Verbeek, 2007). Letting $n_c \to \infty$, is attractive in order to obtain consistent estimators because $\bar{u}_{ct} \to u_c$ will be satisfied automatically if the number of observations per cohort tends to infinity (see Moffitt (1993) and Ridder and Moffitt (2007)).

The number of observations within each cohort as well as the way in which cohorts are constructed is also important. Under the asymptotics selected for this research (type 1), the number of observations per cohort tends to infinity, but there is no general rule for judging whether n_c is large enough. Verbeek and Nijman (1992) however show that cohorts should be greater than 100 observations each in order to (nearly) eliminate bias in the estimators, however it's noted that the bias in the standard within estimator may still be substantial even with large cohort sizes (Verbeek, 2007). Nonetheless, without a general rule that is readily applied in the literature, we use 100 observations per cell as the cutoff for our cohorts.

Lastly, we need to be as careful constructing cohorts as one would be when selecting instruments. Cohorts should be defined based on variables that are observed for all individuals in the sample and which do not vary over time, which substantially narrows the variables on which we can group to construct cohorts.

With these restrictions imposed, our options are quite limited. We choose to group on only country and firm size (measured by the number of employees as small (5-19), medium (20-99), and large (100+)), two characteristics that are observed for all survey responses within the sample and which allow for the greatest number of cohorts exceeding 100 observations.[9] Firms located in the same country face similar governance and macroeconomic conditions for operations, and we assume that firms of similar size may exhibit similar costs and demands for operation. At the same time, the effect of firm size on bribery appears to be ambiguous—larger firms are likely to have a higher ability to pay for bribes (Svensson, 2003) but they also are likely to retain more influence with local authorities and thus may be less vulnerable to the demands of officials (Herrera et al., 2007)—which makes it an attractive characteristic for grouping.

The full repeated cross-section dataset originally consisted of 73,330 firms in 121 countries from 2006 to 2010. Grouping on country and size results in a total of 363 cohorts. Once cohorts with

[9] While it would have been possible to group on more characteristics, thus increasing the within group common characteristics, this would have limited the sample to too few cohorts of more than 100 observations. Similarly, other cohort groupings (such as by country and sector, for instance) also would have been too limiting.

less than 100 observations are eliminated, we have 135 cohorts C over T periods from 2006 to 2010 covering survey data from 63,176 firms in 115 countries.

Lastly, in our sample, the number of firms in each cohort and time period is not the same, which could potentially induce heteroskedasticity. We follow Dargay (2007) to correct for this by weighing all cohort variables by the square root of the number of firms in each cohort (indicated as WLS regressions in our results tables).

4.3 Empirical Estimation

We explore three questions related to how petty corruption may impact the quality of electricity supply provided to end-users: 1) how bribery directly impacts the quality of power supply to end-users, 2) the determinants of bribery, and 3) how corruption impacts firm capacity utilization (indirectly). For our pseudo-panel of $c = 1,,,C$ cohorts observed over $t = 1,,,T$ periods, the general model for each estimation is written as

$$\bar{y}_{ct} = \beta\bar{x}_{ct} + \gamma\bar{z}_{ct} + \bar{u}_c + \bar{v}_t + \bar{\varepsilon}_{ct} \ , c = 1, \dots, C, t = 1, \dots, T, \quad (6)$$

where $\bar{y}_{ct}$ represents the different output variables; $\bar{x}_{ct}$ is a matrix of firm-specific characteristics (sometimes as controls and sometimes as the variables of interest) (mean values); $\bar{z}_{ct}$ is a matrix of country level control variables; $\bar{u}_c$ is the average of the firm fixed effects in cohort c; $\bar{v}_t$ are time (year) fixed effects; and $\bar{\varepsilon}_{ct}$ is the disturbance term. Note that averaging over cohort members eliminates individual heterogeneity. Inclusion of year fixed effects allows for time effects to be accounted for in a flexible way, measuring the impact of sector-level time trends (such as technology advances, macroeconomic fluctuations not captured in our controls, or energy price shocks). Cohort fixed effects control for time-invariant unobservables.

A number of country-level controls are used throughout the analyses. The log of GDP per capita (PPP constant 2005 international \$) (*log(gdppercap)*) controls for an economy's overall wealth, with the assumption that more wealthy economies are less corrupt and provide less incentives to need to bribe for electricity. The log of population density (people per sq. km of land area) (*log(PopDensity)*) is included, and the inflation rate (based on the CPI) (*inflation*) proxies for macroeconomic instability. Country level governance indicators are included to capture higher-level governance influences, so that impacts from firm level corruption measures and firm characteristics can be most precisely identified. For such controls, the World Bank's six Governance Indicators are used (individually included in each regression to capture the effects of different aspects of governance) which serve as useful tools for evaluating broad trends over time, but they do not capture the sector-specific corruption measures or firm-level characteristics that we seek. Each of the indices ranges from -2.5 (weak governance) to 2.5 (strong governance).

For Model 1, three metrics tested as dependent variables to reflect the quality of electricity supply provided to end-users (firms): *electoutages* (the average number of power outages per month); *generatorpercent* (the percentage of electricity coming from a generator that the firm owns or shares); and *electlossesperc* (the estimated losses as a percentage of total annual sales due to power outages). We hypothesize that corruption increases all three of these measures. Corruption at the firm level is measured in two ways. First, *electgifts* represents whether a firm indicated that informal gifts or payments are expected or required in order to obtain an electrical connection (1=yes, 0=no). This variable provides indication of corruption within the electricity sector itself, allowing us to identify sector-specific corruption effects on electricity quality as opposed to strictly country-level governance impacts. Second, *giftspercsales* represents the percentage of total annual sales paid as informal payments to public officials to 'get things done'. While this exceeds the boundaries of the electricity sector, it proxies for the amount (or magnitude) of bribes paid and can be assumed to highly correlated to the magnitude of bribes paid within an electricity context by the same firm.

In some cases, we include firms' perceptions of corruption within the economy (*corrserious*) as a control, which indicates whether the firm noted that corruption is the most serious obstacle to firm operations (1=yes, 0=no, other obstacles are the *most* serious). We also control for electricity costs as a percentage of total sales (*electprices*) in some cases to capture the impact of costs of electricity and whether it's impacting the quality of overall supply.

When assessing determinants of a firm's decision to bribe (and its magnitude) in Model 2, we *giftspercsales* and *electgift* become the dependent variables. Because the pseudo-panel required *electgift* to be averaged, which was originally a binary variable, it now ranges from 0 to 1 and is treated as a continuous variable. Therefore, y_{ct} measures bribery, w_{ct} includes firm characteristics that are hypothesized to affect bribery, and all else remains.

For these estimations, we are primarily interested in whether competition within the firm's market is relevant, and we measure this with *pricedecrease*, whether a firm indicated that the prices of its main product have decreased as a proxy for competition (with the assumption that decreasing prices means increased competition).[10] We also test whether female representation within the ownership of the firm (*femaleown*), whether foreign ownership (*foreign*), and whether a firm is listed publicly (*public*) (1=yes, 0=no) reduce bribery. The variable *electserious* is included in some cases, which indicates how serious of an obstacle electricity is considered in regards to firm operations (1=most serious obstacle, 0=not the most serious obstacle). Similarly, to test whether the informal sector being an obstacle to operations matters for bribery, *informalobstacle* is included in some cases, and *timeregs*, the percentage of senior management's time spent dealing with regulations, is included in some cases but is mostly meant to control for red tape outside of the sector itself. Fuel costs *(fuelcostsperc)* as a percentage of total annual sales and electricity costs (*electcostsperc*) as a percentage of total annual sales control for other costs faced by firms that could impact the need to bribe.

Lastly, we briefly examine the impact of bribery (*electgift* and *giftspercsales*) within the electricity sector on firms' ability to operate as measured by the firm's capacity utilization (measured as a percentage of full capacity) (*utilization*). We assume that firms seek 100% capacity utilization. Other factors influencing capacity utilization may include other firm-specific characteristics such as its age (*age*), electricity costs (*electcostsperc*), and fuel costs (*fuelcostsperc*).

[10] We recognize that this is problematic; price decreases could be due to lower demand.

V Identification

The identification strategy described exploits variation over time and across cohorts in the independent variables of interest (namely corruption, competition, and female ownership), which could be driven by unobserved factors such as changes within the government. Year fixed effects (included in all regressions) account for the productivity impacts of sector level shifts over time, such as energy price shocks, technology changes, and macroeconomic fluctuations, and country-wide trends over that which impact both corruption and the quality of electricity supply.

We attempt to rule out the possibility of other influences that are observable by including numerous sector and country level control variables (see Tables 1, 2 and 3), and the results of these robustness checks are discussed in the next section. Shocks that impact both corruption and countrywide firm and electricity outputs that vary by country and year should be captured in these macroeconomic controls. Nonetheless, it is still likely that unobserved firm, sector, and country level characteristics not captured in our specifications influence electricity quality (such as the age of the physical infrastructure, for instance, or enhanced development goals of the government with a focus on electricity) as well as firms' capacity utilization (such as learning), and thus caution must be taken when interpreting the results. While it is important to bear this in mind, the results are useful for guiding policy discussions and future research aiming to better understand the channels through which corrupt activities can impact the quality of electricity service provision. If the variables measured here help to explain significant differences in the quality of supply, firm capacity utilization, and the determinants of bribery, then this research brings us closer to understanding the areas on which to focus.

We also may be concerned with the potential for reverse causality arising if the quality of electricity supply affects the independent variables. This is unlikely in the case of the country-level corruption and governance indicators since firm-level shocks will likely not impact country-level indicators, and shocks felt by the wider economy will be captured by the use of control variables. On the other hand, we may be concerned with the firm level measures of corruption (bribery). In the case of electricity outages, reverse causality seems unlikely since the number of outages within an entire region probably does not impact whether firms bribe and the amount that they offer. On the other hand, we might suspect that bribery could be endogenous when regressing on *generatorpercent* since it's possible that the percent of power generated by a generator for a single firm could influence that firm's likelihood of bribing. If the impacts of poor quality are directly impacting a firm's cost structure (since using electricity from a back-up generator is generally more expensive than connecting to the grid), then the firm may be more likely to offer bribes and in higher magnitudes in order to gain access to service. Based on similar logic, we also might suspect bribery to be endogenous when regressing on *electlossespercent,* which directly impact firm profits.

Over the longer term, however, this is probably more of an issue (relative to the 5-year period studied here) since the decision of firms to bribe and the magnitude of bribes are probably not strongly influenced by a poor electrical grid over a small number of years—rather, cultural and firm level characteristics of management and the sector's norms are likely to be the main determinants (for instance, it's possible for "optimal" levels of corruption to exist). Still, to check for reverse causality, we use an instrumental variable (IV) approach in some cases. For an IV specification, I follow Dal Bó and Rossi (2007) and use the share of imports in GDP (*imports*) as an instrument for bribery. This is a variable that proxies for a country's openness to trade and which has been shown to play an explanatory role in corruption regressions (Gatti, 1999; Ades and Di Tella, 1997) and we can expect it to not play a role in determining electricity outages or commercial losses. Following similar logic, we might suspect bribery to be endogenous when regressing it on *utilization*: a firm's inability to operate at its full capacity may lead it to offer a bribe. We use *imports* as an instrument again (since openness to trade is unlikely to impact and individual firm's capacity utilization).

Finally, when considering our regressions determining the decision to bribe and the magnitude of bribes, we do not have any reason to believe that female participation within a firm's ownership is endogenous; it's not likely that whether a firm bribes influences whether a female owns the firm, but rather, the relationship is likely to be the other way around as assessed in the original analyses. However, one could argue that *pricedecrease*, our proxy for market competition, is endogenous: it's possible that bribery (higher sector corruption) could decrease market competition, or that they're jointly determined. We use *saleschange* as an instrument, which is whether sales of the main product have increased (1), remained the same (2), or decreased (3) in the year preceding the survey. We wouldn't expect this variable to be correlated with a firm's propensity to bribe and the magnitude of bribes, although we would expect it to be correlated with whether prices have decreased (these relationships were confirmed with regressions on the pseudo-panel).

Lastly, it's important to recognize that corruption and governance, and the various country-level indicators, are treated independently even though they are likely to be correlated. For this methodology, however, this is not a serious problem since all variables appear simultaneously on the right hand side of the regressions.

VI Results & Discussion

Estimation results for when we estimate the impacts of bribery on the quality of electricity supply can be found in Table 1 of the Appendix. The outcomes suggest that the impact of the decision to bribe (*electgifts*) on electricity losses, power outages, and electricity from a generator is positive and significant when including time fixed effects, and while it loses its significance when cohort effects are included, the coefficient maintains its correct sign. Similarly, we find that the magnitude of bribes (*giftspercsales*) is also positive and significant in some cases, and while it loses its significance in some regressions, the direction of its influence is maintained. Our most robust finding for this estimation is that when regressing on electricity losses as a percentage of total sales, the magnitude of bribes is positive and significant when including both time and cohort fixed effects, and when correcting for heteroskedasticity.

The estimation outcomes for assessing the determinants of bribery can be found in Table 2 of the Appendix. We find that female participation within the ownership of a firm has a significant effect on a firm's decision to bribe, maintaining a negative coefficient with significance in all cases.

Here, our competition proxy *(pricedecrease)* is not significant. On the other hand, when estimating the determinants of the magnitude of bribes, female ownership loses its significance when correcting for heteroskedasticity, but more market competition decreases the magnitude of bribes with significance in all cases. We also find that in economies where firms perceive electricity to be a serious obstacle to operations (*electserious*), bribery as measured by both variables increases and is significant in all cases. Findings suggest that fuel costs may increase the magnitude of bribes, as well as the perception of firms that the informal sector is an obstacle to operations, whereas foreign ownership and whether a firm is publicly listed are both insignificant in all regressions.

Lastly, our estimation results exploring the impacts of bribery on firms' capacity utilization can be found in Table 3 of the Appendix. Our most robust finding here is that when correcting for heterskedasticity and when including both time and cohort fixed effects, the magnitude of bribes within a cohort reduces firm capacity utilization. On the other hand, our results suggest that the propensity to bribe could actually increase capacity utilization, although the results are mixed. Its influence is positive and significant when using time fixed effects and when correcting for heteroskedasticity, but the coefficient becomes negative (but not significant) once cohort fixed effects are included.

Our IV estimation results are mixed and can be found in Table 4 of the Appendix. Our most robust finding is that once an IV is used for *pricedecrease* when regressing it on *electgift*, female participation within the ownership of firms is still found to have a negative influence on the decision of firms to bribe (at the 1% level) and electricity being a serious obstacle to firm operations *(electserious*) maintains its positive influence on *electgift* at a 5% level of significance. The positive coefficients on *fuelcostperc* and *electserious* are also maintained when regressed on *giftspercsales* after instrumenting for competition, and while it loses its significance, our competition coefficient still maintains its expected sign with the IV. Also worth noting is that the magnitude of bribes maintains its positive coefficient when regressed on electricity losses and maintains its expected negative coefficient when regressed on capacity utilization, although it loses its significance in both cases.

While some of our results survive a number of robustness checks, it's important to highlight that the significance of results in many cases (but not all) did not hold when cohort fixed effects were included, which is problematic. The lack of significance could be partially explained through the lens of an instrumental variable (IV) interpretation. Estimation based on grouping firm data into cohorts is the same as an IV approach in the sense that the cohort indicators are used as instruments (Verbeek, 2007). Thus, the ways in which we group are critical and should satisfy the conditions for an IV estimator in order to be consistent. This requires that the instruments are valid (uncorrelated with the unobservables) and relevant (appropriately correlated with the explanatory variables) (Verbeek, 2007). Even if we may assume that these 'instruments' are theoretically valid and relevant (i.e. that the country in which a firm is located as well as firm size matter), a large number of IVs consequently introduced, and they may be only weakly correlated with the explanatory variables that they are supposed to instrument (which could imply that the resulting estimators suffer from the "weak instruments" problem) (see Bound, Jaeger and Baker (1995); Staiger and Stock (1997)). This may be the case for our present analysis in which we find significance for our variables of interest for the pseudo-panel when including time fixed effects and when using WLS, as well as for our repeated cross-section dataset. Future work will explore this further, testing various grouping aggregations across different firm level characteristics, and more generally comparing the pseudo-panel approach to a simple cross-section analysis with time dummies.

VII Conclusions

The main goal of this paper was to identify the impacts of firm level corruption on the quality of electricity supply to end-users in emerging and developing economies. This research is important because weak infrastructure has critical implications for economic growth, and in order to meet development goals, it is necessary to understand factors impacting the quality of electricity supply.

Results generally supported our hypotheses with some findings surviving a number of robustness checks. Our results suggest that overall, petty corruption as measured by bribery of firms within an economy can reduce the quality of electricity supply. Furthermore, our most robust finding is that female participation within firm ownership deters the decision to bribe. This result is supported when correcting for heteroskedasticity and when including both time and cohort level fixed effects. While a number of improvements of the models presented here are warranted, this research highlights the importance of understanding the origination of electricity losses as their (often) non-technical causes transcend the boundaries of strictly the electricity sector itself. Electricity losses not only threaten the financial sustainability of the power sector, but they also adversely affect end-users.

We chose to focus on the influence of petty corruption on the quality of electricity supply, however the models estimated would benefit from further investigation seeking valid instruments for corruption as well as alternative grouping mechanisms for cohort creation. Furthermore, future work could focus on other sector-specific channels through which corruption could travel. Lastly, as some jurisdictions have started to explore policies that target loss-reduction, examination of policy impacts on non-technical losses will be needed.

References

Ades, A., Di Tella, R., 1999. Rents, competition and corruption. *The American Economic Review,* 89(4): 982-993.

Aidt TS., 2003. Economic analysis of corruption: a survey. *The Economic Journal,* 113:632-52.

Andersen TB, Dalgaard CJ, 2013. Power outages and economic growth in Africa. *Energy Economics* 38: 19-23.

Andres L., Foster V., Guasch JL., 2006. "The Impact of Privatization on the Performance of the Infrastructure Sector: The Case of Electricity Distribution in Latin American Countries." Policy Research Working Paper 3936. World Bank, Washington, DC.

Antman F., McKenzie DJ., 2007. Earnings Mobility and Measurement Error: A Pseudo-Panel Approach. *Economic Development and Cultural Change* 56(1): 125-161.

Aterido R., Hallward-Driemeier M., Pages C., 2007. Investment climate and employment growth: The impact of access to finance, corruption, and regulations across firms. IZA Discussion Paper No. 3138.

Bardhan P., 1997. Corruption and development: a review of issues. *Journal of Economic Literature,* 35:1320-46.

Beato P., Laffont JJ., 2002. Competition in public utilities in developing countries. *Sustainable Developing Department Technical Paper Series.* Inter-American Development Bank, Washington, DC.

Becker GS., 1968. "Crime and Punishment: An Economic Approach," *Journal of Political Economy* 76(2): 169-217.

Becker G., Stigler G., 1974. Law enforcement, malfeasance, and compensation of enforcers. *Journal of Legal Studies* 3:1-19.

Benitez D., Estache A., 2005. How concentrated are infrastructure markets? *Review of Network Economies,* 4(3): 220-242.
Bergara ME., Henisz WJ., Spiller PT., 1998. "Political Institutions and Electric Utility Investment: A Cross-National Analysis." *California Management Review* 40:3-35.
Besley T., 2006. *Principled Agents? The Political Economy of Good Government,* Lindahl Lectures/Oxford
Bhalla MS., 2000. Transmission and Distribution Losses (Power). In Proceedings of the National Conference on Regulation in Infrastructure Services: progress and way forward. New Delhi, 14-15 November 2000, organized by TERI.
Black B., Kraakman R., Tarassova A., 2000. Russian privatization and corporate governance: What went wrong? *Stanford Law Review,* 52:1731-1808.
Bliss C., Di Tella R., 1997. Does Competition Kill Corruption? *The Journal of Political Economy* 105(5): 1001-1023.
Boubakri N., Cosset JC., 1998. "The Financial and Operating Performance of Newly Privatized Firms; Evidence from Developing Countries." *Journal of Finance* 53(3): 1081-110.
Boubakri N., Cosset JC., Guedhami O., 2008. "Privatization in Developing Countries: Performance and Ownership Effects." *Development Policy Review* 26(3): 275-308.
Breen, M., Doyle, D., 2013. The Determinants of Privatization: a Comparative Analysis of Developing Countries. *Journal of Comparative Policy Analysis* 15(1); p. 1-20.
Chisari O., Estache A., Romero C., 1999. "Winners and Losers from Utility Privatization in Argentina: Lessons from a General Equilibrium Model." *World Bank Economic Review* 13(2): 357-78.
Clarke, GRG, Xu, LC., 2004. Privatization, Competition, and Corruption: How Characteristics of Bribe Takers and Payers Affect Bribes to Utilities. Journal of Public Economics.
Clarke G., Ménard C., and Zuluaga AM., 2000. "The Welfare Effects of Private Sector Participation in Guinea's Urban Water Supply." Policy Research Working Paper 2361. World Bank, Washington, DC.
Commander S., Svejnar J., 2007. "Do Institutions, Ownership, Exporting and Competition Explain Firm Performance? Evidence from 26 Transition Countries." IZA Discussion Paper No. 2637. Institute for the Study of Labor, Bonn.
Cubbin J., Stern J., 2006. The Impact of Regulatory Governance and Privatisation on Electricity Industry Generation Capacity in Developing Economies. *World Bank Economic* Review, vol.20, p. 115-41.
Cuesta J., Nopo H., Pizzolitto G., 2011. Using Pseudo-Panels to Measure Income Mobility in Latin America. IZA Discussion Paper No. 5449.
Dal Bó E., Rossi MA, 2007. Corruption and Inefficiency: Theory and Evidence from Electric Utilities. *Journal of Public Economics* 91 (5-6): 939-962.
Dargay J., 2007. "The effect of prices and income on car travel in the UK." *Transportation Research Part A* 41:949-960.
Deaton A., 1985. "Panel data from time series of cross-sections." *Journal of Econometrics* 30:109-126.
Depuru SSSR., Wang L., and Devabhaktuni V., 2011. Electricity theft: Overview, issues, prevention and a smart meter based approach to control theft. *Energy Policy* 39(2): 1007-1015.
Dethier JJ, Hirn M., Straub S., 2008. Explaining Enterprise Performance in Developing Countries with Business Climate Survey Data. Washington, DC: The World Bank.
Emerson PM., 2006. Corruption, competition and democracy. *Journal of Development Economics* 81: 193-212.
Devereux, 2007. Small Sample Bias in Synthetic Cohort Models of Labor Supply, *Journal of Applied Econometrics,* 22: 839-848.
Dollar D., Hallward-Driemeier M., Mengistae T., 2005. "Business climate and Firm Performance in Developing Economies." *Economic Development and Cultural Change* 54: 1-31.
Enterprise Surveys (http://www.enterprisesurveys.org), Washington, DC: The World Bank.
Escribano A., Guasch J., 2005. "Assessing the Impact of the Business Climate on Productivity Using Firm Level Data: Methodology and the Cases of Guatemala, Honduras, and Nicaragua." Policy Research Working Paper 3621. World Bank, Washington DC.
Estache A., 2006. PPI Partnerships vs PPI Divorces in LDCs. *Review of Industrial Organization* 29: 3-26.
Estache A., Rossi M., 2002. "How Different is the Efficiency of State and Private Water Companies in Asia?" *World Bank Economic Review* 16(1): 139-48.
Estache A., 2006. A survey of recent and upcoming issues. The World Bank Annual Conference on Development Economics, ABCDE, Tokyo 2006, May 29-30.
Estache A., 2006. PPI Partnerships vs PPI Divorces in LDCs, *Review of Industrial Organization* 29, 3-26.

Estache A., Goicoechea A., Trujillo L., 2006. Utilities Reforms and Corruption in Developing Countries. World Bank Policy Research Working Paper 4081, Washington, DC: The World Bank.

Estache A., Goicoechea A., and Trujillo L., 2009. "Utilities reforms and corruption in developing countries." *Utilities Policy* 17 (2):191-202.

Estache A., Trujillo L., 2009. "Corruption and Infrastructure Services: An Overview." *Utilities Policy* 17 (2):153-155.

Estache A., Wren-Lewis L., 2011. "Anti-corruption policy in theories of sector regulation." In *The International Handbook on the Economics of Corruption II,* edited by Susan Rose-Ackerman and Tina Soreide.

Fisman R., Svennson J., 2007. "Are Corruption and Taxation Really Harmful to Growth? Firm Level Evidence." *Journal of Development Economics* 83:63-75.

Friedman E., Johnson S., Kaufmann D., Zoido-Lobaton P., 2000. "Dodging the Grabbing Hand: The Determinants of Unofficial Activity in 69 Countries." *Journal of Public Economics* 76 (3): 459-93.

Galiani S., Gertler P., Schargrodsky E., 2005. "Water for Life: The Impact of the Privatization of Water Services on Child Mortality." *Journal of Political Economy* 113 (1): 83-120.

Gramlich E., 1994. Infrastructure Investment: A Review Essay. *Journal of Economic Literature* 32: 1176-96.

Gulati M., Rao MY., 2006. "Corruption in Electricity Sector". Presentation to World Bank staff, April 2006. http://www1.worldbank.org/publicsector/anticorrupt/bbagdetails.cfm?ID=262

Herrera AM, Lijane L., Rodriguez P., 2007. Bribery and the nature of corruption. Available at: https://www.msu.edu/~herrer20/documents/HLR_may07.pdf.

Hodge G., 1999. *Privatization: An International Performance Review.* Boulder, CO: Westview Press.

Jamil F., and Ahmad, E., 2013. An Economic Investigation of Corruption and Electricity Theft. Pakistan Institute of Development Economics. PIDE Working Papers 2013: 92.

Jaskow PL, 2007. Regulation of Natural Monopolies. Appeared in A. Mitchell Polinsky & Steven Shavell (eds) *Handbook of Law and Economics.*

Kaufmann, D., Krayy A., Mastruzzi, M., 2006. Governance Matters V: Aggregate and Individual Governance Indicators for 1996-2005. *World Bank Policy Research Working Paper No. 4280,* The World Bank, Washington, DC.

Kenny, C., 2006. Measuring and reducing the impact of corruption in infrastructure. World Bank Policy Research Working Paper 4099, Washington, DC: The World Bank.

Kenny C., 2007. Construction, corruption and developing countries, mimeo World Bank.

Kenny C., Søreide, 2008. *Grand Corruption in Utilities,* Washington, DC: The World Bank.

Kessides IN., 2004. *Reforming Infrastructure: privatization, regulation and competition.* World Bank/Oxford University Press.

Krueger A., 1974. The Political Economy of the Rent-Seeking Society. *The American Economic Review* 64(3).

Laffont JJ., 2005. *Regulation and development.* Cambridge University Press.

Lambsdorff JG., 2005. Consequences and causes of corruption: What do we know from a cross-section of countries? In Susan Rose-Ackerman (Ed), *The International Handbook on the Economics of Corruption,* Edward Elgar Publishing.

Leff N., 1964. "Economic Development through Bureaucratic Corruption." *American Behavioral Scientist* 8(3): 6-14.

Leite, C., Weidmann, J., 1999. *Does mother nature corrupt? Natural resources, corruption and economic growth.* IMF working paper WP/99/85, International Monetary Fund. Washington, DC.

Levy, B., Spiller, PT., 1996. *Regulations, Institutions, and Commitment: Comparative Studies of Telecommunications.* Cambridge: Cambridge University Press.

Li H., Xu LC., Zou HF., 2000. "Corruption, Income Distribution, and Growth." *Economics and Politics* 12(2): 155-82.

Lianju S., Luyan P., 2011. Game Theory Analysis of the Bribery Behavior. *International Journal of Business and Social Science* 2(8): 104-107.

Mauro P., 1995. Corruption and growth. *Quarterly Journal of Economics,* 110(3): 681-712.

McKenzie D., Mookherjee D., 2003. "The Distributive Impact of Privatization in Latin America: Evidence from Four Countries." *Economica* 3(2): 161-233.

Megginson W., Nash R., van Randenborgh M., 1994. "The Financial and Operating Performance of Newly Privatized Firms: An Empirical Analysis." *Journal of Finance* 49(2): 403-52.

Megginson, WL., Netter, JM (2001). From State to Market: A Survey of Empirical Studies on Privatization. *Journal of Economic Literature.* 39, p. 321-389.

Megginson WL., Sutter NL., 2006. “Privatization in Developing Countries.” *Corporate Governance: An International Review* 14(4):234-265.
Min B., Golden M., 2014. Electoral cycles in electricity losses in India. *Energy Policy* 65(0): 619-625.
Mo PH, 2001. Corruption and economic growth. *Journal of Comparative Economics,* 29(1): 66-79.
Murphy KM., Shleifer A., Vishny RW., 1993. “Why is Rent-Seeking So Costly to Growth?” *American Economic Review* 83 (2): 409-414.
Mwaura FM., 2012. Adopting electricity prepayment billing system to reduce non-technical energy losses in Uganda: Lesson from Rwanda. *Utilities Policy* 23(0): 72-79.
Newbery DM, 1999. *Privatization, Restructuring and Regulation of Network Industries.* Cambridge, Mass.: MIT Press.
Parker, D., 2002. Economic Regulation: A Review of Issues. *Annals of Public and Cooperative Economics,* 73(4), p. 493-519.
Parker D., Kirkpatrick C., 2005. Privatisation in Developing Countries: A Review of Evidence and Policy Lessons. *Journal of Development Studies* 41(4), p. 513-541.
Poirson, H. 1998. Economic Security, Private Investment, and Growth in Developing Countries. International Monetary Fund Working Paper 98/4. Washington, DC.
Pollitt (1995) *Ownership and Performance in Electric Utilities,* Oxford: Oxford University Press.
Reinikka R., Svensson J., 2002. “Coping with poor public capital” *Journal of Development Economics* 69: 51-69.
Rose-Ackerman S., 1978. *Corruption: A study in political economy.* Academic Press, New York.
Shleifer A., 2004. Does competition destroy ethical behavior? *American Economic Review* 94(2): 414-418.
Shrestha RM., Bhattarai GB., 1994. Utility planning implications of electricity loss reduction in developing countries: The case of Nepal. *Energy Policy* 22(6): 531-537.
Smarzynska BK., Wei SJ., 2000. Corruption and Composition of Foreign Direct Investment: Firm-Level Evidence. NBER Working Papers 7969, National Bureau of Economic Research.
Smith T., 2004. Electricity theft: a comparative analysis. *Energy Policy* 32(2004); 2067-76.
Svensson J., 2003. Who Must Pay Bribes and How Much? Evidence from a Cross Section of Firms, *Quarterly Journal of Economics,* 118(1):207-230.
Tasdoven H., Fiedler BA., and Garayev V., 2012. Improving electricity efficiency in Turkey by addressing illegal electricity consumption: A governance approach. *Energy Policy* 43(0): 226-234.
Transparency International, 2008. *Progress Report 2008: OECD Anti-Bribery Convention.* Berlin: TI International.
Uhlenbruck K., Rodriguez P., Doh J., Eden L., 2006. The Impact of Corruption on Entry Strategy: Evidence from Telecommunication Projects in Emerging Economies, *Organization Science.* 17(3): 402-414.
Verbeek M., Nijman ThE., 1992. Can Cohort Data Be Treated as Genuine Panel Data?, *Empirical Economics,* 17:9-23.
Verbeek M., Nijman ThE., 1993. Minimum MSE Estimation of a Regression Model with Fixed Effects from a Series of Cross-Sections, *Journal of Econometrics,* 59:125-136.
Verbeek, M., 2007. Pseudo panels and repeated cross-sections. Erasmus University, Rotterdam School of Management, Erasmus Research Institute of Management (ERIM).
Villalonga, B., 2000. Privatization and Efficiency: Differentiating Ownership Effects from Political, Organizational, and Dynamic Effects. *Journal of Economic Behaviour & Organization.* 42, p. 43-74.
Wallsten, SJ., 2001. An Econometric Analysis of Telecom Competition, Privatization, and Regulation in Africa and Latin America. *The Journal of Industrial Economics,* 49(1), 1-19.
Wells LT, Ahmed R., 2007. *Making Foreign Investment Safe: Property Rights and National Sovereignty.* Oxford University Press.
World Bank, 1994. *World Development Report 1994: infrastructure for development*. Washington, DC: World Bank.
World Bank, 2009. Reducing Technical and Non-Technical Losses in the Power Sector. Energy Sector Strategy Background Paper. Washington, DC: World Bank.
Wren-Lewis L., 2011. Do infrastructure reforms reduce the effect of corruption? Evidence from electricity firms in Latin America. University of Oxford. University of Oxford, Department of Economics Discussion Paper Series, ISSN 1471-0498.
Wren-Lewis, 2013.
Zhang YF., Parker D., and Kirkpatrick C., 2008. Electricity Sector Reform in Developing Countries: An Econometric Assessment of the Effects of Privatization, Competition and Regulation. *Journal of Regulatory Economics* 33(2), p. 159-178.