Sosyoekonomi

2024, Vol. 32(60), 73-93

RESEARCH ARTICLE

ISSN: 1305-5577
DOI: 10.17233/sosyoekonomi.2024.02.04
Date Submitted: 15.01.2023
Date Revised: 02.02.2024
Date Accepted: 03.03.2024

Impact of Corruption on Utility Prices: A Theoretical and Empirical Analysis for the Electricity Markets[1]

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Yolsuzluğun Kamu Hizmeti Fiyatları Üzerindeki Etkisi: Elektrik Piyasaları için Teorik ve Ampirik Bir İnceleme[2]

Abstract

This study investigates the influence of corruption on utility prices. We develop a game-theoretical model to explore the interactions between the government, an interest group formed by firms, and consumers in determining utility prices. The model suggests that an increase in corruption correlates with a rise in utility prices, a relationship confirmed through empirical analysis of electricity sectors in 21 OECD countries from 1995 to 2015. Additionally, we explore the effects of regulatory reforms on electricity prices, revealing mixed outcomes. The findings emphasise the importance of anti-corruption efforts in shaping fair utility prices.

Keywords : Regulatory Capture, Corruption, Political Agency, Utility Prices, Electricity Prices, Regulatory Reforms.

JEL Classification Codes : D72, D73, L94, L98.

Öz

Bu çalışmada, yolsuzluğun kamu hizmeti fiyatları üzerindeki etkisi araştırılmıştır. Öncelikle, oluşturulan oyun-teorisi modeliyle, görevdeki politikacı, firmalardan oluşan lobi grubu ve temsili tüketicinin kamu hizmeti fiyatının belirlenmesi sürecindeki etkileşimi analiz edilmiştir. Model, yolsuzluğun artması ile kamu hizmeti fiyatlarının yükseldiğine işaret etmektedir. Bu öngörü, 21 OECD ülkesinin 1995-2015 dönemine ait elektrik piyasası verileriyle ampirik olarak test edilmiş ve doğrulanmıştır. Ayrıca, seçilmiş reform değişkenlerinin elektrik fiyatları üzerindeki etkileri de incelenmiştir. Bazı reformların fiyatları düşürdüğü, bazılarının ise fiyat artışlarına katkıda bulunduğu tespit edilmiştir. Bu bulgular, kamu hizmeti fiyatlarının doğru bir biçimde oluşumu için yolsuzlukla mücadelenin önemini vurgulamaktadır.

Anahtar Sözcükler : Düzenleyiciyi Ele Geçirme, Yolsuzluk, Vekalet Teorisi, Kamusal Hizmet Fiyatları, Elektrik Fiyatları, Düzenleyici Reformlar.

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[1] *This article is derived from the PhD Dissertation titled "The Impact of Corruption on Prices and Efficiency in the Electricity Market", prepared by Funda Altun and supervised by Prof.Dr. M. Kadir Doğan in the Graduate School of Social Sciences, Ankara University, in 2021.*

[2] *Bu makale, 2021 yılında Ankara Üniversitesi, Sosyal Bilimler Enstitüsü'nde Prof. Dr. M. Kadir Doğan danışmanlığında Funda Altun tarafından hazırlanan "Yolsuzluğun Elektrik Piyasasında Fiyatlara ve Etkinliğe Etkisi" başlıklı tezden türetilmiştir.*

1. Introduction

Utility prices, especially in the electricity sector, have been extensively examined in economic research. This examination becomes even more relevant in deregulated markets where multiple factors interplay to determine prices, including political and economic influences. Historically, state-owned enterprises dominated the provision of utility services, often leading to inefficiencies and capacity shortages. The liberalisation of these markets, a trend that gained momentum in OECD countries in the 1990s, responded to these challenges, aiming to create competitive markets, reduce public expenditure, and improve service quality (Boehm, 2007). However, this transition has not been without its complexities, particularly concerning the role of corruption in influencing utility prices.

This study is motivated by a notable gap in economic literature: the precise impact of corruption on utility prices within deregulated electricity markets. While prior research has extensively examined the influence of regulatory reforms and market structures on utility prices, the nuanced role of corruption has received comparatively less attention. Studies such as those by Estache and Kouassi (2002) and Dal Bo and Rossi (2007) have primarily focused on the efficiency of utilities or the broad interactions between corruption and regulatory reforms. However, the direct correlation between corruption levels and utility prices, especially in deregulated electricity markets, remains underexplored.

This paper aims to bridge this gap by comprehensively analysing how corruption influences electricity prices. To assess the impact of corruption on utility prices, we formulated a model that integrates the political agency theories of Barro (1973) and Ferejohn (1986) with the interest group models proposed by Baron (1994) and Grossman and Helpman (1994, 1996). In our model, a representative consumer and an interest group attempt to influence the incumbent politician's decisions regarding utility pricing. The interest group may offer a payment to the politician, incentivising the setting of higher utility prices. Conversely, the consumer may utilise the forthcoming election to incentivise the politician towards lower utility prices. The model postulates that increased levels of corruption correlate with higher utility prices, a hypothesis we test using a panel data set from 21 OECD countries covering the period from 1995 to 2015. Our empirical findings indicate a significant positive correlation between corruption and industrial and residential electricity prices, validating our theoretical model.

The empirical analysis also investigates the impact of regulatory reforms on electricity prices. It is observed that establishing a wholesale market and introducing a retail market exert negative influences on both industrial and residential electricity prices. Conversely, the unbundling of generation from transmission positively impacts both prices. Furthermore, introducing independent power producers is associated with a negative impact on residential electricity prices, while establishing a regulatory agency is correlated with a positive influence on residential electricity prices.

This study contributes to the existing literature by proposing a new theoretical framework for understanding the relationship between corruption and utility prices, and it provides empirical evidence on how corruption can counteract the intended benefits of market liberalisation. Moreover, it enriches the empirical research on the impact of regulatory reforms on electricity prices. While the study focuses on OECD countries, where corruption is typically less prevalent, it highlights that even lower levels of corruption can significantly affect utility prices. The study's insights are important for policymakers and regulatory bodies, highlighting the necessity of combating corruption in the electricity market.

The paper is organised as follows: Section 2 reviews the relevant literature. Section 3 explains the theoretical model underpinning this study. In Section 4, we present our empirical analysis and the resultant findings. Finally, Section 5 discusses the broader implications of our study for economic policy and future research.

2. Literature Review

Research on utility market dynamics and corruption is extensive and diverse. Before the deregulation of utility markets, these services were predominantly provided by state-owned enterprises. However, under public ownership, issues such as capacity shortages and inefficiencies in production were widespread, leading to the liberalisation and opening of some parts of these services to competition (Boehm, 2007).

Government intervention in economic processes is a debated topic in political economy. First developed by Pigou (1932), public interest theories of regulation advocate state intervention to correct market failures due to externalities or public goods. Conversely, the regulatory capture theory, articulated by Stigler (1971), suggests that state intervention is often motivated by private interests, with regulation acquired by the industry and primarily operating for its benefits[3]. This emphasises the potential for corruption in regulatory processes[4].

Corruption is defined as the abuse of entrusted powers for private gain[5]. Within the context of utility reforms, it significantly influences the operational dynamics of utility services, affecting their quality, accessibility, and affordability. This relationship has been the subject of various empirical investigations. For instance, Estache and Kouassi (2002)

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[3] *See Dal Bo (2006) and Boehm (2007) for a detailed literature review of regulatory capture.*

[4] *Regulatory capture has aspects that fall under both grand and political corruption. According to Transparency International, corruption has three types: grand, political, and petty. Grand corruption occurs at high levels of government when leaders benefit at the expense of the public interest. Political corruption occurs when political decision-makers manipulate policies, institutions and rules of procedure in allocating resources and financial benefits. To gain power, wealth and status, these decision-makers misuse their position. The last one, petty corruption, occurs when low or middle-level public officials abuse their entrusted power in their official actions. This kind of corruption occurs in institutions like police departments, schools and hospitals. Petty corruption is the extortion performed by low-level bureaucrats against citizens and is out of the context of regulatory capture.*

[5] *Jain (2001) provides a detailed theoretical and empirical review of corruption.*

studied the efficiency of 21 African water utilities and found that corruption negatively affects efficiency. In related research, Estache et al. (2006) investigate the effects of private capital and the establishment of independent regulatory authorities on the performance of the telecommunications sectors of 204 countries. Using panel data from 1990 to 2003, they incorporate an analysis of the influence of corruption on sectoral performance and the interaction between reform policies and corruption. The researchers conclude that corruption plays an important role in explaining the performance dynamics within the telecommunications sector and exhibits interaction with reform policies. Furthermore, Estache et al. (2009) extend their analysis to evaluate the impact of reform policies and corruption across three performance dimensions -access, affordability, and quality- in the electricity, telecommunications, and water sectors. Employing service prices as proxies for affordability, they find that corruption does not significantly affect electricity prices but leads to higher local phone call prices in the telecommunications sector. Focusing on electricity distribution firms, Dal Bo and Rossi (2007) analyse 80 entities across 13 Latin American countries during 1994-2001. They developed a theoretical model suggesting that corruption exacerbates inefficiencies by escalating factor requirements in these firms. Their empirical findings substantiated this model, indicating that heightened corruption levels, as measured by the International Country Risk Guide (ICRG) and Transparency International indexes, correlate with increased inefficiencies in electricity distribution firms. They also find that, in comparison to private firms, public firms demonstrate significantly lower efficiency levels. Expanding on this research, Wren-Lewis (2015) investigated the link between corruption and the productivity of regulated firms, particularly focusing on the influence of policy reforms on this relationship. Their empirical analysis, which encompasses the productivity of 153 electricity distribution firms across 18 countries in Latin America and the Caribbean from 1995 to 2007, finds that an independent regulatory agency significantly mitigates the negative impact of corruption on productivity. Furthermore, they observe that the detrimental interaction between corruption and productivity is comparatively less pronounced in privately owned firms, although this finding exhibits less robustness. In a later study, Imam et al. (2019) investigate the impact of corruption, alongside the establishment of independent regulatory agencies and private sector participation, on three performance indicators. Their dynamic panel data analysis, encompassing 47 Sub-Saharan African countries over the 2002-2013 period, demonstrates that corruption adversely affects technical efficiency, access to electricity, and income levels. In the study by Chang et al. (2018), government quality is examined through the corruption variable, focusing on its influence on energy efficiency. Utilising a panel dataset from 31 OECD countries from 1990 to 2014, their research reveals that an increase in government efficiency correlates with a decrease in energy intensity. This reduction is attributed to the enhancement of energy efficiency across OECD countries. Similarly, a recent study by Liu et al. (2023) explores the impact of corruption on energy efficiency, particularly focusing on its influence via energy investment projects. Analysing data from 30 Chinese provinces from 2000 to 2017, their study uncovers that corruption adversely affects energy efficiency, with energy investments serving as an intermediary in this dynamic. Another study focusing on the electricity sector is that of Kaller et al. (2018), which is closely aligned with our empirical investigation. It examines the impact of regulatory quality and corruption on residential electricity prices across 22 European countries from 2005 to 2013 within the context of electricity market reforms. Their findings reveal that the static model did not yield significant results. However, the dynamic model indicates that enhancements in regulatory quality and reductions in corruption contribute to lower prices for end-users.

While the studies summarised above explore the nexus between corruption, efficiency, and regulatory reforms within utility sectors, another strand of research investigates the influence of various regulatory reforms on utility prices. The seminal work by Stigler and Friedland (1962) serves as the foundational analysis in this domain. Subsequent investigations, such as those conducted by Steiner (2000), Zhang et al. (2002), Hattori and Tsutsui (2004), Nagayama (2007, 2009), Estache et al. (2006, 2009), Erdogdu (2011), Fiorio and Florio (2013), Bacchiocchi et al. (2015), Hyland (2016), Kaller et al. (2018), and Ahmed and Bhatti (2019) have also examined the impacts of regulatory reforms on utility prices.

Considering the existing studies, the distinctive contribution of our research lies in its dual approach. It enriches the existing literature with both theoretical and empirical insights. Firstly, it offers a novel theoretical framework for understanding the relationship between corruption and utility prices, particularly in deregulated electricity markets. Secondly, empirical analysis provides new perspectives on how corruption can counteract the intended benefits of market liberalisation, such as reduced prices. Finally, it augments the empirical literature concerning the effects of regulatory reforms on electricity prices.

3. The Theoretical Model

We have designed a game-theoretical model to analyse interactions among politicians, an interest group formed by firms, and consumers in determining utility prices. The model is based on the political agency models of Barro (1973) and Ferejohn (1986) and the interest group models of Baron (1994) and Grossman and Helpman (1994, 1996)[6]. There are three infinitely-lived players: an incumbent politician, a representative consumer who votes in elections, and an interest group aiming to maximise the firms' profits.

In each period, the politician sets the utility price[7]. We assume a constant marginal cost for the utility, denoted as c. The politician is not allowed to put a price lower than c, to

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6 *According to the political agency models, elections incentivise office-seeking politicians to act in their constituents' interests. Additionally, interest group models argue that these groups may influence a politician's policy choices by offering political contributions contingent on the policy.*

7 *In most countries, the utility markets are regulated, and the prices of utilities are determined through a regulatory process. However, elected politicians have significant control over regulators. They can change the organisational basis, powers, and duties of independent regulatory agencies (IRAs). This control is exerted through legislation, reappointing agency members, nominating agency heads, and determining budgets (Thatcher, 2005). Hanretty and Koop (2013) emphasise that the degree to which IRAs operate independently from politics in practice (actual political independence of IRA) differs from the degree of independence from*

avoid shortages, and there is an upper limit, $\bar{p}$ (where $\bar{p} > c$), representing the maximum price consumers can afford. Therefore, in period t, the price of the utility, p_t, can be in the interval $[c, \bar{p}]$. In a given period, the politician receives a combination of wage and ego rents from holding the office, denoted by w. The discount factor of the politician is represented by $\delta \in (0,1)$. The politician has no term limits, but if they lose an election, they are never re-elected, and their outside payoff is normalised to zero. We also assume that the politician and their opponents are identical in abilities and preferences, and at least one previously unelected opponent exists for the politician in the elections.

Consumer demand for the utility is considered constant in each period, represented by θ. Since the price of the utility cannot be lower than its marginal cost, θ units of utility will be produced by the firms at any given price in a given period. The consumer prefers lower prices to higher prices but has no direct influence on determining the utility price. Still, if the politician wants to hold the office, the consumer can induce the politician to choose a low price by applying a retrospective voting strategy. Since the politician and their opponents are identical in abilities and preferences, the only reason for not re-electing the politician is to punish them ex-post. It is indeed weakly optimal for the consumer to carry out this punishment. Therefore, we assume that the consumer sets a threshold price level $\hat{p}_t \in [c, \bar{p}]$ in period t and re-elects the politician if and only if the politician chooses the price no more than this level.

We assume that utility-producing firms form an interest group aiming to influence the politician's decision through payments. More specifically, before the politician sets the price in a given period, the interest group offers a payment schedule to the politician contingent on the utility price and the threshold price level chosen by the consumer. It carries out the relevant payment after the price is set. This payment is a monetary transfer from the interest group to the politician. In period t, the interest group thus chooses a transfer function $\beta_t: [c, \bar{p}]^2 \rightarrow R_+$, implying that the transfer to be made to the politician is $\beta_t(p_t, \hat{p}_t)$.

A monetary transfer exposes politicians and interest groups to the possibility of legal sanctions and, thus, is not fully efficient (Laffont & Tirole, 1991). The politician can only receive some portion of the transfer due to transfer costs. Let $\mu \in [0,1]$ denote the rate of the monetary transfer received by the politician. In a more transparent and less corrupt political system, it will be more complex and more costly for the politician to receive a monetary

politics inherent in the legal instruments that constitute and govern the agency (formal political independence of IRA). For example, Fernández-i-Marín et al. (2016) find evidence of the significant prevalence of political ties among IRA members, which supports that IRAs are not entirely independent from elected politicians. In a recent paper, Englmaier et al. (2017) demonstrate the control of politicians over electricity prices by providing evidence that the price of electricity is adjusted in response to electoral cycles in Germany. That is, electricity prices systematically decrease in the run-up to elections, and the price reduction is quickly reversed after the elections. Therefore, in this paper, we assume that the incumbent politician controls the regulatory agencies and the determination of the utility prices.

transfer from the interest group, and thus μ will take lower values. Therefore, μ depends on, and increases with, the level of corruption.

The politician's payoff in the period t, given as $[w + \mu\beta_t(p_t, \hat{p}_t)]$, comprises wage and ego rents from holding the office and the payment received from the interest group. The interest group's payoff in period t is displayed by $[(p_t - c)\theta - \beta_t(p_t, \hat{p}_t)]$, which is equal to the difference between the profit of the firms and the transfer made to the politician.

The sequence of the events is as follows. In each period $t \geq 1$:

1. The consumer sets a threshold price level $\hat{p}_t \in [c, \bar{p}]$ which specifies the consumer's re-election decision.

2. The interest group chooses a function $\beta_t: [c, \bar{p}]^2 \rightarrow R_+$ determining the transfer to be made to the politician. β_t can only be observed by the politician.

3. The politician chooses the utility price $p_t \in [c, \bar{p}]$, and then receives a payment of $\mu\beta_t(p_t, \hat{p}_t)$ from the interest group.

4. The election is held, and the consumer re-elects the politician if and only if $p_t \leq \hat{p}_t$.

Our equilibrium concept is the subgame perfect equilibrium in pure strategies. We focus on the stationary subgame perfect equilibria (SSPE), which requires players to act identically and optimally when faced with identical continuation games, implying history-independent strategies. Therefore, the consumer's stationary strategy can be represented by using a threshold price level $\hat{p} \in [c, \bar{p}]$ so that, in a given period, the politician is re-elected if and only if they choose the utility price no more than $\hat{p}$. The interest group's stationary strategy is a function $\beta: [c, \bar{p}]^2 \rightarrow R_+$ so that, in a given period, the transfer to be made to the politician can only depend on the utility price and the threshold price level in that period. In the politician's stationary strategy, the utility price in a given period can only depend on the transfer function of the interest group and the threshold price level in that period.

In the rest of this section, we first characterise the strategies of the politician, the interest group and the consumer in SSPE, respectively. Then, we analyse the outcome in SSPE, focusing on the impact of corruption on the utility price.

Given the consumer's threshold price level $\hat{p}$ and the interest group's transfer function β, the payoff of the politician from a stationary strategy that sets the utility price as p is the following.

$$V(p) = \begin{cases} \frac{\omega + \mu\beta(p,\hat{p})}{1-\delta} \; if \; p \leq \hat{p} \\ \omega + \mu\beta(p,\hat{p}) \; if \; p > \hat{p} \end{cases}$$

The politician faces a trade-off when choosing the utility price. If the politician wants to be re-elected, they will choose the utility price in the $[c,\hat{p}]$ interval which provides the highest transfer from the interest group (indicated by p^L). That is,

$$p^L \in arg\max_{p\in[c,\hat{p}]} \beta(p,\hat{p}).$$

In this case, the payoff of the politician will be equal to the following.

$$V(p^L) = \frac{\omega+\mu\beta(p^L,\hat{p})}{1-\delta} \tag{1}$$

On the other hand, if the politician does not care about re-election, he will choose the price which yields the highest transfer from the interest group (indicated by p^H) which can be displayed as follows.

$$p^H \in arg\max_{p} \beta(p,\hat{p})$$

In this case, the payoff of the politician will be equal to the following[8].

$$V(p^H) = \omega + \mu\beta(p^H,\hat{p}) \tag{2}$$

Note that, given $\hat{p}$, p^L is the maximum of $\beta(p,\hat{p})$ under the constraint that $p \in [c,\hat{p}]$, whereas p^H is its maximum in the domain. Accordingly, p^L cannot be greater than p^H. Given the consumer's threshold price level and the interest group's transfer function, the utility price that the politician sets in SSPE is described in Lemma 1.

Lemma 1: *In any SSPE, given the consumer's threshold price level $\hat{p}$ and the interest group's transfer function β, the politician chooses $p = p^H$ if $\beta(p^H,\hat{p}) \geq \frac{\delta w}{(1-\delta)\mu} + \frac{\beta(p^L,\hat{p})}{(1-\delta)}$ and $p = p^L$ otherwise.*

Proof: In SSPE, the politician compares the payoffs under p^L and p^H price levels and decides accordingly. The politician chooses $p = p^H$ if $V(p^H) \geq V(p^L)$ and $p = p^L$ otherwise. Equations (1) and (2) imply that $V(p^H) \geq V(p^L)$ if $\beta(p^H,\hat{p}) \geq \frac{\delta w}{(1-\delta)\mu} + \frac{\beta(p^L,\hat{p})}{(1-\delta)}$.

■

Given the threshold price level $\hat{p}$, when choosing the transfer function, the interest group considers the profits of the firms at p^L and p^H price levels that the politician can choose and the transfers that should be made to the politician to set these prices. Therefore, the interest group selects the transfer function that induces the politician to choose the price

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[8] *Here, it is assumed that $\hat{p} < \overline{p}$ and $p^H > \hat{p}$. That is, when the politician chooses the price to maximise the transfer from the interest group, the politician will not be re-elected. When the SSPE is constructed, it is observed that this assumption holds. In other words, in SSPE, the price that maximises the transfer function on its domain is greater than the threshold price level set by the consumer.*

level, maximising its payoff. The transfer function of the interest group thus solves the following problem.

$$\max_{\beta(p,\hat{p})} (p-c)\theta - \beta(p,\hat{p})$$

$$s.t.\ p^L \in arg \max_{p\in[c,\hat{p}]} \beta(p,\hat{p})$$

$$p^H \in arg\max_{p} \beta(p,\hat{p})$$

$$p \in arg \max_{p\in\{p^L,p^H\}} V(p)$$

Given the consumer's threshold price level $\hat{p}$, the following Lemma characterises the transfer function and the payoff of the interest group, and the utility price in SSPE when the interest group wants to induce the politician to choose p^L.

Lemma 2: *In any SSPE, given the consumer's threshold price level $\hat{p}$, if the interest group wants to induce the politician to choose p^L, then it selects the following transfer function.*

$$\beta(p,\hat{p}) = \begin{cases} 0\ if\ p \in [c,\hat{p}] \\ \alpha \in \left[0, \frac{\delta\omega}{(1-\delta)\mu}\right)\ if\ p \in (\hat{p},\bar{p}] \end{cases}$$

Then, the politician chooses $p = \hat{p}$ and receives no payment from the interest group, is re-elected, and the interest group receives a payoff of $U^L = (\hat{p} - c)\theta$.

Proof: The interest group's payoff increases with p^L and decreases with the transfer made to the politician. Therefore, if a transfer function can induce the politician to choose the highest level of p^L (which is equal to $\hat{p}$) with no transfer, then it is the optimum transfer function for the interest group to induce the politician to choose p^L.

If the interest group selects the transfer function given in the Lemma, the politician will choose $p^L = \hat{p}$ because $\beta(p,\hat{p}) = 0$ for $p \in [c,\hat{p}]$ and thus the politician cannot be better off by choosing another price in the interval $[c,\hat{p}]$. Moreover, given $p^L = \hat{p}$ and $\beta(\hat{p},\hat{p}) = 0$, Lemma 1 implies that the interest group should make a transfer of at least $\frac{\delta w}{(1-\delta)\mu}$ to the politician in order to induce the politician to choose a price higher than $\hat{p}$. But since $\beta(p,\hat{p}) < \frac{\delta w}{(1-\delta)\mu}$ for $p \in (\hat{p},\bar{p}]$, the politician does not choose a price higher than $\hat{p}$. Consequently, the interest group can induce the politician to choose $\hat{p}$ (the highest value of p^L) with no transfer by using the transfer function given in the Lemma, and thus it is the optimum transfer function for the interest group to induce the politician to choose p^L. Consequently, the interest group will receive a payoff of $U^L = (\hat{p} - c)\theta$ since the politician chooses the utility price as $\hat{p}$ and receives no payment. ■

Given the consumer's threshold price level $\hat{p}$, the following Lemma characterises the transfer function and the payoff of the interest group and the utility price in SSPE when the interest group wants to induce the politician to choose p^H.

Lemma 3: *In any SSPE, given the consumer's threshold level of price $\hat{p}$, if the interest group wants to induce the politician to choose p^H, then it selects the following transfer function.*

$$\beta(p,\hat{p}) = \begin{cases} 0 \; if \; p \in [c, \hat{p}] \\ \alpha \in \left[0, \frac{\delta\omega}{(1-\delta)\mu}\right) \; if \; p \in (\hat{p}, \bar{p}) \\ \frac{\delta w}{(1-\delta)\mu} \; if \; p = \bar{p} \end{cases}$$

Then, the politician chooses $p = \bar{p}$ and receives a transfer of $\frac{\delta w}{(1-\delta)\mu}$ from the interest group and is not re-elected, and the interest group receives a payoff of $U^H = (\bar{p} - c)\theta - \frac{\delta w}{(1-\delta)\mu}$.

Proof: Lemma 1 and Lemma 2 imply that the interest group should make a transfer of at least $\frac{\delta w}{(1-\delta)\mu}$ to the politician in order to induce them to choose a price higher than $\hat{p}$ because the politician will not be re-elected in this case. The interest group's payoff increases with p^H and decreases with the transfer made to the politician. Therefore, if a transfer function can induce the politician to choose the highest possible price ($\bar{p}$) with a transfer of $\frac{\delta w}{(1-\delta)\mu}$, then it is the optimum transfer function to induce the politician to choose p^H. If the interest group selects the transfer function given in the Lemma, the politician chooses the price as $\bar{p}$ and receives a transfer of $\frac{\delta w}{(1-\delta)\mu}$, since the politician cannot reach a higher payoff by setting another price. Consequently, it is the optimum transfer function for the interest group to induce the politician to choose p^H. Then, the interest group receives a payoff of $U^H = (\bar{p} - c)\theta - \frac{\delta w}{(1-\delta)\mu}$ since the politician chooses the utility price as $\bar{p}$ and receives a transfer of $\frac{\delta w}{(1-\delta)\mu}$. ■

Accordingly, given the consumer's threshold price level $\hat{p}$, the interest group decides on the utility price to induce the politician by comparing its payoffs under the prices $p^L = \hat{p}$ and $p^H = \bar{p}$. The price level that the interest group will induce the politician to choose in SSPE is described in Lemma 4.

Lemma 4: *In any SSPE, given the consumer's threshold level of price $\hat{p}$, the interest group induces the politician to choose the following price.*

$$p = \begin{cases} \hat{p} \; if \; \hat{p} \geq \bar{p} - \frac{\delta\omega}{(1-\delta)\mu\theta} \\ \bar{p} \; otherwise \end{cases}$$

Proof: Given the consumer’s threshold level of price $\hat{p}$, if $U^L \geq U^H$, then the interest group induces the politician to choose the utility price as $\hat{p}$ in SSPE by selecting the transfer function given in Lemma 2. On the other hand, if $U^L < U^H$, then the interest group induces the politician to choose the utility price as $\bar{p}$ in SSPE by selecting the transfer function given in Lemma 3. Moreover, Lemma 2 and Lemma 3 imply that $U^L \geq U^H$ if $\hat{p} \geq \bar{p} - \frac{\delta w}{(1-\delta)\mu\theta}$. ■

The consumer prefers lower to higher prices and thus wishes the interest group to induce the politician to set the lowest possible price. Besides, Lemma 4 indicates that there exist only two price levels, $\hat{p}$ and $\bar{p}$ with $\hat{p} \leq \bar{p}$, that the interest group can induce the politician to set. Therefore, as threshold price level, the consumer chooses the lowest price such that the interest group prefers to induce the politician to set price as $\hat{p}$ instead of $\bar{p}$. That is, as threshold price level, the consumer sets the lowest $\hat{p} \in [c, \bar{p}]$ satisfying the following condition.

$$\hat{p} \geq \left(\bar{p} - \frac{\delta\omega}{(1-\delta)\mu\theta}\right) \tag{3}$$

Proposition 1: *If* $(\bar{p} - c)\theta \leq \frac{\delta w}{(1-\delta)\mu}$*, then there exist SSPE with unique outcome in the game. In SSPE, the politician chooses* $p = c$*, receives no payment from the interest group and is re-elected.*

Proof: In this case, $\left(\bar{p} - \frac{\delta w}{(1-\delta)\mu\theta}\right) \leq c$, and thus the lowest threshold price level satisfying the condition given in equation (3) will be lower than or equal to the marginal cost of the utility. Therefore, for any $\hat{p} \in [c, \bar{p}]$, the interest group prefers to induce the politician to set $\hat{p}$ instead of $\bar{p}$ in SSPE, and thus selects the transfer function given in Lemma 2. Hence, the consumer sets the lowest possible price as the threshold price level, which is equal to c. Consequently, in SSPE, the politician sets the price as the marginal cost of the utility, receives no payment from the interest group and is re-elected. ■

Note that $(\bar{p} - c)\theta$ represents the highest profit that can be obtained by the interest group in a given period. On the other hand, the term $\frac{\delta w}{(1-\delta)\mu}$ represents the minimum transfer that the interest group must offer to the politician to incentivise setting a price higher than $\hat{p}$. So, if $(\bar{p} - c)\theta \leq \frac{\delta w}{(1-\delta)\mu}$, then for any threshold price level $\hat{p} \in [c, \bar{p}]$ chosen by the consumer, it is not profitable for the interest group to induce the politician to set a price higher than $\hat{p}$. Hence, in this case, in SSPE, the consumer can induce the politician to set the utility price as the marginal cost of the utility.

We assume that $(\bar{p} - c)\theta > \frac{\delta w}{(1-\delta)\mu}$ in the rest of the paper. That is, in a given period, the highest profit that the firms can achieve is greater than the lowest transfer required to induce the politician to set a higher price than the threshold price level chosen by the consumer. Thus, if the consumer chooses $\hat{p} = c$, then the interest group prefers to induce the politician to choose the price as $\bar{p}$ instead of c.

Proposition 2: *If $(\bar{p} - c)\theta > \frac{\delta w}{(1-\delta)\mu}$, then there exist SSPE with unique outcome in the game. In SSPE, the politician chooses $p^* = \overline{p} - \frac{\delta w}{(1-\delta)\mu\theta}$, receives no payment from the interest group and is re-elected.*

Proof: In this case, $\left(\bar{p} - \frac{\delta w}{(1-\delta)\mu\theta}\right)$, the lowest threshold price level satisfying the condition given in equation (3), is in the interval $(c, \bar{p}]$. Hence, in SSPE, the consumer sets $\hat{p} = \bar{p} - \frac{\delta w}{(1-\delta)\mu\theta}$ and the interest group chooses the transfer function given in Lemma 2. In SSPE, the politician chooses the utility price $p^* = \bar{p} - \frac{\delta w}{(1-\delta)\mu\theta}$ and accordingly receives no payment from the interest group and is re-elected. ■

Having constructed the equilibrium, we now examine its implications. The following proposition states the impact of corruption on the utility price.

Proposition 3: *In SSPE, the utility price increases with the level of corruption.*

Proof: Since μ increases with the level of corruption, the proposition implies that p^* increases with μ. The derivative of p^* with respect to μ is equal to $\frac{\delta w}{(1-\delta)\theta\mu^2}$ and it is positive since δ, w, θ and μ are all positive. Therefore, the utility price in SSPE increases with the level of corruption. ■

Note that the discount factor of the politician (δ), the wage and ego rents that the politician receives from holding the office (w), and the consumer's demand for the utility (θ) also affect the price of the utility in SSPE, together with the level of corruption. The utility's equilibrium price decreases with the politician's discount factor and with the wage and ego rents that the politician receives from holding the office but increases with the consumer's demand for the utility.

4. The Empirical Model and Analysis

The empirical model employed in this study is derived from the theoretical framework developed in the preceding section. This framework, rooted in game theory, analyses the interaction among politicians, interest groups, and consumers in determining utility prices, postulating that higher levels of corruption correlate with higher utility prices. To empirically test this hypothesis, we construct an econometric model reflecting this theoretical prediction. The model aims to quantify the impact of corruption on electricity prices while controlling for other relevant factors that might influence these prices. These factors include regulatory reforms, per capita GDP, fuel costs, net electricity production, and transmission and distribution losses. Their inclusion is informed by both their theoretical relevance, as discussed in the literature review, and their empirical significance, as evidenced by prior studies such as Steiner (2000), Zhang et al. (2002), Hattori and Tsutsui (2004), Nagayama (2007), Estache et al. (2009), Erdogdu (2011), Fiorio and Florio (2013), Hyland (2016), Kaller et al. (2018), and Ahmed and Bhatti (2019).

The empirical model is encapsulated in the following equation:

$$y_{it} = \alpha + X'_{it}\beta + \mu_i + \lambda_t + v_{it} \tag{4}$$

where y_{it} denotes the industrial and residential electricity prices, and X encompasses relevant explanatory variables: a corruption indicator, per capita GDP, the cost of fuels used in electricity production, net electricity production, transmission and distribution losses, alongside an array of regulatory reform indicators. Within this framework, μ_i represents the unobservable time-invariant country-specific effect, λ_t the unobservable time-specific effect and v_{it} the disturbance term. The subscripts i and t respectively signify the country and the period under consideration.

The regulatory reform variables selected for inclusion in our econometric model align with those conventionally utilised in analysing the impact of regulatory reforms on utility prices. This selection is grounded in the precedent seminal works in the field (see Steiner, 2000; Zhang et al., 2002; Hattori & Tsutsui, 2004; Nagayama, 2007, among others). The following regulatory reform measures are formed as dummy variables:

1) *Existence of independent power producers (IPPs)*: We assume the presence of IPPs from the time the first one starts operating in a market.
2) *Privatisation*: This variable is defined as the initiation of privatisation within the generation segment. It is indicated by the sale of government-owned assets to private companies.
3) *Unbundling of generation from transmission*: Following the framework suggested by Nagayama (2007), we consider unbundling to have occurred with the legal separation of transmission system operations within any state or province of a country.
4) *Existence of a wholesale electricity market*: We assume the presence of a wholesale electricity market in a country when at least one of its provinces or states has established such a market.
5) *Establishment of a regulatory agency*: This is assumed to exist within a country when an independent regulatory authority is dedicated explicitly to overseeing the electricity sector.

6) *Introduction of retail competition*: The enactment of legislation that allows consumer groups in the retail electricity market to select their suppliers is used to indicate this measure.

4.1. Sampling and Data

The empirical analysis employs a panel dataset encompassing 441 observations from 21 OECD countries from 1995 to 2015. The time frame is dictated by data availability, with 1995 serving as the starting point of the Corruption Perceptions Index (CPI) in that year. The sample encompasses Austria, Belgium, Canada, Czech Republic, Finland, Germany, Hungary, Ireland, Israel, Italy, Japan, Korea, Mexico, Netherlands, Poland, Portugal, Slovak Republic, Spain, Türkiye, the United Kingdom, and the United States. Countries with insufficient data on electricity prices and fuel costs are omitted from the analysis. The panel is unbalanced due to some missing observations.

Dependent variables in this study, industrial and residential electricity prices inclusive of taxes, are derived from various editions of the Energy Prices and Taxes report by the International Energy Agency. The primary independent variable under scrutiny is the corruption level, represented by the Corruption Perceptions Index (CPI) from Transparency International, ranging from 0 (highly corrupt) to 100 (very clean). Additional independent variables include per capita GDP (sourced from the World Development Indicators database of the World Bank), fuel costs (steam coal and natural gas prices are weighted based on their share in electricity production, with price data from Energy Prices and Taxes and shares in production from the World Development Indicators database of the World Bank), net electricity production (excluding power plant self-consumption, sourced from the International Energy Agency's Electricity Information database), and transmission and distribution losses (comprising all losses in electrical energy transport and distribution, as well as transformer losses not integral to power plants, sourced from International Energy Agency's Electricity Information database). The regulatory reform data is gathered from various national and international energy regulator websites, with each reform measure assigned a binary value (1 for implementation, 0 otherwise).

Table: 1
Descriptive Statistics

	Observation	Mean	Std. Dev.	Min	Max
Industrial price (USD/MWh)	422	118,4	45,1	51,7	330,0
Residential price (USD/MWh)	434	190,9	66,0	78,0	369,1
Corruption Perceptions Index (CPI)	435	64,3	18,2	26,6	100,0
Per capita GDP (USD)	441	31.592	14.944	7.652	70.116
Fuel costs (USD/MWh)	441	17,3	8,4	2,9	46,1
Net electricity production (GWh)	441	401.936	826.503	16.818	4.190.552
Losses (GWh)	441	26.751	51.621	515	269.162
IPPs	441	0,97	0,17	0	1
Privatisation	441	0,85	0,35	0	1
Unbundling	441	0,76	0,43	0	1
Wholesale market	441	0,65	0,48	0	1
Regulatory agency	441	0,83	0,37	0	1
Retail competition	441	0,67	0,47	0	1

Table 1 presents descriptive statistics for the dependent and independent variables. Electricity prices, GDP per capita and fuel costs are adjusted for inflation and converted to 2010 U.S. dollars for each country using consumer price indices and exchange rates from OECD statistics.

4.2. Analysis

In our analytical framework, we assume the presence of country-specific effects. Additionally, we integrate time-specific effects to account for standard cyclical components in prices. As explained by Greene (2012), choosing between fixed effects (FE) and random effects (RE) models depends on whether the individual effect is related to the variables we are studying or not. We use the RE model when the individual effect is unrelated to these variables. On the other hand, we use the FE model when there is a connection between the individual effect and any of the variables. Our study conducted a Hausman-type test to determine which model works best for our analysis.

Table: 2
Estimation Results

	(1)	(2)	(3)	(4)
	Log of IP	Log of IP	Log of RP	Log of RP
	FE	FE (DK)	FE	FE (DK)
Log of CPI	-0,129* (0,072)	-0,129* (0,074)	-0,298*** (0,063)	-0,298*** (0,042)
Log of per capita GDP	0,544*** (0,080)	0,544*** (0,072)	0,467*** (0,068)	0,467*** (0,064)
Log of fuel costs	0,192*** (0,038)	0,192*** (0,032)	0,079** (0,033)	0,079* (0,041)
Log of net electricity production	-0,480*** (0,081)	-0,480*** (0,069)	-0,384*** (0,070)	-0,384*** (0,087)
Log of losses	0,010 (0,055)	0,010 (0,036)	-0,237*** (0,048)	-0,237** (0,092)
IPPs	0,027 (0,062)	0,027 (0,038)	-0,118** (0,054)	-0,118*** (0,022)
Privatisation	-0,032 (0,034)	-0,032 (0,038)	0,035 (0,030)	0,035 (0,036)
Unbundling	0,096*** (0,034)	0,096** (0,034)	0,113*** (0,030)	0,113*** (0,024)
Wholesale market	-0,095*** (0,029)	-0,095*** (0,023)	-0,051** (0,025)	-0,051*** (0,015)
Regulatory agency	0,033 (0,039)	0,033 (0,040)	0,045 (0,034)	0,045* (0,026)
Retail competition	-0,052 (0,032)	-0,052* (0,025)	-0,037 (0,028)	-0,037** (0,017)
Constant	4,868*** (1,055)	4,868*** (0,979)	8,297*** (0,908)	8,297*** (1,187)
Number of observations	416	416	428	428

Notes: Variables, except for dummies, are expressed in natural logarithms.
IP: Industrial Price, RP: Residential Price.
FE (DK) denotes the Fixed Effects Model with Driscoll and Kraay standard errors.
Standard errors are indicated in parentheses.
*Significance levels: ***, **, and * correspond to 0,01; 0,05; and 0,1 levels, respectively.*

We detect heteroscedasticity and autocorrelation in the residuals of the FE model's estimates, with the residuals also correlated across individuals. To overcome this problem, we estimate the FE model with Driscoll and Kraay (DK) standard errors. Then, we ran the Hausman-type test proposed by Hoechle (2007) for FE models, which is robust to general forms of cross-sectional and temporal dependence. According to the results of this test, the null hypothesis of the RE model is rejected against the alternative of the FE model. Hence, we use the estimates of the FE model with Driscoll and Kraay standard errors.

4.3. Results and Discussion

The estimation results are depicted in Table 2. The results of the industrial price equation for the fixed effects model with Driscoll and Kraay standard errors indicate that the CPI exhibits a statistically significant negative coefficient at the 0,1 level. This coefficient suggests a 1% increase in the CPI correlates with a 0,13% decrease in industrial electricity prices. Interpreting this negative association, it becomes evident that higher corruption leads to higher industrial electricity prices, as inferred from lower CPI scores.

The analysis of the regulatory reform variables reveals a positive correlation between the unbundling of generation from transmission and industrial electricity prices, significant at the 0,05 level. This finding suggests that such unbundling initiatives contribute to elevating industrial electricity prices. Conversely, the presence of a wholesale market, significant at the 0,01 level, appears to exert a downward pressure on these prices. Similarly, introducing a retail market is associated with reduced industrial electricity prices. Other reform variables did not demonstrate a significant impact within this model.

Additional variables, namely per capita GDP, fuel costs, and net electricity production, exhibit significant relationships at the 0,01 level with industrial electricity prices. A rise in per capita GDP is linked with higher industrial electricity prices, presumably attributable to augmented demand. Fuel cost increases correspond with increased industrial electricity prices, indicative of heightened production costs. Conversely, an augmentation in net electricity production is associated with reduced industrial electricity prices, likely due to an expanded supply. Within the scope of the investigated variables, transmission and distribution losses are not statistically associated with significant variations in industrial electricity prices.

The residential electricity price analysis reveals a parallel trend with the CPI. As the CPI increases by 1%, residential electricity prices experience a reduction of 0,3%. This outcome aligns with the findings of Kaller et al. (2018), affirming the hypothesis that heightened corruption levels lead to increased residential electricity prices. All reform variables, except privatisation, significantly impact residential electricity prices. The introduction of IPPs, the existence of a wholesale electricity market, and the introduction of a retail market are observed to diminish residential electricity prices. In contrast, the unbundling of generation from transmission and the establishment of a regulatory agency correlate with increased residential electricity prices.

The impacts of per capita GDP, fuel costs, and net electricity production on residential electricity prices mirror those observed in the industrial sector. Increased per capita GDP and fuel costs result in elevated residential electricity prices, while increased net electricity production leads to price reductions. Notably, residential electricity prices decrease as transmission and distribution losses increase, a phenomenon that, as Nagayama (2007) suggests, may indicate the inability to transfer these losses to consumer prices.

While primarily focused on the impact of corruption on utility prices, our analysis also allows for a comparative assessment with existing studies on the effects of regulatory reforms in the electricity sector. In our empirical investigation, corruption significantly negatively influences electricity prices, both for industrial and residential sectors. This finding aligns with the broader literature, reinforcing that increased corruption corresponds to higher utility prices. Simultaneously, our study offers insights into the impacts of regulatory reforms, with observations that align yet differ in certain respects from previous findings. Specifically, we note that the presence of wholesale and retail markets, IPPs, and regulatory agencies exhibit varied effects on electricity prices. This pattern reflects the mixed outcomes reported in other empirical studies, as summarised in Table 3. A particularly consistent observation across these studies is that simply unbundling electricity market operations does not always result in lower prices. On the contrary, it often leads to price increases. This phenomenon emphasises the complexity of regulatory reforms and highlights the critical need for tailoring these reforms to the specific economic and regulatory contexts of individual countries. Our study, therefore, contributes to understanding how corruption influences utility prices and provides more details about the effectiveness of regulatory reforms in the electricity sector.

Table: 3
Summary of Studies on the Impact of Regulatory Reforms on Electricity Prices

Reform Variable	Industrial Price		Residential Price	
	Positive (+)	Negative (-)	Positive (+)	Negative (-)
IPPs		Erdogdu(2011) Ahmed & Bhatti (2019)	Fiorio & Florio (2013)	Our result Ahmed & Bhatti (2019)
Privatisation	Steiner (2000) Estache et al. (2009) Erdogdu (2011)	Hattori & Tsutsui (2004) Nagayama (2007)	Estache et al. (2009) Erdogdu (2011) Fiorio & Florio (2013)	Nagayama (2007)
Unbundling	Our result Erdogdu (2011) Hyland (2016)		Our result Nagayama (2007) Erdogdu (2011) Kaller et al. (2018)	
Wholesale Market	Hattori & Tsutsui (2004) Nagayama (2007) Ahmed & Bhatti (2019)	Our result Steiner (2000) Erdogdu (2011) Hyland (2016)	Kaller et al. (2018)	Our result Erdogdu (2011) Bacchiocchi et al. (2015)
Regulatory Agency		Erdogdu (2011)	Our result Nagayama (2007)	Erdogdu (2011)
Retail Competition		Our result Hattori & Tsutsui (2004)	Erdogdu (2011) Fiorio & Florio (2013)	Our result Nagayama (2007)

5. Conclusion

This study investigates the effects of corruption on utility prices, with a specific focus on electricity. We develop a theoretical model based on game theory, examining the interplay between government, firms, and consumers in setting utility prices. The model posits that higher levels of corruption lead to increased utility prices, a hypothesis we empirically validate using data from the electricity sectors of 21 OECD countries between

1995-2015. Our findings reveal that corruption correlates with higher electricity prices in both industrial and residential sectors.

Additionally, the study examines the effects of regulatory reforms on electricity prices, revealing a complex and inconsistent relationship. We observe varied effects: Certain reforms, such as introducing wholesale and retail markets, generally decrease prices, whereas others, like the unbundling of electricity generation from transmission, lead to price hikes. Introducing IPPs is associated with reduced residential electricity prices, but establishing a regulatory agency is linked to increased residential prices. These findings highlight the heterogeneity of regulatory reforms’ impact, emphasising the need for country-specific policy approaches.

In our empirical evaluation of the various factors affecting electricity prices, we have identified political corruption as a significant influencing element. This underscores the importance of combating corruption, not only for ethical reasons and its negative implications on economic growth (Mauro, 1995; Treisman, 2000), income distribution (Johnston, 1989; Li et al., 2000), and public spending in sectors like education and health (Gupta et al., 2001; Lewis, 2006), but also due to its direct effect on escalating utility prices.

To effectively combat the influence of corruption on electricity prices and ensure equitable and efficient utility services, we align with the World Bank’s recommendations (World Bank, 2009). Implementing mechanisms to improve transparency in the utility sector is a vital first step. Equally crucial is holding corrupt officials accountable. Additionally, establishing robust regulatory frameworks, empowering independent regulatory bodies, and fostering competition in electricity markets are essential for deterring regulatory capture, often linked to corruption. Involving the public in decision-making processes and facilitating independent oversight are vital strategies for monitoring and reducing corruption. Adopting international standards and best practices in utility regulation and management also plays a significant role in combating corruption.

Our study broadens the understanding of the corruption-utility price nexus, particularly in OECD countries where corruption is less prevalent yet still impactful. This expands the focus of corruption studies, traditionally concentrated on developing countries, to include corruption's subtle but significant effects in varied economic contexts. It suggests that corruption can significantly influence utility prices even in economies with comparatively low corruption levels. However, our results necessitate cautious interpretation due to the lower corruption levels in the countries studied. We recommend further investigations encompassing a broader spectrum of developmental categories and diverse economic and geographical contexts. Such comprehensive analyses are crucial for deepening our understanding of the corruption-utility price relationship and formulating more general conclusions.

This study focuses solely on the impact of corruption on utility prices, reflecting utility services' affordability. Recognising the constraints in data availability and accuracy, it is suggested that future research should broaden its scope. They should investigate how corruption affects other critical dimensions of utility services, such as quality and accessibility, to provide a more comprehensive understanding of corruption's overall impact on the utility sector.

In conclusion, through its theoretical framework and empirical evidence, this study highlights the importance of anti-corruption measures in influencing utility prices. These measures are crucial not only for ethical and economic reasons but also due to their significant impact on the affordability of utilities. Addressing corruption in the utility sector, especially in electricity markets, requires a multifaceted strategy. This strategy should encompass regulatory reforms, market competition enhancement, and a commitment to transparency and public accountability. By adopting such an approach, governments can achieve fair pricing for consumers and significantly improve the overall efficiency and sustainability of the utility sector.

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