Political Price Cycles in Regulated Industries: 
Theory and Evidence

By Rodrigo M. S. Moita and Claudio Paiva

The early work of Stigler (1971) treats the regulatory process as the arbitration of conflicting economic and political interests rather than a pure welfare-maximizing effort. This paper builds on these ideas and models the regulatory process as a game where the industry-lobby, consumers-voters, and a regulator-politician interact to define the regulated price, in alternating electoral and non-electoral periods. The equilibrium that emerges consists of a fully rational political price cycle in a regulated industry. Using monthly data for regulated gasoline and electricity prices from Brazil, we find strong evidence pointing towards the existence of electoral price cycles in both markets. (JEL D72, L51, L71, L78, L94, L98, O14)

The relationship between politics and economic policy has a long tradition in the economic literature. One important approach links macroeconomic policy decisions to the electoral cycle and is known in the literature as the political business cycle theory. Pioneered by Nordhaus (1975), followed by Rogoff and Sibert (1988), Persson and Tabellini (1990), and Rogoff (1990), among others, this theory claims that macroeconomic aggregates—such as the money supply and the government budget—are likely to follow a cycle driven by electoral interests.

Another important line of research that relates economic policy decisions to politics focuses on industry-level issues and treats the regulatory process as the arbitration of conflicting social, economic, and political interests rather than a pure welfare-maximizing effort. This approach originated from the early work of Stigler (1971) and Peltzman (1976), and was generalized by the literature linking special interest groups and economic policy: Grossman and Helpman (1994, 2001), and Persson and Tabellini (2000), among others. It views the regulatory process as being driven by the interaction of organized groups, consumers, and the regulator.

This paper combines elements of both approaches described above: the idea that policy decisions may change with the proximity of elections is borrowed from the political business cycle theory to enhance the traditional, static models of lobbying and political regulation. More specifically, we model the regulator’s problem as a game in which politicians set the regulated price trying to maximize lobby...
contributions over time, but also wish to signal to voters a pro-consumer behavior in electoral periods. Political incentives and welfare constraints interact to yield an equilibrium in which the real regulated price may fall in electoral periods to increase the incumbent’s chance of re-election but rise after the election to compensate the lobby.

From a policy perspective, the possibility of a political cycle in regulated prices may represent an additional source of concern to those attempting to insulate the regulatory process from undue political influence. The number of countries that have adopted independent regulatory agencies in the last couple of decades suggests that the problem of political interference in the regulatory process is pervasive. The main goals of such reforms have been to avoid the direct subordination of regulators to the politicians in power, preclude the expropriation of regulated firms through excessively low regulated prices, reduce regulatory uncertainty, and stimulate private investment in regulated sectors (Kessides 2004; The World Bank 2005). This paper advances the regulation policy debate by showing that an electorally-driven price cycle may result from unconstrained political interests in regulated markets.

Besides presenting a new model of political price cycles in regulated industries, we also provide empirical support for this theory. Using monthly data over the period 1969–2008 and 1963–2009 for regulated gasoline and electricity prices in Brazil, respectively, we provide strong statistical and econometric evidence pointing toward the occurrence of electoral price cycles in both markets. We also find some evidence that the electoral cycle in electricity prices may have been eliminated after the creation of an independent regulatory agency in that industry in 1996.

The remainder of this paper is organized as follows. In Section I, we discuss the principles established by the theories of political regulation, lobbying, and political business cycle that form the basis for our theory of electoral cycles in regulated industries. In Section II we introduce our model of dynamic political regulation and derive the results that characterize the political price cycle. Section III presents empirical evidence supporting our theoretical results and assessing possible changes brought by the creation of an independent regulatory agency. Section IV discusses welfare and policy implications of a political price cycle in regulated industries. Section V features our concluding remarks.

I. Background

The pioneering work of Stigler (1971) claims that industry regulation should be viewed as a way to arbitrate among competing interests rather than a way to maximize welfare. Regulators make their decisions about price, market entry, and other relevant variables under pressure from different interest groups. The regulatory outcome is therefore determined by transactions between self-interested suppliers—regulators, with no distinction from the government—and demanders—the interest groups, firms, and consumers. The equilibrium of Stigler’s (1971) model is one in which, in the words of Peltzman (1993, 823), “cohesive minorities tax diffuse majorities,” and the process ends with the capture of the regulatory agency by the firms. This outcome is explained mainly by the fact that consumers have weak incentives to acquire information and actively defend their interests in a particular industry, since each individual regulatory decision has only a limited impact.
Building on Stigler’s (1971) work, Peltzman (1976) and Becker (1983) develop models that capture the political influence of interest groups on the regulatory process. In particular, Peltzman’s model formalizes the idea that a regulatory agency chooses a price to maximize political support for the incumbent government-regulator. More recently, Persson and Tabellini (2000), and Grossman and Helpman (1994, 2001), among others, explicitly address the effect of lobbying on policy decisions. This literature confers a more active role to the industry, since the lobby and policy makers negotiate policy outcomes and industry contributions. This idea naturally fits a regulatory process in which negotiations also determine the regulated price, thus explaining Stigler’s (1971) result of regulatory capture by the industry as the equilibrium of a lobbying game.

A distinct line of research relating politics to economic policy started with the groundbreaking work of Nordhaus (1975) on political business cycles. It argues that governments may pursue expansionary macroeconomic policies in election years to exploit a Philips curve trade-off that is beneficial in the short but not in the long run. The model assumes that consumers have adaptive expectations about inflation and are “myopic,” as they partially forget or heavily discount the past. A common criticism of this type of model is that rational voters would understand the motivation for and the consequences of distorting the optimal policy in election years, therefore making politicians less likely to adopt such strategy. Nonetheless, Tufte (1978), among others, continued to provide empirical evidence of the occurrence of political business cycles, and new models were developed to explain the phenomenon while addressing previous criticism.

Abandoning the old assumptions of adaptive expectations and myopic voters, Rogoff and Sibert (1988), Rogoff (1990), and Persson and Tabelini (1990), rationalize the political business cycle as the equilibrium of a signaling game originated from a temporary information asymmetry between government and voters. Governments are differentiated by their level of competency, with more competent governments providing the same amount of services using fewer resources. Government competency is modeled as a serially correlated stochastic variable that receives a new shock every period. Information asymmetry arises from the fact that the government learns its competency shock before voters do. In election years, the incumbent party has an incentive to act as if it had received a high-competency shock in order to attract voters.

Pondering the possibility that the election calendar may also affect government actions in the regulatory sphere, Paiva (1996) modifies Peltzman’s (1993) model by adding a time dimension to the regulator’s maximization problem. The regulator would have an incentive to set higher prices and secure some level of profits for firms in non-election periods, lowering prices to please consumer-voters in election periods. This model has two potential weaknesses. One is the reliance on myopic
consumer-voters who heavily discount past regulatory decisions. Another is the passive role that the industry plays in the model: rather than actively seeking to influence regulators, industry interests are captured simply by the inclusion of industry profits in the regulator’s maximization problem.

This paper advances the literature by developing a dynamic model of political regulation in which (a) the industry plays a more active and explicit role in influencing regulators, and (b) consumer-voters are rational and forward-looking. Regulatory decisions are modeled as a lobbying game where the industry and the regulator interact to determine regulated prices and campaign donations in a dynamic setting with alternating electoral and non-electoral periods. The incentives, and therefore the optimal strategies of the regulator, change depending on the period, thereby generating an equilibrium that characterizes a political cycle in which the regulated price is lowered in election periods. Our paper also provides strong empirical evidence that these political price cycles have been observed in some regulated industries.

II. A Model of Political Price Cycle in Regulated Industry

A. General Description

Three groups interact to define the regulatory process: a government-regulator, the lobby-industry, and consumers-voters. We treat the problem as that of a government seeking to set prices to maximize welfare and its chances of being re-elected. Consumers of the regulated good are also voters; producers (the industry) are organized as a lobbying group that makes campaign contributions to the regulator. At the beginning of an electoral period, government and lobby negotiate prices and campaign contributions. The regulator makes a binding commitment to the industry about the prices set for the current electoral period and for the period immediately after. The industry then decides the amount of campaign contributions it will give to the government-regulator. We assume that consumers are not an organized pressure group and do not know the details of the agreement between the industry and the regulator.

The regulator’s social welfare function is a weighted average of consumer surplus and industry profits, with weights following a stochastic process. A shock that determines a higher (lower) weight on profits characterizes a pro-industry (pro-consumer) type of regulator and results in the choice of a higher (lower) regulated price.\(^2\) Elections take place every other period. In a non-electoral year, the incumbent government-regulator chooses the price that maximizes welfare and lobby contributions. In an election year, however, the incumbent may lower the regulated price to increase its chance of being re-elected.

Voters do not observe the shock that determines whether the incumbent government-regulator is pro-consumer or pro-industry until after the election.\(^3\) The industry-lobby observes the regulator’s type during the negotiations that precede the

---

\(^2\) Besley and Coate (2000) uses the same terminology to define the regulator type or behavior.

\(^3\) As in Peltzman (1976), this assumption can be justified by the fact that the regulated price is one among several prices that matter to consumers, and gathering information about the shocks is too costly compared to the value of one vote.
election. This temporary information asymmetry between consumers and the regulator would make it possible for a pro-industry regulator to try to mimic the behavior of a pro-consumer type by setting a lower price and increasing its chances of winning the election. However, since deviations from the welfare-plus-contributions maximizing price generate a decrease in government utility at increasing rates, pro-consumer regulators can achieve a price lower than pro-industry regulators for any given level of utility. Therefore, in equilibrium, the pro-consumer regulator will set a price unachievable by the pro-industry type in order to unequivocally signal its type to consumer-voters. Unable to match this lower price, pro-industry regulators have no reason to distort the regulated price at all.

Another result from the model is that the lobby is generally able to influence the regulatory policy in non-electoral years at least as much as it is in electoral years, and more so if the regulator is a pro-consumer type. The regulator lowers the regulated price in an electoral period to please consumers, and increase it after the election to compensate the lobby for the campaign contributions. This result differs significantly from the static models of political regulation (Peltzman 1976, Grossman and Helpman 2000, etc.) in which the regulator had a single price to set and a single chance to please a group in detriment of the other.

The order of events is what drives the cycle. At the beginning of the period \((t)\), the incumbent receives its preference shock. It then decides the current regulated price, observed by consumers, and commits to the industry about future prices. The industry then decides on the amount of campaign contributions. Subsequently, the election happens, the winner is announced, and the period ends. At the beginning of the following period \((t+1)\), the winner of the election takes office until the end of the next period \((t+2)\). Note that a new preference shock will define a new orientation for the incumbent at the beginning of period \(t+2\), and another election will then take place. The incumbent type is revealed to the public at period \(t+1\), since the regulator will set the post-election price that maximizes its social welfare function plus lobby contributions. Voters recognize the regulator’s incentives and can infer its type. The models in Rogoff and Sibert (1988), Rogoff (1990), and Persson and Tabelini (1990), justify the information asymmetry between government and voters by the government having more knowledge of the tasks it performs. The information asymmetry in our model comes from (i) the regulator having more knowledge of the industry’s expected performance and importance for the economy; (ii) the connections the government-regulator has with the regulated industry; and (iii) the government’s changing priorities (affected by extra-industry factors), preferences, and electoral concerns. These aspects define the regulator’s position toward the industry, but are not directly observed by voters. We also consider that factors affecting the closeness between regulator and industry may change over time due to a change of the regulator’s preferences or to external factors. In fact, changes in preferences or external factors may lead to dramatic policy changes by an incumbent, including through the adoption of policies that may belong to the other end of the political spectrum, as shown by Moen and Riis (2010). Examples of external shocks that

\[4\text{Their example of policy reversal is that “anticommunist Richard Nixon opened the door to the West for communist China.”}\]
make the incumbent more pro-industry include (i) a new political coalition that attributes higher importance to securing future investment in the sector; (ii) external constraints that limit the country’s capacity to import the regulated product, requiring an increase in domestic production and the profits to sustain it; or (iii) a negative fiscal shock that would either increase the need to extract additional income taxes from firms in the regulated industry or at least reduce the ability of the regulator to provide compensatory transfers to regulated firms in a low-price environment.

B. Formalizing the Model

The firm’s profit function is given by

\[ \pi = p_t q_t (p_t) - C(q_t), \]

where \( \pi \) is the profit of the firm, \( p_t \) is the price of the regulated good, \( q_t \) is the quantity produced-demanded of the good and \( C(q) \) is the cost function, that we assume to be continuously differentiable with \( C_q > 0 \) and \( C_{qq} > 0 \).

Consumer-voters’ utility function is given by

\[ U(q_t) = \phi(q_t) + \eta_t, \]

where \( \phi' > 0, \phi'' < 0 \), and \( \eta_t \) is a variable related to the government’s performance in areas other than the regulated market that also affect its popularity. It follows that

\[ \eta_t^I - \eta_t^O = s_t + s_{t-1} + e(c^I - c^O), \]

where \( s_t \) is an i.i.d. stochastic variable with an unimodal distribution, twice continuously differentiable with mean zero; \( c^I \) is the total amount spent on campaign prior to election, and \( e \) is the marginal effect of a dollar spent on campaign on the popularity of the party. We consider campaign contribution as coming from the industry lobby, but also allow the possibility that industry lobby contributions be used for different purposes, such as corruption. Superscripts \( I \) and \( O \) refer to incumbent and opposition parties. Given prices, consumers maximize their utility subject to the budget constraint, what gives the demand function \( q = q(p) \) for the good and the indirect utility \( V_t \).

The type of the politician is defined by \( \alpha \), where \( \alpha \in \{ \underline{\alpha}, \overline{\alpha} \} \), with \( \underline{\alpha} \) being the pro-consumer type and \( \overline{\alpha} \) being the pro-industry type, \( 0 \leq \underline{\alpha} < \overline{\alpha} \leq 1 \). The type \( \alpha \) follows a stochastic process with probability \( \mu \) of observing a pro-industry type: \( P(\alpha = \overline{\alpha}) = \mu \).

A politician-regulator receives a new shock every election period. One can think of this assumption as reflecting the greater fluidity of political arrangements, coalition negotiations, government programs, campaign donations, and related factors in the

---

5The Kirschner government in Argentina provides another example of external shocks (external to the industry under analysis) causing policy changes. Initially, when the priority was to stimulate growth and improve the external accounts, policies heavily favored the agricultural sector. Later, inflationary concerns led the government to try to discourage exports and channel production to the domestic market, antagonizing the farm lobby.
run-up to an election. Hence, in the context of our model, a new shock at the beginning of period $t$ will define the regulator’s type in periods $t$ and $t + 1$. A new shock will arrive at the beginning of the next election cycle, $t + 2$.

The incumbent has the following social welfare function:

$$W(p) = \pi(p) + (1 - \alpha)S(p),$$

where $S(p)$ is the consumer’s surplus. However, the objective function of the government is a finite horizon maximization problem, where he decides the regulated price in the two periods that he will be in office. As an extension of the model, to be explored later on, we include the possibility that the regulator is dissociated from the politician. An official in period $t$ chooses prices that maximize the following objective function:

$$\Phi_t' = \max_{p_{t+1}, p_{t+2}} \left[ \phi U^{RA}(c) + (1 - \phi)\sigma R_{t+2} + W(p_{t+1}) + W(p_{t+2}) \right],$$

where $U^{RA}(c)$ is the indirect utility of the independent non-politician regulator, $\phi$ is a binary $[0,1]$ variable that has value 1 if there is an independent regulatory agency and zero otherwise, $R$ is the probability of the incumbent being re-elected and will be formalized below and $\sigma$ is the weight the party places on being elected relative to social welfare. This objective function nests the two extreme types of regulatory institutions: direct regulation by the government or through an independent regulatory agency. For now we assume that $\phi = 0$, and so we focus on the case of a politician-regulator. So the objective function becomes

$$\Phi_t' = \max_{p_{t+1}, p_{t+2}} \left[ \sigma R_{t+2} + W(p_{t+1}) + W(p_{t+2}) \right].$$

The opposition party has a similar objective function. Figure 1 shows the chronological order of the game.

It is important to notice that the government and the lobby have an advantage over the public regarding access to information, since it observes the shock $\alpha$ before the public does.

The incumbent party win the elections in period $t$ if

$$E_t \left[ V_{t+1}^{I} + V_{t+2}^{I} - (V_{t+1}^{O} + V_{t+2}^{O}) \right] \geq 0.$$

---

6 A different structure could be used to model the stochastic process defining the regulator’s type, like an MA(1) as in Rogoff (1990). As in his paper, the essential feature here is that the type in $t$ is independent of the type in $t + 2$ for any $t$, and there is a positive correlation (perfect in our model) within the election cycles. It implies independence of the cycles: the regulator’s type in one election cycle is independent from the type in the last cycle. It rules out reputational concerns in the model—something that significantly increases the complexity of the model and is beyond the objective of this paper. The advantage of using the process we specify here compared to what Rogoff (1990) does is to be able to derive an explicit equilibrium solution.
The shock received in period $t$ provides no information about the shock (and the price) in period $t + 2$ (the time of the next election), since a new shock happens in $t + 2$. Therefore $E_t[V_{t+2}^I] = E_t[V_{t+2}^O]$. So we have,

$$E_t[V_{t+1}^I - V_{t+1}^O] = E_t[\phi(q(p_{t+1}^I)) + \eta_{t+1}^I - \phi(q(p_{t+1}^O)) - \eta_{t+1}^O]$$

$$= E_t[\phi(q(p_{t+1}^I)) - \phi(q(p_{t+1}^O)) + s_{t+1} + s_t + e(c^I - \bar{c})]$$

$$= E_t[\phi(q(p_{t+1}^I))] - \phi + s_t + e(c^I - \bar{c}),$$

where $\phi$ is the expected value of $\phi(q(p))$, $\bar{c}$ is some base amount of campaign contribution a party has if it is not in power, and the expectation is taken conditional on the information available to the public in time $t$.

The incumbent party does not observe $s_t$ when it sets the price $p_t$, hence the probability of winning is given by

$$(6) \quad R^I_t = P\left[E_t[\phi(q(p_{t+2}^I(\alpha)))]) - \phi + s_t + e(c^I - \bar{c}) \geq 0\right],$$

which follows the probability distribution of $s$ and $R^O = 1 - R^I$. At the time the incumbent sets the price he cannot observe the popularity shock, so there is no relation between the price and $s_t$.

C. Equilibrium

Note that periods $t + 1$ and $t + 2$ belong to the same mandate but to different electoral cycles. In fact, an electoral cycle begins in an election period $t$, when a new shock to the regulator’s preferences arrives and negotiation with the industry’s lobby takes place. This electoral cycle lasts until the period immediately preceding the next election, $t + 1$. The new independent shock in $t + 2$ resets the game. In practice, prices in $t + 1$ and $t + 2$ are independent, while prices in $t$ and $t + 1$ are not. It is important to note that no action that the regulator takes in periods $t$ or $t + 1$ affects his chance of re-election, and consequently his utility, in period $t + 2$. Hence, there is no history dependence in this model, and the independence of the cycles implies that no reputation is built over time since a new shock defines a new regulator.
In an election period, the regulator and the industry negotiate and commit to the current and future prices in order to decide on the lobby’s campaign contributions. We make the assumption that the regulator sets the prices and then the lobby decides optimally how much it will contribute to the politician’s electoral campaign. We therefore write the politician’s decision problem as

\[
\Phi = \max_{p_t, p_{t+1}} W(p_t) + W(p_{t+1}) + \sigma R_t
\]

subject to

\[
\pi(p_t) + \pi(p_{t+1}) - c = 2\pi
\]

\[
c \geq 0,
\]

where \(2\pi\) is the amount of profits the industry must earn and \(R_t\) is given by equation (6).

In order to have an explicit solution that is a function of the structural parameters of the problem, we assume that the random part of the consumers’ utility function, given by the variable \(s\) (equations (2) and (3)), follows a uniform distribution on the interval \([-\frac{1}{2f}, \frac{1}{2f}]\) with mean zero and density \(f\). Hence, we can rewrite equation (6) as

\[
R_t = \frac{1}{2} + f\left[Et(S(p_{t+1})) - S(p)\right] + fe\left(c - \bar{c}\right).
\]

We use (7) and (8) to solve for the equilibrium prices. We start with the simpler case where information is symmetric.

**Symmetric Information.**—In this case, voters know the regulator’s type and understand the tradeoff he faces. The regulator therefore has no incentives to distort the price in an electoral period, hence \(p^*_t = p^*_{t+1}\).

Substituting equation (8) in (7), and solving for the first-order condition, we have

\[
p^*_i = \frac{\partial C(q_i)}{\partial q_i} - (\sigma fe + \alpha)\frac{q_i}{q'_i},
\]

where \(i = t, t + 1\) and \(q'_i\) is the derivative of \(q\) with respect to the price \(p\), and \(q'_i < 0\). Note, first, that the type \(\alpha\) of the regulator has a positive effect on the regulated price. Second, without lobbying, or if campaign contributions are ineffective, \(e = 0\) and the optimal price reduces to the regulator’s welfare maximizing price:

\[
p_i = \frac{\partial C(q_i)}{\partial q_i} - \alpha\frac{q_i}{q'_i}.
\]

\(^7\text{Grossman and Helpman (2001) reverse this order, with the industry deciding first, but obtain rather similar results.}\)
Asymmetric Information.—Before characterizing the equilibrium we need some new notations and definitions. Substituting equation (8) and using the constraint on firm’s profits we can rewrite the regulator’s maximization problem given by (7) as

\[
\Phi = \max_{p_t, p_{t+1}} G(\alpha, p_t) + G(\alpha, p_{t+1}) + \sigma \left[ \frac{1}{2} + f(\mathcal{E}_t(S(p_{t+1})) - \bar{S}(p)) - fe(2\pi - \bar{c}) \right],
\]

where \( G(\alpha, p) = (1 + \sigma f)e\pi(p) + (1 - \alpha) S(p) \) is the politician’s “utility.” So the regulator sets prices to maximize

\[
\Phi = \max_{p_t, p_{t+1}} G(\alpha, p_t) + G(\alpha, p_{t+1}) + \sigma f \mathcal{E}_t(S(p_{t+1})).
\]

Note that \( p^*(\alpha) = \arg \max G(\alpha, p) \). Also, define the difference in regulator’s utility when type \( \alpha \) chooses \( p \) or \( p^* \) as \( \lambda(p - p^*) = G(\alpha, p) - G(\alpha, p^*) \). Therefore, when type \( \alpha \) chooses \( p^* \), \( \lambda(p^*(\alpha) - p^*) \) gives a measure of the distortion that type \( \alpha \) creates from deviating from the utility maximizing price \( p^*(\alpha) \). The regulator still needs to solve the problem described by (7). But now at the time of the election consumers do not know the type of the regulator.

We solve the problem recursively, from time \( t + 1 \) to time \( t \). At period \( t + 1 \) there is no election, but the regulator and the industry committed on \( p_{t+1} \) when negotiating campaign contributions. So this price maximizes the politician welfare and lobby contributions. In fact, this price is the same as the one that maximizes the regulator’s program with full information, given by equation (9). So, we have that \( p^*_{t+1} = p^*_{t+1} \), where the superscript \( s \) stands for signaling equilibrium.

Now we turn to the pricing problem in electoral years. We dropped the subscript \( t \) and the superscript \( s \) for simplicity of notation.

First, we characterize the separating equilibrium of this signaling game, and then we prove that it is, indeed, equilibrium. In equilibrium, the incumbent politician adopts the following strategies: if a pro-industry type he sets \( p(\bar{\alpha}) = p^*(\bar{\alpha}) \) and \( \lambda(p^*(\alpha) - p(\alpha)) = 0 \); if a pro-consumer type sets \( p(\alpha) < p^*(\alpha) \) and \( \lambda(p^*(\alpha) - p(\alpha)) > 0 \). Any voters’ beliefs that assign probability one of being a high type when observing \( p(\bar{\alpha}) \), and probability one of being a low type when observing \( p(\alpha) \) is consistent with this equilibrium. This is the well-known result first derived by Spence (1973) that the least favored type (with respect to voters) does not try to signal his type since in equilibrium he will be recognized anyway.

PROPOSITION: In a separating equilibrium, \( p^*(\bar{\alpha}) = p^*(\bar{\alpha}) \) and \( \lambda(p^*(\alpha) - p^*(\bar{\alpha})) = 0 \).

PROOF:
See Appendix A.

\[8\]This is equivalent to what the politician maximizes under full information.
THEOREM: A separating sequential equilibrium of this game has
\[ p^*(\alpha) = p^*(\bar{\alpha}) - \lambda^{-1} \left[ \sigma f E_t \left[ S(p_{t+1}(\alpha)) - S(p_{t+1}(\bar{\alpha})) \right] \right]. \]

PROOF:
See Appendix B.

The distortion of the pro-consumer type is given by \( \lambda (p^*(\alpha) - p^*(\bar{\alpha})) > 0 \). In equilibrium, the distortion of the lower type is a function of the difference between the probability of each type winning the election, and on how the incumbent weights his objective function and the variance of the random shock on voter’s preferences. The greater this difference, the more distortion the lower type will introduce to run away from the higher type. Also, the more weight the politician places on being re-elected compared to the consumer welfare, the more he will distort.\(^9\) It is straightforward to show that in equilibrium the pro-industry type receives more campaign contributions from the lobby than the pro-consumer type.

As stated before, at the beginning of the electoral period the lobby and the regulator negotiate on regulated prices and campaign contributions. Policy distortions related to lobby activity happen in their full dimension in non-electoral times and decrease when elections are near. Roughly speaking, it is easier for the industry lobby to buy policy distortions from the regulator in the non-electoral period. This result extends well beyond the regulatory set up that we analyze here; it applies to any politically sensitive policy that may influence an election outcome.

In summary, we proved here that, in equilibrium, some government-regulators (the pro-consumer type) will distort and lower the regulated price to differentiate themselves from other types of regulators (pro-industry). An empirical implication of our discrete, two-type regulatory model is that the political cycle in regulated industries only takes place when a pro-consumer regulator is in office, what happens with probability \((1 - \mu)\). While our model is sufficient to justify and explain political cycles in regulated prices, a model allowing for more regulator types could be more realistic and allow for cycles of different intensities. In the continuum-of-types case, all but the most pro-industry type would lower the price before elections to differentiate itself from the type immediately below.

D. An Independent Regulatory Agency

Now we turn to the role played by an independent regulatory agency in setting prices.

We rewrite equation (5) below.

\[ \Phi_I = \max_{p_{t+1},p_{t+2}} \left[ \phi U^{RA}(c) + (1 - \phi) \sigma R_{t+2}^I + W(p_{t+1}) + W(p_{t+2}) \right]. \]

\(^9\)It is worth noticing that, without loss of generality, we consider only the case where signaling happens. No signaling happens when \( p^*(\alpha) < p^*(\bar{\alpha}) < p^*(\bar{\alpha}) \), since the high type will not try to mimic the low type anyway, and both types will set prices that maximize the social welfare.
Now we assume that \( \phi = 1 \) and hence there is an independent regulatory agency. The regulator’s objective function becomes \(^{10}\)

\[
\Phi_t' = \max_{p_{t+1}} \left[ U^{RA}(c) + W(p_{t+1}) + W(p_{t+2}) \right],
\]

subject to

\[
\pi(p_t) + \pi(p_{t+1}) - c = 2\bar{\pi}
\]

\[c \geq 0.\]

The main difference between the two types of regulatory institutions is that an independent regulator’s objective function is dissociated from elections. Therefore, the existence of an incoming election has no effect on the regulator’s policy, and there is no political cycle of regulated prices.

Note, however, that even an independent regulator may derive utility from the regulatory outcome through lobbying activities. \(^{11}\) In this case, lobbying would not be associated with campaign contributions, but with corruption, future career opportunities for regulators in the regulated industry, and other benefits.

Absent all the complications derived from asymmetric information and voting, the equilibrium in this case is straightforward: the regulator sets a price \( p^* \) that maximizes problem (13). This price is the same in electoral and non-electoral periods, and it is higher than a pure welfare-maximizing price since it maximizes welfare and lobbying transfers to the regulator. The result that independent regulatory agencies may preclude the occurrence of an electorally-driven price cycle finds support in the empirical evidence presented in the next section.

III. Empirical Evidence

A. The Markets

Our model of political price cycles in regulated industries is tested for the gasoline and residential electricity markets in Brazil. Both prices have been regulated, and both products have a significant impact on the budget of a typical household. Moreover, price and tariff increases have often been covered extensively by the media, creating a powerful “headline impact” on voter sentiment that an electorally concerned government-regulator may seek to avoid in an election period.

B. The Data

The initial dataset comprised monthly series on domestic gasoline prices; average residential electricity tariffs; the consumer price index; the exchange rate of the domestic currency against the US dollar; and international oil prices measured in US

\(^{10}\)Without loss of generality, we implicitly assume that this regulator also regulates the industry for two periods.

\(^{11}\)According to the literature of political theory of regulation—Stigler (1971), Peltzman (1976), Besley and Coate (2003), and others—it is unrealistic to assume that regulators maximize pure social welfare.
dollars. These series were obtained from the government think-tank IPEA (Instituto de Pesquisa Economica Aplicada). Gasoline price data spanned the period 1969:8–2008:12 and electricity prices spanned the period 1963:1–2009:8. A dummy variable was created to differentiate the six months leading up to a national election from non-electoral months. National elections were held every four years starting in 1970.\footnote{Elections for Congress were the only national elections during the 1970s, since state governors and the country’s president were elected by state assembly and national congress members, respectively. National elections started to also include elections for governors and the country’s president in the 1980s.} Seasonal dummy variables were also added to the dataset.

Basic statistics and simple tests of equality of means provide powerful evidence that political cycles have been observed in regulated markets in Brazil (\textbf{Table 1}; Figure 2). Real gasoline prices increased, on average, 0.3 percent a month over the entire sample, but declined 0.6 percent, on average, in the months leading up to an election. This decline is not a recurring seasonal pattern, as real gasoline prices actually increased 0.5 percent a month during the same calendar months in non-election years (the control group). A simple t-test of the equality of means indicates that there is only a 3 percent probability that average real gasoline price increases are the same during election and non-election periods.

Comparing the evolution of gasoline prices against oil costs, the difference between electoral and non-electoral periods is even more pronounced: in the run-up to elections, the average gasoline price increase was 2 percentage points below the average increase in oil costs; during similar months in non-election years, the

\begin{table}
\centering
\begin{tabular}{lrrrrrr}
\hline
 & \multicolumn{2}{c}{Real gasoline price increases} & \multicolumn{2}{c}{Gasoline price increases above oil cost increases} & \multicolumn{2}{c}{Real electricity tariff increases} \\
 & Full & Election & Control & Election & Control & Full & Election & Control \\
\hline
Monthly average & 0.3 & -0.6 & 0.5 & -2.0 & 0.8 & 0.1 & -1.2 & 0.0 \\
Variance & 19.8 & 17.3 & 16.9 & 80.7 & 72.6 & 34.2 & 3.4 & 22.8 \\
Standard deviation & 4.4 & 4.2 & 4.1 & 9.0 & 8.5 & 5.8 & 1.8 & 4.8 \\
Observations & 473 & 70 & 207 & 70 & 207 & 522 & 63 & 242 \\
Probability that average election and control increases are equal & 0.03 & 0.01 & 0.04 & & & & & \\
\hline
\end{tabular}
\end{table}

\begin{figure}
\centering
\includegraphics[width=\textwidth]{figure2.png}
\caption{Contrasting Regulated Price Dynamics in Electoral and Non-Electoral Periods}
\end{figure}
average gasoline price increase was 0.8 percentage point above the increase in oil costs. The mean-comparison test indicates a probability of only 1 percent that the pass-through from oil costs to regulated gasoline prices is the same during election and non-election periods.

A similar discrepancy in regulatory behavior seems to occur in the setting of electricity tariffs. Although electricity tariff adjustments were broadly in line with inflation over the same months in non-electoral years, real electricity tariffs declined by an average of 1.2 percent a month before elections. The probability that tariffs behave the same during electoral and non-electoral months is only 4 percent.

C. Main Econometric Modeling

Moving toward formal econometric modeling of regulated price dynamics over the electoral cycle, the following variables were generated: \( LPGAS \) is defined as the (natural) logarithm of domestic gasoline prices; \( LPMWH \) is the logarithm of domestic electricity tariffs; \( LER \) is the logarithm of the exchange rate; \( LPOIL \) is the logarithm of international oil prices in US dollars; \( LPOILDOM \) is the logarithm of oil prices in domestic currency; and \( LIPC \) is the logarithm of the consumer price index. First-differenced series have their names preceded by the letter “C.” Unit root tests indicate that, with the exception of \( LPOIL \), all series are integrated of order one.\(^{13}\)

Our first set of models focused on the link between regulated gasoline prices and international oil prices expressed in domestic currency. Trace and maximum eigenvalue statistics failed to reject the null hypotheses of no-cointegration between \( LPGAS \) and \( LPOILDOM \), thus favoring the use of first-differenced series.\(^{14}\) Models were then estimated through ordinary least squares (OLS) with White (1980) heteroskedasticity-consistent standard errors and covariance.\(^{15}\) Modeling started with general formulations that were trimmed down to more parsimonious specifications based on individual \( t \)-ratios and the Schwarz information criterion. Selected models summarized in Table 2 also passed Ljung-Box \( Q \)-statistic and the Breusch-Godfrey LM tests for residual autocorrelation up to 7 lags at 10 percent significance level. In all specifications, gasoline price increases are estimated to be about \( 2 \frac{1}{3} \) percentage points lower during months of electoral activity. This electoral impact is highly significant from a statistical standpoint.

An additional set of models breaks down domestic oil costs into \( LER \) and \( LPOIL \). As expected, Wald block exogeneity tests show \( LPOIL \) to be exogenous, since Brazil can be considered a price taker in international oil markets. Test statistics failed to reject the null hypotheses of no cointegration between \( LPGAS \) and \( LER \), favoring the use of first-differenced series. Tests also suggested that contemporaneous changes in the exchange rate should not be considered exogenous, so this variable only enters the equation in lagged form. Models summarized in Table 3 were estimated through

13 See the Appendix C for more details on the data, econometric tests, and estimations.
14 In all tests and estimations involving vector autoregressions, the preferred number of lags was determined so as to minimize the Schwarz criterion (unless otherwise noted). Tests also suggested that contemporaneous changes in the domestic value of oil prices cannot be considered exogenous from gasoline price adjustments, so that variable only enters the equation in lagged form.
15 White (1980).
OLS with White (1980) heteroskedasticity-consistent standard errors and covariance, and passed 𝑄-statistic and LM autocorrelation tests up to 7 lags (autoregressive terms had to be included in the models to mop up some residual correlation). These models confirm the electoral price cycle, with coefficient estimates on the electoral dummy variable remaining highly significant and indicating that regulated
gasoline price adjustments can be up to 2.7 percentage points lower during months of electoral activity.

Turning to the dynamics of electricity prices, the initial modeling strategy kept international oil prices and the exchange rate as a proxy for (marginal) energy costs, since thermoelectric plants complement electricity generation in periods of low rainfall and/or peak demand in Brazil. Exogeneity tests confirmed the appropriateness of treating LPOIL as an exogenous variable, while trace and maximum eigenvalue statistics failed to reject the null hypotheses of no-cointegration between LPMWH and LER. Thus, modeling focused on stationary series and followed the same estimation and selection process used for gasoline price models. Once again, tests suggested that contemporaneous changes in the exchange rate should not be considered exogenous, so this variable only enters the equation in lagged form. Model estimation results, summarized in Table 4, indicate that monthly electricity tariff adjustments tend to be about $2\frac{1}{2}$ percentage points lower before an election, thus suggesting that a political cycle is also observed in electricity tariffs.

Shifting the focus away from measures of energy costs, we now investigate the relationship between regulated prices and the broader inflationary process. Even if regulated price increases generally follow inflation over time, are these increases systematically and significantly lower in the run-up to an election? The models presented below support an affirmative answer to this question and provide additional evidence of electoral cycles in regulated prices in Brazil.

First, and somewhat surprisingly, tests failed to reject the hypothesis of no-cointegration between LIPC and LPGAS. Granger-causality tests detected a uni-directional causality running from CLIPC to CLPGAS. Hence, single equations relating changes in gasoline prices to inflation and seasonal and electoral dummy variables were estimated using OLS with White (1980) heteroskedasticity-consistent standard errors and covariance. Results are summarized in Table 5. Equations (13) and (14) show that gasoline price adjustments tend to be at least 2 percentage points lower during months leading up to an election—a highly significant statistical effect.

Allowing for a different way to measure the impact of electoral campaigns on regulated prices, a slope dummy was used in Models 15 and 16 to capture the possibility of a lower pass-through from inflation to gasoline prices. Coefficient estimates are highly significant and suggest that the pass-through before elections is well below the pass-through estimated for “regular” months.

A similar strategy was employed to relate electricity tariff adjustments and overall inflation. Johansen tests provided weak evidence of cointegration between and LIPC, since test statistics rejected the null hypothesis of no-cointegration at the 10 percent significance level but not at the 5 percent significance level. To be sure, we continued with the estimation of vector error correction models but also estimated single equations using the first-differenced, stationary series

---

16 Neither trace or maximum eigenvalue statistics reached conventional minimum significance levels (10 percent) for vectors with one lag, two lags (which minimize the Schwarz criterion), or five lags (which minimize the Akaike criterion). Tests were run with and without seasonal dummy variables and a trend in the cointegrating equation.

17 The tests were performed for vectors with one lag (to minimize the Schwarz criterion), two lags, and four lags (to minimize Akaike criterion), and with and without seasonal dummy variables.
Both types of models provide evidence of an electoral price cycle in electricity tariffs, as the effect of elections on tariff adjustments remains highly significant. Finally, equations (19) and (20) (Table 6B) suggest that the rate of pass-through from inflation to prices in months leading up to elections is significant.

18 Again, OLS estimates were performed with White (1980) heteroskedasticity-consistent standard errors and covariance. Autoregressive terms had to be included in equations (17)–(20) to mop up some residual correlation.
a election is almost half of the pass-through observed during “regular” months, and this difference is statistically significant.

In summary, whether the dynamics of regulated gasoline and electricity prices are modeled as a function of energy costs or overall inflation (general benchmark strategies to maintain corporate profitability), the influence of the electoral calendar is apparent: price adjustments during electoral periods are consistently and
significantly lower than in regular periods. The econometric results that support this conclusion are robust to different lag specifications, the consideration of seasonal factors, and modeling strategies that focus on nonstationary series (results from nonstationary models are summarized in the Appendix C). Our detailed econometric analysis therefore reinforces the simple mean comparisons presented earlier in identifying political price cycles in regulated industries in Brazil.

D. Additional Econometric Modeling: The Impact of a Regulatory Agency

In this section, we investigate whether the establishment of a regulatory agency in Brazil’s electricity market (ANEEL) in 1996 has altered pricing dynamics and the political cycle in that industry. The World Bank has included Brazil’s regulatory governance in the electricity market among the strongest in Latin America. In principle, and as previously discussed, a dedicated independent regulatory agency would be insulated from political pressure and reduce the likelihood that a political price cycle would arise in the regulated industry. The hypothesis that ANEEL has affected the political price cycle in the electricity market is tested with the help of a dummy variable (DANEEL) that designates the electoral campaign periods that have occurred after the establishment of the regulatory agency.

The ten original models of electricity price dynamics described in Tables 4, 6A, and 6B were augmented with the variable DANEEL and reestimated. The results, summarized in Table 7, provide strong evidence that the creation of ANEEL has indeed contributed to the elimination of a political price cycle in the electricity market: in eight out of the ten models, coefficient estimates on DANEEL are positive, statistically significant, and virtually symmetric to the coefficient on the election dummy variable (which remains highly significant). Therefore, according to most model estimates, the interaction of the two dummy variables suggest that electricity tariff adjustments have no longer been affected by the electoral cycle since the creation of the independent regulatory agency. Formal Wald tests confirm that, in those eight models, the sum of the coefficients on DANEEL and on the election dummy is not significantly different from zero, i.e., that there is no evidence of a political cycle in electricity prices after ANEEL.

Seeking further assurance that this result comes from the new regulatory framework in the electricity market rather than any broader changes that may have also affected the gasoline market, all original models of gasoline price dynamics were reestimated with the post-1996 electoral dummy. Nine out of the 12 models found no indication that the political cycle in gasoline prices was eliminated after 1996: the dummy variable singling out elections after 1996 did not reach minimum significance levels. This further supports the view that the creation of an independent agency to regulate the Brazilian electricity market has reduced the likelihood of occurrence of a political price cycle in that industry.

19Estimation techniques were the same as used in the original models; coefficients on variables other than the electoral dummies were little affected; all models continued to display appropriate fit and pass autocorrelation tests (details omitted for simplicity).
**IV. Welfare and Policy**

**A. General Considerations**

In order to explore possible welfare and policy implications of our model, note first that without the existence of an industry lobby, a political cycle in regulated prices would be welfare reducing. This follows from the fact that, were it not for campaign contributions, the regulator would set the price in non-electoral periods equal to the welfare-maximizing price. From this perspective, the cycle would thus represent a deviation from the optimal price.

When lobbying is included in the model, however, the net impact of a political price cycle on welfare becomes inconclusive. Since the full information price $p^*(\alpha)$ is greater than the welfare-maximizing price $p^w(\alpha)$, and the signaling equilibrium price $p^s(\alpha)$ is lower than the full information price, $p^s(\alpha) \geq p^w(\alpha)$ and $p^s(\alpha) \geq p^*(\alpha)$, one is tempted to think that the signaling price is closer to the welfare-maximizing price. This is a possibility, but need not be the case. It is possible that the increase in the probability of being re-elected, due to a large difference of consumer surplus under both types, is enough to induce a very low signaling price that makes $p^s \geq p^w \geq p^*$ and $W(p^s) \geq W(p^*)$. However, the opposite situation—where the signaling price is closer to the welfare-maximizing price—can also happen with positive probability.

Different outcomes may arise depending on the magnitude of the model’s parameters. The key driving force is the net effect of campaign contributions relative to the political gain of lowering the regulated price. The effect of campaign contributions is determined by the parameter $e$ from the model. The electoral effect of lowering the regulated price is given by the difference in consumers’ surplus under the pro-consumer and pro-industry types.

A policy implication of this uncertainty is that the creation of an independent regulatory agency, which would be able to protect the regulatory process from politicians but not from lobbying, only improves welfare when the political price cycle
is welfare decreasing. In practice, this would correspond to a situation in which the industry lobby is weak relative to the interests and direct interference of politicians. Alternatively, when the industry lobby is strong, political interests and politicians’ interference may counterbalance lobbying pressure, and drive the regulated price towards the welfare maximizing price.

B. Welfare Loss Simulation

We simulate a political price cycle in Brazilian energy markets to tentatively assess its welfare implications. Our results suggest that the average (peak) welfare loss, resulting from a political price cycle in the gasoline market, is substantially higher than in the electricity market: 0.35 (0.84) percent compared to 0.03 (0.07) percent (see Appendix C for details on assumptions, strategy, and results). The difference in welfare loss arises from a more elastic demand and an estimated stronger political cycle in gasoline markets, and implies that a regulatory agency would have an important role in improving market performance in gasoline markets.

V. Concluding Remarks

This paper presents a model of industry regulation in which information asymmetries and the government-regulator’s interest in being re-elected may generate a political cycle in the regulated price. The model derives equilibrium regulation strategies implying that some government-regulators may lower the regulated price in an election period, thereby generating a price cycle. Extensive statistical and econometric analyses using data for gasoline and electricity prices in Brazil provide strong evidence that such electoral price cycles have taken place in those two regulated markets. The empirical work also suggests that the creation of an electricity regulatory agency may have put an end to the political price cycle in that industry.

We model the regulatory process as the interaction of three groups: the government-regulator, the lobby-industry, and consumers-voters. Information asymmetries and optimal strategies by the different players allow for an equilibrium in which the regulator lowers the regulated price in an electoral period to please consumers, raising it back in non-election periods to compensate the lobby for campaign contributions. This result differs from the static models of political regulation where the regulatory strategy defined a single price that favored one group in detriment of another.

We tested the implications of our model for the gasoline and electricity markets in Brazil using monthly data spanning about four decades. Simple statistical analysis provided powerful evidence that political cycles have been observed in those markets: (i) real gasoline prices declined 0.6 percent a month, on average, during the six months leading up to an election but increased 0.5 percent during the same calendar months in non-election years; (ii) the average increase in gasoline prices was 2 percentage points lower than the average increase in oil costs during

---

20We abuse terminology and use “political influence” as describing the political pressure exerted by the regulator-politician only. We call lobbying the political pressure made by the regulated industry.
election periods and 0.8 percentage point higher than the increase in oil costs during non-electoral periods; (iii) although electricity tariff adjustments were broadly in line with inflation over the entire sample period, real electricity tariffs declined an average of 1.2 percent per month during periods of electoral campaign. These differences in means are statistically significant.

Extensive econometric modeling confirmed that political price cycles in gasoline and electricity prices have occurred in Brazil. Whether the dynamics of these regulated prices are measured against benchmark international energy costs or domestic inflation, a dummy variable marking the months leading up to an election shows up as consistently negative and significant across several model specifications. The coefficient estimates on this dummy variable suggest that, during electoral periods, regulated prices tend to be adjusted by 2–2\(\frac{3}{4}\) percentage points less, on average, than during non-election periods. These estimates are robust to different lag specifications and the use of stationary and nonstationary models. Additional econometric results suggest that the introduction in 1996 of an independent agency to regulate the electricity market in Brazil has eliminated the political price cycle in that industry.

The theoretical model also shows that the political price cycle can be welfare-reducing or welfare-improving depending on the relative power of the industry lobby, the importance of campaign contributions for the regulator, and the impact of the regulated product on consumers’ welfare. A simulation of the price cycle using actual quantity and price data for the electoral year of 1994 shows that welfare losses in the gasoline market are more significant than in the electricity market in Brazil. This result stems from a higher price-elasticity of demand and stronger price cycle in the gasoline market, and suggests that the creation of an independent regulatory agency could play an important role in improving welfare in the gasoline market in Brazil.

**Appendix A**

**PROOF OF PROPOSITION:**
Suppose not. Instead, \(p(\alpha) < p^*(\alpha)\) and \(\lambda(p^*(\alpha) - p(\alpha)) = \kappa > 0\). There would be a decreasing in welfare of \(\kappa\). But since in equilibrium the high type \(\alpha\) would be recognized as such, there would be no increase in the probability of being re-elected. Therefore, the high type is better off by setting \(p(\alpha) = p^*(\alpha)\) and \(\lambda(p^*(\alpha) - p(\alpha)) = 0\).

**Appendix B**

**PROOF OF THEOREM:**
Sequential rationality of the game requires that no player finds it better off to deviate from the equilibrium path. This implies the following conditions:

\[
\Phi(\alpha, \alpha) \geq \Phi(\alpha, \bar{\alpha}) \\
\Phi(\bar{\alpha}, \alpha) \geq \Phi(\bar{\alpha}, \alpha),
\]
where the first term within the parentheses is the true type of the incumbent, and the second term is the one he is trying to mimic. The first inequality, \( \Phi(\alpha, \underline{\alpha}) \geq \Phi(\alpha, \overline{\alpha}) \), implies

\[
G(\alpha, p(\alpha)) + \sigma \left[ \frac{1}{2} + fE_t(S(p_{t+1}(\alpha) - \overline{S}(p)) - fe(2\pi - \overline{c}) \right] \\
\geq G(\alpha, p(\overline{\alpha})) + \sigma \left[ \frac{1}{2} + fE_t(S(p_{t+1}(\overline{\alpha}) - \overline{S}(p)) - fe(2\pi - \overline{c}) \right],
\]

which is reduced to

\[
G(\alpha, p(\alpha)) - G(\alpha, p(\overline{\alpha})) \geq -\sigma fE_t [S(p_{t+1}(\alpha)) - S(p_{t+1}(\overline{\alpha}))]
\]

and

\[
\lambda(p(\alpha) - p^*(\overline{\alpha})) \geq -\sigma fE_t [S(p_{t+1}(\alpha)) - S(p_{t+1}(\overline{\alpha}))],
\]

since in equilibrium the pro-industry type set the price that maximizes his utility.

In any equilibrium of this game \( p(\alpha) \leq p^*(\alpha) \), and in this range \( G(\alpha, p(\alpha)) \) increases in \( p(\alpha) \) up to \( p^*(\alpha) \). It implies that \( \lambda(p^*(\overline{\alpha}) - p(\alpha)) \) is a monotonic decreasing function of prices \( p(\overline{\alpha}) \), and therefore it has an inverse, \( \lambda^{-1}(\cdot) \). \( \Phi(\cdot) \) Hence,

\[
p(\alpha) \geq p^*(\overline{\alpha}) - \lambda^{-1} \left[ \sigma fE_t [S(p_{t+1}(\alpha)) - S(p_{t+1}(\overline{\alpha}))] \right].
\]

Using the same argument for the high type restriction, \( \Phi(\overline{\alpha}, \alpha) \geq \Phi(\overline{\alpha}, \alpha) \), the following condition can be derived:

\[
p(\alpha) \leq p^*(\overline{\alpha}) - \lambda^{-1} \left[ \sigma fE_t [S(p_{t+1}(\alpha)) - S(p_{t+1}(\overline{\alpha}))] \right].
\]

Since in equilibrium both conditions must hold, it implies that

\[
p(\alpha) = p^*(\overline{\alpha}) - \lambda^{-1} \left[ \sigma fE_t [S(p_{t+1}(\alpha)) - S(p_{t+1}(\overline{\alpha}))] \right].
\]

**Appendix C: Graphs and Tables**

**The Data: Graphs and Detail.**—Nominal and real gasoline and electricity price changes are plotted in [Figure C1]. The high frequency and variability of the data complicate the visual identification of consistent patterns or cycles. However, mean-comparison tests of real price changes (and price changes in excess of energy costs) during electoral versus non-electoral periods provide strong evidence of a political price cycle in the data. Note that, although the theoretical model referred to price increases and decreases for simplicity, the empirical analyses assume that

\(^{21}\lambda(\cdot) \) is increasing in prices for price levels exceeding the one that maximizes the social welfare. It is not relevant since in equilibrium no price will fall in that region.
firms and consumers do not suffer from “monetary illusion,” i.e., they actually care about real price increases and decreases.

Stationarity or Unit Root Tests.—Unit root tests are presented in Table C1 and indicate that all but one log-level series are integrated of order one, i.e., stationarity is obtained by taking first differences. The exception is LPOIL, which seems to be stationary.

The tests shown are based on augmented Dickey-Fuller statistics obtained from auxiliary regressions in which the lag order was chosen so as to minimize the Schwarz criterion. Alternative test formulations allowed for the presence of a constant term and a time trend.

Additional Econometric Modeling: Nonstationary Models of Price Levels.—Conventional unit root and cointegration tests generally favored the estimation of models in first-differences, as presented in the main body of the paper. Residual analysis and tests, and dummy variables showed that missing observations in the series for electricity prices had no impact on model estimates.

The empirical evidence of the existence of political price cycles in Brazil remains robust when models are estimated using the series in levels. In fact, as shown in Table C2, the electoral dummy variable remains negative and highly

---

22 Auxiliary regressions augmented with seasonal dummy variables supported the findings (available upon request).
significant to explain gasoline price dynamics, whether or not cointegration is assumed in these nonstationary models. 23 Finally, although the electoral dummy capturing a political cycle in electricity prices loses some of its power compared to estimates obtained from stationary models, it remains significant in most specifications, as shown in Table C3. 24

23 All other coefficients are omitted for simplicity. Models in which the optimal number of lags was determined using the Akaike criterion generally captured stronger electoral effects (results available from authors).

24 Dummy variables did not identify any significant structural break due to the missing observations.

### Table C1—Unit Root Tests

<table>
<thead>
<tr>
<th>Levels</th>
<th>ADF statistic</th>
<th>Prob.*</th>
<th>First differences</th>
<th>ADF statistic</th>
<th>Prob.*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ho: LPGAS has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.60</td>
<td>0.868</td>
<td>Constant</td>
<td>−6.05</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−0.77</td>
<td>0.967</td>
<td>Constant and trend</td>
<td>−6.05</td>
<td>0.000</td>
</tr>
<tr>
<td>Ho: LPMWH has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.18</td>
<td>0.971</td>
<td>Constant</td>
<td>−7.24</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−0.88</td>
<td>0.956</td>
<td>Constant and trend</td>
<td>−7.25</td>
<td>0.000</td>
</tr>
<tr>
<td>Ho: LER has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.41</td>
<td>0.905</td>
<td>Constant</td>
<td>−5.33</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−1.10</td>
<td>0.927</td>
<td>Constant and trend</td>
<td>−5.33</td>
<td>0.000</td>
</tr>
<tr>
<td>Ho: LPOIL has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−1.26</td>
<td>0.651</td>
<td>Constant</td>
<td>−18.49</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−0.77</td>
<td>0.967</td>
<td>Constant and trend</td>
<td>−18.49</td>
<td>0.000</td>
</tr>
<tr>
<td>Ho: LPOILDOM has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.19</td>
<td>0.937</td>
<td>Constant</td>
<td>−7.39</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−1.14</td>
<td>0.920</td>
<td>Constant and trend</td>
<td>−7.39</td>
<td>0.000</td>
</tr>
<tr>
<td>Ho: LPC has a unit root</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>−0.47</td>
<td>0.894</td>
<td>Constant</td>
<td>−4.37</td>
<td>0.000</td>
</tr>
<tr>
<td>Constant and trend</td>
<td>−1.38</td>
<td>0.867</td>
<td>Constant and trend</td>
<td>−4.37</td>
<td>0.000</td>
</tr>
</tbody>
</table>

### Table C2—Electoral Dummy in Nonstationary Models of Gasoline Prices

<table>
<thead>
<tr>
<th>Variables in VAR</th>
<th>Optimal lag number</th>
<th>Seasonal dummies</th>
<th>Cointegration</th>
<th>Electoral dummy</th>
</tr>
</thead>
<tbody>
<tr>
<td>LPGAS</td>
<td>Schwarz criteria: 3</td>
<td></td>
<td>Yes</td>
<td>−2.2</td>
</tr>
<tr>
<td>LPOILDOMCUR</td>
<td></td>
<td></td>
<td>No</td>
<td>−2.0</td>
</tr>
<tr>
<td>LPGAS</td>
<td>Schwarz criteria: 2</td>
<td></td>
<td>Yes</td>
<td>−2.2</td>
</tr>
<tr>
<td>LER</td>
<td></td>
<td></td>
<td>No</td>
<td>−2.0</td>
</tr>
<tr>
<td>LPOIL</td>
<td></td>
<td></td>
<td>Yes</td>
<td>−2.2</td>
</tr>
<tr>
<td>LPOIL</td>
<td></td>
<td></td>
<td>No</td>
<td>−2.0</td>
</tr>
</tbody>
</table>

---

23 All other coefficients are omitted for simplicity. Models in which the optimal number of lags was determined using the Akaike criterion generally captured stronger electoral effects (results available from authors).

24 Dummy variables did not identify any significant structural break due to the missing observations.
Simulation of Welfare Losses from Brazil’s Political Price Cycles.—We simulate a price cycle in Brazilian energy markets to obtain an approximate estimate of its welfare implications. Our results suggest that the average welfare loss resulting from a political price cycle in the gasoline market is substantially higher than the electricity market: 0.35 percent compared to 0.03 percent, as shown in Tables C4 and C5, respectively.

The assumptions and the procedure adopted in our simulation are as follows:

- We assume there was no industry lobby in 1994, when both the electricity and the gasoline industry were state owned; we use quantities and prices from this electoral year to simulate the welfare implications of a political price cycle.\(^\text{25}\) Besides the cycle reducing welfare, the absence of a lobby in our model also implies that the regulator sets the optimal price in non-electoral periods.
- We must rely on a strong but necessary and simplifying assumption that industry regulation was “optimal” in the first half of 1994. By “optimal” we mean that it results in zero economic profits and market equilibrium (supply equals demand).
- We assume constant marginal costs (supply is perfectly elastic) and that consumers have a strictly decreasing linear demand function.\(^\text{26}\) In this case, the loss in welfare due to a price decrease away from equilibrium is simply the area of the triangle comprised between the supply and the demand curves, i.e., from the original optimal quantity to the larger quantity induced by the lower price.

\(^{25}\) One may argue that state-owned industries could engage in lobbying activities. In this case, our results can be seen as an upper bound on the cycle’s welfare loss.

\(^{26}\) These assumptions are necessary for the simulation since we only have data for prices and quantities.
Instead of estimating a demand function for each good, we use the mean price elasticities reported by Espey (1996), and Espey and Espey (2004): −0.35 for electricity and −0.53 for gasoline.

The linear demand is of the form \( Q = a - bP \), where \( a \) and \( b \) refer to the intercept and the slope of the demand. We obtain these values using the price elasticity and the mean values of quantity and price.

To start from a more stable base, we use the mean quantity of the first five (non-electoral) months of 1994 as the average monthly demand, which is 192,000 barrels/day and 18,412 MWh, for gasoline and electricity, respectively. The average price during these five months is used as the price of March (the mid-point of the first five months). The average monthly price changes reported in Table 1 is then used to obtain the simulated price series for 1994. The price cycle is shown in the second column. We call this price series the “actual” prices.

Note: We use 192,000 barrels/day as the demand for gasoline.

### Table C4—Welfare Simulation—Gasoline Market

<table>
<thead>
<tr>
<th>Months</th>
<th>Price (actual) US$/barrel</th>
<th>Price (counterfactual) US$/barrel</th>
<th>Price change</th>
<th>Demand change</th>
<th>Welfare loss (1) monthly</th>
<th>Cons. surplus (2) counterfactual</th>
<th>Welfare loss (1)/(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994.01</td>
<td>78.2</td>
<td>78.2</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>14,076,556</td>
</tr>
<tr>
<td>1994.02</td>
<td>78.9</td>
<td>78.9</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>14,016,465</td>
</tr>
<tr>
<td>1994.03</td>
<td>79.5</td>
<td>79.5</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>13,955,894</td>
</tr>
<tr>
<td>1994.04</td>
<td>80.1</td>
<td>80.1</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>13,894,838</td>
</tr>
<tr>
<td>1994.05</td>
<td>80.8</td>
<td>80.8</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>13,833,294</td>
</tr>
<tr>
<td>1994.06 elec</td>
<td>79.2</td>
<td>81.4</td>
<td>−0.03</td>
<td>−0.015</td>
<td>189,093</td>
<td>3,288</td>
<td>13,988,386</td>
</tr>
<tr>
<td>1994.07 elec</td>
<td>77.6</td>
<td>82.1</td>
<td>−0.06</td>
<td>−0.031</td>
<td>186,102</td>
<td>13,260</td>
<td>14,140,376</td>
</tr>
<tr>
<td>1994.08 elec</td>
<td>76.0</td>
<td>82.7</td>
<td>−0.09</td>
<td>−0.047</td>
<td>183,026</td>
<td>30,083</td>
<td>14,289,326</td>
</tr>
<tr>
<td>1994.09 elec</td>
<td>74.5</td>
<td>83.4</td>
<td>−0.12</td>
<td>−0.063</td>
<td>179,862</td>
<td>53,933</td>
<td>14,435,297</td>
</tr>
<tr>
<td>1994.10 elec</td>
<td>73.0</td>
<td>84.1</td>
<td>−0.15</td>
<td>−0.080</td>
<td>176,608</td>
<td>84,996</td>
<td>14,578,349</td>
</tr>
<tr>
<td>1994.11 elec</td>
<td>71.6</td>
<td>84.7</td>
<td>−0.18</td>
<td>−0.098</td>
<td>173,261</td>
<td>123,463</td>
<td>14,718,540</td>
</tr>
<tr>
<td>1994.12</td>
<td>85.4</td>
<td>85.4</td>
<td>0</td>
<td>0</td>
<td>192,000</td>
<td>0</td>
<td>13,389,494</td>
</tr>
</tbody>
</table>

Note: We use 192,000 barrels/day as the demand for gasoline.

### Table C5—Welfare Simulation—Electricity Market

<table>
<thead>
<tr>
<th>Months</th>
<th>Price (actual) US$/MWh</th>
<th>Price (counterfactual) US$/MWh</th>
<th>Price change</th>
<th>Demand change</th>
<th>Welfare loss (1) monthly</th>
<th>Cons. surplus (2) counterfactual</th>
<th>Welfare loss (1)/(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994.01</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
<tr>
<td>1994.02</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
<tr>
<td>1994.03</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
<tr>
<td>1994.04</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
<tr>
<td>1994.05</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
<tr>
<td>1994.06 elec</td>
<td>62.2</td>
<td>63</td>
<td>0.01</td>
<td>0.00</td>
<td>18,334</td>
<td>30</td>
<td>1,604,182</td>
</tr>
<tr>
<td>1994.07 elec</td>
<td>61.5</td>
<td>63</td>
<td>0.02</td>
<td>−0.01</td>
<td>15,255</td>
<td>118</td>
<td>1,597,250</td>
</tr>
<tr>
<td>1994.08 elec</td>
<td>60.8</td>
<td>63</td>
<td>0.04</td>
<td>−0.01</td>
<td>17,147</td>
<td>266</td>
<td>1,590,234</td>
</tr>
<tr>
<td>1994.09 elec</td>
<td>60.0</td>
<td>63</td>
<td>0.05</td>
<td>−0.02</td>
<td>18,093</td>
<td>473</td>
<td>1,583,133</td>
</tr>
<tr>
<td>1994.10 elec</td>
<td>59.3</td>
<td>63</td>
<td>0.06</td>
<td>−0.02</td>
<td>18,011</td>
<td>740</td>
<td>1,575,946</td>
</tr>
<tr>
<td>1994.11 elec</td>
<td>58.6</td>
<td>63</td>
<td>0.08</td>
<td>−0.03</td>
<td>17,928</td>
<td>1,066</td>
<td>1,568,671</td>
</tr>
<tr>
<td>1994.12</td>
<td>63</td>
<td>63</td>
<td>0</td>
<td>0</td>
<td>18,412</td>
<td>0</td>
<td>1,611,030</td>
</tr>
</tbody>
</table>

Note: We use 18,412 MWh as the demand for electricity.

- Instead of estimating a demand function for each good, we use the mean price elasticities reported by Espey (1996), and Espey and Espey (2004): −0.35 for electricity and −0.53 for gasoline.
- The linear demand is of the form \( Q = a - bP \), where \( a \) and \( b \) refer to the intercept and the slope of the demand. We obtain these values using the price elasticity and the mean values of quantity and price.
- To start from a more stable base, we use the mean quantity of the first five (non-electoral) months of 1994 as the average monthly demand, which is 192,000 barrels/day and 18,412 MWh, for gasoline and electricity, respectively. The average price during these five months is used as the price of March (the mid-point of the first five months). The average monthly price changes reported in Table 1 is then used to obtain the simulated price series for 1994. The price cycle is shown in the second column. We call this price series the “actual” prices.

Recall that the average monthly price changes for the sample period are: real gasoline prices increase 0.8 percent in non-electoral months and decrease 2.0 percent in electoral months; electricity prices do not change in real terms in non-electoral months and decrease 1.2 percent in electoral months.
In the third column, we compute the prices that would prevail if there was no election (counterfactual prices). The difference in counterfactual and “actual” prices is used to compute the price change, which multiplied by the price-elasticity yields the percentage change in the quantity demanded. Using this percentage change and the actual (average) quantity demanded, we compute the counterfactual demand, which allows us to compute the area of the triangle that represents the welfare loss.

REFERENCES


