

# Infrastructure Development and Regulatory Rents: The Brazilian Experience

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**How to cite this paper:** Savoia, J. R. F., Peris Wolf, R. W., Contani, E. A. R., & Carvalho, A. C. (2024). Infrastructure Development and Regulatory Rents: The Brazilian Experience. *Beijing Law Review*, 15, 1836-1859.

<https://doi.org/10.4236/blr.2024.153104>

**Received:** June 19, 2024

**Accepted:** September 27, 2024

**Published:** September 30, 2024

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## Abstract

This study analyzes the development of regulatory agencies in Brazil after the privatization process. The focus is on the government's intervention in the electricity sector by means of Provisional Measure 579/2012, which established rules to benefit consumers but also reduce concessionaires' revenues. We used a sample of 22 companies to compare the returns and risks before and after the implementation of the Provisional Measure. The results indicate an increase in systematic risk in the electricity sector and increased equity costs in other infrastructure sectors, showing evidence of contagion on related industries, suggesting that regulatory measures affected the opportunity cost of investments and reduced foreign investments. Consequently, preventing new effects will raise different perceptions of commitment to the rule of law and regulatory stability.

## Keywords

Regulatory Agencies, Regulatory Risk, Electricity Brazilian Sector

## 1. Introduction

Brazil began the process of privatizing state-owned companies in the late 1970s. However, it was in the 1990s that privatization measures increased their importance, and it was a central aspect of the country's economic policy. This shift was driven by two key factors: the need for economic stabilization and the imperative to attract and expand investment. According to [Pinheiro \(2000\)](#), these goals underscored the increased importance and scale of privatization during

this period. The Brazilian government aimed to reduce its fiscal burden, improve efficiency, and stimulate private sector involvement in the economy reducing the share of the public sector. As a result, numerous state-owned enterprises were sold off, leading to substantial changes in the country's economic landscape.

Examining the state's role in infrastructure, we observe changes in public and private agents' practices, enabling regulatory activities. For example, [Jamasb & Pollitt \(2000\)](#) mentioned that governments intend to change the institutional framework, organization, and operating environment of the utility sector to improve efficiency. Additionally, the evolution of regulation theory and practices, led by the UK in the 1980s, inspired many reforms worldwide in the following decades ([Lee & Usman, 2018](#)).

Supranational institutions, such as the International Monetary Fund and World Bank, have played an essential role in promoting infrastructure development in developing countries to stimulate catch-up with international benchmarks ([International Monetary Fund, 2002](#); [Zagha & Nankani, 2005](#)).

In addition, these institutions have produced a wealth of technical literature and provided training and technical assistance to government officials and policymakers to promote best practices and successful experiences worldwide. In particular, they have emphasized the importance of private sector participation in infrastructure development and the need for effective regulatory frameworks ([Jamali, 2004](#)) to ensure competition and promote efficiency.

However, the role of institutions' environment, culture, the state's strength, and the quality of bureaucracy may produce different outputs than those observed in developed countries ([Estache & Wren-Lewis, 2009](#)). These factors can shape the way regulatory agencies function and the outcomes they produce, potentially leading to different results compared to those of the first group. In this regard, [Laffont \(2005\)](#) compares developing countries with economies presenting missing markets and, in response, produces incomplete contracts due to bounded rationality or institutional weakness.

The development of regulatory agencies in Brazil started in the 1990s and reflects the aim of a broader trend in the global infrastructure sector, where governments seek to introduce market mechanisms and increase private participation. According to some relevant studies in this field, [Amann et al. \(2016\)](#), [Navarro Ortega and Neves \(2021\)](#), [Tolmasquim et al. \(2021\)](#), [Botelho et al. \(2022\)](#), the main objectives were:

- 1) Ensure Regulation and Supervision of Privatized Sectors—with the privatization of several state-owned companies, mainly in telecommunications, electricity, transportation and sanitation, it was necessary to create agencies that could regulate and supervise these markets to ensure that they operated efficiently and fairly;
- 2) Protecting Consumers—regulatory agencies were created to protect the interests of consumers by ensuring that the services provided by the new companies were of high quality and that prices were fair. They also set service stand-

ards and monitor compliance with these standards over time;

3) Promote competition—in sectors where privatization could lead to the formation of natural monopolies or oligopolies. This occurred by implementing antitrust policies and creating a regulatory environment that encouraged new competitors to enter the market.

4) Attracting Investment—creating a stable and predictable regulatory environment was essential for attracting both domestic and foreign investment. Regulatory agencies provided legal certainty and assurances that the rules of the game would be clear and stable, which was crucial to encouraging long-term investment in infrastructure sectors.

5) Improving the Efficiency and Transparency of Services—agencies helped to prevent abuses and ensure that companies operated in a transparent and efficient manner; and

6) Decentralizing and Depoliticizing the Management of Public Services—the creation of independent regulatory agencies was a key strategy in this effort, agencies aimed to reduce political influence on regulatory decision-making. This approach ensured that decisions were made based on technical and economic criteria rather than political considerations, reducing political influence on regulatory decision-making.

Historically, the emergence of regulatory agencies began with the creation of the National Agency of Energy and Electricity (ANEEL) under Law no. 9427/1996. The original proposal submitted by the executive did not include decision-making autonomy<sup>1</sup> or the necessary structure and procedures that characterize regulatory agencies. However, Congress sought alternatives based on international experience, which forced the executive to incorporate innovative ideas into the project (da Rocha et al., 2023).

Binenbojm (2005) stated that attracting investments and producing a development path was the objective, so regulatory commitment was essential. Similarly, Bresser-Pereira (1997) stated that the main objective was to restore the state's capacity to promote development.

At the same time, political interference in regulatory decisions became chronic in the 2000s, leading to numerous attempts by regulatory agencies to improve their independence and powers. For example, Magill (2011) reports that while the Brazilian President has limited authority to initiate agency action or change its agenda, they can seek to influence agency decisions through appointments and supervisory constraints.

In our study, we identified a case in which political intervention in the Brazilian electricity sector due to the edition of the Provisional Measure (PM no. 579/2012) was converted into law in 2013. Employing straight orders from the

<sup>1</sup>The Brazilian Federal Constitution has no provision regarding the independence of the agencies. The only mention of a regulatory body appears in article 21, XI, for the telecommunication sector and art. 177, §2°, III, to the oil and gas sector. Therefore, only laws set forth the independence of regulatory agencies are legally considered “special autarchies.” Consequently, only the General Law of Agencies (Federal Law n. 13.848, 2019) prevails regarding its operational and administrative independence from the federal government.

Civil House, the regulator adopted arbitrary measures to reduce tariffs by 50% of their original value with the argument of “reducing inflation.” In addition, the executive power pressured companies to adhere to the measure under the penalty of not renewing the concession contracts as soon as they expired.

Consequently, the tariff rose 20% above inflation, and consumers paid the cost. According to the ANEEL, from 2013 to 2018, after the effects of MP 579, there was an actual tariff increase of approximately 20.4%. As a result, the average value increased from R\$430 per megawatt-hour (MWh) in 2012 to R\$518 per MWh in 2018<sup>2</sup>.

Therefore, the PM was a watershed in the electricity sector. It gave rise to Law 12,783/2013, which renewed the concessions for hydroelectric plants and, since then, has caused an increase in expenses of R\$ 198.4 billion in the sector according to ANEEL (National Electricity Sector Agency) calculations. Additionally, the executive launched a strategy to reduce consumers’ prices in the official vision, but with limits, to avoid shocks and negative externalities.

PM 579 deregulated the electricity sector, changing the previous arrangement and significantly impacting systematic risk levels in infrastructure firms. Consequently, financial costs increased, and investors’ returns decreased (De Castro et al., 2013; Taffarel, da Silva and Clemente, 2013; Assunção et al., 2015; Taffarel et al., 2015), initiating a contagion phenomenon in other infrastructure sectors.

In this context, our research has two principal objectives: 1) to analyze the emergence of regulatory agencies and the Brazilian infrastructure sector’s regulatory apparatus in the electricity subsector and 2) to analyze the development of this regulation in an emerging economy that may suffer government intervention, with the case of PM 579, providing a link between theory and practice.

This article comprises five sections, including this introduction. Section 2 discusses the evolution of regulatory agencies in Brazil. Section 3 discusses the methods used in the study, our results, and the analyses of systematic risk and stock returns derived from PM 579. Finally, Section 4 discusses the results and the consequences of the previous measure and presents conclusions and suggestions for future research.

## 2. The Development of Regulatory Agencies in Brazilian Infrastructures

Regulatory reforms in Brazil aimed to resume investments, which the state could no longer make, and the need to isolate agencies from the Ministries’ bureaucracy, encouraging them to become independent. However, the model adopted replaced the influence of the ministries’ bureaucracy with the direct power of the executive.

Hirschman’s (1958) theory highlights the importance of investment capacity

<sup>2</sup>The main items that caused this cost increase were, according to ABDIB (2019), 1) hydrological risk (R\$ 44.6 billion); 2) loans to the CDE (R\$ 45.5 billion); 3) indemnities to generators and transmission companies (R\$ 18 billion); 4) bonuses to quota plants (R\$ 7 billion), and 5) the failure to hold a new energy auction in 2014 (R\$ 14.6 billion).

or ability, rather than simply the scarcity of savings, as the main obstacle to economic growth in developing countries. He argued that investment in public infrastructure is crucial for private capital accumulation and creating a virtuous cycle of economic growth. Infrastructure, such as roads, bridges, ports, power, and communications systems, provides the primary conditions for the sector to invest and grow.

Nevertheless, the infrastructure investment decision will be especially sensitive to a country's institutional environment due to its long-term horizon, sunk costs, economies of scale and scope, and the politically sensitive nature of service provision, as [Spiller and Savedoff \(1999\)](#) mentioned. In this way, the attractiveness may be reduced, and the public sector will be the only provider.

In Brazil, infrastructure investment has been cyclical for decades, with the public or private sector leading the process ([Baer, Kerstenetzky, & Villela, 1973](#); [Baer & McDonald, 1998](#)). The pattern in the electric sector is similar, as [Baer and McDonald \(1998\)](#) stated: "Prior to the 1960s, electric utilities were in private hands, but were gradually nationalized in the 1960s. By the 1970s, the state had taken over the sector, with massive investments made to expand generation capacity."

With the advent of privatization in the middle of the 1980s, there was a steady increase in Brazilian business owners' investment and later in international groups attracted by the vast range of opportunities in the local market. From 1990 to 2021, Brazil underwent critical regulatory changes, some of which became cornerstone marks for infrastructure recovery.

The first movements around privatization in the Brazilian electricity market occurred during the President Figueiredo administration (1979-1985) due to the growing questioning of promoting the necessary investments in an environment of fiscal constraints that blocked the infrastructure sector's expansion of services.

Subsequently, under President Sarney's administration (1985-1990), pro-market measures expanded, strongly impacted by international experiences of privatization in developed countries during the 1980s, combined with budgetary constraints that the government experienced in maintaining state-owned companies' apparatus after the hyperinflationary crisis. However, the Brazilian Social and Economic Development Bank (BNDES) was their primary funding source. As a result, many reported continuous losses, affecting the banks' figures and reducing the ability to finance new ventures ([Fishlow, 2011](#)).

In 1985, the executive created an interministerial privatization council, which specified the agenda of state-owned companies going into the privatization process. As a result, 38 companies succeeded in this objective. [Velasco Junior \(1999\)](#) reported that during the 1990 presidential campaign, privatization became one of the most emphasized points by the presidential candidate Fernando Collor. Once elected, he quickly promoted the privatization of companies such as Usiminas, the largest steel producer at the time.

In April 1990, the Brazilian Congress approved Law No. 8.031, which insti-

tuted the National Privatization Programme (PND), comprising strategic sectors such as steel plants, petrochemicals, and fertilizer companies.

Over the 1990s, the advent of the Reform of the State Constitutional amendments transferred public services to private companies, formerly a specific prerogative of the public sector. Between 1990 and 1994, the federal government privatized 33 companies. Additionally, there were eight auctions of minority interests under Decree No. 1068/1994. The objective was to rearrange the government's political position in the economy, transferring the management of inefficient state-owned companies to private capital. This measure considered that sales proceeds could reduce Brazilian public debt. Moreover, it avoided monopolies' reemergence, with an explicit mention in Law no. 8031 (1990) of the existence of an industrial and commercial policy, ensuring competitive operating conditions.

However, as mentioned by [Montes & Reis \(2011: p. 172\)](#), after 1998, there was a significant decrease in public sector investments, mainly affecting infrastructure, which fell to deficient levels, slightly above 1% of GDP, in the early years of this decade.

According to [Pacheco \(2006\)](#), the constitution of independent regulatory agencies promoted the debate about government (or more or less politics) and bureaucracy (and bureaucratic controls). [Justen Filho \(2006\)](#) reports that the model made it possible to escape the rigidity of the bureaucratic model, which was part of the Brazilian Constitution of 1988.

In addition, the creation of regulatory agencies endowed with a high degree of autonomy served the greater purpose of disrupting the so-called bureaucratic rings existing in the Ministries, which permeated the privatization process from the beginning and became even more evident anachronistic compared to regulatory practices in developed countries.

The evolution of the Brazilian regulatory process sought to isolate agencies from traditional patrimonialism in politics and reduce conflicts generated by political dynamics. Thus, the primary regulatory methods involved controlling companies' entry into and exit from the market, establishing pricing policies, and promoting competition, performance comparison, and verticalization.

Also, regulators have tried to explore different options to maintain a stable legal environment; nevertheless, administrative measures' judicialization has increased over the years ([Carvalho & Izaias, 2010](#)), as in other Latin American countries ([Guasch, 2004](#)).

The expression "regulatory body" appeared in the Brazilian Constitution with some constitutional amendments in the 1990s and inspired the creation of federal agencies and, later, state and municipal agencies.

We emphasize President Cardoso's role in influencing a coalition-building process among politicians, bureaucrats, and the Brazilian elites to forge the separation between the Ministries staff and the Regulatory Agencies, as [Schneider \(2004\)](#) mentioned, in a "reorganization of modern bureaucracy and a new divi-

sion of power between politicians and bureaucrats within the modern administrative state” (Jordana, Levi-Faur, & Marín, 2011: p. 1344). As stated by Mueller and Pereira (2020: p. 454):

“To get an idea of the executive’s dominance, especially related to regulation, all five regulatory agencies that have been created thus far by the Brazilian Congress have been done so through bills initiated by the executive, which were approved by unanimity in both houses”.

The first characteristic distinguishing Brazil from other countries was that President Cardoso’s actions created regulatory agencies with some degree of independence but kept them under the patronage of executive power (Prado, 2012). Therefore, the executive branch coordinates the Brazilian regulatory system instead of Congress. In this context, a critical question is whether it can avoid potential executive action interfering with the risk of the regulated sector’s rights and investments (Correa et al., 2019). The chief of government mainly appoints the board of directors, and, historically, meritocracy mechanisms are not the most relevant ones in these selections (Figueiroa & Carvalho, 2018).

Their inception aimed to be independent of the ministries’ influence. However, the influence of the executive prevailed, as it created an indirect subordination of the civil house (the presidential cabinet) in a hybrid model. Therefore, it did not remove the executive’s ability to influence, it was not de facto independent, and the long arms of the executive prevailed as an operational way to achieve political objectives, despite affecting credibility (Mueller & Pereira, 2020: p. 449).

These administrative guidelines and efforts to strengthen regulatory agencies helped to improve several infrastructure sectors, which led to the creation of eleven federal regulatory agencies and dozens at the state and municipal levels over the following years.

In the 2000s, hybrid models emerged to exploit these assets through PPPs, keeping them with their public nature. Then, in 2007, at the beginning of President Lula’s second term, the Growth Acceleration Program came (in two phases), comprising the Logistic Investment Program in 2012 and the Partnerships and Investments Program in 2016. All of them were strategies using public funds to foster infrastructure investments. These measures were essential for the continuity of infrastructure expansion, but their results were insufficient to launch a “new development cycle” for institutional and economic reasons.

So, the background of privatization process in Brazil outlined the following context:

Origins and Early Moves (1979-1990):

President Figueiredo Administration (1979-1985): Initial discussions around privatization due to fiscal constraints hindering infrastructure development in the country.

President Sarney Administration (1985-1990): Expansion of pro-market

measures influenced by global privatization trends. Brazilian Social and Economic Development Bank (BNDES) played a crucial role.

Formalization and Expansion (1985-1994):

Creation of Interministerial Privatization Council (Decree n. 91.991/1985): Established to set the agenda for privatization of state-owned enterprises, leading to successful privatization of 38 companies.

Law No. 8.031 (1990): Instituted the National Privatization Program (PND), targeting strategic sectors like steel and petrochemicals.

Constitutional Amendments (1990s): Transferred public services to private entities, reducing the public sector's role.

Implementation and Impact (1990s):

Privatization Execution (1990-1994): Significant privatization efforts by auctioning off majority and minority shares in various companies to reduce public debt and enhance competitiveness.

Regulatory Mark (1990s): Introduction of independent regulatory agencies to oversee privatized sectors and ensure competitive market conditions. Among them, ANEEL was created.

Regulatory Evolution and Challenges (2000s):

Creation of Regulatory Agencies: Presidential initiatives led to the establishment of federal regulatory bodies with varying degrees of autonomy, aiming to reduce bureaucratic interference.

Hybrid Models and PPPs (2000s): Emergence of public-private partnerships (PPPs) to maintain public control while leveraging private investment in infrastructure.

Continued Efforts (2000s-2010s):

Growth Acceleration Programs: Initiatives aimed at stimulating infrastructure investment through public funding and partnerships.

Current Challenges and Future Directions:

Operational Efficiency vs. Political Influence: Ongoing challenges include balancing regulatory autonomy with political oversight, impacting credibility and operational effectiveness.

Infrastructure Development: Efforts continue to address infrastructure gaps and foster economic growth through improved regulatory frameworks and strategic investments.

This outline summarizes the privatization process in Brazil, highlighting key milestones, legislative actions, and the evolving role of regulatory agencies in managing privatized sectors.

### **3. The Case of Provisional Measure No. 579/2012: A General View**

According to the case study showing a particular topic of regulatory intervention in the Brazilian electricity market, we propose the following research hypothesis.

*Research Hypothesis. As there is no de facto independence for regulators, po-*

*litical intervention involves regulatory risk.*

Economic and social growth and development align with investments that promote structural changes to support economic activities and demand. In this sense, public policies play a crucial role since the state is an entity that makes direct investments, acts as a regulator, and promotes an activity's concession. In addition, public policies must produce positive externalities for the sector and society (Vargas & Scatolin, 2011; Carvalho, 2014).

Since privatization, the Brazilian electricity sector has undergone restructuring to render it more competitive, reduce the state's participation, and redesign the administrative configuration of energy generation, transmission, sale, and distribution to improve the sector participants' economic autonomy. Like the other infrastructure sectors in Brazil, the electricity sector is subject to regulatory policy pressures that impact corporate results and market risk.

However, as Turolla (2019) affirms, the sector's problems are currently minor from ANEEL and more from the executive and legislative powers due to frequent changes in the rules. Previous advances have arisen with the use of market signals and robust regulation. In contrast, significant threats to the country's position came precisely with government initiatives that defied market signals and fair regulation.

The systematic risk in the electricity sector arises primarily from regulatory policy pressures and the frequent changes implemented by the executive and legislative branches. This instability can undermine investor confidence and disrupt the economic autonomy of the sector. The privatization efforts aimed at increasing competitiveness and reducing state involvement have faced challenges due to inconsistent policy decisions.

Effective public policies are essential for fostering a stable and predictable regulatory environment, which can produce positive externalities and support sustainable growth. Balancing market signals with robust regulation is crucial to mitigate risks and ensure the sector's long-term stability and efficiency.

Promoting competitiveness in the Brazilian electricity sector involves several key elements aimed at fostering efficiency, innovation, and fair market practices, that are: 1) market liberalization and competition, allowing multiple players (generators, retailers) to operate in the market; 2) encouraging private sector participation through privatization and public-private partnerships (PPPs); 3) regulatory framework and independent agencies, to oversee the sector impartially; 4) implementing transparent rules and regulations to ensure fair market practices and protect consumer interests; 5) setting clear guidelines for market entry, operation, pricing, and quality of service; 6) Infrastructure development with investments in infrastructure improvements, including transmission and distribution networks, to enhance reliability and efficiency; 7) facilitating grid expansion to reach underserved areas and integrate renewable energy sources; 8) energy efficiency and demand-side management, promoting energy efficiency programs and initiatives to reduce overall electricity consumption.

Moreover, 9) use technological innovation and integration of renewables, 10) practice transparent pricing and cost recovery mechanisms; 11) learning from international best practices and experiences in electricity market regulation and competition, collaborating with international organizations and entities to adopt standards and guidelines that enhance competitiveness; 12) policy stability and long-term planning.

By focusing on these elements, Brazil can enhance competitiveness in its electricity sector, leading to improved service quality, lower costs, increased investment, and sustainable development.

The most extreme interventions occurred during the administration of Dilma Rousseff, and these interventions may interfere with independent regulators. First, the executive issued two decrees authorizing the minister of transportation to appoint and dismiss a temporary (interim) board member of the Land Transport Agency (ANTT) and the Waterway Transportation Agency (ANTAQ) without prior consultation or authorization from the Senate. However, the second and most exacerbated measure was entirely disruptive, with PM 579, which established a new regulatory framework for the electricity sector (Correa et al., 2019).

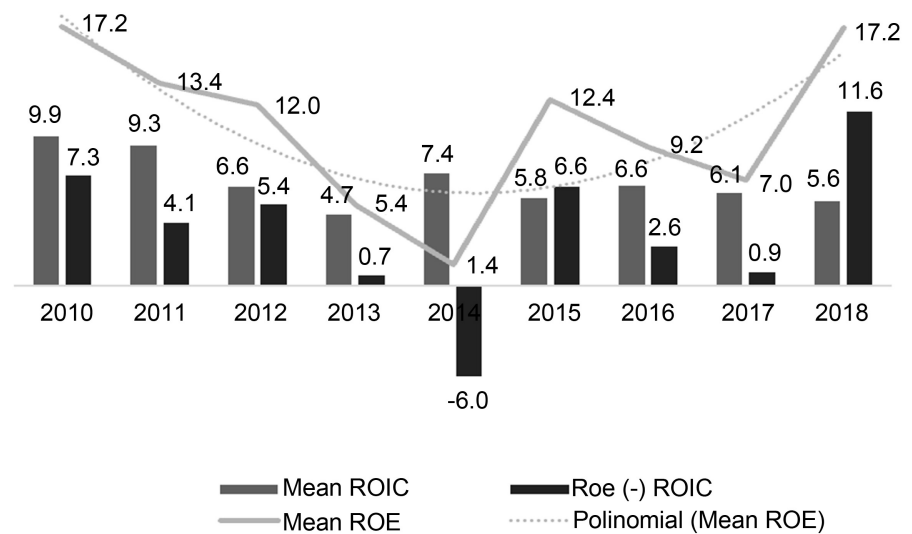
It reduced the final cost of energy and sectoral charges and promoted equitable tariffs, directly impacting the revenues and cost structures of the concessionaires. Revenue from electric energy activities started to be determined by the tariff calculated by ANEEL. Despite the consolidated technical staff in the regulatory agency, their efforts were insufficient to dismiss the government officials' strategy. One possible explanation comes from Ennsner-Jedenastik's (2016: p. 1) research, which affirms that "e granting formal independence to an agency may erect some institutional barriers to political interference, it also generates a strong incentive to appoint ideologically like-minded individuals to the agency leadership."

Concerning the renewal of concessions, companies that complied with PM 579 would forestall contract maturity and be condition operators and maintainers of the plants. Therefore, in terms of financing the activities, they would receive revenues from the tariff.

On the other hand, the companies that previously held the assets would revert their ownership to the federal government and act as service providers, eliminating electricity sales. To provide a clearer picture, the price charged per MWh was BRL 95.00, which fell to BRL 30.00 on November 9, 2020. ANEEL performed operation and maintenance calculations based on a methodology similar to distributors, a parameter for establishing ceiling prices for energy and transmission auctions (De Castro et al., 2013).

In effect, the entry into force of PM 579 produced immediate results on the residential tariffs approved by ANEEL, which had an average reduction of 15.8% in the first year, considering the size of the markets of each concessionaire (Figure 1). However, a second-order effect increases average tariffs above inflation three years after PM 579.

Compensation for these assets was proposed to the concessionaires, representing a reversal of public assets: they were primarily amortized and depreciated.



**Figure 1.** Mean return on capital (%) for selected energy companies. Note. ROIC = Return on invested capital, ROE = Return on equity. Equity is more permanent than invested capital, which changes more over time. ROIC indicates potential sources of sustainable competitive advantages and whether the company maintains sustainable growth, commonly given by the market as the difference between ROIC and ROE (or eventually the WACC). Source: ANEEL (2022).

For this reason, the objective was to relieve the burden on consumers by reducing energy tariffs. The government would thus compensate for unamortized investments, and companies could renew their concessions for up to thirty years (Souza & Hollanda, 2014).

Companies could comply with PM 579, contingent on accepting this new restructuring sector. The companies that did not comply were the Energy Company of São Paulo (CESP), the Energy Company of Minas Gerais (CEMIG), and the Energy Company of Paraná (COPEL). Their decision affected the speed and size of PM 579's effect on tariffs because these companies represented many concession contracts.

The growth and gradual decline in capital returns are represented in Figure 1. The years 2013 and 2014 had the minimum return on capital throughout the series for the mean ROE of distribution companies.

In 2014, the only negative difference was between ROE and ROIC, indicating that the return on the new calculation basis for invested capital exceeded equity; that is, invested capital was reduced. Thus, the tariff policy evolution shows a rupture in the regulatory model during the ten years, gradually decreasing the concessionaries' capital return.

They have sought to evaluate the performance of companies in the electricity and infrastructure sector by conducting temporal analyses on the indicators from different empirical approaches and strategies, which yielded results that contribute to a better understanding of Brazilian regulatory risk and its implications. In particular, the results of the articles suggest that poor-quality institutional frameworks and inappropriate sectoral interventions can increase the risk

of regulated companies, making their investments more difficult.

### 3.1. Study Sample

Our study considers that the electricity sector confronted the risk of political intervention through government interference from PM 579/2012. Considering that 1) PM 579/2012 was enacted by the federal government without further questioning from ANEEL and 2) the PM was revoked four years after a series of regulatory mistakes, we assume that this case illustrates political intervention.

First, we identified the increase in electricity firms' risk by measuring systematic risk and average returns before and after PM 579. Eventually, other companies and sectors were also affected by contagion, but this objective is beyond our research.

The initial sample comprises 72 tickers from 40 firms listed on the Brazilian Stock Exchange (B3) between January 2010 and December 2019. We collected data from the Economatica database. The criteria adopted for the sample selection were 1) the most liquid share (thirty-two tickers excluded); 2) analysis of outliers by each company (ten exclusions); 3) companies that presented missing values of prices and betas in more than 30% of the days of the period (four exclusions); and 4) one exclusion of an outlier at the sample, the leading operator of the sector—Eletrobras.

The final sample comprises 22 companies that adhered to PM 579 and three that did not. The sample used in this study is small due to the reduced number of companies with daily trading liquidity on B3. Nevertheless, the sample represents the market, achieving 64% of total production.

We initially calculated the beta coefficients and the Sharpe returns. Next, we employed quarterly data to calculate beta averages. Then, we performed betas tests with one-year data. Finally, for both analyses, we compared values before and after PM 579, employing the hypothesis test of the difference of means in the Event Study. Section 3.2 presents the calculations, equations used, and results.

### 3.2. Systematic Risk (Beta) and the Impact on Returns

We assessed the returns in two periods: one before the publication of PM 579 and the other after implementing the measure. We calculated the beta coefficient because this obtains a systematic risk measure in finance lies, translating the risk associated with the stock into a value (Baule et al., 2016). In this study's context, each ticker's beta is an indicator that can capture the impact of regulatory risk after the publication of PM 579. The Beta ( $\beta$ ) formula is shown in Equation (1):

$$\beta = \frac{\text{Covariance of the asset's Return}}{\text{Variance of the market return}} \quad (1)$$

where the covariance of the asset's return is given by Equation (2):

$$Cov_{xy} = \frac{\sum_{i=1}^N (x_i - \bar{x})(y_i - \bar{y})}{N - 1} \quad (2)$$

where  $Cov_{xy}$  is the covariance between the asset and the benchmark (Ibovespa is the primary Brazilian stock indicator);  $x_i, y_i$  is the return on asset  $x$  and benchmark  $y$  at moment  $i$  and  $\underline{x}, \underline{y}$  is the mean return on asset  $x$  and benchmark  $y$ .

The variance, in turn, is calculated according to Equation (3):

$$\sigma^2 = \frac{\sum_{i=1}^N (y_i - \underline{y})^2}{N - 1} \tag{3}$$

where  $\sigma^2$  is the variance of the market return;  $y_i$  is the market return at moment  $i$  and  $\underline{y}$  is the expected return or mean market return.

**Table 1** illustrates selected companies' quarterly one-year beta behavior based on daily ticker prices.

**Table 1.** Consolidation: Average 1y beta descriptive data. Source: Research data.

Company	Ticker	id	Av. Beta 2010-2012 (Before)	Av. Beta 2y after MP	Av. Beta 3y after MP	Av. Beta 4y after MP	Av. Beta 5y after MP	Av. Beta 6y after MP	Av. Beta 7y after MP
Ampla Energia	CBEE3	1	0.81	0.03	0.04	0.39	0.40	0.44	0.77
Ceb	CEBR3	2	0.72	0.21	0.21	0.40	0.35	0.33	0.33
Ceee-D	CEED3	3	1.00	-0.06	0.78	0.85	0.80	0.93	0.53
Celesc	CLSC4	4	0.43	-0.47	-0.04	0.29	0.31	0.28	1.13
Celpe	CEPE5	5	0.02	0.91	1.10	0.53	0.28	0.25	0.27
Cemig	CMIG4	6	0.47	-0.06	0.46	1.00	1.21	1.19	1.75
Cesp	CESP6	7	0.51	-0.04	0.12	0.60	0.96	0.87	1.05
Coelba	CEEB3	8	0.02	-0.01	0.07	0.02	-0.02	0.00	-0.18
Coelce	COCE5	9	0.32	0.19	0.24	0.31	0.36	0.39	0.33
Copel	CPLE6	10	0.52	0.51	0.28	0.60	0.95	0.99	1.21
Cosern	CSRN3	11	0.22	1.22	1.34	0.97	0.73	0.60	0.23
CPFL Energia	CPFE3	12	0.22	0.21	0.49	0.73	0.69	0.75	0.88
Elektro	EKTR4	13	0.42	0.29	1.01	0.77	0.58	0.49	0.38
Energias BR	ENBR3	14	0.12	0.86	0.94	0.72	0.62	0.49	0.54
Energisa	ENGI11	15	0.33	0.22	0.29	0.29	0.43	0.53	0.56
Energisa Mt	ENMT4	16	-0.69	0.48	0.55	0.86	1.54	1.54	1.20
Eneva	ENEV3	17	1.42	1.16	1.28	1.20	1.31	1.20	0.98
Engie Brasil	EGIE3	18	0.37	-0.05	-0.04	0.06	0.16	0.27	0.64
Eqtl Maranhao	EQMA3B	19	0.81	-0.20	0.14	-0.08	-0.39	-0.35	-0.64
Equatorial	EQTL3	20	0.16	1.04	0.83	0.73	0.65	0.72	0.79
Light S/A	LIGT3	21	0.64	1.71	1.89	1.71	1.44	1.20	1.66
Rede Energia	REDE3	22	-0.91	5.62	3.89	3.33	2.78	2.47	2.23
Renova	RNEW11	23	1.53	0.11	0.38	-0.45	-0.62	-0.44	0.11
Taesa	TAAE11	24	1.08	0.24	0.34	0.51	0.52	0.50	0.58
Tran Paulist	TRPL4	25	0.37	0.34	0.02	-0.08	-0.07	-0.01	0.04

Note. **Table 1** illustrates the evolution of the one-year betas of the 25 stocks selected in the sample, based on daily ticker prices calculated quarterly, by the average of the respective periods between January 2010 and December 2019, one before PM 579 and six afterward. The fourth column shows the initial average beta (2010-2012). In the six subsequent columns, we show the impact of beta results. We aim to present a perspective on the regulatory change in 25 energy concessionaires' systematic risk. Av. means average. Source: Research data.

Two years after PM 579, six concessionaires experienced intense increases in systematic risk in the short term. However, **Table 2** shows that fourteen concessionaires increased these risks seven years later, suggesting that the systematic risk effect takes ground even in the long run. We expected that companies that adhered to PM 579 would significantly increase their beta, and in the following years, it would remain at a high level. However, some companies have had diffuse risk performance, making the conclusions less evident.

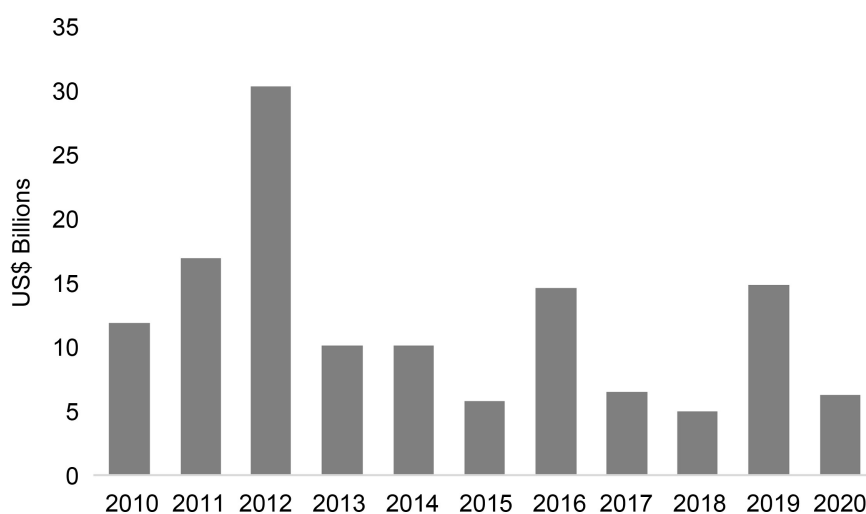
In addition, negative betas and extreme values demonstrate that other factors should influence their results. For this reason, when performing the event study, we excluded observations with negative betas and companies that did not adhere to the regulatory change.

This crisis had a contagious effect on other sectors. Since most infrastructure companies in Brazil are engaged in many sectors in addition to electricity (such as transportation and public utilities), many sectors outside the electricity sector suffer the effects of PM 579. One of the consequences was instability in new long-term investments: new bids had no new competitors over time.

According to data provided by ANEEL, after the period of the repercussions of the PM, there was a reduction in proposals in energy auctions. As a result, the percentage of empty lots ranged from 17% in 2012 to 39% in 2013, 46% in 2014, 63% in 2015, and 42% in 2016, with a return to initial levels only after 2017 (10% of lots without proposals). In addition, 18% of the proposals that were made implied average negative goodwill in 2012, 21% in 2013, and 11% in 2014 and 2015.

Another impact that the sector experienced was the reduction of investments. For example, the FDI database for the energy sector produced by the World Bank showed a reduction from 30 billion dollars to 10 billion dollars in 2013 (**Figure 2**), the year in which the MP became Law 12,873/2013.

The Brazilian Association of Infrastructure and Basic Industries (ABDIB) estimated an impact of more than R\$ 200 billion (approximately US\$ 37 billion)



**Figure 2.** Foreign direct investment (FDI) in the electricity sector is reported in billions of dollars. Source: [World Bank \(2022\)](#).

(ABDIB, 2019). In 2016, PM 735 (converted into Federal Law n. 13,360) attempted to reduce the impact of regulatory risk, but it was unsuccessful in this task. However, Law 13,360 of 2016 alleviated some of the effects on Eletrobras since the company was released from the obligation to distribute energy (ABRAPCH, 2016).

The return is the most straightforward performance indicator and perhaps the most frequently used practice. However, it can be calculated differently, considering daily, weekly, or monthly frequencies. For example, a stock investment's rate of return over the maintenance period is shown in Equation (4):

$$R_t = \frac{P_t - P_{t-1}}{P_{t-1}} \quad (4)$$

where  $P_t$  represents the stock's final price and  $P_{t-1}$  corresponds to the stock's initial price.

**Table 2** illustrates 25 companies' annual returns based on daily prices. The annual returns in the initial period from 2010 to 2012 are shown in the fourth column. The remaining columns show the average annual returns for each company to establish a long-term view.

Remarkably, companies' behavior after PM 579 is not linear: some had negative annual returns, others lively but under the previous level, and others had slightly positive and better returns than in the previous period. Moreover, studies have shown that regulatory change has influenced returns, even in the long run (De Castro et al., 2013; Assunção et al., 2015).

We performed a t test for the means of returns to highlight the difference between the periods, finding significant results in the first three years after PM 579. Thus, it can be concluded that the null hypothesis was rejected. The means of the returns of actions before and after are significantly different. There was no significant difference between betas before and after the PM 579th edition.

From the sample used to calculate the number of betas with 22 shares, we performed an event study to verify whether there was a difference in the systematic risk from the edition of MP 579. For this, we removed the companies that did not adhere to the measure: CESP, COPEL, and CEMIG.

Later, we excluded negative betas, which could influence the results. Next, we organize the base in the format of a time series. Finally, we performed the Shapiro-Wilk normality test (result:  $\text{prob} > z = 0.02060$ ), indicating that the sample was not obtained from a population with a normal distribution.

For this reason, we applied the nonparametric Mann-Whitney test, which revealed a probability of less than 5% of the medians being equal, rejecting the null hypothesis. These results indicate an evidence correlation between the systematic risks measured by betas before and after editing the measure. Moreover, the risk was greater after its edition. **Table 3** presents this ratio.

In conclusion, this affected the return, investment, and foreign capital. There was an increase in risk, despite other factors, as highlighted by ABDIB (2019): the tariff increased above inflation by 20.4%; the main elements that drove the

**Table 2.** Consolidation: Average annual return descriptive data.

Company	Ticker	id	Av. Return 2010-2012 (Before)	Av. Return 2y after	Av. Return 3y after	Av. Return 4y after	Av. Return 5y after	Av. Return 6y after	Av. Return 7y after
Ampla Energ	CBEE3	1	-0.06	-0.03	-0.08	-0.02	-0.06	-0.05	-0.08
Ceb	CEBR3	2	-0.23	0.04	0.01	0.20	0.12	0.12	0.22
Ceee-D	CEED3	3	-0.22	-0.36	-0.36	-0.21	-0.17	-0.11	0.04
Celesc	CLSC4	4	-0.04	-0.22	-0.20	-0.03	0.08	0.19	0.17
Celpe	CEPE5	5	-0.19	-0.18	0.09	0.00	-0.02	0.02	0.08
Cemig	CMIG4	6	0.13	0.07	-0.18	-0.06	-0.06	0.08	0.08
Cesp	CEPE6	7	-0.05	0.26	0.00	0.01	0.01	0.09	0.15
Coelba	CEEB3	8	0.17	-0.20	-0.12	-0.10	-0.07	-0.04	0.04
Coelce	COCE5	9	0.25	-0.02	-0.04	0.06	0.08	0.04	0.08
Copel	CPLE6	10	-0.04	0.13	-0.04	0.01	0.01	0.05	0.18
Cosern	CSRN3	11	0.09	-0.01	0.10	0.22	0.24	0.19	0.19
CPFL Energia	CPFE3	12	0.11	-0.04	-0.09	0.07	0.01	0.08	0.10
Elektro	EKTR4	13	0.17	-0.23	0.05	0.04	0.08	0.03	0.08
Energias BR	ENBR3	14	0.10	-0.10	0.03	0.08	0.07	0.08	0.14
Energisa	ENGI11	15	0.12	0.10	0.10	0.16	0.22	0.25	0.28
Energisa Mt	ENMT4	16	0.06	-0.06	-0.02	0.14	0.19	0.20	0.26
Eneva	ENEV3	17	0.25	-0.81	-0.72	-0.63	-0.53	-0.46	-0.32
Engie Brasil	EGIE3	18	0.22	0.07	0.05	0.06	0.07	0.11	0.17
Eqtl Maranhao	EQMA3B	19	0.05	0.32	0.25	0.30	0.25	0.27	0.32
Equatorial	EQTL3	20	0.23	0.22	0.24	0.32	0.30	0.28	0.31
Light S/A	LIGT3	21	0.07	-0.06	-0.18	-0.01	-0.02	-0.01	0.04
Rede Energia	REDE3	22	-0.29	-0.29	-0.10	0.12	0.14	0.29	0.30
Renova	RNEW11	23	0.33	0.17	-0.02	-0.31	-0.25	-0.34	-0.36
Taesa	TAEE11	24	0.37	0.06	0.04	0.12	0.12	0.14	0.18
Tran Paulista	TRPL4	25	-0.06	0.17	0.17	0.23	0.20	0.21	0.23

Note. **Table 2** illustrates 25 companies' annual returns based on daily prices by the average of the respective periods between January 2010 and December 2019, one before the publication of PM 579 and six afterward. Av. means Average. Source: Research data.

**Table 3.** Mann-Whitney test results.

Two-sample Wilcoxon rank-sum (Mann-Whitney) test			
Time	Observations	Rank Sum	Expected
0	43	1629	2601.5
1	77	5631	4658.5
Combined	120	7260	7260

Note. Unadjusted variance: 33385.92. Adjustment for ties: -19.13. Adjusted variance: 33366.79. H0: Beta (time = 0) = Beta (time = 1).  $z = -5.324$ . Prob  $> |z| = 0.0000$ . Time zero: before the measure. Time one (1): after the measurement.

increase in this cost were “the hydrological risk (R\$ 44.6 billion); loans to the CDE (R\$ 45.5 billion); indemnities to generators and transmission companies (R\$ 18 billion); bonuses to quota plants (R\$ 7 billion); and the failure to hold a new energy auction in 2014 (R\$ 14.6 billion)”. Furthermore, there was an increase in the cost of electricity generation, reaching a post-PM increase of 14.25%.

This was also intensified as a result of water scarcity: “From 2013 onward, there was also a combination of the worst historical series of rains of all times, and the hydroelectric plants could not generate enough to fulfill their contracts”, and to conclude, from Law 12,783/13 (transformation of the PM into law), there was still a significant increase in tariff discounts, and there was an increase in the subsidy for incentivized sources.

This scenario worsened the sector’s financial situation, increasing risk and reducing returns for regulated companies, making foreign investors withdraw or even inhibiting the capital employed in one sector with so much intermittence and inconstancy, as highlighted throughout this paper.

### 3.3. Discussion

We present discussion about theoretical and practical implications about our results.

#### 3.3.1. Theoretical Implications

Brazil started the refoundation of the electricity sector in the 1990s: it created regulatory agencies and other entities, promoted legal bases for contracts, disciplined the regime of concessions in the sector, established the tariff structure, and created the first national public policies in favor of infrastructure sectors. The second stage occurred, especially after 2004, which aimed to correct the effects generated by the first stage and, consequently, advanced with more changes to improve tariff methodology, new consumer protection, and installed capacity expansion (Peris, 2021).

Rocha, Camacho, and Bragança (2007) conducted a study on the electricity distribution sector after privatization from 1998 to 2005. Their aim was to assess whether the return on invested capital was proportional to systematic risk. The authors found that the equity of return was negative until 2003, and only in 2005 did the sector begin to recover.

The study highlighted the need for significant investment in the sector to support its average annual growth rate of 3.7% for the next decade. In a postfact analysis, Barros et al. (2015) found that the introduction of a new regulatory mark had a negative and significant impact on the returns of companies in the electricity sector.

Other researchers, such as Ribeiro, Macedo, and Marques (2012), Curcino, Lemes, and Botinha (2014), Bragança (2015), De Bragança, Pessoa and Rocha (2015a, 2015b), Sampaio, Azevedo, and Azuagab (2018), and Filgueiras et al. (2019), have also explored the concept of risk in the electricity sector in Bra-

zil.

The articles “A New Governance Model for Independent Regulatory Agencies” by Rui Nunes, Sofia B. Nunes, and Guilhermina Rego, and “Regulatory Oversight for Better Regulatory Governance: The Role of the Federal Court of Accounts Following the Mining Dam Collapses in Brazil” by Rosinaldo Sampaio Lobato Junior, provide complementary perspectives on the importance of regulatory oversight and governance for infrastructure companies.

Nunes, Nunes, and Rego (2015) argue that accountability is essential to prevent the government or regulated entities from capturing regulators. They emphasize the value of public competitions for selecting regulators to enhance impartiality and technical competence.

Lobato Junior (2023) highlights the Tribunal de Contas da União’s (TCU) responsive supervision approach, which combines ex-ante risk prevention and ex-post audits and corrections, particularly in dam failures. This approach helped the TCU identify and correct deficiencies within the regulated entity.

Nunes, Nunes and Rego (2015) and Lobato Junior (2023) stress the importance of transparency, accountability, and technical capacity for regulatory agencies’ effectiveness. They propose robust accountability mechanisms and independent supervision to avoid regulatory capture, aligning with recommendations by Bovens, Goodin, and Schillemans (2014).

Additionally, O’Donnell (2004) highlights the need for both vertical (e.g., elections, media pressure) and horizontal (e.g., audits, checks and balances) accountability mechanisms. The TCU’s supervision, as discussed by Lobato Junior, exemplifies horizontal accountability through continuous and specialized oversight.

The integrated conclusion aligns with mainstream literature on regulatory governance and supervision, reaffirming the importance of accountability, responsive supervision, and strengthened institutional structures. These elements are essential for improving regulation in infrastructure companies, mitigating risks, and promoting regulatory efficiency and fairness.

### 3.3.2. Practical Implications

In this sense, the practical implications of the results of this study corroborate that due to the emergence of regulatory risks, the electricity sector lost its prominent position in the market as a stable sector with consistent returns and low volatility, which is typical of the performance of energy firms’ stocks. Moreover, PM 579 increased contagion’s market risk for electricity and other related sectors, suggesting that regulatory measures affected the opportunity cost of investments and reduced foreign investments. Consequently, preventing new effects will raise different perceptions of commitment to the rule of law and regulatory stability.

Establishing mechanisms to prevent government intervention enhances economic benefits to market players and society. In addition, transparency in remuneration and pricing for generators, transmitters, distributors, and consum-

ers will also lead to a search for new sector projects.

Ragazzo (2018) affirms that two measures related to Brazil's regulatory improvement are mandatory: effective central coordination among regulatory agencies and the spread of regulatory best practices. Both must coexist with technical independence in each sector, preventing the regulatory bodies' transformation into a closed system. A blend of technical and political perspectives is essential in regulatory agencies with independent members' appointments to the board. However, numerous situations defeat the theoretical logic endorsing this argument. Ennser-Jedenastik (2016: p. 509) mentioned that it is "less clear that de jure independence also leads to a greater degree of de facto independence."

Therefore, improving conditions and creating a direct link between the above conditions are essential. Better governance produces strong regulation, and regulators' formal independence positively and significantly impacts regulatory quality (Koop & Hanretty, 2018).

#### 4. Conclusion

Brazilian infrastructure has developed based on alternative cycles of predominance, sometimes by the public and private sectors. First, with the advent of privatization, there was a steady increase in Brazilian business owners' investment and later in international groups attracted by the vast range of opportunities in the local market.

Experience with independent regulatory agencies started in the nineties and is more recent in Brazil than in developed countries. First, it started reorganizing the national bureaucracy through different transmission channels, following a usual pattern in emerging economies. After that, however, a substantial evolution occurred, reorganizing the infrastructure, attracting new entrants, and providing better consumer services, although sometimes at unrealistic tariffs.

When creating a modern bureaucracy, two agents did not permit sudden advances to mitigate inherent risks: Brazilian executive power aimed to control and set an agenda, and the "older bureaucracy" also affected the technical staff by means of strong links with government officials.

This study examined the impact of regulatory risk and political intervention in the electricity sector, focusing on a specific occurrence. The findings reveal that regulatory measures, particularly PM 579, had direct effects on investors. These effects included a decrease in international interest as the perceived risk increased. The study also found that these regulatory measures had negative consequences on the performance and value of electricity firms, amplifying operational and financial risks. Additionally, the uncertainty caused by PM 579 persisted for an extended period, leading to reduced investments in new ventures in Brazil for at least three years following its implementation.

The lessons from these episodes motivated a reaction around institutional improvement and evolution in regulatory agencies' legislation. Progressively, the country moved to a new stage, aligning its executive and legislative views. As a

result, the credibility of the market and consumers increased without sudden changes in tariffs and maintained normality in the provision of services. Mainly, regulatory agencies have evolved by approving measures that strengthen independence and good governance.

The enactment of Law n. 13,848 of 2019 was a revolutionary new framework for regulatory agencies in Brazil, and it represents an example of learning lessons from PM 579. In addition, the provision of the Analysis of Regulatory Impact (AIR) tool is critical for preventing and mitigating impacts on the sector. Decree No. 10,411 in 2020 introduced the “regulatory cost” concept, which users or industries in the sector may support.

We expect to investigate whether those changes occurred in future studies and their social and economic implications.

### Acknowledgements

Our appreciation for: CNPq (Conselho Nacional de Desenvolvimento Científico e Tecnológico)—support and research funding—Project n° 870263/1997-8; Capes (Coordenação de Aperfeiçoamento Pessoal de Nível Superior)—Project n° 459640/2014-3; Project n° 471728/2014-4.

### Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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