


## FINANCIAL PERFORMANCE AND STOCK VALUES IN A CONTEXT OF REGULATORY CHANGE: THE CASE OF THE BRAZILIAN ELECTRIC SECTOR

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### ABSTRACT

*The objective of this study is to analyze the degree of relationship between economic-financial performance and the value of the stocks of companies in the Brazilian electric sector in the capital market, together with the effects of the economic regulation provided by Provisional Measure No. 579/2012. The theme of this work can be considered relevant as it analyzes aspects of economic regulation and economic-financial performance of an important segment of the Brazilian economy, essential for the country's economic and social development. The results aim to contribute to the advancement of empirical studies that examine the behavior of the stock market, based on information provided by companies and those available in the market, from firms in regulated segments. The methodological procedures involve a panel econometric regression model comprising 29 concessionaires and permissions electric energy companies listed on the São Paulo Stock Exchange (B3) between 2009 and 2016. Regarding the market value of the shares of the electricity companies, the results indicated a negative association with the provisional measure, positive with the ratio between the Current Liquidity Index and negative with the Indebtedness Ratio. The results indicate that the pricing strategy of investors in regulated companies considers effects of regulatory interventions together with typical market variables.*

**Keywords:** *Economic regulation. Brazilian electric sector. Capital market. Indicators of financial performance.*

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## 1 INTRODUCTION

The last decades have been marked by actions developed by the Brazilian state in the electric sector, with the use of variables to reduce the cost of tariffs, in order to guarantee a positive and growing trajectory in the institution of new models for the electric power industry.

In September 2012, has been proposed the issue of Provisional Measure (MP) No. 579/2012, later converted into Law No. 12,783/2013, which changed the rules of the current legislation, with the objective of enabling the reduction of the cost of electricity to the consumer, to promote low tariffs, to guarantee the supply of electricity, as well as to turn the productive sector more competitive and to contribute to the increase in the level of employment and income in Brazil (Ministry of Mines and Energy, Ministry of Finance & General-Advocacy of the Union, 2012).

However, a number of secondary aspects reflected negatively in the national electricity sector, with possible repercussions in the stock market, when devaluations of the shares of the main electric energy companies in Brazil have been evidenced. In November 2012, B3 S.A. recorded losses never seen in the Brazilian electric sector companies in the last two decades, as verified by the shares of Centrais Elétricas Brasileiras S.A. (Eletrobras), when it reached the second biggest devaluation in history (Cerqueira, 2013). Thus, the main impacts identified in the announcement of this measure relate to market estimates, with a reduction in the value of the shares of energy companies listed in B3, even those not directly affected by the regulatory action (Prado & Silva, 2013).

One year after the implementation of MP 579/2012, experts negatively evaluated the measure, due to the loss of self-sufficiency of the concessionaires, the containment and reduction of costs and the readjustment of revenues, the difficulties of maintaining the economic-financial balance of the companies, suspension of investments, decreased self-sustainability in the sector, limited competitiveness and difficulties with cash flow (Godoi, 2013).

The sector crisis caused by the 2012 regulatory action and government interference led Eletrobras, the largest state-owned company in the sector, to accumulate losses in the order of R\$ 13.2 billion between 2012 and 2013, to delay payments from suppliers, to enter in operations with doubtful returns, and losing part of its staff (Batista & Lima, 2014).

In 2017, the federal government announced its intention to sell Union shares in Eletrobras, through the dilution of its participation in the company. According to data from Eletrobras' individual financial statements, the company has accumulated accounting losses since 2012, with a registered amount of R\$ 6.8 billion in 2012, R\$ 6.2 billion in 2013, R\$ 3 billion in 2014 and R\$ 14.4 billion in 2015. A cost reduction plan, implemented by the company in the second quarter of 2017, aimed to reduce its indebtedness by the order of R\$ 23.4 billion (Pamplona & Wiziack, 2017).

This study aims to analyze the relationship between economic and financial performance, through indicators, and the value of shares in the stock market of companies in the Brazilian electricity sector, in the context of the regulatory change implemented by MP No. 579/2012.

This work becomes relevant by highlighting the need to investigate the possible effects on the market of regulatory changes, using a multivariate analysis, considering the simultaneous effects of an event and economic-financial variables on the market value of companies in a regulated segment of the Brazilian economy. We expect that the obtained results shall contribute to the improvement of the regulation of the sector, by empirically proving that the market reacts to the informational content of regulatory interventions, along with other typical market variables. In addition, we hope that this knowledge shall collaborate in improving the analysis process of regulatory impact by state entities.

This article is divided into five parts, the first of which is this introduction. In the next section, we present the theoretical foundation, highlighting the assumptions of the economic theory of regulation, as well as the results of studies on the association between regulatory events, economic-financial indicators and the capital market and research hypotheses. The third

part discusses the employed methodological procedures, including sampling, data collection and data source, used indicators and definition of the econometric model. Fourth section presents the results of the empirical analysis, including empirical tests, analysis of estimates and discussion of found results. Finally, the last section presents the research findings, study limitations, contributions and suggestions for future works.

## **2 THEORETICAL FRAMEWORK**

This section presents, firstly, the assumptions of the economic theory of regulation, as well as research involving regulatory events and the capital market. Then, we present the economic and financial indicators used in the analysis, accompanied by a review of the literature that deals with their association within the stock market value.

### **2.1 Economic Theory of Regulation**

Regulation is generally an identifiable and discrete activity of state action, through various mechanisms, which can restrict the conduct of economic agents, preventing the occurrence of certain undesirable behavioral actions or facilitating the orderly conduct of economic activity (Baldwin, Cave & Lodge, 2012). Pohlmann and Alves (2012) emphasize that regulation is understood as a set of legal provisions edited by the state or delegated institutions with coercive power over a given economic activity, area of knowledge or sector of the economy.

The first stream of regulation, from an economic perspective, is normative. This approach, based on public interest, argues that regulation should arise when there are market failures (existence of public goods, natural monopoly, externalities, imperfect markets, information failures, unemployment and inflation), in order to correct them and maximizing social well-being, that is, the normative aspect explains when regulation should arise and what form it should take in order to achieve an increase in that well-being (Mueller, 2001; Pohlmann & Alves, 2012).

Facing the difficulty of defining social welfare measures, the normative pattern of the theory of economic liberalism, in the last century, disseminated regulation in order to correct market failures (Schymura, 2014). The normative current bases itself from the premise that the perfect competitive market harmonizes, in an ideal way, the pursuit of particular interest and the construction of the collective good, and maintains that the role of the regulator, with eminently technical functions, is adjusting the balanced functioning of the market in the relationships between economic agents (Shymura, 2014).

Laffont and Tirole (1990) point out that important factors in the decision-making process of governments are not discussed within the normative scope of the theory, nor are they interesting aspects of political science. In this sense, the normative approach incurs simplifications by disregarding political and economic institutions and neglects political issues about the economy, with regard to the huge restrictions on the allocation of resources by the political system (Laffont, 1994; Mueller, 2001).

While the current of regulation under the normative aspect focused on market failures and the welfare economy as justifications for State intervention, critical inflections in relation to the phenomenon of regulation, based on the theory of public choice by Buchanan and Tullock (1962), emerged in order to elucidate the failures of government and the limits of this intervention (Salgado, 2003).

For Buchanan and Tullock (1962), the elementary question lies in the analysis of any motivation strictly in the self-interest of individuals and their behavior in the processes of social choice, and in the fact that these individuals, as such, probably have different objectives and purposes for the results of collective action.

In this context, the agenda of governments and international organizations, in promoting structural adjustment programs of the State is seen, from the perspective of public choice, as a political interference in market transactions, since it threatens individual freedom and economic progress (Borges, 2001).

Furthermore, exchanges in the political environment would be at the heart of the economic problem, since, while considering politics as a market, it converges to a search engine for personal goals (Freire, Costa, Gartner & Clemente, 2013). For Salgado (2003), public choice advocates that public interest gets represented in the market economy, and any other environment, such as the political market, it only confuses the signals provided by the price system and compromises the efficiency of that system, thus free market is the ideal representation of the public interest.

The economic theory of regulation, in turn, innovated in the descriptive aspect by proposing a theory for the process of choosing regulators under the hypotheses of the agent-principal relationship. In effect, it began to consider not only the offer of regulation by regulators, but a demand for regulation by private agents (Pohlmann & Alves, 2012).

In this sense, from the 1970s onwards, new advances in the economic literature called into question the regulator's neutrality in correcting market failures with premises of social well-being (Schymura, 2014), consolidated by Stigler's research (1971), Posner (1974), Peltzman (1976) and Becker (1983).

The Stigler study (1971), a pioneer in formulating a theory of economic regulation, has as its central points explaining who shall receive the benefit of regulation or who shall bear the burden of regulation, which form it takes and what are its effects on allocation of resources. Regulation may be pursued or imposed by a firm. The defended thesis says that regulation, as a rule, is acquired by the industry and fundamentally designed for its benefit. The problem with regulation lies in finding out when and why an industry shall use the State for its purposes or whether it is used by the State for the benefit of others.

Posner (1974) criticizes the premises of the theories of economic regulation insofar as he thinks to simplify the offer of regulation as an initiative of the regulator himself. That way, he proposes a rescue of the public interest theory, created in response to a demand from society, in order to correct inefficient market practices, combining it with the capture theory, formulated in response to interest groups that compete with each other for the maximization of private benefits.

Peltzman (1976), on the other hand, argues that regulatory agencies do not seek to benefit exclusively a single economic agent, but rather distinct interest groups, whether producers or consumers. This way, regulation should continually change in response to exogenous shocks that affect the behavior and performance of regulated entities.

Finally, Becker (1983) principles from a broader understanding of regulation, considering tax structure, subsidies and other administrative instruments as forms of regulation also used to increase the well-being of more influential pressure groups. This way, smaller pressure groups, better organized and with cohesive preferences, would tend to obtain advantages through the regulatory structure.

Given this framework, it is plausible supposing that the market understands possible effects of regulatory changes on the market conditions and the performance of regulated companies, pricing them accordingly to the theory of efficient markets (Fama & French, 1989).

Preliminary research indicates a relative scarcity of academic research on the effects of regulatory interventions on the market value of companies. Smith, Bradley and Jarrell (1986) found evidence of loss of market value for oil refining companies in the USA in 1973 as a result of a change in American regulatory policy. Su e Fleisher (1998) They demonstrated an increase in the volatility of Chinese companies' stock prices between 1990 and 1996, due to changes in financial regulation, highlighting different magnitudes of the effect in two different markets.

Buckland e Fraser (2001) They also found a significant increase in market risk for companies in the UK electricity sector after a regulatory reform introduced in 1992. Also for the

UK electricity sector, Paleari e Redondi (2005) they evidenced a negative relationship between the rigor of regulation and the abnormal returns of electricity distribution companies in the United Kingdom in the period between 1990 and 1995.

Kobialka e Rammerstorfer (2009) They analyzed the effects of 12 regulatory episodes related to the German energy market, finding a relationship between these and abnormal returns and variations in systemic risk for some companies.

As for Brazil, Taffarel, Silva e Clemente (2013) they have studied possible impacts of regulatory events on the price and volatility of the shares of eight companies of the Brazilian energy sector, between 2004 and 2010. Their results have not indicated a homogeneous influence on all companies; however, in certain cases, some regulatory facts have negatively impacted on the return and risk of companies' shares. The aforementioned articles provide examples of situations in which regulatory changes have had an impact on the market value of companies directly affected, as expected, based on the theories of regulation and finance. Therefore, we formulate the first research hypothesis:

**H<sub>1</sub>:** *Is there a negative association between the implementation of the provisions of MP 579/2012 (Law No. 12,783/2013) and the value of the shares of companies of the Brazilian electricity sector?*

## 2.2 Economic-financial indicators and capital markets

Matarazzo (2010), Lagioia (2011) and Pinheiro (2016) describe that stock valuation, based on economic-financial analysis, includes a set of indicators related to the company's accounting data, organized into liquidity, indebtedness or capital structure and profitability indicators. The liquidity indexes show the company's financial base, the debt indexes measure the composition of the company's passive sources of funds, while the profitability indexes seek to show the return of the invested capital (Iudícibus, 2017; Lagioia, 2011; Pinheiro, 2016).

Empirical research on the relevance of financial statements in identifying trends and providing information to investors, for decision-making through indicators, has been developed over the years, based on the pioneering work of Beaver (1966) and Ball and Brown (1968).

Table 1 presents some studies that investigated the relationship between economic and financial indicators and stock value or volatility in several stock markets.

Table 1

### Studies involving economic and financial indicators and capital markets

Authors	Stock market	Sample	Indicators used	Significant variables
Ou & Penman (1989)	USA	Companies listed on NYSE/Amex	LC, LS, PCT, IPL, ML, ROE, ROA	LC, LS, PCT, IPL, ML, ROE, ROA
Holthausen & Larcker (1992)	USA	Companies listed on NYSE/Amex	LC, LS, PCT, ML, ROE, ROA	LC, LS, ML
Johnson & Mitton (2003)	Malaysia	424 companies	LC, LS, CE, IE, ML, ROA	IE, ML, ROA
Hobarth (2006)	USA	9,854 companies	LC, LS, IE, PCT ROA	ROA
Hamzah (2007)	Indonesia	135 manufacturing companies	LC, PCT, ROA	LC
Zeitun & Tian (2007)	Jordan	167 companies	IE, PCT, ROE, ROA	IE, PCT
King & Santor (2008)	Canada	613 companies	IE, ROA	IE, ROA
Martani & Khairurizka (2009)	Indonesia	39 manufacturing companies	LC, PCT, ML, ROE	ML, ROE
Sharma & Sharma (2009)	India	889 manufacturing companies	LC, PCT, ROA	PCT, ROA
Alexakis, Patra & Poshakwale (2010)	Greece	47 companies	LC, IE, PCT, GAT, ML, ROE, ROA	LC, IE, PCT, GAT, ML, ROE, ROA

Riantani, Hartaya & Hasanah (2011)	Indonesia	11 mining companies	PCT, ROA	PCT, ROA
Taani & Banykhaled (2011)	Jordan	40 manufacturing companies	LC, PCT, ML, ROE	PCT, ROE
Goslin, Chai & Gunasekarage (2012)	New Zealand	70 companies	LC, LS, ROE, ROA	LC, LS, ROE, ROA
Hatta & Dwiyanto (2012)	Indonesia	17 companies	LC, PCT, ML, ROA	PCT, ML
Kaveski (2013)	Brazil	27 IBrX-50 index companies	LG, LC, LS, ML, ROE, ROA	LG, LC, LS, ML, ROE, ROA
Petcharabul & Romprasert (2014)	Thailand	22 technology companies	LC, PCT, ROE	ROE
Santos (2017)	Brazil	20 banking institutions	ML, ROE, ROA	ROE
Muhammad & Ali (2018)	Pakistan	115 non-financial companies	LC, PCT, ROA	LC, PCT, ROA

Amex = American Stock Exchange. NYSE = New York Stock Exchange. S&P = Standard & Poor's. IBrX-50= Brazil Index 50. LG = General Ratio. LC = Current Ratio. LS = Quick Ratio. CE = Debt Breakdown. IE = Indebtedness Index. PCT = Third Party Capital Participation. IPL = Fixed Assets of Stockholders' Equity. GAT = Total Asset Turnover. ML = Net Margin. ROE = Return over Equity. ROA = Return on Assets.

Source: Prepared by the authors.

The findings of studies by Ou and Penman (1989), Holthausen and Larcker (1992), Hamzah (2007), Alexakis, Patra and Poshakwale (2010), Goslin, Chai and Gunasekarage (2012), Kaveski (2013) and Santos (2017), indicated a positive relationship between liquidity indicators and share value in the capital market.

Likewise, a positive association between profitability indicators and stock value in the capital market has been found by the empirical works of Hobarth (2006), Martani and Khairurizka (2009), Sharma and Sharma (2009), Alexakis, Patra and Poshakwale (2010), Riantani, Hartaya and Hasanah (2011), Taani and Banykhaled (2011), Goslin, Chai and Gunasekarage (2012), Kaveski (2013), Petcharabul and Romprasert (2014), Santos (2017) and Muhammad and Ali (2018).

The findings of Johnson and Mitton (2003), Zeitun and Tian (2007), King and Santor (2008), Alexakis, Patra and Poshakwale (2010), Riantani, Hartaya and Hasanah (2011) and Hatta and Dwiyanto (2012) suggested negative association between indebtedness indicators and stock value of companies in the stock market.

Given the above, other research hypotheses are presented.

**H<sub>2</sub>:** *Is there a positive relationship between liquidity indicators and the value of shares of companies in the Brazilian electricity sector.*

**H<sub>3</sub>:** *Is there a negative relationship between the debt indicators (capital structure) and the value of the shares of companies in the Brazilian electricity sector.*

**H<sub>4</sub>:** *Is there a positive relationship between liquidity indicators and the value of shares of companies in the Brazilian electricity sector.*

### 3 METHODOLOGICAL PROCEDURES

The market value of the share refers to the price of the last quotation, of each quarter of the most traded share of each company, whether common or preferred. The economic and financial indicators used in this study are the same as the most used in the studies surveyed. Thus, indices representing the three groups have been used: liquidity (LC and LS), indebtedness or capital structure (IE and PCT) and profitability (ROE and ROA).

Table 2

#### Economic and financial indicators used in the research

Variable		Indicator	Description	Formula
Ratio	LC	Current Ratio	It portrays the relationship between current assets and current liabilities	$LC_t = \frac{AC_t}{PC_t}$
	LS	Quick Ratio	Reveals the ability to cover short-term liabilities with short-term assets, disregarding inventories	$LS_t = \frac{AC_t - Inventories_t}{PC_t}$
Indebtedness	IE	Debt to asset ratio	Expresses the share of third party capital in total resources (third party capital plus equity)	$IE_t = \frac{ET_t}{ET_t + PL_t}$
	PCT	Third Party Capital Participation	Indicates the company's level of indebtedness in relation to financing with own resources	$PCT_t = \frac{ET_t}{PL_t}$
Profitability	ROE	Return over Equity	Measures return on funds invested by owners	$ROE_t = \frac{LL_t}{PL_{t-1}}$
	ROA	Return on Assets	Measures the return produced by total resources invested in assets	$ROA_t = \frac{LL_t}{ATM_t}$

AC = Current assets. PC = Current liabilities. ET = Total Indebtedness. PL = Stockholders' equity. LL = Net income. AT = Total Assets. ATM = Average Total Assets  $((AT_t + AT_{t-1})/2)$ . t = current period indicator. t - 1 = previous period indicator.

Source: Lagioia (2011), Iudícibus (2017), Martins, Diniz & Miranda (2018).

Multiple regression econometric model has been employed for panel data in order to analyze the effects of economic regulation implemented by MP no. 579/2012 on the market value of the shares of companies in the Brazilian electric sector, as well as the level of relationship between economic and financial indicators and the value of shares on the capital market, in the period between 2009 and 2016.

Gujarati and Porter (2011) emphasize that panel data may be explored using three estimation techniques. The Ordinary Least Squares (OLS) model for stacked data or *Pooled Ordinary Least Squares* (POLS) simply stacks the observations in a large regression, disregarding the characteristics of data in terms of cross-sectional and time series nature. The Fixed Effects Model (FEM) assumes that the intercept of the regression may differ between individuals, but does not vary over time (each cross-sectional unit has its own intercept with a fixed value). The Random Effects Model (REM) or Error Component Model (ECM) assumes that the intercept is a common random variable between individuals (mean value of all intercepts) and the individual differences of each subject are reflected in the error term.

Wooldridge (2016) understands that statistical inference applications within panel data must distinguish the differences between these models, due to the supposed existence of sufficient information in the data, in order to produce accurate estimates of the coefficients. Therefore, the investigation of the panel modeling that best suits a given data set has been carried out using the tests in Table 3.

**Table 3**  
**Tests for model selection for dashboard data**

	Chow F Test	Breusch-Pagan LM Test	Hausman's test
Model selection	POLS versus FEM	POLS versus REM	FEM versus REM
Selection criteria	H <sub>0</sub> : POLS method H <sub>1</sub> : FEM method	H <sub>0</sub> : POLS method H <sub>1</sub> : REM method	H <sub>0</sub> : REM method H <sub>1</sub> : FEM method

**Note.** H<sub>0</sub>: Null hypothesis. H<sub>1</sub>: Alternative hypothesis.

Source: Fávero & Belfiore (2017), Gujarati & Porter (2011) and Wooldridge (2016).

The multiple regression model for panel data used in this study is:

$$VMA_{i,t} = \alpha + \beta_1 LC_{i,t} + \beta_2 LS_{i,t} + \beta_3 IE_{i,t} + \beta_4 PCT_{i,t} + \beta_5 ROE_{i,t} + \beta_6 ROA_{i,t} + \beta_7 MP_{i,t} + \mu_{i,t} \tag{1}$$

in which,  $VMA_{i,t}$  represents the  $i$  market value of company stock in quarter  $t$ ;  $i$  represents the companies ( $i = 1 \dots 29$ );  $t$  corresponds to the quarters ( $t = 1 \dots 32$ );  $\alpha$  is the intercept or constant of the regression;  $\beta$  are the slopes of each variable;  $LC_{i,t}$  is the  $i$  current liquidity index of the company in quarter  $t$ ;  $LS_{i,t}$  is the dry liquidity index of company  $i$  in quarter  $t$ ;  $IE_{i,t}$  is the Debt Ratio of company  $i$  in quarter  $t$ ;  $PCT_{i,t}$  is the Third Party Equity Indicator of company  $i$  in quarter  $t$ ;  $ROE_{i,t}$  is the Return on Equity indicator of company  $i$  in quarter  $t$ ;  $ROA_{i,t}$  is the Return on Assets indicator for company  $i$  in quarter  $t$ ;  $MP_{i,t}$  is the qualitative (binary) variable that captures the effect of Provisional Measure No. 579/2012, *Dummy* 0 for the pre-MP period (from first quarter of 2009 to third quarter of 2012) and *Dummy* 1 for the post-MP (from fourth quarter of 2012 to fourth quarter of 2016); and  $\mu_{i,t}$  corresponds to the idiosyncratic error or error term.

The description of the explanatory variables used in this research and the respective expected signs are briefly described in Table 4.

Table 4  
Variables explained in the research

Variable	Indicator	Empirical basis	Expected signal
Ratio	LC	Current Ratio	Positive
	LS	Quick Ratio	Positive
Indebtedness	IE	Debt to asset ratio	Negative
	PCT	Third Party Capital Participation	Negative
Profitability	ROE	Return over Equity	Positive
	ROA	Return on Assets	Positive
Regulation	MP	Provisional Measure 579/2012 (variable <i>dummy</i> )	Negative

Source: Prepared by the authors.

The research sample comprises 29 companies holding concession/permission for generation, transmission and/or distribution of electricity that presented traded shares and the selected economic and financial indicators, in the period from 2009 to 2016. Table 5 specifies the research sample.

Table 5  
Sample companies

Company	Action	Company	Action
1. AES Tietê Energia S.A.	TIET3	16. Companhia Estadual de Geração e	EEEL3

		Transmissão de Energia Elétrica	
2. Afluente Transmissora de Energia S.A.	AFLU3	17. Companhia Paranaense de Energia	CPLE3
3. Ampla Energia e Serviços S.A.	CBEE3	18. CPFL Energia S.A.	CPFE3
4. Centrais Elétricas Brasileiras S.A.	ELET3	19. Companhia de Transmissão de Energia Elétrica Paulista	TRPL3
5. Centrais Elétricas de Santa Catarina S.A.	CLSC4	20. EDP Energia do Brasil S.A.	ENBR3
6. Centrais Elétricas do Pará S.A.	CELP5	21. Elektro Redes S.A.	EKTR4
7. Companhia Energética de São Paulo	CESP3	22. Eletropaulo Metropolitana Eletric. de São Paulo S.A.	ELPL3
8. Companhia de Eletricidade do Estado da Bahia	CEEB3	23. Empresa Metropolitana de Águas e Energia S.A.	EMAE4
9. Companhia Energética de Brasília	CEBR3	24. Energisa S.A.	ENGI3
10. Companhia Energética de Minas Gerais	CMIG3	25. Eneva S.A.	ENEV3
11. Companhia Energética de Pernambuco	CEPE5	26. Engie Brasil Energia S.A.	EGIE3
12. Companhia Energética do Ceará	COCE3	27. Equatorial Energia S.A.	EQTL3
13. Companhia Energética do Maranhão	ENMA3	28. Rio Parapanema Energia S.A.	GEPA4
14. Companhia Energética do Rio G. do Norte	CSRN3	29. Companhia Estadual de Distribuição de Energia Elétrica	CEED3
15. Light S.A.	LIGT3		

Source: B3 S.A. (2017).

The analysis period refers to the interval between the first quarter of 2009 and the fourth quarter of 2016, comprising the individual and quarterly information of the sample companies. The collection of company share values and economic and financial indicators has been carried out on the B3 website and in the Economática database.

## 4 RESULTS

In this section, we present the results obtained in the study, highlighting the validation tests of the econometric model, the analysis of the results of regression estimates, as well as discussion of the results under the theoretical assumptions and empirical research.

### 4.1 Tests and analysis of estimation results

The findings of risk of multicollinearity may be observed by means of the Pearson's correlation matrix, shown in Table 6.

Table 6

#### Pearson Correlation Matrix

	LC	LS	IE	PCT	ROE	ROA	MP
LC	1.0000						
LS	1.0000*	1.0000					
IE	-0.3355	-0.3356	1.0000				
PCT	-0.0211	-0.0211	0.0845	1.0000			
ROE	0.0107	0.0107	-0.0154	-0.0010	1.0000		
ROA	-0.0370	-0.0369	-0.1877	-0.0332	-0.2944	1.0000	
MP	-0.0703	-0.0703	0.1007	-0.0076	0.0332	-0.1418	1.0000

Note. \* Significant correlation > 0.8.

Source: Prepared by the authors.

According to this matrix data, there is a significant linear correlation between Current Ratio (LC) and Quick Ratio (LS). Bearing in mind that the Current Liquidity index is more used in empirical studies that research liquidity indexes, we decided to exclude the variable Quick Ratio from the estimation model.

Table 7 shows the result of the application of the VIF (*Variance Inflation Factor*) multicollinearity test without the LS variable, revealing lack of regressors' multicollinearity.

Table 7  
**VIF Statistical Test**

Variable	VIF (Variance Inflation Factor)	1/VIF
IE	1.20	0.834585
ROA	1.17	0.851378
LC	1.14	0.873844
ROE	1.10	0.907393
MP	1.03	0.971096
PCT	1.01	0.971096
Mean VIF	1.11	

**Note.** VIF > 10 = Correlation between variables (Gujarati & Porter, 2011, Wooldridge, 2016).  
 Source: Prepared by the authors.

Following multicollinearity diagnosis, the estimation model that explains the market value of the companies' shares is given by Equation 1, excluding the Quick Ratio variable.

The modeling that best fits the research data has also been examined by comparing the estimators of the POLS model, Fixed Effects Model (FEM) or Random Effects Method (REM). Results of the tests are shown in Table 8.

Table 8  
**Model selection tests for dashboard data**

	Chow F Test	Breusch-Pagan LM Test	Hausman's test
Model selection	POLS versus FEM	POLS versus REM	FEM versus REM
Selection criteria	H <sub>0</sub> : POLS method H <sub>1</sub> : FEM method	H <sub>0</sub> : POLS method H <sub>1</sub> : REM method	H <sub>0</sub> : REM method H <sub>1</sub> : FEM method
Test result	F (28.893) = 27.91 Prob > F = 0.0000	chibar2(01) = 2869.28 Prob > chibar2 = 0.0000	chi2(6) = 1.87 Prob > chi2 = 0.7600
Test Analysis	Rejects H <sub>0</sub>	Rejects H <sub>0</sub>	Does not reject H <sub>0</sub>

Source: Data prepared by the authors.

According to the tests' results, the Random Effects Model (REM) or Error Components Model (ECM) is more appropriate to investigate the behavior of the stock value of the companies in this research.

The Breusch-Pagan and Wooldridge tests for panel data indicated the presence of heteroscedasticity and autocorrelation of errors, according to data of Table 9.

Table 9  
**Test results for heteroscedasticity and autocorrelation**

Tests	Breusch-Pagan test for heteroskedasticity	Wooldridge test for autocorrelation in panel data
Results	H <sub>0</sub> : Constant variance Variables: fitted values of vma chi2(1) = 965.14 Prob chi2 = 0.0000	H <sub>0</sub> : no first-order autocorrelation F (1.28) = 57.476 Prob F = 0.0000
Analysis	Presence of heteroscedasticity	Presence of autocorrelation

Source: Prepared by the authors.

In cases of lack of homoscedasticity of errors (heteroscedasticity), Gujarati and Porter (2011) and Wooldridge (2016) highlight, among the various corrective measures, the use of estimators by the Generalized Least Squares (GLS) or Weighted Least Squares (WLS) methods. In this sense, given that the tests indicated the Random Effects Method (REM) to be used, the correction of the heteroscedasticity of the residues will have been met, since the REM estimates parameters by GLS.

Among the many procedures that treat the serial correlation of the residues, Gujarati and Porter (2011), Wooldridge (2016) and Fávero and Belfiore (2017) suggest the procedure of first order autoregressive effects AR(1) of error terms.

Wooldridge (2016) emphasizes that the regression model, in the presence of

heteroscedasticity and autocorrelation, can be estimated by means of a combined procedure of autoregressive AR(1) and Weighted Least Squares (WLS), correcting both problems. In this way, the results of the regression by REM, estimated by generalized least squares with AR(1) procedure of residues, are shown in Table 10.

Table 10

**Estimation results by REM model with AR(1)**

RE GLS regression with AR(1) disturbances				Number of obs	=	928	
Group variable: id				Number of groups	=	29	
R-sq:	within	=	0.1169	Obs per group: min	=	32	
	between	=	0.0428	avg	=	32.0	
	overall	=	0.0776	max	=	32	
corr(u_i,Xb) = 0 (assumed)				Wald chi2(7)	=	34.94	
				Prob F	=	0.0000	
vma	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]		Sig.
lc	0.319338	0.083813	3.81	0.000	0.155067	0.483608	*
ie	-0.099474	0.050330	-1.98	0.048	-0.198119	-0.000829	**
pct	-0.000015	0.000144	-0.10	0.917	-0.000297	0.000267	
roe	0.000814	0.001273	0.64	0.523	-0.001682	0.003310	
roa	0.027682	0.073551	0.38	0.707	-0.116475	0.171839	
mp	-3.946458	1.285478	-3.07	0.002	-6.465948	-1.426968	*
_cons	26.504340	3.042232	8.71	0.000	20.54168	32.46701	

**Note.** \* and \*\* indicate that the variables are statistically significant at the level of 1% and 5%, respectively.

Source: Prepared by the authors.

The results of the estimation model for the market value of shares of companies in the Brazilian electric sector indicate that LC and MP are statistically significant at the level of 1% and IE is statistically significant at 5%. The findings indicate that the quantitative variables of Current Liquidity and Indebtedness Index and the qualitative variable that measures the impact of MP no. 579/2012 present a statistically significant relationship with the value of the shares of electricity concessionaires.

After performing the tests and analyzing the estimates, we found that the econometric model is statistically significant (Prob F less than 5%), in which 7.76% of the behavior of the general change in the market value of the shares is due to the variation explanatory variables together, reaching 11.69% of explanatory power within the panels.

**4.2 Discussion of results**

Based on the proposed hypotheses, Table 11 presents the results.

Table 11

**Summary of the results of the research hypotheses**

Hypotheses	Result
H1: Is there a negative association between the implementation of the provisions of MP 579/2012 (Law No. 12,783/2013) and the value of the shares of companies of the Brazilian electricity sector?	Does not reject
H2: Is there a positive relationship between liquidity indicators and the value of shares of companies in the Brazilian electricity sector.	Does not reject
H3: Is there a negative relationship between the debt indicators (capital structure) and the value of the shares of companies in the Brazilian electricity sector.	Does not reject
H4: Is there a positive relationship between profitability indicator(s) and value of shares of companies in the Brazilian electricity sector.	Rejects

Source: Prepared by the authors.

According to the results obtained, a negative association has been found between the provisions implemented by MP 579/2012 (Law no. 12,783/2013) and the value of the shares of companies in the Brazilian electricity sector in the capital market, that is, the entry into force of this regulatory precept resulted in decreases in the market value of the shares of the electric

energy concessionaires. Thus, hypothesis 1 cannot be rejected, as the results indicated statistically significant evidence of the expected association.

The findings of the negative association between MP 579/2012 and the market value of the firms' shares are similar to the findings of Smith, Bradley and Jarrell (1986), Paleari and Redondi (2005), Cerqueira (2013), Prado and Silva (2013) and Taffarel, Silva and Clemente (2013).

Theoretical assumptions suggest that the negative effects on capital market in relation to the regulated segments may be associated with impacts from regulatory events, with repercussions on the market value of firms (Paleari & Redondi, 2005). The results of this research pointed out that the adverse effects of MP no. 579/2012 had repercussions on companies holding electricity generation, transmission and/or distribution concessions in the country, with respect to the companies' loss of market value.

Furthermore, according to Buchanan and Tullock (1962), political and economic decisions by government entities are subject to different powers exercised by various agents within the same political system, interfering in the implementation of these decisions, whose impacts can be as varied as possible. While proposing this intervention in the electricity market in order to make it possible to reduce the tariff for the consumer, the state decision, through MP no. 579/2012, caused harmful effects to the companies of the sector.

With regard to the second hypothesis, in which the positive relationship between liquidity indicators and the value of shares of companies in the Brazilian electricity sector has been analyzed, the findings confirmed the hypothesis, since Current Liquidity (LC) presented a statistically significant and positive relationship with the market value of the shares. The increases in the LC index indicated a correlation with augmentation of the value of the shares of the companies analyzed in the capital market. Such results corroborate the findings of Ou and Penman (1989), Hamzah (2007), Alexakis, Patra and Poshakwale (2010), Goslin, Chai and Gunasekarage (2012), Kaveski (2013) and Santos (2017), who pointed out a positive relationship between Current Liquidity and stock value in the stock market.

Capelletto and Corrar (2008) and Gitman (2010) point out that joint stock companies can use financial indicators, such as liquidity, to analyze and monitor their performance, since systemic repercussions linked to liquidity difficulties cause price drops and devaluation of assets in the stock market. Financial strength can predict abnormal returns and future demands from investors, thus, increases in liquidity indicators are good predictors of the valuation of companies' shares (Choi & Sias, 2012), justifying the presence of this significant relationship.

The third hypothesis sought to ascertain the negative relationship between the debt or capital structure indicators and the value of the companies' shares. The hypothesis has not been rejected due to the existence of a negative and significant relationship between the Indebtedness Index (IE) variable and the value of the shares of companies providing electricity services over the analyzed period. The evidences observed in this study coincide with the researches by Johnson and Mitton (2003), Zeitun and Tian (2007) and King and Santor (2008).

According to Assaf (2014), a growth in the indebtedness index may show a reduction in profitability and, consequently, reflections on the market. Companies with high leverage rates tend to raise funds from third parties when their market valuations are low (Baker & Wurgler, 2002).

Regarding the fourth research hypothesis, which examined the supposed positive relationship between profitability indicators and the value of shares in companies in the Brazilian electricity sector, it has been rejected. No profitability indicator showed any connection with the market value of the companies in the sample, thus refuting hypothesis 4. The conclusions are in opposition to the findings of Hobarth (2006), Martani and Khairurizka (2009), Sharma and Sharma (2009), Alexakis, Patra and Poshakwale (2010), Riantani, Hartaya and Hasanah (2011), Taani and Banykhaled (2011), Goslin, Chai and Gunasekarage (2012), Kaveski (2013), Petcharabul and Romprasert (2014), Santos (2017) and Muhammad and Ali (2018), who

observed statistically significant results in this relationship. This result may be related to the tariff policy of companies in the Brazilian electric energy segment, either by regulated tariffs or by allowed annual revenue, which restricts the profitability of companies, with consequences on revenues and, consequently, on profit generation. Consequently, analyzes and perceptions of the stock market would be little sensitive to changes in the profitability indicators of companies in that segment of the economy.

## **5 CONCLUSIONS**

Provisional Measure no. 579/2012 (Law no. 12,783/2013), instituted by the federal government in 2012, changed rules in the regulatory legislation of the Brazilian electricity segment. The implementation of this measure pointed to a wide repercussion in the capital market, with regard to the reduction of the value of the shares of the energy companies listed in B3, in addition to the distrust of local and foreign investors. Furthermore, experts raised aspects experienced by the sector and related to the issue of this regulatory measure, mainly regarding the economic and financial balance of companies.

In this context, the present research aimed to analyze the relationship between the economic-financial performance and the value of the shares of the companies of the Brazilian electric sector in the capital market, correlated with the impact of the economic regulation provided by MP no. 579/2012.

At first, the results indicated that the drop in value of the shares of companies in the Brazilian electricity sector was associated with the entry into force of the provisions of MP no. 579/2012, confirming the premise of the harmful effects of this regulatory intervention on the market value of companies.

These results are consistent with the argument that the free market would be the ideal representation of public interest, because, whether in politics or in the market, individuals influenced by interest groups behave motivated to maximize self-interest to the detriment of some dimension related to public interest, so that regulatory intervention should only occur when it is minimally necessary.

Furthermore, the findings demonstrated that short-term liquidity ratios, precursors to financial complications and indications of cash and insolvency problems, are good predictors for market analysis and investor demands, even in companies of regulated sectors, in addition to serving as a reference for expectations of future earnings in the stock market.

As for the indebtedness index, an increase in this indicator may show a reduction in profitability and, therefore, negative reflexes in the market, since a greater participation of third party resources would increase financial expenses, deteriorating the companies' profitability. Therefore, it is important to analyze the cost of indebtedness in relation to the return produced by the assets financed by these resources, so that the participation of third party capital does not determine an unsustainable liquidity situation.

With regard to corporation profitability, regulatory restrictions on electricity companies' revenues, whether due to regulated tariffs or permitted annual revenue, with effects on profit generation, indicate that they are associated with the insensitivity of capital market expectations in the face of fluctuations in profitability indexes of companies in this sector.

The research, in fact, contributes by highlighting the need to consider the possible impacts of regulatory changes on the market, suggesting the use of a multivariate analysis while considering the simultaneous effects of an event and economic-financial variables on the market value of publicly traded companies. In particular, the results and conclusions obtained contribute to a better understanding of the Brazilian electric sector, an important aspect for the improvement of regulation of the sector, by empirically proving that the market reacts to the informational content of regulatory interventions, along with other typical market variables. In addition, we expect that this knowledge will contribute to improving the carried out regulatory

impact analysis process, before the publication of new rules by state entities.

As for research limitations, these result from the non-inclusion of macroeconomic variables and/or control variables that could be similarly related to the stock market. Furthermore, errors in measuring variables may lead to distortions, and turn the estimation of regression model parameters inconsistent.

Finally, as a suggestion for new works, we propose to extend the research model to regulatory events in other sectors of the Brazilian economy. We also suggest changing the set of economic-financial indicators and/or including macroeconomic and control variables in the estimation model.

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