



## The effects of tax policy and economic regulation on the companies of the electricity sector in Brazil

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### Abstract

The objective of this study was to analyze the possible effects of the electric sector's regulatory regulations and the enactment of laws 10,637 / 2002 and 10,833 / 2003 on the collection of federal PIS and COFINS taxes and on pricing of electric energy tariffs, identifying the determinant factors for fixing them. The multivariate analysis was used as an analytical approach, taking as reference the multiple panel regressions. In general, there was a 113% increase in the payment of PIS and COFINS social contributions after the enactment of Law 10.833/2003, indicating that the right to deduct credits on certain factors of production was not obtained by companies in the electric energy sector increasing, therefore, the tax burden of companies. The direct consequence of this result was the increase in the average electric energy tariff charged from residential consumers, especially after the 2004 period. In this sense, after a 153% increase in the PIS and COFINS rates, and after the concessionaires' right to revise their tariffs when there was an increase in costs, including taxes, there was a considerable increase in the average tariff of electric power in the order of 2.8% and 8.1%, respectively, higher than the increases in their production costs. Therefore, it can be inferred that the increase in electric energy tariffs during the study period was mainly due to the increase of the tax burden and the regulatory factors since the factors of production were not significant in the model.

**Keywords:** Electrical Sector. TAX POLICY. Regulation.

## Introduction

Since the 1990s, the Brazilian Electric Energy sector has undergone several changes of an institutional nature, expansion of private sector participation, technological innovations, economic infrastructure, deregulation of the sector and institution of public policies, among them, the tax police.

In principle, the causes of this process began with the deterioration of the infrastructure, due to the loss of government reinvestment capacity and the difficulties of gaining economies of scale, leading to a process of privatization initiated with the institution of the privatization Law No. 8.031 / 1990 (SILVA, 2007).

From that moment, the government felt the necessity of new changes that in the vision of Moraes (2009), Gomes et.al. (2009) and Viana et. al. (2009) were necessary for the competitiveness and maintenance of the sector, among them: (1) the unbundling of generation, transmission, distribution and commercialization activities (known as MAE / CCEE) and, as of 2004, subdivided into exporters and importers; (2) the purchase of electric power in the transmission and distribution segments started to be done through auctions - observing the lowest tariff criterion and, (3) introduction of the independent producer and self-producer on a larger scale, with the objective of better Allocation, production and distribution of resources.

It could be said that the basic concern was to create a competitive pressure in the possible segments (generation and commercialization) and regulation in the segments where it was needed (transmission and distribution), as shown in Figure 1.

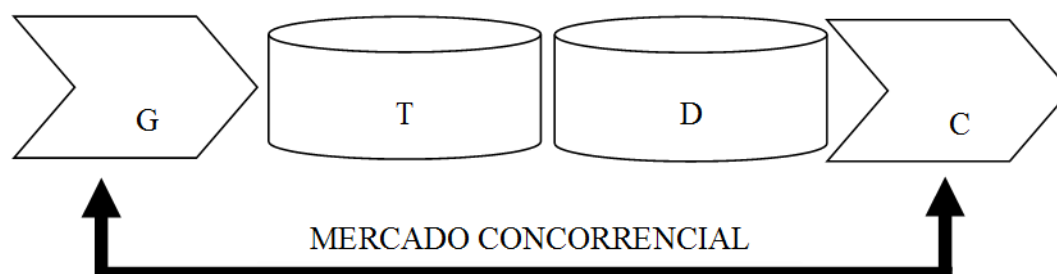


Figure 1. Restructuring of the Electrical sector.

Source: Adapted from Silva (2007).

Table 1 presents a summary of the main changes between the models, which resulted in changes in the activities of some agents in the sector.

Table 1 - Brazilian regulatory models from the point of view of the Restructuring of the Electric Sector

<b>Old Model (up to 1995)</b>	<b>Model of Free Market (1995-2003)</b>	<b>Current Model (as of 2004)</b>
Vertical Companies	Companies divided by activity: generation, transmission, distribution and commercialization	Companies divided by activity: generation, transmission, distribution, marketing, import and export.
Companies predominantly State companies	Openness and Emphasis on Companies Privatization	Coexistence between State and Private Companies
Monopolies - No competition	Competition in generation and marketing with minimum regulation and Natural Monopoly in Transmission and Distribution, with strong regulation, therefore treated as regulated public services.	Competition in generation and marketing with minimum regulation and Natural Monopoly in Transmission and Distribution, with strong regulation, therefore treated as regulated public services.
Captive consumers	Free and captive consumers	Free and captive consumers
Tariffs regulated in all segments	Prices freely negotiated in generation and commercialization.	In the free environment: prices freely negotiated in generation and commercialization. In the regulated environment: auction and bidding for the lowest tariff.

Source: Adapted from Vieira et. Al. (2009).

Another important step in this process was the creation of Law no. 8.631 / 1993 and Decree No. 774/1993 which regulated the tariff levels to be charged for the consideration of the public electricity supply service, according to the specific characteristics of each concession area.

From the tariff point of view, these laws extinguished the tariff equalization and maintained the service regime at cost, with the readjustment of the tariffs proposed by the concessionaires, homologated by the Granting Authority, and the levels of energy tariffs provided by the concessionaires Shall be fixed taking into account the specific costs of the concessionaires, the amounts related to the prices of electricity purchased from the suppliers, the transportation of the electricity generated by Itaipu Binacional, the annual quotas of the Global Reversion Reserve, the apportionment of fuel costs And financial compensation for the use of water resources (Article 2, Decree 774/93). The minimum legal remuneration of 10% on the investment, in effect since the Water Code, of 1934, was thus eliminated, establishing, from these changes, the current tariff regime.

Thus, from Law no. 8.631 / 1993 and Decree No. 774, the current system now includes the so-called Binomial Rate, consisting of two distinct parcels, that is, the recorded electricity consumption (kW / h) calculated based on the power (or demand) values of the various equipment used (in Watts, W) and the power consumption (in hours, h) of these electrical equipment. In addition to this distinction be-

tween power and energy, the system added the Horo-Seasonal segment, which establishes tariffs for peak (HP) and off-peak hours (HFP). The first refers to the one with the highest energy demand and consists of three consecutive daily hours defined by the distributor considering the load curve of its electric system, approved by ANEEL for the entire concession area, except for weekends holidays defined by federal law. On average, there are 66 hours during the month. The off-peak hours are the complementary hours to the three consecutive hours that make up the peak hours, plus all the hours of weekends and holidays. At this time the energy tariffs are lower than the HP and an average of 664 hours during the month. The system also fixes different values for the periods of the year between May and November, defined as dry period (PS) and between December and April as wet period (PU). The amounts are set by the National Electric Energy Agency (ANEEL), which regulates relations between concessionaires and consumers, establishing the various types of contracts, standards and instructions.(Lei nº 8.631/1993 e Decreto nº 774/1993)

Likewise, article 9 of Law 8.987 of 1995 inaugurated the tariff regime for the price, with the possibility of forecasting mechanisms for readjustment and revision of tariffs. According to the legislation, the tariff charged should be established by the regulatory agency, in this case the National Electric Energy Agency (ANEEL), and be sufficient to cover all costs of the service, including taxes, in order to guarantee economic and financial balance of the concessionaire and the remuneration of the investments necessary to maintain the services with quality and reliability.

Very similar, Laws no. 8.931 / 1993 and 8.987 / 1995 granted the concessionaire the right to establish a revision of electric energy tariffs whenever there is an increase in operating costs, regardless of origin, as well as the creation, alteration or extinction of any tax, except for taxes on the income.

In 2002 also included the system of tariff modalities, according to Decree No. 4.413 / 2002, which are: conventional modality, green horo-seasonal and blue horo-seasonal. Lastly, as of January 2015, the flag system was also included in Brazil's electricity tariff structure, which consists of passing on (and demonstrating) monthly to the consumer the additional cost of buying energy from less favorable conditions for the generation of energy. There are currently 3 flags: green (which indicates favorable conditions, normal tariff does not increase), yellow (conditions less favorable, increase of R\$ 0.015 per kWh) and red (more expensive conditions of generation, increase of R\$ 0.03 or R\$ 0.045 depending on the seriousness of the situation) (Normative Resolution No. 574/13, ANEEL, 2013). In all tariffs modalities, ICMS, PIS and COFINS are charged on the sum of the installments, and the ICMS is not levied on the portion of inactive contracted demand, that is, contracted but not used.

With regard to PIS and COFINS taxes, a major change for companies in the electricity sector occurred with the enactment of laws 10.637 / 2002, 10.833 / 2003 and 10.865 / 2004. With the enactment of these laws, PIS and COFINS had their rates changed to 1.65% and 7.6%, respectively, and were calculated in a non-cumulative manner. As a result, the average rate of these taxes started to vary with the volume of credits established monthly by the concessionaires and with PIS and COFINS paid on costs and expenses in the same period, such as electricity purchased for resale to the consumer.

Thus, if, on the one hand, the institution of laws no. 8.631 / 1993 and 8.987 / 1995 came to stimulate the search for the efficiency of companies in the electricity sector, on the other hand, laws 10.637 / 2002, 10.833 / 2003 and 10.865 / 2004 increased the tax burden in this sector. Of course with the possibility of credit discounts.

Therefore, it is evident that the higher the costs, the higher the final product prices (electric energy) for consumers. It remains to be seen how much of the tax cost on each of the electric power segments is passed on to the final product and how the tariff is fixed in each segment of the industry (generation, transmission, distribution and commercialization).

### **Non-cumulative incidence regime: Laws 10.637 / 2002 and 10.833 / 2003**

Concerning the reforms of the Brazilian tax system, the concern with economic competitiveness turned to taxes on consumption and production, which usually include social contributions to Social Security Financing (COFINS) and to the Program Of Social Integration (PIS). Another issue that also worries and, according to available literature, impairs competitiveness and productive efficiency, is the cumulative system of taxation present in the tax system.

Based on diagnoses of this nature, the government proposed, through Law 10.637 / 2002, effective December 2002 and Laws 10.833 / 2003 and 10.865 / 2004 in force from February and April 2014, respectively, to institute the system of non-cumulative PIS and COFINS taxes, for all publicly-held companies, with the exceptions described in art. 8 of Law 10.637 / 2002, and of art. 10 of Law 10.833 / 2003, observing the provisions of art. 15 of this last Law.

Among these exceptions, are the revenues earned in the purchase and sale of electric power, within the scope of the Wholesale Electricity Market (MAE), observing the provisions of art. 47 of Law 10.637 / 2002. An observation should be placed in relation to the other segments (generation, transmission and distribution) of this sector, since none of the legislation mention their exclusion, showing that they would be in the new modality, generating confusion among accountants and administrators.

In addition to the change in the basis of calculation, these two contributions had their rates increased. In the case of COFINS, the rate increased from 3% to 7.6%, while in the case of PIS it increased from 0.65% to 1.65%. (Art.2 of Laws 10.637 / 02 and 10.833 / 2003).

The new legislation also gave the taxpayer the right to deduct credits, 9.25%, on the expenses of certain inputs set forth in Article 3 of both laws. It should be noted that the expenses with Labor paid to the individual and the acquisition of goods or services not subject to payment of the contribution do not generate the right to credit.

### **Rationale and relevance of the research**

Wessel (2003) points out that the type of market structure in which a taxed product is inserted is a determining factor of the implications of taxation on generation capacity, transmission and the intensity of supply and demand along the chain.

In this aspect, according to Gremaud et al. (2003) the first repercussion of a tax on products traded in imperfect markets, as is the case of the Brazilian electricity sec-

tor, is the increase in the initial marginal cost in the amount equal to the value of the tax.

According to these authors, the implications observed for the impact of taxation on imperfect competition markets are generally the same in cases of taxation of products transacted in the monopoly structure, but with the aggravating circumstance of the inefficiencies inherent in the monopoly. In this sense, for the monopoly companies (segments of transmission and distribution of electric energy in Brazil), the possibility of a rise in the price of the product greater than the value of the tribute is admitted.

However, while on the one hand, companies in the electric power sector are taxed and "carry" a high tax burden that increases their production costs and, theoretically, having monopoly and competitive segments throughout their chain could pass on this cost for the price of electricity, on the other, they are companies that have their price and supply regulated by government agencies.

In this sense, taking into account that the current structure of the Brazilian energy sector is divided into competing companies (generation and commercialization) and monopolies (transmission and distribution), and that are still companies whose decision on the quantity offered and the final price are regulated by ANEEL and CCEE, this work sought to present evidence of the impacts that public policies - notably tax policy and regulatory issues - have on the determination of the sale price of companies and on the behavior of production costs in the energy sector, without, however, to disregard competitive and regulatory aspects that also contribute to these facts.

Thus, the choice of the electric power sector as a topic of study was due to: (1) the importance of this activity for the Brazilian economy; (2) the structural changes that the industry has undergone in recent years, which instigates research regarding the behavior of decisions on product supply, selling price and cost variation; (3) because it is a sector with economic regulation and, (4) considering the tax change occurred in Brazil and included the electric power sector in these changes.

For this purpose, the objective of this study was to analyze the possible effects of the electric sector's regulatory regulations and the enactment of laws 10.637 / 2002 and 10.833 / 2003 on the collection of federal PIS and COFINS taxes and on pricing of electric energy tariffs, identifying the determinant factors for fixing them.

## Methodology

### Study area and data source

The study adopted as a space of analysis the set of 54 (fifty-four) Brazilian companies in the electric energy sector with shares traded on the São Paulo Stock Exchange (BMF & BOVESPA) from 2001 to 2012.

The data were collected in the system database @Economática and made available by BMF & BOVESPA, ANEEL and the Applied Research Institute (IPEA).

The consolidated financial statements of only one paper type - common shares -, measured at book values, adjusted by the IGP-DI, as of 12/31/2012, in thousands of reais, were used.

With respects to the treatment of *outliers*, companies that did not have all the information available during the review period were excluded. Among other types of

*Outliers*, extreme values were eliminated, considering the observations with values outside the limit of three standard deviations, in order to avoid distortions.

After these procedures of filtering the data corresponding to the 54 companies available, a sample of 10 companies was obtained, classified according to the share capital and the operating segments, as presented in Table 2.

It should be noted that the sample number was reduced due to non-availability of the tariff variable charged to final consumers by ANEEL at the date of the survey.

Table 2 - Study sample

<b>Company name in the trading floor</b>	<b>Stock control</b>	<b>Operating segment</b>
CPFL PAULISTA	Private	Generation, commercialization
CPFL PIRATININGA	Private	Generation, commercialization
ENERGISA	Private	Generation, distribution and commercialization
Ienergia elétrica	Private	Distribution
Light S / A	Private	Generation, commercialization and transmission
Electric Neoenergy	Private	Generation, distribution and commercialization
Electrical power grid	Private	Generation
CEB	Public	Distributor
CEMIG	Public	Generation, transmission
COPEL	Public	Generation, transmission

Source: Economática; ANEEL (2010)

### **Definition of the variables**

In order to evaluate the possible effects of the changes introduced by Laws 10.637 / 2002 and 10.833 / 2003, they may have influenced the collection of the PIS and COFINS contributions of the Brazilian electric power sector, the estimated PIS and COFINS collected by companies in each year of study and obtained through published accounting information was used as dependent variable and, as independent variables, those described in Table 3.



Table 3 - Relationship of independent variables and theoretical expectations (model 1)

Attribute	Indicator	Formula / Proxy
Production Factors	Operating and Financial Expenses	Sales Expense (SALW)
		Administrative Expenses (DESPA)
		Depreciation Expense (DEP)
		Financial Expense (DESPF)
		Staff costs (MO)
Added Value	Added Value in proportion to Gross Revenue	(Net Profit + taxes paid + total staff cost)/RB (VA%)
	Added Value	Net Profit + taxes paid + total staff cost (VA)
Macroeconomic Factor	Real GDP	Real GDP (GDP)
Constitution of laws 10.637/2002 and 10.833/2003	Validity of non-cumulative PIS (2003) and non-cumulative COFINS (2004), as well as the validity of the regulatory imposition of revision of electric energy tariffs	Dummy D03 and Dummy D04
Share Capital Management	Public and Private Companies	Dummy Control (DCONT)

Source: Prepared by the authors.

To capture these possible impacts, the variable *Dummy* (DPIS), assigning values 0 for the years prior to the non-cumulative PIS and 1 for the subsequent years, and the Dummy variable (DCOFINS) assigning values 0 for the years prior to its validity and 1 for previous years (Table 3), was created.

It is expected that all variables related to production factors, except for the variable Cost of Personnel, have a negative relation with the total collection of federal taxes PIS and COFINS, since art. 30 of laws 10.637/2002 and 10,833/2003 gave companies the right to deduct credits thereon.

In order for taxation on value added and gross revenue to result in the same tax burden, segments should add at most 39.45% of taxes and margin in its cost of production (RAIMUNDI, 2010). In this sense, it is expected that the variable (VA) is positively related to the dependent PISCOFINS, so that the higher the value added of the company, the higher the PIS and COFINS collected by the industries.

We expect a positive correlation between GDP and the dependent variable, believing that this sector presents a positive correlation with the level of economic activity, accompanying the stimulus that this economic greatness presents on the demand for electric energy.

As for the variables *Dummies* PIS and COFINS, the expected signal is positive, demonstrating that the increase in the rates of 153% on the social contributions PIS and COFINS were not offset by the discounts of credits on the factors of production.

In order to evaluate the possible impact of the changes imposed by Laws 10.637 / 2002 and 10.833 / 2003 and the regulatory rules of the electricity sector on the fixing of the electric energy tariff, the average tariff charged by the final consumer was used as the dependent variable each year and for each company, based on the



revenue composition established by ANEEL to the concessionaires: The concessionaire's revenue is composed of two installments: "Portion A", represented by the non-management costs of the company (sector and tax charges and transmission charges and purchase of energy for resale and for use of connection facilities) and part B, which aggregates the manageable costs (operating expenses - such as personnel, material, third party services and overheads, maintenance expenses - depreciation and, capital expenditure - financial expenses and other capital remuneration expenses).

As independent variables of this second model, items directly related to the formation of the sale price described by ANEEL (2010) were selected, as well as the items included in the cost of production, which are directly related to the debts established by the Laws 10.637 / 2002 and 10.833 / 2003.

Variables related to enterprise size and growth expectation were also included, besides including macroeconomic variables such as real GDP, exchange rate, Brazilian income and number of inhabitants. Regarding the variables of size and growth expectancy, a negative relation is expected, since the larger the companies, the greater the possibility of economies of scale. Regarding the macroeconomic variables, a particular signal is not expected, but rather they are significant, since all are directly related to consumption, although it can not be inferred in what form they are related to the price fixing of the tariff.

With the objective of verifying the influence of the management of the capital stock on the price fixing of the residential electric tariff also includes a *Dummy*, Attributing Value 1 (one), for private and 0 (zero), for public enterprises. In this case, as in model 1, variables *dummies were included*. A particular signal is not expected, but rather they show significance.

## Procedures and methods for panel modeling

### Development of the Panel Model

First, the presence or not of multi-collinearity between the dependent variable and the independent variables was measured by simple correlation analysis, as in Plata et. Al. (2005) and Mário (2002). In order to reduce multi-collinearity problems among the independent variables, those with a correlation above 75% were eliminated, which, according to Famá and Melher (1999), show a mean correlation between the variables. Gujarati (2006) calls this procedure a partial correlation.

In order to estimate the effects of Laws 10.637/2002 and 10.833/2003 on the total collection of PIS and COFINS contributions in the 10 companies over the 11 years of analysis, the multivariate regression for panel data was used. This technique combines analyzes by company (series Cross-section) with the analyzes per unit of time (time series), encompassing elements of both (WOOLDRIDGE, 2006).

Models 1 and 2 were estimated for each year (2001 to 2012) and considered only one form of adjustment, the Fixed Effect Model, given the amount of degrees of freedom.

In order to estimate the influence of the independent variables on each one of the dependents, the coefficient of determination  $R^2$ -adj was analysed. The serial autocorrelation hypothesis in the residues was tested using the *Durbin-Watson* "d" test.

For Marques (2007), the parameter of this test is both better and closer to 2. The significance parameters of the independent variables were up to 5% for the entry and exit of each one.

In this sense, after all methodological procedures, the final model was specified in functional form *Log-Lin* as described in equation 1.

$$\begin{aligned} \text{LogPISCOFINS}_{it} = & \alpha'_i + D03 + D04 + VA_{it} + DESPA_{it} + DESPV_{it} + EST_{it} \\ & + DEP_{it} + PIB_{it} + DCONT_{it} + \mu_i + \varepsilon_{it} \end{aligned} \quad (1)$$

On what:  $\text{LogPISCOFINS}_{it}$  Is the log-dependent variable of the total PIS and COFINS collected by the companies distributed for each cross section (i) in each year (t); DPIS is the variable *Dummy* to capture the effect of Law 10.637 / 2002; D04 is the variable *Dummy* to capture the effect of Law  $VA_{it}$  10.833 / 2003; Is the independent variable Added Value  $DESPA_{it}$ ;  $DESPV_{it}$  Is the variable Administrative Expense;  $EST_{it}$  Is the variable Sales Expense;  $DEP_{it}$  Is the Stock variable; Is the Depreciation Expense  $PIB_{it}$  variable; Is the variable Gross Domestic Product of the Industries;  $DCONT$  Is the variable *Dummy* Indicating the effect of public and private companies on corporate taxation;  $\varepsilon_{it}$  Is the independent and identically distributed error term on (t) (i);  $\mu_{it}$  Is the parameter to be estimated and  $\alpha'_i$  Measures the heterogeneity, or the specific effect of each group or individual, containing a constant term and a set of variables not observed by the model, but correlated with the regressors.

The second model was also specified in the Log-Lin form, according to equation 2.

$$\begin{aligned} \text{LogTAX}_{it} = & \alpha'_i + D03 + D04 + \text{PISCOFINS}_{it} + INV_{it} + CTA_{it} + CTB1_{it} + CTB2_{it} \\ & + CTB3_{it} + AT_{it} + PIB_{it} + C_{it} + RD_{it} + POP_{it} + VA_{it} + Q_{it} + DCONT_{it} + \mu_i + \varepsilon_{it} \end{aligned} \quad (2)$$

On what:  $\text{LogTAX}_{it}$  Is the dependent variable Logarithm of the price of the residential tariff distributed for each cross section (i) in each year (t); D03 is the variable *Dummy* to capture the effect of Law 10.637 / 2002 and Law 8.631 / 2003; D04 is the variable *Dummy* To capture the effect of Law  $INV_{it}$  10.833 / 2003; Is the independent variable Investment in the total company Permanent  $CTA_{it}$ ; Is the variable that represents the total of non-management  $CTB1_{it}$  costs and expenses;  $CTB2_{it}$  Is the variable that represents the operational management costs and expenses; Is the variable that represents the costs and expenses maintenance managements;  $CTB3_{it}$  Is the variable that represents the costs and expenses capital and financial managements  $AT_{it}$ ; Is the total active variable  $PIB_{it}$ ; Is the real Gross Domestic Product  $C_{it}$  variable;  $RD_{it}$  Is the variable Exchange rate; Is the Gross Income variable of Brazilians;  $POP_{it}$  Is the variable number of Brazilian inhabitants  $VA_{it}$ ; Is the Added Value  $Q_{it}$  variable; Is the variable that represents the total amount of electric energy produced and sold;  $DCONT$  Is the variable *dummy* indicating the

effect of public and private companies on corporate taxation;  $\varepsilon_{it}$  Is the independent and identically distributed error term on ( $t$ ) and ( $i$ );  $\mu_{it}$  is the parameter to be estimated, and  $\alpha'_i$  measures the heterogeneity or the specific effect of each group or individual, containing a constant term and a set of variables not observed by the model and not correlated with the regressors.

The statistical treatment of the data, in all stages of the models, was carried out through the *Software Gretl 1.9.3*, which enabled the operation of the descriptive statistics and the calculations of the multivariate regression coefficients for the panel.

## Results and discussion

### Descriptive analysis of variables

Table 4 presents the descriptive statistics of the variables selected for the tax collection models and generation of supply.

It can be verified that the average value of the tariff charged by residential final consumers during the analyzed period was R\$ 0.29 and that the difference between the values was R\$ 0.22, that is, consumers paid different amounts for the same product.

The value of the collection of PISCOFINS contributions by the companies presented an average of R\$ 379,333.00, which represented 6.36% of the Gross Revenue of the companies. On average, the collection of PISCOFINS by the companies had a significant increase over the period. From 2001 to 2009, the increase was 187%, and in the years 2002 to 2003, 2003 to 2004 and 2004 to 2005 the percentage increase was more significant, 20.40, 43.48 and 57.19%, respectively.

Table 4 - Descriptive analysis of variables

	In Reais			
	Mean	Minimum	Maximum	STD. Default
<b>Dependent variables</b>				
Collection of PIS and CO-FINS (R\$)	379,333.00	834.94	1,360,509.52	142,969.63
Final consumer residential tariff (R\$ / kWh)	0.29	0.20	0.42	0.01
<b>Independent variables</b>				
Total Assets (R\$)	9,065,100	395,780	28,866,273	611,467
Cost of installment A (sales taxes)	4,125,045.78	21,998	15,958,848	697,433
Cost of installment B (capital cost)	903,949	16,199	7,500,879	679,942
Cost of installment B (operational exp.)	3,213,094	14,677	13,405,660	532,558
Cost of installment B (exp. Maintenance)	327,976	0	1,111,805	46,387
Administrative expenses (R\$)	656,142	0	6,929,615	954,173
Depreciation expenses	327,976	0	1,111,805	46,387

(R\$)				
Selling expenses (R\$)	100,752	0	518.613	60,810
Stock consumed (R\$)	16,879	0	94,190	3,923
Investment Purchase Fixed Assets (R\$)	561,221	0	2,193,002	113,700
Total Permanent Investment (R\$)	732,605	1	2,739,515	144,104
Number of inhabitants residing in Brazil	183,071,280	173,808,010	191,480,630	6,071,724
Actual GDP (in R\$)	2,756,485	2,398,210	3,148,857	288,916
Quantity of electric energy produced and sold (kWh)	19,602,772	77,621	67,483,898	2,930,430
Gross Revenue (R\$)	5,967,054	22,875	20,846,193	1,018,812
Gross Income of Brazilians (R\$)	382	304	480	64
Exchange Rate (R\$)	105	81	141	19
Value added (R\$)	2,377,766	-191,941	16,148,572	1,367,749
Percentage added value (%)	62	-172	320	20

Source: authors

It is also observed that the percentage of value added by the companies presented an average of 62%, which suggests that companies in the electricity sector were not benefited by the institution of Laws 10.637 / 2002 and 10.833 / 2003. The exception was observed in the company Ienergia Elétrica (IEN), which managed to obtain, over the analyzed period, more rights to tax credits than to debts. It remains to be seen if she has been able to lower the value of its fare.

When checking the behavior of the variable average tariff charged to final consumers (TAX), it can be seen that the lowest tariff was charged by public companies CEB and COPEL, with an average tariff of R\$ 0.27. The tariff charged by CEMIG was the largest among the 10 companies (Table 5). This fact has even been the subject of complaints among many consumers.

In this sense, at first, it can be affirmed that public companies, with the exception of CEMIG, are the ones that present the lowest tariff value and, furthermore, we can assume that the electric energy company may have benefited from the tax change, however, it presented the third highest rate charged.

There was also a 17.6% increase in the average energy tariff price over the eleven periods, and this increase was greater in the years in which Laws 10.637 / 2002 and 10.833 / 2003 came into force. This variation was greater in private companies.

Therefore, a preliminary analysis of the data showed that, during the analyzed period, there was a positive variation both in the increase of electric energy tariffs charged to the consumers, as well as in the collection of PIS and COFINS by the companies and that this increase was greater in the period in which PIS and COFINS suffered a 153% increase in their rates.

	Public Enterprise			Private company						
	CEB	CEMIG	COPEL	CPFL	CPFL	ENERGISA	Elétrica	LIGHT	Neenergia	Network
				Paulista	Piratinga				Elétrica	Electrical Energy
2001	0.28	0.25	0.21	0.24	0.28	0.25	0.20	0.31	0.20	0.28
2002	0.28	0.27	0.24	0.27	0.29	0.27	0.23	0.31	0.22	0.27
2003	0.28	0.31	0.27	0.30	0.31	0.29	0.26	0.31	0.25	0.27
2004	0.28	0.34	0.30	0.33	0.32	0.29	0.30	0.31	0.28	0.27
2005	0.28	0.38	0.30	0.33	0.31	0.29	0.32	0.32	0.31	0.28
2006	0.26	0.40	0.28	0.33	0.31	0.29	0.34	0.33	0.32	0.29
2007	0.25	0.42	0.26	0.33	0.30	0.29	0.35	0.31	0.33	0.29
2008	0.25	0.40	0.26	0.31	0.29	0.29	0.34	0.31	0.32	0.28
2009	0.25	0.37	0.28	0.30	0.30	0.29	0.34	0.31	0.32	0.28
2010	0.27	0.37	0.29	0.31	0.31	0.29	0.37	0.31	0.32	0.29
2011	0.30	0.39	0.30	0.32	0.31	0.30	0.37	0.34	0.33	0.29
2012	0.32	0.40	0.31	0.34	0.31	0.30	0.35	0.38	0.33	0.3
Mean	0.28	0.36	0.28	0.31	0.30	0.29	0.31	0.32	0.29	0.28

Source: authors

**Table 5** - Average per company of the average tariff charged by the residential consumer over the period

### Results obtained for Panel regressions

The result of model (1) to detect the effects of Laws 10.637 / 2002 and 10.833 / 2003 on the collection of the contributions provided in these legislations presented an  $R^2$ -adj in the order of 79.42% and a statistical coefficient *Durbin-Watson* close to 2, indicating a high fit of the model (Table 6).

Table 6 - Coefficients obtained by the estimation of the Fixed Effects model - TAX

Variables	Estimated Parameter Significance Level (Estimated Standard Deviation)
<b>Constant</b>	8, 54794 *** (0.00001)
<b>D03</b>	-0.905855 (0.14410)
<b>D04</b>	1. 13326 ** (0. 03916)
<b>VA</b>	6. 52159e-08 ** (0. 05480)
<b>GDP</b>	1. 03868e-06 *** (0.00002)
<b>EST</b>	-1. 37473e-06 (0. 84770)
<b>DEP</b>	1. 7465e-06 ** (0. 01420)
<b>STD</b>	8. 74675e-07 (0. 33107)
<b>DESPA</b>	-2. 85344e-07 *** (0. 00017)
<b>R<sup>2</sup>Adjust.</b>	0.7942
<b>Note:</b>	76
<b>Sum squared resid</b>	27.7175

<b>Durbin-Watson statistic</b>	1.7396
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Note: \*\*\* Significant at 1%. \*\* Significant at 5%. Values in parentheses refer to standard errors. Dependent variable: PISCOFINS.

Source: research results.

The results show that the total input factor used in the production process (represented by the EST variable) does not seem to be an intrinsic attribute to determine the calculation of the PIS and COFINS collection, since it did not present statistical significance. Possibly, its significance could have been captured through the variable purchase of electric energy for resale and for use of connection facilities. The same happened with the variable Expense with sales (DESPV), coefficient not significant. It should be noted that the model omitted the variable DCONT because of the exact colinearity presented.

The signal presented by the variable DEP was contrary to what was expected, demonstrating that companies in the electricity sector were not benefited by the right to discount depreciation credits. It should be noted that this result can be explained by the subsequent change to Laws 10.637 / 2002 and 10.833 / 2003, in which the right to deduct credit on depreciation became valid only for investments made from 2005 on.

The result presented by the DESPA variable presented the expected result, indicating that for each R\$ 1.00 of expenses with telephone expenses, general maintenance expenses and the own electric energy used in the companies, the lower the value of the tax collected by the companies given the possibility of deducting 9.25% of the total amount. Therefore, the right to deduct credits calculated on the factors of production specified in article 3 of Laws 10.637 / 2002 and 10.833 / 2003, for the most part, was not deducted by the electric power sector, a result corroborated by the positive and significant coefficient of the variable *Dummy* D04. That is, after the enactment of Law 10.833 / 2003, effective as from 2004, there was a significant 113% increase in the collection of PIS and COFINS from Brazilian companies in the electric energy sector. It should be noted that the variable D03 was not significant, demonstrating that the institution of Law 10.637 / 2002 did not bring impacts on the PIS and COFINS collection, which can be explained given the "maturation" period of a given law on an agent.

Another interesting result is that the variable Added Value (VA) presented a positive and significant coefficient at 5%, indicating that at each increase in the VA there is an increment in the PIS and COFINS collection of 6. 52159e-08 corroborating the results of many studies in the tax area of which companies that aggregate above 39.45% of taxes and margin in their cost of production were affected by the new system of non-cumulatively. In this sense, as companies in the electric power sector added little more than 62%, we could expect the result presented by the VA variable.

Finally, the GDP variable presented satisfactory results, both with respect to the significance of the estimate and the sign of the parameter presented, an indication that, in times of economic growth, there is a tendency of increase in the collection of taxes collected by the companies, and consequently, In the tax collection of the government.

Table 7 presents the results for estimating the impact of tax changes and economic regulation on the generation of supply of Brazilian companies in the electricity sector.

Table 7 - Coefficients obtained by the estimation of the Fixed Effects model - TAX

Variables	Estimated Parameter - Significance Level (Estimated Standard Deviation)
<b>Constant</b>	-4. 76696 *** (0.00001)
<b>D03</b>	0. 0276987 * (0. 06660)
<b>D04</b>	0. 0810169 ** (0. 01635)
<b>PISCOFINS</b>	2. 43678e-07 * (0. 06318)
<b>AT</b>	-3. 01971e-09 (0. 61076)
<b>INV</b>	1. 66224e-08 (0. 57716)
<b>CTA</b>	1. 24307e-08 (0. 71398)
<b>CTB1</b>	2. 65131e-08 (0. 28760)
<b>CTB2</b>	1. 56704e-07 (0. 12741)
<b>VA</b>	1. 69978e-08 ** (0. 02402)
<b>Q</b>	-1. 46504e-08 *** (0. 00043)
<b>GDP</b>	-2. 43088e-07 ** (0.02417)
<b>C</b>	-5. 77492e-05 (0. 87897)
<b>RD</b>	-0. 000670925 * (0. 09623)
<b>POP</b>	2. 38612e-08 *** (0.00001)
<b>R<sup>2</sup></b>	0,8176
<b>Note:</b>	76
<b>Sum squared resid</b>	0.2125
<b>Durbin-Watson statistic</b>	0. 6186

Note: \*\*\* Significant at 1%. \*\* Significant at 5%. \* Significant at 10%. Values in parentheses refer to standard errors. Dependent variable: TAX Source: research results.

Source: research results.

The result of the model to detect the effects of Laws 10.637 / 2002 and 10.833 / 2003 on the fixation of electric energy tariffs presented an  $R^2\text{-Adj}$  in the order of 81.76%, indicating a high adjustment of the model. However, the statistical coefficient *Durbin-Watson* was only 0.68, possibly due to the low correlation between the CTB3 variable and the TAX-dependent variable and the possible multi-collinearity



problems between the AT, INV, CTA, CTB1 and CTB variables, which were not detected in the simple correlation analysis composed the final model.

By the correlation analysis presented in the previous section and by the results presented in table 6, it can be observed that the variables that form the value of electric energy tariffs (Installment A - non-managerial costs of the company and installment B - manageable costs) do not appear to be an intrinsic attribute of stimulus in the generation of supply or at least a relevant factor for the fixation of the electric energy tariff value, since they did not present statistical significance. The same rationale applies to the size of the company (AT) and to the total investments made by the company annually (INV).

On the other hand, the value-added variable of the companies presented a significant and positive coefficient, demonstrating that the price of residential rates increases as companies add more value. This fact may eventually be an indication of barriers to entry, that is, the companies in the electricity sector analyzed in this work have a high cost, however, they can achieve a high profitability given the high price of the tariffs, thus preventing the entry of other companies that can not afford the high cost.

It is also observed that, in addition to taxes on income, the PIS and COFINS collection is also a determining factor for the fixation of the electric energy tariff and, even if the significance of the parameter has been at the 10% level, it can be inferred that the higher the value of the tax collected, the greater the price of the tariff.

In Brazil, both the result presented by the variable VA and the result presented by the variable PISCOFINS corroborates with a discussion that has long been discussed: the high Brazilian tax burden.

The macroeconomic variables - GDP, income and the Brazilian population - presented quite curious results regarding the sign of the presented parameters: it is expected that the larger the Gross Domestic Product of a country, the greater its consumption of electric energy. In the same way, the greater the population growth and the income of this population, the greater the consumption of electric energy. Following this reasoning, the coefficients of the GDP, Population and income variables were expected to be inversely proportional to the price of the electric energy tariff, since the larger the quantities produced and sold of a product, the greater the possibility of diluting the fixed costs of the company and, consequently, lower the value of the sale price. In this sense, only the population variable did not present the expected coefficient, indicating that, at the 1% level of significance, with each increase in the Brazilian population, the electric energy tariff increases 2.38612e-08 reais. It should be emphasized that a more detailed analysis should be done to enhance these results. On the other hand, the exchange rate variable was not significant for the fixation of the price of the electricity tariff.

As for the variables *dummies*, these presented positive and significant coefficients in relation to the dependent variable TAX indicating that, after the period of changes in the tax legislation and after a period of establishing a regulatory law, there was a 2.8% increase in the fare price after 2003 and of 8.1% after the year 2004. In this sense, it can be affirmed that changes in fiscal policies, especially in tax policies and economic regulation in a given sector, have a significant impact on the economy of a country.

It is also observed that these results corroborated with the results presented in the previous model, that is, an increase of 113% in the PIS and COFINS collection after 2004 was verified, indicating that the right to deduct credits on some factors of production was not obtained by companies in the electric energy sector, thus raising the tax burden of companies. The direct consequence of this result was the increase in the average electric energy tariff charged from residential consumers, especially after the 2004 period.

That is, after the increase in the COFINS tax rate from 3% to 7.6%, and after the concessionaires' right to revise their tariffs when there was an increase in costs, including taxes, there was an increase of 8.1% in the price of electric power higher than the increase in other production costs. As a consequence, companies have partly passed on the burden of the tax burden on their final products. In this way, part of the increase in tax rates was borne by producers and partly by consumers.

Therefore, it can be inferred that the increase in electric energy tariffs during the study period was mainly due to the increase of the tax burden and the regulatory factors since the factors of production were not significant in the model.

The result of the variable Q (Quantity produced and commercialized of electric power) reinforces this affirmation since it presented a negative and significant coefficient to 1% indicating that for every 1 kWh of electricity commercialized there is a decrease of  $1.46504e-08$  in the price of Electricity tariff. This would be more indicative of economies of scale, that is, the more production, given a fixed production structure, the greater the possibility of dilution of production and maintenance costs and the lower the product price.

It should be noted that the model omitted the variable DCONT because of the exact colinearity presented.

Therefore, the results of the preliminary analysis (descriptive analysis of the data) as well as the results presented by the panel models partially corroborate the theory presented by Gremaud et al. (2004) and Pindyck and Rubinfeld (2004). According to these authors, with the imposition of taxes on imperfect markets, as it is the case of the sample companies, formed by oligopolistic and monopolistic companies, there is an increase in the production costs of these industries, a rise in consumer prices and, consequently, a reduction in the aggregate supply of a particular sector, regardless of whether there is a reduction or increase in the number of companies in the market. They further argue that the cost of the tax burden will fall partly on the consumer and partly on the producer, varying according to the shape of the demand and supply curves and, in particular, the elasticities of supply and demand.

## Conclusions

In general, it was verified that the tax changes instituted by Law 10.833 / 2003 significantly affected the Brazilian publicly traded companies in the Brazilian electricity sector, in view of the 113% increase in PIS and COFINS since the year 2004, thus indicating that the 153% increase in the PIS and COFINS rates was not offset by the credits calculated on the production factors allowed by the legislation.

The direct consequence of this result was the increase in the average electric energy tariff charged from residential consumers, especially after the 2004 period. The

results showed a considerable increase in the average electricity tariff in the order of 2.8% after 2003 and 8.1% after 2004.

In this sense, after the increase in the COFINS tax from 3% to 7.6%, and after the concessionaires' right to revise their tariffs when there was an increase in costs, including taxes, there was an increase in the price of energy higher than the increase of their production costs, since no statistical significance was found in the coefficients presented by the factors of production in the presented model,

There was no significant change after the institution of Law 10.637 / 2002 on the collection of these contributions.

The main contribution of this work lies in the importance of its results for the understanding of the potential effects of public policies on the industrial segments.

It should be emphasized that the results found in this work should, however, be weighted by the limitations that surround them. In the first place, a variable dummy for each segment of energy activity in the sector could have been generated and taken into account in the estimates, but since the sample consisted of only 10 companies would be practically impossible to do so, because several degrees of freedom would be lost, which are important for the significance tests of the parameters. The alternative would be to do isolated analyzes of each segment looking for a larger number of companies. Secondly, it was the omission by the model of the variable dummy of share control, extremely important for the analysis of this work. Therefore, these are suggestions for adjustments for future research.

Another suggestion would be to verify how much of the resources raised by the government (since there was a significant increase in the federal tax collection) are reinvested in companies of the electric power sector and in society, through investment, work, healthcare, education. Objectives of fiscal policies are being followed by Brazilian rulers in the face of so many changes in tax and regulatory legislation.

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