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Sticky costs: An Empirical Study in Brazilian and the North American Companies of the Energy Sector

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Abstract

This study aims to determine the presence of stick costs (sticky costs) in Brazilian and US power companies. To this end, we collected data revenues, sold merchandise cost and taxes of 33 Brazilian power companies that are listed on the BM & FBOVESPA and 25 American companies of the same sector that trade their shares on the NASDAQ and the NYSE during the years 2004 to 2013. The research findings showed that the sticky costs can be verified in the Brazilian context, since for every percentage increase of 1% of revenue the variable costs increased 1.32%, while for 1% decrease in revenues, expenses 0.78% decrease variables. Since, in the American context, there has been the presence of sticky costs, given the linearity of the increase and decrease of the variable costs due to increased or decreased revenue. These results show the differences in the management of Brazilian and North American power companies.

Keywords: Sticky costs. Electricity sector. Brazilian companies. US companies. Variable costs. Variable expenses.

Introduction

The high competitiveness among industrial organizations, of services or business, turned the cost management a key tool in the decision-making process (MARTINS, 2010). Thus, for the company's competitive advantage, it is necessary to look for new ways to understand the costs and new techniques to carry out their management.

Traditionally, the literature classifies costs in fixed and variable. Fixed costs have constant value regardless the volume produced (not necessarily repeat over time), and variable costs have a symmetric behavior to variation in production volume, that is, the higher volume of production, the higher will increase costs resulted from this production (MARTINS, 2010).

However, studies have shown that the behavior of variable costs, although dependent on the volume produced, is not as symmetrical as shown in traditional literature, as noted in Anderson, Banker and Janakiraman (2003), Medeiros, Costa e Silva (2005), Werbin, Vinuesa and Porporato (2012) and Richartz, Borgert and Lunkes (2014). Thus, their behavior does not change so immediately when a cut in production occurs. Then, the same studies show that the costs actually are sticky, that is, its impact and duration in the companies cost structure may have more or less relevance, subject to action to be taken in relation to the volume of production (cut or boost). The theme, though little explored in the literature (Gwin; Vanhoose, 2011; Kama; Weiss, 2013; Cannon, 2014), is not as new as it seems. Malcolm (1991) have made explicit one of the first definitions for sticky costs using as an example the costs of order and the use of production materials: as production increases, more materials and more staff to manage them are needed, but when production decreases this staff is not immediately dismissed, employees can stay longer in the company or be relocated. Therefore, the variable costs become sticky, staying in the company's cost structure for a period that exceeds the process of production cut, resulting in an asymmetrical behavior of variable costs volume, which situation is different from the one most recognized and widely publicized by academy nowadays.

The theme also demystifies the action to cut the volume of production to wipe the short-term cost structure, given that these are not diluted as immediately as the production, which is clear from the example set by Malcolm (1991). It is noticed then the importance of the managerial decision to determine what will be the cost behavior in relation to production.

Another topic relevant for both the theoretical discussion as to the practical application of sticky costs is as it behaves in relation to analysis of different periods. To Anderson, Banker and Janakiraman (2003) the behavior of sticky costs observed in a period can be reversed in the subsequent period, which suggests that asymmetry may be less pronounced when the period analyzed is long. In this study, the analysis also presented a sectoral approach, companies of the same sector located in Brazil and United States were observed.

Sticky costs can be considered an unexpected result of the management decision on the increase or decrease in production volume, since the impact and relevance of those costs are often not calculated, as the period they will remain in the company's cost structure. However, once the concept is understood and calculation of sticky costs is applied to the organizational context, the provision of sticky costs may become a

powerful management tool, particularly with regard to decision making on the variation of the production volume and impacts to be achieved in production costs on the provisioned period. Thus, the research problem of this paper is: "The presence of sticky costs can be observed in Brazilian and North American power companies?".

Is then justified the importance of studying more deeply the types of costs, what is their impact on organizations in the short and long term, and what would be the best way to deal with them in order to achieve an optimal result. The traditional separation of costs into fixed and variable already has numerous publications and consequently methods to better deal with them, minimizing the strategic issues involving costs. However, sticky costs, cost modality that has only recently become the focus of studies, is still unknown by managers and academics.

Checked the literature on the subject, a gap is observed: there are relatively few publications regarding sticky costs. Then, this paper aims to contribute as much to the theoretical question, providing material regarding sticky costs for future studies, contributing to the identified gap, as to the practice of the subject matter, with the implementation of the study in Brazilian and American companies. In addition, verify how variable costs behave: if variation of the variable costs takes place in the same proportion and at the same speed once decided to decrease or increase the production volume.

Thus, this paper is structured as follows: after the presentation of the subject in this first section, follows the theoretical framework in section 2, followed by the research methodology section. Then, in section 4, the research results are presented. Section 5 presents the conclusions of the research.

Theoretical Framework

Theoretical aspects of sticky costs

Traditionally, it is assumed that variable costs have a substantially symmetrical response to the level of production, that is, if production level is incremented, the variable cost increases at the same rate and, on the other hand, if level of production decreases, the variable cost proportionally decreases as well (WERBIN; VINUESA; PORPORATO, 2012).

Noreen and Soderstrom (1997) analyzed the prediction of the traditional cost model and realized some costs have realized smaller responses to the low production volume compared to an increase. From this, Anderson, Banker and Janakiraman (2003) performed contemporary studies on the subject.

Despite being considered a new concept, Malcolm (1991) has introduced the concept of sticky costs to the academy. To explain the new concept, the case of direct labor was used as an example: when an increase of production volume is needed more hires are made, in order to increase the handling of direct material. However, in case of a production cut, most of the staff is not immediately fired; employees can go to other departments or other production activities. For exemplification purposes, Malcolm (1991) used direct labor, but as will be shown in the following studies, sticky costs are not strictly related to this type of charge.

Noreen and Soderstrom (1997) state that the variable costs have a stronger response when there is an increase in production than when there is a decrease. So when there is an increase in production volume, variable costs increase in direct proportion and has almost immediate impact on the cost structure. However, when there is a cut in production, the variable costs are not immediately assessed and there may be remnants of them in other periods. Costs that present this behavior are called sticky costs.

What was found in several studies is that sticky costs have a different behavior between different branches companies as between same industry companies ,both operating in different countries as much in more developed economies as in more unstable economies of emerging countries (WERBIN; VINUESA; PORPORATO, 2012).

For Werbin, Vinuesa and Porporato (2012) the existence of sticky costs is related to opposing forces in relation to the adjustment of resources, due to decreased activity level managers decide not to follow up with a cost reduction in proportional terms. The same authors suggest that sticky costs occur because there is a decision to keep idle resources in the period from the reduction in the volume of activity to the setting date.

Despite already being a phenomenon previously studied, was from the Anderson, Banker and Janakiraman (2003) research that sticky costs sparked a renewed interest in the academic community (WERBIN; VINUESA; PORPORATO, 2012). The results of Anderson, Banker and Janakiraman (2003) research were relevant to a better definition of sticky costs and its importance to the management focused on costs.

When demand falls, managers decide whether to keep the whole structure of production and bear the costs of unused capacity or reduce the production structure and bear the production cost reduction, increasing the structure again when demand increases (ANDERSON; BANKER; JANAKIRAMAN, 2003). The research conducted by Anderson, Banker and Janakiraman (2003) also brought other important features for the definition of sticky costs, as its direct relationship with decision making of managers.

Evidence of this research also demonstrated that the behavior of sticky costs is consistent with taking deliberate decision of managers, which weigh the economic consequences of their actions (ANDERSON; BANKER; JANAKIRAMAN, 2003).

One implication of Anderson, Janakiraman and Banker (2003) management analysis is that sticky costs can be recognized and controlled. The authors conclude that managers can assess their exposure to sticky cost considering the sensitivity of costs in relation to decreases in volume, and can increase the sensitivity of costs on volume changes taking decisions regarding hiring, to reduce the adjustment of costs associated with the change of the level of committed resources (ANDERSON; BANKER; JANAKIRAMAN, 2003).

Previous researches regarding sticky costs

The research of Werbin, Vinuesa and Porporato (2012) aimed to verify whether Spanish companies had the same level of costs with sticky behavior as has been observed in other location in previous studies. To empirically assess the existence of sticky costs in Spain, data from furniture manufacturing sectors, hotels and restaurants were analyzed. The variables measured by Werbin, Vinuesa and Porporato (2012)

were operating income and operating costs. To measure the variation of the operating expenses regard changes in operating profit, Werbin, Vinuesa and Porporato (2012) used the model of Anderson, Banker and Janakiraman (2003).

As a result, it was found that for the mobile sector operating costs increase 0.97% to 1% increase in operating profit and 0.44% decreases when the operating profit decreases 1%. For the accommodation and restoration sector, it was found an increase in operating costs of 0.91% while operating profit increased by 1%, and 0.84% decrease when operating profit decreased 1%.The article proved, then, that sticky costs are observed in Spanish companies in the period from 2005 to 2007 (Werbin; VINUESA; PORPORATO, 2012).

Anderson, Banker and Janakiraman (2003) evaluated whether general, administrative and sales costs have sticky behavior. Primary, secondary and tertiary sectors data were analyzed in a period of 20 years, covering the years from 1979 to 1998. The primary variables of the study are the general, administrative and sales costs and net sales. It was observed that general, administrative and sales costs increased on average by 0.55% to 1% increase in sales, but fell 0.35% to 1% decrease in sales (ANDERSON; BANKER; Janakiraman, 2003)

Subramaniam and Weidenmier (2003) examined whether the behavior of sticky cost depends on the magnitude of the change in activity, or if different levels of sales can impact costs on its own sticky characteristic considering a period of 22 years (1979-2000). As a result, Subramaniam and Weidenmier (2003) observed that general, administrative, sales costs and cost of sales did not exhibit a sticky feature for small changes in revenue; however, when the recipe varies more than 10% costs became sticky. The research also shows that this behavior has inter-industry variation (SUBRAMANIAM; WEIDENMIER, 2003).

Richartz and Borgert (2014) researched how listed Brazilian companies costs behave between 1994 and 2011, emphasizing sticky costs. Results showed that in relation to sticky costs, when performing an overview with all companies, the theory proposed by Anderson, Banker and Janakiraman (2003) is partially applicable, once to varying levels of income of up to 10 % the sticky costs are confirmed (RICHARTZ; BORGET, 2014).

Methodology

The present section will present the methodology applied for the development of this research: characterization, then the outline of the research, the constitutive and operational definitions of variables, population and sample used and, finally, the statistical analysis of data.

Research characterization

The research is characterized as Explanatory or Causal. According to Aaker, Kumar and Day (2001) causal research is used when it is necessary to show that a variable determines the behavior or value of other variables "wherein the causal or independent variables are handled in a relatively controlled environment". At this, other variables can affect the dependent variable, and can be verified or controlled (MALHOTRA, 2012).

This research aims to assess whether the change in the value of a variable has a significant impact on the variable with respect to variable costs and expenses noticed in publicly traded companies in the electricity sector that will be part of the sample.

Research design

Among the items found to statistically undergird this work are the Anderson, Banker and Janakiraman (2003) study, Subramaniam and Weidenmier (2003) and as a main methodological inspiration, Werbin, Vinuesa and Porporato (2012) paper. For this study, were applied methods used Werbin, Vinuesa and Porporato (2012) research. Firstly, data were collected in the consolidated financial statements of Brazilian companies and US companies of electricity sector for the period between 2004-2013 and such data were taken from Economática database in 2015.2014 year's data were not included, since until the date of collection, these data were not available in the database. The variables used in the observation are: gross revenue, variable costs and variable expenses. The model proposed by Anderson, Banker and Janakiraman (2003) study was used, making possible to check for sticky costs in the electricity sector in Brazil and the United States and make a comparison between the results obtained in both countries.

Constitutive and operational definitions of variables

Chart 1 presents constitutive and operational definitions of variables taken from financial statements, which will be used later for the verification of the existence of sticky costs.

Chart 1 – Constitutive and Operational Definitions of Variables

Variables	Constitutive Definition	Operational Definition
Gross Revenue	Total revenue originated from sales related to main activities (FERRARI, 2010).	Gross Revenue.
Variable Costs	Expenses related directly to the production and varying in proportion to the volume produced (MARTINS, 2010).	Costs of goods sold, as per Werbin, Vinuesa and Porporato (2012) study.
Variable Expenses	Expenses that change in proportion to the variation in the volume of revenue (PEREZ JR; OLIVEIRA; COSTA, 2001).	Direct and indirect taxes (taxes on income and taxes on income).

Source: elaborated by the authors (2015).

Regarding the variable costs, since the data provided by the companies were not separated between fixed and variable costs, it was decided to use only data that are uniquely variable, and in the income statement the only expense of this nature is taxes. Given the variables, its constitutive and operational definitions, next section will present the sample to be used for the development of this research.

Research population and sample

Once the publicly traded companies have greater organizational and operational structure, as well as its most relevance in the market, this paper will examine companies whose shares are traded on BM&FBOVESPA (in the case of the Brazilian market), the NASDAQ and NYSE (referring to the US market).

Currently on the BM&FBOVESPA 67 companies whose activities are classified as electrical industry players, either with generation, transmission, distribution, franchise, marketing and/or participation in society of companies that have similar activities trade their shares. Of the population were taken out 15 companies that do not provide financial reports since 2004, 9 holding companies whose subsidiaries have sold their shares, 3 holding companies of participation that invested in many sectors, not only the electrical one, and 7 companies whose data were outdated in Economática. Chart 2 presents a sample of 33 companies in the Brazilian electricity sector, of which financial data will be used, and their respective activities.

Chart 2 - Brazilian companies of electricity sector listed on BM&FBOVESPA and its activities.

Compay	Activity
AES Sul Distribuidora Gaúcha de Energia	Distribution
AES Tietê	Generation
Ampla Energia e Serviços	Distribution
Bandeirante Energia	Distribution
Eletrobrás	Generation, transmissionand distribution
Centrais Elétricas de Santa Catarina	Generation and distribution
Centrais Elétricas do Pará	Distribution
CESP - Companhia Energética de São Paulo	Generation and trade
COELBA - Companhia de Eletricidade do Estado da Bahia	Distribution
Cia Energética de Brasília	Generation and distribution
CEMIG - Companhia Energética de Minas Gerais	Generation, concessions and supply
CELPE - Companhia Energética de Pernambuco	Concessions
COELCE - Companhia Energética do Ceará	Distribution
CEMAR - Companhia Energética do Maranhão	Distribution
COSERN - Companhia Energética do Rio Grande do Norte	Distribution
CEEE-GT - Companhia Estadual de Geração e Transmissão de Energia Elétrica	Generation and transmission
COPEL - Companhia Paranaense de Energia	Generation, distribution, transmission and trade.
Companhia Paulista de Força e Luz	Distribution
Companhia Piratininga de Força e Luz	Distribution
CPFL Geração de Energia	Generation
CTEEP - Companhia de Transmissão de Energia	Transmission

Elétrica Paulista	
Duke Energy International Geração Paranapanema	Generation and trade
EDP Energias do Brasil	Generation, distribution and trade
Elektro - Eletricidade e Serviços	Distribution
Eletropaulo Metropolitana eletricidade de São Paulo	Distribution
EMAE - Empresa Metropolitana de Águas e Energia	Production
ENERSUL - Empresa Energética de Mato Grosso do Sul	Distribution
Energisa	Distribution
Escelsa - Espírito Santo Centrais Elétricas	Distribution
Neoenergia	Generation, distribution, transmissionand trade
PROMAN Geração - Produtores Energéticos de Manso	Generation
Rio Grande Energia	Distribution
Tractebel Energia	Generation and trade

Source: BM&FBOVESPA (2015)

Na categoria de utilidade pública, a NASDAQ comercializa ações de 37 empresas cujas atividades são classificadas como integrantes do subsetor de Electric Utilities. These companies perform generation, transmission, distribution and sale of electricity. To compose the sample were taken out 5 companies that do not have financial reports since 2004, 1 holding company that distributes its investments in several sectors, 1 company whose subsidiaries have shares sold by NASDAQ and 13 companies that have outdated data in the software Economática database. From 57 energy companies that trade their shares on the New York Stock Exchange (NYSE), 8 were integrated into the sample under the same criteria listed above. As standard in the American market, it is possible to realize the extent of the segments of business, but the market profile will be discussed later. Chart 3 presents the 25 companies included in the sample, of which financial data will be used, and their respective activities.

Chart 3 – US Companies of electricity sector listed on NASDAQ and NYSE and its activities.

Empresa	Atividade
American Electric Power Company, Inc.	Generation, transmission and distribution
CenterPoint Energy, Inc.	Transmission and distribution
CMS Energy	Distribution
DominionResources, Inc.	Generation, transmission and distribution
DTE Energy Company	Generation, distribution and sale
Edison International	Generation and supply
Energy Future	Generation, transmission and distribution
Entergy Corporation	Generation, sale and distribution
EverSource	Transmission
FirstEnergy Corporation	Generation, transmission, distribution and sale
GreatPlains Energy Inc	Generation, transmission, distribution and sale
Hawaiian Electric Industries, Inc.	Generation, transmission, distribution and sale
IDACORP, Inc.	Generation, transmission, distribution and sale
Integrys Energy Group	Generation, transmission, distribution
NextEra Energy, Inc.	Generation, transmission, distribution and sale
NRG Energy, Inc.	Generation, transmission, distribution and sale
OGE Energy Corporation	Generation, transmission, distribution and sale
Pinnacle West Capital Corporation	Generation, transmission, distribution and sale
PNM Resources, Inc. (Holding Co.)	Generation and sale
PPL Corporation	Generation and distribution
Puget Energy	Distribution
TECO Energy, Inc.	Generation and sale
Westar Energy	Generation and transmission
Wisconsin Energy	Generation and transmission
XCEL Energy	Generation, transmission and distribution

Source: Adapted from Economática (2015).

Once given the sample, an understanding of the operation of the chosen sector is needed - so the theory developed in this work has application consistent with the chosen market - as well as the understanding of its economic importance. Therefore, the following sections aim to explain the electricity sector as a whole and detail the sector in Brazil and the United States.

Sector Characteristics Observed

The choice of the electricity sector to verify the research hypothesis was given by its importance against the economic development of a country. Energy is an essential requirement for the functioning of the productive apparatus that has a particular society (SILVERIO; WINCK, 2003).

Electricity can be generated from the most diverse sources: hydro, natural gas, oil, coal, nuclear, biomass, wind, solar, geothermal, sea and biogas (CÂMARA DE COMERCIALIZAÇÃO DE ENERGIA ELÉTRICA, 2011). Despite the large number of sources options, some countries, for their environmental characteristics or infrastructure facilities, give preference to power generation with one source instead of the other, a fact to be verified later, when the profile of Brazilian and US markets will be detailed.

The electricity sector has as main segments: electric power generation, transportation (transmission and distribution) and commercialization. The generation is the segment of the industry responsible for producing electric power and direct to transport systems. Concessionary companies are responsible for the transport (transmission) of large quantities of electricity from the generating units to distribution companies or big end user units. Distribution companies have the function of a portion of electric power transmission, as its name implies, distributes electricity to small businesses, industries and residences. The marketing segment is relatively new in Brazil and in the global context; its function is to buy and resell electricity, serving as an intermediary between power plants and free consumers (ASSOCIAÇÃO BRASILEIRA DE DISTRIBUIDORAS DE ENERGIA ELÉTRICA, 2014).

Electricity Sector Profile in Brazil

Regarding the economic importance of electricity to Brazil and the country's potentialities, Gomes et al. (2002) states that it is undeniable that an electric power supply in adequate quantity and quality is a prerequisite for any economic development project. According to the author, the current Brazilian energy matrix and its potential grant a privileged position to the country when it concerns to the sustainable development, since besides hydroelectric potential, other abundant renewable energy sources should be highlighted, for example, biomass, wind power and solar energy.

According to the National Electric Energy Agency of Brazil - ANEEL (2015), Brazil currently has 3,599 generators operating enterprises, providing 133,985,522 kW of installed capacity. This number should increase in upcoming years, since it will be added 36,779,425 kW in generating capacity with 209 projects that are under construction and 575 whose buildings have not yet started.

Of the generating enterprises of electric power in operation in Brazil, 231 are wind power, 317 photovoltaic, 1159 of hydroelectric sources, and 1892 of fuel source (AGÊNCIA NACIONAL DE ENERGIA ELÉTRICA, 2015). Despite the investments for the diversification of the Brazilian energy matrix, the energy produced by hydroelectric source is still the most widely used and commercialized. The effective participation of each source of energy in power generation can be verified in Table 1.

Table 1 – Brazilian Energetic Matrix

Type	Quantity (%)
Hydro	61.96%
Biomass	8.71%
Wind	4.25%
Fossil	18.09%
Nuclear	1.37%
Solar	0.01%
Import	5.61%

Source: Agência Nacional de Energia Elétrica (2015)

Systemic approach to innovation The Brazilian electric sector currently involves the public and private spheres. The generation segment was competitive until 2012; from 2013 on some mills had their prices regulated by the National Electric Energy Agency (ANEEL), as a condition for the renewal of the concession contracts.

In the transport segment, which include the transmission and distribution activities, Brazil has 77 dealers responsible for transmission that operates lines of voltage exceeding 230,000 volts and 63 electricity distribution companies, operating lines of voltage less than 230,000 Volts, which distributes electricity to smaller consumers such as residences, trade and industry. Differently from what happens in the generation segment, the transport segment has its activity fully controlled by ANEEL, since the review and periodic adjustment of prices to the negotiation of the concession contracts.

Finally, the marketing segment, as explained above, is relatively new in Brazil and in the world, the first contact of the domestic market with this type of activity was in 1999 and currently has over 100 companies conducting trade electricity, which serves as an intermediate between plants and free consumers (ASSOCIAÇÃO BRASILEIRA DE ENERGIA ELÉTRICA, 2014).

Profile of the electric sector in the United States

The US electricity sector was chosen for characterization of the country as the greatest power in the global economy, in addition to the degree of excellence of its operations, considered reference. Also, several previous research has analyzed the American electricity sector (CARLEY; ANDREWS, 2012; BURTRAW et al., 2013; YI, 2015; SAUNORIS; SHERIDAN, 2013). On the economic importance of the United States, Ceceña (2002) states that the country has technological superiority in almost all strategic fields of competition; superiority in control of natural sources of strategic resources; productive network of greater depth and density in the world; management of more diverse labor market from the cultural, geographical and levels and types of knowledge points of view.

According to the US Energy Information Administration - EIA (2012) there are 3,115 power plants in operation on American soil, with generation capacity of at least 1 MW, of these 315 are coal, 815 oil, 797 gas, 34 power nuclear, hydro 875, 238 other renewable sources, 36 hydroelectric storage and 5 other sources.

Data indicate that in 2013 were generated 4.058 billion kilowatt-hours, of this total 68% was derived from burning fossil fuels (coal, natural gas and oil) and of those approximately 39% just from burning coal. The details of power generation by source type can be verified in Table 2.

Table 2 – US Energetic Matrix

Type	Quantity (%)
Coal	39.00%
Natural Gas	27.00%
Nuclear	19.00%
Hydro	6.00%
Biomass	1.70%
Geothermal	0.40%
Solar	0.40%
Wind	4.40%
Oil	1.00%
Other Gases	<1%

Source: U.S. Energy Information Administration (2014)

Through the graphs, it is possible to observe that both in Brazil and in the United States the diversity of energy sources is large, however the effective participation of each source in the generation of energy is what differentiates and characterizes the energy sector of each country. In Brazil, the major source is hydroelectric, which is justified by its extensive watershed, all other sources of energy serve as complements. In the United States, on the other hand, is possible to verify a balanced distribution of power generation between nuclear, natural gas and especially coal.

Data collect

The observation period of 10 years, beginning in 2004 and ending in 2013, was chosen based on previous studies that also analyzed secondary data from financial statements, which: Brugni et al. (2012), Carvalho et al. (2014), Avelar, Santos, Ribeiro and Oliveira (2012) and Silva Tavares, Araújo e Silva (2013).

As Catapan et al. (2013) and Artuso and Neto (2010) data were collected using the Economática software. The number of companies and their respective variables over 10 years give the study 1,740 observations.

Processing statistical data

The statistical processing of data, multiple linear regression was chosen. According to Hair, Anderson, and Tatham (2005), when there is a dependent variable and more than one explanatory variable, regression is presented as the most suitable method for the treatment of the data. Gujarati and Porter (2010) state that the regression of the dependency is a variable study for one or more variables in order to estimate the average value of the first population as a function of known values of the second one.

Regarding the multiplicity of variables in the linear regression, Gujari and Porter (2010) explain that in this model the dependent variable depends on two or more independent variables, in the case of this research, for example, has two independent variables.

Regression model proposed by Anderson, Janakiraman and Banker (2003), also used by Werbin, Vinuesa and Porporato (2012), used in this study can be verified in Formula 1 below.

$$\log\left(\frac{NI_{i,t}}{NI_{i,t-1}}\right) = \beta_0 + \beta_1 \log\left(\frac{CE_{i,t}}{CE_{i,t-1}}\right) + \beta_2 * Dummy_{i,t} * \log\left(\frac{CE_{i,t}}{CE_{i,t-1}}\right) + \varepsilon_{i,t}$$

Wherin:
NI = Net Income.
CD = Variable Costs and Expenses = costs of goods sold + taxes.

To apply Anderson, Banker and Janakiraman (2003) model, was necessary set variable cost and expenses as a direct function of net operating income, due to the need to establish a relationship between the current net income (〖NI〗_(i,t))and the net income of previous period (〖NI〗_(i,t-1)).Therefore, establishing the same relation to the current variable costs and expenses (〖CE〗_(i,t))and variable costs and expenses of previous period (〖CE〗_(i,t-1)).

In order to show whether there is or not the presence of sticky costs, it will be included a dichotomous variable (Dummy) to be equal to 1 when the net income decrease between the analyzed periods and equal to 0 when the net income increases or remains the same (WERBIN; VINUESA; PORPORATO, 2012). Anderson, Banker and Janakiraman (2003) highlight that if traditional model of variable costs is valid, changes in cost, for more or less, are equal and therefore, β_2=0.

Similarly, when revenue increases, the value of the variable Dummy is 0 and β_1 coefficient will aim to measure the percentage of increase in expenses compared to an increase of 1% of revenue. In addition, in the situation where the income decreases, the value of the dummy is 1 and the sum of the coefficients β_1+ β_2 measures the percentage by which operating expenses decrease compared to a decrease of 1% in revenue (WERBIN; VINUESA; PORPORATO, 2012). If the operating expenses are sticky, the variation they face when an increase in revenue occurs should be superior when the opposite happens, in case of a lower revenue.

Therefore, the hypothesis for the sticky costs is that when β_1 is positive, β_2 will be negative and less than β_1, considering an absolute value (WERBIN; VINUESA; PORPORATO, 2012).

Presentation and analysis of research findings

The work presented by Werbin, Vinuesa and Porporato (2012) used as data processing the multiple linear regression model between operating income (independent variable) and operating costs (dependent variable). Performing multiple linear regression in data obtained from American and Brazilian energy sectors in order to understand how much revenue can be explained by the amount of variable costs (cost of goods sold), the following results were obtained:

Table 3 – Regression results considering only the cost of goods sold

Brazil		United States	
R multiple	0,57	R multiple	0,88
R-Squared	0,320	R-Squared	0,779
Adjusted R-Squared	0,318	Adjusted R-Squared	0,778
Standard Error	2.122.097	Standard Error	2.143.684
Observations	330	Observations	250

Source: Elaborated by the authors (2015).

According to Hair et al (2005) the R multiple is the correlation coefficient between the dependent variable (cost of goods sold) and the independent variable (income).By calculating the multiple linear regression between the variables, it was possible to notice a big difference between Brazil and the United States regarding the correlation between electricity sector revenues and costs, while 88% of revenue can be explained by the amount of the costs in the United States, only 57% can be explained in Brazil.

The R-squared, also known as the coefficient of determination, shows the percentage of variation of the independent variable that can be explained by the dependent variable (HAIR et al, 2005). The R-squared applied to this study indicates how much of the variation in income can be explained by the cost of goods sold: while 77.8% of American income can be explained by costs, in Brazil this ratio is only of 31.8%.

By understanding that the relevance of the explanation of cost of goods sold in relation to income is low, and in order to increase the predictive model proposed by previous authors, it was opted to add taxes as variable expense. In Brazil, only tax on net income, since the disclosure of the data comes from the net income; and in the case of the United States, taxes on revenue - since the release of data comes from the gross revenue - in addition to the income taxes). Thus, the regression model can be applied with a higher degree of reliability, as a result, the Brazilian market coefficients proved more satisfactory, as can be observed in Table 4.

Table 4 – Regression results considering the cost of goods sold and taxes.

Brazil		United States	
R multiple	0,66	R multiple	0,92
R-Squared	0,44	R-Squared	0,85
Adjusted R-Squared	0,44	Adjusted R-Squared	0,85
Standard Error	1.928.341	Standard Error	1.760.804
Observations	330	Observations	250

Source: Elaborated by the authors (2015).

With the addition of taxes, the relationship explained between the dependent and independent variables increased from 57% to 66% in the Brazilian electricity sector and 88% to 92% in the US, confirming the increase in the model prediction relevance. The explanation of the revenue variation also had numbers that are more consistent in the Brazilian electricity sector, 44% of the variation can be explained by the

cost of goods sold and income tax; and in the American electric sector, the variation in the revenue has a correlation of 85% with the dependent variables.

Descriptive statistics

This section presents the data collected from 58 companies in the sample, 33 Brazilian and 25 from United States. Revenue, cost of goods sold and income tax were collected over a decade, giving 1,740 observations to the research. In order to summarize the information and realize the sample tendencies, it will be used the method of descriptive statistics.

The data presented in the following subsections are separated by country and summarized per year. The descriptive analysis will be made by calculating the mean, standard error, median, mode, standard deviation, the sample variance, kurtosis, asymmetry, minimum, maximum, and counting, the concepts of these measures are summarized in Chart 4. It is necessary to point out that all values were calculated in US dollars, both for Brazilian companies as American, in order to standardize the unit of measure.

Chart 4 – Summary of measure tendencies

Measure tendency	Description
Mean	Sum of the values of the observations divided by the number of observations. Sample balance point.
Standard Error	Sample standard deviation divided by the square root of the sample size.
Median	Value that takes the central position of the observed sample.
Mode	Value of observations that is most often found.
Standard Deviation	Square root of the variance, evaluates mean distortion to the observed values.
Sample Variance	Average squared deviation from the mean.
Kurtosis	Degree of flattening of the distribution, to quantify distribution concentration or dispersion.
Asymmetry	It describes how data is distributed.

Source: Adapted from Guedes et al. (2005) and Dancey and Reidy (2013)

Table 5 presents the means descriptive statistics found between the years 2004 and 2013, considering only companies in the Brazilian electric sector. Data are shown in Brazilian currency (Real).

Table 5 – Descriptive statistics of Brazilian companies between the years 2004 and 2013

	Revenue	CGS	Taxes
Mean	1,688,219.97	886,837.17	77,415.95
Standard error	141,461.74	56,422.72	7,946.06
Median	946,537.50	555,085.00	37,271.50
Standard deviation	2,569,780.19	1,024,969.62	144,347.30
Sample Variance	6,603,770,216,770.99	1,050,562,725,280.12	20,836,142,882.02
Kurtosis	19.71	5.00	25.95
Asymmetry	4.03	2.13	3.14
Interval	19,348,598.00	6,059,962.00	2,067,746.00
Maximum	-	-	(687,123.00)
Minimum	19,348,598.00	6,059,962.00	1,380,623.00

Source: elaborated by the authors (2015).
Note: Data in millions of reais (R$).

Since the sample variance and standard deviation, the general mean for the decade does not faithfully represent the individual elements of the sample, this is due to the fact that companies have very different sizes, revenue volumes and operations, however describes the scenario of the Brazilian market during the analyzed decade, facilitating the comparison with the American market.

The asymmetry of the data is very close to 0, giving the distribution curve a very similar characteristic to a standard curve, the negative kurtosis, however, shows that the data are more widely dispersed along the curve, the reason why the distribution is flatter. As Table 5 shows the average of the result of Brazilian electricity sector between 2004 and 2013, Table 6 shows the results of the US market.

Table 6 – Descriptive statistics of American companies between the years 2004 and 2013

	Revenue	CGS	Taxes
Mean	7,172,895.81	3,497,211.88	212,803.21
Standard Error	287,856.29	136,650.22	20,994.40
Median	6,481,000.00	3,509,800.00	148,700.00
Standard Deviation	4,551,407.51	2,160,629.73	331,950.66
Sample Variance	20,715,310,328,852.20	4,668,320,827,653.34	110,191,241,912.44
Kurtosis	(1.06)	0.13	8.57
Asymmetry	0.42	0.59	0.57
Interval	17,196,509.00	11,978,612.00	3,328,000.00
Maximum	844,491.00	419,788.00	(1,271,000.00)
Minimum	18,041,000.00	12,398,400.00	2,057,000.00

Source: Elaborated by the authors (2015).
Note: Data in millions of dollars (US$).

It was decided to not take all the data, both Brazilian companies as US companies, due to the great variation of the real against the dollar in recent months.

In Table 6, as explained earlier, the overall mean of market cannot be used to accurately treat the individual elements of the sample, given the high levels of variance

and standard deviation, explained by the difference between the sizes of the companies studied, which work with different levels of operation. The positive kurtosis checked in revenue, cost of goods sold (CGS) and taxes shows that the data are concentrated in the center of the curve, with high elevation and reduction of the amplitude. The negative asymmetry presented by the revenue, shows that the curve tends to extend to the left, and the positive asymmetry of variable costs and expenses shows a curve which extend to the right. However, the curves begin to move away from the normal curve significantly only when they have values greater than±1 (CET, 2014), what is noticed only by the average of costs of goods sold.

Regressions

For indexes that indicate the presence or absence of sticky costs in the electricity sector in Brazil and the United States, the regression model proposed by Anderson, Banker and Janakiraman (2003) was used, as set out above. The regression results are shown in Tables 7 and 8.

Table 7 – Statistical regression between NI and CE of Brazilian companies

Brazil –Statistical regression	
R multiple	0,49
R-Squared	0,24
Adjusted R-Squared	0,23
Standard Error	0,21
Observations	297

Source: Elaborated by the authors (2015).

The data submitted to regression - through the Anderson, Banker and Janakiraman (2003) model - show a low correlation between the variables. By 21% of error, 49% of total revenue can be explained by variable costs and expenses. The revenue changes over the analyzed decade have only 24% of relation with costs of goods sold and income tax. Table 8 shows regression coefficients of Brazilian companies.

Table 8 – Statistical regression between NI and CE of Brazilian companies

	Coefficient	Standard Error	T Test	P value
Intersection	-0.0076	0.018219	-0.41732	0.676752
X1 Variable	1.31926	0.204714	6.444397	4.74E-10
X2 Variable	-0.53948	0.302692	-1.78228	0.075736

Source: Elaborated by the authors (2015).

To analyze sticky costs, the method transforms the regression coefficients in percentage. Thus, the coefficients found in the application of the formula wereβ_0=-0,0076%; β_1=1,32%, that is, every 1% increase in revenue, expenditures increase 1.32%, andβ_2= -0,54%. The sum of the coefficientsβ_1+ β_2=0,78%measures the percentage that decreases the expenses when revenue decreases 1%.The results confirm the presence of sticky costs in Brazilian electric sector companies, since the change in costs is superior to an increase in revenue (1.32% for each 1% increase in

revenue) compared to the variation a decrease in revenue happens (0.78% for every 1% decrease in revenue).Another condition for the evidence of the existence of sticky costs met by results is the empirical hypothesis that whenβ_1is positiveβ_2is negative and smaller thanβ_1in absolute value. Table 9 shows the results for American companies.

Table 9 – Statistical regression between NI and CE of American companies

United States – Statistical Regression	
R multiple	0,87
R-Squared	0,75
Adjusted R-Squared	0,75
Standard Error	0,05
Observations	225

Source: Elaborated by the authors (2015).

By calculating the regression to American companies, the result of correlation between dependent and independent variables shown by R multiple efficient, by a standard error of 5%, was 87%; and 75% of the variation in income can be explained by the variable costs and expenses. Table 10 presents the regression coefficients of American companies.

Table 10 – Statistical regression between NI and CE of American companies

	Coefficient	Standard Error	T Test	P value
Intersection	0.004759	0.004518	1.05336	0.293321
X1Variable	1.018322	0.082921	12.28062	8.54E-27
X2 Variable	0.557541	0.135991	4.099827	5.8E-05

Source: Elaborated by the authors (2015).

The coefficients found in the application of the formula wereβ_0=-0,0047%; β_1=1,02%, that is, each 1% of increase in revenue the expenses increased 1.02%; β_2= 0,56%. The sum of coefficientsβ_1+ β_2=1,58%, which measures the percentage that expenses decrease faces a 1% of decrease in revenue, showed a higher result than the variation of expenses to an increase of 1% in revenue. This result proves that there is no presence of sticky costs in the observed American companies. Another fact that points to the absence of sticky costs is that despiteβ_2being smaller thanβ_1in absolute value, the coefficient is not negative, not respecting the condition to establishing the existence of sticky costs, as per Werbin, Vinuesa and Porporato (2012).

Conclusions

The impact and relevance of costs in US and Brazilian companies are distinguished precisely by their different energy matrices. As shown previously, the US energy matrix is diversified and balanced with respect to the use of different energy sources. This mixed production incurs more production costs and, thus, more variable expenses, which will affect the margin and consequently in revenue. On the other hand, in Brazil, the energy matrix depends only 63% of a source, hydroelectric, which was

already mentioned, has as a fuel with zero raw material cost: water. This explains the low cost impact on revenue.

The analysis of the sticky costs reveals a different market profile and cost management between both countries. The results presented by US companies demonstrate efficiency in cost management, when there is a greater variation in costs when decrease in revenue occurs, and as this goes directly against the logic of sticky costs, since sticky costs present less variation when facing a decrease in revenue. Can be said, then, that there is a bigger control of expenses and an effective strategic management to variations in revenue. It must be noted that the impact and relevance of sticky costs, if they existed in the American electricity sector, would be high, impacting directly on costs and tariffs to maintain the level of income, given the results obtained in the regression that shows the correlation between income and variable expenses.

The evidence of the existence of sticky costs in the case of Brazilian companies reveals a weaker cost management. This can be explained by the configuration of distribution and generation companies, generally of mixed economy, have a management focused on politics and not necessarily to the results. This may help to explain the current situation of the distribution companies, which had to raise tariffs for end users because the generation companies needed to operate thermoelectric plants as a solution to the low level of water reservoirs of hydroelectric plants, incurring in an increase of costs (AES ELETROPAULO, 2015). On the other hand, as seen in the results of the regression variables, expenses have a correlation of only 49% with revenue, so the relevance of the stickiness of these expenditures is questionable. In any case, the existence of sticky costs should be considered to rethink the management that has been taken in these companies, as the market requires a management focused on competence and results than to obtain political advantages. Greater control of sticky costs may contribute to a decrease in the impact of stickiness on actual business costs and thus reduce the negative impact on revenue in times of crisis, as the one observed nowadays.

Although it is not a new theme, there are few studies on sticky costs, which have limited support on the subject. In later works, it is recommended to explore other sectors, compare different sectors, increase the number of countries analyzed, as well as the chosen period. Another approach that can be given is about the power purchase agreements with the distribution companies, since these contracts, when poorly done, can result in cost impact according to the level of effective demand for electricity.

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