RELATIONSHIP BETWEEN INVESTMENT AND CASH FLOW OF BRAZILIAN ELECTRICITY SECTOR COMPANIES UNDER CONDITIONS OF FINANCIAL CONSTRAINT

Juliana Cardoso Amaral[1]
Laíse Ferraz Correia[2]
Joyce Mariella Medeiros Cavalcanti[3]
Hudson Fernandes Amaral[4]

▪ Received: 06/16/2024 ▪▪ Approved: 05/15/2025

ABSTRACT

The choice of investments that provide the best risk–return trade-off and the resources to finance them are fundamental factors in financial decision-making. Market imperfections, financing costs, and access to external funds can create financial constraints for companies, making them dependent on internal funds to implement their projects. This study analyzed the relationship between investment and cash flow of companies in the Brazilian electricity sector under conditions of financial constraint. To this end, accounting and financial data were collected from electricity sector companies listed on Brasil, Bolsa, Balcão (B3). Five criteria were used to classify companies as financially constrained or unconstrained: dividend policy, firm size, return on assets, interest coverage ratio, and corporate governance. The relationship was estimated using quantile regression models with panel data from 35 electricity sector companies over the period 2009 to 2019. The results show that investments are sensitive to cash flow in Brazilian electricity sector companies, and are also influenced by the interest rate, Tobin's q, and market value. No such effect was observed for cost of capital and debt. It is concluded

[1] Master's in Administration from the Graduate Program in Administration at the Federal Center for Technological Education of Minas Gerais (CEFET-MG), Avenida Amazonas, 7675, Nova Gameleira, CEFET-MG Campus Nova Gameleira – Main Building, 2nd floor, Room 201, Belo Horizonte/MG, Brazil, (31) 3319-6740, jucardosoadm@gmail.com. https://orcid.org/0000-0002-5882-2213.

[2] PhD in Administration from the Federal University of Minas Gerais (UFMG). Professor in the Graduate Program in Administration at the Federal Center for Technological Education of Minas Gerais (CEFET-MG), Avenida Amazonas, 7675, Nova Gameleira, CEFET-MG Campus Nova Gameleira – Main Building, 2nd floor, Room 201, Belo Horizonte/MG, Brazil, (31) 3319-6740, laise@cefetmg.br. https://orcid.org/0000-0002-0977-9298.

[3] PhD in Administration from the Federal University of Minas Gerais (UFMG). Professor in the Graduate Program in Administration at Universidade Potiguar, Avenida Senador Salgado Filho, 1610, Lagoa Nova, Natal/RN, Brazil, (84) 3227-1234, joyce.cavalcant@ulife.com.br. https://orcid.org/0000-0001-6213-1266.

[4] PhD in Management Sciences (Sciences de Gestion) from Université Pierre Mendès France – Grenoble II. Professor in the Academic Master's Program in Administration at Centro Universitário Unihorizontes, Brazil, (31) 3349-2933, hudson.amaral@unihorizontes.br. https://orcid.org/0000-0001-8455-0285.

The authors would like to thank the Federal Center for Technological Education of Minas Gerais (CEFET-MG), the Minas Gerais State Agency for Research and Development (FAPEMIG), the National Council for Scientific and Technological Development (CNPq), and Anima Institute (AI) for their support.

that analyzing the relationship between investment and cash flow under conditions of financial constraint contributes to the decision-making process of companies in the accounting and financial domains.

Keywords: Investment. Cash flow. Financial Constraint. Electricity Sector. Decision-Making.

RELACIONAMENTO ENTRE INVESTIMENTO E FLUXO DE CAIXA DE COMPANHIAS DO SETOR ELÉTRICO BRASILEIRO SOB CONDIÇÕES DE RESTRIÇÃO FINANCEIRA

RESUMO

A escolha de investimentos que ofereçam a melhor relação risco-retorno e os recursos para financiá-los são fatores fundamentais na tomada de decisões financeiras. Imperfeições de mercado, custos de financiamento e acesso a recursos externos podem acarretar restrições financeiras às empresas, o que as tornam dependentes de recursos internos para execução de seus projetos. Nesse sentido, este artigo analisou a relação entre investimento e fluxo de caixa de companhias do setor elétrico brasileiro sob condições de restrição financeira. Para isso, foram coletadas informações contábeis e financeiras de companhias listadas na Brasil, Bolsa, Balcão (B3) pertencentes ao setor elétrico. Para classificar as companhias em restritas e irrestritas financeiramente, cinco critérios diferentes foram utilizados: política de dividendos; tamanho; rentabilidade do ativo; índice de cobertura de juros; e governança corporativa. A relação pesquisada foi estimada por meio de modelos de regressão quantílica com dados em painel de 35 companhias do setor elétrico no período de 2009 a 2019. Os resultados encontrados demonstraram que existe uma sensibilidade dos investimentos ao fluxo de caixa nas empresas do setor elétrico brasileiro, os quais são impactados também pela taxa de juros, Q de Tobin e valor de mercado. Essas evidências não foram observadas para custo de capital e dívida. Conclui-se, assim, que a análise do relacionamento entre investimento e fluxo de caixa, em condições de restrição financeira, contribui para o processo da tomada de decisão das empresas nas áreas contábil e financeira.

Palavras-Chave: Investimento. Fluxo de caixa. Restrição financeira. Setor Elétrico. Tomada de Decisão.

1 INTRODUCTION

The relationship between corporate investment and financing sources has been extensively discussed in the corporate finance literature in recent years (Chalhoub, Kirch & Terra, 2015; Byrro & Bressan, 2016; Bragioni & Santos, 2018; Pereira & Botinha, 2018; Machado, Meirelles & Rossetti, 2019). Modigliani and Miller (1958) – a landmark in the theory of investment, capital structure, and cost of capital – initially argued that a company's value is independent of its capital structure; in other words, financing decisions are irrelevant to the determination of firms' market value. They proposed that the weighted average cost of capital

(WACC) would remain constant across different funding choices, thereby suggesting that firm value depends solely on the quality of investments. Later, Modigliani and Miller (1963) revised this model to incorporate the effects of taxation, recognizing them as a relevant market imperfection. Subsequently, other market imperfections were incorporated into the literature, such as agency costs, bankruptcy costs, and information asymmetry. Other theorists, such as proponents of the Trade-Off Theory and the Pecking Order Theory, argued that the costs of external financing tend to increase with financial leverage – either in the pursuit of an optimal debt level or in determining the preference for financing sources, namely raising debt and/or issuing new equity.

In this sense, given the limited access to external capital, firms may face financial constraints that directly affect their investment decisions, as these constraints create dependence on internal funds (Fazzari, Hubbard, Petersen, Blinder & Poterba, 1988; Almeida, Campello & Weisbach, 2004). Although extensively analyzed, the field of financial research that examines the association between investment and internal cash generation – particularly when firms are financially constrained – still presents gaps, not only regarding the degree and direction of this relationship but also concerning methods for measuring financial constraints (Denis & Sibilkov, 2010). On one hand, empirical studies show that financially constrained firms rely more on internal funds to finance their investments than unconstrained firms (Fazzari et al., 1988; Schaller, 1993; Terra, 2003; Almeida & Campello, 2007; Chen, Liu & Wang, 2013; Machado, Meirelles & Rossetti, 2019). On the other hand, other studies report opposite findings, showing that less financially constrained firms display greater sensitivity of investment to cash flow, thereby questioning the reliability of cash flow as a proxy for the availability of internal funds (Kaplan & Zingales, 1997; Cleary, 1999; Hamburger, 2003; Aldrighi & Bisinha, 2010; Madeira, 2013).

The financial constraints faced by companies can be aggravated by the economic environment in which they operate and by the nature of their operations. In this regard, it is relevant to examine the impact of this phenomenon on companies in strategic sectors such as the electricity industry, which plays an important role in the economic and social development of countries.

The Brazilian electricity sector, in particular, comprises companies that operate in a complex and demanding context, which, in order to remain viable, has for decades required large volumes of both public and private investment (Leopoldi & Francisco, 2023). According to these authors, over the past decades the national electricity sector has been affected by a succession of domestic and international economic crises. Since the 1980s, the country has faced hyperinflation, rising external debt, and the consequences of the 1994 monetary stabilization. Later, between 1998 and 1999, international financial crises culminated in the collapse of the Real Plan, which led to a reorientation of Brazil's macroeconomic policy. Leopoldi and Francisco (2023) show that this succession of crises, together with the fiscal adjustment policies of the 1990s, reduced investment in the electricity sector, generating crises and blackouts, such as the one that occurred in 2001. They also note that resource allocation in the sector varied considerably between 1995 and 2021, particularly from 2016 onward, when investment levels fell sharply.

With all this in mind, it is pertinent to ask: to what extent does the cash flow of companies in the Brazilian electricity sector affect their investment under conditions of financial constraint?

Thus, the aim of this article is to analyze the relationship between investment and cash flow of Brazilian electricity companies listed on B3, under conditions of financial constraint. It is expected that investment will be more sensitive to cash flow in financially constrained firms, given their greater reliance on internal funds for financing.

This study is relevant for several reasons. First, because there is no consensus in the literature regarding the relationship between investment and cash flow under financial constraints, particularly with respect to the most appropriate methodology for classifying firms as financially constrained or unconstrained (Denis & Sibilkov, 2010). Second, due to the scarcity of previous studies focusing on the Brazilian electricity sector. Third, because the results documented here reveal the sensitivity of investment in Brazilian electricity sector companies to variations in cash flow, which are also affected by the interest rate, Tobin's q, and firms' market value. These results have important implications for emerging economies in which the electricity sector is a key driver of economic and social development; they may guide public policymakers in designing prudent fiscal, financial, and regulatory measures to mitigate the negative effects of reduced investment in the sector.

This article is organized into five sections, including this introduction. The second section presents the theoretical background and develops the hypotheses, as well as discussing the main theories and empirical studies on the relationship between investment and cash flow in the context of financial constraint. The third section describes the method used in the empirical analysis. The fourth presents and discusses the results in light of previous studies. The fifth and final section sets out the conclusions.

2 THEORETICAL FRAMEWORK

2.1 Capital Structure Theories

One of the central topics in finance theory is capital structure, that is, the ways in which firms finance themselves – whether through equity, debt, or an optimal combination of both. The main discussion lies in examining whether the method of financing affects the market value of a firm. In the traditional approach, Durand (1952) argued for the existence of an optimal capital structure that minimizes the weighted average cost of capital (WACC) and maximizes firm value. In contrast, in Modern Financial Theory, Modigliani and Miller (1958) proposed that, in a perfect market, capital structure would be irrelevant to firm value, since the increased risk from leverage would offset the gains from the use of debt. However, when taxes are taken into account – a market imperfection – Modigliani and Miller (1963) recognized the importance of the tax shield on debt for firm value. Other authors (Jensen & Meckling, 1976; Myers & Majluf, 1984) identified the effects of additional market imperfections, such as agency costs, bankruptcy costs, and information asymmetry. In this context, two key theories were proposed: (i) the Trade-Off Theory, which postulates that firms should pursue an optimal level of

leverage by balancing tax benefits against bankruptcy costs; and (ii) the Pecking Order Theory, which suggests that firms follow a financing hierarchy, starting with internal funds, followed by debt, and finally equity issuance. It is worth noting that this remains an open debate in finance theory.

In a scenario of unlimited resources, in theory, investment decisions could be made simply by accepting projects whose estimated return exceeds the opportunity cost, while rejecting the rest. In practice, however, resources are scarce, and firms must balance the use of internal and external funds, considering their respective constraints and costs. The next section discusses empirical studies on the relationship between investment and cash flow, with emphasis on the proxies used to classify firms according to financial constraints, in order to develop the research hypotheses.

2.2 Development of the Research Hypotheses

In one of the first studies on the subject, Fazzari et al. (1988) empirically tested the sensitivity of investment to variations in cash flow availability in a sample of 421 U.S. manufacturing firms, using data from a 15-year period (1970-1984). As a criterion for classifying financially constrained firms, they employed the dividend payout ratio. According to these authors, if the cost of external financing could be disregarded, the volume of retained internal funds should not provide meaningful information about investment. This is because, when faced with any variation in capital availability, firms could resort to external financing to ensure their investments were executed. Conversely, if the cost of external financing is significant, the fact that firms consistently retain profits may suggest difficulties in accessing other low-cost sources of financing, highlighting dependence on cash flow for investment. The results of Fazzari et al. (1988) revealed that more financially constrained firms had their investment capacity more strongly affected.

Based on the analysis of 49 firms that composed Group 01 of Fazzari et al.'s (1988) sample – low-dividend-paying firms – Kaplan and Zingales (1997) introduced a new categorization of these organizations, based on (i) qualitative criteria related to firms' soundness, as reported in annual reports and market disclosures; and (ii) quantitative financial indicators, such as liquidity, leverage, sales growth, interest coverage, profit margin, and debt capacity. However, Kaplan and Zingales (1997) refuted Fazzari et al.'s (1988) hypothesis, arguing that less financially constrained firms exhibit greater investment sensitivity to cash flow. They concluded that cash flow is an unreliable proxy for the availability of internal funds, while also questioning the very existence of a relationship between investment, cash flow, and financial constraints.

Subsequently, Almeida, Campello, and Weisbach (2004) re-examined the models of Fazzari et al. (1988) and Kaplan and Zingales (1997), introducing variations. They modeled firms' demand for liquidity to develop a new test of the effect of financial constraints on financing decisions. They analyzed manufacturing firms from 1971 to 2000, applying criteria such as dividend distribution policy, bond ratings, firm size, and the Kaplan and Zingales (1997) index – the KZ index – to determine the degree of financial constraint faced by the firms. They found that firms' ability to save through cash flow retention reflects the effects

of financial constraints more accurately than investment sensitivity. However, when categorized by the KZ index, firms displayed the opposite behavior.

This model was tested by Chalhoub, Kirch, and Terra (2015) in a study of Brazilian firms, using firm size (total assets) as a proxy for financial constraint. Their findings indicated that more financially constrained firms are more likely to retain internal funds. Expanding this line of inquiry, Bragioni and Santos (2018) analyzed the impact of financial constraints on the relationship between investment and cash flow in a sample of 319 publicly traded firms listed in the different corporate governance segments of B3 between 2009 and 2016. They considered a set of variables to measure the degree of financial constraint, including capital retention, firm size (total assets), capital expenditures (CAPEX), Tobin's q, corporate governance, cash flow, geographic location, and asset tangibility. Their results indicated a positive and significant relationship between financial constraints and cash flow sensitivity, corroborating the hypotheses of Fazzari et al. (1988) and Almeida, Campello, and Weisbach (2004), which suggest that firms with lower liquidity and cash flow tend to retain more resources. They also found that cash retention is more pronounced in firms located near the country's main financial center, regardless of governance level.

New models were proposed over time, such as Almeida and Campello (2007), who introduced asset tangibility as a facilitating factor for firms in obtaining credit. Kirch, Procianoy, and Terra (2014) applied Almeida and Campello's (2007) methodology to Brazilian firms and corroborated their findings. They classified firms according to two schemes: (1) total assets; and (2) sector and total assets. They concluded that the investment demand of less financially constrained firms is sensitive only to their investment opportunities. Among constrained firms, investment demand is sensitive to the availability of internal funds (cash flows). In firms classified as constrained under Scheme (2), not only was this sensitivity positive, but there was also evidence that it increases with the level of asset tangibility. Under Scheme (1), however, no such relationship was identified.

Considering the role of asset tangibility, Guan, Mittoo, and Zhang (2021) analyzed the relationship between investment and cash flow in a sample of manufacturing and energy firms in Canada and the United States from 1981 to 2015. Their results showed that the relationship is dominated by the sensitivity of investment to cash flow and asset tangibility, and that this sensitivity has been declining in manufacturing in recent years. This decline reflects the fact that investment is sensitive to both the predictability of cash flows and the tangibility of assets. They also found no evidence of such a decline in the energy sector. In addition, Guan, Mittoo, and Zhang (2021) examined two cycles of rising and falling oil prices as a natural experiment to distinguish the impact of financial constraints and asset tangibility on the investment-cash flow relationship. They observed that asset tangibility has a more relevant impact on investment than financial constraints in the sample considered.

In the electricity sector, where the nature of the business requires large-scale investments – mostly characterized by high tangibility (land, facilities, and equipment) – this variable can play a significant role in the model. Miranda and Callado (2019), for example, when analyzing the relationship between the intangibility index and performance variables of companies in the Brazilian

electricity sector, showed that returns obtained through tangible assets are higher than those from investments in intangible assets, underscoring the importance of tangible assets for these firms.

Using a method similar to that of Fazzari et al. (1988) – which incorporated factors such as changes in total debt and the Working Capital Investment Requirement (NIG) – Machado, Meirelles, and Rossetti (2019) analyzed a sample of 42 Brazilian companies in the manufacturing and extractive industries listed on B3 to study the effect of financial constraints (classified using the Interest Coverage Ratio, ICR) on investment. Their results showed that financially constrained firms rely more heavily on internal funds to finance their investments than unconstrained firms.

Examining the effect of macroeconomic variables on investment, studies such as Almeida, Campello, and Weisbach (2004) and Khurana, Martin, and Pereira (2006) assessed the sensitivity of cash flow to economic cycles, using real GDP growth, inflation, and variations in the benchmark interest rate as independent variables. The findings showed that firms are less sensitive during periods of economic expansion and more sensitive during recessions. The hypothesis was that an increase in credit supply or a reduction in interest rates would lessen firms' financial constraints and, consequently, reduce the sensitivity of investment to cash flow, thereby leading to higher levels of investment.

Financial leverage has also been considered in prior studies as a driver of firms' investment decisions. According to Fu and Tang (2016), leverage can mitigate agency costs; however, an increase in short-term debt can hinder firms' ability to maintain operational liquidity and, consequently, reduce their capacity to undertake long-term investments.

In light of these findings, it is clear that the sensitivity of investment to variations in cash flow under financial constraints remains a controversial issue in accounting and finance, with numerous variables tested in the literature to classify the degree of firms' financial constraint. There is also a notable lack of studies evaluating these dynamics within specific sectors.

The following research hypotheses are therefore proposed:

H_1: Firms with low dividend payout ratios face greater financial constraints, indicating the need to retain internal funds to finance their investments.

H_2: Smaller firms face greater difficulty accessing debt and equity markets, implying greater reliance on internally generated cash flow to finance their investments.

H_3: Firms with higher return on assets signal greater debt repayment capacity and, consequently, greater access to credit to finance their investments.

H_4: Firms with a higher Interest Coverage Ratio (ICR) have broader access to external funds to finance their investments.

H_5: Firms with higher levels of corporate governance provide greater security to investors and, consequently, have greater access to external financing.

H_6: The higher the cash flows of Brazilian electricity sector companies listed on B3, the greater their investment levels under conditions of financial constraint.

3 METHODOLOGY

To construct the sample for this study, we compiled a list of 57 companies in the electricity segment listed on B3 (Brasil, Bolsa, Balcão). From this group, 22 firms were excluded because they did not have assets traded on the spot market, leaving 35 companies in the final sample.

After extracting data for the 35 companies from the Bloomberg platform, quarterly information was collected from their financial statements for the period 2009 to 2019, totaling 1,540 observations. Subsequent years were excluded from the analysis due to the potential effects of the COVID-19 pandemic on the variables, especially investment, cash flow, and financial constraints. In addition, the year 2008 was included to calculate lagged variables. Next, 60 observations from firms with negative Tobin's q were excluded, following Kammler and Alves (2009). Theoretically, Tobin's q cannot assume negative values, as it reflects the relationship between a company's market value and its replacement cost. This left 1,480 observations in the final sample.

To classify the companies a priori as financially constrained or unconstrained, the variables and criteria described in Figure 1 were applied, forming the basis for the research hypotheses regarding the conditions under which firms have greater or lesser access to external financing.

Variables	Formula	Classification criteria	Acronym	Author(s)	Hypothesis
Dividend distribution policy (DDP)	$\frac{Dividends}{Net\ Income}$	Dummy: (1) financially constrained firms (never paid more than 20% of profits in dividends over the entire period); (0) financially unconstrained firms (paid out 20% or more).	$d_{FinC} = \text{Div\_dist}$	Fazzari et al. (1988); Cleary (1999); Hamburger (2003); Almeida, Campello & Weisbach (2004)	H_1
Firm size (SIZ)	ln (Total Assets)	Dummy: (1) financially constrained firms (Small – log of total assets below the median for the year); (0) financially unconstrained firms (Large – log of total assets above the median).	$d_{FinC} = \text{Size}$	Terra (2003); Almeida, Campello & Weisbach (2004)	H_2
Return on assets (ROA)	$\frac{Net\ Income}{Total\ Assets}$	Dummy: (1) financially constrained firms (ROA below the median); (0) financially unconstrained firms (ROA above the median).	$d_{FinC} = \text{ROA}$	Kirch, Procianoy & Terra (2014)	H_3
Interest Coverage Ratio (ICR)	$\frac{EBIT}{Total\ Debt}$	Dummy: (1) financially constrained firms (ICR below the median); (0)	$d_{FinC} = \text{ICR}$	Kaplan & Zingales (1997),	H_4

		financially unconstrained firms (ICR above the median).		Bragioni & Santos (2018); Machado, Meirelles & Rossetti (2019)	
Corporate governance (GOV)	GOV	Dummy: (1) financially constrained firms (not listed in B3's differentiated governance segments); (0) financially unconstrained firms (listed in B3's N1, N2, or Novo Mercado segments).	$d_{FinC} = \mathrm{GOV}$	Francis et al. (2013), Bragioni & Santos (2018)	H_5

Figure 1 – Variables and criteria used to identify financial constraint and corresponding research hypotheses
Source: Prepared by the authors.

After categorizing the companies according to financial (un)constraints, the econometric models to estimate the behavior of investment relative to variations in cash flow were specified separately for each financial constraint variable. The quantile regression model for panel data was employed in this analysis. This econometric technique provides more detailed and robust results by accounting for distributional effects in the data, since the method can handle the presence of outliers and asymmetries in the distribution (Koenker & Bassett Jr., 1978). Thus, following Canay's (2011) arguments, quantile regression is expected to capture unexplored heterogeneity and the effects of heterogeneous covariates, while panel data allows the inclusion of fixed effects to control for unobserved covariates.

In this study, three quartiles of the distribution were considered (0–25; 25–50; 50–75). The model's dependent variable was the logarithm of investment (CAPEX). This variable is employed to examine the investment decisions of firms operating in imperfect markets and to assess their sensitivity to the availability of internal funds, according to firm categories defined as constrained or unconstrained (Hamburger, 2003).

The dependent and independent variables used in the estimated models are described in Figure 2.

Classification	**Description**		**Definition**	**Authors**
Dependent Variables	INV_{it}	Investment	Log of CAPEX	Rodziewicz (2018)
Independent Variables	$CF_{i,t-1}$	Cash Flow	Net income plus depreciation and amortization, together with other non-cash adjustments and changes in working capital not related to cash flow	Almeida & Campello (2007); Guan, Mittoo & Zhang (2019)

	$Q_{i,t-1}$	Tobin's q	Market value of equity plus debt, divided by total assets	Chung & Pruitt (1994); Silva, Caixe & Krauter (2019)
	$Debt_{i,t-1}$	Debt	Sum of short- and long-term interest-bearing debt (loans, financing, debentures) divided by total assets	Silva, Caixe & Krauter (2019)
	IR_t	Interest Rate	Nominal Selic rate in the period	Almeida, Campello & Weisbach (2004)
	$Wacc_t$	WACC	Real after-tax rate of return, by electricity sector segment (generation, transmission, distribution)	ANEEL
	$MV_{i,t-1}$	Market Value	Market value per share multiplied by the number of shares in the period	Restrepo & Uribe (2023)
	d_FinC	Financial Constraint	See classification criteria in Figure 1	-

Figure 2 – Dependent and independent variables used in the econometric models
Source: Prepared by the authors.

To analyze the relationship between investment and cash flow under financial constraint, as tested through H_6, the quantile regression model for panel data represented by Equation (1) was employed:

$$\boldsymbol{INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1} + \beta_4 IR_t + \beta_5 MV_{i,t-1} + \beta_6 Wacc_t + d\_FinC_{i,t} + \mu_t + \varepsilon_{\theta i,t}} \quad (1)$$

Where: θ represents the quartiles; β_K is the coefficient of each explanatory variable for investment in each quartile; μ_t captures period-specific effects, represented by a set of year dummy variables; and $\varepsilon_{i,t}$ is the error term.

It is important to note that the interaction variable between cash flow and tangibility, proposed by Almeida and Campello (2007), was excluded from this study because it exhibited a strong positive correlation with cash flow, which did not justify its use as an interaction term in the model. Furthermore, tangibility was not included due to its statistical irrelevance across all models.

4 ANALYSIS AND DISCUSSION OF RESULTS

4.1 Descriptive Statistics

Table 1 presents the descriptive statistics of the variables used to estimate the empirical model, covering all segments of the companies in the sample (generation, transmission, and distribution).

Table 1
Descriptive statistics of the variables used in the models

Variables	Mean	Standard Deviation	Minimum	Maximum	Notes
INV_{it}	3.65	2.14	- 6.91	8.15	1,138
$Q_{i,t-1}$	28,446.24	66,562.21	0.00	516,672.00	1,451
$CF_{i,t-1}$	227.86	484.06	- 2,758.34	5,639.13	1,384
$Debt_{i,t-1}$	0.33	0.17	0.00	0.97	1,451
IR_t	0.10	0.03	0.05	0.14	1,480
$Wacc_t$	0.08	0.01	0.07	0.10	1,319
$MV_{i,t-1}$	15.14	4.41	5.26	23.62	1,233

Source: Prepared by the authors.

The data are highly heterogeneous, even though the sample units belong to the same sector (electricity). This may be explained by the inclusion of companies engaged in generation, transmission, and distribution, which have distinct characteristics. For example, the wide range between minimum and maximum values for several variables contributes to the high standard deviations. These variations are smaller for debt ($Debt_{i,t-1}$), interest rates (IR_t), and WACC ($Wacc_t$). It is also worth noting that Tobin's q ($Q_{i,t-1}$) does not present negative values. due to the treatment applied during the sample selection process, as described in the methodology. Finally, differences in the number of observations indicate that the panel is unbalanced.

Table 2 presents the intensity and direction of the associations among the variables analyzed.

Table 2
Correlation matrix between independent and dependent variables

	INV_{it}	$Q_{i,t-1}$	$CF_{i,t-1}$	$Wacc_t$	$Debt_{i,t-1}$	IR_t	$MV_{i,t-1}$
INV_{it}	1.000						
$Q_{i,t-1}$	0.126*	1.000					
$CF_{i,t-1}$	0.241*	0.058*	1.000				
$Wacc_t$	0.207*	0.027	0.010	1.000			
$Debt_{i,t-1}$	0.183*	0.138*	-0.045	-0.011	1.000		
IR_t	-0.024	-0.003	0.041	0.069*	-0.035	1.000	
$MV_{i,t-1}$	0.285*	0.664*	0.326*	0.068*	0.245*	-0.036	1.000

Source: Prepared by the authors.

Indeed, the correlations in Table 2 suggest that multicollinearity is not a concern, given the relatively low coefficients among the explanatory variables. Regarding the dependent variable (INV), a negative relationship is observed

between investment and the interest rate in the sample, indicating that an increase in the interest rate tends to reduce firms' investment levels. Since the interest rate captures macroeconomic effects on investment, this relationship is consistent with the hypothesis advanced. For Tobin's q, cash flow (CF), cost of capital (Wacc), debt (Debt), and market value (MV), the associations are positive, suggesting that higher values of these variables are linked to higher levels of investment (INV).

This preliminary analysis already provides evidence that the relationship between investment and cash flow aligns with the findings of Fazzari et al. (1988), Schaller (1993), Chen, Liu, and Wang (2013), Bragioni and Santos (2018), and Machado, Meirelles, and Rossetti (2019), which show that insufficient internal funds may reduce firms' investment. In other words, the correlations reported in Table 4 corroborate this prior evidence, particularly regarding cash flow, which was expected to display a positive and significant association with investment – demonstrating that investment is sensitive to fluctuations in cash flow.

4.2 Estimated Models: Relationship between investment and cash flow

4.2.1 Dividend distribution policy as a criterion for classifying financial constraints

The analysis of the relationship between investment and cash flow began with the dividend distribution policy as the criterion for classifying financial constraints. The significance level adopted was 5% (Table 3).

Table 3
Relationship between investment and cash flow with financial constraint identified according to dividend distribution

$$INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1}\beta_4 IR_{i,t} + \beta_5 Wacc_t + \beta_6 MV_{i,t-1} + \beta_7 Div\_dist_{i,t} + \mu_t + \varepsilon_{\theta i,t}$$

		q25	q50	q75
Q	**b[1]**	0.0000	**0.0000***	**0.0000***
	se[2]	0.0000	0.0000	0.0000
	p[3]	0.1779	**0.0526**	**0.0938**
CF	**b[1]**	**0.0004****	**0.0004****	0.0005
	se[2]	0.0002	0.0002	0.0003
	p[3]	**0.0212**	**0.0187**	0.1014
Wacc	**b[1]**	**-36.5530****	-18.8333	-3.9069
	se[2]	17.2535	17.0643	24.6607
	p[3]	**0.0341**	0.2697	0.8741
Debt	**b[1]**	-1.6687	-1.5046	-1.3664
	se[2]	1.1936	1.1835	1.7150
	p[3]	0.1621	0.2036	0.4256
IR	**b[1]**	**-21.5077*****	**-18.9932*****	-16.8751
	se[2]	7.4833	7.4178	10.7457
	p[3]	**0.0041**	**0.0105**	0.1163
MV	**b[1]**	**-0.2201*****	**-0.1815*****	**-0.1489***
	se[2]	0.0567	0.0562	0.0813
	p[3]	**0.0001**	**0.0012**	**0.0671**
Div_dist	**b[1]**	**-0.5186*****	**-0.5021*****	**-0.4883****
	se[2]	0.1722	0.1707	0.2474

	p³	**0.0026**	**0.0033**	**0.0484**

Note: b¹ = coefficient; se²= standard error; p³= p-value; Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.
Source: Prepared by the authors.

Table 3 shows that, under this criterion, the variables cost of capital (Wacc) and debt (Debt) were generally not statistically significant in explaining investment by Brazilian electricity sector firms. The exception was the WACC coefficient in the first quartile, which was negative and significant, indicating that firms with lower investment levels are more affected by the cost of capital. Tobin's q was significant only in the upper quartiles, that is, for firms with higher investment levels, although the coefficients were very close to zero. For cash flow, the coefficients were positive but small, with greater significance in the lower quartiles, suggesting that higher cash generation leads to higher investment, thereby corroborating H_6.

Cash flow (CF), the interest rate (IR), market value (MV), and the dividend distribution dummy (Div_dist) were statistically significant. For the latter three variables, the relationship with investment was negative. This indicates that financially constrained firms, or those with low dividend distributions, tend to invest less and therefore display greater sensitivity of investment to internal funds. These results are consistent with Fazzari et al. (1988) and support H_1 of this study, which posits that firms with low dividend payout ratios face greater financial constraints, underscoring the need to retain internal resources to finance investments. As expected, higher interest rates and higher market value were associated with lower investment levels. However, with respect to market value, the results diverge from those of Lucchesi and Famá (2007) and Antunes and Procianoy (2003), who found that announcements of increased investment could raise firms' share prices – that is, a positive and directly proportional relationship.

Although the year dummy variables are not shown in Table 3, the coefficient for 2009 was positive and significant, indicating that, on average, firms invested more in that year than in others within the period analyzed. Similar behavior was observed in 2011, 2015, and 2016, but only for the lower quartiles (q25 and q50), i.e., for firms with the lowest investment levels.

4.2.2 Firm size as a criterion for classifying financial constraints

Table 4 presents the results of the model using firm size as the criterion for classifying financial constraints.

When using firm size as a criterion for classifying companies into constrained and unconstrained, following Terra (2003), Almeida, Campello and Weisbach (2004), Aldrighi and Bisinha (2010), and Kirch, Procianoy and Terra (2014), it was expected that smaller firms would face greater difficulty accessing both debt and equity markets, thereby relying more heavily on internally generated cash flows.

Table 4
Investment–cash flow relationship with financial constraint identified according to firm size

$$INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1} + \beta_4 IR_t + \beta_5 Wacc_t + \beta_6 MV_{i,t-1} + \beta_7 size_{i,t} + \mu_t + \varepsilon_{\theta i,t}$$

		q25	q50	q75
Q	**b¹**	0.0000	**0.0000***	**0.0000****
	se²	0.0000	0.0000	0.0000
	p³	0.4611	**0.0596**	**0.0129**
CF	**b¹**	0.0005	**0.0004****	**0.0004****
	se²	0.0004	0.0002	0.0002
	p³	0.1939	**0.0218**	**0.0152**
Wacc	**b¹**	-35.9898	-20.6326	-9.4010
	se²	32.6835	17.6732	16.0860
	p³	0.2708	0.2430	0.5589
Debt	**b¹**	-1.7860	-1.2987	-0.9424
	se²	2.3615	1.2754	1.1613
	p³	0.4495	0.3085	0.4171
IR	**b¹**	-21.6778	**-18.8456****	**-16.7743****
	se²	14.2880	7.7166	7.0266
	p³	0.1292	**0.0146**	**0.0170**
MV	**b¹**	**-0.2138****	**-0.1779*****	**-0.1517*****
	se²	0.1069	0.0578	0.0526
	p³	**0.0456**	**0.0021**	**0.0039**
Size	**b¹**	-0.1273	-0.6025	**-0.9501*****
	se²	0.7110	0.3855	**0.3507**
	p³	0.8579	0.1181	**0.0067**

Note: b¹ = coefficient; se²= standard error; p³= p-value; Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.
Source: Prepared by the authors.

The results in Table 4, however, reveal significant differences across the quartiles, underscoring the value of using quantile regression. Tobin's q, cash flow, the interest rate, and market value were significant, particularly in the upper quartiles (q50 and q75), i.e., for firms with higher investment levels. The cash flow coefficient was positive and significant in the upper quartiles, suggesting that firms with greater investment volumes and stronger internal resources tend to invest more, corroborating H6. Nevertheless, the low economic significance of the coefficients should be noted, as their magnitudes are very close to zero. Similarly, Tobin's q was positive and significant for the upper quartiles, indicating that firms with higher investment levels are better positioned to seize investment opportunities. The interest rate was negative with large coefficients, reflecting the effect of macroeconomic conditions and the cost of credit during the period. Market value also showed a negative association, suggesting that firms with higher investment levels tend to have, on average, lower market values.

The size dummy, used to classify firms, was significant only in the highest quartile (q75), indicating the limitations of size as a proxy for financial constraints. To some extent, these findings support hypothesis H_2 of this study, which posits that smaller firms face greater difficulty accessing debt and equity markets, thereby relying more heavily on internally generated cash flows – consistent with the results of Terra (2003), Almeida, Campello and Weisbach (2004), Aldrighi and Bisinha

(2010), and Kirch, Procianoy and Terra (2014).

Debt and WACC were not statistically significant in this model. Regarding the year dummy variables, 2009, 2011, and 2014 to 2016 were significant, with positive coefficients, suggesting higher levels of investment in those years relative to others in the sample period.

4.2.3 Return on assets as a criterion for classifying financial constraints

Table 5 presents the results of the model that used return on assets (ROA) as a criterion for classifying firms into constrained and unconstrained, in order to test the hypothesis that companies with higher returns on assets exhibit greater debt repayment capacity and therefore enjoy broader access to credit (Kirch, Procianoy & Terra, 2014).

Table 5
Investment-cash flow relationship with financial constraint identified according to ROA

$$INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1} + \beta_4 IR_t + \beta_5 Wacc_{it} + \beta_6 MV_{i,t-1} + \beta_7 ROA_{i,t} + \mu_t + \varepsilon_{\theta i,t}$$

		q25	q50	q75
Q	**b¹**	0.0000	**0.0000*****	**0.0000*****
	se²	0.0000	0.0000	0.0000
	p³	0.1495	**0.0071**	**0.0087**
CF	**b¹**	**0.0005****	**0.0005*****	**0.0005*****
	se²	0.0002	0.0001	0.0002
	p³	**0.0112**	**0.0006**	**0.0066**
Wacc	**b¹**	**-35.8888****	-20.1930	-7.5401
	se²	16.4408	12.4522	15.7939
	p³	**0.0290**	0.1049	0.6331
Debt	**b¹**	-1.7417	**-1.7209****	-1.7042
	se²	1.1536	0.8732	1.1117
	p³	0.1311	**0.0488**	0.1253
IR	**b¹**	**-21.0697*****	**-18.4150*****	**-16.2749****
	se²	7.1697	5.4278	6.9058
	p³	**0.0033**	**0.0007**	**0.0184**
MV	**b¹**	**-0.2132*****	**-0.1760*****	**-0.1461*****
	se²	0.0551	0.0417	0.0530
	p³	**0.0001**	**0.0000**	**0.0058**
ROA	**b¹**	-0.2061	-0.1615	-0.1256
	se²	0.1780	0.1347	0.1715
	p³	0.2468	0.2305	0.4640

Note: b¹ = coefficient; se²= standard error; p³= p-value; Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.
Source: Prepared by the authors.

The estimates in Table 5 show that ROA was not statistically significant in the model. Thus, hypothesis H_3 of this study – that firms with higher returns on assets signal greater debt repayment capacity and, consequently, greater access to credit to finance their investments – cannot be corroborated.

Tobin's q, cash flow, the interest rate, and market value were significant,

displaying patterns similar to the previous models: Tobin's q and cash flow had positive but very small coefficients, while the interest rate and market value showed large and negative coefficients. Debt was significant only in the second quartile, with large negative coefficients.

The WACC was statistically significant only for the first quartile, where it had an inverse relationship with investment. Finally, the year dummy variables behaved consistently with the previous models, with 2009 showing the strongest relevance.

4.2.4 Interest Coverage Ratio as a criterion for classifying financial constraints

Table 6 presents the results of the model that used the Interest Coverage Ratio (ICR) to classify firms as financially constrained or unconstrained. The aim was to assess whether firms with a lower ICR (constrained) rely more heavily on internal resources to finance investments, given their greater difficulty in accessing credit or the higher cost of raising external funds (Pereira & Martins, 2015).

Table 6
Investment-cash flow relationship with financial constraint identified according to ICR

$$INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1} + \beta_4 IR_t + \beta_5 Wacc_t + \beta_6 MV_{i,t-1} + \beta_7 ICR_{i,t} + \mu_t + \varepsilon_{\theta i,t}$$

		q25	q50	q75
Q	**b¹**	0.0000	**0.0000***	**0.0000****
	se²	0.0000	0.0000	0.0000
	p³	0.5456	**0.0986**	**0.0215**
CF	**b¹**	0.0005	**0.0005****	**0.0005****
	se²	0.0004	0.0002	0.0002
	p³	0.2538	**0.0316**	**0.0153**
Wacc	**b¹**	-37.5894	-20.5020	-7.1109
	se²	36.1986	19.7231	17.7977
	p³	0.2991	0.2986	0.6895
Debt	**b¹**	-2.1496	-1.9002	-1.7047
	se²	2.5956	1.4114	1.2739
	p³	0.4076	0.1782	0.1808
IR	**b¹**	-21.1468	**-18.3016****	**-16.0718****
	se²	16.0655	8.7383	7.8869
	p³	0.1881	**0.0362**	**0.0416**
MV	**b¹**	**-0.2104***	**-0.1732*****	**-0.1440****
	se²	0.1220	0.0664	0.0599
	p³	**0.0846**	**0.0091**	**0.0163**
ICR	**b¹**	0.2304	0.0625	-0.0691
	se²	0.3770	0.2054	0.1853
	p³	0.5411	0.7608	0.7094

Note: b¹ = coefficient; se²= standard error; p³= p-value; Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.
Source: Prepared by the authors.

The estimates in Table 6 show that, similar to ROA, ICR was not statistically significant in the model. This finding also refutes hypothesis H_4, which posited that firms with a higher Interest Coverage Ratio (ICR) would have broader access to

external resources to finance their investments.

Tobin's q, cash flow, and the interest rate were significant in the second (q50) and third (q75) quartiles, i.e., for firms with higher investment levels. Market value was significant across all quartiles, with negative coefficients, indicating that firms with higher investment volumes during the period tended to exhibit lower market values, holding other factors constant.

4.2.5 Corporate governance as a criterion for classifying financial constraints

Table 7 presents the results of the model that used corporate governance as a criterion for classifying firms with respect to financial constraints. The objective was to test whether good governance practices can mitigate the effects of financial constraints and provide firms with greater access to external resources at lower costs (IBGC, 2020). The underlying hypothesis is that constrained companies – those operating at B3's basic level – exhibit greater investment sensitivity compared to unconstrained companies listed in B3's differentiated governance segments, i.e., N1, N2, and Novo Mercado.

Table 7
Investment-cash flow relationship with financial constraint identified according to corporate governance

$$INV_{it} = \beta_0 + \beta_1 CF_{i,t-1} + \beta_2 Q_{i,t-1} + \beta_3 Debt_{i,t-1} + \beta_4 IR_t + \beta_5 Wacc_t + \beta_6 MV_{i,t-1} + \beta_7 GOV_{i,t} + \mu_t + \varepsilon_{\theta i,t}$$

		q25	q50	q75
Q	**b¹**	0.0000	0.0000	**0.0000*****
	se²	0.0000	0.0000	0.0000
	p³	0.6372	0.1330	**0.0074**
CF	**b¹**	0.0004	**0.0004***	**0.0005*****
	se²	0.0005	0.0002	0.0002
	p³	0.4032	**0.0657**	**0.0064**
Wacc	**b¹**	-37.8751	-22.6055	-11.9197
	se²	47.1355	22.2156	15.3779
	p³	0.4217	0.3089	0.4383
Debt	**b¹**	-1.6767	-1.2744	-0.9928
	se²	3.2556	1.5328	1.0604
	p³	0.6065	0.4057	0.3491
IR	**b¹**	-22.5601	**-18.0869***	**-14.9566****
	se²	20.4081	9.6128	6.6523
	p³	0.2690	**0.0599**	**0.0246**
MV	**b¹**	-0.1923	**-0.1461****	**-0.1137****
	se²	0.1527	0.0719	0.0498
	p³	0.2078	**0.0423**	**0.0224**
GOV	**b¹**	-0.6957	-1.3256	**-1.7664*****
	se²	1.9548	0.9215	0.6380
	p³	0.7219	0.1503	**0.0056**

Note: b¹ = coefficient; se²= standard error; p³= p-value; Statistical significance at the 10%, 5%, and 1% levels is denoted by *, **, and ***, respectively.
Source: Prepared by the authors.

The results in Table 7 partially corroborate hypothesis H_5, which states that firms with stronger governance practices provide greater security to investors and therefore enjoy broader access to external resources. The governance variable was significant for the top quartile (q75), with large negative coefficients, indicating that firms with weaker governance structures tend to invest less than unconstrained firms, or in other words, are more reliant on internal resources.

The market value variable was significant and negative for the upper quartiles (q50 and q75), indicating that firms with higher (lower) valuations tend to invest less (more). Debt and WACC were not statistically significant. As in previous models, Tobin's q and cash flow were positive and significant, though with very small coefficients (corroborating H_6), while the interest rate was negative and substantial.

Overall, the findings suggest that the choice of classification criterion has limited influence on the results. Differences between constrained and unconstrained firms emerged only when *dividend distribution*, *firm size*, and *corporate governance* were used as criteria (Tables 3, 4, and 7, respectively). Under these criteria, investment in constrained firms, at least in some quartiles, was positively influenced by cash flow. By contrast, ROA and ICJ exhibited similar patterns, as these criteria did not differentiate between constrained and unconstrained firms, since their respective dummy variables were not statistically significant in the models reported in Tables 5 and 6.

Regarding the role of macroeconomic variables (or economic cycles), the results here are consistent with Almeida, Campello and Weisbach (2004), Khurana, Martin and Pereira (2009), and Byrro and Bressan (2016). However, they contradict Lucchesi and Famá (2007) and Antunes and Procianoy (2003) regarding firm value and the signaling effect of investment announcements on the market.

5 CONCLUSIONS

This study examined the impact of cash flow on the investment of companies in the Brazilian electricity sector listed on the capital markets under conditions of financial constraint, classified according to different criteria. For this purpose, quantile regression models for panel data were employed, which, in addition to providing greater robustness to the estimates, make it possible to capture differences across the quantiles of the investment distribution, considering the varying levels observed among the companies analyzed.

The results of the empirical analysis revealed that cash flow was positive and significant in almost all models, suggesting that, for the electricity sector firms studied, investment is associated with the internal generation of funds. Overall, the findings support the central argument that cash flow has a greater impact on investment in constrained companies when classified by dividend policy, firm size, and level of corporate governance.

From an economic perspective, Tobin's q did not prove relevant for explaining investment decisions in the sample of electricity sector firms analyzed. However, these results are consistent with longstanding criticisms regarding the limited effectiveness of Tobin's q in accurately reflecting firms' investment

opportunities and in serving as a reliable control when testing the role of cash flow as a source of financing.

At the same time, the empirical evidence highlighted the importance of market value and interest rates for investment decisions. Both variables displayed negative and significant coefficients in almost all models, suggesting that higher interest rates and higher firm valuations are associated with a lower propensity to invest in new projects. By contrast, the regulatory rate of return on capital in the electricity sector (regulatory WACC) – expected to positively influence investment by enhancing its attractiveness – was not statistically significant in most specifications.

Altogether, these findings demonstrate that the results documented in this article are relevant both for accounting-financial decision-making within firms and for external users (e.g., investors and regulatory agencies in the electricity sector). The evidence provides valuable insights for understanding investment behavior in the sector, contributing not only to the accounting and finance literature but also to public policy. In particular, the results have important implications for emerging economies, where the electricity sector plays a strategic role in driving economic growth, by offering guidance for fiscal, financial, and regulatory policies aimed at mitigating reductions in investment levels.

The main limitations of this study are the relatively short time horizon analyzed and the restriction of the sample to companies whose shares are traded on B3. For future research, it is suggested to compare the investment sensitivity of this sector with that of other industries, especially regulated infrastructure sectors. Furthermore, the sample could be expanded to include electricity companies from other countries, particularly those in emerging markets.

REFERENCES

Aldrighi, D. M., & Bisinha, R. (2010). Restrição financeira em empresas com ações negociadas na Bovespa. *Revista Brasileira de Economia*, 64(1), 25-47. https://doi.org/10.1590/S0034-71402010000100002.

Almeida, H., & Campello, M. (2007). Financial Constraints, Asset Tangibility, and Corporate Investment. *The Review of Financial Studies*, 20(5), 1429-1460. https://doi.org/10.1093/rfs/hhm019.

Almeida, H., Campello, M., & Weisbach, M. S. (2004). The Cash Flow Sensitivity of Cash. *The Journal of Finance*, 59(4), 1777-1804. https://doi.org/10.1111/j.1540-6261.2004.00679.x.

Antunes, M. A., & Procianoy, J. L. (2003). Os efeitos das decisões de investimento das empresas sobre os preços de suas ações no mercado de capitais. *Revista de Administração da USP*, 38(1), 5-14. https://rausp.usp.br/wp-content/uploads/files/V3801005.pdf.

Bragioni, C. A., & Santos, D. F. L. (2018). Restrição financeira e a sensibilidade do fluxo de caixa das empresas brasileiras. *Estudios Gerenciales*, 34(149), 373-384. https://doi.org/10.18046/j.estger.2018.149.2735.

Byrro, L. M. N., & Bressan, A. A. (2016). A sensibilidade do caixa ao fluxo de caixa nas companhias abertas brasileiras: uma análise do período pré e pós-crise de 2008. *Revista de Finanças Aplicadas*, 7(2), 1-32. http://www.financasaplicadas.fia.com.br/index.php/financasaplicadas/article/view/263.

Canay, I. A. (2011). A simple approach to quantile regression for panel data. *The Econometrics Journal*, 14(3), 368-386. https://doi.org/10.1111/j.1368-423X.2011.00349.x.

Chalhoub, L., Kirch, G., & Terra, P. R. S. (2015). Fontes de Caixa e Restrições Financeiras: Evidências das Firmas Listadas na BM&FBOVESPA. *Revista Brasileira de Finanças*, 13(3), 470-503. https://doi.org/10.12660/rbfin.v13n3.2015.57475.

Chen, L., Liu, C., & Wang, G. (2013). Financial constraints, investments efficiency and corporate governance: empirical evidence from China. In *Anais do 10º International Conference on Service Systems and Service Management*. Hong Kong: IEEE Xplore. https://doi.org/10.1109/ICSSSM.2013.6602546.

Chung, K. H., & Pruitt, S. W. (1994). A simple approximation of Tobin's q. *Financial management*, 23(2), 70-74. https://www.jstor.org/stable/3665623.

Cleary, S. (1999). The relationship between firm investment and financial status. *The Journal of Finance*, 54(2), 673-692. https://doi.org/10.1111/0022-1082.00121.

Denis, D. J., & Sibilkov, V. (2010). Financial constraints, investment, and the value of cash holdings. *The Review of Financial Studies*, 23(1), 247-269. https://doi.org/10.1093/rfs/hhp031.

Durand, D. (1952). Costs of debt and equity funds for business: trends and problems of measurement. In *Conference on research in business finance* (pp. 215-262). NBER.

Fazzari, S. M., Hubbard, R. G., Petersen, B. C., Blinder, A. S., & Poterba, J. M. (1988). Financing Constraints and Corporate Investment. *Brookings Papers on Economic Activity*, 1988(1), 141-206. https://doi.org/10.2307/2534426.

Francis, B., Hasan, I., Song, L., & Waisman, M. (2013). Corporate governance and investment-cash flow sensitivity: evidence from emerging markets. *Emerging Markets Review*, 15, 57-71. https://doi.org/10.1016/j.ememar.2012.08.002.

Fu, X. & Tang, T. (2016). Corporate debt maturity and acquisition decisions. *Financial Management*, 45(3), 737-768. https://doi.org/10.1111/fima.12117.

Guan, F., Mittoo, U. R., & Zhang, Z. (2021). Investment to Cash Flow Sensitivity: Evidence from Manufacturing and Energy Sectors. *Emerging Markets Finance and Trade*, 57(8), 2206-2229. https://doi.org/10.1080/1540496X.2019.1629902.

Hamburger, R. R. (2003). Restrições financeiras e os investimentos corporativos no Brasil. (Tese de Doutorado, Escola de Administração de Empresas de São Paulo, Fundação Getúlio Vargas, São Paulo). Recuperado de http://hdl.handle.net/10438/2540.

Jensen, M. C.; Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, 3(4), 305-360. https://doi.org/10.1016/0304-405X(76)90026-X.

Kammler, E. L., & Alves, T. W. (2009). Análise da capacidade explicativa do investimento pelo "q" de tobin em empresas brasileiras de capital aberto. *RAE-eletrônica*, 8(2), Art. 12. https://doi.org/10.1590/S1676-56482009000200007.

Kaplan, S. N., & Zingales, L. (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints?. *The Quarterly Journal of Economics*, 112(1), 169-215. https://doi.org/10.1162/003355397555163.

Khurana, I. K., Martin, X., & Pereira, R. (2006). Financial development and the cash flow sensitivity of cash. *Journal of Financial and Quantitative Analysis*, 41(4), 787- 808. https://doi.org/10.1017/S0022109000002647.

Kirch, G., Procianoy, J. L., & Terra, P. R. S. (2014). Restrições financeiras e a decisão de investimento das firmas brasileiras. *Revista Brasileira de Economia*, 68(1), 103-123. https://doi.org/10.1590/S0034-71402014000100006.

Koenker, R., & Bassett Jr., G. (1978). Regression quantile. *Econometrica*, 46(1), 33-50. https://doi.org/10.2307/1913643.

Leopoldi, M. A. & Francisco, J. P. (2023). Capítulo 9: Capacidades estatais no setor elétrico brasileiro: construção, desmonte e desafios. In: A. A. Gomide, M. M. S. Silva & M. A. Leopoldi (Org.*), Desmonte e Reconfiguração de Políticas Públicas (2016-2022)*, 1 ed. Brasília: IPEA, 2023, pp. 255-285. http://dx.doi.org/10.38116/978-65-5635-049-3.

Lucchesi, E. P., & Famá, R. (2007). O impacto das decisões de investimento das empresas no valor de mercado das ações negociadas na Bovespa no período de 1996 a 2003. *Revista de Administração USP*, 42(2), 249-260. http://rausp.usp.br/wp-content/uploads/files/v4202249.pdf.

Machado, K. de S. R., Meirelles, J. L. F., & Rossetti, N. (2019). Análise da sensibilidade do investimento em relação ao fluxo de caixa: um estudo nas empresas da indústria brasileira listadas na BM&FBOVESPA entre os períodos de 2004 a 2008 e 2009 a 2014. *Brazilian Journal of Business*, 1(3), 1016-1028. https://ojs.brazilianjournals.com.br/ojs/index.php/BJB/article/view/2984.

Madeira, R. F. (2013). Restrições financeiras nas empresas brasileiras de capital aberto: a relevância da estrutura de capital para o investimento. *Revista do BNDES*, 39, 69-122. http://web.bndes.gov.br/bib/jspui/handle/1408/2985.

Miranda, C. C., & Callado, A. L. C. (2019). Influência do nível de intangibilidade no desempenho das companhias brasileiras do setor de energia elétrica. *Revista de Auditoria Governança e Contabilidade*, 7(30), 47-62. http://www.fucamp.edu.br/editora/index.php/ragc/article/view/1867.

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 48(3), 261-297. https://www.jstor.org/stable/1809766.

Modigliani, F., & Miller, M. H. (1963). Corporate income taxes and the cost of capital: a correction. *The American economic review*, 53(3), 433-443. https://www.jstor.org/stable/1809167.

Myers, S. C., & Majluf, N. S. (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of financial economics*, 13(2), 187-221. https://doi.org/10.1016/0304-405X(84)90023-0.

Pereira, L. H. M., & Martins, O. S. (2015). Rating de crédito, governança corporativa e desempenho das empresas listadas na BM&FBOVESPA. *REGE - Revista de Gestão*, 22(2), 205-221. https://www.sciencedirect.com/science/article/pii/S1809227616301096.

Pereira, M. R., & Botinha, R. A. (2018). Restrições Financeiras e seus Impactos na Decisão de Investimento das Companhias Abertas Brasileiras. In *Anais do 4º Unb Conference on Accounting and Governance, e do 1º Congresso Unb de Iniciação Científica – CCGUNB*. Brasília: UnB. https://conferencias.unb.br/index.php/ccgunb/4CCGUnB/paper/view/1139.

Restrepo, N., & Uribe, J. M. (2023). Cash flow investment, external funding and the energy transition: Evidence from large US energy firms. *Energy Policy*, 181, 113720. https://doi.org/10.1016/j.enpol.2023.113720.

Rodziewicz, D. (2018). Energy Investment Variability within the Macroeconomy. Federal Reserve Bank of Kansas City, *Economic Review*, 103(3), 53-75. https://doi.org/10.18651/ER/3q18Rodziewicz.

Schaller, H. (1993). Assymetric information, liquidity constraints, and Canadian investment. *The Canadian Journal of Economics/Revue Canadienne d'Economique*, 26(3), 552-574. https://doi.org/10.2307/135887.

Silva, B. A. de O., Caixe, D. F., & Krauter, E. (2019). Governança corporativa e sensibilidade investimento-fluxo de caixa no Brasil. *Brazilian Review of Finance*, 17(2), 72-86. https://doi.org/10.12660/rbfin.v17n2.2019.78083.

Terra, M. C. T. (2003). Credit constraints in Brazilian firms: evidence from panel data. *Revista Brasileira de Economia*, *57*(2), 443-464. https://doi.org/10.1590/S0034-71402003000200006.