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Contaduría y Administración
Accounting & Management

Contaduría y Administración 71 (1), 2026, e537

Investment heterogeneity and economic policy uncertainty in Brazil

Heterogeneidad de la inversión e incertidumbre de la política económica en Brasil

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Received June 01, 2024; accepted November 12, 2024
Available online November 1, 2025

Abstract

Recent literature investigating the relationship between investment and economic policy uncertainty (EPU) has primarily focused on the conditional mean effects on corporate investment due to fluctuations in uncertainty. However, this approach overlooks potential firm heterogeneity within listed companies. Single coefficients may not adequately capture the nuanced influence of EPU across different points of distribution of investment. Supported by the Real Options approach, this paper examines the EPU and corporate investment in Brazil employing Unconditional Quantile Regression approach. This method allows to investigate how the impact of EPU varies across the distribution of corporate investment, addressing the issue of firm heterogeneity. The research sample comprised 170 Brazilian firms listed on the B3 stock exchange (Brasil, Bolsa e Balcão) from 2010 to 2022, with data collected on a quarterly basis. Capital expenditures and the EPU Index were used as proxies for corporate investment and uncertainty, respectively. Findings confirm a negative relationship. Furthermore, the results suggest that the impact of EPU shocks is amplified for firms with higher levels of capital expenditures to assets ratio.

JEL Code: E22, E32, G18
Keywords: corporate investment; economic policy uncertainty; unconditional; quantile regression analysis

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Peer Review under the responsibility of Universidad Nacional Autónoma de México.

http://dx.doi.org/10.22201/fca.24488410e.2026.5612

Resumen

La literatura reciente que investiga la relación entre inversión e incertidumbre de política económica (EPU, por sus siglas en inglés) se ha centrado principalmente en los efectos promedio condicionales sobre la inversión corporativa debido a las fluctuaciones en la incertidumbre. Sin embargo, este enfoque pasa por alto la posible heterogeneidad entre las empresas que cotizan en bolsa. Coeficientes únicos pueden no capturar adecuadamente la influencia matizada de la EPU en diferentes puntos de la distribución de la inversión. Apoyado en el enfoque de Opciones Reales, este artículo examina la EPU y la inversión corporativa en Brasil utilizando el enfoque de Regresión Cuantílica Incondicional. Este método permite analizar cómo varía el impacto de la EPU a lo largo de la distribución de la inversión corporativa, abordando así la cuestión de la heterogeneidad empresarial. La muestra de investigación está compuesta por 170 empresas brasileñas que cotizan en la bolsa B3 (Brasil, Bolsa e Balcão) entre 2010 y 2022, con datos recopilados de forma trimestral. Los gastos de capital y el índice EPU se utilizaron como variables proxy para la inversión corporativa y la incertidumbre, respectivamente. Los resultados confirman una relación negativa. Además, los hallazgos sugieren que el impacto de los choques de EPU se amplifica en las empresas con mayores niveles de razón de gastos de capital sobre activos.

Código JEL: E22, E32, G18
Palabras clave: inversión corporativa; incertidumbre de política económica; análisis de regresión cuantílica incondicional

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Introduction

Uncertainty reaches the economic environment through Real-Option, Risk-Premia, and Precautionary Savings channels (Bloom, 2014). The Real Options theory posits that investors, acting as rational decision-makers, approach corporate investment with caution due to the existence of irreversible expenditures that cannot be recovered (Bernanke, 1983; Pindyck, 1991; Dixit & Pindyck, 1994). This cautious stems from the potential for future uncertainties to impact the value of these investments.

Since the development of the monthly newspaper-based economic policy uncertainty index (EPU index) by Baker et al. (2016) in early 2010, substantial research has investigated the adverse effects of economic policy uncertainty on corporate productive investment (Caixe, 2022; Chen et al., 2019, Chen et al., 2020; Gulen & Ion, 2016; Kang et al., 2014; Oliver, 2020; Suh & Yang, 2021; Wang et al., 2014; Norberto et al., 2024). These findings provide evidence that corporate policy decisions do not remain unaffected by economic policy uncertainty.

However, most studies rely on single coefficients to illustrate the reduction in the longitudinal conditional mean of corporate investment due to increased economic policy uncertainty. Focusing solely on average effects overlooks potential differences within the sample. Studies that focus on longitudinal mean effects often disregard the behavior of the dependent variable across its entire distribution (Maiti, 2019; Reichstein et al., 2010). Such distributions may hide potential patterns, such as non-linearity,

absence of significance in parts of the sample, or varying intensity of impact. This suggests that a constrained average analysis of the investment-uncertainty relationship can be problematic.

Exploring alternatives that consider the distribution of corporate investment in response to economic policy uncertainty offers a provocative approach. Coefficients estimated using entire samples of listed companies may fail to accurately capture the detrimental impact of economic uncertainty on corporate investment. Recognizing corporate heterogeneity across country samples can provide a more nuanced understanding of how economic policy uncertainty affects firm-level investment decisions. This is the key point of this paper.

Theoretical frameworks and longitudinal analyses in finance suggest that firms exhibit distinct characteristics due to differences in size, cash flow, growth opportunities, market valuation, leverage, ownership structure, business cycles, and other factors. This inherent diversity implies that potential differences extend to investment decision-making. Corporations engage in risky investments to expand revenues and profits by selecting various projects that demand different asset specifications. Additionally, macroeconomic conditions and pervasive uncertainty significantly impact the business environment (Ahsan et al., 2022; Anzuini et al., 2020; Demir & Ersan, 2017; Montes & Nogueira, 2022). Furthermore, uncertainty affects the corporate investment environment as investors must deal with irreversibility and managerial flexibility (Arrow, 1968; Bloom, 2014; Bernanke, 1983; Dixit & Pindyck, 1994; Marschak, 1949; Pindyck, 1991).

Failing to acknowledge and investigate the heterogeneous impact of investment determinants may obscure biases or mask behaviors that conditional mean approaches (e.g., fixed-effect and GMM-sys analyses) are not designed to map (Campello et al., 2013). Recognizing that corporations may exhibit diverse reactions to uncertainty (Akron et al., 2020; Klayme et al., 2023) is essential due to importance of inspecting the relationship between variables throughout the range of the explained variable. Empirical approaches that account for corporate heterogeneity (Galvão et al., 2018; Ghardallou, 2023; Ku & Yen, 2016; Shawtari et al., 2016; Sündal, 2023) suggest the potential to draw a broader picture regarding the impact of economic policy uncertainty shocks on corporate investments.

The objective of this research is to investigate potential discrepancies regarding how firms respond to uncertainty shocks on investment. To reach it, it was investigated the impact of economic policy uncertainty on corporate investment disclosed quarterly in cash flow statements by listed Brazilian companies. This includes average and multiple quantiles analysis of firm-level investment to disclose potential diversity hidden in corporate investment decisions. With respect to multiple quantiles, unconditional quantile regression approach was used to examine how economic policy uncertainty affects various points in the corporate investment distribution, accounting for numerous fixed effects within samples (Borgen, 2016). This is critical for capturing potential heterogenous effects across different firms.

This study focused on the Brazilian scenario for several reasons. First, Brazil's business environment is significant within the Americas, especially considering the turbulence between 2010 and 2019. Brazil ranks among the top 10 largest capital markets globally, with a company market value of US$1.77 trillion, making it the third-largest in the Americas after the United States and Canada. In 2019 alone, companies listed on the stock exchange made corporate investments totaling US$47.61 billion (Refinitiv, 2023). Gross fixed capital amounted to US$274.09 billion, accounting for 15% of GDP, with foreign direct investments totaling US$65.73 billion in the same year (BCB, 2022). Furthermore, Brazil faced significant economic downturns in 2015 and 2016, with GDP contractions of -3.8% and -3.5%, respectively (Oreiro, 2017). This period was marked by widespread corruption scandals and upheavals in central government administration, drawing considerable international attention. The coverage of Brazil's challenges by prestigious publications like The Economist headlined the gravity of the situation, highlighting titles such as "Brazil takes off" (2009), "Has Brazil blown it?" (2013), "The betrayal of Brazil" (2016), and "Latin America's latest Menace" (2018).

Given these circumstances, it is indispensable for investors to understand the contexts under which corporate investment decisions were made in Brazil. It was adopted an estimation strategy based on quantiles allows for a deeper understanding of how firms reacted to economic policy uncertainty spread. This approach suggests that new insights can be garnered from examining diverse corporate reactions to economic policy uncertainty due to their inherent heterogeneity. By considering diversity among firms at the investment level, it becomes feasible the expansion of the knowledge on investment-uncertainty relationship.

Hypothesis development

Governmental policies exert essential role in influencing the corporate risk commitment, as consequence, investment policies (Bloom, 2009; Julio & Yook; Gulen & Ion, 2016; (Suh & Yang, 2021). Factors such as economic downturns, political polarization, disputes, electoral processes, corruption scandals, conflicts and widespread protests intensify uncertainties, creating critical scenarios for investor scrutiny (Baker et al., 2016; (Çolak et al., 2018; Bajaj et al. 2021). Investors persistently adapt their decision-making sense to align with dominant economic trajectories, since they are prone to be influenced by governmental decisions, actions or signals (Julio & Yook, 2012).

Similar to stock markets, where expectations for increasing prices influences investors' propensity to value and acquire Call Options at fixed prices and exert them under for favorable circumstances (Dixit & Pindyck, 1994), Real Options Approach illustrates a parallelism regarding real investment decision-making scenarios. It introduces insights into how corporations evaluate and respond

to the spread of uncertainty valuing the options to delay, expand or abandon investment commitments (Baecker & Hommel, 2011; Mun, 2004). Valuing options regard value associated to the flexibility of postpone investment considering a business environment permeated by uncertainty. They are irreversible and cannot be undone without incurring significant costs. As possible option, postponing the decision to commit can be advantageous and, in itself, represent a managerial discretion that enhances the value of the investment under scrutiny (Bloom, 2009).

This foundation arranges the perspective that investment commitments are significantly affected by the timing, irreversibility and uncertainty. Hence, it highlights the importance of managerial discretion (Bernanke, 1983; McDonald & Siegel, 1986; Arrow, 1968; Dixit & Pindyck, 1994; Pindyck, 1991). When faced with heightened economic policy uncertainty, firms are propense to postpone or diminish their investments to alleviate potential losses from adverse policy shifts (Pindyck, 1991; Dixit & Pindyck, 1994). This hesitating behavior is further intensified by possible policy-related economic shocks to weaken investment value and profitability (Baker et al., 2016; Bloom, 2014; Pindyck, 1991; Rodrik, 1991).

Empirical evidence emphasizes that economic policy uncertainty is negatively associated with corporate investment (Batista et al., 2024; Caixe, 2022; Wang et al., 2014; Gulen & Ion, 2016). Studies reveal that during periods of high uncertainty, firms exhibit reduced investment activities due to increased risk premiums and a heightened sense of caution (Bloom, 2009; Gulen & Ion, 2016). Additionally, the adverse impact of uncertainty on financing conditions and market volatility further deters firms from committing to new investments (Ferreira & Vilela, 2004; Zhang e al., 2015; Almustafa et al. 2023). Given these dynamic, our first research hypothesis posits that corporate investment is negatively associated with economic policy uncertainty. This hypothesis is grounded in the understanding that the unpredictable nature of policy environments compels firms to adopt conservative behavior regarding investment policies.

Hypothesis 1: Corporate investment is negatively associated with economic policy uncertainty.

Investment ratios disclosed to capital markets, such capital expenditures, often fail to convey crucial details regarding stages of implementation of corporate investment commitments, their sensitivity to economic uncertainty or the firms' Net Present Values. Specific regulatory requirements that may rule investment decisions, varying budgets size among firms and differing investment opportunities (Al-Thaqeb & Algharabali, 2019; Demir & Ersan, 2017; Gulen & Ion, 2016; Suh & Yang, 2021) also weaken the assumption that the prevalent association between investment and uncertainty is feasible captured by central estimations.

Companies tend to be different from each other. Real Options Theory posits that irreversibility, managerial discretion and uncertainty are inherent traits in investment decisions. However, it is silent in

addressing potential heterogeneity stemming from corporations' characteristics regarding investment-uncertainty interaction. Accounting for potential differences within firms, it can be argued that they do not cope homogenously with irreversibility and uncertainty. Because of that, it is coherent to assume they also deal with sunk costs differently when they plan and execute investment projects. Due to irreversibility inherent to investments, companies with historically lower investment commitment may experience weaker impact from economic policy uncertainty increasing. On the other side, companies more engaged in corporate investment would present a more pronounced reduction in investments as uncertainty spreads. This reasoning presents the second research hypothesis:

Hypothesis 2: The higher the historical of corporate investment, the higher the impact of economic policy uncertainty on investment reduction.

Empirical design

Accounting and financial data of corporations listed at Brazilian stock exchange B3 (Brasil, Bolsa and Balcão) were obtained through Refinitiv®. Data analysis ranges the first quarter of 2010 to fourth quarter of 2022. The series begins in 2010, the year of Brazil's full adoption of the International Financial Reporting Standards (IFRS). In line with similar thematic research, we used the following restrictions to select the sample. First, we exclude financial companies. Second, we removed companies with negative asset values. Third, we winsorized the financial variables (1st and 99th percentiles) to mitigate the influence of extreme values. The final sample comprises an unbalanced panel with 170 companies.

Following recent studies that explore the relationship of corporate investment with economic policy uncertainty such as Almustafa et al. (2023), Chen et al. (2020), Caixe (2002), among others, this investigation utilizes accounting-based data through multiple regression analysis. Corporate data analyzed is derived from publicly disclosed financial statements. The research framework is designed to test hypotheses concerning economic policy uncertainty and to estimate the regression coefficients associated with the chosen proxies for uncertainty. In this sense, baseline model variants do not consider variables related to stock prices or stock options in circulation during the research period. As such, the formation of proxies and the interpretation of hypotheses are confined to financial statement data, without reliance on market-based indicators such as stock prices or derivatives.

Research variables

Corporate investment

On a quarterly basis, we measured corporate investments through capital expenditures to total assets ratio. Capital expenditures include the acquisition of fixed, intangible, and other long-term assets (Caixe, 2022; Gulen & Ion, 2016; Suh et al., 2021). From that point on, this variable will be specified as *cpx* (capital expenditures).

Economic policy uncertainty

Economic and Policy uncertainty may acquire different intensities depending on the particularities of regions and countries (Baker et al., 2016; Al-Thaqeb & Algharabali, 2019). In the first half of the 2010s, Baker et al., 2016 developed a metric, usually identified as EPU Index, to serve as a monthly proxy for economic policy uncertainty (EPU). To obtain EPU Index for Brazil, the metric proposed considers, for example, keywords such as "uncertainty", "uncertain", associated with "central bank", "chamber of deputies", "deficit", "regulation" and "tariff" from the newspaper Folha de S. Paulo. This metric has been available monthly on the website https://www.policyuncertainty.com for several countries. The EPU Index is reported monthly. To put it on a quarterly basis, we used weighting similar to that arranged by Gulen and Ion (2016), Nguyen (2017) and Schwartz & Zóboli (2021), as specified (1). The acronym epu_t identifies the Brazilian weighted EPU Index on quarterly basis and m represents EPU Index for a given month. This variable will be identified as follows.

$$epu_t = \ln[(3.epu_m + 2.epu_{m-1} + 1.epu_{m-2})/6] \quad (1)$$

Brazilian economic uncertainty index

Research and teaching institution of economics and business Fundação Getúlio Vargas in Brazil monthly releases Brazilian economic uncertainty index developed by Ferreira et al., (2019). This metric disclosed weight news from Brazilian newspapers and expectations on macroeconomic variables. It considers close to 30,000 news articles linked to uncertainty in economics and politics. The general indicator was also taken into account when analyzing the baseline model. This variable will be identified as beui. To put

them in quarterly bases, the weighting followed the same fashion of equation 1. This indicator is also available on the website https://www.policyuncertainty.com. Considering Brazilian economic environment, this indicator was also employed by Caixe (2022) and Montes & Valadares (2024).

Robustness verification

It cannot be ignored the possibility of error measurement in EPU index. One possible factor contributing to these errors is the presence of macroeconomic variables within the model that can affect the level of policy uncertainty. Specifically, it is important to consider the impact of fluctuations in inflation (*inf*), gross domestic product (*gdp*), exchange rates (*exc*), and equity markets (*sto*) on policy uncertainty. These variables may vary concurrently with changes in policy uncertainty, which could potentially confound our understanding of its true effects. Therefore, it is reasonable to account for these variables as potential confounders in our analysis to ensure the accuracy and reliability of our results.

$$epu_t = \lambda_0 + \lambda_1 inf_t + \lambda_2 gdp_t + \lambda_3 exc_t + \lambda_4 sto_t + \varepsilon_t \quad (2)$$

To deal with this issue, an auxiliary regression was computed by regressing EPU index against the macroeconomic control variables (Equation 2). The residual obtained from this auxiliary regression was then used to replace the EPU variable in the baseline model. This approach is consistent with previous studies, including Kaviani et al., 2020 and Schwarz & Dalmácio (2021), who suggest that the Residual Uncertainty derived from this approach can help alleviate the measurement error bias inherent in the EPU variable. Gulen and Ion (2016) also argue that models that aim to estimate Residual Uncertainty may provide a cleaner version of the EPU Index. The residual EPU will be identified as *epur*.

Control variables

It was used control variables for firm and economy level (Table 1). For firm level, the variables employed are similar to Gulen & Ion (2016) and Wang et al., 2014. They are sales growth (rev), cash flow of operations (cfo), size (sze) and growth opportunities (q), profit, size and property equipment and plants, which are identified in Table 1. To fit macroeconomic controls appropriated to the Brazilian environment, we use similar approach to Caixe (2022) considering inflation and gross domestic product and added exchange fluctuation (identified as exc) and equity market fluctuation (identified as sto). The following table summarizes the variable definitions and expected signs for economic policy uncertainty proxies and controls.

Table 1
Research variables

Variable	Hypothesis	Id	es	Definition	References
Corporate Investments	n.a.	cpx_{it}	n.a.	Capital expenditures to total assets at the end of each quarter.	Empirical Design
Economic policy uncertainty	H1 and H2	epu_{t-1}	-	Economic policy uncertainty index proposed by Baker et al., (2016) in quarter basis.	Empirical Design
Residual economic policy uncertainty	Robustness analysis	$epur_{t-1}$	-	Residual economic policy uncertainty in quarter basis.	Empirical Design
Brazilian economic uncertainty index	Robustness analysis	$beui_{t-1}$	-	Brazilian economic uncertainty index proposed by Ferreira et al. (2019) in quarter basis.	Empirical Design
Sales Growth	Firm-level control	rev_{it-1}		Quarterly percent change in revenues at the end of each quarter	Chen et al. (2020); Gulen et al. 2015
Cash flow of operations	Firm control	cfo_{it-1}	+	Cash flow of operation to total assets at the end of each year.	Caixe (2022); Wang et al., (2014)
Size	Firm control	siz_{it-1}	+	Natural logarithm of total corporate assets at the end of each quarter.	Gulen & Ion (2016); Chen et al. (2019); Oliver (2020)
Growth opportunities	Firm control	gro_{it-1}	-	Proxied by a variant of Tobin Ratio measured by the ratio of total debt plus market capitalization and total corporate assets at the of each quarter	Chen et al. (2020); Suh & Yang (2021); Wang et al. (2014);
Inflation	Macroeconomic control	ipc_{t-1}	-	Quarterly percent change in the consumer price index at the end of each quarter	Caixe (2022); Chen et al. (2020)
Economic Growth	Macroeconomic control	gdp_{t-1}	+	Quarterly percent change in gross domestic product of each quarter	Gulen & Ion, 2016; Zhang et al., 2015;
Stock Market	Macroeconomic control	sto_{t-1}	-	Quarterly percent change in the Ibovespa index for each quarter	Cao et al., 2013
Exchange	Macroeconomic control	exc_{t-1}	-	Quarterly percent change in dollars for each quarter.	-

Notes. n.a. indicates non-applicable. id indicates the abbreviation of research variables. es describes expected sign for each variable. Source: by the authors

Control variables are lagged by one quarter. Based on augmented Dick-Fuller stationary tests, we applied fisher-type unit-root test for panel data. Under null hypothesis that all panels contain unit roots, results for them are presented in Table 2.

Baseline model

The baseline model for the purposes of this research is presented as follows. This is the model that will provide the coefficients to support or refute hypothesis developed in section 2.

$$cpx_{it} = \beta_0 + \beta_1 epu_{t-1} + v'firmsi_{t-1} + \pi'macro_{t-1} + \varepsilon_{it} \quad (3)$$

Dependent variable, cpx_{it}, indicates the quarterly corporate investment of the companies in the sample. v' indicates the estimated coefficients for the control variables at the firm level and π' presents the estimators of control variables at the economy level. εit represents model residuals. $\beta 0$ is the model intercept. The main interest of this study is the result of the coefficient associated with the variable eput-1. A negative result is expected (H0: $\beta 1 \geq 0$ and H1: $\beta 1 < 0$). Thus, it is a left one-tailed hypothesis test (critical values of 1.28, 1.65, and 2.33 for significance of 10%, 5%, and 1%, respectively).

Inference strategy

This subsection describes the stages for proceeding inferential analysis. Its purpose is to guide inferences on the relationship between corporate investment and economic policy uncertainty. The analysis was split into two stages. First, Systemic Generalized Method of Moments (GMM-sys) panel data (Blundell & Bond, 1998) was computed in order to provide technical support to H1. GMM-sys instead of conventional panel data computations is due the fact that traditional estimations do not deal adequately with endogeneity caused by omitted variables (Ozkan, 2001). Considering parametric approaches, GMM-sys is also feasible to cope with issues related to simultaneity (Bournakis & Mallick, 2018). The validity of GMM-sys estimations depends on three verifications. The first one is the absence of second-order autocorrelation in residuals (Arellano & Bond, 1991). Null hypothesis describes the absence of second order autocorrelation. Second, the absence of endogeneity regarding instruments (Hansen, 1982). Null hypothesis describes that instruments are exogenous. Lastly, the number of instruments must be lower than the number of units (companies) observed (Roodman, 2009).

The estimations based on single coefficients presents only part of relationship between variables. A wider analysis would provide regressors at different points of variables distribution (Cameron

& Trivedi, 2013). As second stage, a set of Quantile regression analysis was conducted to account for potential heterogeneity within the sample. The set of estimations regards unconditional quantile regression for fixed effects proposed by Borgen (2016). Specifically, the fixed effects considered are the sample companies in an effort to not disregard the behavior of firms through the distribution of capital expenditures. Instead of single estimator, this methodology will provide different point estimations (Shawtari et al., 2016) regarding the relationship between corporate investment and economic policy uncertainty. Taking into consideration the heterogeneity within listed companies in a same single country, it is expected that Quantile analysis discloses more regular patters for the relationship uncertainty-investment in Brazil since the distribution of the association between them is detailed. The purpose of application of Fixed effects in unconditional quantile regression is to confirm or refute H2. Further, robustness verifications were undertaken in two steps. Firstly, quantile analysis is employed considering Residual economic policy uncertainty (epur). And finally, this approach considered the employment of Brazilian economic uncertainty index (beui).

The hypothesized negative relationships (H1 and H2) and the regression coefficients under the null hypotheses are grounded in Real Options Theory. Following Bernanke (1983) and Dixit & Pindyck (1994), this framework draws an analogy to stock market call options, highlighting the optionality inherent in investment decisions. Notably, adopting the Real Options approach as a theoretical basis does not necessitate the inclusion of stock option variables in hypothesis testing.

Empirical findings

Descriptives

Table 2 Summirizes variables and quantile descriptions. Tests for the presence of unit-root are also detailed.

Table 2
Descriptive statistics

Variables	n	Mean	SD	$Q_{25\%}$	$Q_{50\%}$	$Q_{75\%}$	$Q_{90\%}$	Df.
Firm								
Cpx	8306	0.0096	0.0108	0.0020	0.0060	0.0130	0.0230	53.815***
Grow	8306	0.0034	0.0391	-0.0100	0.0030	0.0180	0.0420	68.132***
Cfo	8306	0.0150	0.0322	-0.0010	0.0150	0.0320	0.0510	24.034***
Sze	8306	21.932	17.945	20.628	21.903	23.199	24.409	19.212***
Q	8306	10.535	0.8123	0.5640	0.8170	12.510	19.880	61.816***
Country								
Epu	52	51.880	0.4415	49.530	51.639	55.563	57.434	-4.208***

Epur	52	0.0000	0.4120	-0.2817	0.0284	0.2861	0.5191	-4.307***
Beui	52	4.7063	0.1455	4.5836	4.7057	4.7798	4.8700	-2.260
Inf	52	0.0150	0.0100	0.0083	0.0155	0.0217	0.0285	-5.045***
Gdp	52	0.0210	0.0350	-0.0191	0.0281	0.0420	0.0627	-9.297***
Sto	52	0.0170	0.1140	-0.0640	0.0137	0.0845	0.1339	-9.986***
Exc	52	0.0220	0.0740	-0.0214	0.0026	0.0779	0.1093	-6.461***

Notes: This table reports the sample descriptives based on unbalanced panel (170 companies). Time range: first quarter of 2010 to fourth quarter of 2022. Dick-fuller test for each variable is presented in the last Column Df (H0: data contain unit root). Variables definitions specified in Table 1. Source: by the authors.

Multivariate analysis

GMM-sys estimations

This subsection aims to estimate the average economic effect of economic policy uncertainty on corporate investment. It is based on GMM-sys approach. Results in Table 3 reports the coefficient estimates for four different specifications according to baseline model. The estimations are split into unbalanced and balanced panel and take into account EPU index and residual EPU to proxy economic policy uncertainty.

Table 3
Brazilian economic uncertainty index on corporate investment. GMM-sys approach

#	(1)	(2)	(3)	(4)
cpx_{t-1}	0.11052***	0.12594***	0.13011***	0.15328***
	(0.04020)	(0.04068)	(0.04133)	(0.04113)
epu_{t-1}	-0.00336***		-0.00390***	
	(0.00117)		(0.00096)	
$epur_{t-1}$		-0.00329**		-0.00335***
		(0.00133)		(0.00098)
gro_{t-1}	-0.02096	-0.00023	-0.01558	0.02247
	(0.08263)	(0.05560)	(0.06217)	(0.03179)
cfo_{t-1}	0.28543***	0.29432***	0.27397***	0.25108***
	(0.08514)	(0.07813)	(0.07848)	(0.06615)
sze_{t-1}	-0.01188***	-0.01104***	-0.00973***	-0.00891***
	(0.00325)	(0.00326)	(0.00277)	(0.00237)
q_{t-1}	-0.00692*	-0.00550	-0.00519*	-0.00428
	(0.00360)	(0.00393)	(0.00314)	(0.00312)
inf_{t-1}	0.07431*	0.07889*	0.08918**	0.09599**
	(0.04508)	(0.04460)	(0.04459)	(0.03827)
gdp_{t-1}	0.00030	-0.02211	-0.00857	-0.03356**
	(0.02838)	(0.02371)	(0.02042)	(0.01467)
sto_{t-1}	-0.00695	-0.00808	-0.00552	-0.00713
	(0.00644)	(0.00657)	(0.00575)	(0.00560)
exc_{t-1}	-0.02167**	-0.02075**	-0.01827**	-0.01661**
	(0.00871)	(0.00946)	(0.00821)	(0.00724)
Const.	0.35056***	0.30575***	0.30533***	0.22903***

	(0.10549)	(0.09810)	(0.09427)	(0.06545)
$lb \leq \beta_{1(GMM\text{-}sys)} \leq ub$	[-0.0056; -0.0010]	[-0.0059; -0.0006]	[-0.0057; -0.0020]	[-0.0052; -0.0014]
Time	Y	Y	Y	Y
Industry	Y	Y	Y	Y
Wald test (p-value)	0.0000	0.0000	0.0000	0.0000
Number of Instruments	62	62	62	62
AR2 (p-value)	0,168	0,094	0.131	0.223
Hansen J (p-value)	0,384	0,373	0.114	0.314
Companies	170	170	146	146
Observations	7,985	7,985	7,245	7,245

Notes: This Table reports the baseline model estimations considering an unbalanced panel (170 companies) in Columns (1) and (2) and a balanced dataset (146 companies). Time describes the presence of time dummies (Y). Industry indicates the presence of dummies for economic sectors (Y). The expression $lb \leq \beta 1(GMM\text{-}sys) \leq ub$ denotes the lower and the upper bound confidence interval for GMM-sys slopes associated to EPU. Estimations of parameters are based on two-step GMM-Sys. Standard-errors in parenthesis. All firm and country level variables are lagged into a quarter. ***, ** and * indicate significance at level of 1%, 5%, and 10%, respectively. Source: by the authors.

At 1% of significant, Columns (1) and (2) in Table 3 show that EPU and residual EPU have negative impact on capital expenditures as presented by scores of Zepu = -2.87 (-0.00336/0,00117) and Zepur = -2.47 (-0,00329/0,00133). Considering a balanced panel (Columns 3 and 4), the slopes associated to EPU and Residual EPU are significant as they disclose Zepu = -4,06 (-0,0039/0,00096) and Zepur = -3.42 (-0,00335/0,00098), both significant at 1%. Table 3 provides verification for second-order residual autocorrelation hypothesis (AR2). Results indicate absence of autocorrelation issues (p-value range 0,094 to 0.223). Regarding Hansen J test, the results indicate that the hypothesis of exogeneity of the instruments were not rejected indicating that the instruments are valid (p-value range 0.114 to 0.384. The number of instruments is inferior to the number of groups (companies) for all models (62 instruments). Taken together, these results support the validity of the estimations, suggesting that even with the use of a proxy potentially feasible of mitigating measurement error (Residual EPU) and the transition from an unbalanced to a balanced panel sample, the findings remain robust. Estimates remained analogous pointing to the same direction and with similar magnitudes (coefficients) taking as reference their confidence interval reported in Table 3.

On average, higher EPU index is associated with a lower historical capital expenditure to total assets ratio. Given the statistical significance related to economic policy uncertainty proxy, ceteris paribus, one standard deviation of increase in EPU corresponds to a decrease of 0,1483% (-0.00336*0.4415*100) in corporate investment. Regarding the measurement of Capex mean in Table 1 (1.080%), the detrimental effect of economic uncertainty matches to -13,73% (0.1483%/1.080%). These results corroborate the idea that fluctuations in economic policy dent the appetite for corporate investment (Baker et al., 2016).

Uncertainty spread by decisions or perspective for decisions regarding economic policy can leads to frictions on corporate investment policies. Negative effect indicates a conservative behavior adopted by investors (as central planners) as they are compelled to deal with possible huge irreversibility costs. This corporate behavior corroborates "wait and see" sense advocated by Real Options approach (Bernanke, 1983; Dixit & Pindyck, 1994; and Pindyck, 1991) and provide evidence to confirm the first hypothesis (H1).

The negative relationship found for the Brazilian economic environment reveals consistency with studies conducted by Batista et al. (2024), Caixe (2022), Chen et al., (2019), Chen et al., (2020), Gulen & Ion (2016), Kang et al., (2014), Oliver (2020), Su et al., (2021) Oliver (2020), even they screened diverse longitudinal data. Caixe (2022) also evaluated Brazilian environment, yet comprising a longer time range. In that research, Z scores associated with EPU coefficients and equivalent standard-errors were revealed in Table 11 in six different specifications. They varied between -3,49 to -3,76 and -0.0038 to -0,0041, respectively. Thus, the standard error associated to each estimation can be recovered (-0,0038/-3,49 = 0,001089) and consequently the confidence interval (by 95% confidence) can be reconstituted and compared to the present research. This analysis aims to highlight patterns observed in previous studies and expand our understanding of the relationship between investment and uncertainty

Accounting for lowest Z score (to keep it conservative), the inferior bound of confident interval would be -0,00593 (-0,0038-0,001089*1,96) and superior -0,00167 (-0,0038+0,001089*1,96). Despite differences in time ranges (2001 to 2019), sample compositions and model specifications, the estimated coefficients for economic policy uncertainty in this study are consistent with those found in previous research, suggesting a consistent negative impact of EPU across different contexts. This assertion can be made because all the estimated confidence intervals in Table 3 intersect with the estimated confidence interval derived from Caixe (2022). All confidence interval of the present research match to those estimations. It can be argued that the economic message underlying to this detailing is that economy policy uncertainty decreases corporate investment with a magnitude of average shock that haven´t changed expressively through different time ranging and potential different firm sample. This analysis corroborates the significant negative impact on corporate investment decisions, suggesting that they are deeply troubled by the uncertainty stemming from economic policy management. It suggests that the rise of option value to wait presents the same direction of uncertainty rise. As uncertainty rises, the potential benefit of waiting for more information also increases. In summary, the consistent negative relationship between EPU and corporate investment observed across different models and sample configurations draw attention to the significant deterrent effect of economic uncertainty on corporate investment decisions. This finding aligns with the 'wait and see' behavior predicted by Real Options theory, highlighting the importance of stable policy environments for fostering corporate investment.

This subsection has established that uncertainty continues to exert a negative influence on investment, with a consistent magnitude of impact. Nevertheless, it does not allow inferences regarding the distribution of corporate investment responses to uncertainty. This is because GMM-Sys estimators concentrate specifically on the central tendency of the distribution. In this sense, they disregard possible relevance of the independent variable on corporate investment in different intervals.

Economic policy uncertainty on capex: quantile regression approach

In this subsection, we employed a fixed-effects quantile panel regression approach to explore the impact of economic policy uncertainty (EPU) on corporate investment, specifically across different points in the distribution of capital expenditures. This method allows us to test whether the relationship between corporate investment and uncertainty varies across different levels of capital expenditures, thereby examining the heterogeneity of investment responses, as posited by second hypothesis.

Table 4
Effect of economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) Q20%	(2) Q40%	(3) Q60%	(4) Q80%
epu_{t-1}	-0.00094***	-0.00139***	-0.00258***	-0.00350***
	(0.00025)	(0.00034)	(0.00047)	(0.00089)
gro_{t-1}	0.00036**	0.00095***	0.00160***	0.00243***
	(0.00017)	(0.00035)	(0.00051)	(0.00093)
cfo_{t-1}	0.00671***	0.01224***	0.02354***	0.03786***
	(0.00223)	(0.00341)	(0.00474)	(0.00981)
sze_{t-1}	0.00032	-0.00044	-0.00043	-0.00160
	(0.00032)	(0.00037)	(0.00053)	(0.00110)
q_{t-1}	0.00320***	0.00295*	0.00518**	0.00186
	(0.00110)	(0.00172)	(0.00220)	(0.00613)
inf_{t-1}	0.00327**	0.00937***	0.02572***	0.02611***
	(0.00149)	(0.00324)	(0.00403)	(0.00706)
gdp_{t-1}	0.00384	0.00670	0.00924	0.02829*
	(0.00503)	(0.00687)	(0.00978)	(0.01527)
sto_{t-1}	-0.00008	-0.00129	-0.00337*	-0.01110***
	(0.00088)	(0.00155)	(0.00196)	(0.00327)
exc_{t-1}	0.00042	0.00020	0.00090	-0.00373**
	(0.00056)	(0.00099)	(0.00084)	(0.00183)
Const.	-0.00132	0.01994**	0.02889***	0.06551***
	(0.00646)	(0.00786)	(0.01106)	(0.02339)
Conf. I.	-.0014351; -.0004498	-.0020576; -.0007286	-.0035087; -.0016525	-.0052389; -.0017556
Time	Y	Y	Y	Y
F test	36.59***	38.10***	28.51***	21.52***
R^2	0,02148	0,04300	0,06134	0,04219
Obs	7985	7985	7985	7985

Notes: This Table reports the baseline model estimations considering an unbalanced panel (170 companies). Expression Conf. I. denotes the confidence interval with lower (lb) and upper bound (ub) for slopes associated to eput-1. Columns (1) to (4) identifies the estimations considering which quantile. Time describes the presence of time dummies (Y). Estimations of parameters based on bootstrapping replications. Cluster-bootstrapped standard errors (in parenthesis) with clustering on the fixed-effects variable specified in i(companies). ***, ** and * indicate significance at level of 1%, 5%, and 10%, respectively. Source: By the authors.

In Table 4, lower quantile (Q20%) regards companies with smaller capital expenditures to assets ratio than other quantiles. At significance of 1%, it discloses negative effect of EPU index on capital expenditures for all quantiles with decreasing negative progression. As higher the quantile, as intense (more negative) is the magnitude of coefficient associated to eput-1 index with -0,00094, -0,00139, 0,00258 and 0,00350. The t teste ratios are -3.76 (Q20%), -4.09 (Q40%), -5.49 (Q60%) and -3.93 (Q80%). At 95% confidence level, the confidence interval of increasing quantile estimates related to EPU coefficients are [-0.0014351 ≤ β1(Q20%) ≤ -0.0004498], [-0.0020576 ≤ β1(Q40%) ≤ -0.0007286], [-0.0035087 ≤ β1(Q60%) ≤ -0.0016525] and [-.0052389 ≤ β1(Q80%) ≤ -.0017556], respectively. For possible interceptions between confidence intervals, at Q20% and Q40% it is not possible to infer differences. A close examination on confidence interval allows to infer that Q20% to Q60% and Q20% to Q80%, does not present interceptions and therefore centered coefficients can be considered statistically different. Estimations in Table 4 reveals that EPU effect on capital expenditures are different and progressive according to quantiles. These findings suggest that firms with higher capital expenditures are more adversely affected by economic policy uncertainty.

Preceding results allow to affirm that coefficients related to EPU are statistically significant within quartiles. The coefficients sign and significance does not chance or lose relevance through quantiles. In turn, estimations provide empirical support to assert that economic negative impact of EPU on Capex is stronger at higher quantile. Since all EPU index coefficients are significant, it becomes feasible to estimate the magnitude of economic impact of uncertainty at all quantile, ceteris paribus. One standard deviation of increase on EPU ($1\sigma = 0.4415$) leads to decrease of -0.04150% (Q20%), -0.11391% (Q60%) and -0,15453% (Q80%) in capital expenditures, respectively. While the impact of economic policy uncertainty (EPU) remains negative across all quantiles of capital expenditure distribution, the magnitude of this effect appears to be heterogeneous. Firms with lower capital expenditure to asset ratios appear to be less sensitive to EPU. It can be observed a gradual increase in the intensity of effect of EPU index estimator as capital expenditures moves towards higher quantiles (culminating at the Q80 percentile).

These results provide evidence that the effect of economic policy uncertainty on capital expenditures tends not to be uniform across firms but it is instead heterogeneous, varying significantly

with the firm's level of investment. Firms in the lower quantiles, which represent those with lower capital expenditures, show a weaker response to EPU. In contrast, firms at higher quantiles, which have more substantial capital expenditures, exhibit a more pronounced reduction in investment in response to increased uncertainty. This pattern aligns with the theoretical expectations derived from the second hypothesis regarding that firms with higher levels of irreversible investments (sunk costs) are more sensitive to uncertainty. Such firms are likely to delay or scale back investment in the face of heightened economic policy uncertainty to avoid potential losses.

To expand the analysis, we provided intermediary specifications through splitting quantiles into 10%, 30%, 50%, 70% and 90%. Jointly, Tables 4 and 5 will provide decile analysis.

Table 5
Effect of economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) Q10%	(2) Q30%	(3) Q50%	(4) Q70%	(5) Q90%
epu_{t-1}	-0.00058***	-0.00113***	-0.00183***	-0.00299***	-0.00489***
	(0.00016)	(0.00027)	(0.00044)	(0.00050)	(0.00135)
gro_{t-1}	0.00015	0.00055*	0.00127***	0.00155*	0.00327**
	(0.00012)	(0.00032)	(0.00048)	(0.00085)	(0.00154)
cfo_{t-1}	0.00141	0.00888***	0.01852***	0.03601***	0.06757***
	(0.00157)	(0.00193)	(0.00374)	(0.00736)	(0.02050)
sze_{t-1}	0.00050**	0.00003	-0.00050	-0.00109	-0.00330**
	(0.00022)	(0.00040)	(0.00047)	(0.00080)	(0.00167)
q_{t-1}	0.00170	0.00417***	0.00195	0.00300	0.00243
	(0.00106)	(0.00140)	(0.00215)	(0.00473)	(0.00838)
inf_{t-1}	0.00019	0.00632***	0.01697***	0.02601***	0.03740***
	(0.00144)	(0.00211)	(0.00390)	(0.00380)	(0.01230)
gdp_{t-1}	-0.00799	0.00092	0.00710	0.01852	0.02898
	(0.00515)	(0.00681)	(0.00887)	(0.01424)	(0.03770)
sto_{t-1}	-0.00080	-0.00074	-0.00307**	-0.00626***	-0.01624**
	(0.00095)	(0.00127)	(0.00121)	(0.00238)	(0.00681)
exc_{t-1}	-0.00019	0.00018	0.00058	-0.00109	-0.00767**
	(0.00051)	(0.00059)	(0.00082)	(0.00160)	(0.00349)
Const.	-0.00763*	0.00715	0.02470**	0.04839***	0.11587***
	(0.00455)	(0.00806)	(0.01042)	(0.01742)	(0.03926)
Conf. I.	-.000897; -.0002542	-.0016577; -.0005948	-.0026896; -.0009626	-.0039803; -.0020014	-.0075364; -.0022392
Time	Y	Y	Y	Y	Y
F test	29.47***	41.39***	32.38***	24.90***	13.07***
R^2	0.01194	0.02809	0.0546	0.05285	0.03274
Obs	7,895	7,895	7,895	7,895	7,895

Notes: Similar to Table 4 with different quantile intervals. Source: by the authors.

Table 5 demonstrates that all regressions have negative coefficients related to EPU. It can be noticed the existence of similar progression of negative coefficients significance and magnitudes as described in Table 4 for different quantiles. The higher quantile, the stronger will be the effect of EPU on

capital expenditures. Comparing the size of EPU coefficient in extremes of capex distribution in Table 5 (Q10% and Q90%), it can be observed that the coefficient at highest quantile (Q90%: -0.00489) is more than 8 times higher than the coefficient observed at lowest one (Q10%: -0.00058). In economic terms, ceteris paribus, a standard deviation of increase on EPU ($1\sigma = 0.4415$) leads to decrease of -0,02561% and -0,21589% in capital expenditures at Q10% and Q90%, respectively. The estimations presented in Tables 4 and 5 provide empirical support for heterogeneous effect of Economic Policy Uncertainty on Corporate Investment in Brazil. They provide evidence to confirm the second hypothesis (H2) that the impact of EPU on corporate investment will be different at different quantiles. The significance of all coefficients presented in Table 4 and 5 also makes possible the measurement of economic impact of EPU index on capital expenditures at all quantiles. This is the purpose of Graph 1.

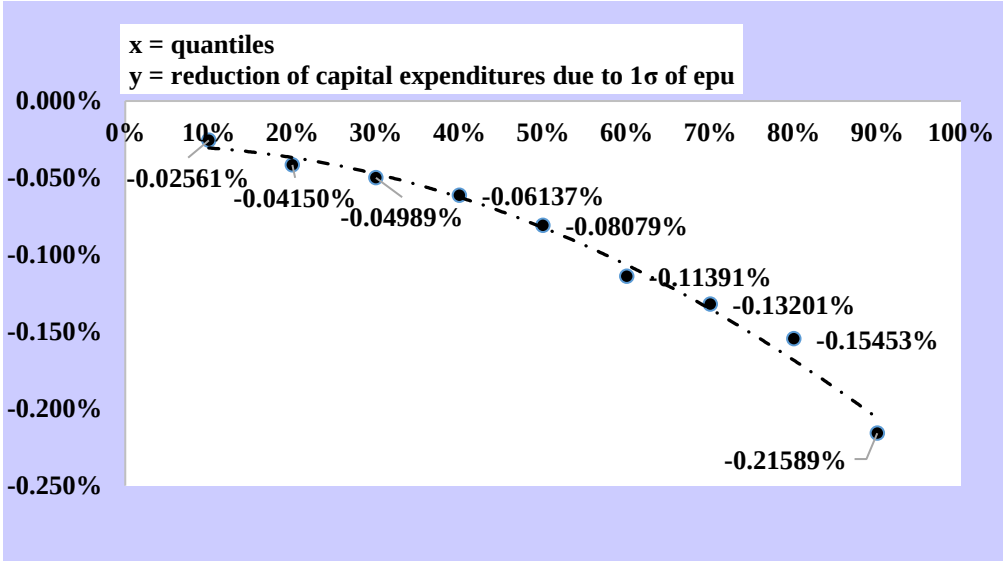

Figure 1. Capex in deciles and economic policy uncertainty impact
Notes: This graph describes the behavior of capital expenditures and economic effect of EPU within different deciles. The left scale describes the economic effect of EPU based on a standard deviation upturn of EPU. The right scale discloses capital expenditures of each decile. Source: by the authors.

Figure 1 illustrates the relationship between capital expenditures and the economic effect of EPU across different deciles, providing a visual confirmation of the heterogeneity observed in the quantile regression results. The graph shows a clear gradient, with the economic impact of EPU becoming increasingly negative as capital expenditures rise across deciles. It discloses a dispersion line graph which aims to describe, at one standard deviation of EPU index (ceteris paribus), what would be the impact on capital expenditures in respect to all quantiles (Q10% to Q90%). As ordered pairs, X e Y lines represent

one standard deviation of EPU Index and the economic impact of economic policy uncertainty, respectively, at each quantile.

The findings of this subsection extend prior empirical research on the association between economic policy uncertainty and investment by examining the heterogeneity of quantile responses. While previous studies have focused on the conservative "wait-and-see" behavior of investors (Arrow, 1968; Bernanke, 1983; Dixit & Pindyck, 1994; Marschak, 1949; Pindyck, 1991) disregarding the distribution of investment-uncertainty distribution, this research suggests how this behavior varies across firms. The findings reveal that the historical representativeness of corporate investment to total assets influences the sensitivity to economic policy uncertainty. Firms with lower share of capital locked in as sunk costs exhibit a weaker response to uncertainty compared to those with a higher historical exposure to investment risk. Firms with historically low investment commitments experience a modest impact from uncertainty, while those with high commitments experience a more amplified effect. These findings delve deeper into Real Options approach, suggesting a more pronounced "wait-and-see" strategy for firms with greater investment commitments on what could be denominated as uncertainty friction pattern.

Robustness analysis

This subsection presents a battery of verifications regarding alternative measurements to economic policy. First, it was applied residual EPU (epur) as described in subsection of Empirical design for this purpose. Second, it was applied a regional composite to proxy Brazilian economic uncertainty (beui) through quantile analysis.

Quantile regression; Residual EPU

Table 6 and 7 disclose the baseline model estimations considering Residual EPU (epur) as proxy for economic uncertainty. All controls remained the same.

Table 6
Residual economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) Q20%	(2) Q40%	(3) Q60%	(3) Q80%
$epur_{t-1}$	-0.00082***	-0.00100***	-0.00173***	-0.00212***
	(0.00027)	(0.00032)	(0.00052)	(0.00076)
gro_{t-1}	0.00034*	0.00092**	0.00154**	0.00233**
	(0.00018)	(0.00042)	(0.00061)	(0.00103)
cfo_{t-1}	0.00678***	0.01231***	0.02365***	0.03797***
	(0.00197)	(0.00280)	(0.00402)	(0.00998)

sze_{t-1}	0.00026	-0.00057	-0.00070	-0.00200**
	(0.00032)	(0.00046)	(0.00054)	(0.00099)
q_{t-1}	0.00315***	0.00290*	0.00512*	0.00181
	(0.00100)	(0.00153)	(0.00278)	(0.00592)
inf_{t-1}	0.00217	0.00790***	0.02310***	0.02273***
	(0.00146)	(0.00225)	(0.00382)	(0.00674)
gdp_{t-1}	0.00549	0.00859	0.01237	0.03195*
	(0.00483)	(0.00904)	(0.01059)	(0.01687)
sto_{t-1}	0.00066	0.00041	0.00121	-0.00345**
	(0.00054)	(0.00084)	(0.00091)	(0.00167)
exc_{t-1}	-0.00003	-0.00135	-0.00356*	-0.01151***
	(0.00079)	(0.00166)	(0.00198)	(0.00396)
Const.	-0.00488	0.01564	0.02155*	0.05657***
	(0.00720)	(0.01036)	(0.01230)	(0.02176)
Conf. I.	-.0013923; -.0002475	-.0016607; -.0003491	-.0026349; -.0008165	-.0037108; -.0005356
Time	Y	Y	Y	Y
F test	36.50***	38.03***	28.41***	21.48***
R^2	0.01916	0.04011	0.05654	0.03917
Obs.	7,895	7,895	7,895	7,895

Notes: This table reports the baseline model estimations considering an unbalanced panel (170 companies). Expression Conf. I. denotes the confidence interval with lower and upper bound for slopes associated to epurt-1 (residual EPU). Columns (1) to (4) identifies the estimations considering which quantile. Time describes the presence of time dummies (Y). Estimations of parameters based on bootstrapping replications. Cluster-bootstrapped standard errors (in parenthesis) with clustering on the fixed-effects variable specified in i (companies). ***, ** and * indicate significance at level of 1%, 5%, and 10%, respectively. Source: By the authors.

At 1% significance, Table 6 exhibits that the slope related to residual EPU also present negative estimators. Results remained different across quantiles and can be considered similar when compared to estimations presented in subsection 4.2.2. They reinforce that corporate investment are differently affected by the spread of economic policy uncertainty within business environment. Table 7 expand the analysis for different set of quantiles.

Table 7
Residual economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) 10%	(2) 30%	(3) 50%	(4) 70%	(5) 90%
$epur_{t-1}$	-0.00049**	-0.00080**	-0.00135***	-0.00188***	-0.00305**
	(0.00021)	(0.00032)	(0.00043)	(0.00060)	(0.00139)
gro_{t-1}	0.00014	0.00052	0.00122***	0.00147**	0.00314**
	(0.00011)	(0.00032)	(0.00037)	(0.00064)	(0.00157)
cfo_{t-1}	0.00145	0.00894***	0.01861***	0.03612***	0.06774***
	(0.00137)	(0.00202)	(0.00359)	(0.00697)	(0.01749)
sze_{t-1}	0.00046**	-0.00007	-0.00066	-0.00142*	-0.00384***
	(0.00019)	(0.00036)	(0.00045)	(0.00079)	(0.00131)

q_{t-1}	0.00167**	0.00413***	0.00189	0.00295	0.00234
	(0.00077)	(0.00131)	(0.00199)	(0.00427)	(0.00968)
inf_{t-1}	-0.00047	0.00514***	0.01502***	0.02307***	0.03262***
	(0.00119)	(0.00191)	(0.00314)	(0.00395)	(0.01188)
gdp_{t-1}	-0.00702	0.00241	0.00966	0.02184*	0.03434
	(0.00491)	(0.00746)	(0.00826)	(0.01192)	(0.02870)
sto_{t-1}	-0.00006	0.00035	0.00088	-0.00080	-0.00722**
	(0.00042)	(0.00087)	(0.00087)	(0.00160)	(0.00360)
exc_{t-1}	-0.00077	-0.00079	-0.00312**	-0.00656**	-0.01675***
	(0.00083)	(0.00130)	(0.00126)	(0.00305)	(0.00584)
Const.	-0.00974**	0.00373	0.01893*	0.04043**	0.10297***
	(0.00406)	(0.00816)	(0.00975)	(0.01778)	(0.02950)
Conf. I.	-.0008493 - .0001239	-.0014574 - .0001468	-.0021346 - .0005577	-.003344 - .0004237	-.0052208 - .0008885
Time	Y	Y	Y	Y	Y
F test	29.41***	41.28***	32.31***	24.85***	13.07***
R^2	0.01070	0.02517	0.05170	0.04892	0.03076
Obs	7,895	7,895	7,895	7,895	7,895

Notes: Similar to Table 6 with different quantile intervals. Source: by the authors.

Quantile regression; Brazilian economic uncertainty index

Table 8 and 9 evidences the baseline model estimations considering Brazilian economic uncertainty index (beui) as proxy for economic policy uncertainty. All controls remained the same.

Table 8
Brazilian economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) Q20%	(2) Q40%	(3) Q60%	(3) Q80%
$beui_{t-1}$	-0.00341***	-0.00588***	-0.01057***	-0.01599***
	(0.00082)	(0.00101)	(0.00194)	(0.00216)
gro_{t-1}	0.00041**	0.00105***	0.00177***	0.00270***
	(0.00020)	(0.00038)	(0.00057)	(0.00074)
cfo_{t-1}	0.00708***	0.01290***	0.02471***	0.03965***
	(0.00184)	(0.00370)	(0.00441)	(0.00830)
sze_{t-1}	0.00045	-0.00016	0.00005	-0.00077
	(0.00029)	(0.00043)	(0.00054)	(0.00092)
q_{t-1}	0.00375***	0.00388**	0.00687**	0.00438
	(0.00102)	(0.00190)	(0.00279)	(0.00419)
inf_{t-1}	0.00450***	0.01159***	0.02968***	0.03230***
	(0.00132)	(0.00337)	(0.00433)	(0.00490)
gdp_{t-1}	0.00622	0.01094	0.01681	0.04000**
	(0.00474)	(0.00821)	(0.01061)	(0.01900)
sto_{t-1}	0.00087*	0.00104	0.00238**	-0.00135

	(0.00047)	(0.00079)	(0.00113)	(0.00214)
exc_{t-1}	-0.00039	-0.00169	-0.00413*	-0.01204***
	(0.00080)	(0.00141)	(0.00230)	(0.00351)
Cons.	0.00710	0.03439***	0.05491***	0.10477***
	(0.00560)	(0.00947)	(0.01199)	(0.02332)
Conf. I.	-.0047005; -.0021146	-.008271; -.0034817	-.0139885; -.0071486	-.0206787; -.0113038
Time	Y	Y	Y	Y
F test	36.78***	38.26***	28.69***	21.61***
R^2	0.02532	0.04923	0.06968	0.04927
Obs	7,895	7,895	7,895	7,895

Notes: This table reports the baseline model estimations considering an unbalanced panel (170 companies). Expression Conf. I. denotes the confidence interval with lower and upper bound for slopes associated to beuit-1 (Brazilian economic uncertainty index). Columns (1) to (4) identifies the estimations considering which quantile. Time describes the presence of time dummies (Y). Estimations of parameters based on bootstrapping replications. Cluster-bootstrapped standard errors (in parenthesis) with clustering on the fixed-effects variable specified in i (companies). ***, ** and * indicate significance at level of 1%, 5%, and 10%, respectively. Source: By the authors.

At 1% significance level, the economic effect remained negative across quantiles. It has to be observed that the coefficients associated to beui are expressively different from those estimated with EPU index (Table 4) and residual EPU (Table 7). As consequence, the confidence intervals will be different. Descriptives present that one standard deviation of beui is 0.1455. It means that EPU standard-deviation is 3,03 (0.4415/0.1455) times larger than beui. This provide evidence that the fluctuation of the first can be considered expressively higher compared to the second.

Those differences are due to the methodological issues (Ferreira et al., 2019) between approaches. They bring up the idea that economic effect (ceteris paribus) measurement will be different as well. The economic impact is partially compensated by the larger size of the coefficients in Table 8 and lower magnitude of beui standard deviation (Table 2). Taking into account a standard deviation of beui, the impacts on reduction of corporate investments are -0.0549%, -0,1120%, -0,2002% and -0,3274% for Q20%, Q40%, Q60% and Q80%, respectively. Thus, close to the double of the economic impact measured by EPU described in Table 5. It cannot be ignored that these differences are critical for economic impact measurement. Nevertheless, for inferential purposes, since the objective of this subsection in to seek for robustness analysis, Table 8 presents that negative direction of the coefficients related to beui persisted. Additionally, the progression of the estimates in Tabel 8 is similar to progression evidenced when using EPU as proxy, as the results evidence that the impact of economic policy uncertainty is stronger at higher quantiles. Table 9 provides more estimations regarding different quantiles.

Table 9
Brazilian economic policy uncertainty on corporate investment. Quantile analysis.

#	(1) 10%	(2) 30%	(3) 50%	(4) 70%	(5) 90%
$beui_{t-1}$	-0.00233***	-0.00456***	-0.00784***	-0.01333***	-0.01883***
	(0.00063)	(0.00095)	(0.00178)	(0.00188)	(0.00456)
gro_{t-1}	0.00019*	0.00062***	0.00140***	0.00178**	0.00357**
	(0.00011)	(0.00024)	(0.00045)	(0.00069)	(0.00146)
cfo_{t-1}	0.00167	0.00939***	0.01939***	0.03751***	0.06963***
	(0.00137)	(0.00223)	(0.00471)	(0.00681)	(0.01654)
sze_{t-1}	0.00061**	0.00024	-0.00012	-0.00041	-0.00251
	(0.00025)	(0.00039)	(0.00046)	(0.00054)	(0.00153)
q_{t-1}	0.00207*	0.00490***	0.00319	0.00510	0.00545
	(0.00125)	(0.00127)	(0.00200)	(0.00355)	(0.00831)
inf_{t-1}	0.00106	0.00803***	0.01995***	0.03114***	0.04433***
	(0.00153)	(0.00227)	(0.00308)	(0.00440)	(0.00894)
gdp_{t-1}	-0.00633	0.00418	0.01277	0.02823**	0.04231
	(0.00463)	(0.00768)	(0.00954)	(0.01428)	(0.03476)
sto_{t-1}	0.00013	0.00082	0.00171	0.00087	-0.00512
	(0.00047)	(0.00072)	(0.00105)	(0.00177)	(0.00413)
exc_{t-1}	-0.00097	-0.00107	-0.00359**	-0.00708**	-0.01775**
	(0.00074)	(0.00115)	(0.00141)	(0.00310)	(0.00707)
Const.	-0.00189	0.01838**	0.04397***	0.08113***	0.16229***
	(0.00390)	(0.00744)	(0.01050)	(0.01351)	(0.04200)
Conf. I.	-.0035734 - .0010848	-.0069729 - .0021448	-.0112496 - .0044215	-.0174408 - .0092133	-.0276096 - .0100436
Time	Y	Y	Y	Y	Y
F test	29.64***	41.61***	32.54***	25.04***	13.07***
R^2	0.01506	0.03339	0.06266	0.06159	0.03527
Obs	7,895	7,895	7,895	7,895	7,895

Notes: Similar to Table 8, with different quantile intervals. Source: by the authors.

Conclusions

Proxied by EPU index and capital expenditures, this paper analyzed the relation between economic policy uncertainty and corporate investment in Brazil. The sample is comprised by 170 companies for the period of 2010 to 2022. Instead of central based estimations, it provided a more nuanced understanding of how EPU affects corporate investment across different levels of capital expenditures.

The key findings of this study are as follows. First, detrimental impact of uncertainty on Investment. Economic policy uncertainty consistently exerts a negative effect on corporate investment across the entire distribution of capital expenditures. Whether analyzed through central-based estimations (GMM-sys) or through a methodological approach that accounts for corporate heterogeneity (quantile regressions), the results consistently indicate a detrimental impact. However, the severity of this impact

varies progressively across different levels of investment intensity. Second, heterogeneous effects based on capital expenditure levels. The negative impact of EPU is more pronounced for companies with higher capital expenditures relative to their assets. Firms that allocate a larger portion of their assets to investment are more likely to experience significant and enduring negative effects from economic policy uncertainty. This suggests that firms with substantial investment commitments face greater risks under uncertain policy environments. Taking into account corporate heterogeneity, it is coherent to assert that they do not cope uniformly with irreversibility and uncertainty. Consequently, firms are likely to manage sunk costs differently when planning and executing risk investment projects. These firms are typically more exposed to risks associated with sunk costs and have less flexibility to adjust their investment plans without incurring significant losses.

This study contributes to a broader understanding of the investment-uncertainty relationship by incorporating the concept of corporate heterogeneity into the analysis. The findings reveal that as economic uncertainty increases, so does the option value of waiting to invest, with this effect being most significant at higher quantiles. This evidence supports the existence of a heterogeneous impact of uncertainty on investment decisions, highlighting that the friction caused by uncertainty is not uniform across all firms within a country. These insights suggest that relying solely on average effects may obscure important differences in how uncertainty impacts firms with varying levels of capital expenditures. Future research could benefit from exploring the distributional patterns of uncertainty's impact on different corporate policies variables, providing a richer understanding of how different types of firms navigate uncertain economic environments.

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