

## ARTICLES

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# GOVERNMENT CORRUPTION ON BRAZILIAN CAPITAL MARKETS: A STUDY ON LAVA JATO (CAR WASH) INVESTIGATION

*Corrupção governamental no mercado de capitais: Um estudo acerca da operação Lava Jato*

*Corrupción gubernamental en el mercado de capitales: Un estudio acerca de la operación Lava Jato*

### ABSTRACT

In recent years, Brazil has faced economic and political crises resulting from the actions of an elaborate syndicate of corruption in the government. The financial literature points to two lines of thought related to corruption. One approach defends the existence or bestowal of benefits, and the other points to losses in the public network. An event study based on the GARCHX-in-Mean model was conducted to understand the relationship between corruption and the decrease in the level of investment, and to identify the potential impact of corruption on selected assets. The results indicate that there was a significant devaluation of the largest state-owned companies traded on the Brazilian Stock Exchange and in American Depository Receipts, leading to money laundering and a decrease in economic growth. This supports the theory of a long-term crisis due to corruption.

**KEYWORDS** | Event study, return, volatility, GARCHX-in-mean, corruption.

### RESUMO

*O Brasil apresentou, nos últimos anos, um cenário de crise econômica e política, resultado do funcionamento de uma elaborada rede de corrupção no governo. A literatura financeira aponta duas linhas de pensamento relacionadas ao tema corrupção, uma que defende a existência de efeitos benéficos e outra que aponta os prejuízos no sistema público. A fim de se entender a relação entre a queda no nível de investimento e a corrupção, foi realizado um estudo de eventos, com base no modelo GARCHX-in-Mean, que permitisse identificar a existência e/ou o potencial sentido do impacto da corrupção para alguns ativos selecionados. Os resultados apontam que, no Brasil, houve uma grande desvalorização nas maiores empresas estatais negociadas na bolsa de valores nacional e também em suas American Depository Receipt (ADR), conseqüentemente, gerando um cenário de fuga de recursos financeiros e indicando uma queda no crescimento econômico, apoiando a teoria de prejuízo em longo prazo da corrupção.*

**PALAVRAS-CHAVE** | Estudo de eventos, retorno, volatilidade, GARCHX-in-mean, corrupção.

### RESUMEN

*Brasil presentó, en los últimos años, un escenario de crisis económica y política, resultado del funcionamiento de una elaborada red de corrupción en el gobierno. La literatura financiera apunta dos líneas de pensamiento relacionadas al tema corrupción: una que defiende la existencia de efectos benéficos y otra que apunta los perjuicios en el sistema público. A los efectos de entender la relación entre la caída del nivel de inversión y la corrupción, se realizó un estudio de eventos, con base en el modelo GARCHX-in-mean, que permitiera identificar la existencia y/o el potencial sentido del impacto de la corrupción para algunos activos seleccionados. Los resultados indican que, en Brasil, hubo una gran desvalorización en las mayores empresas estatales negociadas en la bolsa de valores nacional y también en sus American depositary receipt (ADR) que, conseqüentemente, generó un escenario de fuga de recursos financieros e indicó una baja en el crecimiento económico, lo que apoya la teoría de perjuicio a largo plazo de la corrupción.*

**PALABRAS CLAVE** | Estudio de eventos, rendimiento, volatilidad, GARCHX-in-mean, corrupción.

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## INTRODUCTION

The world economy has undergone a major change in the last decade. With the advances in technology, the effect of globalization is becoming stronger and increasingly prevalent in everyday life. Connectedness between countries and easy access to information has encouraged growth in international transactions in several markets. Claessens, Klingebiel, and Schmukler (2006), for example, argued that the integration and negotiation of goods and resources between countries impact the agents involved in the economic and legal structures aimed at maintaining national competitiveness and ensuring commercial growth.

Brazil has experienced a great change in its social and economic structure, as pointed out by the World Bank (2015). The country exhibited a 4.5% average growth in the Gross Domestic Product (GDP) between 2006 and 2010, but faced a drop in the following years due to the crisis in the economic and political sectors as a result of public corruption, reaching -3.05% according to the October 2015 report of the Banco Central do Brasil (2015). The scenario of uncertainty and distrust caused by high government expenditure and the increase in inflation and interest rates triggered conditions that made it hard for Brazilian companies to survive and grow, as observed in the changes in returns and an increase in assets risk in the financial market.

Many studies, such as the works of Shleifer and Vishny (1993) and Mauro (1995), have tried to understand the relationship between government corruption and the economic growth of countries. Shleifer and Vishny (1993) defined this phenomenon as the use of power and public influence for personal gain, and found it more often in developing countries due to the common unstable and extremely bureaucratic structure of these governments. In general, the studies disclosed both positive and negative effects of corruption events in the development of each nation, leading to two lines of analysis: (1) *Grease the Wheel*, which presents the beneficial economic results of corruption; and (2) *Sand the Wheel*, which criticizes corruption and seeks to highlight the obstacles and losses it causes. Several social and economic points were considered within these analyses, aiming at the identification of the reasons and factors that contributed to the continuity of the event in question. Still, few studies are specifically focused on the effects within a particular country, and the socioeconomic analysis of this relationship.

In response to the current and growing interest in public corruption, several international entities have opened avenues for discussions on the subject. The World Economic Forum is an organization that aims to discuss various issues around the

economic and social development of the member countries. At the January 2017 meeting in Davos, Switzerland, one of the topics was the fight against corruption and each nation's efforts to combat the problem. The agenda for debates highlighted the strong and constant presence of corruption in Latin America, a topic that has attracted international media attention, especially since 2014, and how countries such as Brazil and Chile have adopted proactive positions committed to investigating and punishing those involved in corruption scandals.

When considering the attention and importance with which the international and national communities regard the subject, investigations such as the *Lava Jato* (Car Wash) Criminal Investigation present a fundamental opportunity to understand and quantify the impact that corruption has in Brazil. *Lava Jato* started investigations on March 17, 2014, with the purpose of uncovering financial crimes and the misappropriation of public money, and today has thirty investigation phases. The World Economic Forum has classified it as one of the preeminent corruption scandals reported in Brazil. Initially, the investigations were focused on unraveling crimes involving illicit operations at gas stations; however, as the investigation progressed and new evidence was obtained, a much wider corruption scheme encompassing large sectors of the economy such as oil, civil construction, the finance sector and the country's political sphere was disclosed. Once the extent of corruption in the Brazilian socio-economic system was identified, the study of this event was directed, at first, to assets such as Petrobras (PETR4 and PETR3), Vale (VALE5 and VALE3), and Banco do Brasil (Bank of Brazil) (BBAS3) that are present in the capital market, and that are highly relevant to the composition of the main index of the Stock, Commodities, and Futures Exchange (BM&FBOVESPA). The selection of state-owned companies was due to the strong presence of these assets in the national capital market, and because they represent the country's oil, mining, and financial sectors, as well as being directly linked to decisions and events involving the Brazilian State. Then, the same event and same companies were analyzed through their ADRs for assets listed on the international market on the Nasdaq (n. d.) stock exchange.

Thus, this study presents research focused on the Brazilian reality, and seeks to measure, as far as possible, the impact of corruption on the risk and returns of the main state assets that make up the BM&FBOVESPA index. As a focal event, we studied the effect of the disclosure of public activities resulting from the *Lava Jato* Criminal Investigation, such as search and seizures, coercive driving, and arrests, on the risk premium and volatility of these assets, particularly for the state-owned companies Petrobras, Banco do Brasil, and Vale. The understanding of how

this event affects the risk premium and its volatility will be of great help for economic agents to re-value their portfolios, and will provide support for compliance policies in organizations in Brazil and Latin America by disclosing how institutional corruption is harmful in the long term, regardless of apparent short-term advantages.

## THEORETICAL REFERENCE

This section presents the two main approaches adopted by researchers who have studied public corruption. Initially, we will present the results and theories of researchers who have highlighted the positive points of corruption, entitled *Grease the Wheels*, followed by the second approach, which pursues the negative effects of the event, identified as *Sand the Wheels*.

### Grease the Wheels

Several researchers in this field have attempted to prove the existence of beneficial effects of corruption in the social and economic development of countries. The basis of their argument is the existence of a bureaucratic and inefficient government system. [Leys \(1965\)](#) argued that a negative view of corruption due to the moralistic principles imposed by society contaminates the opinion of others, even though corruption itself is a neutral manifestation shaped according to the conditions of the environment.

[Huntington \(2006\)](#) analyzed the bureaucratic and political system of several countries at different moments in their histories. In cases where the author identified histories of highly centralized and bureaucratic governments, he diagnosed a slow and exhaustive public process in the social and economic environment. Key events included a high level of development in the country, accompanied by corruption news and scandals, leading to the belief that the latter is a driving event for the slow system. Following this principle, [Lau, Demir, and Bilgin \(2013\)](#) found a positive effect on the speed of government action, in which the payment of bribes and “kickbacks” is important and ensures that public servants carry out their work and continue to exercise their functions.

When analyzing the gains by public servants, corruption itself manifests a character of privilege and protection for those involved. According to the research of [Leys \(1965\)](#) and [Bayley \(1966\)](#), the occurrence of this phenomenon in the public sphere increases the demand for positions that provide exposure to bribes and a “kickbacks” cycle of receipts. This means that only individuals with aptitude and high qualifications would

be selected, and that they gain a guarantee of adequate compensation, since positions in the private sector involve uncertainties and risks. Investigating this point, [Dobson and Ramlogan-Dobson \(2012\)](#) carried out a study to determine the impact of corruption on the growth of the informal sector, and found a negative relationship between the variables.

When considering the enhanced agility in the government sector which accompanies corruption, besides the already mentioned gains, the public projects sector also benefits. [Leff \(1964\)](#) and [Bayley \(1966\)](#) mentioned two benefits for the government and for the population: (1) public bidding for projects will be more efficient, since the companies involved must present themselves as competent to carry out the project and deliver it with the agreed upon quality as a part of the remuneration that the company would receive was used for payment of kickbacks or bribes; (2) when faced with a law that cannot be circumvented, or when attempting to guarantee the interest of another party, the government would evaluate and revise the existing norms. In this way, laws that do not fit the reality of society will be changed and replaced.

### Sand the Wheels

While the *Grease the Wheels* approach is based on government inefficiency, the *Sand the Wheels* approach analyzes and argues the points raised based on the long-term impact on, and costs to, the country. Recent research, as presented in this article, strengthens the basis of this approach and adds new data on the true functioning and effects of corruption on economic indexes.

[Myrdal \(1994\)](#) criticized the existing relationship between the increases in the speed of execution in public processes and corruption. He raised two points related to the slowness of the system, which may be slow in reality or appear to be slow. In the first case, there is a short-term gain with corruption, but when analyzed over a longer time horizon, the evolution of the system toward efficiency may be obstructed by corrupt service providers. The same applies to the second case: public servants will tend to maintain and preserve the difficulties of the corrupt activities to ensure illicit gains, thus presenting an obstacle to the country’s growth.

After evaluating the systemic issue, [Kurer \(1993\)](#) investigated the impacts related to the members of the cycle and the corruption schemes. In his paper, the author described the effect of the patronage, characterized as a way by which the most powerful and influential member maintains his/her status based on alliances and favors in exchange for protection.

This system is found inside the public machinery, where cliques prevent the entrance of new members as a means of maintaining the clandestine organization and gain distribution. Therefore, the admission of new employees to the public sector will not necessarily result in better workforce qualifications or an increase in service quality, but rather in the maintenance or propagation of the already corrupt and inefficient system.

Regarding the gains obtained from government projects, several authors have criticized and countered the message espoused by the other current of thought. The first one, [Rose-Ackerman \(1997\)](#), pointed out that illegal payments to ensure election in a bidding process does not mean that the most efficient supplier will be chosen, but rather that the one who pays the most will acquire the license. The result is the allocation of public resources to projects with low social return, high cost, and doubtful quality, besides fostering a method to allow the entry of new companies that participate in the payment scheme without necessarily being the most suitable for the project. [Bardhan \(1997\)](#) and [Lambsdorff \(2003\)](#) analyzed the legislative reformulation proposed by corruption; the basis for the contestation relies on the corruption characteristic of reducing the level of companies' confidence in the laws. We observed that the occurrence of this phenomenon increases the risk perceived by the entrepreneurs, both in the country and in its functioning. In this way, the government would not have the means to demonstrate or guarantee legitimacy of its system beyond compliance with laws.

In addition to the points inherent to public functioning, [Mauro \(1995\)](#) analyzed the impact within a country's level of investment and growth. The author considered two variables to evaluate corruption: (1) the efficiency of the bureaucracy: determined by the judicial system, quantity of norms, and corruption indexes; (2) political stability: calculated through institutional and social changes, opposition control, work stability, relationship with neighboring countries, and terrorism index. A strong positive relationship was identified between bureaucratic efficiency and political stability, where the decisive factor for private investment in a country is political stability and confidence in the government. [Cicchini, Durbin, and Ng \(2003\)](#) tried to identify the impact of corruption in the financial market, as done by [Mauro \(1995\)](#), but focused on the private sector only. They found that investors expect a higher risk premium in countries with high corruption rates, and this is more evident in the emerging countries.

A study by [Nguyen and Dijk \(2012\)](#) in Vietnam pursued the understanding of corruption and its impact on the country. The authors mentioned six factors that promote the emergence of the phenomenon and favor its continuity: (1) type of existing

governance, considering the level of government centralization; (2) regional autonomy, related to the power each region has to exercise its laws; (3) public expenses; (4) access to property, considering the necessary expense to gain this access and time consumed; (5) law implementation and consistence, support for laws, and the reasons for its creation; and (6) private sector development policies, divided into entrance costs and time to enter the market.

[Nguyen and Dijk \(2012\)](#) noticed that the factors that reduced corruption levels in the country were the capacity for implementing laws, their consistency, and access to property. These factors were the result of a low level of bureaucratization and high government efficiency. The same research also found that factors related to private sector development policies have a strong positive relation with the development of the event in question. According to the authors, the relation can be explained by a bureaucracy whose actions slow down the process of functioning of private companies.

Current literature offers few studies that are directly linked to the reality of a country, or to a proven corruption case. Brazil is nevertheless interested in studying this phenomenon; however, papers that investigate this subject and address the view of the financial and capital markets through a quantitative methodology are rare. This study aims to bridge this gap in the research.

## METHODOLOGY

The basic methodology chosen to investigate the impact of corruption on financial and capital markets has its origin in the field of financial econometrics, and is classified as an event study. According to [Campbell, Lo, and MacKinlay \(1997\)](#), this technique was developed with the purpose of understanding, measuring, and relating the effect of a certain event or phenomenon on the market. The first similar published study is dated 1933 and conducted by Dolley, who investigated the returns for the issuance of new shares in existing companies. [Binder \(1998\)](#) discussed the evolution and sophistication of the methodology, and several researchers contributed to the current model conception.

[Campbell et al. \(1997\)](#) stipulated the main steps for conducting an events study – an important reference resource for field researchers. The first step is considered to be the definition of the event of interest, when one must define the event to be studied, the period in which it occurs, and stipulate its base of entries according to the date. There are no time/space restrictions; in other words, the methodology can be applied to annual, monthly, or daily data, provided that the number of observations is enough to meet the model preconditions (like the Central Limit

Theorem, in asymptotic cases). Some authors, such as [Dann \(1981\)](#), questioned the relevance of the methodology for daily observations due to the distortion of the normality assumption in the stochastic model component. This effect can be smoothed out when we calculate the natural logarithm of the return, and modify the distribution defined in the model into any distribution with heavier tails as done by [Rachev and Mittnik \(2000\)](#), or by using the methodology of robust parameter estimation to deviations in data normality, as conducted by [White \(1982\)](#).

A daily time unit was considered for the analysis of the event and the returns of the assets in question. Furthermore, as a proxy for the corruption event, we chose the official disclosure of the *Lava Jato* Criminal Investigation deployments, whose dates were important milestones for establishing the analysis period. In this regard, the first step was to define the estimation and event windows, methodologically referred to as the period without the interference of the event, being (1) the estimation window for the Brazilian data from January 3, 2000 to March 16, 2014 (2) and the estimation window for the North American data from June 13, 2006 to March 16, 2014. The second step is to define the event window, i.e., the period in which the studied event was found, dated from March 17, 2014 to December 29, 2016, and applied for both scenarios – national and international.

After defining the window intervals, we performed an evaluation of the impact of events associated with the *Lava Jato* Criminal Investigation, such as search and seizures, coercive driving, and arrests. The data of each operational deployment was obtained directly from the website of the [Federal Police \(2014\)](#). In order to understand news absorption and diffusion, we created time windows of one, two, five, ten, and fifteen days from this disclosure date. Each window represents a binary variable that assumes a value equal to 1 during the considered period, and zero otherwise, resulting in daily or non-daily appearances of the event.

The adopted econometric model for the event study was the *GARCH-in-mean* (GARCH-M) model, which was chosen based on the work by [Jong, Kemna, and Kloek \(1992\)](#), which incorporated the presence of volatility and time dependence in the mean equation, and the work by [Staikouras \(2006\)](#), who introduced the exogenous variables in the volatility equation. Mathematically, the adopted model assumed the following structure:

$$\begin{cases} r_{it} - r_{ft} = \beta(r_{mt} - r_{ft}) + \delta I_{jt} + \epsilon_t \\ \sigma_t^2 = \gamma_0 + \gamma_1 r_{i(t-1)}^2 + \gamma_2 \sigma_{i(t-1)}^2 + \omega I_{jt} \end{cases} \quad (1)$$

so that  $\epsilon_t \sim N(0, \sigma_t^2)$ . Additionally, we considered  $r_{it}$  as the adjusted return of company  $i$  during period  $t$ , so that  $i = 1, 2, 3$ , representing, respectively, Petrobras, Banco do Brasil, and Vale.  $r_{ft}$  and  $r_{mt}$  are respectively the returns of risk free asset, the reference rate of the Special Settlement and Custody System (Sistema Especial de Liquidação e de Custódia [Selic]), and the adjusted return of the market index (Bovespa Index), during period  $t$ , for the national market. For the international market, we considered the adjusted return of the *S&P 500* index as the market return, and *Treasury Bills* of the North American market as risk-free asset.

In the system presented by the equations, in 1, the first equation is composed by the *Capital Asset Pricing Model* (CAPM), in which the premium for the risk ( $r_{mt} - r_{ft}$ ) is explained by the market  $\beta$  multiplied by the premium for the risk in the market ( $r_{mt} - r_{ft}$ ). In addition, the parameter  $\delta$  measures the effect of the event disclosure on the premium by the asset risk and, therefore measures the expected percentage loss (or expected percentage gain) when new developments occur in the event of interest.

In the second equation, we have the GARCHX (1, 1) model for modeling the premium volatility by the risk ( $r_{mt} - r_{ft}$ ), added to the effect of the event on the volatility, given by the  $\omega$  parameter. The GARCH (1, 1) structure was adopted considering the frequently stylized fact of the good fit of this model in financial time series, as shown by [Hansen and Lunde \(2005\)](#). The parameters in the equations system 1 were estimated by the *Quasi Maximum Likelihood Estimation* (QMLE), a robust method for the handling of deviations in the assumption of normality, as presented by [White \(1982\)](#).

In other words, the QMLE estimator is used for models whose distributions may deviate from the basic assumption. According to the model presented in equations system 1, this assumption is the normality assumption, since  $\epsilon_t \sim N(0, \sigma_t^2)$ . Therefore, the QMLE estimator consistently estimates the vector of the parameters of interest, minimizing the Kullback-Leibler divergence between postulated and specified distribution. This estimator, therefore, is asymptotically normal and consistent, enabling good estimates if the sample is big enough ([Cox & Reid, 2004](#)).

The estimates for other model parameters were omitted because they were not the main parameters to be evaluated. However, for all estimated models, the weighted test Ljung-Box, developed by [Ljung and Box \(1978\)](#), for the squared residuals, presented a  $p$ -value above 5%, thereby indicating that the null hypothesis of absence of residues serial correlation shall not

be rejected, and then the structure of time dependence was complementarily modeled by the equations system 1 in all cases. The *dummy*  $I_{jt}$  variable assumed a value equal to 1 on the dates the operation was carried out, followed by the  $j = \{1, 2, 5, 10, 15\}$  windows subsequent to the registration. As mentioned previously,  $\delta$  and  $\omega$  represent the effect of disclosing this information in the windows considered for the risk premium and its volatility, respectively. It is also expected that as this window increases, this effect will decrease, representing the rate of “memory loss” of investors. This is because, the more distant from the deployment date, the lower the impact on risk and volatility.

## RESULTS

### Domestic market

The impact of the event, and its dispersion over time, was individually determined for each asset, taking into account the publication intervals of official news on the *Lava Jato* Criminal Investigation, as disclosed on the website of the [Federal Police \(2014\)](#). The tables reflect the results and present the behavior of risk premiums in relation to events, including the volatility and the expected value, as determined by us, for each time interval of corruption news:

**Table 1. Results without news post-disclosure interval**

Asset		Estimates	Standard error	T-Value	P-Value
PETR4	Return ( $\delta$ )	-0.15148	0.01571	-9.64120	< 0. 0001
	Volatility ( $\omega$ )	0.01627	0.00811	2.00600	0.04485
PETR3	Return ( $\delta$ )	0.012011	0.032418	0.3705	0.711010
	Volatility ( $\omega$ )	0.371702	0.155426	2.3915	0.016779
BBAS3	Return ( $\delta$ )	0.10127	0.01151	8.79903	< 0. 0001
	Volatility ( $\omega$ )	0.01939	0.05998	0.32331	0.74646
VALE5	Return ( $\delta$ )	-0.21034	0.01688	-12.46080	< 0. 0001
	Volatility ( $\omega$ )	0.06779	0.01749	3.87590	< 0. 0001
VALE3	Return ( $\delta$ )	0.020960	0.052565	0.39875	0.690079
	Volatility ( $\omega$ )	0.031565	0.025443	1.24062	0.214746

**Table 2. Results with two-day news post-disclosure interval**

Asset		Estimates	Standard error	T-Value	P-Value
PETR4	Return ( $\delta$ )	-0.16810	0.01128	-14.90430	< 0. 0001
	Volatility ( $\omega$ )	0.02976	0.00843	3.53060	< 0. 0001
PETR3	Return ( $\delta$ )	0.003109	0.040926	0.075977	0.939438
	Volatility ( $\omega$ )	0.417077	0.166138	2.510422	0.012059
BBAS3	Return ( $\delta$ )	0.10971	0.02332	4.70443	< 0. 0001
	Volatility ( $\omega$ )	0.19851	0.25180	0.78835	0.43049
VALE5	Return ( $\delta$ )	-0.22058	0.20020	-1.10178	0.27056
	Volatility ( $\omega$ )	0.09728	0.21299	0.45675	0.64786
VALE3	Return ( $\delta$ )	-0.178937	0.010994	-16.2766	< 0. 0001
	Volatility ( $\omega$ )	0.430601	0.240608	1.7896	0.073512

Table 3. Results with five-day news post-disclosure interval

Asset		Estimates	Standard error	T-Value	P-Value
PETR4	Return ( $\delta$ )	-0.16997	0.01195	-14.22102	< 0. 0001
	Volatility ( $\omega$ )	0.02659	0.02465	1.07856	0.28078
PETR3	Return ( $\delta$ )	-0.001467	0.028938	-0.050679	0.959581
	Volatility ( $\omega$ )	0.411288	0.088410	4.652056	< 0. 001
BBAS3	Return ( $\delta$ )	0.11957	0.00815	14.67920	< 0. 001
	Volatility ( $\omega$ )	0.22717	0.06247	3.63650	0.00028
VALE5	Return ( $\delta$ )	-0.23161	0.02192	-10.56630	< 0. 0001
	Volatility ( $\omega$ )	0.09413	0.01496	6.29240	< 0. 0001
VALE3	Return ( $\delta$ )	-0.324164	0.054404	-5.9585	< 0. 0001
	Volatility ( $\omega$ )	0.482791	0.225188	2.1439	0.032037

Table 4. Results with ten-day news post-disclosure interval

Asset		Estimates	Standard error	T-Value	P-Value
PETR4	Return ( $\delta$ )	-0.15743	0.00878	-17.92677	< 0. 0001
	Volatility ( $\omega$ )	0.01664	0.00569	2.92612	0.00343
PETR3	Return ( $\delta$ )	0.000705	0.022261	0.031686	0.974722
	Volatility ( $\omega$ )	0.307617	0.090620	3.394593	0.000687
BBAS3	Return ( $\delta$ )	0.13385	0.00764	17.51450	< 0. 0001
	Volatility ( $\omega$ )	0.20553	0.05566	3.69300	0.00022
VALE5	Return ( $\delta$ )	-0.23259	0.02293	-10.14450	< 0. 0001
	Volatility ( $\omega$ )	0.08908	0.01421	6.26870	< 0. 0001
VALE3	Return ( $\delta$ )	-0.187544	0.008857	-21.1758	< 0. 0001
	Volatility ( $\omega$ )	0.413990	0.197360	2.0976	0.035937

Table 5. Results with fifteen-day news post-disclosure interval

Asset		Estimates	Standard error	T-Value	P-Value
PETR4	Return ( $\delta$ )	-0.15163	0.00835	-18.16100	< 0. 0001
	Volatility ( $\omega$ )	0.02003	0.00806	2.48590	0.01292
PETR3	Return ( $\delta$ )	0.003510	0.021677	0.1619	0.87138
	Volatility ( $\omega$ )	0.235711	0.090987	2.5906	0.00958
BBAS3	Return ( $\delta$ )	0.13970	0.00734	19.04480	< 0. 0001
	Volatility ( $\omega$ )	0.19330	0.05260	3.67520	0.00024
VALE5	Return ( $\delta$ )	-0.23097	0.02410	-9.58350	< 0. 0001
	Volatility ( $\omega$ )	0.08622	0.01390	6.20490	< 0. 0001
VALE3	Return ( $\delta$ )	-0.144889	0.073957	-1.9591	0.050103
	Volatility ( $\omega$ )	0.019606	0.005226	3.7519	0.000175

Starting with the Petrobras results, we noticed that the behavior of the variables remained the same for all scenarios. For (PETR<sub>4</sub>) preferred shares, the dependent variable – understood as the risk premium – dropped at all news divulgation intervals, where the observed corruption event significantly affected the risk premium (and consequently the adjusted return) negatively to a level of 5%, considered a critical level. When we analyzed the determination of risk linked to the asset, i.e., the volatility of the risk premium, we found the same pattern for all scenarios, where the event causes an increase in PETR<sub>4</sub> risk perception. The greatest effect appeared in two- and five-day intervals after the disclosure of more corruption news; however, only the two-day window result was statistically relevant for the analysis, at a 5% critical level. Regarding the effect on the common stock (PETR<sub>3</sub>), we noticed that the event did not present a statistically significant impact on the dependent variable, but it is possible to see an existing and significant relationship with volatility, where all scenarios showed an expressive increase in asset risk at an average of 34%, for a 5% critical level. Comparing the impact on the risk measure for preferred shares (PETR<sub>4</sub>) and common stock (PETR<sub>3</sub>), we were able to identify a greater event impact for the second case, which can be explained by the low priority assigned by the holders of these assets to the receiving of dividends or returns on their investment.

In contrast to the effect observed for oil sector assets, the BBAS<sub>3</sub> asset increased for both variables in all scenarios. For all post-event day intervals, there was an increase in the risk premium value of Banco do Brasil, statistically relevant at 5%. A possible explanation for the stock valuation is the reaction of economic agents in the Brazilian stock market moving their asset capital like PETR<sub>4</sub> into other sectors, still under the veil of the state. The volatility also disclosed positive behavior in the

face of the event, where the BBAS<sub>3</sub> risk increased at every new disclosure, relevant only for the scenarios with intervals longer than two days after the corruption news were published. This result reinforces the hypothesis of investors' memory regarding market events, the higher volatility value noticed in the five-day window and the drop with the window increase.

The asset linked to Vale (VALE<sub>5</sub>) displayed a similar behavior to that of PETR<sub>4</sub>. The return showed a negative trend with statistic relevance to the event appearance in all scenarios, leading us to infer that the corruption event resulted in a devaluation of the closing price adjusted day after day. The risk measure disclosed a positive trend, in which the risk perception of VALE<sub>5</sub> increased with each disclosure in all scenarios. However, we saw a drop in volatility with an increase in the post-news interval, which implies an "investor's memory loss" similar to the case of Banco do Brasil.

In addition to the Brazilian stock exchange price, the studied companies present a portion of their resources to the international market. Since the present study seeks to understand the impact of the event on real value and risk in firms, it is important to identify and analyze foreign investors' perception of Brazil for measuring the reaction of the international community in the face of the event, and to gauge how they interpret institutionalized public sector corruption.

## International market

As for the domestic scenario, the following tables present the impact of the event on Brazilian assets traded on the US stock exchange through ADRs. The assets refer to the same companies previously studied:

**Table 6. International results without news post-disclosure interval**

Asset		Estimates	Standard error	T-Value	P-Value
PBR.A	Return ( $\delta$ )	-0.385367	0.022586	-17.062	< 0. 0001
	Volatility ( $\omega$ )	0.000000	0.004873	0.000	1.000000
PBR	Return ( $\delta$ )	-0.223702	0.063765	-3.50821	0.000451
	Volatility ( $\omega$ )	0.158795	0.206887	0.76755	0.442756
BDORY	Return ( $\delta$ )	-0.327730	0.020041	-16.35296	0.00024
	Volatility ( $\omega$ )	0.001863	0.003463	0.53806	0.590537
VALE.P	Return ( $\delta$ )	-0.405261	0.024724	-16.3913	< 0. 0001
	Volatility ( $\omega$ )	0.037458	0.010913	3.4326	0.000598
VALE	Return ( $\delta$ )	-0.377874	0.022910	-16.4936	< 0. 0001
	Volatility ( $\omega$ )	0.034979	0.010419	3.3571	0.000788

Table 7. International results with two-day news post-disclosure interval

	Asset	Estimates	Standard error	T-Value	P-Value
PBR.A	Return ( $\delta$ )	-0.302383	0.066405	-4.5536	< 0.0001
	Volatility ( $\omega$ )	0.081036	0.032606	2.4853	0.012945
PBR	Return ( $\delta$ )	-0.231084	0.039713	-5.8189	< 0.0001
	Volatility ( $\omega$ )	0.060436	0.023479	2.5741	0.010050
BDORY	Return ( $\delta$ )	-0.336692	0.016017	-21.0215	< 0.0001
	Volatility ( $\omega$ )	0.016001	0.007801	2.0513	0.040236
VALE.P	Return ( $\delta$ )	-0.411128	0.024559	-16.7403	< 0.0001
	Volatility ( $\omega$ )	0.043638	0.008284	5.2679	< 0.0001
VALE	Return ( $\delta$ )	-0.385960	0.022855	-16.88741	< 0.0001
	Volatility ( $\omega$ )	0.031614	0.010786	2.93115	0.003377

Table 8. International results with five-day news post-disclosure interval

	Asset	Estimates	Standard error	T-Value	P-Value
PBR.A	Return ( $\delta$ )	-0.254660	0.030124	-8.45367	< 0.0001
	Volatility ( $\omega$ )	0.025636	0.026164	0.97982	0.327176
PBR	Return ( $\delta$ )	-0.226523	0.028605	-7.9191	< 0.0001
	Volatility ( $\omega$ )	0.044911	0.019940	2.2522	0.024307
BDORY	Return ( $\delta$ )	-0.354265	0.071955	-4.923386	< 0.0001
	Volatility ( $\omega$ )	0.027545	0.061781	0.445843	0.655710
VALE.P	Return ( $\delta$ )	-0.420082	0.023681	-17.7392	< 0.0001
	Volatility ( $\omega$ )	0.029393	0.019210	1.5300	0.12601
VALE	Return ( $\delta$ )	-0.390447	0.023769	-16.4268	< 0.0001
	Volatility ( $\omega$ )	0.044948	0.013013	3.4541	0.000552

Table 9. International results with ten-day news post-disclosure interval

	Asset	Estimates	Standard error	T-Value	P-Value
PBR.A	Return ( $\delta$ )	-0.195522	0.035540	-5.50142	< 0.0001
	Volatility ( $\omega$ )	0.064662	0.073850	0.87559	0.381255
PBR	Return ( $\delta$ )	-0.184730	0.031245	-5.9124	< 0.0001
	Volatility ( $\omega$ )	0.044969	0.014684	3.0625	0.002195
BDORY	Return ( $\delta$ )	-0.335027	0.043156	-7.76316	< 0.0001
	Volatility ( $\omega$ )	0.024560	0.027742	0.88527	0.37601
VALE.P	Return ( $\delta$ )	-0.40721	0.025095	-16.22704	< 0.0001
	Volatility ( $\omega$ )	0.02324	0.012604	1.84389	0.065199
VALE	Return ( $\delta$ )	-0.384051	0.022037	-17.4273	< 0.0001
	Volatility ( $\omega$ )	0.020394	0.010379	1.9648	0.049438

Table 10. International results with fifteen-day news post-disclosure interval

	Asset	Estimates	Standard error	T-Value	P-Value
PBR.A	Return ( $\delta$ )	-0.183221	0.036545	-5.0135	< 0. 0001
	Volatility ( $\omega$ )	0.061386	0.035652	1.7218	0.085103
PBR	Return ( $\delta$ )	-0.15721	0.034401	-4.5700	< 0. 0001
	Volatility ( $\omega$ )	0.04764	0.014770	3.2254	0.001258
BDORY	Return ( $\delta$ )	-0.321569	0.029898	-10.75564	< 0. 0001
	Volatility ( $\omega$ )	0.023713	0.021583	1.09870	0.27190
VALE.P	Return ( $\delta$ )	-0.387834	0.027333	-14.18934	< 0. 0001
	Volatility ( $\omega$ )	0.055259	0.008216	6.72613	< 0. 0001
VALE	Return ( $\delta$ )	-0.375277	0.022661	-16.5605	< 0. 0001
	Volatility ( $\omega$ )	0.019299	0.007893	2.4450	0.014485

Petrobras assets – preferred (PBR.A) and common stock (PBR) – traded on the US stock exchange displayed similar behavior for all estimated scenarios. The risk premium was negatively impacted by the reported event, independent from the type of traded stock. Here, we noticed a strong market reaction in the first days, at a critical 5% confidence level, followed by a mitigation of devaluation. Considering all stipulated scenarios, and considering the effect of the “investor’s memory,” assets suffered an average devaluation of 26.41% for PBR.A and 20.46% for PBR. However, in observing the effect on volatility, only the common stock showed an increase in perceived risk by the market. PBR.A did not present, in any scenario, statistically significant changes, since they exceed the critical level of 5%, while PBR presented significant results after the two-day window of the news exposure to the economic agents, which may represent the time of absorption and reaction of the market to a specific event of the Brazilian reality.

Banco do Brasil (BDORY) shares exhibited a behavior similar to PBR, both being classified as common stock. The risk premium faced devaluation in all scenarios at an average of 33.5%. Volatility appeared as relevant only from the two-day window of the news exposure, and, as observed for PBR, it is possible that foreign investors experience a delay in reacting to and interpreting Brazilian news.

The results of Vale followed the trend identified by the Petrobras results. The preferred shares (VALE.P) and the common stock (VALE) were negatively affected by the event at a 40% average for VALE.P and 38% average for VALE, both within the 5% critical level of analysis, followed by a mitigation of devaluation, which indicates that foreign investors seem to gradually absorb

and moderate the impact of the news. In contrast, the risk perception increased in general for both assets, in all scenarios. It was interesting to observe the effect in the case of Vale, in which both the behavior of the risk premium and the risk itself presented a similar smoothing curve over time. This information indicates that the international market has an adaptation period to a specific event of Brazilian politics.

## CONCLUSION

Given the estimates associated with the impact of the event on assets in the national and North American stock exchanges, it is interesting to compare the intensity of the effects caused by this phenomenon for each company.

Petrobras offers shares classified as preferred (PETR4 and PBR.A) and common (PETR3 and PBR) in both the domestic and North American markets. Considering the estimates of the event impact on the dependent variable, in all built scenarios, and using only the ones below the established critical level, we noticed that the international market experienced a greater impact from the event than the domestic market, where PBR.A was devaluated by approximately -36.41% and PBR by -20.46%, while PETR4 showed a -15.97% and PETR3 did not show statistically significant evidence of change in its risk premium. When comparing the risks attributed to the assets, we can see that a significant increase occurred in the international market for the common stock; however, for the common stock, the result was the opposite. PETR3 strongly surpassed the risk readjustment in relation to PBR, an understandable result, since we consider that there

was no evidence for the impact of the event on PETR3. Banco do Brasil only offers common stocks in the markets in which it is traded, and presents disruptive behavior. For the Brazilian market (BBAS3), an average valuation of 12% was found, considering only the scenarios whose p-value was below 5%, while for the US stock market (BDORY) there was an average devaluation of 33.5% for the same conditions. The divergence between the effects of the event on the risk premium may be an indication that for national investors, the financial sector presents a viable option to direct their resources amid the political scandals involving Petrobras, while the foreign investor does not realize that there is a difference between the Brazilian sectors, leading to devaluation. The risk measure was positive for BBAS3 and BDORY, but with a more significant effect on the Brazilian scenario than on the international scenario. Perhaps, the most interesting aspect of this relationship is that even with a perception of greater risk, Brazilian investors remain interested and continue to acquire it, while the international market seems to avoid acquiring the stocks.

For the assets linked to Vale, both types of shares presented the highest devaluations abroad. The US stock exchange disclosed average devaluations of 40% for VALE.P and 38% for VALE, while the effect in the domestic market showed an average of almost half of that, with VALE5 devaluated at 22.63% and VALE3 at 20.88%. However, for the volatility analysis, national investors present a much higher level of investment risk than that presented by international investors, similar to that found in BBAS3, which had a greater impact on volatility than on the risk premium. As pointed out by [Cicchini et al. \(2003\)](#) and [Mauro \(1995\)](#), such evidence explains the drop in the country's investment level, since investors require a greater return on investment for nations where proven suspicions or cases of public corruption occur. Brazil, by failing to meet this requirement and by not showing signs of improvement or change in the scenario, incurs a loss of investment in its public assets.

As we can see from the reported results, Brazil presents a devaluation of its assets and consequent loss of investments of national and international origin. This market response to government corruption is a reflection of Brazil's difficulty to offer returns to its investors. It also contributes to the evidence of real capital loss, and the perception by other economic agents of an increased risk profile, which will result in an increment in capital flight if the reliability and credibility of the country is not restored.

Due to the impact of corruption on the functioning of countries, public discussions concerning corruption and its effects have become internationally popular. As presented by the World Economic Forum in 2016, countries are expected to take

proactive measures against corruption. This is especially the case in Latin America, given its high corruption perception indexes. This research presents empirical and significant results that illustrate and prove the harmful effects on the Brazilian economy in the long term. It illustrates that Brazil will lose even more financial resources, and will face grave difficulties to recover from the current economic crisis as long as the climate of scandals persists. The innovative nature of this research lies in the quantified alert in the financial sector, with predictions of loss if the current situation remains constant. Furthermore, this pioneering model for the analysis of a major corruption event as registered in Brazil is an example of and an incentive for new field research to assist with the dismantling of the corruption network in Brazil.

In addition, the present work contributes to the assembling of a Brazilian national literature archive on governmental corruption in the investments sector. Several research papers have already initiated the discussion of this subject in Brazil. [Silva \(1994\)](#) and [Brei \(1996\)](#) have offered concepts, questions, and theoretical solutions for the government corruption, followed by a recent analysis by [Marino, Soares, Luca, and Vasconcelos \(2016\)](#) of the correlation between public corruption and its effects on GDP growth. [Caldas, Costa, and Pagliarussi \(2016\)](#) studied Brazilian public expenditure, and [Gehrke, Borba, and Ferreira \(2017\)](#) proved that during the last few years, including the period chosen for the analysis of this work, Brazil has been occupying space in the international media as a country inextricably linked to public corruption. Such results disclose that the country's international reputation and attractiveness to investors decrease over time, and will persist while good governance measures and policies are absent. Compared to the recent international literature, the main identified focus of investigation is the effect of corruption on public expenses and its generalized effect on the formal and informal economy, as presented by [Cooray and Schneider \(2013\)](#) and [Benfratello, Monte, and Pennacchio \(2015\)](#), albeit without a deep investment-related approach, as presented by this research.

From a financial and business perspective, the research quantitatively demonstrates the importance of corruption events in the calculation and projection of investments in the country. Due to limitations with regard to data and time, it was not possible to identify a quantitative indicator for corruption, therefore justifying the use of the proxy of news disclosure. However, comprehensive indexes that measure and incorporate risk would be more accurate for forecasting models and estimates of returns on investment. It is valid to question whether an assessment of the risk of corruption is already included in the systemic risk or the required rates of return. However, the present study proves that even models such as CAPM, which theoretically addresses

the investor's sensitivity and perception of risk, are not capable of fully capturing the effects of events on the stock market.

Finally, the objective of this research was to verify the impact of corruption on financial and capital markets, which can be approximated to the impact on Brazil's internal and external investment. As presented by the literature, studies on the formation and consequences of state corruption events are discussed, but without applications in the Brazilian scenario. As a means of combating such events through compliance policies and increased efficiency and fundraising, it would be valuable to seek out the real causes of corruption, so that plans can be drawn up to combat corruption with political transparency and public system efficiency.

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