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CAPITAL MARKET REACTIONS IN BRAZIL AND AUSTRALIA AFTER THE ENVIRONMENTAL ACCIDENT OF SAMARCO MINING COMPANY

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ABSTRACT

This paper analyzes the reaction of the capital market after the environmental accident of the mining company Samarco. Samarco is organized as a joint venture between the Brazilian company Vale and the Anglo-Australian company BHP Billiton. The technique of event study was used to calculate the systematic risk (beta) and to evaluate the variations in the return of the shares of companies of the mining sector of the Brazilian and Australian capital markets. Data for the study were obtained from the BM & FBOVESPA for Brazilian companies and the Australian Securities Exchange (ASX) for Australian businesses, throughout the year 2015. The survey results show that in Brazil, just Vale company showed a decline beta coefficient. In the case of Australian companies there was a decline in systematic risk for companies BHP Billiton, Rio Tinto and NCM. The disruption of the Samarco mining dam Fundão has entered into the role of global environmental disasters. However, the economic, environmental, and social impacts were quickly absorbed by the capital market, and did not affect the value of the shares of mining companies in the sector in Brazil and Australia in the long run.

Keywords: Institutional Theory. Stakeholder Theory. Event Analysis. Mining Sector. Environmental Accidents.

1 INTRODUCTION

On November 5, 2015, the Samarco Mining Company dam Fundão, controlled by the companies Vale S.A. and BHP Billiton Brazil LTDA, broke and caused a leakage of about 60 million of m3 of mud of industrial tailings. This mud reached the rivers of the Rio Doce basin, in the states of Minas Gerais and Espírito Santo, and dewatered in the Atlantic Ocean. The

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environmental accident devastated the district of Bento Rodrigues, located in the municipality of Mariana (MG), and caused the death of 19 people. Espíndola, Campos, Lamounir and Silva (2016) reinforce that the impact of the disaster was not restricted to immediate areas downstream of the bus, but impacted waterways, farmland, economic activities and water supply, affecting the Biodiversity of the Rio Doce State Park. More than 1,469 hectares of land were destroyed and around 1,200 people were homeless.

Fonseca and Fonseca (2016) indicate that the environmental accident of the mining company Samarco resulted in global records in terms of volume and distance traveled from toxic mud. The Rio Doce State Park, the main remnant of the Atlantic Forest in the state of Minas Gerais, was faced with an unanticipated threat in its management plan. The negative impacts on the aquatic environment were extended by 663 km, until they penetrated the coastal waters of the state of Espírito Santo. The population of the region faced difficulties related mainly to the lack of water. Most of the cities affected depended on the supply of the rivers of the Rio Doce basin, which were unsuitable for human and animal consumption.

Paradoxically, Samarco mining company has been recognized in the past 20 years as a leader in environmental responsibility in Brazil. In addition to being the first mining company in the world to have ISO 14001 certification for all stages of production. However, the pressure for increased production, added to the uncertainties about the storage capacity of the waste and an inefficient operational monitoring, led to the disruption of the Fundão dam. Fontes e Lopes (2017) explain that this dam is supervised by the National Department of Mineral Production (DNPM) and was classified as a category of "low risk" and "high potential damage associated".

Magness (2008) warns that the anthropocentric focus excludes companies from their ethical obligations on the natural environment. Companies focus only on issues defined within the scope of their "management jurisdiction." The expansion of this jurisdiction, in addition to economic and legal issues, requires the inclusion of arbitrary or ideological driving forces, towards a responsible performance. The perspective of legitimacy leads companies to monitor social values and act in order to remain aligned with these values. In this sense, *stakeholders* can act (or not) in the direction of maintaining the "social consciousness" of corporations, which in turn develop (or not) an organizational culture based on ethics.

Abreu, Varvakis and Figueiredo (2004) emphasize that environmental accidents give dynamism to the structure of the industry. The changes happen because companies are subjected to significant events that require answers in the conduct, with reflections on performance and the market structure itself. Accidents impact the cash flows of companies (Blanco, Maquieira, & Lozano, 2009; Klassen & McLaughlin, 1996; Yamaguchi, 2008) and increase environmental and social costs (Deegan, 2002; Patten & Trompeter, 2003; Karpoff, Lott, & Wehrly, 2005). Pargai and Wheeler (1995) report that community pressures and informal sanctions can also aggravate penalties in the face of an environmental accident.

Based on the attributes of "legitimacy", "urgency" and "power" established in the model of boss Mitchell, Agle and Wood (1997), it is observed that none of these attributes is fixed in time, and that environmental accidents confer a dynamic. The environmental accident of the mining company Samarco brings out the "legitimacy" of operational procedures involving the storage of mining waste. Under normal operating conditions, the residents of the district of Bento Rodrigues do not have any "power" to force the mining company Samarco and its controllers (Vale and BHP) to worry about the welfare of the population or with the preservation of the Rio Doce State Park, and to show that there is "urgency" in their demands.

Morgan, Gomes e Perez-Aleman (2016) That the accident of the mining company Samarco may be the result of an institutional failure. In the absence of environmental regulation and efficient supervision, multinational companies operate without adequate environmental monitoring of their productive activities, which jeopardize the safety and health of employees, neighboring communities and the environment. In opposition to *stakeholder* theory, the firm's theory maintains that shareholders and investors are the only *stakeholders* that really matter, and that are affected by the performance of companies over time.

Based on the above, this work is based on the following research question: *The capital market, the mining sector of Brazil and Australia, reacted negatively to the environmental accident of the mining company Samarco?* The research uses "event study" methodology to evaluate the responses of investors in the mining sector in Brazil and Australia. The evaluation

of the return of actions and the change in systemic risk (beta), which occurred from the first day after the rupture of the Fundão dam up to the hundredth day, allows to understand the pressures that lead the decision makers of the mining sector to incorporate (or no ethical and environmental issues in their business models.

This study contributes to the literature of corporate social responsibility by showing evidence of the relationship between high financial returns in the mining sector and a low concern with environmental accidents (Kumar, Lamb, & Wokutch, 2002; Klerk & Villieres, 2012). The disruption of the Fundão dam of the mining company Samarco entered the list of global environmental disasters. However, economic, environmental and social impacts seem not to have been sufficient to immediately influence the value of the shares of mining companies in Brazil and Australia.

The article is structured in sections. Next, the effect of the institutional environment on corporate decisions and the impact of environmental accidents on investor behavior are presented. In the methodology section are described the econometric models adopted in the study of events and the results on the value of the shares of mining companies in the Australian Securities Exchange (ASX) and the BM & FBovespa. Finally, the discussions reinforce the importance of the capital market in promoting an efficient response of companies towards the prevention and mitigation of the impacts of environmental accidents.

2 EFFECT OF INSTITUTIONAL ENVIRONMENT IN CORPORATE SOCIALLY RESPONSIBLE DECISION-MAKING

Companies generate contributions to sustainable development through socially responsible action. Corporate Social Responsibility (CSR) is characterized by the identification, anticipation and management of *stakeholder* expectations (Clarkson, 1995). CSR's concept is based on understanding how the institutional environment and governmental policies affect the company and, therefore, reflect the company-society Relations (Siltaoja & Onkila 2013). These relationships can be market-oriented or not. However, institutions are needed to encourage corporations to respond to social concerns beyond their own economic interests (Campbell, 2007).

The institutional framework of each country reflects its history and the peculiarities of its socio-political figuration (Jamali & Mirshak, 2007). However, based on the common thesis of globalization, the Western model of RSC has been introduced in emerging countries. In this sense, a "cosmetic" level of "explicit" CRS can be materialized by means of isomorphic pressures (Jamali & Neville, 2011). Abreu, Cunha and Barlow (2015) demonstrate that developed countries have a clear set of limits and parameters that guide their responses to corporate social responsibility. In contrast, in emerging countries, the boundaries are more blurred, allowing organizations to experience new formulations and sustainability definitions.

Institutional dynamics and organizations are interrelated. However, organizations do not react directly to all pressures dictated by the organizational environment, nor do they act in a completely autonomous manner, without the influence of external pressure (Hoffman, 2001). A variety of institutional conditions influence management decisions to act in a socially responsible manner. Companies are more likely to act responsibly when monitored by strong state regulations, NGOs and other independent organizations or that have collective industrial self-regulation. These *stakeholders* can be engaged in dialogue and create pressure on the companies (Campbell, 2007).

Managerial decisions are therefore strongly influenced by three institutional mechanisms – coercive, mimetic and normative isomorphism – which create and disseminate a common set of values, norms and rules to produce similar practices and structures Between organizations that share the same field (DiMaggio & Powell, 1983). Institutional theory emphasizes, therefore, the role of pressures imposed on institutions, which influence the organizational field in which companies operate (Meyer & Scott, 1992; Milstein, Hart, & York, 2002).

Within the institutional context, there are pressures that can influence the strategic decisions of managers, such as the pressure exerted by governmental agencies, which are

realized through legislations, regulations and other coercive mechanisms. Delmas and Toffel (2004) state that the existence of governmental pressure is important because society, in general, is not aware of the environmental impacts generated by productive activities. Henriques and Sadorsky (1996) argue that without proper regulation it would be unlikely that there would be efforts to mitigate such impacts.

Other sources of pressure, pointed out by Delmas and Toffel (2004), are the community and consumers. Communities can also exert coercive pressures on companies through political representation, environmental activism, and NGOs. Community pressure can lead the government to create more incisive mechanisms for protection and regulation. This, in turn, can induce companies that lead the market to adopt a more environmentally proactive posture. The institutional pressure of consumers originates in the competitive environment in which companies operate. The supplier-consumer relationship is the main mechanism through which management attitudes and standards are developed with a focus on the quality of products and services.

In the case of mining companies, Lin, Li and Bu (2015) recommend that, in order to be considered responsible, companies should evaluate the positive and negative impacts resulting from their productive activities. To get the "social license" to operate, mining companies must engage with the community. Jennings and Zandbergen (1995) evidenced the influence of the institutional environment on the adoption of environmental practices, especially after the occurrence of environmental disasters. In this sense, Alpaslan, Green and Mitroff (2009) Confirm that "crisis situations" can affect the dynamics of *stakeholder* management.

2.1 Effect of environmental accidents on the investor behavior

Magness (2008) used the projection model proposed by Mitchell et al. (1997) to investigate the dynamics of decision-making by investors and managers, with respect to two environmental accidents involving mining companies. In the view of Baskerville-Morley (2004), legitimacy and power are attributes that can vary depending on each situation. However, urgency is a "chronological" attribute, that is, it can change from a particular event, fixed as a point in time. Specifically for managers, Magness (2008) found a perception of the "power" attribute, followed by an increase in regulatory requirements.

Magness (2000) It states that the operational risks faced by a company are common in the industry. An environmental accident can intensify regulation on the part of the government, which will affect all companies in the sector. Stricter governmental regulation can impact business cash flow. Magness (2008) observed a significant difference in investor behavior in cases of a second environmental accident involving companies from the same industrial sector. Due to the low knowledge about the operation of the company and its operations, investors see the first accident as a fatality. However, when a second accident occurs, the behavior changes, and investors start to penalize, in general, the companies in the sector.

Jenkins and Yakovleva (2006) recognize that investors are increasingly interested in investigating the social, environmental and ethical dimension of a company before investing in it. In the case of the mining industry, disseminating social and environmental information is crucial to obtaining an image of "responsible company" in front of investors. The analysis of the annual reports represents, therefore, a way of understanding in what degree environmental accidents change operational procedures and the conduct of managers.

Elliott, Wang, Lowe and Kleindorfer (2004) show that the level of attention of companies in the chemical sector to environmental impacts, including those generated by accidents, is associated with the socioeconomic level of the surrounding community. The authors show that the largest chemical companies are located close to communities with a higher level of social inequality. These communities have a low capacity to organize themselves and end up being exposed to high health risks and other environmental effects.

Environmental disasters, such as an oil spill or the disruption of a containment barrage, can influence the investor's perception of the company's future cash flows. This will lead to a movement to buy and sell shares, influencing its price and, consequently, its non-systematic risk (Bansal & Clelland, 2009). Jennings and Zandbergen (1995) Confirm that the accident at

the Three Mile Island plant has created a crisis of legitimacy among nuclear power generators in the U.S.

The Fukushima accident in Japan has caused a global impact on the nuclear energy sector. Visschers and Siegrist (2012) suggest that managers should focus on communication with the public, being transparent about the risks that involve nuclear energy and demonstrating its advantages in order to influence public opinion. Goebel, Krekel, Tiefenbach and Ziebarth (2015) evidenced the impact of the nuclear accident on the energy consumption profile of Japanese consumers. Before the accident, there was an average rate of 37% of Japanese consumers who ceased to consume nuclear energy and used energy from renewable sources. In the year of the accident, this rate rose to 74%, and continued at 64% the following year.

Heflin and Wallace (2015) show that after British Petroleum's oil spill, which occurred in 2010, investors began to look for oil and gas companies with better environmental evidence. It was believed that companies would be better prepared for possible changes in environmental regulation, and also for presenting a lower risk of accidents. As a result of BP's accident, there was an increase in the dissemination of environmental information, in particular information about the plans for responses to environmental accidents.

The level of market concentration is also an important element in the dissemination of environmental practices. If a market is dominated by a few actors, there are fewer incentives to engage in socially responsible actions. Patten (1992) evaluated the responses of U.S. petrochemical Companies after the oil spill caused by the Exxon Valdez ship in Alaska. The environmental disclosure of companies in the petrochemical sector increased significantly after the accident. The diversity of large companies in the oil and gas sector influenced the level of disclosure. In the occurrence of extreme situations, other *stakeholders* gain importance, that is, maximizing the value of shareholders is no longer the only goal of CEOs. This effect is strongly observed in more integrated economic environments.

Garcia, Ribeiro, Oliveira Roque, Ochoa-Quintero and Laurance (2017) calculate that the environmental and social damage resulting from the accident of Fundão dam, starring by the mining company Samarco, are of US $521 million per year. The estimated annual loss is around six times greater than all seven fines imposed by the Brazilian government. Other fines are still being discussed, and include different economic, environmental and social compensations. Based on the above, it is possible to establish the first hypothesis of this study:

Hypothesis 1: *The environmental accident of the mining company Samarco negatively impacted the return of the shares of mining companies in the Brazilian and Australian markets.*

2.2 Effect of environmental accidents on the systematic risk of the capital market

Risk is an important element in strategic management and a determinant factor in the performance of companies. Kothari, Li and Short (2009) argue that when the analysis of the content of the reports indicates unfavorable evidence, the company's risk (e.g., measured by the cost of capital, volatility of the return of shares and beta coefficient) grows significantly.

Zreik and Louhichi (2017) Explain that there are three conceptions of risk: total, systematic and non-systematic. The total risk is the sum of systematic and non-systematic risks. The systematic risk, which reflects the return of the company's response to market movements, is represented by the beta coefficient and affects the market more broadly, with economic recessions, changes in the interest rate or increase in inflation (Brigham & Houston, 1999). Klassen and McLaughlin (1996) and Magness (2000) observed changes in the beta coefficient using the technique of "event studies". A decline in the beta coefficient was observed when new information reaches the market.

According to Magness (2008), the decline in the beta coefficient is partially related to a misfit between the company's actions and the market. Investors interpret new information from a meaningful event and take it out on the price of the share. In addition, the communication of high-risk companies on their own risk is positively associated with total and systematic risk. On the other hand, for low-risk firms, communication decreases the three types of risk.

The non-systematic risk reflects the volatility of the return of the company's shares and cannot be explained by the market movements. It reflects the price variability of a company's

shares and is associated with events directly linked to it. A lower non-systematic risk is associated with the environmental issue in terms of meeting *stakeholder* expectations. Therefore, we should reduce externalities and increase the evidence of environmental practices (Suchman, 1995).

Bansal and Clelland (2009) explain that the non-systematic risk, which is affected by investor behavior, is related to the environmental legitimacy of the company, which can be explained from the perspective of institutional theory. The authors argue that the environmental legitimacy of a company is seen differently by all its *stakeholders*, each considering its specificity and connection with the company. As an example, they explain that the contamination of a water source generates a health-related concern in the neighboring community, while a shareholder's concern is a fine that can be applied to the company.

The non-systematic risk is associated with a single company or sector, and can be mitigated through portfolio diversification, that is, investment in companies with different activities. However, Bonami and Lejeune (2009) show that, in practice, achieving this diversification is a difficult task due to factors such as: limited number of sectors of the economy, little profitability arising from small holdings in companies and difficulties in acquisition of shares.

In this sense, Aaker and Jacobson (1987) point out that, due to this difficulty, investors in general prefer actions with low non-systematic risk, reducing the need for diversification. This context, environmental information gains great relevance for investors, since the costs generated in the interaction with the environment are, in general, specific to each company, and there is a great difficulty in anticipating environmental events with negative impact (Bansal & Clelland, 2009).

For example, the communication of systematic risk during the 2008 financial crisis increased the non-systematic risk and total risk (Zreik & Louhichi, 2017). Most investors are at risk and interpret the risk communication of a "high-risk company" as an additional risk. On the other hand, low-risk companies, when they disclose their risks, are considered transparent. Lokuwaduge and Heenetigala (2017) reveal that reports can create negative *stakeholder* reactions. Strategically, it seems important to create a positive expectation in *stakeholders* to manage them (or manipulate them) to obtain their approval or distract their disapproval. Based on the above, it is possible to establish the second hypothesis of this study:

Hypothesis 2: *The systematic risk (beta coefficient) decreased after the environmental accident of the mining company Samarco, for companies and the Brazilian and Australian markets.*

3 METHODOLOGY

3.1 Selection of mining companies in the Brazilian and Australian market

A sampling of the Australian and Brazilian mining industries was conducted based on two criteria: industries with the same classification of activity (exploration, development and production of minerals) and that have shares listed in the BM & FBovespa (e.g., Brazilian companies) and Australian Securities Exchange (ASX) (e.g., Australian companies). In the case of the Brazilian market, all companies in the mining sector were selected, totalizing four companies. The Brazilian market is incipient, with Vale as its leader, and the other companies operating as co-adjuvants.

On the other hand, the Australian market is more crowded, and the disparity in the number of companies in relation to Brazil demanded the definition of a criteria for sample selection. A minimum market value of A$600mi was fixed, with the aim of working with companies of similar sizes, which led to the total of eight Australian companies. The effects of stock price change become more evident in this group, containing the largest Australian companies in market value.

3.2 Event Study

The response to the stock price is examined using the "event study" methodology. Campbell, Lo and Mackinlay (1996) define a study events such as the method by which it is possible to measure the effect of an economic event in the value of a given company. This method evaluates the rationality of the market, considering that the effect of an event will be reflected immediately in the prices of the assets.

Curran and Moran (2007) Explain that event studies are used in accounting and finance research to assess the impact on the firm's value in the event of changes in environmental regulation or due to a legal process that may cause damage to the firm. According to Binder (1998), the event study has been used for two main reasons: 1) to test the null hypothesis that the market efficiently incorporates information; and 2) to examine the impact of a particular event on the wealth of shareholders of a given company, based on the "efficient market hypothesis".

The study events assume that an environmental accident that directly affected only a single company will trigger a transfer of information to the entire industry. This transfer is felt in the capital market, with the oscillation of the stock price (Clinch & Sinclair, 1987). Indrabudiman (2017) explains that the reactions in the stock price can be measured by means of abnormal returns, which consist of the variation in the prices of the assets after the event (e.g., environmental accidents, mergers and acquisitions).

Magness (2008) states that event studies are rare. This is partly due to the statistical problems associated with small samples and the influence of the market dynamics itself. Moreover, it is based on the hypothesis that investors will discount "their fear of a legal reaction" in the price of the action. A legal reaction could mean a suspension of the right to operate. Companies in the affected industrial sector could face an increase in information demand, generating an increase in the costs of disclosure.

3.3 Calculation of expected returns

Following the methodology proposed by Magness (2006), to calculate the returns of actions "without the effect of the accident" it is essential to choose a time window. A gap was chosen "200 days before the accident" and "200 days after the accident". The day of the environmental accident of the mining company Samarco (5/11/2015) was fixed with Day 0. The daily returns of the company's portfolio are regressed in relation to the market return, based on the following econometric model:

$$R_{i,t} = \beta_0 + \beta_1 \times RM_{p,t} + \varepsilon_{i,t}$$

Where $R_{i,t}$ it is the return of the company I and T is the daily variation of the price of the company's share in time t, expressed in percentage; β_0 it is the intercept; β_1 it represents the systematic risk; RM is the return of the market, T is the daily variation in the market and $\varepsilon_{i,t}$it is the end of the referred error of the model. For the Australian market, the return of the S&P/ASX 300 was used, and the return of the Ibovespa was adopted for the Brazilian market. The objective of this analysis is to calculate the values of returns without the effect of the accident.

To evaluate the "effect of the accident", the window of calculation of abnormal returns was reduced to 100 days. Starting from "Day 1", which is the first commercial day after the environmental accident of the mining company Samarco, until "Day 100", separating strata of 10 days in 10. In this gap of 100 days are compared the differences of averages of "returns without the effect of the accident" and the "real returns", using the T test of equality of averages. This analysis identifies whether there was the effect of contagion of the accident in Brazilian and Australian mining.

Portfolio returns are used instead of the company's individual return, because the portfolio-based model has greater explanatory power (Blacconiere & Patten, 1994, p. 367). However, to include in the portfolio the companies directly affected by the accident can influence the results. This is because direct financial repercussions (e.g. environmental costs, costs of repairing damages and litigation) can impact the price of the company's shares. For this

reason, the analysis of the return of the portfolio was made with and without the companies Vale and BHP, responsible for the environmental accident of the mining company Samarco.

To measure the value of the companies after the accident, was added the variable Dummy D, which assumes a value of 0 for the days before the date of the accident, and 1 on the day of the accident and ahead. This variable allows you to capture the part of the total return that is attributed to a change of the beta at the time of the accident, as follows:

$$R_{i,t} = \beta_0 + \beta_1 \times RM_{p,t} + \beta_2 \times RM_{p,t} \times D_t + \varepsilon_{i,t}$$

The gap used to calculate the loss of market value due to the accident was "200 days before the accident" and "200 days after the accident". If it is correct to assume that after the accident the shareholders reassessed the importance of environmental management in the risk/return trade-off, the coefficient β_2 will be significant and less than the β_1 coefficient.

4 RESULTS

Table 1 shows the comparison between the "returns without the effect of the accident" and the "real returns" in the window of 100 days after the accident, for the Brazilian and Australian portfolios with and without the companies responsible for the accident. Statistically significant values reveal an abnormal behavior arising from the environmental accident of the mining company Samarco. The significance values allow evaluating behaviors of the type "up and down" of the actions. It can be observed that, for the Brazilian portfolio, including Vale, there is a significant difference in the returns between the model "without the effect of the accident" and the "real behavior of actions" for the days 11 to 20, and 51 to 60. This result indicates an effect on the actions of the mining market arising from the disclosure of the environmental accident of the Samarco mining company. Only for Vale company there was a significant difference in the first 10 days, and in the days 51-60 and 61-70. When the portfolio of Brazilian companies is analyzed without Vale, the econometric model loses reliability. This happens from the fact that Vale is the only mining company with shares traded daily at BM & FBovespa.

Table 1
Significance level of Wilcoxon test between the expected and observed the actions immediately after Day 1 and up to 100 days of the accident

Period (days)	Portfolio Brazil			Portfolio Australia		
	With Vale	Only Vale	Without Vale	With BHP	Only BHP	Without BHP
1-10	0.3049	*0.0658*	0.0526	0.1598	0.1525	0.2099
11-20	*0.0371***	0.4744	0.0253**	0.2727	0.7596	0.4723
21-30	0.4260	0.2610	0.2716	0.3832	0.2610	0.4260
31-40	0.9095	0.1840	0.9698	0.3432	*0.0079****	0.3060
41-50	0.1826	0.9183	0.1588	0.9698	0.1525	0.9698
51-60	*0.0800*	*0.0048****	*0.0058****	*0.0477***	0.4039	*0.0477***
61-70	0.1209	*0.0829*	0.0638	0.7335	*0.0248***	0.5202
71-80	*0.0735*	0.1823	0.0435**	0.9090	0.6080	0.9090
81-90	0.3432	0.6094	0.2399	0.1846	0.7592	0.1201
91-100	0.2342	0.3526	0.0420**	0.6200	0.2201	0.7330

Note. *p<0,10; **p<0,05; ***p<0,01
Source: Survey data collected in Australian Securities Exchange (ASX) and BM & FBovespa.

For the Australian market, the portfolio with BHP shows that the difference in the return of shares without the accident and the value of shares is significant for the days 51 to 60. This indicates a late effect affecting the actions of the Australian mining market, originating from the disclosure of the accident of the Samarco miner. Analyzing only BHP, it is observed that the company's actions were affected before (e.g., between 31 and 40 days) and then (e.g., between days 61 to 70) of the effect observed in the Australian market. By removing BHP from the Australian portfolio, the differences show significance in the same period, that is, between days

51 to 60. This result confirms the greater diversification of the Australian stock market in the mining sector. The effect on the actions of a single company cannot affect the market, because there are others with the same volume of negotiations. Therefore, in relation to hypothesis 1, the accident caused a negative impact between the days 11 and 20 for the Brazilian mining market. For the Australian market, the first effect was felt between the days 51 and 60.

Table 2 shows whether there was a change in non-systematic (beta) risk after the accident for the Brazilian market. The portfolio returns are regressed in two moments using the dummy variable, D. The magnitude and significance of the β1 and β2 betas for each company in both markets, as well as for the markets including or excluding Vale, are observed.

Table 2
Comparison of the impact on business in the Brazilian market of 200 days before and 200 days after the environmental accident Samarco mining

Companies in Brazil	β_1	Sig	β_2	Sig	Test F	R^2
Vale	*1.098*	0.000	*0.663*	0.006	59.440	0.308
Bradespar	*0.606*	0.000	*1.261*	0.000	64.050	0.325
CCX	0.439	0.066	0.301	0.320	1.351	0.010
MMX	0.444	0.656	0.551	0.663	0.475	0.004
Portfolio without Vale	0.203	*0.561*	0.337	*0.447*	1.788	0.013
Portfolio with Vale	0.427	*0.118*	0.419	*0.227*	6.403	0.046

Source: Survey data collected at BM & FBovespa.

The portfolio of mining companies in Brazil, including or not the main company of this market (Vale) did not show significance, which indicates that the accident did not impact the Brazilian mining market. It can be observed that the magnitude of the beta coefficient before (β_1) and after the accident (β_2) fell to the company Vale, as expected, reinforcing the results found in Table 1. However, for the company Bradespar there was an upward behavior, and for the CCX and MMX companies there was a little significant change.

Table 3 shows the comparison of the impact of the environmental accident of the mining company Samarco in the Australian market. The β_1 coefficient is significant, and the magnitude of the betas coefficients fell to all companies. However, only for BHP, Rio Tinto and NCM companies the β_2 values remain significant. This result indicates that the effects of the environmental accident of the mining company Samarco reduced the value of the shares of these companies. Analyzing the Australian portfolio with and without BHP, it can be observed that the β_2 coefficient is only significant in the portfolio with BHP, observing a reduction of 1.073 in the value of β_1 to 0.277 in the value of β_2. This result confirms the diversity of the Australian stock market in the mining sector, which has several investment options.

Table 3
Comparison of the impact on business in the Australian market of 200 days before and 200 days after the environmental accident Samarco mining

Companies in Australia	β_1	Sig	β_2	Sig	Test F	R^2
BHP	1.225	0.000	0.731	*0.000*	124.000	0.482
AWC	1.074	0.000	0.331	0.102	50.850	0.276
Rio Tinto	1.059	0.000	0.489	*0.001*	108.800	0.449
FMG	1.485	0.000	0.473	0.214	27.290	0.170
NCM	0.622	0.000	0.523	*0.036*	5.771	0.042
BSL	1.277	0.000	0.066	0.812	27.740	0.172
SGM	0.670	0.029	0.493	0.292	5.125	0.038
ILU	1.177	0.000	0.287	0.190	48.920	0.268
Portfolio without BHP	1.052	0.000	*0.212*	0.175	73.870	0.394
Portfolio with BHP	1.073	0.000	*0.277*	0.067	86.720	0.390

Source: Survey data collected in Australian Securities Exchange (ASX).

The confirmation of hypothesis 2 for companies and the Australian market is observed. There was a decline in systemic beta risk for BHP, Rio Tinto and NCM companies, and for the

portfolio with BHP. In the case of Brazil, hypothesis 2 was confirmed for Vale and rejected for the Brazilian market as a whole.

5 DISCUSSION

The study adopted the methodology of "event study" to evaluate the responses of the capital market to the environmental accident of the mining company Samarco. The variations in the return of actions and the systematic risk (beta) of the controlling companies BHP and Vale were evaluated and the markets in which they operate. The results allow evaluating the dynamics of the institutional environment and the effects of the environmental accident of the mining company Samarco in the behavior of shareholders and investors in the mining sectors in Brazil and Australia.

Using the model that presents the market parameters for the return of the shares of the Brazilian and Australian mining companies, it was observed that, in the first days after the accident, Vale's actions suffer losses, and soon after the Brazilian market as a Whole is affected. The disclosure of causes, effects and responsible people generated a change in the actions of Vale and the Brazilian market. But after 60 days of the accident the effect of "climbs and descends" of actions is no more sense.

For the Australian market (without and with BHP), the effect is significant only from days 51 to 60. The actions of BHP were subsequently affected by the Brazilian parent company. Vale and BHP companies were not associated with the operation of the Samarco mining company. Corroborating this result, studies by Laplante and Lanoie (1994) in Canada state that stock prices do not respond immediately when a company is cited for an environmental infringement or when a regulatory action is incited. The significant effect occurs only when a lawsuit results in a fine.

The systematic Risk analysis (Beta) demonstrates that the market and the companies in Brazil, except for Vale, did not present significant results. Klassen and McLaughlin (1996) studied the beta coefficient in front of several events. Magness (2008) Concluded that the decline in the beta coefficient is related to a misfit in the price of shares while investors are assimilating the event, its intercurrences and the effects generated.

The results for companies in the Australian market showed a decline in systematic beta risk only for companies BHP, Rio Tinto and NCM. The Australian market seems to have felt more the effects of the environmental accident of the mining company Samarco due to its competitiveness and volatility characteristics. These results are consistent with the findings of Lokuwaduge and Heenetigala (2017), in which Australian mining companies perceive stakeholder pressures to report on environmental, operational security and corporate governance information. In line with the theory of legitimacy and stakeholder theory, companies in the metals and mining industry in Australia disclose this information in a way that reduces regulatory risk and safeguards its legitimacy.

The Brazilian mining market has a low competitiveness and limited investment options. According to the international consultancy SNL, in 2014, of US $11.4 billion invested by private initiative in non-ferrous mineral research projects, only 3% were carried to Brazil. While other countries received greater investment potential, such as Chile (7%), Peru (5%), Mexico (7%), USA (7%), Australia (12%) and Canada (14%)(TRENDS, 2015). In Brazil, it is still observed the presence of Vale company, operating in almost the entire market, and the company Bradespar, as the second largest company in the mining market, which also invests in Vale. Two other companies (CCX and MMX) behave in an incipient way in the mining market.

The study of the events along a "200-day gap" allows evaluating the influence of the institutional environment on the behavior of the decision makers of the mining company Samarco and its controllers. Evaluating the regulatory pressures, Fonseca and Fonseca (2016) warn that the legal-normative environmental framework of Brazil has been fragile and in danger of acting summarily in defense of corporate interests. One of the pillars of environmental legislation, which lies in the precautionary principle, in which the State should adopt measures to avoid significant environmental damage, seems to be neglected. The dysfunctional division of

power between the companies involved and their *stakeholders* becomes evident in the lack of control of the actions of the Public Ministry and Judicial Power.

Weak normative and mimetic pressures confirm the delay in the response of the stock market. This result signals that weak corporate social responsibility models are accepted in the mining sector. The results of this research seem to indicate that the performance of the mining company Samarco was limited to the scope of its "management jurisdiction", which translates the gaps in the institutional environment. It is also observed the absence of the attributes of the *stakeholders*, defined by Mitchell et al. (1997). Ethical/social and/or environmental investments would only have been made if the stock market sent clear signals to companies in the mining sector. The decisions of the mining company Samarco seem to have been guided by a weak code of corporate governance, which excludes *stakeholder* demands and focuses on maximizing return to shareholders and investors.

A relevant issue to explain this "delay" in the mining sector response involves an assessment of how the media dealt with the environmental disaster caused by the Samarco mining company. Fontes e Lopes (2017) highlight that the media, at first, did not approach in depth the issues related to environmental impacts (e.g., mud toxicity, water supply and impacts on the biological diversity of the affected region). This behavior can be explained by the lack of knowledge, or even intentional, due to the interests of the companies controlling the mining company Samarco.

However, the sensationalist approach was present, and always minimizing the responsibilities of Samarco, Vale and BHP companies and their possible consequences. Thus, the media transmits the information to society but without presenting the existing relationships between mining activity, environmental damage and social issues. Garcia et al. (2017) warns that the looting of certain Brazilian laws and the granting of new exploration areas are being carried out without a clear dialogue with society.

6 CONCLUSIONS

The event study revealed that there was an immediate negative impact shortly after the accident only for Vale's actions. The Brazilian market felt this effect after 10 days, and the Australian market after 50. Only with the disclosure of the details of the accident is that it could be seen a late and temporary effect on the actions of the controlling companies and their markets. However, the economic, environmental and social impacts were quickly absorbed by the capital market in Brazil and Australia, and did not influence the value of the shares of long-term mining companies.

Regarding the hypothesis of systematic risk (beta), the research findings reveal that there was a decline in the coefficient for the companies Vale, BHP, Rio Tinto and NCM. The findings of the research confirm the argument that in more competitive markets there is a tendency to seek legitimacy. As they argue Pellegrino and Lodhia (2012), there is a social contract between organizations and society based on implicit and explicit expectations that society has on conducting business operations.

It should be recognized as a limiting factor of this research the restricted number of companies and the very particular situation of the Brazilian mining market, with only one leading company (Vale), one investor (Bradespar) and two companies (MMX and CCX) with incipient operations In the mining market. Another limitation involves the amount of explanatory variables in the econometric model for calculating the return of shares. Despite the limitations, the work warns of the need to broaden the pressures of investors on the mining sector. This pressure should ensure that mining companies act responsibly, and that the traumas of this disaster do not protrude or repeat themselves.

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