Environmental disclosure effects on returns and market value

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Abstract
This paper analyzes whether the environmental information disclosure level practiced by firms listed on the Brazilian Stock Market affects their profitability and value. The results show some disclosure by most of the sample firms, and significant differences in characteristics between firms that disclose and those that do not disclose environmental information. The paper contributes to the extant social responsibility and environmental disclosure literature by analyzing annual reports and standardized financial statements as a source of evidence, but especially for analyzing the relationship between the level of disclosure of environmental information and its lack of reflection on the profitability and value of firms. Results suggest the importance of both legitimacy theory and proprietary costs theory, each explaining part of the decision process regarding the disclosure of environmental information. Our results also demonstrate that environmental disclosure positively affects the value of publicly traded Brazilian companies.

1 Introduction

In this paper, we analyze whether the environmental information disclosure level practiced by firms listed on B3 (the Brazilian Stock Market, formerly known as BM&FBOVESPA) affects their profitability and value. The economic and population growth in the twentieth century have markedly contributed to an unprecedented increase

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in natural resource consumption. Between 1900 and 2005, the total material consumption in the world economies, consisting of the material use and energy inputs in socioeconomic systems, and the consequent generation of waste, grew eightfold (Krausmann et al. 2009). Along with the need to adopt effective actions to reduce the impacts generated using natural resources, there is an increasing discussion on firms' disclosure of environmentally related information to their investors, customers, debt holders, and other stakeholders.

Firms are subject to external forces that exert pressure for the adoption of environmentally responsible behavior. The extent of the firms' disclosures regarding social and environmental information is a function of their exposure to public pressure in the social and political environment in which they are embedded (Ortas et al. 2015). Odriozola and Baraibar-Diez (2017) state that the increasing demand by stakeholders leads companies to make an extra effort in terms of providing environmental, social, and governance information.

The demand for this information encouraged international bodies, such as the Global Reporting Initiative—GRI in 1997, to indicate standards for communicating social and environmental impacts caused by the usual activities of companies. Following the same line, the stock exchanges of several countries created indices that distinguish companies committed to corporate sustainability, such as the Dow Jones Sustainability Index World.

In Brazil, the B3 created the Corporate Sustainability Index (ISE—*Índice de Sustentabilidade Empresarial*), with a portfolio consisting of shares of firms that have recognizably committed to social responsibility and corporate sustainability. However, firms participating in the ISE index are not required to adhere to broad disclosure policies regarding environmentally related information. The selection of stocks included in the ISE is done annually by the B3, based on a specific questionnaire that is answered by eligible firms, whose commitment to sustainability is given through their voluntary completion periodically. Even though information regarding the answers provided by firms is made available to the general public by B3 since 2015, the Brazilian regulations for the disclosure of environmental information demand a remarkably low level of detail when compared to the SEC (Securities and Exchange Commission), FASB (Financial Accounting Standards Board), AICPA (American Institute of Certified Public Accountants) and ISAR/UNCTAD (Intergovernmental Working Group of Experts on International Standards of Accounting and Reporting—United Nations) (Lindstaedt 2007).

Furthermore, environmental information disclosure in Brazil is voluntary due to the absence of specific legislation on the subject. Managers decide whether to disclose information about the firm's relationship with the environment, without having uniformity in the disclosure of information, since they are shaped from the perception of different managers about society's expectations (Radhouane 2019). The information, when disclosed, can be qualitative (e.g., governance structure and management system, environmental policies) or quantitative (such as pollutant emission indicators, environmental expenditures).

Considering the Brazilian context, where there is voluntary disclosure of environmental information, it is assumed that firms might disclose information with the purpose of legitimizing their operations with society (Ortas et al. 2015; Radhouane 2019). But on the other hand, they might withhold information whenever its disclosure could lead to costs, reducing the market value of the firm (Verrecchia 1983; Qiu et al. 2016).

Prior studies performed on samples of Brazilian firms (Kosztrzepa 2004; Lindstaedt 2007; Nossa 2002; Sampaio et al. 2012; Tinoco and Robles 2006) examined the characteristics of the environmental disclosure. They focused on legitimacy, public interest and regulation, online disclosure, environmental performance and comparative disclosure among countries, and specific aspects of corporate environmental accounting, among other topics.

Our analysis of the reports of the firms listed on the B3 also allowed us to verify whether firms adhere to recommendations made on GRI publications, which are taken as a standard for environmental disclosure. We combined the adherence to GRI guidelines with contributions of the extant literature on the subject, to build indicators of environmental disclosure. These indicators were validated by academics who study the environmental theme. Our final results demonstrate that environmental disclosure positively impacts the value of publicly traded companies in Brazil, and this relationship is statistically significant.

This study contributes to the existing literature by analyzing the relationship between the level of disclosure of environmental information and its relationship with the profitability and value of companies, as it partially confirms the perspectives of Jensen and Meckling (1979), Verrecchia (1983), Dye (1986), and Wagenhofer (1990) that the disclosure of voluntary information would reduce the risk and, thus, the cost of capital, reflecting on the profitability and value of the firm. Another possible contribution is the use of the annual report as a source of disclosure evidence, a document that can be used in disputes between the CEO who authorized its disclosure and shareholders, setting up an important communication channel between the company and its stakeholders. Our analysis can also contribute to the evolution of Brazilian environmental disclosure standards, improving the selection of actions that are part of the Corporate Sustainability Index (ISE) by establishing minimum disclosure criteria.

The remainder of this article is organized as follows. In Sect. 2, we present a review on the main aspects and theoretical assumptions that supported the design of this research. In Sect. 3, we present the hypotheses development. In Sect. 4, we explain the research design. In Sect. 5, we present and discuss the results of the study. In Sect. 6, we state our concluding remarks.

2 Rationale for the disclosure of environmental information: opposing views

The literature on disclosure of environmental information is approached in a different theoretical way and obtained different results in the various researches carried out, so this section describes the position of distinct authors on the subject.

The legitimacy theory assumes the existence of a social contract between the firms and the environment of the society in which they are inserted (Shocker and Sethi 1973) and the existence of information asymmetry between firms and their stakeholders (Akerlof 1980). The social contract between the firm and its environment can be either implicit or explicit. It has a dynamic characteristic, in which the firms continually seek to validate their operations, acting within the limits and norms of their respective societies. The social contract framework governs the expected behavior of those involved. In other words, firms could expect the community to engage in behavior committed to them, such as buying their products and services, providing inputs and materials, and providing services. On the other hand, the community might expect benefits that could not result in harm to society, including harm to the environment.

The other relevant assumption of the legitimacy theory, that of information asymmetry, recognizes that there is a difference in the level of information held by the firm in relation to that of the community (Williamson 1979). The community could not be aware of all the operations performed by the firm, unless the firm chooses to publicly disclose information representative of those operations. By not knowing whether the firm is acting to

create social benefits, the community could at least stop valuing the firm, preferring to deal primarily with firms on which there is a higher level of available information. Thus, the legitimacy theory suggests that disclosure is one mechanism by reduces the asymmetry of information existing between the firm and the community in which the firm is inserted.

The disclosure of information reduces the asymmetry between the parties to the social contract, in response to pressures exerted by stakeholders that are part of the firm's community (von Alberti-Alhtaybat et al. 2012; Seibert 2017; Radhouane 2019). Hence, disclosing information about the decisions and environmental actions taken by the firm might be a way for the firm to disclose its intentions and its conduct in relation to the environment, demonstrating that their activities are conducted within limits acceptable to the community in which they operate. As a result, the way the firm conducts its business may impact its social relations with the community (Wilmshurst and Frost 2000).

Based on the firm's disclosure practices, the stakeholders can assess the firm's social responsibility and its continuity prospects. The legitimacy obtained with the disclosure might accordingly be valued by the shareholders, for recognizing that the firm is duly constituted, that it is committed to rules, norms, values, and models accepted by society, and that it uses appropriate means to achieve socially acceptable goals (Martín *et al.* 2010). Odriozola and Baraibar-Diez (2017) highlight the impact of the quality of disclosed environmental information (along with social and governance) when it comes to building a corporate reputation, showing that assured report increases the likelihood of Spanish firms being in the group of higher corporate reputation firms.

Analyzing only the search for legitimacy, it could be logical to assume that the firms might adopt a practice of full disclosure of their environmental information. The main theoretical argument that opposes the search for legitimacy is the theory of proprietary costs. This theory has as main assumptions the asymmetry of information, the rationality of the managers of the firms, and the existence of costs associated with the disclosure of information that are supported by the firm (Dye 1986, 2001; Lev 1992; Macagnan 2007; Verrecchia 1983, 2001; Wagenhofer 1990).

Proprietary costs may be directly associated with the cost of preparing and publishing information. However, the main proprietary costs to be considered in the context of the environmental disclosures are the adjustment in the price attributed by the markets to the stocks and the possible competitive disadvantages resulting from the disclosure to other market participants of the firm's sensitive information (Darrough and Stoughton 1990; Elliott and Jacobson 1994; Fishman and Hagerty 1989; Lev 1992; Verrecchia 1983). We assume that the level of information is related to the property costs associated with disclosure and that this assumption could affect the level of environmental information. In this context, we also include information adopted for decision making by the firm's management (Macagnan 2007).

The firm may disclose to competitors and other relevant parties (such as customers) the existence of weaknesses or opportunities to be exploited (Prencipe 2004). Wagenhofer (1990) emphasizes that the competitor may use favorable information to take actions that benefit his firm and, therefore, the proprietary costs might be represented by the lost profit. The disclosure level may have a balanced strategy so that the firm maximizes its net price, reduces the adverse action of its competitors, and reduces the risk of misinterpreted by investors (Wagenhofer 1990).

The understanding of the balanced strategy suggested by Wagenhofer (1990) can benefit from Dye's (2001) argument, that the issue of voluntary disclosure is embedded in a game theory context, whose central premise is the understanding that the firm will disclose—or not—its information, whether or not it is favorable. Verrecchia (1983) argues

that the management of the firm may delay—or not—the disclosure of information because it understands that it may affect the firm's market value. Dye (1986) ponders that managers may be concerned with how disclosures about corporate financial performance influence their personal reputation, how the disclosures could affect their dealings with unions, suppliers or their relationships with government entities or even the behavior of their competitors.

Thus, the main assumption of the proprietary cost theory arises, in which managers, foreseeing the repercussion of the disclosure of information, may retain or omit information to eliminate the cost that the disclosure could cause to the firm. The proprietary costs theory does not refer only to negative information because it considers that information of a positive nature can provide advantages to the firm's competitors and reduce the market value of the firm. Next, we present a review of the empirical studies on environmental disclosure, informing the development of this study's hypotheses.

3 Hypotheses development

Based on the assumptions of the legitimacy theory, managers have incentives to adopt a behavior of ample disclosure of environmental information, to achieve or maintain the legitimacy of the firm within society. A higher level of disclosure of environmental information could result in greater support from society. This support could result in equity gains for the firm. Therefore, the greater the level of disclosure of environmental information, the greater the firm's profits and returns on equity. In contrast, the theory of proprietary costs assumes that the disclosure of information entails costs to the firm, which could indicate the expectation of a negative relationship between disclosure and returns obtained by the firm.

The empirical literature presents interesting results supporting both theories. Patten's (1991) study examined whether the variation in social disclosures between firms would be a function of public pressure or profitability, suggesting that corporate social legitimacy should be more related to the variables of public pressure than to the variables representative of profitability. The results of the survey carried out with 128 firms in 1985 indicate that size and industry—aspects understood as public pressure—are important explanatory variables of the extent of social disclosure, unlike the variables that represent profitability, which were not statistically significant predictors. Subsequently, Patten (1992) examined the effect of the Exxon Valdez oil spill on the release of the annual environmental report by oil firms, excluding Exxon. The paper revealed that there was an increase in disclosures from 1988 to 1989, that is, from an event that changed the society's perception about the firms in a certain industry, followed a response with a higher level of disclosures to avoid losing legitimacy.

In a similar context, Laine (2009) investigated a large chemical firm in Finland from 1972 to 2005, studying how corporate environmental disclosures are used to respond to institutional pressures arising from the social context. The results of the research indicated that, in 34 years, large transitions occurred in the way the firm carried out its environmental disclosures, coinciding with changes in the social and institutional context. Thus, Laine (2009) inferred that the firm adjusted its disclosures to respond to pressures and to maintain a legitimate position in society.

Deswanto and Siregar (2018), among other hypotheses, verified the impact of environmental disclosures on the company's market value. As market value, the share value at

the end of a period was used, in a sample of Indonesian firms. Environmental results and disclosures do not affect the market value. The reviewed studies suggest that firms provide information that legitimizes their activity, through the dissemination of qualitative and quantitative information, informing markets about actions taken to minimize the effects of their businesses in the environment.

The empirical study by de Sousa Campos et al. (2009) analyzed companies with environmental certification, concluding that these companies have a higher ROE (Return on Assets) than others. In contrast, the studies by Pereira et al. (2011) reported results that indicate that companies with greater disclosure of environmental information have worse financial performance, using ROE and ROI (Return on Investment) as performance measures when compared to those that do not publish environmental information. Similar result identified by Qiu et al. (2016) who found no relationship between environmental disclosures and profitability (ROE—return on equity, ROA—return on assets, and ROS—return on sales). The possible factors of this contradiction may be related to the type of report used for the construction of the environmental disclosure variable and the sample. Campos et al. (2014) used as a data source a mandatory report by the CVM (Brazilian Securities and Exchange Commission), while Pereira et al. used a voluntary report (sustainability report). Qiu et al. (2016) constructed his variable for environmental disclosure based on data collected at Bloomberg. Another possibility would be the sample used in the studies, since de Sousa Campos et al. (2009) analyzed firms in sectors with potentially polluting activities (PP) and users of natural resources (GU), while the other authors used samples that included firms from different sectors. Thus, there is ambiguity in the expected signal regarding the first hypothesis proposed in this article, formulated as follows in an alternative form:

H1 There is a relationship between the level of disclosure of environmental information and the firm's return on equity.

In addition to the analysis of the association between the return on shareholders' equity and the disclosure of environmental information, the extant literature also presents tests regarding the association of environmental disclosure and the firm's return on asset (ROA), an indicator that considers the firm's operating profitability, controlling for specific size effects and disregarding the effect of financial leverage. The statistical relationship between the disclosure of environmental information and the return on assets analyzed by Cezar and Silva (2008) was not significant. However, de Sousa Campos et al. (2009) and Stanwick and Stanwick (2000) have presented evidence that the financial performance, represented by the ROA, is linked to the levels of environmental evidence. Thus, hypothesis 2 is formulated as follows in alternative form. Due to the ambiguity of results reported in the literature, there is no expected signal for hypothesis 2.

H2 There is a relationship between the level of disclosure of environmental information and the firm's return on assets.

We use two performance measures, ROE and ROA, because ROE represents the company's profitability in relation to its shareholders' equity, while ROA represents the profitability, before taxes, of the firm's assets. The use of ROA considers all the invested capital (own and third parties), while ROE, on the other hand, indicates profitability just in relation to equity

Dowell et al. (2000) consider Tobin's Q as an indicator of the company's value, reflecting possible future gains, being used in several studies as a representative variable of the company's value. King and Lenox (2002) conducted a study showing that waste prevention generates financial gains, and this gain is represented by the Tobin's Q of companies. The findings of Fazzini and Dal Maso (2016) indicate that voluntary environmental disclosure is positively correlated with the market value of companies; however, the firm market value is measured by capitalization divided by the book value equity. Buallay (2019) used Tobin's Q as the company's market value variable to analyze the European banking sector's, finding the positive effect of environmental disclosure and Tobin's Q. Huian and Mironiuc's (2019) found a positive relationship between qualitative environmental information and financial performance, measured by Tobin's Q. To test whether the disclosure of environmental information affects the value of the firm, our hypothesis 3 is specified in alternative form:

H3 There is a positive relationship between the level of environmental information disclosure and the Tobin's Q of the firm.

The existence of a positive relation between the variables measuring firm returns and value with environmental disclosure would provide evidence in favor of the assumptions of the legitimacy theory. Opposing to that positive relation, we consider that either an absence of relation, or even a negative relation, would suggest the effects of the proprietary cost theory dominate any legitimacy issues. In the next section, we present the proposed econometric models, as well as the indicators of environmental evidence considered in our specification. Subsequently, we present the sample considered, the sources of data, and information about the collection of evidence.

4 Research design

We performed the estimation of statistical models described in this section in order to verify whether our results support the hypotheses proposed in section three, consistent with theory and with the previous studies. We estimated our econometric models using the generalized method of moments (GMM), using panel data, and adopting measures of profitability and value of the firms as dependent variables. We opted for GMM estimation to work around possible endogeneity problems. Usually, in studies of corporate finance, variables such as profitability, debt, investment, and dividends are difficult to control for the effects of reverse causality (Forti and Peixoto 2015). Such variables are the result of simultaneous decisions by companies, and it is difficult to find a cause-and-effect relationship between them. One of the approaches to deal with this problem is through GMM because this method allows all regressors in the model to be endogenous and yet is capable of presenting robust and efficient coefficients linear regression models considering the panel data, adopting measures of profitability and value of the firms as dependent variables. In Eq. (1), we present the proposed model for the analysis of hypotheses H1 and H2:

$$Return_{i,t} = \beta_0 + \beta_1 Disclosure\ Level_{i,t-1} + \sum_{k=1}^{z} \left\{ \gamma_k Control_{k,i,t} \right\} + v_{i,t}. \tag{1}$$

Table 1 Number of indicators validated by studies on environmental disclosure

Paper	Total indicators	Country
Wiseman (1982)	19	USA
Deegan and Gordon (1996)	32	Australia
Hackston and Milne (1996)	90	New Zealand
Fekrat et al. (1996)	18	18 countries
Deegan et al. (2002)	49	Australia
Cormier et al. (2004)	28	Europe and North America
Cormier et al. (2005)	36	Germany
Clarkson et al. (2008)	46	USA
Mussoi and Van Bellen (2010)	38	Brazil
Calixto (2009)	16	Brazil
Elijido-ten (2009)	19	Malaysia
Islam and Deegan (2010)	56	USA

We estimate a company's return in two different ways: through ROA (return on assets) and ROE (return on equity). The objective is to estimate the accounting profitability of the companies used in the sample.

The variable *Disclosure Level$_{i,t-1}$* was created through the review of theoretical and empirical studies, which are listed in Table 1, and it is our main variable of interest. After, the set of indicators were organized and sent to review by five scholars who authored research related to disclosure, focusing on environmental information. Based on their suggestions, the final set of indicators is presented in Table 2. This variable represents the extent of environmental disclosure of the firm, having all of the indicators listed in Table 2 as reference. It is the percentage of the firms' adherence to the indicators of disclosure i and may vary from 0%, in the case of no disclosure of environmental information in the financial statements, up to 100%, in the case of a firm that discloses all the information identified in Table 2. This variable is an unweighted index.

We use a series of control variables to isolate the effect of environmental disclosure on companies' profitability. Among these, we have the variable Leverage (calculated as the ratio between the company's total liabilities and assets), Log Assets (proxy for company size, calculated by the logarithm of total assets), Ownership (percentage of common shares held by the largest shareholder), and Volatility (the standard deviation of the firms' net profit in the past three years). We even include dummies of years to control the effect of time.

In Eq. (2), we present our specification designed for the test of hypothesis H3. Also considering *DisclosureLevel$_{i,t}$* as the main variable of interest, Eq. (2) tests the existence of a positive relation between firm value and its level of disclosure.

$$Value_{i,t} = \beta_0 + \beta_1 DisclosureLevel_{i,t-1} + \beta_2 ReturnonAssets_{i,t} + \beta_3 BETA_{i,t} + \sum_{k=1}^{z} \left\{ \gamma_k Control_{k,i,t} \right\} + \mu_{i,t}.$$

(2)

We represent value$_{i,t}$ through Firm i Tobin's Q on year *t*. Sample firms' Tobin's Q was based on the simplified approximation proposed by Chung and Pruitt (1994), and adapted

Table 2 Indicators of environmental disclosure

1 Statement of the firm's environmental policy

2 Existence of department of pollution control and/or management of environmental problems

3 Existence of environmental affairs committee on board or other executive body

4 Existence of terms and conditions applicable to suppliers and/or customers regarding environmental practices

5 Involvement of stakeholders in the choice of environmental policies practiced by the firm

6 Status of the firm's environmental management system (EMS) and its level of reliability

7 Implementation of ISO 14001

8 Executive compensation linked to environmental performance

9 CEO discloses environmental performance in a statement to shareholdings and/or stakeholders

10 There are an environmental policy, with values and principles, and documented environmental codes of conduct

11 There is a formal statement regarding risk management and environmental performance systems

12 There is a formal statement that the company undertakes periodic reviews and assessments of its environmental performance

13 There is a statement of measurable goals in terms of future environmental performance

14 There is a specific statement on environmental innovation and/or new technologies

15 Adoption of GRI standards for the preparation of publicly disclosed reports

16 Independent auditing/verification for the environmental information of firm reports

17 Certification of environmental programs or environmental licenses issued by regulatory agencies

18 The products/services are environmentally certified, being the relevant certification issued by a specialized agency

19 External award regarding environmental performance or inclusion in some environmental index

20 Participation in specific industry associations/initiatives to improve environmental practices

21 Participation in other environmental organizations/associations of environmental improvement practices

22 Energy efficiency indicator

23 Water utilization and efficiency indicator

24 Greenhouse gas emissions indicator

25 Indicator of emission of other pollutant gases

26 Toxic emission indicator (TRI), water, earth, and air

27 Indicator of emission of solid or liquid waste

28 Indicator of recycling and use of waste

29 Indicator of recovered products and packaging

30 Indicator of the use of non-renewable resources and conservation of biodiversity

31 Indicator of the impact of products and services on the environment

32 Environmental performance compliance indicator

33 Indicator of the use of total material resources

34 Indicator of the use of fuels (renewable and non-renewable)

35 Spill indicator (incidents)

36 Indicators of global warming (neutralization)

37 Amount spent to improve environmental performance/eco-efficiency or environmental projects

38 Amount spent on fines or environmental proceedings

39 Amount spent in reverse logistics

40 Environmental revenues

41 Costs/investments/environmental expenses

Table 2 (continued)

42 Environmental liabilities

43 Environmental accounting practices

44 Environmental insurance

45 Tangible and intangible environmental assets

by Kammler and Alves (2009) as described in Eq. 3. We calculated firms' Tobin's Q based on the market value of the firm's shares (MV), taken as the sum of the product of the quantity of common and preferred shares by their respective market prices (Kammler and Alves 2009). This adaptation of Tobin's Q is more suited to the reality of the Brazilian capital market.

$$\text{Tobin's Q} = \frac{\text{MV} + \text{DV}}{\text{AT}} \tag{3}$$

where MV = total market value of the firm's shares; VD = value of the firm's debt, obtained through current liabilities less current assets added to the book value of long-term debt; and AT = Firm's total assets

We used the same control variables used in the previous model, adding two more. The first is ROA (return on assets) and the second is BETA. (This coefficient of the firm indicates its systematic risk and is calculated based on the stock's fluctuations and the reference index of the Brazilian stock exchange—Ibovespa, measured by the ratio between the covariance function and the standard deviation of the returns.)

4.1 Sample

The population analyzed in this study covered the firms listed on the B3 that integrated the Brazilian Broad Index (IBrA) on October 28, 2013. IBrA aims to offer a broad view of the stock market, tracking the financial performance of listed firms, selected by market liquidity and weighted in the index portfolio by the market value of the shares available for trading. To be part of the index, a given stock must be part of a list of stocks whose combined marketability indexes represent 99% of the accumulated value of all individual indices and have a presence in the trading sessions with participation volume equal to or higher than 95%. The choice of the IBrA index was due to the objective proposed by this study, which is to verify whether there is an association between the level of disclosure of environmental information and profitability. Stocks in IBrA have considerable trading volume, and the price of their stocks is expected to reflect the investors' perceptions in a dynamic fashion.

The IBrA on October 28, 2013, was composed of 130 firms. For the selection of the sample of firms, the following criteria were followed: a) to be listed on B3 in the whole period from 2006 to 2012; b) to disclose either on their Web site or on the Brazilian Securities Commission (CVM) Web site, the annual report or the standardized financial statements (DFP). Of the 130 firms, 22 were excluded because they were not listed on the B3 since 2006. We also eliminated 31 firms with activities typical of financial institutions, financial intermediation, holding companies, insurance, and real estate brokerage. Under environmental regulation set forth by the Brazilian environmental authority (*Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis*—IBAMA), these activities are not polluting ones, as well as they are not intense on natural resources consumption.

In the collection of firm's financial reports, we located two firms that did not have in their disclosures all the necessary data for the calculation of the variables, being those two firms excluded from our sample. Likewise, we also excluded two firms which were incorporated in 2006 and two firms whose fiscal year is different from the calendar year. One firm, which was subject of a corporate split-off in the period, was also disregarded. The final sample included 69 firms, surveyed between 2006 and 2012, totaling 414 firm-year observations.

Environmental disclosure data were collected from firms' annual reports and standardized financial statements. Annual reports were those made available on the firms' electronic pages, indicated as: annual report, sustainability report, annual and sustainability report, social report, socio-environmental balance sheet and corporate social responsibility report. The standardized financial statements are mandatory for all firms that have publicly traded stocks on B3. They include individual and consolidated financial statements (when applicable), explanatory notes, a management discussion and Analysis section and the corresponding auditor's report.

The data needed for ROA, ROE, and Tobin's Q calculation were collected in the Economática database. Data collected on Economática were subsequently reviewed on a sample basis through comparison with the data collected in standardized financial statements. In the calculation of Tobin's Q, we considered the common and preferred shares' closing price on the last day of March of the year following the annual report and financial statements reporting period. The issuance of financial statements by publicly traded firms, according to CVM Instruction No. 480/09, should not exceed three months from the end of the calendar year.

The collection of environmental disclosure information in the firms' annual reports and standardized financial statements was carried out through the complete reading of these reports. When a given, indicator was disclosed in these reports, we attributed the value of one to that indicator. We assigned zero value to indicators that were not disclosed in each report. The indicator regarding the review or verification of environmental disclosures by external auditors was considered present when it was explicitly stated that the auditors reviewed the annual report or performance report. In many of the sample's reports, the review by auditors referred solely to the financial statements and notes, which did not imply the review of additional information contained in the financial report.

5 Results

We present in Table 3 the descriptive statistics of the dependent variables ROE, ROA and Tobin's Q, as well as the explanatory variable $DisclosureLevel_{i,t}$ and control variables, all defined in the previous section. The average level of environmental disclosure is low, and no firm considered in the sample reached 100% of the possible disclosures. The low $DisclosureLevel_{i,t}$ variable average (0.20) combined with a standard deviation of equal magnitude (0.20) indicates a high incidence of firms with no environmental disclosure, providing support to the proprietary costs theory.

In Table 4, we report the means of the variables for the group of firms with no environmental disclosure ($DisclosureLevel_{i,t-1}$ equal to 0) and for firms with some environmental disclosure ($DisclosureLevel_{i,t}$ greater than zero). Except for the ROA variable, all other variables present statistically significant differences between the groups. Firms that do not carry out any environmental disclosure have a higher average Tobin's Q and

Table 3 Descriptive statistics

Variable	n	Mean	Std.Dev.	Min	Max
Panel A: *Sample of Eq. (1)*					
ROE	414	0.19	0.24	(10.29)	1.56
ROA	414	0.09	0.09	(0.29)	0.42
Disclosure Level	414	0.22	0.20	–	0.67
Log(Assets)	414	15.78	1.40	12.63	20.33
Leverage	414	58.24%	16.43%	11.98%	116.37%
Ownership	414	45.62%	24.60%	0.14%	100.00%
Volatility	414	(0.09)	3.03	(13.34)	51.88
Panel B: *Sample of Eq. (2)*					
Tobin's Q	315	1.26	1.002	0.04	6.59
Beta	315	0.75	0.64	− 0.73	3.66
ROE	315	0.20	0.23	− 10	1.56
Disclosure level	315	0.25	0.20	0.00	0.67
Log (assets)	315	16.05	13.98	13.00	20.33
Leverage	315	59.55%	15.43%	11.98%	95.54%
Ownership	315	46.27%	25.83%	0.14%	100.00%
Volatility	315	− 0.15	1.53	-12.58	10.52

Table 4 Comparison of means between groups

Variables	N	Mean	N	Mean	Mean diff
Group	(A) $DisclosureLevel_{i,t} = 0$		(B) > 0 $DisclosureLevel_{i,t}$		
ROE	86	0.161	328	0.193	− 0.032
ROA	86	0.106	328	0.094	0.013
Disclosure Level	86	0.000	328	0.277	− 0.278***
Log(Assets)	86	14.66	328	16.08	− 1.424***
Leverage	86	0.553	328	0.590	− 0.037*
Ownership	86	0.302	328	0.497	− 0.195***
Volatility	86	− 0.144	328	− 0.087	− 0.058
ROE	86	0.161	328	0.193	− 0.032

***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

higher systematic risk than those of firms that disclose environmental information. The firms that disclose environmental information are, on average, larger in terms of total assets and income, more indebted, and present higher returns on investments. These differences constitute evidence favorable to legitimacy theory, as firms that disclose environmental information are larger and more profitable, and we expect them to be subject of greater legitimacy related pressure.

After the descriptive analysis shown in Tables 3 and 4, we performed the correlation analysis between the variables to identify potential multicollinearity problems. This analysis aims to prevent variables with high correlation (> 0.8) from being used together in the estimation of econometric models' parameters. As evidenced in Table 5, no pair

Table 5 Matrix of correlation of variables

	1	2	3	4	5	6	7
Panel A: *Eq.* 1 *sample*							
ROE	1						
ROA	0.7585*	1					
Disclosure Level	0.0750	0.0466	1				
Log(Assets)	−0.1956*	−0.2928*	0.5443*	1			
Leverage	0.0993*	−0.2877*	0.0697	0.1726*	1		
Ownership	−0.0213	−0.1235*	0.2045*	0.1837*	0.0587	1	
Volatility	0.0357	0.0769	−0.0116	−0.0288	−0.0712	−0.0655	1

	1	2	3	4	5	6	7	8
Panel B: *Eq.* 2 *sample*								
Tobin's Q	1							
ROE	0.5009*	1						
Beta	−0.1891*	−0.1786*	1					
Disclosure level	−0.1004	0.0619	−0.1528*	1				
Log (assets)	−0.3641*	−0.2448*	0.1078	0.4912*	1			
Leverage	−0.0559	0.1904*	0.0949	−0.0293	0.0486	1		
Ownership	−0.2028*	−0.0341	−0.1065	0.2438*	0.1972*	0.0140	1	
Volatility	0.0826	0.1722*	−0.2178*	0.0308	−0.0156	−0.1346*	−0.0952	1

*$p < 0.05$

of variables present a correlation coefficient higher than 0.8, suggesting problems with multicollinearity.

In Table 6, we present the results for the dependent variables ROE and ROA, according to models defined in Eq (1). Due to the occurrence of heteroscedasticity in the models, the standard errors reported were estimated with a robust variance–covariance matrix. The choice between random and fixed effects estimation was made based on Hausman test results.

As shown in Table 6, the variable of interest *DisclosureLevel* has no statistically significant association with both dependent variables, *ceteris paribus,* in any of our specifications. In other words, we cannot say that environmental disclosure affects the profitability of publicly held companies.

About the control variables, only Leverage and Log (Assets) obtained statistical significance in some specification, and both with negative coefficients. That is, the company's leverage and size negatively influence the profitability of the companies studied.

After analyzing the explanatory variables ROE and ROA, and finding no support for the existence of the relationships predicted in hypotheses H1 and H2, we report the results referring to the effects of the environmental disclosure on the of the sample firms' Tobin's Q.

In Table 7, we present the results of the estimation of Eq (2). The variable of interest that represents the disclosure of environmental information ($DisclosureLevel_{i,t}$) again has no statistically significant coefficient, evidencing that holding other variables constant, a greater disclosure of environmental information is not associated with changes in firms' Tobin's Q.

Table 6 Estimation of Eq. (1) for ROE- and ROA-dependent variables

Dependent variables	(1) ROE	(2) ROE	(3) ROA	(4) ROA
Disclosure level	0.21301	0.02973	0.03875	0.02817
	(0.71839)	(0.69486)	(0.18049)	(0.18451)
Leverage	0.36381	0.38776	− 0.22928***	− 0.19173**
	(0.35452)	(0.38489)	(0.06201)	(0.05850)
Log(assets)	− 0.13894*	− 0.07334	− 0.04152*	− 0.02544
	(0.06049)	(0.09945)	(0.01725)	(0.02116)
Ownership	0.07717	0.03258	− 0.06811	− 0.07787
	(0.31563)	(0.28367)	(0.07556)	(0.06869)
Volatility	− 0.00479	− 0.00389	0.00133	0.00127
	(0.00577)	(0.00478)	(0.00212)	(0.00186)
2007		0.00000		0.00000
		(.)		(.)
2008		0.02527		0.01644
		(0.06501)		(0.02029)
2009		0.08960		0.02061
		(0.05646)		(0.01349)
2010		0.11931***		0.03333**
		(0.03537)		(0.01013)
2011		0.06481**		0.02145**
		(0.02334)		(0.00698)
2012		0.00000		0.00000
		(.)		(.)
AIC	− 2.66e+02	− 2.81e+02	− 9.80e+02	− 9.90e+02
BIC	− 2.48e+02	− 2.48e+02	− 9.61e+02	− 9.57e+02
Kleibergen-Paap rk LM statistic	0.028	0.051	0.028	0.051
Hansen J statistic	0.478	0.731	0.230	0.332
F-test	2.007	3.600	6.112	11.099
R^2	0.076	0.147	0.173	0.223
Observations	286	286	286	286

Robust standard errors in parentheses. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

Results reported in Tables 6 and 7 provide evidence against the hypotheses tested. The disclosure of environmental information is not statistically related to firm accounting returns (ROE and ROA) and market values (Tobin's Q), contrary to expectations based on legitimacy and proprietary costs theory. The disclosure of environmental information results in no notable loss of performance or firms market values. These results are contrary to the findings reported by Pereira et al. (2011) and Roque and Cortez (2006), in the sense that firms with greater disclosure of environmental information present worse financial performance when compared to those that do not disclosure environmental information.

In other words, according to the results of the proposed econometric models, we cannot infer that environmental disclosure is a determinant of the company's profitability or value. Thus, to test the robustness of the data, specifically of our variable of interest, we looked for a different database for another proxy for environmental disclosure.

Table 7 Estimation of Eq. (2) for the dependent variable Tobin's Q	(1)
	Tobin' q
Disclosure Level	-1.13228
	(1.91213)
Leverage	-1.77947
	(1.34012)
Log(Assets)	-0.27212
	(0.20832)
Ownership	-0.66147
	(0.79429)
Volatility	-0.00942
	(0.02203)
BETA	-0.08331
	(0.07877)
2007	-0.16023
	(0.21411)
2008	-0.50543^{**}
	(0.16252)
2009	-0.08975
	(0.12268)
2010	-0.07537
	(0.09016)
2011	-0.03631
	(0.06899)
2012	0.00000
	$(.)$
AIC	391.12396
BIC	430.66578
Kleibergen-Paap rk LM statistic	0.021
Hansen J statistic	
F-test	4.718
R^2	0.136
Observations	269

Robust standard errors in parentheses. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

From the Thomson Reuters database, we obtained the Environmental, Social and Governance (ESG) Scores. And from the ESG, we used only the Environmental Pillar, an index that measures a company's disclosure on environmental issues.[1] Table 8 summarizes the results of the new model. It is important to note that the period of new data collected differs from that of the model initially proposed. This fact stems from the

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[1] To full understand of the index, visit: https://www.refinitiv.com/content/dam/marketing/en_us/documents/methodology/esg-scores-methodology.pdf}.

Table 8 Estimation of Eqs. (1 and 2) for a different variable of interest and dataset

	(1) ROE	(2) ROE	(3) ROA	(4) ROA	(5) Tobin'q	(6) Tobin'q
Environment_Pillar_Score	−0.00670	−0.00326	0.00027	0.00004	0.01150[*]	0.00884[*]
	(0.00868)	(0.00904)	(0.00062)	(0.00064)	(0.00569)	(0.00506)
Leverage	0.14654	0.12689	−0.00099	−0.00087	0.00797	−0.00398
	(0.16173)	(0.15349)	(0.00134)	(0.00158)	(0.00862)	(0.00820)
Log(Assets)	0.57011	0.60138	0.00815	−0.00950	−0.40008[**]	−0.24387
	(0.39190)	(0.43617)	(0.02315)	(0.02900)	(0.13629)	(0.17238)
Volatility	−0.57041	0.02430	−0.05632	−0.07424	−0.44810	−0.80464
	(0.95409)	(0.97561)	(0.08108)	(0.10399)	(0.44779)	(0.50836)
Number_of_Analysts	0.01223	0.00183	−0.00011	0.00204	−0.03832[*]	0.00583
	(0.01773)	(0.02262)	(0.00235)	(0.00188)	(0.01591)	(0.01331)
Ownership	−0.21659	−0.18736	−0.03971[*]	−0.03374[*]	−0.03985	0.21482[*]
	(0.17838)	(0.18074)	(0.01901)	(0.01625)	(0.07877)	(0.10173)
2011		0.00000		0.00000		0.00000
		(.)		(.)		(.)
2012		0.27257		−0.00477		−0.56044[***]
		(0.26412)		(0.01096)		(0.14352)
2013		0.27290		−0.02125		−0.51980[***]
		(0.23240)		(0.01678)		(0.11371)
2014		−0.00380		−0.01960[+]		−0.82573[***]
		(0.14529)		(0.01188)		(0.13233)
2015		0.08604		−0.03444[*]		−0.32653[**]
		(0.16583)		(0.01340)		(0.11422)
2016		−0.00010		−0.00223		−0.37424[***]
		(0.09213)		(0.01142)		(0.09773)
2017		0.16166		−0.00657		−0.51432[***]
		(0.13125)		(0.00702)		(0.09607)
2018		0.00000		0.00000		0.00000
		(.)		(.)		(.)
AIC	932.41706	941.05526	−9.46e+02	−9.43e+02	503.01281	422.16198
BIC	956.02642	988.27399	−9.23e+02	−8.96e+02	526.71667	469.56969
Kleibergen–Paap rk LM statistic	0.001	0.001	0.001	0.001	0.001	0.001
Hansen J statistic	0.127	0.116	0.300	0.192	0.894	0.366
F-test	2.999	1.631	7.581	8.055	7.051	7.947
R^2	0.186	0.194	0.019	0.042	0.073	0.272
Observations	378	378	383	383	384	384

Robust standard errors in parentheses. ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$

implementation of IFRS; that is, the new database covers the period from 2010 to 2018. Despite making comparisons with the other database difficult, this fact brings benefits, such as more recent data, a larger window of time, and different form of measurement. It is important to note that we continue to use data from Brazilian companies.

We also estimated this new model using GMM. For the dependent variables ROE and ROA, the new variable of interest (Environment_Pillar_Score) also does not have statistical significance. In other words, we cannot say that environmental disclosure impacts the company's profitability.

However, for the dependent variable Tobin's Q, environmental disclosure has a statistically significant impact on the company's value. This result corroborates the third hypothesis of the present study. It is important to note that, due to the low number of observations in the Brazilian capital market, it is more challenging to obtain coefficients with statistical significance, that is, reinforcing the importance of the new result.

So, as demonstrated in Table 8, the relationship between company value and environmental disclosure is now statistically significant. In other words, the higher the environmental disclosure, the greater the company's value. That is, the Brazilian capital market perceives value in companies that offer information about their environmental issues. This fact reinforces, for example, the concept that environmental disclosure reduces information asymmetry, making the investor perceive less risk in a company and consequently assign a higher value to it.

6 Concluding remarks

This study analyzes the economic consequences of the disclosure of environmental information, having two competing theories as our main theoretical frame of analysis. The theory of legitimacy suggests that firms disclose environmental information to provide evidence of compliance with their obligations under the implicit contract they have entered with society, which is necessary for the firm's position to be legitimized. On the other hand, the theory of proprietary costs, embedded in the context of theoretical disclosure models, assumes that firms analyze the costs and benefits of private information disclosure, including the disadvantages of losing competitive advantage through the disclosure of sensitive information.

The results found in the sample of Brazilian firms for seven years indicate that the environmental disclosure is not associated with changes in firms' accounting returns. Still, it is a determining factor of the value attributed to publicly traded Brazilian companies. That is, the financial market perceives value in companies that offer information about their environmental issues. Regarding the lack of a relationship between disclosure and profitability, in general, sustainability studies suggest that this effect would be a long-term affair. As a consequence, it might not be captured in the financial data of firms for a short period. These results allow us to speculate whether the environmental information disclosure policy stems from the interaction of two competing forces. Institutional pressure suggested by the theory of legitimacy acts in the sense of demanding a higher level of disclosure, but disclosure is costly, as it may lead to the revealing of strategic or sensitive information. Thus, our results support the importance of both theories, each explaining part of the decision process regarding the disclosure of environmental information. We suggest further research on the determinants of environmental disclosure, assessing the impact of institutional pressure based on theories such as institutional theory and the theory of political costs, which could provide a suitable framework for a better understanding of the interaction between the theory of legitimacy and the theory of proprietary costs.

Our analysis of the economic consequences of the disclosure of environmental information was carried out through quantitative disclosure indicators, measured through the

reading of financial statements. We also recommend that future research evaluate the economic consequences of disclosure through differencing disclosure quality, as well as considering various dimensions of environmental disclosure, inspired by Odriozola and Baraibar-Diez's (2017) findings that the quality of sustainability reporting increases the likelihood of having higher corporate reputation. Some interesting dimensions to be considered are governance structure, environmental policies, and environmental expenditures and revenues.

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