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Environmental Innovation and Systematic Risk: Moderating Role of Board Diversity

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1 Introduction

Environmental innovation refers to new or modified processes, techniques, systems and products that act to prevent or reduce environmental damage (Kemp & Pontoglio, 2011), i.e. it is a component of business innovation that acts to reduce environmental impact to achieve sustainable development (Al-Shami & Rashid, 2021). Environmental innovation is a key factor in the development of strategies by countries to confront the most important existing environmental problems of our society (García-Sánchez et al., 2021). In this sense, environmental innovation is increasingly used by companies as it is the best solution to face their environmental problems (Liao & Liu, 2021) and society pressures companies to implement environmental innovation due to increased awareness of the importance of corporate ethical and environmental responsibility (Ha et al., 2021). Moreover, environmental innovation is different from general innovation in that it places more emphasis on environmental advances rather than focusing solely on for-profit activities (Pan et al., 2021) and although environmental product innovations are more expensive than nonenvironmental innovations, companies are able to sacrifice short-term profits in order to achieve long-term business goals (Hizarci-Payne et al., 2021) aiming at competitive advantage and legitimising their activities (Nadeem et al., 2020).

Companies' operations can help generate profits, but at the same time they can also induce risks (Farah et al., 2021). Firm risk can be minimised, managed or reduced, but it is difficult to eliminate it completely, and more difficult when firm risk is associated with economic, political and social events called systematic risks (Garcia et al., 2017). Systematic risk is related to the covariance of a company's stock return with the market or to the sensitivity of the stock return to the market, such as exchange rate adjustments and changes in the price of energy (Park et al., 2017). A firm's systematic risk can be affected by decisions related to the firm's investments, operations, and financing, because these decisions will change the variation of the firm's return compared to the average market return, so firm-specific decisions can explain its systematic risk (Djoutsa Wamba et al., 2020) and environmental issues can be an important source of uncertainty and risk that influences the company's business. (Xue et al., 2020).

In recent years, board diversity has attracted attention from researchers, policy makers and companies (Ozdemir et al., 2021). Board diversity allows board members to better perform their duties through their diverse perspectives (Baker et al., 2020). Decision making improves with diversity, with the company being able to consider more options from a more diverse set of perspectives (Hillman, 2015), so board diversity in observable aspects such as gender and nationality and unobservable aspects such as education and experience affect the decisions made by the board (Issa et al., 2021). Moreover, the actions and contributions of the board members are different from each other and depend on experience, age, gender, nationality and so on, i.e., these attitudes depend on board diversity (Post et al., 2021).

Previous studies show the influence of social and environmental aspects on a company's financial risk (Eriandani & Wijaya, 2021; Salama et al., 2011; Sassen et al., 2016; Shakil, 2021). However, there are no studies that address the relationship between environmental innovation and systematic risk. Only a few studies have examined the moderating effect of board diversity on the environmental issues - financial risk nexus (Shakil, 2021) and there are no previous studies that address the moderation of aspects such as board independence and board skills in the relationship between environmental aspects and financial risk. The study seeks to fill this gap.

This paper seeks to answer four research questions aiming to fill the gap in the literature and provides theoretical and empirical evidence to contribute to the environmental aspects and

systematic risk literature. The research questions are as follows: (1) To what extent does environmental innovation influence firms' systematic risk? (2) To what extent does gender diversity moderate the environmental innovation - firms' systematic risk nexus? (3) To what extent does independent director diversity moderate the relationship between environmental innovation and firms' systematic risk? and (4) To what extent does specific skill diversity moderate the environmental innovation-firms' systematic risk? Theoretically, the effect of environmental innovation on environmental innovation can be explained using stakeholder and risk management theory. Stakeholder theory (Freeman, 1984) states that a company's value depends on its ability to satisfy the needs of its stakeholders (Post et al., 2021), and that protecting the environment is beneficial to the whole company (Djoutsa Wamba et al., 2020), thus, according to stakeholder theory one of the ways the company can be effective on behalf of its stakeholders is when environmental and social performance is demonstrated (Galbreath, 2018). Risk management theory (Godfrey, 2005) proposes that the company's engagement in social and environmental activities results in "moral capital" and "relational wealth" resulting from the relationship with its stakeholders (Chakraborty et al., 2019).

Our study contributes to the literature on environmental innovation, financial risk and board diversity in a number of important ways. First, in Latin America, 80% of the population lives in urban areas that harbor some of the greatest social inequalities in the world (Kephart et al., 2021) and Latin America is a source of essential resources for the global economy, with extensive energy, mining and agricultural resources, with Latin American economies having a number of factors and components to position themselves as one of the fastest growing regions in the world (Gouvea et al., 2021). Thus, research on environmental innovation in Latin America is important, and this is the first contribution of the study. Second, the study extends the literature by quantitatively examining the relationship between environmental innovation and systematic risk and the moderating role of board diversity in this relationship. Third, the study measures systematic risk by the beta index, which is a measure used by practitioners and academics (Djoutsa Wamba et al., 2020). Finally, COVID-19 pandemic originating in Wuhan, Hubei Province, China in 2019 has become a major public health problem around the world, impacting environmental sustainability and responsibility, as well as people's quality of life (Severo et al., 2021) and brought new challenges and opportunities for business innovation (Loia & Adinolfi, 2021). Thus, the study contributes by discussing aspects (environmental innovation, systematic risk, and board diversity) that will be important in the post-pandemic world.

The remainder of this paper is structured as follows. The second section discusses the literature review. Next, we discuss our data and methodology. The fourth section presents the empirical analyses of the study. Finally, we discuss the findings and make concluding remarks, we point out to the research limitations and delineate the related future research directions.

2 Literature review and hypothesis development

2.1 Environmental innovation and systematic risk

According to The United Nations Principles for Responsible Investment (UNPRI) credit rating agencies and institutional investors consider social, environmental, and governance factors in their credit risk analysis framework (Kim & Li, 2021). In this context, better social and environmental behavior encourages ethical behavior by managers, generating a positive impact on the firm reputation and, indirectly, can increase firm value and reduce financial risk (Hsu & Chen, 2015). Moreover, investing in social and environmental aspects improves the managerial portfolio, with increased return and reduced portfolio risk (Broadstock et al., 2021).

Risk management theory posits that companies increase their engagement in environmental and social activities to mitigate negative effects on their reputation (Col & Patel, 2019). According to risk management theory, companies with higher environmental

performance have stakeholder loyalty because they have accumulated moral capital, and loyal stakeholders may be less inclined to react sensitively to negative news, leading to less financial risk (Sassen et al., 2016). An implication of this view is that the company's involvement in social and environmental activities reduces the company's risk (Chakraborty et al., 2019).

According to stakeholder theory, companies with good environmental performance have good relationships with their stakeholders, anticipating their needs and carrying out environmental management processes to reduce the volatility of financial results (Djoutsa Wamba et al., 2020). Stakeholder theory posits that decisions based on long-term value is of interest to all stakeholders, allowing strategies to deal with possible conflict of interest among stakeholders, thus investing in environmental issues increases the value of the company and reduces its financial risk, because managers have a greater incentive to seek value maximization (Xue et al., 2020). According to stakeholder theory, higher environmental performance meets the needs of stakeholders, leading to less financial risk, so higher environmental performance leads to lower stock volatility in the capital market (Sassen et al., 2016) and environmental aspects are related to corporate risk management, aiming to manage the relationship with its stakeholders by providing intelligence on what these risks are and providing an effective response to the risks (Eriandani & Wijaya, 2021). Therefore, stakeholder theory is based on the risk mitigation view, implying that engaging in social and environmental activities has a negative impact on companies' financial risk (Farah et al., 2021) and environmentally responsible companies tend to lower their market risk (Salama et al., 2011).

Shakil, (2021) found that Environmental, Social and Governance (ESG) negatively impacts total risk. Eriandani & Wijaya, (2021) found that environmental and social performance can reduce corporate risks, as measured by the volatility of daily stock returns. Djoutsa Wamba et al. (2020) found a negative relationship between environmental performance and systematic company risk as measured by the beta index. Salama et al., (2011) found that environmental performance is inversely related to systematic financial risk. Sassen et al., (2016) found that in environmentally sensitive industries, environmental performance reduces the company's systematic risk. Thus, in line with risk management and stakeholder theory and prior empirical findings, the following hypothesis is proposed:

Hypothesis 1: Environmental innovation is negatively related to systematic risk

2.2 The moderation effect of gender diversity on the relationship between environmental innovation and systematic risk

According to stakeholder theory, women directors are more likely to get involved in strategic issues that affect social and environmental aspects of the company because of their experience and their psychological and historical characteristics (Manita et al., 2018) and women directors have greater communication, collaborative, and diplomatic skills than male directors, thus women directors are more engaged in environmental activities and are better able to assess stakeholder needs (Campanella et al., 2021). In this line, women directors take the needs of the stakeholders more into consideration and take an active part in the strategic issues that influence the company and its stakeholders (Martinez-Jimenez et al., 2020) and e women directors are most likely to influence the company's decisions to increase the reliability of the reported non-financial information (Buertey, 2021). Therefore, women directors have greater communication, collaborative, and diplomatic skills than male directors, so women directors are more engaged in environmental activities and can better assess stakeholder needs (Hussain et al., 2018).

Mohsni et al., (2021) found gender diversity to be negatively related to risk and positively related to financial performance. Teodósio et al., (2021) found that gender diversity

decreases firms' litigation risk and operational risk, and has a contingent effect on financial risk, manipulation risk, total risk, idiosyncratic risk, and systematic risk. However, Chen et al., (2019) found that gender diversity positively influences financial risk and Loukil and Yousfi (2016) found no significant relationship between gender diversity and financial risk. Bufarwa et al., (2020) explains that gender diversity positively influences financial risk disclosure. Wang et al., (2021) show that gender diversity positively influences CSR reporting. Boukattaya and Omri (2021) corporate social irresponsibility (CSI). Shakil (2021) suggest that board diversity moderates the relationship between environmental, social and governance and financial risk. Thus, in line with stakeholder theory and prior empirical findings, the following hypothesis is proposed:

Hypothesis 2: Gender diversity negatively moderates the relationship between environmental innovation and systematic risk

2.3 The moderation effect of board independence on the relationship between environmental innovation and systematic risk

Companies that satisfy a wide range of stakeholders have a greater number of independent directors (Radu & Smaili, 2021). According to stakeholder theory, a higher proportion of independent directors allows the company to incorporate new knowledge innovations from different aspects and promotes the interest of shareholders and other stakeholders (Nwude & Nwude, 2021) and board independence can be a company strategy to take into account the interest of a wide range of stakeholders in management decision making (Ramdhony et al., 2021). Therefore, the main objective of selecting independent directors is to add value to the board by protecting the interests of all stakeholders (Rashid & Hossain, 2021). Thus, independent directors decide to pay special attention to involvement in environmental and social issues (Zaid et al., 2020).

Baulkaran and Bhattarai, (2020) found that the board independence influences negatively the firm risk. Aslam and Haron (2021) found that board independence negative associated with credit and liquidity risk. Vallascas et al., (2017) found that in most large international banks, the independence of the board does not influence the risk. Dupire and Slagmulder (2019) found that companies with greater board independence have a more independent risk committee. Desender (2011) found that the board independence does not influence the firm risk. Moreover, various studies show that there is a positive relationship between board independence and environmental issues (Alia & Mardawi, 2021; Ben Fatma & Chouaibi, 2021; Bhuiyan et al., 2021). Thus, in line with stakeholder theory and prior empirical findings, the following hypothesis is proposed:

Hypothesis 3: Board independence negatively moderates the relationship between environmental innovation and systematic risk

2.4 The moderation effect of board specific skills on the relationship between environmental innovation and systematic risk

A more diverse board allows the board to acquire different cognitive and professional skills (Boukattaya & Omri, 2021). Specialized knowledge of directors relates to the advisory role of the board of directors (Bătae et al., 2021) and board members who have specific skills have knowledge and experience that make them more effective than others (Gallego-Álvarez & Pucheta-Martínez, 2020). In this line, there is a link between the company and its external resources, influencing the appointment of directors with specific knowledge (Badu & Appiah, 2017). Therefore, companies that have a greater diversity of skills are more likely to increase

the resources of the board, improving the company's decisions on environmental aspects (Al-Qahtani & Elgharbawy, 2020).

To the best of our knowledge, there are no studies linking specific skill diversity and company risk, however, skills diversity is positively related to financial performance (Noja et al., 2021). Orazalin and Mahmood (2021) suggests that skills diversity does not influence environmental performance. Harjoto et al., (2019) found that diverse educational backgrounds are positively associated with corporate social performance and there is a positive relationship between board educational background and environmental issues (Cabeza-García et al., 2018). Thus, in line with prior empirical findings, the following hypothesis is proposed:

Hypothesis 4: Board specific skills negatively moderates the relationship between environmental innovation and systematic risk

3 Data and methodology

3.1 Sample construction

To test the hypotheses, we use a sample consisting of 1942 firms-year observation of 242 firms from Argentina, Brazil, Chile, Colombia, Mexico, and Peru between 2010 and 2019. These countries were selected because they belong to the Morgan Stanley Capital International (MSCI) Emerging Markets Latin America Index, created in 1990, Which has medium and large capitalisation representation in six Emerging Market countries in Latin America (Argentina, Brazil, Chile, Colombia, Mexico and Peru) (MSCI, 2021). The sample is unbalanced, because full data is not available for all companies and for all years, and it consists of a total of 1942 firm-year observations. Our data set is made up of information from the Refinitiv database. Refinitiv database has information from 900 points of ratings by companies, from various sources such as annual and sustainability reports, country stock exchanges, non-governmental organizations and independent news sources in order to ensure the reliability of the data (Xu et al., 2021). Table 1 illustrates the sector classification used in this analysis, based on the Global Industry Classification Standard (GICS).

Table 1

Sample distribution by sector of activity and countries

	Argentina	Brazil	Chile	Colombia	México	Peru	Total
Communication Services	12	29	10	4	23	0	78
Consumer Discretionary	12	139	20	2	35	0	208
Consumer Staples	21	98	43	14	81	25	282
Energy	16	40	10	10	1	0	77
Financials	28	103	51	56	63	26	327
Health Care	2	42	0	0	7	0	51
Industrials	15	86	36	7	62	12	218
Information Technology	4	21	6	0	0	0	31
Materials	18	109	32	20	74	59	312
Real State	10	33	7	0	9	4	63
Utilities	33	145	77	20	4	16	295
Total	171	845	292	133	359	142	1942

As is evident from the data in Table 1, the sample comprised eleven activity sectors. Firms belonging to the financial sector represent 327 observations (16,8%), followed by the materials, utilities and consumer staples sectors at 312 (16,02%), 295 (15,1%) and 282 (14,5%) observations, respectively. The sector with the lowest representation was information technology with 31 observations (1%). In reference to countries, Brazil is the country with the most observations with 845 (43,5%), followed by Mexico and Chile with 359 (18,4%) and 292 (15,0%) observations, respectively.

3.2 Variables

3.2.1 Dependent variable

In this paper, we study the impact of environmental innovation on firms' systematic risk. The systematic risk (beta) for each firm in a given year is estimated by CAPM beta, a measure of how much the stock moves for a given market move, being the covariance of the movement of the security's price relative to the movement of the market price. In order of preference, monthly Beta 5Y, weekly Beta 3Y, weekly Beta 2Y, daily Beta 180D, daily Beta 90D are used in the calculation, in line with previous studies (Farah et al., 2021; Shakil, 2021).

3.2.2 Independent and moderating variables

Environmental innovation was measured by the environmental innovation score that reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products, in line with previous studies (Burkhardt et al., 2020; Rajesh & Rajendran, 2020). See the variables description in Table 2.

Table 2

Variables description

Variable name	Variable name	Model name	Proxy
Dependent	Beta index	BETA	Covariance of the movement of the security's price relative to the movement of the market price
Independent	Environmental innovation score	EINOV	Environmental innovation score
Moderator	Gender diversity	GEND	Proportion of women on the board of directors
Moderator	Board independence	BIND	Proportion of independent directors on the board of directors
Moderator	Board specific skills	BSS	Proportion of directors with specific skills on the board of directors
Control	Board size	BSIZE	Total number of board members
Control	CEO duality	CEODUAL	Dummy variable equals 0 if the company operates with the same person as CEO and chairman at the same time, and otherwise 1
Control	CSR Committee	CSR	Dummy variable equals 1 if the company has CSR sustainable committee, and otherwise 0
Control	Profitability	ROA	Income after taxes for the fiscal period/Total assets
Control	Leverage	LEV	Total debt/Total assets
Control	Firm size	FSIZE	Natural logarithm of total assets

Regarding the moderating variables, gender diversity is calculated by the proportion of female directors, which is the ratio of the number of female directors by the total number of directors (Boukattaya & Omri, 2021). Board independence is measured by the proportion of independent directors, which is the ratio of the total number of independent directors to the total number of directors. Board specific skills is calculated by the proportion of the number of directors with specific skills, which is the ratio of the number of directors with specific skills by the total number of board members.

3.2.3 Control variables

Control variables regarding systematic risk were introduced to the regression model to decrease the likelihood of bias in the results. Board size is the total number of board member and larger boards have more individuals to effectively monitor managers' risk behavior

(Baulkaran & Bhattarai, 2020), thus we expect a negative relationship between board size and systematic risk. CEO duality is dummy variable equals 0 if the company operates with the same person as CEO and chairman at the same time, and otherwise 0. Powerful directors may want fewer challenges ahead of the board, so a negative relationship is expected between CEO duality and systematic risk (Mathew et al., 2018). CSR sustainable committee is dummy variable equals 1 if the company has CSR sustainable committee, and otherwise 0. CSR Committee can be an effective mechanism to define risk incentive for the CEO (Dunbar et al., 2020), thus we expect a negative relationship between CSR sustainable committee and systematic risk. Profitability is the ratio between income after taxes for the fiscal period and total assets and more profitable companies tend to have lower risk (Lam & Zhan, 2021), thus we expect a negative relationship between profitability and systematic risk. Leverage is measured as debt over total assets and leverage can affect the company's risk, more leveraged companies have a higher risk (Shakil, 2021), thus we expect a positive relationship between leverage and systematic risk. Finally, firm size is the natural logarithm of total assets and larger companies can control risk by having more resources (Benlemlih & Girerd-Potin, 2017), thus we expect a negative relationship between firm size and systematic risk.

3.3 Empirical Models

Statistical tests were performed to verify the appropriate econometric method. The Breusch-Pagan Lagrange multiplier test is applied to verify heteroscedasticity, the result presented statistical significance ($p<0.01$), rejecting the null hypothesis, indicating heteroscedasticity. Wooldrige test was performed to check for first order autocorrelation in the panel data, statistical significance was verified ($p<0.01$), proving the existence of first order autocorrelation. Thus, to deal with the problems of autocorrelation and heteroscedasticity we used Feasible Generalized Least Squares (FGLS). FGLS is a method that is able to eliminate hetoscedasticity and autocorrelation from the model (Reed & Ye, 2011), and can simultaneously deal with heteroscedasticity and autocorrelation in the data (Symeou et al., 2019). Thus, in order to verify the influence of environmental innovation on systematic risk and the moderating effect of board diversity on this relationship, the following models are estimated:

$$BETA_{i,t} = \beta_0 + \beta_1 EINOV_{i,t} + \beta_2 GEND_{i,t} + \beta_3 BIND_{i,t} + \beta_4 BSS_{i,t} + \beta_5 BSIZE_{i,t} + \beta_6 CEODUAL_{i,t} + \beta_7 CSR_{i,t} + \beta_8 ROA_{i,t} + \beta_9 LEV_{i,t} + \beta_{10} FSIZE_{i,t} \varepsilon \quad (1)$$

$$BETA_{i,t} = \beta_0 + \beta_1 EINOV_{i,t} * GEND_{i,t} + \beta_2 EINOV_{i,t} * BIND_{i,t} + \beta_3 EINOV_{i,t} * BSS_{i,t} + \beta_4 BSIZE_{i,t} + \beta_5 CEODUAL_{i,t} + \beta_6 CSR_{i,t} + \beta_7 ROA_{i,t} + \beta_8 LEV_{i,t} + \beta_9 FSIZE_{i,t} \varepsilon \quad (2)$$

where, BETA is beta index. EINOV is the Environmental innovation score. GEND is the gender diversity. BIND is the board independence. BSS is the board specific skills. BSIZE is the board size. CEODUAL is the is the duality between CEO and chairman. CSR is the CSR Committee. ROA is the profitability. LEV is the leverage. Firm Size is the company size.

4 Results

4.1 Descriptive Statics

Table 3 reports a summary of the descriptive statistics for all variables considered in the study model. The beta index showed a mean of 1,001 and standard deviation of 0,474; the higher the index, the more systematic risk the company has. The environmental innovation variable presented a mean of 20,62, with a standard deviation of 30,42 and a maximum value

of 99,72, meaning that by the mean the Latin American companies do not have a good environmental innovation score.

Table 3

Descriptive statics

Variables	N	Mean	SD	Minimum	Maximum
BETA	1933	1,001	0,474	-0,209	2,482
EINOV	1943	20,62	30,42	0	99,70
GEND	1943	8,006	9,578	0	85,71
BIND	1938	35,02	22,17	0	100
BSS	1820	30,10	20,11	0	100
BSIZE	1943	10,57	4,120	1	33
CEODUAL	1943	0,293	0,455	0	1
CSR	1943	0,530	0,499	0	1
ROA	1572	0,335	0,706	-16,18	14,46
LEV	1673	1,316	1,365	0	17,69
FSIZE	1673	20,78	1,421	15,75	24,89

Gender diversity has an average of 8,006, that is, the board composition of Latin American companies has an average of 8% women, a very low number. The average for board independence is 35,02 and for directors with specific skills 30,10.

4.2 Multivariate analysis

The study used the xtgls routine in the STATA 16 program. Table 4 presents the results of models 1 and 2.

Table 4

Results

	Dependent variable: Beta index	
	Feasible Generalized Least Squares	
	Model 1	Model 2
	Coefficient	Coefficient
EINOV	-0,0000525***	
GEND	-0,0001938**	
BIND	0,0000415	
BSS	0,0000117	
EINOV*GEND		-0,0000000293***
EINOV*BIND		0,00000000127
EINOV*BSS		-0,0000000332
BSIZE	-0,0003505**	-0,0001478**
CEODUAL	-0,0008026	-0,0004573
CSR	-0,0024059	-0,0018388
ROA	-0,0005678	-0,0001849
LEV	0,0011416	0,006264
FSIZE	0,0149045***	0,13385***
Constant	0,6701613***	0,6981843***
N	1413	1413
Firms	242	242
Wald chi2	134,16***	102,96***
Períod	10	10

In Model 1 we explore the relationship between environmental innovation and systematic risk. In Model 2 we examine the moderating role of board diversity in the relationship between environmental innovation and systematic risk. In Model 1, our results find a positive and significant relationship between environmental innovation and systematic risk (coeff=-0,0000525; p=0,000) supporting hypothesis 1. In Model 2, our results find that gender

diversity negatively moderates the relationship between environmental innovation and systematic risk (coeff=-0,0000000293;p=0,000), supporting hypothesis 2. Furthermore, a negative and significant relationship is observed between gender diversity (coeff=-0,0001938;p=0,048), and board size (coeff=-0,0003505;p=0,048), and systematic risk and a positive and significant relationship between firm size (coeff = 0,0149045;p=0,048), and systematic risk.

4.3 Sensitive analysis

The panel-corrected standard error (PCSE) method was used to further robust the results. FGLS can overestimate the significance of the coefficients (Beck & Katz, 1995) and PCSE is also a method that can overcome the heteroscedasticity of the model (Hossain, 2016). PSCE has a more reliable error structure than the generalized least squares method (Khalil & Taktak, 2020). Therefore, the xtpcse command was used. Table 5 shows the results.

Table 5
Results

	Dependent variable: Beta index	
	Feasible Generalized Least Squares	
	Model 1	Model 2
	Coefficient	Coefficient
EINOV	-0,0019118***	
GEND	-0,0023729**	
BIND	-0,000096	
BSS	0,000261	
EINOV*GEND		-0,000141***
EINOV*BIND		0,00000000619
EINOV*BSS		-0,000351
BSIZE	-0,0062366**	-0,0052921*
CEODUAL	-0,0711107***	-0,0575699**
CSR	-0,053067	-0,0514765
ROA	-0,0751104	-0,007000
LEV	0,0264636	0,0252378
FSIZE	0,0541137***	0,0564408***
Constant	0,0172412***	-0,0626059***
N	1413	1413
Firms	242	242
R squared	0,0523	0,0579
Wald chi2	79,88***	119,68***
Períod	10	10

Similar results are observed, with environmental innovation negatively influencing systematic risk and gender diversity negatively moderating this relationship. In addition, board of directors, gender diversity, and CEO/Chairman duality negatively influence systematic risk. In addition, size positively influences systematic risk.

5 Discussion

The results confirm the effect of environmental innovation on systematic risk, meeting the risk management theory that states that firms invest in environmental activities to increase their reputation, accumulating moral capital, reducing systematic risk, and also meeting the stakeholder theory that suggests that higher environmental performance satisfies stakeholders, meeting their needs and reducing systematic risk.

These findings confirm previous studies (Eriandani & Wijaya, 2021; Salama et al., 2011; Sassen et al., 2016; Shakil, 2021). Shakil, (2021) analyzed the relationship between ESG performance and total risk, from a sample of 70 oil and gas firms from 2010 to 2018, the results showed that ESG performance negatively influences total risk and gender diversity and ESG controversies negatively moderates this relationship. analyzed the benefits of CSR on corporate risk in controversial and non-controversial sectors from a sample of 927 companies listed on the Indonesia Stock Exchange from 2016 to 2019, the results suggest that the performance of CSR can reduce corporate risk. Djoutsa Wamba et al., (2020) examined the relationship between environmental performance and firm systematic risk from a sample of 351 European firms over the period between 2007 and 2015, they found a negative relationship between environmental performance and systematic risk. Salama et al., (2011) analyzed the benefits of CSR on corporate risk in controversial and non-controversial sectors from a sample of 927 companies listed on the Indonesia Stock Exchange from 2016 to 2019, the results suggest that the performance of CSR can reduce corporate risk. Sassen et al., (2016) investigated the impact of corporate social performance on systematic, idiosyncratic, and total risk from a sample of 8,752 firm-year observations covering the period 2002-2014. The results showed that social performance has a significantly negative effect on all three risk measures and environmental performance generally decreases idiosyncratic risk, while total risk and systematic risk are affected only in environmentally sensitive sectors.

The results also confirm that gender diversity negatively moderates the relationship between environmental innovation and systematic risk, that is, in companies with greater gender diversity, environmental innovation decreases systematic risk, this result meets the stakeholder theory that states that women tend to meet stakeholders' needs more than men, this result confirms the study of (Shakil, 2021).

Board independence does not moderate the relationship between environmental innovation and systematic risk. A explanation for this result is that independent directors, being external to the organization, may not be as involved with the organization, not thinking long term and not supporting investment in environmental innovation activities, so in companies with more independent directors it may be that environmental innovation does not decrease systematic risk. The higher number of directors with specific skills also does not moderate the environmental innovation-systematic risk relationship, this result can be explained by the fact that some specific skills, such as financial expertise, may not help much in investing in environmental innovation, so in companies with a higher number of directors with specific skills environmental innovation does not influence the systematic risk. Also, larger boards seem to monitor the risk behavior of managers making it have a negative relationship with systematic risk and larger firms by having more resources seem to think they can take more risk. The summary of hypotheses is presented in Table 6.

Table 6

Summary of hypothesis

Hypothesis	Expected sign	Actual sign	Level of support

Hypothesis 1: Environmental innovation is negatively related to systematic risk	(-)	(-)	Supported
Hypothesis 2: Gender diversity negatively moderates the relationship between environmental innovation and systematic risk	(-)	(-)	Supported
Hypothesis 3: Board independence negatively moderates the relationship between environmental innovation and systematic risk	(-)	(0)	Not Supported
Hypothesis 4: Board specific skills negatively moderates the relationship between environmental innovation and systematic risk	(-)	(0)	Not Supported

In sum, the study brings theoretical and practical implications. By studying the relationship between two constructs as important as environmental innovation and systematic risk, the study contributes theoretically to its literature by offering new perspectives suffers the effect of environmental aspects, such as environmental innovation, on systematic risk, the study also shows that in companies with a greater presence of women the effect is more relevant. In addition, the study presents originality by studying the reality of Latin American countries. The practical implications of the study are that policy makers can encourage investment in environmental innovation by managers to decrease the firm's systematic risk, and policy makers can encourage companies to increase the percentage of women on the board of directors because they have a greater interaction with the company's stakeholders and can make the investment in environmental innovation decrease the firm's systematic risk.

6 Conclusions

This study examines the relationship between environmental innovation and systematic risk and the moderating role of board diversity. Using data from 242 firms from Argentina, Brazil, Chile, Colombia, Mexico, and Peru collected from 2010 to 2019, we employ the Feasible Generalized Least Squares (FGLS) method. We measured systematic risk by the beta index, a measure of how much the stock moves for a given market move, being the covariance of the movement of the security's price relative to the movement of the market price. Environmental innovation was calculated using the environmental innovation score provided by the Refinitiv database.

We find a negative and significant relationship between environmental innovation and systematic risk. The results show that gender diversity negatively moderates the relationship between environmental innovation and systematic risk and that board independence and specific skill diversity do not moderate the relationship between environmental innovation and systematic risk. In addition, we also find a negative and significant relationship between board size and systematic risk and a positive and significant relationship between firm size and systematic risk.

This study suffers of some limitations. First, other risks can be used, such as total risk, and systematic risk can be metrified by other measures, such as price change. Second, regarding environmental innovation metrics a qualitative approach can be used. Finally, other realities besides Latin America can be studied, so future research can be done with countries with different institutional characteristics and with the use of other metrics for a more robust result.

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