ASIAN JOURNAL OF ECONOMICS AND BUSINESS MANAGEMENT
2024, VOL. 3, NO. 1, 429 – 439
https://doi.org/10.53402/ajebm.v3i1.364

Exploration of research and development, foreign ownership, and carbon emissions disclosure in Indonesia

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ABSTRACT
Carbon emission disclosure (CED) is one of the corporate world's efforts to assist environmental conservation while also improving the company's public image. Efforts are being made to make firm operations greener by optimizing research and development (R&D), which leads to environmental improvements. Several prior studies investigated research and development on corporate social responsibility in general. The purpose of this study is to investigate the the impacts of R&D and foreign ownership on carbon emissions disclosure in Indonesian companies. This research also examines proactive steps done by firms to significantly reduce emissions through green research and development and supported by large foreign share ownership, which is regarded to be involved with high concern. The empirical analysis applies multiple regression and moderated regression, with purposive sampling on the Indonesia Stock Exchange (BEI) company between 2016 and 2019, obtained 522 samples. Carbon emissions disclosure is measured using a checklist index based on the Carbon Disclosure Project (CDP) and content analysis of the company's sustainability report. Based on the findings, RnD intensity has a positive impact on carbon emissions disclosure (CED), however foreign ownership in Indonesia has no effect on the relationship between RnD intensity and CED. This suggests that R&D will enhance the amount of carbon emissions disclosure, yet foreign ownership in Indonesia remained minimal, hence it has minimal effect on the company's long-term decisions. Research has limitations in recognizing RnD that implemented proactive approaches, so further studies on each company are required for future research.

KEYWORDS
Carbon Emission Disclosure; R&D Intensity; Green Innovation; Sustainability; Foreign Ownership

Received: 15 September 2023
Accepted: 14 February 2024
Published: 15 February 2024

Introduction

Conference of the Parties (COP) 26 which was held in 2021 in Glasgow, Scotland resulted in an agreement to mitigate global climate. This is a follow-up to the Paris Agreement to maintain global temperatures of no more than 1.5˚C. Based on information announced by the Intergovernmental Panel on Climate Change (International Panel on Climate Change, 2018), it was revealed that during the 2006-2015 period, global warming reached 0.87˚C (± 0.12˚C). Currently, global temperatures are experiencing an annual increase of around 0.2˚C (± 0.1˚C), with the main cause being human activity which has increased global temperatures by 1˚C above pre-industrial levels in 2017. If the trend This warming continues, it is estimated that the earth's surface temperature will reach 1.5˚C in 2040, potentially causing negative impacts on humans and the environment (Liu et al., 2015) and (Department of Pollution Control and Technologies Technological Education Institute of Western Macedonia Kozani, Greece et al., 2016). Therefore, doubts arise regarding the important role of business in achieving better environmental performance through more sustainable production practices, operations, and product innovation efforts (Busch & Hoffmann, 2011) and (Lee & Kim, 2011).

In Indonesia, there are several regulations governing climate change as a commitment to reducing greenhouse gases. Namely through Law Number 17 of 2004 concerning climate change, which aims to enable companies in Indonesia to encourage themselves to change business activities to be more environmentally friendly so that carbon emissions are reduced (Asmaranti & Lindrianasari, 2014). In addition, the Paris Agreement to the United Nations Framework for Climate Change Convention and Presidential Regulation Number 61 of 2011, which governs national action plans to reduce gas emissions, have been put into effect, strengthening efforts to reduce carbon emissions. Presidential Regulation Number 71 of 2011, which manages the execution of the national greenhouse gas inventory, and greenhouse gas (RAN-GRK).

With the enactment of various regulations issued by the Indonesian government, companies in this country are required to disclose activities related to environmental aspects in their business operations. This includes environmental innovation efforts, such as efforts to develop sustainable products or improve operational efficiency and energy use (Dangelico & Pujari, 2010). For example, companies can implement environmental management

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systems, adopt pollution prevention measures, reuse and recycling practices, as well as efforts to improve energy efficiency and carbon management (Lee & Min, 2015). Furthermore, the views expressed by (Lee et al., 2015) highlight the close link between environmental innovation and corporate investment in research and development (R&D).

Several studies have conducted research on R&D and carbon emissions disclosure, including (McWilliams & Siegel, 2000); (Cole et al., 2005); (Hull & Rothenberg, 2008)); (Dangelico & Pujari, 2010); (Triguero et al., 2013); and (Lee & Min, 2015). They explained that companies that have greater R&D activities generally experience lower pollution intensity because they have adopted environmental improvement programs that will increase the value of corporate social and environmental disclosures. However, (Padgett & Galan, 2010) did not find significant results in the non-manufacturing industries.

This research includes foreign ownership as a moderating variable. Foreign ownership is considered an entity that pays attention to issues related to social and environmental disclosure in companies. In the context of foreign ownership, there is a significant increase in pressure from management to implement Corporate Social Responsibility (CSR), which is supported by the finding of a positive relationship between survey responses in Carbon Disclosure Project (CDP) participation and the proportion of foreign ownership (Kim & Jung, 2019); (Jung & Kim, 2020). However, (Amran & Devi, 2008) and (Said et al., 2009) also noted insignificant results regarding foreign share ownership and CSR disclosure.

Based on the information above, it appears that the existence of R&D activities within a company can be a driving force for implementing environmentally friendly business practices, including in aspects of production, technology, and products. Furthermore, the presence of foreign ownership in the company will increase the influence of R&D intensity on carbon emissions disclosure. However, the results of previous studies showed inconsistencies, so this study tried to retest to achieve consistent results. Therefore, the research question asked is as follows: "Does R&D Intensity influence the extent of carbon emissions disclosure? Will foreign ownership strengthen the influence between R&D intensity and carbon emissions disclosure in Indonesia?".

Literature review

Natural Resource-Based View Theory (NRBV Theory)

According to the concept of Natural Resource-Based View (NRBV), companies, in response to environmental challenges and to ensure enduring success, should amass and manage resources with a focus on long-term objectives rather than solely pursuing short-term profits that may harm the environment. It is crucial for companies to possess the capability to plan sustainable technology and products to gain a competitive edge in the market (Lee & Min, 2015). The extended perspective of NRBV emphasizes the connection between environmental strategy, green capabilities, and corporate competitiveness (Hart, 2005); (Hart & Dowell, 2011). Specifically, NRBV contends that the long-term competitive advantage of organizations relies on their ability to use resources in a socially responsible manner through the development of proactive approaches to the environment, include sustainable development, product stewardship, and pollution control. An examination of the adoption of NRBV in research over the past fifteen years indicates a resurgence of strategic capabilities for sustainable development, classified into two main categories: clean technology and base of the pyramid capabilities (Hart & Dowell, 2011).

Carbon Emission Disclosure (CED)

Environmental reporting can be interpreted as a company's actions to convey information about environmental impacts arising from their activities, involving expanding the company's role in disclosing financial information by taking into account environmental aspects comprehensively (Rustam et al., 2019). In addition, environmental reporting also functions as a means for companies to inform stakeholders that the business activities and investment decisions they take have sustainable environmental considerations (Masud et al., 2018). Through environmental reporting, companies can build stakeholder trust, evaluate potential risks related to the implementation of business activities, and is considered a step to reduce negative environmental impacts resulting from company operations (Bhalla & Singh, 2018) and (Rustam et al., 2019). Carbon Emission Disclosure in the context of this research will be measured or defined using the assessment index developed by Choi (2013) which includes several important elements for assessing the extent to which disclosure information is adopted or developed based on guidance from the Carbon Disclosure Project (CDP) (Choi et al., 2013).

Research and Development (R&D)

Research and development (R&D) is considered a form of investment taken by companies to increase knowledge, with the aim of improving long-term performance and having a positive impact on company value through continuous improvement and innovation efforts, both in processes and products (Padgett & Galan, 2010). Apart from that, R&D also has the potential to increase company productivity (McWilliams & Siegel, 2000). This view is supported by various studies that show that R&D is not only a strategy for gaining a competitive edge, but it can also be used by businesses to optimize their business operations. Investments in R&D are also considered a means of achieving sustainable competitiveness, involving the allocation of resources and development of a company's capabilities for new products and services, processes, and technologies that can improve operational efficiency and reduce environmental impacts. In this way, a win-win situation can be created that combines improved financial performance and environmental sustainability of the company (Alam et al., 2019). The research from (Kabongo & Okpara, 2013)

also highlight that investment in environmental innovation through R&D can help companies overcome environmental challenges.

Foreign ownership

Foreign ownership is considered an entity that pays attention to social and environmental issues due to its exposure to foreign markets (Khan et al., 2013). According to (Lindrianasari et al., 2017) investors tend to evaluate a company's environmental performance, as measured by records of pollution or other environmental damage, relative to applicable regulations. The findings of (Tanimoto & Suzuki, 2005) also show that the presence of foreign ownership in public companies in Japan can encourage the adoption of the Global Reporting Initiative (GRI) in Corporate Social Responsibility Disclosure. Foreign investors differ from their domestic counterparts in terms of preference, familiarity, timing and degree of information asymmetry (Panicker, 2017). Foreign investors, with different preferences, familiarity, timing, and levels of information asymmetry from domestic counterparts, tend to prefer to invest in socially responsible companies. This is because engagement in Corporate Social Responsibility (CSR) is considered a strategy to reduce information asymmetry and risk (Al-Gamrh et al., 2020). Thus, multinational companies seek to adapt their business behavior to continue to legitimize their operations and maintain their reputation. For example, multinational or foreign-owned companies see the benefits of stakeholder legitimacy based on the market in which the company operates (home market), so that it can secure the company's long-term continuity or sustainability (Barkemeyer, 2007).

Methods

Population and sample

The population in this study includes all companies listed on the Indonesia Stock Exchange during the 2016-2019 period. Sample determination was carried out using a purposive sampling method, where companies that are listed on the Indonesia Stock Exchange, publish annual reports or sustainability reports on the Indonesia Stock Exchange website and disclose at least one item related to carbon emissions are selected as samples. Samples were taken from various categories of company sectors on the IDX to identify the proportion of carbon emissions disclosure over each sector. Purposive sampling was applied, and 2,394 observation data were collected over 2016 and 2019. According to 222 observation data that were not published in annual reports and sustainability reports have been eliminated from the data. Additionally, considering at least one policy in the company's annual report did not explicitly identify emissions, 1,650 observation data had to be eliminated from the sample. Thus, there are 522 observation data in the firm sample. The data used in this research was obtained from the Indonesian Stock Exchange website and/or the official website of each company.

Research variable

1. R&D intensity

In this research, RnD intensity refers to the definition from (Berrone et al., 2007) and (Lu et al., 2010), which measures research & development expenses as a percentage of a company's total assets.

2. Foreign Ownership

The foreign ownership variable in this study is measured by calculating the percentage of foreign share ownership in the company (Rustiarini, 2011).

3. Carbon Emissions Disclosure

Carbon emission disclosure was measured using an index developed by Choi et al. (2013), who used a checklist based on the Carbon Disclosure Project's (CDP) information request methodology. If the company discloses an item according to the stipulated rules, it will be given a score of one; if the expected item is not released, it will be given a score of zero.

Table1. Carbon Emissions Disclosure Index

Category	Items	Information
Climate change	CC1	Risks caused by climate change are assessed or described, along with the steps that have been or will be conducted to mitigate those risks.
	CC2	An assessment or explanation of the financial consequences, business results, and opportunities that climate change presents now and in the future
Calculation of GHG Emissions	GHG1	An explanation of the process used to measure and compute greenhouse gas emissions
	GHG2	The availability of independent verification when calculating GHG emissions
	GHG3	Total amount of greenhouse gases released
	GHG4	Transparency of GHG emissions in scopes 1 and 2, or scope 3.
	GHG5	Factors of GHG emissions published
	GHG6	Transparency of GHG facilities or areas
	GHG7	GHG emissions in comparison to the prior year

Category	Items	Information
Energy Consumption	EC1	Total amount of energy used
	EC2	Energy use from renewable sources quantified
	EC3	Type, facility, or segment disclosure
GHG costs and reductions	RC1	Comprehensive plans or tactics to minimize greenhouse gas emissions
	RC2	Level and year targets for minimizing greenhouse gas emissions
	RC3	Plans that minimize emission levels are currently leading to savings, cost accomplishments, and reductions in emissions.
	RC4	Calculated carbon that will be considered in capital planning in coming years
Carbon Emissions Accountability	acc1	A representation of the board committee in charge of taking action about climate change
	ACC2	An explanation of the procedures the board uses to assess the company's climate change initiatives

4. Control Variable

This study utilizes the control variable total assets which is approximated using the natural logarithm of total assets.

Data analysis

Descriptive and statistical analysis are applied in this study to acquire an overall overview of the sample observation data. Multiple regression analysis is one of the statistical techniques used to evaluate hypothesis 1, which is the relationship between R&D intensity and carbon emission disclosure (CED). The second hypothesis, which is that foreign ownership has a moderating effect on the interaction between R&D and CED, is next investigated using moderation regression. In order to fit this study model and provide more appropriate results, a separate regression analysis is used in the statistical analysis of hypotheses 1 and 2. In addition, the author tests the categorical dependent variable—which will be discussed in more detail—using logistic regression as part of further testing to validate the findings and increase their accuracy. The regression equation applied is as follows:

$$CED = \alpha+\beta1RnD+ \beta2TA \quad \text{.....(1)}$$

$$CED = \alpha+\beta1RnD+ \beta2FOROWN+ \beta3RnD*FOROWN+ \beta4TA+\varepsilon \quad \text{.....(2)}$$

CED	*Carbon Emissions Disclosure*
RnD	R&D intensity
FOWN	*Foreign Ownership*
RnD*FOROWN	Interaction between R&D Intensity and Foreign Ownership
α	*Cconstant*
β1, β2, β3, β4,	*Regression coefficient*
e	*Error*

The methods explain clearly how the author carried out the research. The method must describe the research design clearly, the replicable research procedures, describe how to summarize, and analyze the data.

Results

The research sample was 522 companies during 2016-2019. Data analysis was carried out using multiple regression and moderated regression using two equations to get good prediction results. The following are the results of data analysis.

Table 2. Descriptive Statistics Results

No.	Variables	Minimum	Maximum	Means	Deviation Std.
1	CED	0.0556	0.9444	0.3373	0.2169
2	RnD	0.0000	0.2111	0.0013	0.0133
3	FOROWN	0.0000	99.4768	25.9411	31.3445
4	TA (Ln)	24.7440	34.8871	29.9460	1.7241

Table 1 demonstrates that the disclosure of carbon emissions ranges from a minimum value of 0.0556, representing one disclosure item, to a maximum value of 0.9444, indicating 17 disclosure items. The average disclosure value is 0.3373, suggesting that Indonesian companies, on average, disclose six items. This relatively low value can be attributed to the absence of government regulations. However, Eagle High Plantation Ltd. is a non-service company; the majority of minimum value firms are in the trade, service, and investment sectors as well as the banking sector. This suggests that businesses in the service sector have not addressed environmental issues to the best of their abilities. This might also occur because, in contrast to businesses in the non-service sector, these organizations' operations do not directly interact with natural ecosystems. In addition, the descriptive analysis's findings show that concerned mining and industrial enterprises are about environmental issues, particularly those associated with carbon

emissions. This could be legitimate due to businesses in this industry have a significant environmental impact as a result of their operations.

Concerning R&D intensity, the minimum value is 0.000, the maximum is 0.2111, and the average is 0.0013. This suggests that Indonesian companies are currently not prioritizing the research and development aspect, particularly in green R&D focusing on sustainable environmental values. Table 1 shows that in 2017, PT Semen Indonesia (Persero) Ltd., a company in the basic industrial and chemical sector, possessed the largest value. In cases where compared to other nations that are already concerned about R&D, this value is still quite poor. That being stated, this suggests that Indonesian industrial and chemical businesses prioritize research and development because it is an essential component of maintaining or enhancing their company operations.Descriptive analysis of the R&D variable's results reveals that Indonesian corporations continue to give research and development (R&D) a low priority, particularly green R&D, which emphasizes sustainable environmental principles.

Considering a minimum value of 0.0000, the foreign ownership variable is owned by 64 firms out of the 133 sample companies, or 48.12% of the companies that do not have foreign ownership. This suggests that, in comparison to the number of companies in the sample, foreign ownership is still quite low in Indonesia, with a percentage value of nearly 50% for firms without foreign ownership. In terms of the overall percentage of foreign ownership across all sample companies, the basic and chemical industries have the highest proportion of foreign ownership (23.58%) when evaluated from each industrial sector. The reason for this is that the chemical and basic industries account for the majority of the enterprises in this study group. Next in order of importance are the industries of goods and consumption (18.11%), finance (15.86%), mining (15.48%), agriculture (8.79%), various industrial (8.67%), property, real estate, and building construction (3.38%), trade and investment (3.22%), and infrastructure, real estate, and building construction (2.92%). The basic industrial and chemical sector company PT Citra Tubindo Ltd. is the one with the highest value. This variable's highest possible value is extremely high, reflecting a high level of foreign ownership among several Indonesian enterprises. In any case, the data shows that a significant number of enterprises still have very little or no foreign ownership, and some even have none at all. This indicates that there is still a large disparity in the value of foreign ownership in Indonesia, which may be brought about by the limited number of international investors looking to fund Indonesian businesses.

Total assets as a control variable are proxied by the natural logarithm of assets, which have a minimum value of 24.7440 or IDR 55,741,701,528 and a maximum value of 34.8871 or IDR 1,416,758,840,000,000. then, the average value is 29.9460 or IDR 48,974,879,145,378. Within the basic industrial and chemical sectors, PT Krakatau Steel Ltd. is the business with the lowest value. Due to its extreme disparity from the average value of all corporate assets in Indonesia, this number is categorized as extremely low. In addition, the banking industry company PT Bank Rakyat Indonesia (Persero) Ltd. is the holder of the largest value.

Hypothesis test

After testing the hypothesis with two equations, the results of regression analysis were obtained using multiple linear regression for the first hypothesis and moderated regression for the second hypothesis. The results of hypothesis testing are as follows.

Table 3. Hypothesis Test Results

No.	Hypothesis	B	t	Sig.	Result
H1	The intensity of RnD has a positive effect on the extent of disclosure of carbon emissions	2.725	4.126	0.000	Supported
H2	Foreign ownership strengthens the influence between the intensity of RnD and the extent of disclosure of carbon emissions	0.016	0.692	0.489	Not supported

Based on the outcomes of statistical examinations concerning the first hypothesis, the regression coefficient is 2.725, indicating that each one-point increase in R&D intensity corresponds to a 2.725-point increase in the carbon emission disclosure score. The t-statistic is 4.126, with a significance of 0.000, which is below the 5% significance level (0.000 < 0.05). Consequently, the results of the regression analysis support the first hypothesis (H1). In essence, this study demonstrates that R&D intensity has a positive and significant impact on the disclosure of carbon emissions in Indonesia.

Regarding the second hypothesis, the obtained regression coefficient is 0.016, and the significance value is 0.489, exceeding the 0.05 threshold. This implies that the moderating variable, foreign ownership, does not enhance the relationship between R&D intensity and carbon emission disclosure (CED). The t-statistic is 0.692 with a significance of 0.489, which is greater than the 5% significance level (0.489 > 0.05). Consequently, the results of the regression analysis do not support the third hypothesis (H3). In other words, this study establishes that ownership does not strengthen the influence of R&D intensity on the disclosure of carbon emissions in Indonesian companies.

Robustness test

Additional testing in this research was carried out to see whether the company's disclosure of carbon emissions was bad news or good news. This means whether the company has really succeeded in reducing the level of emissions in its company with the efforts it has made. Additional tests in this research will be carried out using logistic regression analysis. The carbon reporting score is applied to assess the independent variable., which is carbon emissions disclosure. Next, a dummy variable is used to measure the dependent variable, which is either good or bad news. If

the company is still unable to reduce its emissions or does not provide disclosure explaining that it has reduced its emissions levels (bad news), it will be given a score of 0. Then, if the company reveals that it has succeeded in reducing its emissions levels (good news), it will be given a score of 0. value 1. Following are the results of additional testing with logistic regression analysis.

Table 4. Feasibility Test Model

Step	Chi-Square	Df	Sig
1	6.971	8	0.540

The regression model feasibility table (Goodness of Fit) above shows that the significance value of the Hosmer and Lemeshow Test is 0.540 > α = 5%. It is determined that the model is appropriate or practicable in describing the research variables when this value is significantly higher than 0.05.

Table 5. Overall Model Fit Test

-2 Log Likelihood	Itearation History
Block 0	711.222
Block 1	280.545
	430.677

Based on the overall model suitability test in table 5, the initial -2 Log Likelihood value which is a constant alone is 711.222 and the final -2 Log Likelihood value which is the value when adding the independent variable carbon emission disclosure to the model, the -2Log L value becomes 280.545 . From these results it can be seen that the -2 Log Likelihood value decreased by only 430.677. This shows that adding independent variables to the model can improve model fit.

Table 6. Coefficient of Determination Test

Step	-2 Log likelihood	Cox and Snell R Square	Nagelkerke R Square
1	280.545a	0.566	0.757

The Nagelkerke R Square value is 0.757, as indicated by the coefficient of determination test in Table 6. This indicates that 75.7% of the variability of the dependent variable can be accounted for by the variability of the independent variable, with variables outside of this study model accounting for the remaining 24.3%. Given that this figure is regarded as extremely high, it makes sense to continue testing this model.

Table 7. Hypothesis Test (Robustness)

Variable	B	Sig.
Carbon Emission Disclosure (CED)	21.453	0.000

The carbon emission disclosure (CED) variable has a positive coefficient of 21.453 with a significance level (p) of 0.00 (α = 5%), according to the results of the hypothesis test in Table 7. Therefore, further testing is needed to determine whether the company's disclosure of carbon emissions reflects supported good news. The results of this research prove that the company's disclosure of carbon emissions has a significant influence on the company's good news related to carbon emissions. The significance value in this additional test has the same value as the main test shown in table 4.17, namely 0.000.

These findings indicate that companies in Indonesia have participated in efforts to reduce carbon emissions, as mandated by the government to keep global temperatures below 20C or even 1.50C. Also, to fulfill Indonesia's commitment to reduce carbon emissions by 26 percent or approximately 0.67 Gt in 2020 (Asmaranti & Lindrianasari, 2014). This can be seen in the 522 companies observed, then after outlier data there were 516 companies from 2016 to 2019.

Of the 516 samples, it was found that 281 samples or 54.46% of the observations revealed that carbon emissions were good news for the company, meaning that it had succeeded in reducing the level of emissions in the company. Then, a total of 235 observation samples or 45.54% of companies that disclosed carbon emissions were bad news. This means that the company does not reveal that it has succeeded in reducing carbon emissions or the company reveals that it has not succeeded in reducing emissions, in other words that the company has a constant level of emissions from the previous year or has experienced an increase in the carbon emissions produced by the company.

This test found significant results, it can be seen that the greater the disclosure made by the company, the more likely it is to be good news. There is a significant positive relationship between carbon disclosure and carbon performance. This shows that the company's voluntary carbon disclosure in the Carbon Disclosure Project (CDP) shows the company's actual carbon performance. Apart from that, these results also confirm the signal theory that disclosure will create a good or bad signal to the public, so this disclosure is important for the company.

Discussion

RnD intensity has a positive effect on the extensive disclosure of carbon emissions

This study's findings support the principles of the natural resource-based view (NRBV), which states that in order to tackle environmental challenges and achieve long-term success, companies must identify resources and manage capabilities with a focus on long-term goals instead of short-term profits. This long-term commitment can be realized through the adoption of eco-innovation, specifically research and development (R&D), which aims to identify sustainable manufacturing techniques and technologies, increase energy efficiency, and support product innovation (Sambasivan et al., 2013). (Sambasivan et al., 2013). This finding is consistent with the findings of (Berrone et al., 2013), who found that R&D intensity can promote environmental innovation, particularly in pollution control initiatives aimed at protecting the environment by reducing or eliminating the use and manufacture of hazardous compounds. Furthermore, (Amores-Salvadó et al., 2014) stated that among types of technical environmental innovation, there are two forms, namely environmental process innovation and environmental product innovation. Environmental process innovation directs attention towards the environmental consequences arising from the product's utilization and disposal (such as emissions of CO2 or metals from batteries), rather than concentrating on the production phase. Conversely, when considering environmental product innovation broadly, it places greater emphasis on product use, highlighting specific aspects and practices linked to the overall life cycle of the product.

This research also supports the findings of (López-Gamero et al., 2009), which shows that initial investment and the intensity of environmental problems can influence the implementation of proactive environmental management, thereby improving environmental performance. This is reflected in the positive relationship between R&D intensity and CSR, which is reflected in a decrease in the level of environmental problems, including chemicals. More broadly, this research is consistent with findings from (Lee & Min, 2015), (Arora & Cason, 1996), (Cole et al., 2005), (McWilliams & Siegel, 2000), (Berrone et al., 2007), (Padgett & Galan, 2010), (Clarkson et al., 2011), (Huaman & Jun, 2014), and (Lindrianasari & Asmaranti, 2016) who found significant results between R&D and social and environmental disclosures. Moreover, the present investigation corresponds with by (Y.-J. Zhang et al., 2017), which affirms that environmental innovation substantially contributes to reducing carbon emissions in China from 2000 to 2013. Key factors such as energy efficiency, the economic impact of R&D, patent output rate, and informationization levels play crucial roles in mitigating carbon emissions, as indicated by this research and supported by (Alam et al., 2019), who demonstrates that RnD investment significantly and negatively influences both energy consumption and the intensity of carbon emissions. This research contradicts to (Dhaliwal et al., 2011) findings, which highlight that businesses operating in highly litigious industry have no influence on CSR disclosure. According to (Ghomi & Leung, 2013) and (Zhang et al., 2013), there was no discernible relationship between greenhouse gas declaration and business practices that have improved the environment. These findings were likewise deemed insignificant.These research findings carry significant policy implications for entrepreneurs, policymakers, and regulators, providing empirical evidence for the importance of R&D investment in enhancing energy efficiency and addressing carbon emissions.

Foreign ownership strengthens the leverage between rnd intensity and extent of disclosure of carbon emissions

Foreign ownership in Indonesia does not have a significant impact because foreign ownership in Indonesia is still low and the distribution is not evenly distributed. Only a small number of companies in Indonesia with high foreign ownership. Companies that have high foreign ownership do not necessarily have R&D activities in them, so this results in insignificant results. This study does not support the validity argument, which suggests that disclosure reflects community values and norms and legitimizes a business's existence. The study conducted by (Kim & Jung, 2019) did not support the findings of this research, which indicated that management is under more pressure to adopt CSR when there is foreign ownership. The results also demonstrate that decisions for carbon disclosure can be significantly influenced by foreign investors. Furthermore, this study contradicts the results of (Jung & Kim, 2020), who demonstrate a positive correlation between survey responses indicating participation in the Carbon Disclosure Project (CDP) and the percentage of foreign ownership. However, this research is in line with the findings of (Amran & Devi, 2008) which explains that there is no significant contribution from foreign ownership to CSR disclosure.

The findings of this research are supported by the results of previous research, as stated by (Said et al., 2009), (Amran & Haniffa, 2011), which show that foreign ownership has no impact on the level of social and environmental disclosure. This finding is also in line with research by (Garanina & Aray, 2021), which concluded that foreign ownership does not increase CSR disclosure because foreign share ownership in the company does not reflect the position of the controlling shareholder. These results indicate that foreign owners do not particularly prioritize CSR disclosure to the public, perhaps due to limited involvement in the company's long-term planning (Meutia et al., 2017). The implication is that regulations are found to regulate environmental aspects in Indonesian companies because foreign ownership in Indonesia does not show a significant impact on environmental disclosure. Therefore, companies are expected to have awareness of the urgency of environmental issues and manage them through internal regulatory arrangements. This is in accordance with the concept of regulatory theory, especially the public interest theory which states that the regulations implemented must be supportive and provide benefits for the entire community (Hantke-Domas, 2003). In this context, this includes regulations related to environmental improvement initiatives.

RnD intensity has a positive effect on the extensive disclosure of carbon emissions

This study's findings support the principles of the natural resource-based view (NRBV), which states that in order to tackle environmental challenges and achieve long-term success, companies must identify resources and

manage capabilities with a focus on long-term goals instead of short-term profits. This long-term commitment can be realized through the adoption of eco-innovation, specifically research and development (R&D), which aims to identify sustainable manufacturing techniques and technologies, increase energy efficiency, and support product innovation (Sambasivan et al., 2013). (Sambasivan et al., 2013). This finding is consistent with the findings of (Berrone et al., 2013), who found that R&D intensity can promote environmental innovation, particularly in pollution control initiatives aimed at protecting the environment by reducing or eliminating the use and manufacture of hazardous compounds. Furthermore, (Amores-Salvadó et al., 2014) stated that among types of technical environmental innovation, there are two forms, namely environmental process innovation and environmental product innovation. Environmental process innovation directs attention towards the environmental consequences arising from the product's utilization and disposal (such as emissions of CO2 or metals from batteries), rather than concentrating on the production phase. Conversely, when considering environmental product innovation broadly, it places greater emphasis on product use, highlighting specific aspects and practices linked to the overall life cycle of the product.

This research also supports the findings of (López-Gamero et al., 2009), which shows that initial investment and the intensity of environmental problems can influence the implementation of proactive environmental management, thereby improving environmental performance. This is reflected in the positive relationship between R&D intensity and CSR, which is reflected in a decrease in the level of environmental problems, including chemicals. More broadly, this research is consistent with findings from (Lee & Min, 2015), (Arora & Cason, 1996), (Cole et al., 2005), (McWilliams & Siegel, 2000), (Berrone et al., 2007), (Padgett & Galan, 2010), (Clarkson et al., 2011), (Huaman & Jun, 2014), and (Lindrianasari & Asmaranti, 2016) who found significant results between R&D and social and environmental disclosures. Moreover, the present investigation corresponds with by (Y.-J. Zhang et al., 2017), which affirms that environmental innovation substantially contributes to reducing carbon emissions in China from 2000 to 2013. Key factors such as energy efficiency, the economic impact of R&D, patent output rate, and informationization levels play crucial roles in mitigating carbon emissions, as indicated by this research and supported by (Alam et al., 2019), who demonstrates that RnD investment significantly and negatively influences both energy consumption and the intensity of carbon emissions. This research contradicts to (Dhaliwal et al., 2011) findings, which highlight that businesses operating in highly litigious industry have no influence on CSR disclosure. According to (Ghomi & Leung, 2013) and (S. Zhang et al., 2013), there was no discernible relationship between greenhouse gas declaration and business practices that have improved the environment. These findings were likewise deemed insignificant. These research findings carry significant policy implications for entrepreneurs, policymakers, and regulators, providing empirical evidence for the importance of R&D investment in enhancing energy efficiency and addressing carbon emissions.

Foreign ownership strengthens the leverage between rnd intensity and extent of disclosure of carbon emissions

Foreign ownership in Indonesia does not have a significant impact because foreign ownership in Indonesia is still low and the distribution is not evenly distributed. Only a small number of companies in Indonesia with high foreign ownership. Companies that have high foreign ownership do not necessarily have R&D activities in them, so this results in insignificant results. This study does not support the validity argument, which suggests that disclosure reflects community values and norms and legitimizes a business's existence. The study conducted by (Kim & Jung, 2019) did not support the findings of this research, which indicated that management is under more pressure to adopt CSR when there is foreign ownership. The results also demonstrate that decisions for carbon disclosure can be significantly influenced by foreign investors. Furthermore, this study contradicts the results of (Jung & Kim, 2020), who demonstrate a positive correlation between survey responses indicating participation in the Carbon Disclosure Project (CDP) and the percentage of foreign ownership. However, this research is in line with the findings of (Amran & Devi, 2008) which explains that there is no significant contribution from foreign ownership to CSR disclosure.

The findings of this research are supported by the results of previous research, as stated by (Said et al., 2009), (Amran & Haniffa, 2011), which show that foreign ownership has no impact on the level of social and environmental disclosure. This finding is also in line with research by (Garanina & Aray, 2021), which concluded that foreign ownership does not increase CSR disclosure because foreign share ownership in the company does not reflect the position of the controlling shareholder. These results indicate that foreign owners do not particularly prioritize CSR disclosure to the public, perhaps due to limited involvement in the company's long-term planning (Meutia et al., 2017). The implication is that regulations are found to regulate environmental aspects in Indonesian companies because foreign ownership in Indonesia does not show a significant impact on environmental disclosure. Therefore, companies are expected to have awareness of the urgency of environmental issues and manage them through internal regulatory arrangements. This is in accordance with the concept of regulatory theory, especially the public interest theory which states that the regulations implemented must be supportive and provide benefits for the entire community (Hantke-Domas, 2003). In this context, this includes regulations related to environmental improvement initiatives.

Conclusion

The purpose of this study is to investigate how foreign share ownership and research and development affect Indonesia's level of carbon emissions disclosure. This study is designed to investigate if research and development initiatives have taken the initiative to integrate green business practices into their respective organizations' operations. The company's disclosures, particularly the one on carbon emissions, which shows the company's performance, will show whether or not it has made an effort to improve the environment. Furthermore, it will enhance

environmental performance and make carbon emissions more widely disclosed if this is backed by a large foreign share ownership, which is a party that cares about enhancing the global environment.

The research findings indicate that the amount of R&D intensity has a positive and significant impact on carbon emissions disclosure in Indonesia. This means that the higher a company's degree of R&D intensity, the greater its disclosure of carbon emissions. Meanwhile, the foreign ownership variable has no substantial impact on improving the influence of R&D intensity on carbon emissions disclosure in Indonesia. However, this variable shows a positive, although not significant, regression coefficient on foreign ownership. This reflects that foreign ownership in Indonesia is generally limited (without controlling shares), so it has minimal influence on the company's long-term decisions.On the other hand, the control variable total assets show a positive and significant relationship with carbon emissions disclosure. In other words, the greater the assets a company owns, the higher the level of carbon emissions disclosure carried out by the company. This is because the company has sufficient additional funds to carry out this disclosure.

This research has several limitations, namely, it cannot differentiate whether research and development companies have implemented proactive method (pollution prevention, product management, and sustainable development). It would be better if regulations regarding the environment should be readjusted, considering that there are still a limited number of companies that implement green R&D practices in their companies. Then, in fact, companies that already have a research and development division still rarely disclose R&D costs separately from other costs. So, it is necessary to collaborate with the government and the accounting profession in creating standard standards so that companies have more freedom in disclosing R&D activities and the costs they incur in financial reports. Remembering this is very important for the sustainability of the company and is also important for legitimizing the company.

Acknowledgements

The researcher would like to thank all parties who have helped and provided support in completing this research.

Funding

This research did not obtain a specific grant from any funding entity, whether it be a public, commercial, or non-profit organization.

References

Alam, Md. S., Atif, M., Chien-Chi, C., & Soytaş, U. (2019). Does corporate R&D investment affect firm environmental performance? Evidence from G-6 countries. *Energy Economics*, *78*, 401–411. https://doi.org/10.1016/j.eneco.2018.11.031

Al-Gamrh, B., Al-Dhamari, R., Jalan, A., & Afshar Jahanshahi, A. (2020). The impact of board independence and foreign ownership on financial and social performance of firms: Evidence from the UAE. *Journal of Applied Accounting Research*, *21*(2), 201–229. https://doi.org/10.1108/JAAR-09-2018-0147

Amores-Salvadó, J., Castro, G. M., & Navas-López, J. E. (2014). Green corporate image: Moderating the connection between environmental product innovation and firm performance. *Journal of Cleaner Production*, *83*, 356–365. https://doi.org/10.1016/j.jclepro.2014.07.059

Amran, A., & Devi, S. S. (2008). The impact of government and foreign affiliate influence on corporate social reporting: The case of Malaysia. *Managerial Auditing Journal*, *23*(4), 386–404. https://doi.org/10.1108/02686900810864327

Amran, A., & Haniffa, R. (2011). Evidence in development of sustainability reporting: A case of a developing country. *Business Strategy and the Environment*, *20*(3), 141–156. https://doi.org/10.1002/bse.672

Arora, S., & Cason, T. N. (1996). Why Do Firms Volunteer to Exceed Environmental Regulations? Understanding Participation in EPA's 33/50 Program. *Land Economics*, *72*(4), 413. https://doi.org/10.2307/3146906

Asmaranti, Y., & Lindrianasari, L. (2014). Comparation of Greenhouse Gas Emission Disclosure Before and After Enactment of the Indonesia Act No. 17 of 2004. *Issues In Social And Environmental Accounting*, *8*(4), 225. https://doi.org/10.22164/isea.v8i4.95

Barkemeyer, R. (2007). Legitimacy as a Key Driver and Determinant of CSR in Developing Countries. *Paper for the 2007 Marie Curie Summer School on Earth System Governance*, 271–350.

Berrone, P., Fosfuri, A., Gelabert, L., & Gomez-Mejia, L. R. (2013). Necessity as the mother of 'green' inventions: Institutional pressures and environmental innovations: Necessity as the Mother of 'Green' Inventions. *Strategic Management Journal*, *34*(8), 891–909. https://doi.org/10.1002/smj.2041

Berrone, P., Surroca, J., & Tribó, J. A. (2007). Corporate Ethical Identity as a Determinant of Firm Performance: A Test of the Mediating Role of Stakeholder Satisfaction. *Journal of Business Ethics*, *76*(1), 35–53. https://doi.org/10.1007/s10551-006-9276-1

Bhalla, M., & Singh, I. (2018). COMPANY CHARACTERISTICS INFLUENCING WEB- BASED ENVIRONMENT DISCLOSURE- AN EMPIRICAL ANALYSIS OF SELECTED INDIAN MANUFACTURING COMPANIES. *International Journal of Social Science and Economic Research*, *03*(01). https://ijsser.org/more2018.php?id=15

Busch, T., & Hoffmann, V. H. (2011). How Hot Is Your Bottom Line? Linking Carbon and Financial Performance. *Business & Society*, *50*(2), 233–265. https://doi.org/10.1177/0007650311398780

Choi, B. B., Lee, D., & Psaros, J. (2013). An analysis of Australian company carbon emission disclosures. *Pacific Accounting Review*, *25*(1), 58–79. https://doi.org/10.1108/01140581311318968

Clarkson, P. M., Li, Y., Richardson, G. D., & Vasvari, F. P. (2011). Does it really pay to be green? Determinants and consequences of proactive environmental strategies. *Journal of Accounting and Public Policy*, *30*(2), 122–144. https://doi.org/10.1016/j.jaccpubpol.2010.09.013

Cole, M. A., Elliott, R. J. R., & Shimamoto, K. (2005). Industrial characteristics, environmental regulations and air pollution: An analysis of the UK manufacturing sector. *Journal of Environmental Economics and Management*, *50*(1), 121–143. https://doi.org/10.1016/j.jeem.2004.08.001

Dangelico, R. M., & Pujari, D. (2010). Mainstreaming Green Product Innovation: Why and How Companies Integrate Environmental Sustainability. *Journal of Business Ethics*, *95*(3), 471–486. https://doi.org/10.1007/s10551-010-0434-0

Department of Pollution Control and Technologies Technological Education Institute of Western Macedonia Kozani, Greece, Tsanaktsidis, C. G., Kiratzis, N., Tzilantonis, G. T., Sariannidis, N. S., Spinthiropoulos, K. G., & Department of Accounting and Finance Technological Education Institute of Western Macedonia Kozani, Greece. (2016, February 22). Variation of Density and Conductivity with mixtures of Diesel and Biodiesel (animal and vegetable) by analysis of variance using the linear regression and interpretation using mathematical equations. *5th Annual International Conference on Sustainable Energy and Environmental Sciences (SEES 2016)*. Annual International Conference on Sustainable Energy and Environmental Sciences. https://doi.org/10.5176/2251-189X_SEES16.31

Dhaliwal, D. S., Li, O. Z., Tsang, A., & Yang, Y. G. (2011). Voluntary Nonfinancial Disclosure and the Cost of Equity Capital: The Initiation of Corporate Social Responsibility Reporting. *THE ACCOUNTING REVIEW*, *86*(1), 59–100. https://doi.org/10.2308/accr.00000005

Garanina, T., & Aray, Y. (2021). Enhancing CSR disclosure through foreign ownership, foreign board members, and cross-listing: Does it work in Russian context? *Emerging Markets Review*, *46*, 100754. https://doi.org/10.1016/j.ememar.2020.100754

Ghomi, Z. B., & Leung, P. (2013). An Empirical Analysis of the Determinants of Greenhouse Gas Voluntary Disclosure in Australia. *Accounting and Finance Research*, *2*(1), 110–127. https://doi.org/10.5430/afr.v2n1p110

Hantke-Domas, M. (2003). The Public Interest Theory of Regulation: Non-Existence or Misinterpretation? *European Journal of Law and Economics*, *15*(2), 165–194. https://doi.org/10.1023/A:1021814416688

Hart, S. L. (2005). Innovation, Creative Destruction and Sustainability. *Research-Technology Management*, *48*(5), 21–27. https://doi.org/10.1080/08956308.2005.11657334

Hart, S. L., & Dowell, G. (2011). Invited Editorial: A Natural-Resource-Based View of the Firm: Fifteen Years After. *Journal of Management*, *37*(5), 1464–1479. https://doi.org/10.1177/0149206310390219

Huaman, R. N. E., & Jun, T. X. (2014). Energy related CO2 emissions and the progress on CCS projects: A review. *Renewable and Sustainable Energy Reviews*, *31*, 368–385. https://doi.org/10.1016/j.rser.2013.12.002

Hull, C. E., & Rothenberg, S. (2008). Firm performance: The interactions of corporate social performance with innovation and industry differentiation. *Strategic Management Journal*, *29*(7), 781–789. https://doi.org/10.1002/smj.675

International Panel on Climate Change. (2018). *IPCC Final Report Chapter1: Framing and Context*. IPCC.

Jung, Y.-K., & Kim, S.-H. (2020). Corporate Carbon Disclosure and Foreign Investor Participation in Korean Firms. *Korea International Trade Research Institute*, *16*(1), 95–112. https://doi.org/10.16980/jitc.16.1.202002.95

Kabongo, J. D., & Okpara, J. O. (2013). Environmental Performance: The Impact of R&D Intensity on Firms' Environmental Concerns. In J. O. Okpara & S. O. Idowu (Eds.), *Corporate Social Responsibility* (pp. 89–110). Springer Berlin Heidelberg. https://doi.org/10.1007/978-3-642-40975-2_6

Khan, A., Muttakin, M. B., & Siddiqui, J. (2013). Corporate Governance and Corporate Social Responsibility Disclosures: Evidence from an Emerging Economy. *Journal of Business Ethics*, *114*(2), 207–223. https://doi.org/10.1007/s10551-012-1336-0

Kim, S.-H., & Jung, Y.-K. (2019). Korean Corporate Ownership Structures, Agency Costs, and Social Responsibility Practices. *Korea International Trade Research Institute*, *15*(1), 1–23. https://doi.org/10.16980/jitc.15.1.201902.1

Lee, K.-H., & Kim, J.-W. (2011). Integrating Suppliers into Green Product Innovation Development: An Empirical Case Study in the Semiconductor Industry: An Empirical Case Study in the Semiconductor Industry. *Business Strategy and the Environment*, *20*(8), 527–538. https://doi.org/10.1002/bse.714

Lee, K.-H., & Min, B. (2015). Green R&D for eco-innovation and its impact on carbon emissions and firm performance. *Journal of Cleaner Production*, *108*, 534–542. https://doi.org/10.1016/j.jclepro.2015.05.114

Lee, K.-H., Min, B., & Yook, K.-H. (2015). The impacts of carbon (CO2) emissions and environmental research and development (R&D) investment on firm performance. *International Journal of Production Economics*, *167*, 1–11. https://doi.org/10.1016/j.ijpe.2015.05.018

Lindrianasari, L., & Asmaranti, Y. (2016). Investigative Studies on Environmental Disclosure and the Costs of R&D as a Compliance with Government Policy on Corporate Social Responsibility in Indonesia. *International Journal of Environment and Sustainability (IJES)*, *5*(2), 61–71.

Lindrianasari, L., Kufepaksi, M., & Asmaranti, Y. (2017). Environmental Asset, Environmental Quality, and the Number of Exports. *Review of Integrative Business and Economics Research*, *6*(2), 205–216.

Liu, Y., Zhou, Z., Zhang, X., Xu, X., Chen, H., & Xiong, Z. (2015). Net global warming potential and greenhouse gas intensity from the double rice system with integrated soil–crop system management: A three-year field study. *Atmospheric Environment*, *116*, 92–101. https://doi.org/10.1016/j.atmosenv.2015.06.018

López-Gamero, M. D., Molina-Azorín, J. F., & Claver-Cortés, E. (2009). The whole relationship between environmental variables and firm performance: Competitive advantage and firm resources as mediator variables. *Journal of Environmental Management*, *90*(10), 3110–3121. https://doi.org/10.1016/j.jenvman.2009.05.007

Lu, Y.-H., Tsai, C.-F., & Yen, D. C. (2010). Discovering important factors of intangible firm value by association rules. *The International Journal of Digital Accounting Research*, *10*. https://doi.org/10.4192/1577-8517-v10_3

Masud, Md. A. K., Nurunnabi, M., & Bae, S. M. (2018). The effects of corporate governance on environmental sustainability reporting: Empirical evidence from South Asian countries. *Asian Journal of Sustainability and Social Responsibility*, *3*(1), 3. https://doi.org/10.1186/s41180-018-0019-x

McWilliams, A., & Siegel, D. (2000). Corporate social responsibility and financial performance: Correlation or misspecification? *Strategic Management Journal*, *21*(5), 603–609. https://doi.org/10.1002/(SICI)1097-0266(200005)21:5<603::AID-SMJ101>3.0.CO;2-3

Meutia, I., Mukhtaruddin, M., Saftiana, Y., & Faisal, M. (2017). CEO's experience, foreign ownership and corporate social responsibility: A case of manufacturing companies. *Corporate Ownership and Control*, *14*(3), 377–392. https://doi.org/10.22495/cocv14i3c2art12

Padgett, R. C., & Galan, J. I. (2010). The Effect of R&D Intensity on Corporate Social Responsibility. *Journal of Business Ethics*, *93*(3), 407–418. https://doi.org/10.1007/s10551-009-0230-x

Panicker, V. S. (2017). Ownership and corporate social responsibility in Indian firms. *Social Responsibility Journal*, *13*(4), 714–727. https://doi.org/10.1108/SRJ-02-2017-0030

Rustam, A., Wang, Y., & Zameer, H. (2019). Does foreign ownership affect corporate sustainability disclosure in Pakistan? A sequential mixed methods approach. *Environmental Science and Pollution Research*, *26*(30), 31178–31197. https://doi.org/10.1007/s11356-019-06250-3

Rustiarini, N. W. (2011). Pengaruh struktur kepemilikan saham pada pengungkapan corporate social responsibility. *Jurnal Ilmiah Akuntansi Dan Bisnis*, *6*(1), 1–24.

Said, R., Hj Zainuddin, Y., & Haron, H. (2009). The relationship between corporate social responsibility disclosure and corporate governance characteristics in Malaysian public listed companies. *Social Responsibility Journal*, *5*(2), 212–226. https://doi.org/10.1108/17471110910964496

Sambasivan, M., Bah, S. M., & Jo-Ann, H. (2013). Making the case for operating “Green”: Impact of environmental proactivity on multiple performance outcomes of Malaysian firms. *Journal of Cleaner Production*, *42*, 69–82. https://doi.org/10.1016/j.jclepro.2012.11.016

Tanimoto, K., & Suzuki, K. (2005). CORPORATE SOCIAL RESPONSIBILITY IN JAPAN: ANALYZING THE PARTICIPATING COMPANIES IN GLOBAL REPORTING INITIATIVE. *Stockholm School of Economics, The European Institute of Japanese Studies*.

Triguero, A., Moreno-Mondéjar, L., & Davia, M. A. (2013). Drivers of different types of eco-innovation in European SMEs. *Ecological Economics*, *92*, 25–33. https://doi.org/10.1016/j.ecolecon.2013.04.009

Zhang, S., Patty, M., & Birt, J. (2013). Australian Corporate Responses to Climate Change: The Carbon Disclosure Project. *Journal of Accounting*.

Zhang, Y.-J., Peng, Y.-L., Ma, C.-Q., & Shen, B. (2017). Can environmental innovation facilitate carbon emissions reduction? Evidence from China. *Energy Policy*, *100*, 18–28. https://doi.org/10.1016/j.enpol.2016.10.005