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An exploration of sustainable innovation investment in emerging markets: An archival study

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ABSTRACT

This study aims to examine the relationship between asymmetric cost behavior and innovation of listed firms in emerging markets, i.e., listed firms in the Indonesian capital market. The Sustainable Development Goals (SDGs) topic has become a hot issue worldwide. Innovation, as a part of SDGs, is a prerequisite to reducing the carbon emissions in a country, including the listed firms on the Indonesian capital market. This study employs quantitative method. To investigate Indonesian-listed firms investment in innovation, we use innovation scores from Thomson Reuters to investigate the investment in innovation by the Indonesian-listed firms. This study utilizes multiple regression tests to examine the empirical model. Our study uses an asymmetric cost behavior model to examine the investment from the firms. We apply data panel to examine the model, i.e., the listed firms of Indonesian capital market during 2010-2019. The result is that innovation influences asymmetric cost behavior. This study also performs a robustness check regarding the empirical model. The result shows that the model is robust. We contribute to the literature on sustainability accounting and the literature on the capital markets. The implication of this study is to give investors information related to the development of sustainability in developing markets. The developing market is a promising investment for investors worldwide. This study also gives feedback to regulators related to the development of innovation in developing markets, particularly Indonesian capital market.

Contribution/Originality: This study examines the investment in innovation by the listed firms in developing markets. We investigate how environmental innovation is performed by the firms in developing countries based on the implementation of Sustainable Development Goals. Our study used the innovation score of Thompson Reuters to measure innovation performance of the firms.

1. INTRODUCTION

This study aims to investigate whether asymmetric cost behavior influences sustainable innovation of listed firms in Indonesian capital market. The concept of sustainable innovation suggests that the firms integrate the development of innovation with environmental, economic, and social objectives (Cillo, Petruzzelli, Ardito, & Del Giudice, 2019). The issue of sustainable innovation has been the focus of the stakeholders worldwide. But there are a few studies that examine the determinants of sustainable innovation. The previous studies have examined the sustainable innovation related to cross-country analysis (Doluca, Holzner, & Wagner, 2019), literature review approach(Cillo et al., 2019), Sustainable Development Goals (SDGs) framework (Fernández & Lucena, 2022) social enterprises (Harsanto, Mulyana, Faisal, & Shandy, 2022) market orientation and marketing capabilities (Kamboj &

Rahman, 2017) business model innovation (Kneipp, Gomes, Krugliankas, Motke, & Frizzo, 2021) appropriation mechanism (Morales, Flikkema, Castaldi, & de Man, 2022) and market-based capabilities (Weidner, Nakata, & Zhu, 2021). However, a few studies have examined the relationship between performance firms and sustainable innovation (Cillo et al., 2019). We were motivated to explore whether the firms invest in sustainable innovation, i.e., how the firms make an eco-friendly product to achieve the green profitability goal.

The concept of cost behavior states that costs behave according to the firm activities. It means that costs fluctuate with the magnitude of operational activities by the firms. There is the role of firm manager in deciding whether to invest or cut costs related to firm activities. The decision of the manager generated the asymmetry between the direction of costs and the fluctuation of sales predictions. The literature calls the pattern of costs asymmetric cost behavior (Banker & Byzalov, 2014). We predict that when the firms invest in sustainable innovation, the costs will change according to the future sales predictions. The decision manager is able to lead asymmetric cost behavior.

A number of prior studies have examined the association between asymmetric cost behavior[1] and the various factors. We divided the factors associated into three aspects, i.e., Economic, Country and Environmental, Social and Governance (ESG). First, the economic factors consist of conservatism appraisal (Banker, Basu, Byzalov, & Chen, 2016) competition features (Cheung, Kim, Kim, & Huang, 2018) earnings prediction error (Ciftci & Salama, 2018), issuance of profit estimates (Dai, Huang, & Yan, 2018), the gauge of sales change (Ciftci & Zoubi, 2019), the prediction of management (Chen, Kama, & Lehavy, 2019), labor adjustment cost (Golden, Mashruwala, & Pevzner, 2020), earnings quality (Martusa, Meythi, & Dharmawan, 2022), and stock price crash risk (Tang, Huang, Liu, & Wan, 2022). Second, the country factors comprise culture (Kitching, Mashruwala, & Pevzner, 2016), local government level (Cohen, Karatzimas, & Naoum, 2017), municipal setting (Bradbury & Scott, 2018), state ownership and socio-political factors (Prabowo, Hooghiemstra, & Van Veen-Dirks, 2018), and tax evasion (Xu & Zheng, 2020). Finally, the ESG factors are Corporate Social Responsibility (CSR)(Habib & Hasan, 2019), charity sector (Habib & Huang, 2019), institutional shareholder (Chung, Hur, & Liu, 2019) stakeholder orientation (Liu, Liu, & Reid, 2019), sustainability factors (Golden & Kohlbeck, 2020). But a limited study investigates the relationship between investment decisions of firm managers and sustainable innovation, i.e., eco-friendly designed products. The study uses listed firms in emerging market, essentially in Indonesian capital market.

The demands of sustainability practices have pressured business organizations worldwide, including Asia. In 2009, the Group of Twenty (G20) countries made a commitment to reduce carbon emissions at the Pittsburg summit in the USA (G20, 2009). As a member of G20, Indonesia released the SDGs program to develop the integration of economic, environmental, social, and governance in all areas, including the capital market. The Financial Services Authorities have issued the regulations of sustainable finance and sustainability reporting toward the listed firms in Indonesian capital market (OJK, 2017). The listed firms are driven by the regulation to perform a green business in their day-to-day operations. Therefore, this study predicts that the listed firms in Indonesian capital market will invest in environmental, social, and governance innovation, essentially sustainable innovation. However, will the firms invest in sustainable innovation? Do changes in the magnitude of investments lead to asymmetric cost behavior?

The previous study stated that the stream of studies on sustainable innovation topics can be classified by three perspectives, i.e., internal-managerial perspective, external-relational perspective, and performance evaluation perspective (Cillo et al., 2019). But there are few studies to investigate sustainable innovation based on performance evaluation. This study uses innovation score as one of the categories in the environmental score to measure the eco-performance of the firm. We intend to verify how much the firm decides to invest in its strategic resources based on

[1]The concept of asymmetric cost behavior consists of sticky and anti-sticky cost, but we use asymmetric cost behavior in this study to substitute sticky cost for consistency.

sustainable innovation. Based on asymmetric cost behavior model, our study examines whether the managers of the firms decide to invest in the sustainable innovation. Certainly, if managers invest the resources in sustainable innovation, they will retain slack resources as the sales decrease. It leads to asymmetric cost behavior. If the firms invest to more Environmental Social and Governance (ESG) expenditure, they will adjust their resource costs more, which will lead to asymmetric cost behavior (Golden & Kohlbeck, 2020).

This study utilizes an asymmetric cost behavior model to measure how much firms invest in resources related to sustainable innovation. This study employs an innovation score from Thompson Reuters to quantify how well the firms perform in innovation. The findings of our study show that the association between sustainable innovation and asymmetric cost behavior in emerging markets is supported. We also check the robustness of empirical model from this study according to study of Habib and Hasan (2019). The result indicates that the model is robust enough to examine this study.

This study extends the literature on sustainable innovation as follows: First, this study investigates the sustainable innovation of the listed firms in relation to the emerging countries, particularly Indonesia. Second, this study examines the sustainable innovation of the firms in related to the SDGs program. Third, this study describes the efforts of the G20 countries, particularly Indonesia, to reduce carbon emissions as a part of their commitment to the United Nations program (Bebbington & Unerman, 2018). This study also contributes to literature on asymmetric cost behavior in relation to the sustainability factors (Golden & Kohlbeck, 2020) and CSR (Habib & Hasan, 2019).

This study is divided into three sections to investigate the association between sustainable innovation and asymmetric cost behavior. The literature review and hypothesis development section explores the previous studies that have examined sustainable innovation and asymmetric cost behavior. The section also delves into the concepts of signaling and stakeholder theory, which are crucial in developing our hypothesis. Both theories collaborate with the prior studies to build an argument supporting the hypothesis. The method section describes the empirical model of this study. Certainly, the dependent and independent variables are used in this study. We also show how to select our samples. The next section will analyze the results of this study and discuss the relationship between the results and the prior literature. The last sections conclude the result of this study and the contribution to the literature and the practices.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

The concept of business sustainability is a hot topic internationally. But the concept is not only branding and greenwashing from the firms. In the last decade, stakeholders have required sustainability as a strategic imperative of the business firms worldwide. The sustainable innovation perspective has been an important issue among the firms, investors, creditors, government, customers, and society. A study by Cillo et al. (2019) stated that there are three research frameworks related to sustainable innovation. The frameworks comprise internal-managerial, external-managerial, and performance evaluation.

In mixed frameworks, i.e., internal and external managerial, Doluca et al. (2019) perform exploratory analysis to examine whether time-, country-, industry-specific differences influence the relationship between corporate sustainability and environmental innovation. The study has given empirical evidence that management systems and country effects influence sustainable innovation activities. They employed a data survey from European Business Environment Barometer in 2001 and European Business Sustainability Barometer in 2016. The samples of study are manufacturing firms in Germany and the United Kingdom. The study compares the development of sustainable innovation among the firms over the past fifteen years in two European countries. There are three environmental activities that were added recently in 2016 in the both German and United Kingdom firms. The activities are biodiversity conservation, biodiversity restoration, and emissions offsetting.

Furthermore, they also observe the differences between Germany and the United Kingdom regarding environmental operational activities. The firms in Germany tend to focus on efficient products, but the firms in the United Kingdom focus on recycling. Yet both German and United Kingdom firms have similar trend in which the firms tend to increase in performing processes and product environmental. Therefore, on average, the firms in Germany and the United Kingdom adopted environmental managerial activities rather than environmental operational activities. But the average German firms took up more environmental managerial activities than the average United Kingdom firms.

In the case of eco-labels, the firms of Germany have an upper trend than the firms of the United Kingdom in terms of adoption level. However, the German firms use more environmental performance indicators and drive suppliers to employ environmental activities, while the United Kingdom firms push for the integration of environmental data into the annual report. Afterwards, in both countries, the size of the firms correlated with the increasing trend of sustainability and environmental innovation. During the past fifteen years, there has been a rising trend for small and medium-sized firms to utilize environmental management activities. Based on external-managerial framework, the German firms have a higher level of collaboration with suppliers and customers than the British firms do in environmental innovation. But in social activities; the firms in both countries have the same level of treatment for employees. Yet the British firms tend to focus more on child care support than the German firms.

A study by Fernández and Lucena (2022) highlighted that sustainable innovation is a part of sustainability development goals that are pronounced by the United Nations towards the countries worldwide. Based on Sustainability Development Goal 9, the study showed that there are two important things that are done by academics and industrial firms related to sustainable innovation. The enhancement of scientific research and the upgrading of technological capabilities should be done in developing countries. Therefore, the regulator should support the policy of technological development, research, and innovation. Finally, how do firms in developing countries build sustainable innovation to faces pandemic Covid-19.

The previous study suggested that sustainable innovation could be practiced by social enterprises (Harsanto et al., 2022). The enterprises provide scholarships for students and provide social services for the surrounding communities. The study employs qualitative method with semi-structured interview with respondents. The respondents come from social enterprises in the education sector in Indonesia. The prior study examined the association among market orientation, marketing capabilities, and sustainable innovation that is mediated by sustainable consumption and competitive advantage (Kamboj & Rahman, 2017). The study divided the concept of marketing capabilities into product development, communication, channel linking, and pricing. The study also separated the concept of sustainable innovation into technical innovation and non-technical innovation. The study found the relationship between variables to be the following: First, there is the relationship between market orientation and market capabilities. Second, product development affects technical innovation. Third, the impact of channel linking capabilities on technical innovation is significant. Fourth, pricing capability influences non-technical innovation. Fifth, the effect of non-technical innovation on sustainable consumption. Sixth, technical and non-technical innovations have a competitive advantage for firms. Overall, they also found that the relationship between sustainable innovation and competitive advantage is partially mediated by market capabilities. The study screens the financial and services firms in India based on sales and revenue data, including those in the top Fortune India 500 list. They perform surveys for marketing managers in the firms. The managers are sent a questionnaire on a five-point Likert scale.

The study by Kneipp et al. (2021) stated that the firms that have high level of innovation in their business perspectives invest in strategic sector of sustainable innovation. They utilize 256 firms that originate from the Brazilian National Association of Research and Development of Innovative Companies and respondents to MERCOPAR (Latin America's subcontracting and industrial innovation fair). The questionnaire comprises closed questions and employs an interval scale that shows the agreement of respondents with sustainable innovation

practices performed by the firms in a range between 1 (lower level of agreement) and 5 (maximum level of agreement) and in relation to the level of innovation in firms' business perspectives in the range between 1 (incremental) and 10 (radical). The category of firms in the study is a micro-, small-, and medium-sized enterprises (SMEs) in Brazil.

Prior studies have analyzed the association between appropriation mechanisms of informal and formal and commercial success of sustainable innovation in small-, medium-sized enterprises (Morales et al., 2022). The result finds that appropriation mechanisms are related to the commercial success of sustainable innovation in small- and medium-sized enterprises. The appropriation mechanisms, as independent variables, consist of patent, trademark, secrecy, confidentiality agreement, lead time advantage, and complexity, and then the study measures extended possibilities of new service performance as dependent variable. They use samples of two competitions for sustainable innovation in Netherlands, i.e., the Blue Tulip Awards and the Innovation Top 100. The potential respondents to the study are sent questionnaires via email and phone.

The study by Weidner et al. (2021) also examined the relationship between antecedents and consequences for sustainable innovation. The antecedents of sustainable innovation comprise market-based sustainability, public ownership, organizational learning, and organizational unlearning. Whereas the consequences of sustainable innovation consist of triple-bottom lines, i.e., environmental, social, and economic performances from the firms. Thus, the implementation of sustainable innovation for firms is affected by their capabilities. But the capabilities of the firms are contingent on public ownership, organizational learning, and unlearning. Because the firms with public ownership are more exposed to stakeholders than those with private ownership. Therefore, the organizational learning led the firms to study the turbulence that stakeholders demand from the organization. The firms are able to invent a new way according to their relationship with the stakeholders. However, the firms are also able to choose not to learn about the relationships among stakeholders. The option of learning or unlearning an organization impacts the implementation of sustainable innovation for firms. Finally, the outcome of sustainable innovation for the firms is triple-bottom lines because the outcome must meet its stakeholders, i.e., environmental, economic, and social.

International society has demanded that businesses reveal the impact of their economic activity on environmental and social The scholars declare that the business firms in the capital market, which get capital from public society should disclose the impact of their economic activities toward Environmental, Social, and Governance (ESG), which affect the surrounding communities (Rezaee, Tsui, Cheng, & Gaoguang, 2019). The firms disclose that their operational businesses have implemented sustainable innovation, as an information signal, to their stakeholders (Connelly, Certo, Ireland, & Reutzel, 2011).

Signaling theory suggests that when there is asymmetry in information between investors and firms in capital market, the firms deliver credible information to the stakeholders (Hahn & Kühnen, 2013). The firms that implement sustainable innovation tend to invest in Economic, Environmental and Social aspects. This study analogizes the firms that are able to disclose the information about their investments in sustainability and innovation to the stakeholders. Consequently, the stakeholders will choose the firms that invest in sustainable innovation.

The listed firms worldwide and Asia in particular have demanded to integrate ESG issues into their operational businesses while focusing on sustainable finance (Rezaee et al., 2019). The literature on sustainable innovation suggests that there are three perspectives that relate to sustainable innovation in firms, i.e., internal-management, external-relation, and performance evaluation (Cillo et al., 2019). Based on performance evaluation approach, the firms are able to achieve economic and sustainable advantages through the cooperation with the parties who stake in the organization (Rauter, Globocnik, Perl-Vorbach, & Baumgartner, 2019).

The literature on asymmetric cost behavior suggests that the asymmetric cost behavior is affected by economic factors (Anderson, Banker, & Janakiraman, 2003), local government level (Cohen et al., 2017), management's

issuance of earnings forecasts (Dai et al., 2018), tax avoidance (Xu & Zheng, 2020) board characteristics (Ibrahim, 2018) and competition factors (Cheung et al., 2018) the magnitude of sales change (Ciftci & Zoubi, 2019), corporate social responsibility (Habib & Hasan, 2019), the charity sector (Habib & Huang, 2019), institutional investors (Chung et al., 2019) and sustainability factors (Golden & Kohlbeck, 2020). In asymmetric cost behavior concept, the managers of the firms decide to invest in committed resources, but they must adjust the cost of the resources based on the stochastic nature of sales demand (Anderson et al., 2003). The firms have initiatives in ESG that lead to the high adjustment cost (Golden et al., 2020). This study hypothesizes that the firms that invest ESG in strategic resources have asymmetric cost behavior.

The studies of sustainable innovation stated that there are factors that influence sustainable innovation, i.e., enterprise characteristics (Wei, Li, Liu, & Du, 2022) SDGs (Fernández & Lucena, 2022), industrial transformation and upgrading (Wang, Xu, Zhou, & Cheng, 2022), innovation of business model (Kneipp et al., 2021), market orientation, and marketing capabilities (Kamboj & Rahman, 2017). In emerging countries, innovation technology relates to management innovation (Henao-García & Montoya, 2021). But study by Cillo et al. (2019) described the firms were able to integrate economic and sustainable innovation (Cillo et al., 2019). One of factors that affect sustainable innovation is the Sustainable Development Goals.

As members of G20, Indonesia applies the Sustainable Development Goals program to the various sectors, particularly listed firms in the capital market. In terms of economic factors, earnings quality influences asymmetric cost behavior in the listed firm of Indonesian Capital Market (Martusa et al., 2022). Based on the regulation of Indonesia Financial Services Authorities (OJK, 2017) this study expected that the listed firms of Indonesia would also invest in ESG voluntarily. Therefore, the listed firms that apply sustainable innovation to committed resources have asymmetric cost behavior. Based on above argument, the following hypotheses are advanced in this study:

H_1: Sustainable innovation is associated with asymmetric cost behavior.

3. METHOD

This study employs the purposive sampling method. The population of this study is the listed firm of Indonesia Capital Market during 2010-2019. We begin with an initial sample of 7500 firm-year observations from 2010-2019, provided from Thomson Reuters database. This study screens the sample data observed based on the innovation scores, the value of revenue, earnings before extraordinary items, operating income after depreciation. After we decrease the data observed that do not have the innovation scores and the financial value, we get 7250 firm-year observations. Finally, the total of our data is 250 firm-years. We utilize the panel data to investigate our hypotheses.

This study uses archival technique to examine our empirical model. The model employs regression test to examine our panel data. The empirical model to measure asymmetric cost behavior of the observation firm-year according to the model is used in the study of Habib and Hasan (2019) as the following.

$$ln\frac{OC_{i,t}}{OC_{i,t-1}} = \gamma_0 + \gamma_1 ln\left[\frac{R_{i,t}}{R_{i,t-1}}\right] + \gamma_2 DD_{i,t} \times ln\left[\frac{R_{i,t}}{R_{i,t-1}}\right] + \varepsilon_{i,t} \quad (1)$$

The equation model (1). OC is sales revenues minus earnings before extraordinary items for firm i in year t. Sales revenue (Ri,t) is employed in this study as a proxy for firm i in year t. This study also assumes that operating costs, which include expenses related to innovation, fluctuate according to the changes in sales. When year t of sales revenue is less than year t-1 of sales revenue, Decrease Dummy ($DD_{i,t}$) is 1, otherwise it is 0. For every 1% rise in sales revenue, coefficient 1 shows the percentage increase in operating costs (OC). The total coefficients ($\gamma_1+\gamma_2$) show the percentage drop in OC resulting from a 1% drop in sales revenue. Asymmetric cost behavior is confirmed by a positive coefficient for $\gamma 1$ and a negative value for γ_2.Habib and Hasan (2019) use the asymmetric cost behavior model to investigate Corporate Social Responsibility activities that are performed by the firms. With the same

model, this study investigates sustainable innovation activities and is performed in the firms. The differences are study of Habib and Hasan (2019) are done in developed country and this study is performed in developing country.

This study uses an innovation score from Thomson Reuter's database. The scores measure sustainable innovation related to environmental and green revenue. Thomson Reuters is a corporate social responsibility database that gives valuable information to the stakeholders of the firms (De Villiers, Jia, & Li, 2022). This study splits the firms according to their innovation scores. Based on the average scores, we divide the firms into two groups. The firms that score less than the mean innovation score are included in the low sustainable innovation group, and the others are included in the high sustainable innovation group. Afterwards, this study examines both of the groups employing an asymmetric cost behavior model, respectively. The last, result of both groups would be a t-test for comparing coefficients across regression according to equation model from study of Clogg, Petkova, and Haritou (1995) as follows:

$$z = \frac{(\gamma_1 - \gamma_2)}{\sqrt{SE_1^2 + SE_2^2}} \qquad (2)$$

Where SE_1^2 and SE_2^2 are the standard errors of the squared regression coefficients from each sample groups and γ_1 and γ_2 are the regression coefficients of each sample group. The equation model is employed in this study to examine whether there are differences in asymmetric cost behavior levels between the low sustainable innovation group and high sustainable innovation group.

4. RESULT AND DISCUSSION

4.1. Descriptive Statistics and Correlation Analysis

Table 1 shows descriptive statistics of the variables used in the association between sustainable innovation and asymmetric cost behavior. The variables consist of operating costs, sales revenue, and asymmetric cost behavior. We use mean, median, quartiles 1 and 3 and observation numbers.

Table 1. Descriptive statistics.

High sustainable innovation					
Variables	**Mean**	**Median**	**Quartile 1**	**Quartile 3**	**Numbers**
Operating cost	0.004	-0.013	-0.064	0.080	140
Sales revenue	-0.018	-0.013	-0.070	0.049	140
Asymmetric cost behavior	-0.020	0	0	0	140
Low sustainable innovation					
Variables	Mean	Median	Quartile 1	Quartile 3	Numbers
Operating cost	-0.026	-0.021	-0.111	0.051	110
Sales revenue	-0.026	-0.020	-0.096	0.037	110
Asymmetric cost behavior	-0.018	0	0	0	110

The mean and median values of operating cost and sales revenue variables have a slightly range for the both high sustainable innovation and low sustainable innovation. This shows that the distribution of the variable values for the both is normal. On the other hand, the mean and median values of asymmetric cost behavior are very close to zero. The values describe the relatively balanced distribution of firms with negative and positive sustainable innovation performance.

The result of correlation analysis of the variables used is provided in Table 2. According to the result, all of the variables have significant correlation values at conventional level. Overall, there is a significant positive correlation among the variables, i.e., operating costs, sales revenue, and asymmetric cost behavior. We removed the extreme values observed from the estimation by using interquartile range method, according to the study of Vinutha, Poornima, and Sagar (2018). This study excludes the values observed when they are below the lower and upper

bounds of interquartile formula. All variables also comply with the classical assumption test. Thus, this study states that the values of all variables observed are the best linear unbiased estimations.

Table 2. Correlation analysis.

High sustainable innovation			
Variable	**Operating cost**	**Sales revenue**	**Asymmetric cost behavior**
Operating cost	1.000	0.733**	0.391**
Sales revenue	0.733**	1.000	0.594**
Asymmetric cost behavior	0.391**	0.594**	1.000
Low sustainable innovation			
Variable	Operating cost	Sales revenue	Asymmetric cost behavior
Operating cost	1.000	0.845**	0.452**
Sales revenue	0.845**	1.000	0.521**
Asymmetric cost behavior	0.452**	0.521**	1.000

Note: **ρ< 0.01 (One tailed).

4.2. Result and Robustness Test

Table 3 provides the result of regression test regarding the impact of sustainable innovation on asymmetric cost behavior. The regression results show that the changes in operating costs related to the changes in sales revenue are significant at 0.05 percent in both samples, i.e., high sustainable innovation and low sustainable innovation. Based on the high sustainable innovation sample, the predicted value of γ_1= 0.943 with a t statistic of 14.417 shows that operating costs rose 0.94% per 1% growth in sales revenue. Then, based on the low sustainable innovation sample, the predicted value of γ_1= 0.955 with a t statistic of 13.808 indicates that operating cost increased by 0.96% per 1% increase in sales revenue. However, the values of interaction, i.e., asymmetric cost behavior, are not supported in both the samples. Based on the high sustainable innovation sample, the predicted value of γ_2= -0.139 with a t statistic of -1.281. But based on the low sustainable innovation sample, the predicted value of γ_2= 0.035 with a t statistic is 0.274. Although the predicted values of both samples are not supported but the sign of the value from high sustainable innovation and low sustainable innovation samples is different. The predicted value of a High Sustainable Innovation sample denotes negative sign, but the other predicted value indicates a positive sign. Moreover, the result of the Z test indicates that there are significant differences between the both groups regarding the values of asymmetric cost behavior. The value of -2.123 > 1,651 (t table) indicates that the differences between two samples are significant at 0.05. This means that even though the investment in sustainable innovation by the firms is small, there are differences in investment between the firms that invest heavily and the firms that invest less.

Table 3. Result.

Variable	**Operating cost**	
	High sustainable innovation	**Low sustainable innovation**
Sales revenue	0.943** (14.417)	0.955** (13.808)
Asymmetric cost behavior	-0.139 (-1.281)	0.035 (0.274)
Constanta	0.009 (1.568)	-0.001 (-0.106)
Observation	240	110
Adjusted R squared	0.536	0.709
Z tests	-2.123**	

Note: Robust t statistics in brackets. **ρ< 0.01 (One tailed).

This study also applies a robustness test to the empirical model in Table 4.This test examines the same empirical model, as before, but this test uses a different version to measure operating costs, i.e., sales revenues

subtract operating incomes after depreciation. The predicted values of both samples, i.e., high sustainable innovation and low sustainable innovation, are γ_1= 0.830 with a t statistic of 11.398 and γ_1= 0.845 with a t statistic of 9.735. These results for both samples are significant in conventional terms. However, the predicted values of the interactions from the both samples are not supported. But there are the differences in sign between the predicted values of both high sustainable innovation and low sustainable innovation samples. The result of the test is consistent with the result of empirical model above. So, we conclude that the empirical model of this study is robust.

Table 4. Robustness test.

Variable	Operating cost	
	High sustainable innovation	**Low sustainable innovation**
Sales revenue	0.830** (11.398)	0.845** (9.735)
Asymmetric cost behavior	-0.162 (-1.340)	0.050 (0.313)
Constanta	0.007 (1.071)	0.003 (0.417)
Observation	240	110
Adjusted R^2	0.411	0.549
Z Tests	-1.061*	

Note: Robust t statistics in brackets. **ρ< 0.01 (One tailed); *ρ< 0.05 (One tailed).

4.3. Discussion

This study explores the association between sustainable innovation and asymmetric cost behavior. We intend to investigate whether the firm's investment in sustainable innovation causes asymmetric cost behavior. Even though the studies of sustainable innovation are growing, the literature can be grouped into three perspectives, i.e., internal-managerial, external-relational, and performance evaluation (Cillo et al., 2019). One perspective stated that there is a relationship between the management capabilities (Barney, 1991; Teece, 1998; Wernerfelt, 1995) and sustainable innovation implementation. The later perspective holds that the role of stakeholder involvement (Freeman, 1984) is related to the application of sustainable innovation. The other view declares that the firms that perform innovation, sustainable innovation, and non-financial disclosure are respected by the market, and in turn, enhance in value. Because the firms give a signal to the stakeholders that they perform better in sustainable innovation than the other firms (Connelly et al., 2011).

Among the three perspectives above, there are few studies that investigate sustainable innovation related to performance (Cillo et al., 2019). Because of this, it is important to explore whether the firms invest their resources according to sustainable innovation. The concept of cost behavior able to describe the patterns of sustainable innovation investment. Thus, the concept states that changes in sustainable innovation are proportionate to changes in activity. But in actuality the patterns of sustainable innovation investment are likely to be complicated. Because sustainable innovation involves the commitment of resources by firms related to long-term investment. As a result, the firms will signal to the stakeholders that they have better performance than the others.

This study argues that when a manager decides to invest in sustainable innovation costs, the manager adjusts the resources to the fluctuation of sales demand. But the managers will not cut the investment when the sales demand decreases. However, the managers will add the investment when the sales demand recovers. So, the managers retain the sustainable innovation investment when the sales demand falls but they will develop the investment when the sales demand climbs. Furthermore, the managers must manage the slack resources, and lastly, it is likely to have asymmetric cost behavior.

Employing innovation score of Thompson Reuters database, this study indicates that the cost of sustainable innovation reveals that there is a differences between the firms that have high sustainable innovation investment and the firms that have low investment. The firms that have most high investment are getting close to asymmetric

cost behavior, but others do not. This shows that the sustainable innovation involvement of listed firms in emerging markets, particularly Indonesian capital market, is still low. This result is highlighted by the study by Loh and Thomas (2018) in which the listed firms of Indonesia have the lowest score in related sustainability among the ASEAN countries.

This study also gives empirical evidence that there are two groups of the firms related to investment in sustainable innovation in emerging market. The first group is the firms that have high sustainable innovation performance. The second group is the firms that have low sustainable innovation performance. Although the results of regression tests between two groups are not statistically significant, there are significant differences between the two groups. The first group shows that even though the finding is not supported, the sign of coefficient is negative. Based on sustainable innovation, this indicates that the high-performance firms have invested in it, but it is a preliminary level. However, the low-performance firms have not yet invested. This result indicates that the high-performance firms provide signal to the stakeholders that they perform better than the other firms. The result of this study is different from prior studies in developed countries (Golden et al., 2020; Habib & Hasan, 2019; Weidner et al., 2021).

We argue that even though the average development of sustainability performance in Indonesia lower than that the other ASEAN[2] countries (Loh & Thomas, 2018) there is a progression of the investment in sustainability, including sustainable innovation. The Financial Services Authorities of Indonesia have regulated sustainable finance and sustainability reporting for the listed firms in Indonesia (OJK, 2017). As a result, although not all of the Indonesia listed firms have invested in sustainable innovation yet, there are several firms that have already invested in it.

The findings of this study imply that the public firms of Indonesia are prepared to compete in sustainable innovation worldwide. Even the government has integrated the blue and green program (environmental) with digital economics to support not only the listed firms of capital market but also small and medium enterprises. The government also released the program to facilitate collaboration between the academics of university and the firms to develop sustainable innovation. In the future, Indonesian firms will be ready for sustainability competition across the business firms in the worldwide.

5. CONCLUSION

This study examines the association between sustainable innovation and asymmetric cost behavior. We use innovation scores of Thompson Reuters database to measure the performance of the firms related to environmental innovation. This study also employs an asymmetric cost behavior model to quantify investment of the firms in sustainable innovation. This study finds that overall, sustainable innovation influences asymmetric cost behavior and is not supported. However, the findings partially indicate that some firms have made investments in sustainable innovation, albeit at a preliminary stage. Although the average, sustainability performance of Indonesian firms is lower than that of the firms in other countries in ASEAN (Loh & Thomas, 2018) there is a development in sustainability according to the implementation of sustainability development goals in the Indonesian capital market.

This study contributes to the literature on sustainable innovation and asymmetric cost behavior. This study also extends the concept of asymmetric cost behavior to relate to sustainability factors, particularly in emerging countries. Our study uses signaling theory to explain performance of the firms related to sustainable innovation. The limitation of this study is that only few firms have an innovation score in the emerging market, particularly in the Indonesian capital market. So, we only investigate few of the firms in terms of sustainable innovation

[2]ASEAN or Association of South East Asia Nations are the organizations of geopolitics and economy from the countries of south east region, i.e. Brunei Darussalam, Burma, Cambodia, Indonesia, Laos, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

performance. This study suggests that future studies will be able to investigate sustainable innovation in the disclosures of the firms, i.e., sustainability reporting. In the future, the study will also be able to investigate sustainable innovation in an internal-managerial or external-relational framework in relation to asymmetric cost behavior.

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