

Article

Does Sustainability Affect Corporate Performance and Economic Development? Evidence from the Asia-Pacific Region and North America [†]

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Abstract: This paper explores how sustainability influences financial returns and economic development in the Asia-Pacific region and North America, utilizing real data empirically. It is controversial that sustainable activities are related to financial performance. For clarification, we tested hypotheses analyzing sustainability index, seven stock markets, financial data such as ROI, ROIC, and ROA from eleven companies, and GDP/GNI per capita, based on the Asia-Pacific region and North America. The results indicate that both financial return for companies and economic development in the two regions are positively germane to sustainable investment. Besides, we found evidence that sustainable investment impacts economic development based on variance decomposition analysis, depending on GDP per capita between the two regions. This implication will be interesting for both practitioners and researchers regarding the measurement of sustainable performance.

Keywords: sustainability; sustainable investment; corporate performance; economic development; VAR; and VECM

1. Introduction

Sustainability has been an important issue for several decades because companies want to secure competitive advantages for their future such as cost savings, consumer demand, risk mitigation, tax incentives, and using resources efficiently in saturated or competitive markets. The business environment has been changed by the enforcement of the global environment, an increase in green consumers, and economic loss due to lack of environmental control. Besides, firms' economic burden has been increased by environmental regulations such as the reduction of emissions and greenhouse gas. We trace back to why it became an important agenda. At the G-8 summit meeting, 2007, the main agenda was sustainability due to global warming caused by climate change. The issues of energy and environment have been cardinal factors determining a nation's economic future. According to the EPA (Environmental Protection Agency, Washington, DC, USA), a 2016 report states that three major factors provoke climate changes regarding earth's energy balance, including (1) variations in the sun's energy reaching earth; (2) changes in the reflectivity of earth's atmosphere and surface; (3) changes in the greenhouse effect, which affects the amount of heat, and retaining earth's atmosphere. Basically, in order to protect the environment, a lot of money is needed. The UNEP FI [1] report says that the environmental costs generated by the top 3000 companies, which are responsible for 35% of total global externalities caused by human and economic activity, totaled \$2.15 trillion, including impacts from the operation and production of purchased goods and services. Even though the firms pay

the environment costs, they not only should continue to pay for it because the government does not give them more incentives and beneficial policies but should also be in charge of corporate social responsibility. If they do not protect the environmental issues from which climate change, water scarcity, food security and deforestation have emerged, they are not able to obtain sustainable competitive advantages such as envisioning various scenarios for the future. Corporate sustainability is becoming significant as the mainstream for the current and future growth engine. In theoretical and empirical research papers, it was demonstrated why companies need a sustainable strategy because there was a positive relationship between sustainable management and financial returns as evidenced by [2–6].

All activities regarding sustainability include more than the economic status. However, in general, sustainability cannot only have an influence on the economic growth, but is also germane to economic development. In other words, the major goal of economic growth is sustainability. When we categorize developed countries, the main criterion would be the economic growth and environmental constraints and risks. According to the global environmental outlook [7], the Regional Environment Information Network (REIN) decided that the Asia-Pacific region is a priority to perform environmental actions with critical issues; in addition, it has the worst record of affecting 4.5 billion people, which caused a loss of \$1076 billion between 1990 and 2014. On the other hand, the environmental conditions in North America have significantly improved for a decade, considering investments in policies, institutions, data collection and assessment and regulatory frameworks. Figure 1 shows the vulnerability of climate change and environmental risk throughout the world. There are the global mega forces that affect water scarcity, energy and fuel, deforestation and ecosystem decline directly. This research focuses on North America and the Asia-Pacific region. As mentioned above, the environmental situation differs between the two regions. By comparing them, we corroborate that sustainable investment in well-performing regions leads to social and economic growth and environmental stability.

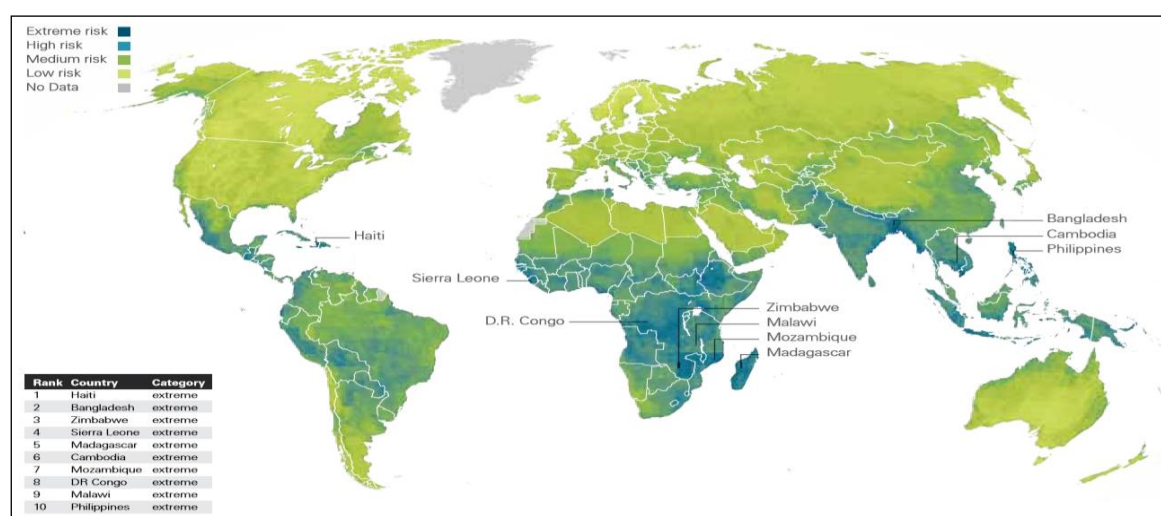


Figure 1. Climate change vulnerability index. Sources: KPMG US (2012) and Maplecroft (2012), The Climate Change and Environmental Risk Atlas.

Based on a previous literature review, current research on the economics of sustainability is mainly historical [8]. Besides, estimating sustainability is like a conundrum because it has two properties. Firstly, sustainability has a long-term value [2]. Measuring the performance of sustainable activities requires precise data because it is not the only part of performance but is the result of the enterprise's performance from each business unit, including the strategies and forecasting multiple scenarios over a long-term period. However, long-term values can be estimated accurately. This research uses on a long-term period between 10 and 20 years. In the stock market, similarly, there is a calculation method for sustainable growth rates using accounting rates such as in financial statements. Through predictive

modeling, we attempt to prove corporate and economic performance relative to sustainable investment and management.

The purpose of this article is to substantiate that a firm's sustainable activity is associated with financial performance, and the relationship between sustainable investment and economic development is the causality. We contribute to the sustainability literature, especially with respect to measuring sustainable investment and why companies should ensure sustainable management. We structure the article as follows. First, we provide the theoretical background from previous research on the corporate performance, investment, and economic development of sustainability. We apply this theoretical background to the sustainable investment index. We propose an empirical hypothesis linking affordable methodology such as VAR (Vector Autoregressive) and VECM (Vector Error Correction Model) in a time series model. We conclude with implications for research and practice and limitations.

2. Background for Hypotheses

2.1. Corporate Performance and Investment Theory on Sustainability

It is controversial that the relationship between financial or economic returns and sustainable behavior is positive or negative. There is prior research that indicates no correlation between them. Margolis and Walsh [9] found no evidence that sustainable management creates revenues. The work of Palmer and Siebert suggested that as natural resources are the main production factors, imposing limitations on them increases unit costs and limits a firm's ability to grow [10,11]. Hansen et al. [12] indicated that the relation among the indicators of society, environment and financial performance for 1100 CEOs had no correlation. Neoclassical economists have argued for the shareholder theory, stating that the only corporate social responsibility is to increase the profits, but consequently, investing resources for sustainability will necessarily reduce shareholder value based on Friedman [13].

The investors or executives tend to think sustainable investment is an insignificant investment since they think it is only for future, not in the present and physical consequences do not occur immediately. However, one of our studies emphasized the importance of sustainability. The Boston Consulting Group [14] surveyed 1500 corporate executives and managers from companies throughout the world. The results showed that more than 70 percent of survey respondents showed their company had not developed a clear business case for sustainability, and self-identified experts believed that the more firms recognize sustainable management, the more they will receive revenue. In addition, sixty-two percent of these respondents considered that it is necessary to maintain good relations between providers and demanders.

The recent papers suggest that sustainable investments can increase beneficial performance such as financial returns, and other work continues to find a correlation between financial returns and investments in the sustainability written by Rebecca [15]. The management of sustainability performance requires a stable management framework (1) which is linked to environmental and social management and (2) which is integrated into environmental and social information of sustainability, based on Schaltegger and Wagner [16]. Galema et al. [17] stated that investing in social responsibility influences stock returns by lowering the book-to-market ratio. Prior research on corporate sustainability has shown evidence that sustainable firms significantly outperform both stock markets and accounting performance and in doing so, they think sustainability makes the dominant beliefs for the future, based on [18–21].

Fundamentally, corporate performance comes from a variety of factors, and companies cannot provide benefits without investments, which are obtained from institutional investors. According to the U.S. Securities and Exchange Commission, the growth in the proportion of assets managed by institutional investors has been accompanied by a dramatic increase in the market capitalization of U.S. listed companies. For example, in 1950, the combined market value of all stocks listed on the

New York Stock Exchange (NYSE, New York, NY, USA) was about \$94 billion [22]. By 2012, however, the domestic market capitalization of the NYSE was more than \$14 trillion, an increase of nearly 1500%. As mentioned for institutional investors above, why do they invest a lot of money in a company's stock? The answer to this question is that they want to get money back, as much as they invested, and to obtain savings. Plus, from another aspect, many companies need the investments from them as well because in general, the business expansion for the future accrues the competitive advantages eventually. In the investment theory, investment has two motivations. Goetzmann [23] stated that motivation of the investment is the desire to increase wealth (i.e., make money grow). Another is the desire to pass money from the present to the future. The business anticipates the demands of future cash and expects that future earnings guarantee those demands.

In order to prove the relation between sustainability investments and financial performance, we utilize ROI (Return On Investment), ROIC (Return On Invested Capital), and ROA (Return On Asset). These financial statements are the overarching factors to evaluate a company's financial performance and investment returns. There is evidence that firms have begun to monitor and track some of these measures through internal cost-benefit analyses and activity-based costing [24–26]. Basically, ROI shows how companies invest efficiently, and the value of ROIC indicates the cost of capital and how much a company invests. ROA denotes how efficiently a firm obtains income using its assets. We reckon that firms, which calculate the accounting rates of return such as ROA, ROI, and ROIC, have better financial performance. In a previous study of accounting rates and sustainability, Robert et al. [27] demonstrated that the performance of high sustainability companies and low sustainability companies differed in the long-term by comparing samples of 180 US firms. The results showed that high sustainability companies significantly outperformed over the long-term, using variables such as ROE, ROA, stakeholder engagement, the disclosure of nonfinancial information, and governance. In this work, we concentrate on ROI, ROIC, and ROA, different from former studies because they are reasonable when evaluating revenues based on an amount invested, not a sales account. This point can reduce the distortion that an index like total sales has extensive benefit rates including ROA, ROE. In other words, if we use the ROIC in a company, we will see only benefit rates based on how much we invest.

In this regard, because the environmental investment is significant, this sector requires a lot of money because we are not able to ameliorate the environment by developing economic status without it. As mentioned above, previous research on the relation between financial returns and sustainability has been corroborated positively, and there was an argument in which several studies showed no evidence and findings. We attempt to find their causality, not their correlation. Corporate investment for sustainability is to determine future values for the competitive advantages, and it increases the company's present value such as economic benefits, and financial performance will be increased. Accordingly, we hypothesize positive causality between stock investment and sustainability:

Hypothesis 1. *The causality between sustainability and financial returns will be positively associated with a firm's present and future values.*

Hypothesis 1a. *Major capital flows of the stock market in both North America and the Asia-Pacific region will have a positive relationship with sustainable investment.*

Hypothesis 1b. *A firm's stock prices, which are under sustainable management in both North America and the Asia-Pacific region, will be positively associated with the sustainable investment.*

Hypothesis 1c. *A firm's accounting of rates with ROI, ROIC, and ROA will be positively associated with sustainability investments.*

2.2. Economic Development Theory on Sustainability

The prominent norm of sustainability performance among countries depends on two situations which we focused on our paper, even though there are many standards to appraise sustainability. The first one is how much money has been invested in the industries of its country. Another one is how

well the countries have been burgeoned economically for sustainability, including ESG (Environment, Society, and Governance). In particular, an environmental sector in sustainability has a significant contribution to the economic growth. Meadow et al. [8] showed that economic growth is the perceived driver behind environmental degradation and resource depletion. Plus, it is an operational objective in the attainment of sustainability. Coxhead [28] verified the analysis on the features of the relationship between economic growth and environmental resources in different parts of the region. The economic development is related to environmental and natural resource assets in Asia. Zhang [29] contemplated environmental degradation due to an increase in energy demand across Asia and recommended that setting policies is a crucial factor for economic expansion.

This paper concentrates on two regions, Asia-Pacific and North America, separating well-performed and lacking performance with respect to sustainability. Asia is not only faced with the environmental problems of air pollution, water management, and land degradation but also has serious issues like susceptible environmental circumstances. In Figure 2, greenhouse gases, water abstraction, and pollutants account for most of the rate. This means that the environmental situation is bad. In particular, East Asia has had high economic growth rates from 2006 to now and environmental capital. There is evidence that in 2014 notably, buyout-backed companies in the Asia-Pacific market shot up to nearly \$53 billion, i.e., by 120% [30]. In all, the environmental capital in Asia-Pacific topped \$105 billion, meaning that this percentage is the largest figure compared to North America (34%) and Europe (50%). As shown in Figure 2, North America has a small proportion in environmental issues compared to the Asia-Pacific region.

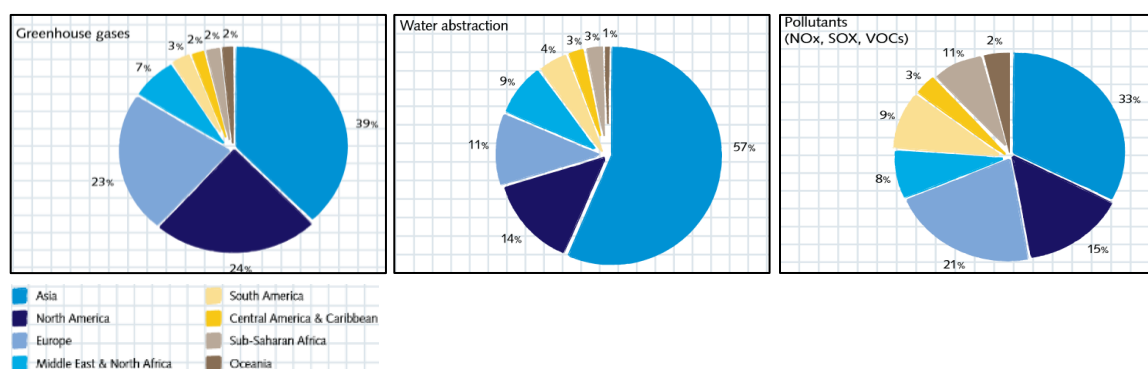


Figure 2. Regional Rate of Environmental Issues. Sources: ISSP Insight (2013).

Regarding development, Sumner and Tribe [31] defined three categories; (1) short- to medium-term outcome of attractive targets; (2) long-term process of structural societal transformation; (3) a dominant discourse of western modernity. The development we referred to in the literature review above is a similar concept to sustainability. This point we assume is the final goal for our research, which means sustainability has a tremendous importance in economic development. In accordance with our assumption, Howarth [32] says that sustainable development requires economic activity, social welfare, and a stable environment.

Albeit there is the difference in the economic development, depending on the subject of leading researchers such as Smith, Marx, Schumpeter, Lewis, and Rostow, we found the properties involving the theory of economic development. Table 1 demonstrates that economic development theories have evolved through capital, technology, education, savings, and knowledge. The recent issue in economic development is sustainable development because it has integration; developing in a way that benefits the widest possible range of sectors, across borders and even between generations [33].

Table 1. The evolution of development economics.

By Time	Main Key Words and Models (Theories)	Researchers
Early Views	Capitalism; free trade, private property and competition	Smith [34]
	Communism; social or public ownership of property, and independence of foreign capital and goods	Marx [35]
	Technology; business cycles, innovation, socialism	Schumpeter [36]
Classical Theories	Linear Stage Growth Model, Education	Rostow [37], Harrod [38], Domar [39]
	Structural Change Model	Lewis [40], Chenery [41]
	International Dependence Model	Singer [42], Baran [43]
	Neoclassical Counter Revolution Model	Stiglitz [44]
Contemporary Theories	New Growth Model; knowledge, role of public sector and investment	Aghion [45], Sen [46]

The goal of economic development in its simplest form is to improve the quality of life and to ensure sustainable development, and the most significant thing is to bring about growth such as gross income per capita. Before the 1970s, rapid economic growth was considered a good proxy for other attributes of development [47]. There are many ways to evaluate the economic development. In our paper, we concentrate on GNP and GDP, which have properties to elucidate the importance of sustainability and economic development empirically. Giang and Sui [48] demonstrated that financial performance is measured by an annual increase in gross national product (GNP), and the World Bank estimates it as GNI per capita. Also, Carroll and Stanfield [49] utilized factors like stock price and GDP substantiating that regional development design generates sustainable economic development. In comparison with previous research, there was no multi-faceted sustainability performance regionally and empirically, while what we distinguish is two instructions using both stock prices associated with local investment and GNP/GDP. In summary, regional differences and the link between sustainability and economic development lead directly to our second hypothesis:

Hypothesis 2. *Sustainability is positively related with economic development in both Asia-Pacific and North America.*

Hypothesis 2a. *The gross national income (GNI) and gross domestic product (GDP) that are overarching factors for economic development will be positively associated with sustainability investment in each region.*

Hypothesis 2b. *Sustainability investment between Asia-Pacific and North America will have different level of economic development.*

3. Methods

VAR Properties. Our goal is to figure out causality among sustainability performance, financial returns, and economic development. To do this, we use the VAR (Vector Autoregressive) model. In former studies, they have been utilized by analyses such as financial data, stock prices/returns, and money supply by [50–52]. The VAR model in economics was made popular by Sims [53]. Especially, it is proven when describing the dynamic behaviors of economics and financial time series and for forecasting, and it has been known as the model from univariate autoregressive to multivariate autoregressive frequently used for projection and efficiency analysis by the change of endogenous variables. Zivot and Wang [54] indicated that the VAR model is used for structural inference and policy analysis. In structural analysis, certain assumptions about the causal data structure are imposed and the resulting causal impacts of unexpected shocks or innovations are summarized. Utilizing the VAR model can show how an endogenous variable changes the dynamic response; our goal concentrates on the causality, not a correlation between investing sustainability and financial returns.

There is a difference between time-series and cross-sectional data. Based on the stationarity of a variable, time series analysis satisfies phenomenon's assumption and is efficient. When variables of time series have non-stationarity, they have to be eradicated because the data should be detrended before estimating a specific VAR model. The first thing we do is to employ the Augmented Dickey-Fuller (ADF) and Phillips-Person (PP) unit root tests for the multivariate approach of Johansen and Juselius [55]. After the ADF test, if the variable is non-stationary, we have to treat the first difference of the variable indicating that the non-stationary variable is modified into being stationary. Then, given the nature of the results, we can make a decision selecting the lag length. As denoted in Table 2, our paper is embraced in 'multivariate' mode, analyzing our hypotheses by VAR and VECM. Why we chose this VAR model is that first, the impulse response analysis attests a change of one variable in endogenous variables influencing dynamic effects. Secondly, through the variance decomposition, we can analyze the size of the contribution of these variables to the total variation in each endogenous variation. What it means is that VAR does not settle the theoretical hypothesis by economic theory but analyzes real economic situations using given economic time series. In other words, it makes systematic outputs utilizing parallax variables like an explanatory variable relative to all variables.

Table 2. How to operate the time series model.

Div.	Univariate	Multivariate
Stationary	ARMA Model	VAR Model (Vector Autoregressive)
Non-Stationary	Unit Root Test	VECM (Vector Error Correction Model)

Modeling and Data. In order to clarify the relationship between sustainability performance, financial returns, and economic development, we have garnered the variables such as the data of stock market regionally, each firm's stock price, and macro economic factors. Many types of studies have demonstrated the relation among stock market, stock returns, and specific economic variables, i.e., [56–61]. This paper has different contributions in comparison with them. First, it extends regional stock markets in Asia-Pacific and North America, including a particular topic, sustainability performance empirically. The only conceptual 'buildup' was performed considerably because it is demanding to gather real data, and hardship exists in measuring quantitatively. Hence, we settle on a variable of sustainability by DJSI (Dow Jones Sustainability Index) because DJSI is an assessment model of sustainability considering financial, social, and environmental information.

In comparison with previous works, which are based on empirical methodology, our work differentiates macro and micro perspectives by using representative stock indices in Asia and North America and stock prices of individual firms. How we proceed 'step by step' for Hypothesis 1 is through two approaches; (1) selecting capital flows of major stock markets such as Nikkei 225, Shanghai-Shenzhen, KOSPI, AUS 200, and Hong Kong Hansen of Asia-Pacific and NASDAQ, S&P 500 of North America. These are all responsible for handling and organizing the investment in each region; (2) constituting stock prices of the top 5 sustainability companies of DJSI regionally; (3) using the variables of accounting of rates such as ROI, ROIC, and ROA from an investment company, 'Five Tree' in South Korea. Hypothesis 2 portrays the causality between sustainability performance and economic development by GDP per capita and GNI per capita. To prevent multicollinearity, it requires other variables because depending on the population, the values of GDP and GNI can show a discrepancy in which two predictors in multiple regression models are highly correlated, indicating that one variable may be linearly predicted from the others with an equivalent degree of accuracy. We focus on GNI and GDP as mentioned in theory building of the last section, albeit the macro economy has many indicators like money supply, CPI, and un/employment. The time setting for Hypothesis 2 is from 1998 to 2016 because economic development is not 'fleeting innovation,' while Hypothesis 1, which is

germane to sustainability, settles on 2010 through 2016. Plus, all variables were modified to logarithms to set up the normal distribution in which the regression equation is stable.

When the time series variables have stationarity, the first model of the time series we can consider is the ARIMA. However, that has a limited option, utilizing only the information related to their past. In order to generally observe the relationship between each variable, the ARIMA model has some limitations that do not consider additional information such as factors. Therefore, we need to add the other variables influencing the dependent variable. By adding vectors, the AR model includes the scalar variable, while the VAR model deals with a vector, which means dependent and explanatory variables. Hypothesis 1 construes the causality between sustainability performance and economic value, especially financial returns. To do so, we use the VAR basic model in (1) as below:

$$Y_t = \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + e_t, e_t \sim \text{i.i.d. } (0, \Omega) \quad (1)$$

$$\text{Only, } Y_t = \begin{bmatrix} Y_{1,t} \\ Y_{2,t} \end{bmatrix}, \phi_1 = \begin{bmatrix} \phi_{11,1} & \phi_{12,1} \\ \phi_{21,1} & \phi_{22,1} \end{bmatrix}, e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}.$$

where, $Y_t = (Y_{1t} \dots Y_{2t} \dots Y_{kt})$ constitutes the vector, some “k” endogenous variable of analysis target. If we use the VAR model, it is possible to consider how other variables affect our objective variable, Y_t . All time series variables should accord with stationarity so they prevent divergence of the significance of endogenous variables. If our variables have unsated stationary time series, we move to VECM (Vector Error Correction Model), in (1) following that to estimate the co-integration relationship, the stationarity satisfies added lagged variables, Z_{t-1} .

$$Y_t = \gamma Z_{t-1} + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \dots + \phi_p y_{t-p} + e_t, e_t \sim \text{i.i.d. } (0, \Omega) \quad (2)$$

$$\text{Only, } Y_t = \begin{bmatrix} Y_{1,t} \\ Y_{2,t} \end{bmatrix}, \phi_1 = \begin{bmatrix} \phi_{11,1} & \phi_{12,1} \\ \phi_{21,1} & \phi_{22,1} \end{bmatrix}, e_t = \begin{bmatrix} e_{1t} \\ e_{2t} \end{bmatrix}, \gamma = \begin{bmatrix} \gamma_1 \\ \gamma_2 \end{bmatrix}, Z_{t-1} = Y_{1,t} - \alpha Y_{2,t}$$

It is possible that VAR analysis can be applied to dummy variables [46]. We define the dummy variables as zero and one (0, 1). When the GNI and GDP have a higher value compared to an average value in each time, the value is one, 1; Otherwise, zero, 0. As mentioned in Table 3, we set another dummy variable such as GR (Great Recession) from 2008 to 2009 as these variables need to undergo shock mitigation, not influencing the other variables.

Table 3. Independent Variables for Hypothesis.

Part	Region	Independent Variables	
Hypothesis 1	The Asia-Pacific region	▪ Nikkei 225 (NK) ▪ KOSPI (KP) ▪ Hong Kong Hangsen (HKH)	▪ Shanghai Shenzhen (SS) ▪ AUS 200 (AUS)
	North America	▪ NASDAQ (ND)	▪ S&P 500 Total Revenue (SP)
	The Asia-Pacific region (Each company's Stock Price, ROI, ROE, and ROIC)	▪ Samsung Electronics (SE) ▪ Seven and Holdings (SH) ▪ Toyota Motors (TM)	▪ NTT Docomo (NTD) ▪ West Banking (WB) ▪ Astellas Pharma (AP)
	North America (Each company's Stock Price, ROI, ROE, and ROIC)	▪ Apple Inc. (AI) ▪ Exxon Mobil (EM) ▪ Johnson and Johnson (JJ)	▪ Pepsi Co. Inc. (PCI, Purchase, NY, USA) ▪ Verizon (VZ)
	The Asia-Pacific region and North America	▪ Gross National Income per capita ▪ Gross Domestic Product per capita	
Dummy Variables		▪ Great Recession (2008 and 2009) ▪ Population by each region	

Sources: World Bank, APEC, Federal Reserve Bank of St. Louis, Each company's stock by searching. Period: Hypothesis 1 (4th January 2010 through 7th December 2015), Hypothesis 2 (to 4th January 1998 through 2016 of GDP. (Quarterly) and GNI (Quarterly/Annually) by each region). Dependent Variables: Dow Jones Sustainability Index by each region.

Preliminary Analysis: ADF and KPSS Test. In order to verify the stationarity of the VAR model, we employ the ADF and KPSS analysis of the unit root test individually. The estimation of the ADF test is in (3), and the null hypothesis is $H_0: \pi = 0$. We assume that if a null hypothesis cannot be rejected, the unit root exists.

$$Y_t = \beta_1 + \beta_2 t + \pi y_{t-1} + \sum_{j=1}^K \gamma_j y_{t-j} + e_t \quad (3)$$

Showing the consequences of ADF and KPSS test in Table 4, we reject the null hypothesis, meaning that unit root exists. However, after the first difference in the KPSS test, all variables have stationarity. In this regard, Eagle and Granger [62] substantiated that even if there is a change of trend in individual economic time series to an abnormal set (or unstable) and if the linear combination having stationary time series over the long-term exists, the linear combination becomes a stationary time series variable. In other words, these time series variables are in a co-integrating relationship. However, co-integrated method of Eagle and Granger [62] has the deficiency when the co-integrating vector has a value of two or more. Johansen [63] found that when variables are non-stationary, it is possible to modify the alternatives using the vector error correction model (VECM) after performing the co-integration test. As we settle on not only a standard of time series analysis in Table 2, but also a literature review as mentioned above, the remainder of the variables are operated on by the vector error correction model (VECM) except for log(ND), log(NTD), and log(AP GDP). To lay the groundwork for VECM, we first perform the co-integration test such as the Johansen test (See Appendix A.1 in Supplementary Materials).

Table 4. Values of ADF and the KPSS Test.

Variables (Log Values)	Lag	ADF Test (Asymptotic <i>p</i> -Value)	KPSS Test (After First Differentiation)
DJSI AP (Asia Pacific) TR	3	0.2663	0.0494 ***
SP (S&P 500)	6	0.3586	0.0432 ***
DJSI NA TR	6	0.1252	0.0350 ***
ND	6	0.0966 *	0.0338 ***
AUS	9	0.5919	0.0838 ***
HKH	3	0.1626	0.0311 ***
NK	5	0.3870	0.1812 ***
SS	5	0.7615	0.1820 ***
KP	8	0.1152	0.0678 ***
AI	3	0.6133	0.1854 ***
AI ROA	2	0.7854	0.11451 **
AI ROI	2	0.7706	0.11873 **
AI ROIC	2	0.9916	0.1919
JJ	3	0.5118	0.1097 ***
JJ ROA	2	0.5263	0.1013 **
JJ ROI	2	0.474	0.09113 *
JJ ROIC	2	0.1413	0.1890 ***
EM	6	0.8878	0.1602 ***
EM ROA	2	0.9938	0.3328
EM ROI	2	0.9945	0.3225
EM ROIC	2	0.9454	0.2564 ***
PCI	6	0.2567	0.0381 ***
PCI ROA	2	0.6134	0.18212 ***
PCI ROI	2	0.947	0.25858 ***
PCI ROIC	2	0.7627	0.0936 ***
VZ	3	0.8888	0.1000 ***
VZ ROA	2	0.7322	0.138304 ***
VZ ROI	2	0.9056	0.1712 ***
VZ ROIC	2	0.8623	0.13447 ***
SE	3	0.7589	0.1226 ***
SE ROA	2	0.02 **	0.08427 *

Table 4. Cont.

Variables (Log Values)	Lag	ADF Test (Asymptotic <i>p</i> -Value)	KPSS Test (After First Differentiation)
SE ROI	2	0.1636	0.0761 *
SE ROIC	2	0.639	0.10265
TM	3	0.9647	0.3699 *
TM ROA	2	0.789	0.090 *
TM ROI	2	0.6846	0.0941
TM ROIC	2	0.7539	0.09741 *
NTD	2	0.1000 *	0.2121 ***
NTD ROA	2	0.04274 **	0.0861 *
NTD ROI	2	0.03814 **	0.0875 *
NTD ROIC	2	0.1558	0.07932 *
AP	3	0.1404	0.1549 ***
AP ROA	2	0.3804	0.08343
AP ROI	2	0.3528	0.0713 *
AP ROIC	2	0.669	0.103959
SH	3	0.9455	0.1719 ***
SH ROA	2	0.2475	0.06941 *
SH ROI	2	0.3069	0.0845 *
SH ROIC	2	0.543	0.06347 *
WB	6	0.7358	0.0794 ***
WB ROA	2	0.06568 *	0.0970 *
WB ROI	2	0.07466 *	0.0971 *
WB ROIC	1	0.443	0.07282 *
The Asia-Pacific region(AP) GDP	7	0.0044 ***	0.0451 ***
The Asia-Pacific region(AP) GNI	1	N/A	0.3200 ***
North America(NA) GDP	3	0.3293	0.3134 *
North America(NA) GNI	2	0.3371	0.2382 ***

KPSS Test: Critical Values: * $p < 10\%$; ** $p < 5\%$; and *** $p < 1\%$, depending on how many variables have samples.

After ADF and the KPSS test, we know how variables should be organized in the VAR or VECM. The time series analysis does not mean a theoretical prediction model but an extended prediction model when a real situation happens in social issues or business sectors. As mentioned above, we structure the VAR and VECM respectively by inserting our variables as in the examples of Equations (3) and (4) below. An equation does not indicate the matrix of each variable.

$$Sustain_t = \phi_{01} + \phi_{11,1}Sustain_{t-1} + \phi_{12,1}Inde.Vari._{t-1} + e_{1,t} \quad (4)$$

$$Sustain_t = \gamma z_{t-1} + \phi_{01} + \phi_{11,1}Sustain_{t-1} + \phi_{12,1}Inde.Vari._{t-1} + e_{1,t} \quad (5)$$

4. Results

Table 5 shows the summary statistics. According to the result of Hypothesis 1a, using VECM in daily data from 2010 to 2015, sustainability performance in the Asia-Pacific region is positively associated with Asia major stock markets such as AUS (<0.00001), SS (0.07), KP (0.007) in Table 6. The rest, NK, and HKH, however, are not significant with sustainability total returns. As determinants of variable stationarity, eigenvectors are 0.05, 0.03, 0.02, 0.01, 0.008, and 0.005, indicating that they are stationary, i.e., less than one, '1' (See the Appendix A.1.1 in Supplementary Materials). In North America, the consequences of VECM show that ND and SP have a strong relationship with sustainability performance. Albeit many companies are registered in ND and SP, which are pertinent to the investment and financial returns like economic values. That is a crucial reason why this research determines vector autoregressive analysis instead of correlation between the variables. Their eigenvectors between Asia Pacific and top 5 companies in the Asia Pacific area are stationary. In other words, this VECM is stable (See Appendixes A.1.2 and A.1.3 in Supplementary Materials).

Table 7 indicates that sustainability has the positive relationship between the DJSI of North America and stock market's flow like NASDAQ.

Table 5. Descriptive Statistics in Variables.

Variable	Mean	Min	Max	SD
DJSI Asia-Pacific region PR	4.8950	4.6821	5.0626	0.089772
DJSI Asia-Pacific region TR	5.0854	4.8283	5.3181	0.12261
DJSI North America PR	4.7621	4.4308	5.0499	0.17934
DJSI North America TR	5.0304	4.6347	5.3799	0.22150
S&P500 Net TR	7.8956	7.4396	8.2787	0.24603
S&P500 TR	7.8956	7.4396	8.2787	0.25683
NASDAQ	8.1154	7.6458	8.5600	0.26890
AUS200	8.4924	8.2594	8.6966	0.10522
Hangsen	10.00	9.6959	10.256	0.089740
Nikkei_225	9.4215	9.0070	9.9460	0.29007
Shanghai	4.0858	7.3478	7.7093	3.1459
Kospi	7.567	7.3478	7.7093	7.4305
Apple Stock	5.6839	4.5029	6.5541	0.63070
Apple ROI	2.8098	0.483635	3.8340	1.2732
Apple ROIC	1.2032	−0.2729	1.7015	0.6519
Apple ROA	2.3157	0.053807	3.3514	1.1754
Johnson & Johnson Stock	4.3565	4.5029	6.5541	0.21043
Johnson & Johnson ROI	3.2059	2.8343	3.4070	0.17322
Johnson & Johnson ROIC	1.4460	1.3035	1.5753	0.0961
Johnson & Johnson ROA	2.6180	2.1897	2.8868	0.21260
Exxon Mobile Stock	4.4177	4.0355	4.6480	0.13751
Exxon Mobile ROI	3.0698	1.5341	3.6514	0.53059
Exxon Mobile ROIC	1.2499	−0.4340	1.6699	0.4884
Exxon Mobile ROA	2.3722	0.85466	2.9568	0.53255
Pepsi Co. Inc. Stock	4.3333	4.0769	4.6355	0.16256
Pepsi Co. Inc. ROI	3.5378	3.3616	4.0098	0.15505
Pepsi Co. Inc. ROIC	1.4233	1.2311	1.5556	0.1271
Pepsi Co. Inc. ROA	2.4906	2.0514	2.9070	0.28066
Verizon Inc. Stock	3.7275	3.2768	3.9873	3.3696
Verizon Inc. ROI	2.6784	0.14770	4.8241	1.1409
Verizon Inc. ROIC	1.0263	0.7501	1.2864	0.1312
Verizon Inc. ROA	0.90302	−1.461	2.1401	0.98054
Samsung Elec. Stock	14.023	13.430	14.270	0.17532
Samsung Elec. Stock ROI	1.2239	0.9407	1.5027	0.16806
Samsung Elec. Stock ROIC	1.1866	0.88841	1.4866	0.14762
Samsung Elec. Stock ROA	1.0077	0.74529	1.2009	0.13259
Toyota Motor Stock	8.5629	7.7732	9.0758	0.3634
Toyota Motor ROI	0.90318	0.2200	1.1721	0.32382
Toyota Motor ROIC	0.68154	−0.31235	0.99723	0.42451
Toyota Motor ROA	0.49120	−0.15175	0.73501	0.28427
NTT Docomo Stock	7.3021	6.4118	8.1212	0.47102
NTT Docomo ROI	0.89456	−1.5797	1.2931	0.65033
NTT Docomo ROIC	1.2425	1.0535	1.3970	0.088932
NTT Docomo ROA	0.70764	−1.8362	1.0813	0.66539
Astellas Phama. Stock	7.2175	6.4118	8.1212	0.40104
Astellas Phama. ROI	0.9698	0.6617	1.2058	0.14793
Astellas Phama. ROIC	1.1956	1.0132	1.3956	0.10885
Astellas Phama. ROA	0.84955	0.56970	1.0888	0.14384
Seven Hold. Stock	8.2068	7.6261	8.6837	0.30809
Seven Hold. ROI	0.80880	0.40794	0.94476	0.11741
Seven Hold. ROIC	0.96942	0.87852	1.0452	0.051038
Seven Hold. ROA	0.43234	0.083764	0.58799	0.13094
West Banking Stock	3.3498	2.9269	3.6836	0.20039
West Banking ROI	1.2566	1.1208	1.3629	0.08336

Table 5. Cont.

Variable	Mean	Min	Max	SD
West Banking ROIC	0.64964	0.55104	0.76485	0.077440
West Banking ROIA	0.0020104	−0.17418	0.061080	0.054821
GDP per capita in The Asia-Pacific region	3.7891	2.3876	4.9523	0.56972
GNI in The Asia-Pacific region	3.3990	3.3079	3.4246	0.036030
GDP per capita in North America	9.5601	9.3344	9.7248	0.10190
GNI in North America	9.5742	9.3421	9.7504	0.10636

Table 6. Results of Hypothesis 1a for The Asia-Pacific region. Equation: DJSI The Asia-Pacific region TR and Asia's Major Investment Indices.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	
const	−0.25828	0.0501213	−5.1531	<0.00001	***
DJSI The Asia-Pacific region TR 1	−0.376414	0.0878289	−4.2858	0.00002	***
DJSI The Asia-Pacific region TR 2	−0.279773	0.10485	−2.6683	0.00771	***
AUS	0.0425609	0.00946702	4.4957	<0.00001	***
HKH	−0.00243169	0.00564701	−0.4306	0.66681	
NK	6.69217×10^{-5}	0.00252908	0.0265	0.97889	
SS	−0.00166616	0.000929865	−1.7918	0.07336	*
KP	0.0173326	0.00646122	2.6826	0.00739	***

* $p < 10\%$; and *** $p < 1\%$.**Table 7.** Results of Hypothesis 1a for North America.

Equation: NASDAQ and DJSI in North America					
Variable	Coefficient	Std. Error	T-Ratio	p-Value	
const	0.102927	0.0309391	3.3267	0.00090	***
NASDAQ 1	−0.00147645	0.0891948	−0.0166	0.98680	
NASDAQ 2	−0.000152853	0.0891785	−0.0017	0.99863	
NASDAQ 3	−0.19826	0.089072	−2.2258	0.02618	**
DJSI North America TR	0.091003	0.0286718	3.1740	0.00153	***
EC1	−0.0259547	0.00911177	−2.8485	0.00445	***
Equation: S&P500 Net TR and DJSI North America					
Variable	Coefficient	Std. Error	T-Ratio	p-Value	
const	−0.128415	0.0171057	−7.5071	<0.00001	***
DJSI North America TR 1	−0.231994	0.0716583	−3.2375	0.00123	***
DJSI North America TR 2	−0.200256	0.0860118	−2.3282	0.02003	**
DJSI North America TR 3	−0.200014	0.0858076	−2.3310	0.01989	**
DJSI North America TR 4	−0.119864	0.0719811	−1.6652	0.09608	*
S&P 500 Net TR	0.0471296	0.0122462	3.8485	0.00012	***
NASDAQ	0.0112437	0.0105518	1.0656	0.28679	
EC1	0.00226497	0.00027094	8.3597	<0.00001	***

* $p < 10\%$; ** $p < 5\%$; and *** $p < 1\%$.

In order to verify the relation between sustainability performance and financial returns, we estimate the causality with specific variables for Hypothesis 1b. Tables 8 and 9 show that most of top 5 companies, which are sustainable in each region, are germane to financial returns. Of course, statistically, several companies such as SE, TM, SH, and WB in The Asia-Pacific region, also AI, JJ, and VZ in North America, are not significant but as seen in Table 10, AP, TM, SH, and WB are all significant with sustainability total returns after individual VECM analysis by exposing them to endogenous variables. That is because, in one of the properties in VAR, it is not necessary to worry which variable is the endogenous variable and which is the exogenous variable [64]. The remainders of independent variables, AI, JJ, and VZ are not significant with respect to sustainability total returns

even after analyzing individual VECM. Here, there is an implication that we need to categorize by industry and then to figure out why these companies have significance through an in-depth case study.

Table 8. Results of Hypothesis 1b for The Asia-Pacific region.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	x
const	0.0276998	0.0343111	0.8073	0.41964	
DJSI The Asia-Pacific region TR1	−0.250126	0.0302913	−8.2574	<0.00001	***
DJSI The Asia-Pacific region TR 2	−0.132501	0.0305765	−4.3334	0.00002	***
DJSI The Asia-Pacific region TR 3	−0.0682469	0.0297634	−2.2930	0.02202	**
SE	−0.00121541	0.00260241	−0.4670	0.64056	
TM	0.000247451	0.0031117	0.0795	0.93663	
NTD	−0.00590851	0.00271244	−2.1783	0.02957	**
AP	0.00485957	0.00272154	1.7856	0.07441	*
SH	−0.00150992	0.00397724	−0.3796	0.70428	
WB	−0.00364771	0.00490616	−0.7435	0.45732	
EC1	−0.0208552	0.00873587	−2.3873	0.01712	**

* $p < 10\%$; ** $p < 5\%$; and *** $p < 1\%$.

Table 9. VECM Results of Hypothesis 1b for North America.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	
const	0.0439565	0.0225431	1.9499	0.05138	*
DJSI North America TR 1	−0.372026	0.0745782	−4.9884	<0.00001	***
DJSI North America TR 2	−0.365586	0.0923568	−3.9584	0.00008	***
DJSI North America TR 3	−0.372294	0.0961928	−3.8703	0.00011	***
DJSI North America TR 4	−0.312382	0.0917764	−3.4037	0.00068	***
DJSI North America TR 5	−0.23167	0.0740189	−3.1299	0.00178	***
AI	−0.00078442	0.000748456	−1.0481	0.29479	
JJ	0.00493479	0.00543489	0.9080	0.36403	
EM	0.0136437	0.00481917	2.8311	0.00470	***
PCI	0.0149709	0.00827384	1.8094	0.07059	*
VZ	−0.00567402	0.00517378	−1.0967	0.27296	
EC1	−0.102535	0.0184821	−5.5478	<0.00001	***

* $p < 10\%$; and *** $p < 1\%$.

Table 10. Results of Hypothesis 1b for The Asia-Pacific region.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	
AP and DJSI The Asia-Pacific region TR 3	0.275416	0.123704	2.226	0.0262	**
TM and DJSI The Asia-Pacific region TR 3	0.318044	0.184161	1.727	0.0844	*
DJSI The Asia-Pacific region TR 4	0.327980	0.154622	2.121	0.0341	**
SH and DJSI The Asia-Pacific region TR 2	−0.314653	0.178842	−1.759	0.0788	*
WB and DJSI The Asia-Pacific region TR 1	−0.204422	0.119337	−1.713	0.0870	*
DJSI The Asia-Pacific region TR 3	−0.299495	0.135512	−2.210	0.0273	**
DJSI The Asia-Pacific region TR 4	−0.200700	0.113776	−1.764	0.0780	*

* $p < 10\%$; and ** $p < 5\%$.

Causalities among the variables are shown in Table 11. Hypothesis 1c is substantiated. In North America and The Asia-Pacific region, the financial earns of investment are germane to sustainable management in their firms. All p -values in ROI, ROIC, and ROA are significant. Besides, adjusted R -squared values indicating explanatory power between variables are high in The Asia-Pacific region especially. As mentioned for ROI and ROIC, these results indicate that there are causalities

between the efficiency of investment and sustainable management. It assumes carefully that high sustainable management will be outperformed in comparison with not ensuring sustainable management. We accentuate that sustainable management encompasses all of the corporate processes. To preserve the environment, the firms have to not only develop technologies using their core competencies but also to distribute the contribution to society; they try to solve the poverty as volunteers, donating one part of their revenues. Plus, by assuming organizational governance, the firms let investors know that a company uses accurate and transparent accounting methodologies.

Table 11. Results of Hypothesis 1c for North America and The Asia-Pacific region.

Variable	Accounting of Rates	Adjusted R-Squared	F-Value	Sum Squared Resid	p-Value(F)	
North America	ROI	0.436652	2.660931	0.421648	0.09	*
	ROIC	0.400598	2.432132	0.448633	0.1	*
	ROA	0.477294	2.956687	0.391229	0.07	*
The Asia-Pacific region	ROI	0.832195	10.29866	0.065429	0.002	***
	ROIC	0.764873	7.099418	0.091679	0.008	***
	ROA	0.843936	11.13932	0.060851	0.002	***

* $p < 10\%$; and *** $p < 1\%$.

As considerable literature has suggested for the relation between macroeconomic variables and economic growth, our paper has the characteristics of analyzing real and authentic data of sustainability, a firm's accounting of rates, and macro-economic variables like GDP per capita and GNI per capita. As a result, Table 12 shows that the relationship between an economic development and sustainability index in the Asia Pacific is manifested as the GDP(0.05915) and GNI (0.03319) being significant, and sustainability total returns in The Asia-Pacific region and eigenvalues are stationary, less than '1' (See Appendixes A.1.1 and A.1.2 in Supplementary Materials). North America's consequences of GDP and GNI relative to sustainability are 0.00088 and 0.0285, respectively.

Table 12. Results of Hypothesis 2a, GDP and GNI per capita for The Asia-Pacific region.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	
const	0.106917	0.133464	0.8011	0.42680	
Population(log) 1	0.054724	0.0266501	2.0534	0.04518	**
Population(log) 2	0.0501459	0.0266954	1.8784	0.06604	*
DJSI The Asia-Pacific region	−0.226886	0.132538	−1.7119	0.09300	*
GDP in The Asia-Pacific region	0.034562	0.017906	1.9302	0.05915	*
EC1	−0.0334078	0.0264163	−1.2647	0.21174	
Equation: Sustainability in Asia Pacific and GNI(ARIMA)					
Const	18.5077	5.19202	3.5646	0.00036	***
Phi 1	−0.11305	0.251165	−0.4501	0.65264	
Theta 1	1	0.309313	3.2330	0.00123	***
DJSI The Asia-Pacific region	2.29636	1.07819	2.1298	0.03319	**

* $p < 10\%$; ** $p < 5\%$; and *** $p < 1\%$.

As to Hypothesis 2a, the relation between GNI in North America and sustainability investment is positively pertinent (Refer to Table 13). To test Hypothesis 2b, we use forecast error variance decomposition. The difference between regions exists precisely. In the Asia-Pacific region, for example, after the 15th quarters, sustainability variance explains 65.59%. Meanwhile, GDP and the population of variance contribute to sustainability with 9.86% and 24.55%(Refer to Table 14), respectively, while in North America, sustainability variance is 51.03%, and the rest of the variances account for GDP 24.68% and population 2.56%. Depending on the quarters, we know how the values of indicators like sustainability and GDP can be predicted. The findings for Hypothesis 2b then provide not

vague explanations but support for an idea of why sustainability in The Asia-Pacific region has importance for the future because it would be the overarching factor for the near future. In summary, the results are consistent with the hypotheses developed above. We know the ramification of how sustainability impacts financial returns and how economic development influences several industries (See Appendix C in Supplementary Materials).

Table 13. Results of Hypothesis 2a, GNI per capita for North America.

Variable	Coefficient	Std. Error	T-Ratio	p-Value	
Const	0.00708408	0.00173884	4.0740	0.00015	***
GNI in North America	0.379953	0.139819	2.7175	0.00878	***
DJSI in North America	0.0275953	0.0078443	3.5179	0.00088	***
Population(log)	−0.0024001	0.00136396	−1.7597	0.08403	*
Great Recession	−0.00782993	0.00291081	−2.6900	0.00944	***
Equation: GDP and DJSI North America					
Const	0.00431492	0.00212025	2.0351	0.04667	**
GDP in North America	0.377127	0.187582	2.0105	0.04930	**
DJSI in North America	0.0227566	0.00956496	2.3792	0.02085	**
Population(log)	−0.00100094	0.00166315	−0.6018	0.54976	
Great Recession	−0.00450185	0.0035493	−1.2684	0.21001	

* $p < 10\%$; ** $p < 5\%$; and *** $p < 1\%$.

Table 14. Results of Forecast Error Variance Decomposition for Hypothesis 2b.

Variable	Sustainability	GDP	Population
The Asia-Pacific region	0.6559 (65.59%)	0.0986 (9.86%)	0.2455 (24.55%)
North America	0.5103 (51.03%)	0.2468 (24.68%)	0.0256 (2.56%)

5. Discussion

5.1. Contributions

As discussed in the previous section, the literature has argued that sustainability benefit is relevant to financial returns and economic values of firms, depending on times such as short and long runs, against the opponents who think that it has no guarantee for the present and future. While there are many conceptual and theoretical papers in this field, the fact is that there are not many empirical studies. Moreover, as seen in the BCG report [14], the recognitions for why sustainability is being crucial have not been changed by thinking that it is not only an environmental strategy but also a future plan. Sustainability conforms to the cardinal natures in which environment, society, and governance interact at different rates. Besides, its quantification model requires considerable time and variables. Sustainable management helps firms or institutions perform innovative processes, reduce waste, and gain insight into possible growth areas as evidenced by [65]. Therefore, sustainability is not an environmentally oriented strategy but a multifaceted solution that subsumes environment, society, and governance in public and private sectors.

Showing the relationship between financial performance and economic development regarding sustainability of The Asia-Pacific region and North America is meaningful. We have two contributions from the micro perspective and macro perspective through this study. Firstly, from the micro view, using real and authentic data, we found a strong relationship between financial returns and sustainability, analyzing capital flows in stock markets and firm's share prices and financial statements. If many companies recognize this implication, they will invest actively in assets such as amenities and facilities and will adopt new technologies including upright entrepreneurship. In general, this is because they want to get many investments from institutional investors. Through the results of

Hypothesis 1, their relation between corporate performance and sustainability's investment was significant for now and the future, not including a tedious story that investments are highly pertinent to financial returns.

Secondly, a macro perspective shows us the significance that sustainability is positively germane to not only financial performance but also to economic growth by classifying two regions like The Asia-Pacific region and North America. Among macro-economic variables, especially concerning economic growth, the most commonly used variables are GDP and GNI, adding their per capita individually. This implication is imprinted on policymakers because a cardinal principle of sustainability, like ESG, can apply to all countries, even though each nation depends on different history, economy, society, and political circumstances. Following that economic growth has importance for the overall quality of life and education level, this paper demonstrated clearly that two regions, The Asia-Pacific region and North America have different sustainability and GDP values in forecast error variance decomposition. There is one more contribution that the firms in this paper were considered to make through several industries such as beverage, oil, telecommunications, electronics, automotive, pharmaceutical, and banking industries, although each company does not mean an industry representative.

5.2. Limitations and Future Research

The VAR model has some limitations, e.g., limited preliminary information such as being atheoretical; using nonstationary variables [66]; showing different values for the time length, which means critical values can be changed. Despite these drawbacks, what we did was to run the ADF test to obtain stationary variables individually and to determine the reasonable time length, which was obtained by the test of the lag selection. Depending on each variable's stationarity, we ran different sorts of time series analysis such as VECM, and ARIMA. Even though the VAR model is a-theoretical, this study provided rational equations of sustainability to supplement the defect, which has less prior information. We, however, still have a limit due to the lack of data, i.e., the Asia-Pacific region GNI per capita and firm's data for each region. This point is what we have to make up for in future research. Plus, to prove economic development, many macro-economic variables such as private and public consumption, price level, money supply, and un-/employment rate are needed, even though both GNI and GDP are important factors when evaluating the economic index.

Supplementary Materials: The following materials are available online at <http://www.mdpi.com/2071-1050/10/4/909/s1>.

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