



Research Paper

Materializing sustainability and business resiliency: The numerical experiments with value at risk (VaR)

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ABSTRACT

Thai listed companies currently pursue the circumstance of sustainability, especially during the first global pandemic in over 100 years, COVID-19. The reason behind the need to sustain their firms was not only to manage the resources, but also to assert their resiliency. Based on this concern, the research hypothesis was determined as “Thai listed companies that are involved with the participation in the Dow Jones Sustainability Index have better resilience and are less violated regarding their stocks during crises”. Numerical experiments were conducted two times across Thai listed industries. The results from each experiment represent the Value at Risk (VaR) given the historical and parametric principles. According to the experiments, majority of the findings under two of such VaR principles show that Thai listed companies that participated in the DJSI index have lower market risk during normal and crisis times. Additionally, after the spread of COVID-19 wave one, firms that are now in the DJSI index exhibited the lower values of VaR, in which they persist with more resiliency, faster recovery and sustainability.

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INTRODUCTION

The concepts of sustainability and resilience became more inevitable after the outbreak of corona virus (COVID-19). Since the World Health Organization (WHO) eventually declared the COVID-19 outbreak as a global pandemic on March 11 2020, human beings and business units around the world have been affected (AIMD and CRD, 2020:3). Businesses globally have changed to Work From Home (WFH) mode. The service sector, especially travel and tourism, as well as business operations and supply chains have been disrupted. One essential attribute of firms is therefore their business resilience.

The paradigm of business has been shifted from maximizing profit to sustainable organization due to the issue of the limitations of natural resources. Historically, the principles of economics have conveyed an imbalance between human needs and resources. Based on this principle, the leader in an industry could be defined as the

one who possesses the majority of necessary resources. The challenge we are all facing is “even if we are the industry leader, can the resources be deemed enough?” Or, “how could we sustain our business in the era of limited resources, global pandemic, and geopolitical risks?” Therefore, apart from the business concerns in sustainability, policy makers in several nations constantly align with the United Nations “2030 Agenda for Sustainable Development”, which includes 17 Sustainable Development Goals (SDGs) with 169 targets (GRI and UN Global Compact, 2017). The SDGs are derived from the concept of sustainable development that focuses on the economic, social and environmental aspects. Therefore, it is obvious that firms around the world compete for the limited natural resources, and this is why they are interested in implementing the SDGs.

Before the COVID-19 crisis, compared to the economic, geopolitical and societal risks, environmental risks were

Table 1: Environmental Risks.

2019 Top three risks		2018 Top three risks		2017 Top three risks	
Likelihood	Impact	Likelihood	Impact	Likelihood	Impact
Extreme weather events	Weapons of mass destruction	Extreme weather events	Weapons of mass destruction	Extreme weather events	Weapons of mass destruction
Failure of climate change mitigation and adaptation	Failure of climate-change mitigation and adaptation	Natural disasters	Extreme weather events	Large scale migration	Extreme weather events
Natural disasters	Extreme weather events	Cyber-attacks	Natural disasters	Natural disasters	Water crises

Source: Sae-Lim (2020:9).

the most significant concern. As seen in Table 1, environmental risks, such as climate action failure, extreme weather, natural disasters and so on, were rated with both high likelihood (chance of occurrence) and impact (WEF, 2020). The WEF (2020) concluded that “environmental concerns dominated the top long-term risks by likelihood among members of the World Economic Forum’s multi-stakeholder community; three of the top five risks by impact are also environmental”.

Environmental risks, particularly climate change, present the utmost challenge. Based on the Intergovernmental Panel on Climate Change (IPCC, 2013), human activities leading towards the emission of carbon dioxide are the direct root cause of climate risks. From the IPCC report in Figure 1, it can be observed that the globally averaged combined land and ocean surface temperatures began increasing during the period of the industrial revolution driven by carbon dioxide. The challenge accounts for “how nations can achieve growth under the limitations of carbon dioxide”.

The challenges of sustainability driven by environmental damage are not limited to any nation. Yet, business itself also requires immediate action. HRB (2020:3) indicated that “in recent years,

AT&T has spent \$874 million on repairs after natural disasters that the company tied to climate change”. Moreover, environmental damage could also consequently lead to business financial risks. GARP (2019:10) stated that climate change or even some environmental damage could create transverse risk that manifests itself through existing risk types. Most of the studies indicated that “climate change looks at those risks as arising through two main channels: physical risk and transition risk” (GARP, 2019:7). To the former, it is about the loss of physical effects from environmental damage while for the latter, it arises from the process of adjusting towards a lower- carbon economy.

The numerical experiments under the Thai economy were thus conducted in this study. The authors selected “Thai listed companies” due to the issue of stock price disclosure. According to their circumstances, the high maturity of companies begins to add the issue of environmental concerns to the business direction. SCG, a leading business conglomerate in the ASEAN region, has committed to and merged the concept of the “SCG circular way” with the business operations under the concern of limited natural resources, for the use and loop back into the production process as new

raw materials. Nevertheless, such business direction is posited as a rare case in low maturity firms.

As mentioned above, firms also need to sustain their businesses; yet the concept of sustainability is truly abstract. Executive management is mostly focused on maximizing profit and attracting more potential customers with no means of interest in sustainability. Regarding this factor, the objective in this research is related to the materialization of the business concerns in sustainability given the sustainability index using the concept of Value at Risk (VaR), which displays the worst loss over a target horizon that will not be exceeded with a given level of confidence (Jorion, 2007). The authors conducted experiments to compare between the Thai listed companies that participated in the sustainability index and those that did not participate in the sustainability index under three phases of crisis management: pre-, during- and post-crisis (Sae-Lim and Pathranarakul, 2018:117). The research question considers that “companies with the concerns of sustainability have better resilience during crises”. The research outcomes will assist firms with making a decision to enter into the sustainability index for the alignment of national and global sustainability indexes.

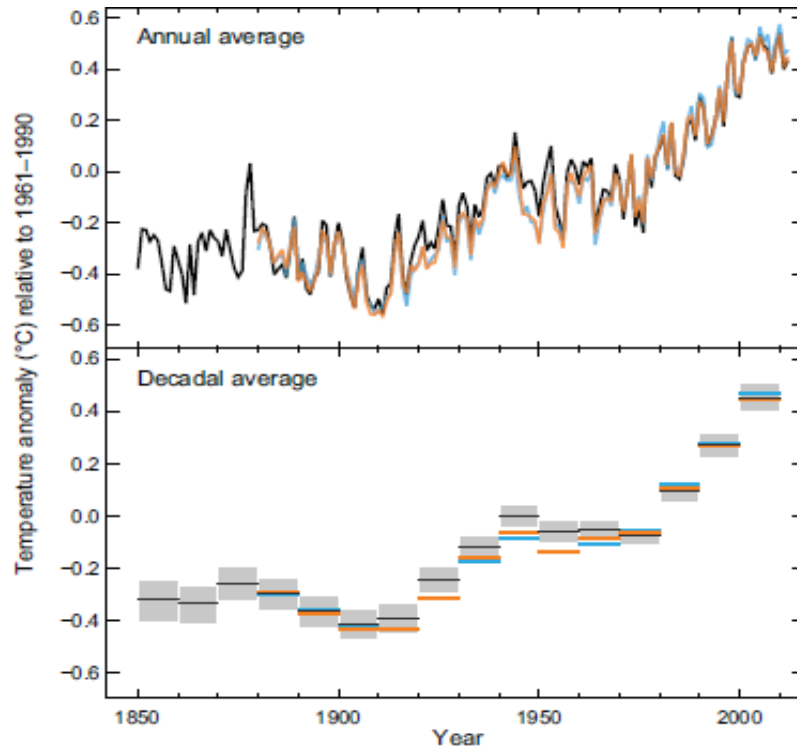


Figure 1: Observed globally averaged combined land and ocean surface temperature anomalies.

Source: IPCC (2013).

THEORETICAL CONSTRUCTION AND LITERATURE REVIEW

Sustainability in the Thai business environment

Sustainability has been modeled under the theory of development. Historically, development was interchangeable with the growth process (Mongsawad, 2010:123) that demanded high capital and resource allocation driven from low-productivity agricultural sectors to high-productivity manufacturing sectors. GDP (Gross Domestic Product) was then applied as a measurement of a nation's growth.

GDP, which is focused on production, is not deemed a representative of the national development, especially for human and psychological development (Sae-Lim, 2020:4). Moreover, the previous concepts of development are still challenges that should be addressed regarding the concerns of the imbalance between national production and the limitation of resources, problems of institutions, human capital, the environment and the role of government (Mongsawad, 2010:127). Theorists then developed the concept of "sustainability" in order to rectify the prior development theories.

The concept of sustainability became a global buzzword that was promoted by the United Nations. Sustainability Development Group (UNSDG), which constantly drives sustainability at both the global and regional levels. The

UNSDG (2017) has shared the most recent "2030 Agenda for Sustainable Development", which constitutes 17 goals, 169 targets and 243 measurements. At its heart are the 17 SDGs that cover economics, social and environmental aspects that are an urgent call for all stakeholders: national, regional, local government, business sectors, civil society, academia and the public at large.

As mentioned above, to achieve the 2030 Agenda for Sustainable Development, the business sector should be significantly involved. Therefore, the concepts of the SDGs have been embedded as a corporate vision and mission. With this importance, the Stock Exchange of Thailand (SET), driven by the potential economic growth from the concept of a sustainable Thai capital market, "joined the UN Sustainable Stock Exchanges Initiative, jointly launched by the United Nations Conference on Trade and Development (UNCTAD), the United Nations Global Compact (UN Global Compact), the United Nations Principles for Responsible Investment (UNPRI), and the United Nations Environment Program Finance Initiative (UNEP FI) in 2009" (Sustainable Stock Exchange, 2014). The objective of this conference was to stimulate sustainable investment in Thailand's capital market.

In terms of implementation, there are two categories measured for sustainable investment driven by the SET. First, the SET selects high performance listed companies under the international sustainable index, the Dow Jones Sustainability Index (DJSI), which was the first global index

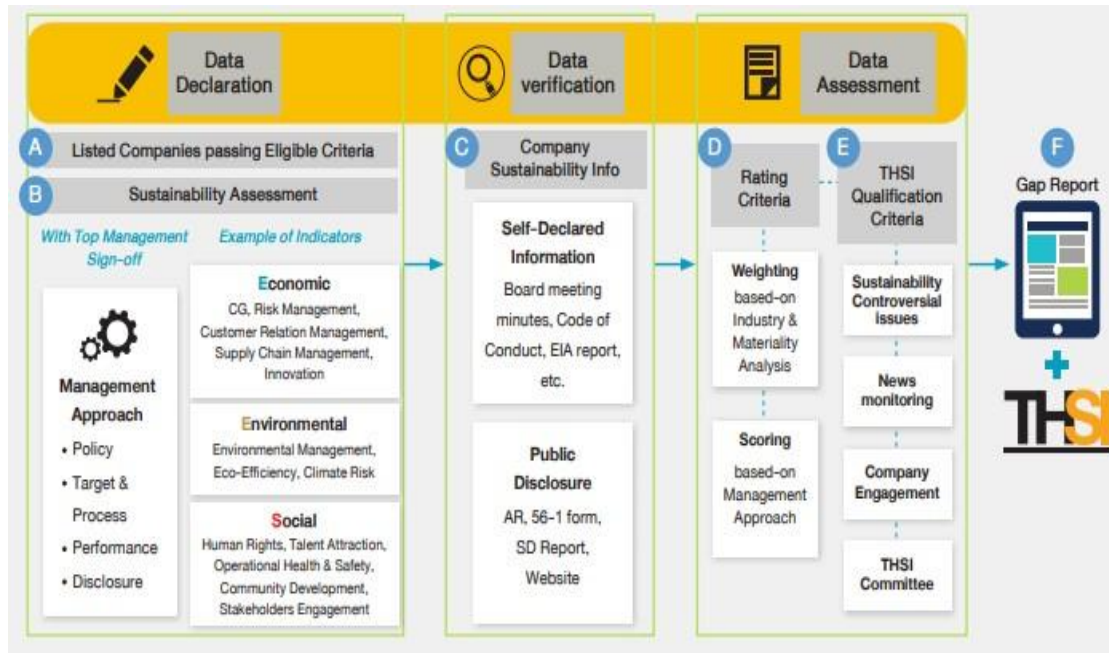


Figure 2: Thailand Sustainability Investment (THSI) Assessment methodology.
Source: THSI (2016).

to track sustainability-driven public companies based on RobecoSAM's ESG analysis (Huber et al., 2017:4). High performance organizations are selected based on the Corporate Sustainability Assessment (CSA), which covers economics, the environment and governance. Moreover, the CSA questionnaire includes topics such as corporate governance, risk management, code of business conduct, tax strategy, environmental reporting and so on.

The second local methodology, which is known as the "Thailand Sustainability Investment (THSI) Assessment Methodology", was developed by the SET itself. As seen in Figure 2, the SET determined the eligibility criteria and proposed three steps: data declaration, data verification and data assessment under four aspects, namely policy, process, performance and disclosure (THSI, 2016).

Although the THSI was systematically developed in order to set a high standard of research, the first methodology, the DJSI, which is adopted all around the world, was chosen for this research. The authors then conducted the experiments comparing the Thai-listed companies that are now in the DJSI listing and the non-DJSI companies.

Business resiliency

Measuring business resiliency can be possible with both qualitative and quantitative results. Nevertheless, the concept of business resiliency in the Thai context has become the organizational core competency driven by Thailand's Sufficiency Economy philosophy, which stems from remarks made by His Majesty King Bhumibol

Adulyadej throughout his 58 years on the throne (NESDB, 2004).

Business resiliency can be defined as a multifaceted term. Somers (2009) defined resilience as "a reaction to an event and concludes that resilience is represented after an event or crisis has occurred", while Fiksel (2003) determined that resilience is an organizational competency to prevent crises and disasters all of the time.

Kantabutra (2014) empirically conducted the prediction of corporate sustainability. From this study, it seems that business resiliency is significantly associated with corporate sustainability. Therefore, firms that constantly require the cultivation of sustainability also embed the resiliency. In other words, it is difficult to quantify in which organizations there is better resiliency. As evidence, what business resiliency means for internal management is something that some firms do not obviously disclose. Importantly, business resiliency can be interpreted in terms of financial indicators. There were several articles from empirical studies on the correlation between finance and resiliency (Salignac et al., 2019; Rose, 2013). Simply, this study measures financial resiliency based on the stock price violation given the Value at Risk concept as explained hereafter.

Crisis cycle and risk management

There are several types of risk, including both the internal and external risks. Nevertheless, not all risks are considered to be crises. Particular risks could be interpreted

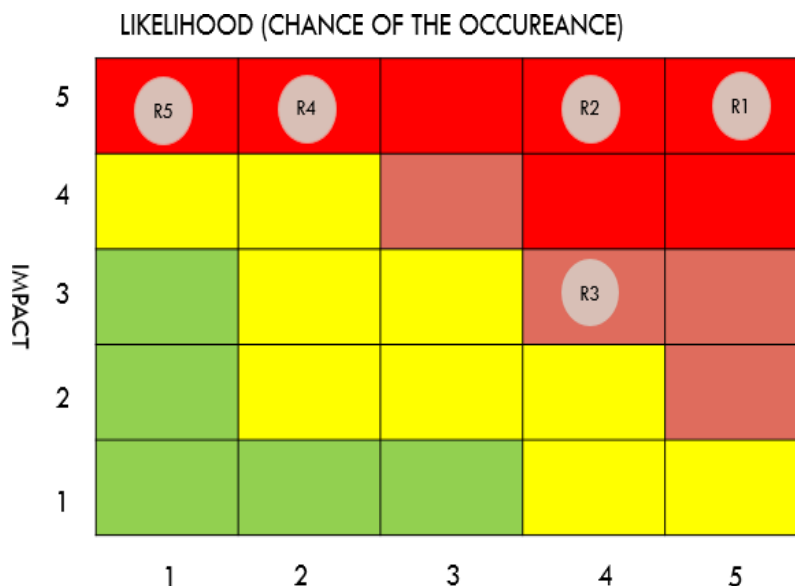


Figure 3: Risk Map.
Source: Authors' graphic design.

as crises when the risk is located in the low likelihood and high impact levels (Sae-Lim and Pathranarakul, 2018: 115).

According to Figure 3, there is a possibility that R4 and R5 can be regarded as an organizational crisis due to the high impact but low or moderate likelihood. With this categorization, crisis management is concerned with the risk mitigation focused on reducing risk impact.

Definitions of crises involve multifaceted terms as well as their typology. Olawal (2014) listed seven types of crises: natural disasters, technological crisis, confrontation, malevolence, organizational misdeeds, workplace violence and rumors, while crisis typology can be consolidated as internal and external crises. Typology and definitions of crises do not truly matter; nevertheless, effectively managing them is still a challenge due to the limitation of crisis knowledge in firms, the need for a high level of stakeholder engagement and the new forms of crises.

This study experimentally applied a given crisis management framework. Theoretically, crisis management can be divided as "pre-crisis, during-crisis and post-crisis" (Mejri and De Wolf, 2013; Sae-Lim and Pathranarakul, 2018). Consequently, this study includes numerical experiments by collecting the stock prices under three ranges of time: before the COVID-19 spread, during the COVID-19 spread, and post-COVID-19 (first wave).

RESEARCH METHODOLOGY AND NUMERICAL EXPERIMENTS

This study rests upon quantitative analysis. The objective variable accounts for "Value at Risk (VaR)" from the stock

prices obtained by the conducting of the numerical experiments. The details of the research methodology are stated hereafter.

Value at risk (VAR)

VaR is a risk assessment methodology based on statistical and mathematical concepts. It has been one of the most widely adopted models in risk management since the 1980s (Olson and Wu, 2017). Jorion (2007) simplified VaR as the "worst loss over a target horizon that will not be exceeded with a given level of confidence". To conclude, VaR allows us to measure market risk.

If the variable is defined as a "stock price", with $VaR = Y$, it indicates that over the next X days, we can expect to lose no more than $\$Y$ with a $Z\%$ confidence level. One of the most important components of VaR is the understanding and calculation of profit and loss (PL) distribution. Return distribution can be highly asymmetric for the structures produced, while PL distribution itself is not always symmetric.

Broadly, there are three principle VaR methodologies: historical VaR, the parametric approach and the Monte Carlo Simulation (Jorion, 2017). Historical VaR uses pass return data to conduct loss distribution without the means of the assumed normal distribution. The benefit of this principle is that it is intuitive and easy to understand since no assumption is required. However, parametric VaR or variance/covariance works well for linear instruments and is computationally intensive. Moreover, this principle assumes PL as a normal distribution. Consequently, it is not applicable for non-linear instruments. Lastly, the Monte

Table 2: Numerical experiment results.

Stage	Experiment 1		Experiment 2	
	Historical VaR	Parametric VaR	Historical VaR	Parametric VaR
Pre-crisis	(-15,371, -14,817)	(-13,489, -13,092)	(-13,316, -15,512)	(-15,158, 16,383)
During-crisis	(-32,740, -47,110)	(-37,856, -38,324)	(-30,680, -29,100)	(-37,365, -27,875)
Post-crisis	(-13,243, -16,412)	(-15,579, -15,477)	(-13,012, -15,285)	(-15,239, 15,869)
Total	(-19,918, -22,330)	(-26,000, -25,159)	(-18,575, -21,867)	(-25,818, -26,256)

VaR represented in Thai baht, (x,y): x = VaR in DJSI Companies, Y = VaR in non-DJSI Companies.

Carlo Simulation of VaR is time consuming and computationally intensive.

Design of the numerical experiments

The experiments were done based on: firms participating in the DJSI and those not participating in 2019-2020. In the first experiment, we selected 1) agro and food, 2) finance, 3) services and 4) technology. The second experiment includes 1) industry, 2) property and construction and 3) resources (due to having no DJSI companies in the consumer product group). We systematically selected two companies in each group. Therefore, the total of all selected firms was 14 companies.

Each experiment was conducted along with the three stages of the crisis cycle as mentioned above: pre-, during- and post-crises. The scenario that was used involved collecting the stock prices under three ranges of time: before the COVID-19 spread, during the COVID-19 spread, and post- COVID-19 (first wave).

Importantly, our assumption is composed of two views: 1) less correlation among assets and 2) correlation among assets in the two experiments. PL distribution in this study, firstly, was adopted with the methodology of historical VaR. The rationale of this methodology is “what is the 95% worst return?” Secondly, parametric VaR or variance/covariance was also employed. Due to having more than one asset, we need to consider the correlation and covariance among assets. Then, the VaR formula becomes as below.

$$VVVVVV = \alpha \alpha * \sqrt{LNN_{nn}} \left[\begin{matrix} \rho_{11} \sigma_{11} & \dots & \rho_{1n} \sigma_{1n} \\ \vdots & \ddots & \vdots \\ \rho_{n1} \sigma_{n1} & \dots & \rho_{nn} \sigma_{nn} \end{matrix} \right]$$

α = confident interval
 ρ_{iiii} = correlation between assets i and j

σ_{ii} = standard deviation asset i (uncertainty)

FINDINGS

The study made use of some assumptions. Suppose we invested \$100,000 in each asset. We then invested \$800,000 in Experiment 1, while investing \$600,000 in Experiment 2. Each experiment has two groups: companies in the DJSI and companies not in the DJSI. The confidence interval in the experiment is approximately 95%.

In terms of the explanation, the historical VaR during crisis accounts for (-32,740, -47,110) in Experiment 1, which means that during 100 days, in only 5 days, the investors who invested in Thai stocks that participated in the DJSI would lose more than 32,740 baht, while there would be a loss of more than 47,110 baht for those who invested in Thai stocks that did not participate in the DJSI.

The authors hypothesize that “Thai stocks which joined the DJSI index are less violated or even sustained compared to other Thai stocks” in both normal situations and times of crisis. The objective variable is the VaR value across the historical and parametric methods. As shown in Table 2, this experiment indicated that:

1) Majority of the Thai listed companies that participated in the DJSI index had the lower market risk during 1 October 2019 to 31 October 2020: (-19,918 > -22,330), (-26,000 < -25,159), (-18,575 > -21,867) and (-25,818 > -26,256). This confirms the authors’ hypothesis. The negative results indicate a loss of value.

2) During the crisis, the results were unclear. One half of the Thai listed companies that are participating in the DJSI index had the lower market risk during 1 October 2019 to 31 October 2020 and the rest did not: (-32,740 > -47,110), (-37,856 > -38,324), (-30,680 < 29,100) and (-37,365 < -27,875). For such results, the historical VaR method supports the research hypothesis, yet the parametric VaR does not confirm the hypothesis.

3) However, what we can measure about the business resiliency and sustainability is in the post-crisis. Businesses that retain more resiliency and sustainability should be less

violated and recover faster. According to the findings, it confirms the hypothesis that after the COVID-19 wave 1 lockdown, from 1 July 2020 to 31 October 2021 (defined as the post-crisis wave 1), most of the Thai listed companies that are participating in the DJSI index have the lower market risk: (-13,243 > -16,412), (-15,579 < -15,477), (-13,012 > -15,285) and (-15,239 > 15,869).

CONCLUSIONS AND IMPLICATIONS

The aim of this study is to investigate whether the companies with concerns of sustainability are more resilient to crises. The research was conducted with the crisis being divided into pre-crisis, during-crisis, and post-crisis. Historical VaR and parametric VaR assessments were then conducted for the Thai listed companies participating in the DJSI and those that are not. Two experiments were conducted for two groups of 14 companies.

The results show that during the period of the COVID-19 crisis from October 2019 to October 2020, there was lower market risk for the companies that participated in the DJSI index compared to those which did not. Thus, the research hypothesis is confirmed. This means that Thai stocks that are included in the DJSI index were less violated compared to others, of which the total historical VaR values are (-19,918 > -22,330) and (-18,575 > -21,867) for Experiment 1 and Experiment 2, respectively.

Nevertheless, the results of the VaR assessment for the during-crisis period were unclear. Not all of the Thai listed companies that participated in the DJSI had lower market risk during October 2019 to October 2020. Companies in Experiment 1 showed the lower market risk of those firms that participated in DJSI compared to those not in the DJSI, that is, (-32,740 > -47,110), contrary to Experiment 2, in which the non-DJSI companies market risk was lower than the companies that participated in the DJSI. For Experiment 2, the lower market risk of the companies that did not participate in the DJSI (for Experiment 2) may be because of their business types, that is, industrial estates, corrugated box and paper craft trading, oil and energy trading, and electronic device trading, which could be considered to have more stability in terms of market demand with less technology intensiveness.

Although, the business resilience and sustainability measured by the post-crisis VaR was of the opinion that it is more reflective. The empirical research reveals the results of lower VaR values of Thai listed companies that participated in the DJSI index, which were (-13,243 > -16,412) and (-13,012 > -15,285) for Experiments 1 and 2, respectively. This indicates that market risk was lower and also faster recovery and less violation of the Thai listed companies that participated in the DJSI index. The reason that the DJSI has listed the companies is that it brought them the opportunities among economic, social and environmental acceptance.

The implication of this study is that the authors displayed the empirically numerical experiments of the contribution from the international sustainable index, the Dow Jones Sustainability Index (DJSI), including the well-known market risk assessment Value at Risk (VaR). The confirmation of the research hypothesis contributes to both individual investors and regulators. To the former, if they are the value investors (VI) type, selecting stocks in the DJSI lists for their portfolio could provide significantly low violation compared to other stocks. Moreover, during global crises, such stocks posit more resilience. Evidently, VI investors who select DJSI stocks can be ensured of the long-term growth. As for the latter, the SET has enhanced the local sustainable index, the "Thailand Sustainability Investment (THSI) Assessment Methodology". The THSI should be systematically designed so that the system can be aligned with the DJSI system, which could significantly ensure the sustainability and resiliency. Ultimately, the sustainability and resiliency of the Thai stock market will result in a higher level of efficiency in the Thai economy.

In conclusion, the future study can demonstrate more sophisticated experimental designs. Understanding the correlation insights could possibly provide more accurate results. Apart from the historical and parametric VaR, there are also other principles of VaR, such as the huge scale of simulation. Moreover, there are several sustainable stock indexes besides the DJSI. Several comparisons of the effectiveness of such indexes could provide more contributions.

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