Does the COVID-19 pandemic matter for market risks across sectors in Vietnam?

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ABSTRACT
Vietnam has been considered one of the few countries that put the COVID-19 pandemic under control and successfully achieved solid economic growth in 2020. However, the national economy has been hit hard by the pandemic in 2021. National borders across the countries have been closed for an extended time. As such, supporting local industries is essential to sustain economic growth. This study measures the market risks across industries in Vietnam before and during the COVID-19 period. Two important measures, the Value-at-Risk and the Conditional Value-at-Risk, are used for the 2012–2020 period. We then extend the analyses by estimating the market risks using the monthly VaR for the 2019–2020 period. Key findings from this study can be summarized as follows. First, market risks across the Vietnamese industries have changed significantly in response to the pandemic, both at the level and their rankings. Second, among the changes, the services industry appears to be hardest hit by the pandemic as expected, whereas the education sector has significantly improved its standing during these challenging times. Our analysis also confirms that complete lockdowns negatively affect the market risk of various Vietnamese industries. We note that the service industry is a critical contributor to the Vietnamese economy and that lockdown during the pandemic does matter to the market risk. Policy implications have emerged on these findings.

1. Introduction

The COVID-19 pandemic, which took place at the end of 2019, has profoundly impacted the economies and people in all countries. The pandemic has significantly affected all members of the Association of Southeast Asian Nations (ASEAN). The region's GDP growth has been revised to -2 per cent in 2020 (ADB, 2021). The real GDP growth of ASEAN countries varied from 3.3 per cent (in Myanmar) to -9.6 per cent (in the Philippines). Cambodia, Malaysia, the Philippines, Singapore, and Thailand recorded substantial declines (ADB, 2021). Vietnam is one of the few countries globally that have put the COVID-19 pandemic under control until the end of 2020. However, the same policies successfully adopted in 2020 do not appear to work well in 2021 with the emergence of a new Delta variant. The Vietnam economy has severely been affected by the pandemic. Although Vietnam's economic growth is still positive, this growth rate is at the lowest level compared to the same years in the 2011–2020 period (ASEAN, 2020).

The service sector's contribution to GDP has increased steadily in recent years, while the agricultural sector has decreased (as shown in Figure 1). While the service sector's contribution slightly decreases, the share of the agricultural sector increases from 2019 to 2020. Accordingly, the industry-construction sector and service sector have been suffered the most from the COVID-19 pandemic. These sectors decreased by 86.1 per cent and 85.9 per cent compared to the previous year, respectively. The agriculture, forestry and fishery sector decreased by 78.7 per cent. Businesses in various sectors have been affected by the adverse effects of COVID-19, including 100 per cent in aviation, 97.1 per cent in accommodation services and 95.5 per cent in food services (GSO, 2020). Aviation services and travel services make a significant contribution to Vietnam's GDP. The aviation services and travel services contributed more than 9.2 per cent to Vietnam's GDP in 2019 (IATA Economics, 2019). Services and tourism industries have been hit hard by the COVID-19 pandemic. The tourism and transportation (especially air transport) sectors have experienced a sharp decline, mainly due to travel restrictions and social distance. In the first six months of 2020, the number of international visitors to Vietnam decreased by 55.8 per cent over the same period last year, while domestic tourists also decreased by 27.3 per cent (GSO, 2020). Consequently, the COVID-19 pandemic negatively impacts the contributions of these industries to the Vietnamese economy.
The financial market offers many attractive capital mobilization channels and various investment types with varying levels of risks. Previous empirical studies in Vietnam have mainly focused on measuring the risk of the banking system. Meanwhile, the market risk assessment for industries in Vietnam has largely been ignored (Tran et al., 2019). This study focuses on the ten industries in Vietnam, including Banking and Insurance, Education, Energy, Food, Oil and Gas, Real Estate, Pharmacy, Securities, Services, and Technology and Telecom. A firm’s performance from these industries is generally considered sensitive to abnormal events such as the COVID-19 epidemic (Skare et al., 2021). As such, this paper examines the expected loss of these ten industries since the emergence of the COVID-19 pandemic.

The daily stock price data from January 3rd 2012, to October 19th 2020, are used. We also conducted analysis in 2019 and 2020 using monthly data to examine the market risks due to the emergence of the COVID-19 pandemic. The following research questions have been addressed in this paper. First, how significant are the market risks of the Vietnamese industries and have they changed before and during the COVID-19 pandemic? Second, which Vietnamese industry is considered the riskiest one for the periods before and during the pandemic? How the rankings concerning the market risks have been changed during the 2012 to 2020 period. Third, which industries have the most significant degree of market risks in the emergence of the COVID-19 pandemic. In achieving these objectives, the Value-at-Risk (VAR) and the Conditional Value-at-Risk (CoVaR) measures are used to estimate the market risk of various sectors in the Vietnamese economy.

Our analysis is then extended to compare the market risks level between Vietnam and Thailand. We consider that Thailand is the closest comparable country with Vietnam. Many similarities between the two countries are well recognized. Thailand was the first member of the ASEAN region to operate the stock exchange on April 30th, 1975. The Thai economy had also experienced several economic crises, including the ASEAN financial crisis in 1997. Based on international trade, Vietnam and Thailand are direct competitors in many sectors, such as tourism, finance, transportation, food and beverage, technology, and many. During the COVID-19 pandemic, the services sector has also been the most affected sector in the Thai economy (Haydon & Kumar, 2020). We are comparing market risks across industries between Vietnam and Thailand, which plays a vital role in understanding the actual effect of the COVID-19 pandemic for appropriate policy implications.

Following this instruction, the remainder of the paper is structured as follows. Section 2 discusses and synthesizes relevant theories and empirical analyses. Section 3 discusses research methodology and data. Finally, the empirical results are presented and discussed in section 4, followed by concluding remarks and policy implications in section 5 of the paper.

2. Measuring the market risk

Market risk is generally considered the risk of loss for a portfolio due to the changes in commodity prices, stock prices, exchange rates, interest rates, credit spreads, and other indices influenced by the financial markets (Dowd, 2002). Different methods are used to measure the market risk, such as the Value-at-Risk (VaR), the Conditional Value-at-Risk (CoVaR), the Expected Shortfall (E.S.) or the Maximum Loss (Studer, 1999; Rockafellar and Uryasev, 2000; Kuester, 2005; Uyar and Kahraman, 2019; Vo et al., 2019). The VaR measure is commonly used by risk managers and investors worldwide to implement long-term capital management strategies and measure expected losses (Jorion, 2007). The measure has been viewed as a standard tool for describing the downside risk of a market portfolio among financial institutions. The VaR is defined as the magnitude of a financial product that can be lost over a specific time with certain reliability (Cheung and Powell, 2012). Tran et al. (2019) refer to VaR as a threshold where the likelihood of an index’s loss to the market-corrected value over a certain period exceeds the value at a certain probability level.

Previous studies also discuss the limitations of the VaR. Artzner et al. (1999) point out that the VaR is not a consistent measure of risk because it does not retain the sub-additive. As a result, the VaR does not explain the extent of the loss when the limit of risk value is exceeded. Breuer (2006) mentions that two important assumptions are required to ensure the validity of the VaR measure. First, the market characteristics must be stable in the future. This requirement means that the VaR is only valid when future market movements are the same as the past conditions. Another assumption of the VaR is that the changes in risk factors follow a multivariate normal distribution. However, it is challenging to accept this assumption. Cube Investing (2017) points out that the VaR measure does not consider the left end of the distributions, where the losses can occur. These reasons have led previous studies to use the CoVaR instead of the VaR. Nevertheless, the CoVaR is an appropriate measure of risk for its convexity and sub-additivity attributes (Pflug, 2000). Krokhmal et al. (2002) assert that CoVaR can be used in various applications. The CoVaR is considered as a substitute for VaR in measuring market and credit risks (Allen and Powell, 2007). Sawik (2015) considers that the CoVaR constraint is more profound than the VaR when its bounds coincide. Therefore, the CoVaR is a more effective tool to control risk-averse agents. Tran et al. (2019) consider that the CoVaR can estimate a conditional marginal value beyond the VaR’s possibility.

Adrian and Brunnermeier (2016) developed the “ΔCoVaR” to measure systematic risk. The ΔCoVaR captures the tail-dependency between firms and the financial system. Both VaR and CoVaR measures are used to identify solely how risky an asset is (Allen and Powell, 2007; Allen et al., 2012; and Vo et al., 2019). This current study aims to observe the risk movements of ten sectors in Vietnam before and during the COVID-19 period. We focus on the VaR and CoVaR measures which are widely used in previous analyses, including Allen and Powell (2007), Allen et al. (2012), Cheung and Powell (2012), McNeil et al. (2005), and Powell et al. (2017).

Previous studies have been conducted to examine the market risk level in various stock markets (e.g., Bitcoin market in Uyar and Kahraman, 2019; Indian Stock Market in Aziz and Ansari, 2017; S&P Goldman Sachs Commodity Index in Powell et al., 2017; Bucharest Stock Exchange in Terinte, 2015; French stock market index in Kourouma et al., 2010; market risk of industries in Australia in Allen and Powell, 2007). In addition, different market risk measurements are used, such as the value-at-risk (Najaf et al., 2020); the conditional value-at-risk (Tran et al., 2019; Allen et al., 2012); Cornish–Fisher expected shortfall (Kokoris et al., 2020); expected policyholder deficit (Wagner, 2014). Odening and Hinrichs (2003) assert that extreme value theory is a useful complement to traditional VaR measures.

Kokoris et al. (2020) examine the market risk of certain packaged retail and insurance-based investment products (PRIIPs) using the methodology introduced by the European Supervisory Authorities (ESAs).
within Delegated Regulation (European Union) 2017/653. In general, the authors state that Cornish-Fisher value at risk (CFVaR) is a more robust risk model than the simpler historical VaR. In addition, they also reveal that the Cornish-Fisher expansion is unable to accurately calculate the market risk of unit-linked products when excessive fat-tailed or non-symmetrical distributions exist.

Kourouma et al. (2010) calculated the market risk of Standard & Poor’s Aggregate 500 Index (S&P500), Cotation Assistée en Continu-French stock market index (CAC 40), and Wheat and Crude oil indexes, during the GFC using VaR and expected shortfall. Two methods are used, namely the non-parametric historical simulation method and the extreme value theory. They conclude that the conditional VaR is more effective than the VaR. Besides, the conditional extreme value theory provides a more reliable and accurate predicting property loss than the historical simulation method. Chang et al. (2019) use stochastic dominance to order the distributions in terms of welfare and portfolio selection, using VaR and expected shortfall. The results show that the expected shortfall should be preferred by risk-averse policymakers, who favour more significant but less volatile capital requirements. On the other aspect, Najaf et al. (2020) employ the VaR measure and find that fintech firms’ portfolios have a higher financial risk than non-fintech firms’ portfolios. Besides, they also point out that the non-fintech firms’ portfolios exhibit a lower financial risk regardless of the holding periods.

Our literature review indicates that the market risk assessments at the industry levels are limited in the emerging markets in the ASEAN region, particularly for Vietnam. In addition, the current COVID-19 pandemic provides a trigger point for us to consider the significance of the market risks of different sectors in Vietnam since the emergence of the pandemic. We also examine the changes in the level of market risks. This research gap warrants our study to be conducted. Findings from this critical paper provide direct implications for the Vietnamese government and other emerging markets to formulate and implement economic policies to support the affected sectors.

Furthermore, the VaR and CoVaR measures have been considered the appropriate and widely used risk measurements in the existing literature. The extensive analysis and comparisons of these measures with other risk measurements have been conducted in the literature (Allen and Powell, 2007; Cheung and Powell, 2012; Jorion, 2007; and Powell et al., 2017; Krokhmal et al., 2002; Najaf et al., 2020; Odening and Hinrichs, 2003; Pflug, 2000; Tran et al., 2019). This paper uses the VaR and CoVaR to measure the market risks at the industry level in Vietnam before and during the pandemic.

3. Data and research methodology

3.1. Data

Data from all traded stocks from ten industries on Ho Chi Minh Stock Exchange (HSX) and Hanoi Stock Exchange (HNX) are used. Our paper focuses on ten different industries in Vietnam, including Banking and Insurance, Education, Energy, Food, Oil and Gas, Real Estate, Pharmacy, Securities, Services, and Technology and Telecom, during the COVID-19 pandemic. The daily stock price data is collected for the January 3rd 2012, to October 19th 2020 period. We use the closed-price index of each industry to estimate daily returns. We use stock price data published on the Stock Exchange of Thailand (SET) in our comparative analysis for Thailand. Different industry classifications between the two databases have been noted. In our analysis, we use VaR and CoVaR measures to examine the market risk level for the four industries, namely Food, Energy, Services, and Telecommunication.

3.2. Methodology

Besides other measurements of the market risk, the VaR and CoVaR measures are the two most commonly applied measures in estimating the market risks (Jorion, 2007; and Powell et al., 2017). There are three standard procedures for estimating VaR, including (i) Monte Carlo simulation, (ii) historical simulation, and (iii) the method of variance-covariance. Odening and Hinrichs (2003) suggest that each procedure has specific advantages and disadvantages. The Monte Carlo simulation method is capable of handling different return distributions. However, the drawback of this measure is the high computation cost in the case of a complex portfolio. In addition, the historical simulation method computes return directly from observable historical data without conducting simulations by random number generators. This method is sensitive to changes in the data sample, and it cannot predict the events which are worse than the maximum loss in the study period.

On the other hand, the parametric method identifies maximum expected loss using a statistical method. The parametric method assumes that data follows a normal distribution. It then uses the standard deviation of the distributions to calculate VaR. The parametric method is generally employed in empirical studies. This paper uses the parametric method to estimate the VaR of ten industries in Vietnam.

The parametric measure assumes stock returns to follow a normal distribution. The following steps are used to calculate VaR. McNeil et al. (2005) present the parametric VaR method, as presented in Eq. (1) below.

$$\text{VaR}_\alpha = \mu + \sigma f^{-1}_{\alpha}$$

where: $\mu$ represents the averaged value; $\sigma$ is the standard deviation, $f^{-1}_{\alpha}$ is the generalized inverse function of the distribution of stock returns, and $1-\alpha$ represents the confidence level.

Besides the Value-at-Risk, the conditional Vale-at-Risk (CoVaR) refers to an average expected loss that exceeds the maximum loss estimated by VaR. The CoVaR can then be measured using Eq. (2) below.

$$\text{CoVaR}_\alpha = E[r|r \geq \text{VaR}_\alpha]$$

where: $r$ represents the return of the stock.

Our study employs VaR and CoVaR measures to estimate the market risk for ten industries in Vietnam. We track the changes in the market risk levels among these ten industries during the COVID-19 pandemic. Based on these statistical findings, we identify the most affected industries during the pandemic.

Several statistical tests and empirical analyses are used to confirm the effects of COVID-19 and economic lockdowns on the market risk of ten sectors in Vietnam. These statistical tests include the normal and equal distribution tests before and during the COVID-19 pandemic. The market risks of ten Vietnamese sectors using VaR measures follow a non-normal distribution presented in section 4. As such, the Krukal-Wallis test is used instead of the ANOVA test to examine the distributions of each sector’s market risk. The market risks might have changed before and during the COVID-19 pandemic.

In addition, multivariate regression is used to examine the effects of the COVID-19 and economic lockdowns on the market risks, measured by VaR, of ten sectors in Vietnam from 2012 to 2020. We use a panel of ten sectors and 106 months (from January 2012 to October 2020). With a long-time panel, the Cross-sectional time-series feasible generalized least squares regression appears to be appropriate. However, we also use the pooled ordinary least squares and the fixed-effects linear models with an AR(1) disturbance regression to confirm the robustness of the results. In addition, the COVID-19 had emerged in February 2020 in Vietnam. As such, only ten out of 106 months are with the presence of the COVID-19.

On the other hand, the two economic lockdowns in Vietnam appear to be effective in the two short-time periods. The first lockdown took place from the middle of March 2020 to the end of April 2020. The second lockdown was implemented from July 2020 to August 2020. Other unobserved events from 2012 to 2020 could affect our empirical results if we did not capture those effects in the empirical analysis. As such, additional analyses using sub-samples from 2019 to 2020 are used to
minimize the effects of other unobserved events on the market risk of Vietnamese sectors.

4. Empirical results

Table 1 presents descriptive statistics of the daily stock return to calculate the market risks using VaR and CoVaR for ten industries in Vietnam from January 3rd 2012 to October 19th 2020. We use 2,194 daily observations to estimate the market risks yearly and monthly using VaR measures and the yearly CoVaR measure for ten sectors. The energy sector appears to have the highest daily return at 0.078 per cent, while Oil and Gas experience the lowest average daily return at 0.026 per cent in the same period. In addition, Pharmacy appears to be the least risky sector, and Services appears to be the riskiest sector among the ten sectors in Vietnam if we consider the standard deviation of the daily returns as risk.

Table 2 presents yearly market risks using VaR measure (Panel A) and CoVaR measure (Panel B) of ten industries in Vietnam. The “Average” row of the two panels represents the average of the market risks measured by VaR (in Panel A) and by CoVaR (in Panel B) for each of the ten industries. Meanwhile, the “average” column indicates the average value of the market risks used VaR (in Panel A) and CoVaR (in Panel B) of all ten industries for each year from 2012 to 2020. Overall, the average risk in Vietnam measured by VaR and CoVaR has an average of 2.33 per cent and 2.91 per cent for a research period. The lowest expected loss using VaR measure belongs to the Pharmacy at 1.71 per cent and the highest expected loss of 3.05 per cent for Oil and Gas. The same conclusion applies when the CoVaR measure is used.

COVID-19 pandemic has emerged in Vietnam since February 2020. As such, we examine the changes in the market risk level across industries during this pandemic. Table 2 presents a sudden increase in the market risk in most industries in Vietnam from 2019 to 2020. In 2020, the Services sector appeared to have the most significant expected loss at 4.11 per cent measured by VaR and 5.07 per cent measured by CoVaR. Meanwhile, in the same period, the Energy sector exhibited the lowest expected loss at 1.81 per cent measured by VaR and 2.27 per cent measured by CoVaR. Finally, the Oil and Gas sector experienced the most significant change between 2019 and 2020. The expected loss increases by 1.82 percentage points from 2019 to 2020.

Table 3 presents the changes in the market risk ranking among ten industries in Vietnam. In our analysis, the value of “1” represents the highest level of risk, and “10” represents the lowest risk level in Vietnam. Panel A represents the ranking of the market risk sorted by VaR, while Panel B represents ranking sorted by CoVaR. Overall, the Services sector usually appears to be the riskiest industry among ten industries in Vietnam. The Oil & Gas sector is ranked the second riskiest industry in Vietnam. We note that the Security sector was used to be considered the riskiest industry before 2014. However, since 2014, the Security sector has been ranked in the middle among all ten sectors. The ranking of Services, Education, and Banking & Insurance sectors vary significantly.

Table 1. Descriptive statistics of the daily return of ten industries in Vietnam.

| Industry         | N | Mean  | St.Dev | Min     | Max     |
|------------------|---|-------|--------|---------|---------|
| Real Estate      | 2194 | 0.00040 | 0.01411 | -0.06831 | 0.05557 |
| Securities       | 2194 | 0.00039 | 0.01768 | -0.07854 | 0.06712 |
| Telecom          | 2194 | 0.00063 | 0.01265 | -0.07252 | 0.05568 |
| Oil & Gas        | 2194 | 0.00026 | 0.01910 | -0.08105 | 0.06423 |
| Services         | 2194 | 0.00054 | 0.01912 | -0.09548 | 0.09081 |
| Pharmacy         | 2194 | 0.00055 | 0.01087 | -0.06240 | 0.05643 |
| Education        | 2194 | 0.00058 | 0.01614 | -0.07869 | 0.09422 |
| Energy           | 2194 | 0.00078 | 0.01182 | -0.06551 | 0.05031 |
| Banking & Insurance | 2194 | 0.00043 | 0.01513 | -0.07281 | 0.05712 |
| Food             | 2194 | 0.00049 | 0.01201 | -0.06692 | 0.04580 |

In particular, Services was the riskiest industry in many years during the research period. Education is generally ranked at the average level of market risk in Vietnam. Other sectors appear to be relatively stable in terms of the market risk in Vietnam during the 2012–2020 period and during the monthly period from January 2019 to October 2020.

With the emergence of the COVID-19 pandemic in Vietnam, many industries immediately responded to the shock due to the pandemic. Figure 2 presents the monthly changes of the market risk levels of the ten industries in Vietnam. In response to the pandemic, the Vietnamese government forced two economic isolations in April 2020 and July 2020. At the end of the first economic lockdown at the end of April 2020, the market’s resilience was represented by the risk reductions of all industries. Two months later, in June and July 2020, the Vietnamese government implemented a lockdown again. However, while the first lockdown is the closure of the entire economy, the second lockdown targets specific provinces and cities where the virus spreads. As such, in the second depression, the changes in the market risks of the ten industries are different. From June to July 2020, an increase in the market risk in the Services, Energy, Oil & Gas, and Food industries was observed. In contrast, a decreased market risk was observed in Securities, Real Estate, and Education sectors.

The estimates of the market risk presented in Table 4 and Table 5 below provide a closer look at the change in the market risks of ten industries in Vietnam during the pandemic using the monthly volatility. Table 4 presents the monthly estimates of the market risk for ten industries using the VaR measure. We note that common movements of the market risk in 2019 for all ten industries are observed (Table 4). The sudden change in the level of the market risk occurred when Vietnam came into a complete lockdown in March 2020. The most significant expected loss was from Oil & Gas industry. The isolation of the entire society and economy had provided the most negative effect on Oil & Gas industry due to the shutdown of the whole economy. In addition, we consider that the quarantine within the Vietnamese cities/provinces put significant pressure on transportation because the entire sector appears to be redundant. The huge reduction of travel flows and domestic production reduced demand for oil and gas. As a result, the price of gasoline (the IRON 95) was reduced more than 40 per cent from 21,090 VND/lit, approximately equivalent to 0.9 USD/lit (in February 2020) to 12,660 VND/lit, approximately 0.54 USD/lit (in March 2020).

Our analysis also confirmed a strong response from the industries to the COVID-19 pandemic in February 2020. As a result, education exhibited a minor change of its expected loss from 4.08 per cent in February 2020 to 4.10 per cent in March 2020. In Vietnam, the undergraduate programs have two long vacations. The first one is during the summer vacation from May to August every year. The second long vacation is during the “Tet” holiday, which lasts for approximately three weeks in February. As a result, we consider that the business cycle of the Education industry has exhibited two downturns represented by two extreme losses. The first most significant loss started from May 2020 to July 2020. This loss follows the summer vacation. The second-largest loss started in January 2020 - the Tet holiday. Similar findings are observed when the CoVaR measure is used to estimate the market risks for various industries in Vietnam.

Figure 3 compares the market risks using the VaR measures for industries (Food, Energy, Services, and Telecommunication) between Thailand and Vietnam. Our analyses highlight five differences between Thailand and Vietnam during the emergence of the COVID-19. First, from January 2019 to October 2020, Thailand has a slightly higher overall

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1 The monthly volatility of expected loss is estimated using VaR only because of the similarity between VaR and CoVaR estimates, as presented in Table 1 and Table 2.

2 The gasoline prices were officially announced on the Vietnam National Petroleum Group website: [https://www.petrolimex.com.vn/nl/thong-cao-bao-chi.html](https://www.petrolimex.com.vn/nl/thong-cao-bao-chi.html).
average market risk than Vietnam. The overall average VaR of Thailand and Vietnam are 1.95 per cent and 1.94 per cent. Second, the results presented in Figure 3 demonstrate a stable change. Thai’s industries appear to exhibit a similar level of market risk until March 2020. However, for the same period, these four key industries in Vietnam experienced a very different profile of the market risks.

Third, from March 2020, the Energy sector in Thailand was the most affected sector with its VaR of approximate 10 per cent. The average market risk measured using VaR of the four sectors was almost 8 per cent. In comparison, two significant increases in the market risk level are associated with the two economic lockdowns in Vietnam in March 2020 and July 2020. The monthly average market risk using VaR measure in Vietnam was 5.12 per cent and 3.46 per cent for the first and the second economic lockdown. The Services sector has been the riskiest industry since the occurrence of COVID-19 in Vietnam.

Fourth, the shock to various industries in Thailand took two months to return to their pre-pandemic level, from March to May 2020. However, in Vietnam, the market took almost a month to adjust its risk back to the pre-pandemic level during the two lockdowns.

Fifth, Telecommunication had the highest level of market risk using VaR measure in Thailand before the pandemic from August 2019 to December 2019. However, Energy has now become the riskiest sector since the occurrence of COVID-19 in Thailand. Following Energy, Services has

Table 2. The market risks measured by VaR and CoVaR for ten industries in Vietnam from 2012 to 2020.

| Year | Average | Real estate | Securities | Telecom | Oil & Gas | Services | Pharma | Education | Energy | Banking & Insurance | Food |
|------|---------|-------------|------------|---------|-----------|----------|--------|-----------|--------|---------------------|------|
| 2020 | 2.82%   | 2.86%       | 3.03%      | 2.44%   | 3.79%     | 4.41%    | 2.48%  | 2.57%     | 2.48%  | 3.34%               | 1.90%|
| 2019 | 1.70%   | 2.15%       | 2.58%      | 1.97%   | 2.51%     | 2.59%    | 2.67%  | 1.82%     | 1.81%  | 2.03%               | 1.94%|
| 2018 | 2.83%   | 2.56%       | 3.44%      | 2.42%   | 4.44%     | 2.86%    | 2.03%  | 2.89%     | 2.09%  | 2.65%               | 1.92%|
| 2017 | 1.73%   | 1.38%       | 1.64%      | 1.47%   | 1.94%     | 2.44%    | 1.58%  | 2.10%     | 1.82%  | 1.64%               | 1.92%|
| 2016 | 2.45%   | 1.85%       | 2.01%      | 1.39%   | 3.21%     | 4.90%    | 1.78%  | 3.08%     | 1.37%  | 2.03%               | 1.99%|
| 2015 | 2.20%   | 1.17%       | 2.57%      | 1.77%   | 3.36%     | 3.34%    | 1.61%  | 2.53%     | 1.27%  | 2.71%               | 1.84%|
| 2014 | 2.37%   | 2.59%       | 3.91%      | 2.69%   | 3.27%     | 1.83%    | 1.73%  | 1.94%     | 1.93%  | 1.94%               | 1.84%|
| 2013 | 2.18%   | 2.45%       | 2.58%      | 1.96%   | 2.49%     | 2.63%    | 1.65%  | 1.55%     | 2.22%  | 2.18%               | 1.25%|
| 2012 | 2.64%   | 2.97%       | 3.93%      | 2.24%   | 3.07%     | 2.25%    | 2.04%  | 2.44%     | 2.43%  | 2.69%               | 2.92%|

Table 3. Risk ranking for ten industries based on VaR (Panel A) and CoVaR (Panel B) from 2012 to 2020.

| Year | Real Estate | Securities | Telecom | Oil & Gas | Services | Pharma | Education | Energy | Banking & Insurance | Food |
|------|-------------|------------|---------|-----------|----------|--------|-----------|--------|---------------------|------|
| 2020 | 5           | 4          | 2       | 8         | 2        | 1      | 9         | 6      | 10                  | 3    |
| 2019 | 4           | 5          | 6       | 3         | 2        | 10     | 10        | 1      | 8                   | 7    |
| 2018 | 6           | 3          | 7       | 1         | 5        | 9      | 4         | 8      | 2                   | 10   |
| 2017 | 9           | 6          | 8       | 3         | 1        | 7      | 2         | 4      | 5                   | 10   |
| 2016 | 7           | 5          | 9       | 3         | 1        | 8      | 2         | 10     | 4                   | 6    |
| 2015 | 6           | 4          | 8       | 1         | 2        | 9      | 5         | 10     | 5                   | 7    |
| 2014 | 4           | 1          | 3       | 2         | 9        | 10     | 6         | 7      | 5                   | 8    |
| 2013 | 3           | 2          | 8       | 4         | 1        | 9      | 10        | 5      | 6                   | 7    |
| 2012 | 3           | 1          | 9       | 2         | 8        | 2      | 10        | 5      | 6                   | 4    |
Figure 2. Monthly market risk of ten industries in Vietnam using the VaR measures.

Table 4. The market risk for ten Vietnamese industries using VaR measure, January 2019 to October 2020.

| Year | Month | Real estate | Securities | Telecom | Oil & Gas | Services | Pharmacy | Education | Energy | Banking & Insurance | Food |
|------|-------|-------------|------------|---------|-----------|----------|-----------|-----------|--------|---------------------|------|
| 2020 | 10    | 0.60%       | 1.67%      | 1.13%   | 1.01%     | 2.96%    | 0.95%     | 0.60%     | 0.93%  | 0.52%               | 0.89%|
| 2020 | 9     | 1.25%       | 0.83%      | 1.46%   | 1.51%     | 1.67%    | 0.86%     | 2.42%     | 0.76%  | 1.45%               | 0.74%|
| 2020 | 8     | 0.73%       | 1.18%      | 0.94%   | 0.85%     | 1.44%    | 0.95%     | 3.14%     | 0.60%  | 0.98%               | 0.79%|
| 2020 | 7     | 2.82%       | 3.85%      | 2.72%   | 4.45%     | 5.80%    | 1.53%     | 1.83%     | 1.97%  | 3.49%               | 3.35%|
| 2020 | 6     | 3.20%       | 4.14%      | 2.27%   | 3.63%     | 4.13%    | 1.59%     | 2.76%     | 1.38%  | 3.17%               | 2.59%|
| 2020 | 5     | 1.50%       | 2.17%      | 1.60%   | 1.79%     | 2.54%    | 0.55%     | 1.36%     | 1.79%  | 1.54%               | 1.51%|
| 2020 | 4     | 2.48%       | 2.47%      | 2.34%   | 4.03%     | 2.75%    | 0.88%     | 1.18%     | 1.32%  | 2.69%               | 2.20%|
| 2020 | 3     | 6.88%       | 5.52%      | 4.79%   | 8.07%     | 7.30%    | 3.79%     | 4.10%     | 3.56%  | 6.98%               | 4.83%|
| 2020 | 2     | 2.09%       | 2.64%      | 1.90%   | 3.14%     | 3.90%    | 2.66%     | 4.08%     | 1.82%  | 2.76%               | 2.46%|
| 2020 | 1     | 1.35%       | 2.52%      | 1.95%   | 3.53%     | 2.66%    | 2.19%     | 2.12%     | 1.88%  | 2.78%               | 2.87%|
| 2019 | 12    | 0.90%       | 1.59%      | 1.56%   | 1.94%     | 2.04%    | 0.92%     | 2.14%     | 1.46%  | 1.64%               | 1.36%|
| 2019 | 11    | 1.59%       | 1.04%      | 1.98%   | 1.46%     | 1.60%    | 0.58%     | 2.89%     | 1.04%  | 1.77%               | 1.55%|
| 2019 | 10    | 0.75%       | 1.55%      | 1.57%   | 1.42%     | 1.23%    | 0.73%     | 3.23%     | 0.69%  | 1.03%               | 0.73%|
| 2019 | 9     | 0.92%       | 1.30%      | 1.62%   | 1.52%     | 2.39%    | 0.83%     | 1.79%     | 0.85%  | 1.10%               | 0.73%|
| 2019 | 8     | 2.08%       | 1.79%      | 1.25%   | 2.15%     | 1.91%    | 1.19%     | 2.28%     | 0.88%  | 1.24%               | 1.32%|
| 2019 | 7     | 1.53%       | 1.37%      | 1.32%   | 1.73%     | 2.60%    | 1.24%     | 2.43%     | 1.43%  | 1.26%               | 1.03%|
| 2019 | 6     | 1.51%       | 1.17%      | 1.28%   | 2.94%     | 4.33%    | 1.38%     | 3.62%     | 1.70%  | 1.45%               | 1.26%|
| 2019 | 5     | 1.32%       | 1.56%      | 1.64%   | 2.71%     | 2.00%    | 0.97%     | 2.52%     | 1.72%  | 1.63%               | 1.28%|
| 2019 | 4     | 1.62%       | 1.71%      | 1.05%   | 1.34%     | 2.94%    | 1.17%     | 1.36%     | 0.97%  | 1.16%               | 1.46%|
| 2019 | 3     | 2.30%       | 2.06%      | 1.64%   | 2.25%     | 3.22%    | 0.72%     | 3.06%     | 2.32%  | 1.62%               | 0.86%|
| 2019 | 2     | 2.85%       | 1.61%      | 1.75%   | 1.89%     | 1.49%    | 0.80%     | 1.89%     | 1.80%  | 1.52%               | 1.73%|
| 2019 | 1     | 1.04%       | 1.75%      | 1.16%   | 1.54%     | 1.44%    | 1.62%     | 3.49%     | 1.53%  | 1.60%               | 1.06%|
Table 5. Ranking of the monthly market risk for ten industries based on VaR at 95 per cent confidence level.

| Year | Month | Real estate | Securities | Telecom | Oil & Gas | Services | Pharmacy | Education | Energy | Banking & Insurance | Food |
|------|-------|-------------|------------|---------|-----------|----------|-----------|-----------|--------|---------------------|------|
| 2020 | 10    | 8           | 2          | 3       | 4         | 1        | 5         | 9         | 6      | 10                  | 7    |
| 2020 | 9     | 6           | 8          | 4       | 3         | 2        | 7         | 1         | 9      | 5                  | 10   |
| 2020 | 8     | 9           | 3          | 6       | 7         | 2        | 5         | 1         | 10     | 4                  | 8    |
| 2020 | 7     | 6           | 3          | 7       | 2         | 1        | 10        | 9         | 8      | 4                  | 5    |
| 2020 | 6     | 4           | 1          | 8       | 3         | 2        | 9         | 6         | 10     | 5                  | 7    |
| 2020 | 5     | 8           | 2          | 5       | 3         | 1        | 10        | 9         | 4      | 6                  | 7    |
| 2020 | 4     | 4           | 5          | 6       | 1         | 2        | 10        | 9         | 8      | 3                  | 7    |
| 2020 | 3     | 4           | 5          | 7       | 1         | 2        | 9         | 8         | 10     | 3                  | 6    |
| 2020 | 2     | 8           | 6          | 9       | 3         | 2        | 5         | 1         | 10     | 4                  | 7    |
| 2020 | 1     | 10          | 5          | 8       | 1         | 4        | 6         | 7         | 9      | 3                  | 2    |
| 2019 | 12    | 10          | 5          | 6       | 3         | 2        | 9         | 1         | 7      | 4                  | 8    |
| 2019 | 11    | 5           | 9          | 2       | 7         | 4        | 10        | 1         | 8      | 3                  | 6    |
| 2019 | 10    | 7           | 3          | 2       | 4         | 5         | 9         | 1         | 10     | 6                  | 8    |
| 2019 | 9     | 7           | 5          | 3       | 4         | 1        | 9         | 2         | 8      | 6                  | 10   |
| 2019 | 8     | 3           | 5          | 6       | 2         | 4         | 9         | 1         | 10     | 8                  | 7    |
| 2019 | 7     | 4           | 6          | 7       | 3         | 1        | 9         | 2         | 5      | 8                  | 10   |
| 2019 | 6     | 5           | 10         | 8       | 3         | 1        | 7         | 2         | 4      | 6                  | 9    |
| 2019 | 5     | 8           | 7           | 5       | 1        | 3        | 10        | 2         | 4      | 6                  | 9    |
| 2019 | 4     | 3           | 2           | 9       | 6         | 1        | 7         | 5         | 10     | 8                  | 4    |
| 2019 | 3     | 4           | 6           | 7       | 5         | 1        | 10        | 2         | 3      | 8                  | 9    |
| 2019 | 2     | 1           | 7           | 5       | 2         | 9         | 10        | 3         | 4      | 8                  | 6    |
| 2019 | 1     | 10          | 2           | 8       | 5         | 7         | 3         | 1         | 6      | 4                  | 9    |
become the second riskiest sector in Thailand. In Vietnam, among Food, Energy, Services, and Telecommunication, Service had the highest market risk level measured by VaR from March 2019 to September 2019. The sector remains the riskiest sector during the COVID-19 pandemic.

Because of the non-normal distribution of all ten sectors in Vietnam, we consider that the ANOVA test is inappropriate to analyze distributions of the market risk of these sectors before and during the COVID-19 pandemic. Meanwhile, the Kruskal-Wallis test is an alternative to the ANOVA for non-normal distribution data. Thus, we employ the Kruskal-Wallis test to examine equal distributions of the market risk of ten sectors before and during the COVID-19 pandemic in Vietnam. Table 6 presents the results of the Kruskal-Wallis test. As presented in Table 6, two sub-samples are considered with the entire sample from 2012 to 2020 and a sub-sample from 2019 to 2020. We note that only the Services sector appears to follow different distribution before and during the COVID-19 in the samples. The Services sector reveals different distributions before and during the COVID-19 if the sub-sample from 2019 to 2020 is considered. Our results confirm that the COVID-19 pandemic potentially impacts the market risk of the Services and the Securities sectors. We fail to reject the null hypothesis of having the same distribution before and during the COVID-19 for other sectors in Vietnam. However, we note that this statistical evidence does not imply that the COVID-19 does not significantly affect the other eight sectors in Vietnam.

Table 7 reports empirical findings concerning the effect of the COVID-19 pandemic on the market risk of ten sectors in Vietnam. In Table 7, Panel A presents the total data of the ten sectors and 106 months from January 2012 to October 2020. Meanwhile, Panel B focuses on a shorter time window from January 2019 to October 2020 to minimize the impact of unobserved events. In general, the emergence of the COVID-19 does not affect to market risks of ten sectors in both samples. The insignificant effect of the dummy variable of the COVID-19 pandemic on the market risk is observed. The change from the negative impact of COVID-19 on VaR (in Panel A) to the positive impact (in Panel B) implies a possibility of insufficient data in which we have limited observations on COVID-19.

Meanwhile, the two economic lockdowns during the COVID-19 in 2020 appear to affect the market risk of ten sectors in Vietnam significantly. In both panels in Table 7, economic lockdowns significantly increase the market risk in all three empirical analyses. A possible explanation for the significant effect of economic lockdowns on market risk is that economic lockdowns represent urgent threats of COVID-19 in Vietnam, in which all social and economic activities have been prohibited. As such, a sudden break of normal economic activities creates uncertainty for the whole system in Vietnam. As a result, the market risks of ten sectors tend to increase during the economic lockdown periods. The result has been consistently supported by empirical evidence in Table 7 or statistical considerations in Table 4, Figure 2 and Figure 3.

5. Concluding remarks

The COVID-19 is currently the most severe pandemic in the modern world. The current COVID-19 pandemic is considered a dual crisis – the economic crisis and the health crisis. Vietnam has generally been recognized as one of the most successful countries in managing this dual crisis in 2020. However, Vietnam struggled to control the virus until September 2021, when this paper was revised. In the latest update from Vietnam’s Ministry of Health on Thursday, October 14th 2021, Vietnam has had 853,842 people infected with 20,950 dead victims. However, the economic growth has been significantly affected in Vietnam, albeit still positive and one of the most successful economies in the ASEAN region and the world, presents potential damage from the COVID-19. In this study, we estimate the market risk levels for ten industries in Vietnam.

Table 6. Kruskal-Wallis test for equal distribution.

| Variable       | From 2012 to 2020 | From 2019 to 2020 |
|---------------|------------------|-------------------|
|               | With COVID-19 event | With COVID-19 event |
| Real Estate   | 0.000            | 0.697             |
|               | (0.986)          | (0.404)           |
| Securities    | 0.084            | 3.372*            |
|               | (0.773)          | (0.066)           |
| Telecom       | 0.440            | 1.366             |
|               | (0.507)          | (0.243)           |
| Oil & Gas     | 0.003            | 0.938             |
|               | (0.959)          | (0.333)           |
| Services      | 3.066*           | 3.132*            |
|               | (0.080)          | (0.077)           |
| Pharmacy      | 1.099            | 0.590             |
|               | (0.294)          | (0.443)           |
| Education     | 0.000            | 0.135             |
|               | (0.995)          | (0.713)           |
| Energy        | 1.052            | 0.010             |
|               | (0.305)          | (0.920)           |
| Banking & Insurance | 0.162 | 1.214 |
|               | (0.587)          | (0.271)           |
| Food          | 0.315            | 1.874             |
|               | (0.575)          | (0.171)           |

Note: p-value in parentheses; * is statistically significant at 10 per cent.

These industries include Real Estate, Securities, Telecommunication, Oil & Gas, Services, Pharmacy, Education, Energy, Banking & Insurance, and Food in Vietnam during the COVID-19 pandemic. Our study uses both VaR and CoVaR measures to estimate the market risk of various Vietnamese industries.

We find a significant change in the market risk among ten industries in Vietnam since the emergence of the COVID-19 pandemic. Many industries responded to the COVID-19 pandemic. These responses are represented by an increase in the expected loss in February, June, and July 2020. However, it is worth noting that each industry responded differently to the pandemic. First, the Services industry appeared to be the riskiest in 2020. This finding is expected as air travel and holiday services are generally considered the hardest-hit industry during the pandemic. Second, the Education sector may be hit hard by the COVID-19 pandemic. However, this sector has significantly improved in terms of market risk compared to other sectors in Vietnam. It is because Vietnam has successfully implemented the most extensive online programs for schools and universities. Third, Oil & Gas industry used to be in the middle of the market risk measured by VaR and CoVaR.

In addition, our analysis is extended to examine the effect of the COVID-19 pandemic on the market risk of ten Vietnamese sectors. Our empirical findings indicate that the COVID-19 does not appear to affect the market risks of ten sectors in Vietnam. However, we find that the two economic lockdowns during the COVID-19 in 2020 in Vietnam appear to affect the market risk of ten sectors in Vietnam significantly.

Policy implications have emerged on the ground of the above findings for the Vietnamese government. First, the Services sector, one of the most critical sectors in the Vietnamese economy, has been the hardest hit industry during the COVID-19 pandemic. This finding is expected because social and economic activities have been put on hold for an extended period during 2020. The current COVID-19 pandemic has yet to come to an end. However, people and firms appear to be adaptable to the new everyday life. Therefore, we consider it essential for the government to support the services industry for its recovery. Second, the Vietnamese government appears to intervene heavily in the education sector and oil & gas sector. These sectors have exhibited a significant change in the market risk level during the COVID-19 pandemic. These sectors have been considered risky sectors when the pandemic has just hit the country.

\[3\] The normal distribution tests for all ten sectors in Vietnam are in the appendix.
However, later on in the pandemic, these sectors appear to be adaptable well to the change. Public expenditure for education accounts for a large proportion of the Vietnamese GDP (Ho et al., 2020). In addition, many companies in the education and oil & gas industries are state-owned companies. As a result, the quick turnaround of these sectors during the pandemic can be expected from government support. We consider that the Vietnamese government may consider relocating public resources to the hardest-hit sectors so that the economy can recover quickly and firmly when we get out of the pandemic. A simple comparison of the market risk levels between Thailand and Vietnam presents exciting findings concerning the different impacts of the COVID-19 pandemic on the market. As such, while the international experience in managing the current crisis is essential, the unique characteristics of the national economy should be carefully considered to ensure the appropriateness of the policies.

Declarations

Author contribution statement

Chi Minh Ho: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Wrote the paper.

Toan Tan Pham: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Hung Le-Phuc Nguyen: Performed the experiments; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Duc Hong Vo: Conceived and designed the experiments; Analyzed and interpreted the data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

Appendix. Normal distribution tests

| Variable         | Chi-2 test statistics | p-value | Skewness (p-value) | Kurtosis (p-value) |
|------------------|------------------------|---------|--------------------|--------------------|
| Real Estate      | 29.746                 | 0.000   | 0.000              | 0.000              |
| Securities       | 16.454                 | 0.000   | 0.000              | 0.072              |
| Telecom          | 35.982                 | 0.000   | 0.000              | 0.000              |
| Oil & Gas        | 26.982                 | 0.000   | 0.000              | 0.002              |
| Services         | 20.139                 | 0.000   | 0.000              | 0.015              |
| Pharmacy         | 21.928                 | 0.000   | 0.000              | 0.003              |
| Education        | 28.328                 | 0.000   | 0.000              | 0.000              |
| Energy           | 15.398                 | 0.000   | 0.000              | 0.041              |
| Banking and Insurance | 30.202             | 0.000   | 0.000              | 0.001              |
| Food             | 14.356                 | 0.001   | 0.000              | 0.111              |

Note: Null hypothesis is that each variable follows a normal distribution.
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