Are Electric Vehicle Stocks in ASEAN Countries Investible during the Covid-19 Pandemic?

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Abstract. Electric vehicle, as one of the low carbon footprints, has transformed a wide range of energy and public sectors. Utilizing the WHO Covid-19 pandemic statement, we search for the optimal portfolio from the top seven Electric Vehicle (EV) enterprises in ASEAN. Using the MonteCarlo simulation of optimal risky assets portfolio, we find that before and during the pandemic, the optimal portfolio weights differ significantly. Before (during) the pandemic, the investment weight of optimal portfolio consists of Toyota Motor Corporation 49.83% (42.99%), Star 8 Corporation 23.20% (9.73%), Hyundai Motor Corporation 20.81% (10.63%), BMW.DE 2.79% (32.08%), Honda Motor Company 2.56% (0.64%), Mitsubishi Motor Corporation 0.68% (0.09%), and Nissan Motor Co. 0.14% (3.84%). The Sharpe Ratio shows how during the pandemic, the portfolio of EV stocks give more excessive return compare to their risks, from 93.55% to 250.62%. These findings support the notion of how EV stocks are investible, especially during the Covid-19 pandemic. Keywords: Electronic Vehicle; Covid-19; Efficient Frontier; Stocks; Pandemic

1. Introduction

The case of recent Covid-19 pandemic had brought whirlwind to the financial markets worldwide. On the day after the declaration of worldwide pandemic status1, the S&P500, Nikkei-225, and FTSE-100 all decrease to about 9.51%, 4.41%, and 10.87%. The worldwide financial market turbulences could be due to how China, as the epicentrum of the pandemic, transmits shocks to the financial and non-financial firms in G7 countries [1]. Moreover, the shocks also transmit to the brands carrying ‘Corona’ name [2].

The market crash during the Covid-19 pandemic supports the notion of market co-movement during the crisis. The increasing correlation during crisis [3], surge the needs of assets that negatively correlated during market crash. This asset, is later known as the safe-haven asset [4]. Interestingly, empirical evidence shows how alternative investments serve as safe-haven for stocks during the pandemic (see, for example, [5], [6]). Investor, especially modern investors, always consider investments diversity to attain optimal portfolio structures and achieving optimal profit as well. In this case, Markowitz is the first to introduce the concept of selecting asset classes into a defined set of the optimal portfolio, denoting the beginning of Modern Portfolio Theory (MPT) [7]. The concept that being offered by Markowitz (1952) is the Mean-Variance rule, in which investors could optimize their allocation of financial assets by maximize their returns with exact risk tolerance.

The public’s interest in the EVs is growing in the Association of Southeast Asian Nations (ASEAN). According to the ASEAN Automotive Federation, the total number of vehicle sales in ASEAN countries was 3.4 million in 2019. This number is estimated to increase in the next 50 years due to population growth and economic development [8]. Moreover, it is projected that the emerging EV technology unleash the high-efficiency energy, sustainable ecosystem and human beings’ health [8].

1 The World Health Organization (WHO) announces the worldwide pandemic status of Coronavirus disease of 2019 (COVID-19) on March 11, 2020.
The increasing attention of EV in ASEAN could also affect to their stocks’ performance. The positive expectation of markets to the potential of EV could resulting in the high return of EV stocks in the ASEAN countries. Therefore, we aim to shed some light on this issue by scrutinizing the investment decision during Covid-19 pandemic that affects the portfolio of EV stocks’ performances. Using the Monte-Carlo simulation, we construct the efficient frontier of the top 7 EV corporations in ASEAN: Toyota Motor Corporation (TM), Star 8 Corporation (STRH), Hyundai Motor Corporation (HYMTF), Bayerische Motoren Werke AG (BMW.DE), Honda Motor Company (HMC), Mitsubishi Motor Corporation (MMTOF), and Nissan Motor Co. (NSANY) [9]. The findings demonstrate that EV stocks are relatively investible, especially during the Covid19 pandemic, due to the higher Sharpe ratio of the EV stocks portfolio.

2. Data and Method

2.1. Data
We collect the daily price data of the top 7 major players in ASEAN EV industries (TM, STRH, HYMTF, BMW.DE, HMC, MMTOF, NSANY) from Yahoo Finance by installing ‘yfinance’ library in Python programming code. Due to the low global market share of EV stocks in 2016 (0.2%) (Schroder et al., 2021), we deliberately utilize the research period from July 1, 2017 until August 12, 2021. We divide the research period into two sub-periods to investigate the optimal portfolio before and during the Covid-19 pandemic crisis. The first sub-period is from July 1, 2017 until March 10, 2020 and the second sub-period is from March 11, 2020 until August 12, 2021.

2.2. Optimal portfolio construction
We compute the daily return of EV stocks using the following equation.

\[ r_{it} = \frac{P_{it} - P_{it-1}}{P_{it-1}} \]  

Whereas \( r_{i} \) is the daily return of EV stock \( i \), \( P_{i} \) is the price of EV stock \( i \) in time \( t \) and \( P_{i-1} \) is the price of the stock \( i \) in time \( t - 1 \).

We then calculate the expected return \( E(r_{p}) \) and standard deviation (\( \sigma_{p} \)) of the stock’s portfolio using the equation (2) and (3) as follows.

\[ E(r_{p}) = \sum_{i=1}^{n} w_{i} r_{it} \]  
\[ \sigma_{p} = \sqrt{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{i} w_{j} Cov(r_{i}, r_{j})} \]  

Whereas \( w_{i} \) is the portfolio weight of stocks \( i \), and can be calculated from the bordered covariance matrix [10].

We then employ the Monte-Carlo simulation to identify the efficient set of portfolios, or the efficient frontier of risky assets. According to the MPT, the Efficient Frontier is defined as a set of optimal portfolios in the risk-return spectrum [11]. Therefore, the portfolio sets that lie in the efficient frontier offer the highest return for a given level of risk and offer the lowest risk for a given level of return [10], [11].
3. Results and Discussions

3.1 The prices of EV Stocks

![Figure 1. Prices of Top 7 Market Players of EV Stocks in ASEAN Countries from 2017-2021. The dashed line denotes the WHO Covid-19 pandemic in March 11, 2020. Source: Authors' Processed Data (2021)](image)

From the stock price evolutions of the top seven leading players of EV in ASEAN Countries, we could see how Toyota Motor has significantly higher price from other EV companies during 2017-2021. However, all of the EV key players in ASEAN countries face price drops during the day of the WHO Covid-19 pandemic announcement (March 11, 2020). This finding support the notion on how financial markets tend to co-move during the crisis [3], which in line with the other price drops in another stock indices and assets (see, for example, [5], [12]).

Remarkably, during the Covid-19 pandemic (which started with the WHO pandemic announcement until now), all of the EV top market players in ASEAN have significant price increases. Interestingly, Toyota Motor Corporation, Honda Motor Company, and Hyundai Motor Corporation show higher stock performances during than before the pandemic takes place. This phenomenon could be an early indicator on how EV stocks, could be investible during the Covid-19 pandemic.

3.2. Electronic vehicle stocks – before covid-19 pandemic

The top 7 market caps EV stocks’ prices vary before the Covid-19 pandemic, with the highest price mean held by the BMW.DE in 1790000 US Dollar (USD), and the lowest price mean held by the HYMTF in 1963.20 USD (see Table 1). However, the maximum price of EV stock held by the STRH in 8967885 USD, while the HYMTF also held the lowest maximum price in 97900 USD per stock. Interestingly, the highest (lowest) volatility stock before the pandemic held by the STRH (HYMTF) in 1199938 USD (7938.24 USD).
We then investigate the optimal portfolio weight of the top 7 market caps EV stocks by searching the stocks portfolio with highest Sharpe ratio. It means that, the portfolio held the highest excess return from the riskfree rate asset compared to its’ risk (standard deviation). By employing the Monte-Carlo simulation using the Python programming, we unveil that the highest optimal portfolio weight held by TM (49.83%), followed by STRH (23.20%), HYMTF (20.81%). The rest of the EV stocks held similar optimal portfolio weight: BMW.DE (2.79%) HMC (2.56%), MMTOF (0.68%), and NSANY (0.14%) (see Table 2).

Figure 2 displays the efficient frontier of EV stocks before the pandemic, while Figure 3 displays the plot of maximum Sharpe ratio and minimum variance portfolio. The maximum Sharpe ratio depicts the optimal portfolio, while the minimum variance means the lowest risk stocks portfolio. We could see how; the optimal portfolio EV stocks have the expected return of 52.64% and expected standard deviation of 56.27%. The Sharpe ratio of 0.9355 unveil that the excess return of the stock’s portfolio is 93.55% proportionate to the level of portfolio risk.

| No. | Name of Stocks | Weight  |
|-----|----------------|---------|
| 1   | TM             | 49.83%  |
| 2   | STRH           | 23.20%  |
| 3   | HYMTF          | 20.81%  |
| 4   | BMW.DE         | 2.79%   |
| 5   | HMC            | 2.56%   |
| 6   | MMTOF          | 0.68%   |
| 7   | NSANY          | 0.14%   |

Portfolios Performance

| No.  | Metric                         | Value  |
|------|--------------------------------|--------|
| 1    | Sharpe Ratio                   | 0.9355 |
| 2    | Expected Return                | 52.64% |
| 3    | Expected Standard Deviation    | 56.27% |

Table 2. Optimal Portfolio Weight of Top 7 Market Caps EV Stocks – Before Covid-19 Pandemic.

Source: Authors’ Processed Data (2021)
3.3. Electronic vehicle stocks – during covid-19 pandemic
During the Covid-19 pandemic, the top 7 market caps EV stocks’ prices vary greatly. The highest price mean held by the BMW.DE in 1766316 US Dollar (USD), and the lowest price mean held by the MMTOF in 4217.24 USD (see Table 1). However, the maximum price of EV stock held by the STRH in 9497730 USD, while the MMTOF also held the lowest maximum price in 60700 USD per stock. Notably, the highest (lowest) volatility stock before the pandemic held by the BMW.DE (HYMTF, MMTOF, STRH) in 595391 USD (0.00 USD) (see Table 3). Nevertheless, the overall standard deviation of EV stocks is significantly lower during than before the pandemic.
Table 3. Descriptive Statistics of Top 7 Market Caps EV Stocks -During Covid-19 Pandemic.

|          | BMW.DE | HMC     | HYMTF   | MMTOF   | NSANY   | STRH    | TM       |
|----------|--------|---------|---------|---------|---------|---------|----------|
| Mean     | 1766316| 815738.2| 7856.61 | 4217.24 | 130313.9| 737523.2| 257516.4 |
| Standard Deviation | 595391 | 209700  | 0       | 0       | 27100   | 0       | 59900    |
| Min      | 0      | 158000  | 0       | 0       | 4900    | 0       | 48400    |
| Max      | 671261.8| 395060  | 219100  | 60700   | 998700  | 9497730 | 1415500  |
| Count    | 360    | 359     | 348     | 290     | 359     | 226     | 359      |

Source: Authors’ Processed Data (2021)

We also investigate the optimal portfolio weight of the top 7 market caps EV stocks by searching the stocks portfolio with highest Sharpe ratio. By employing the Monte-Carlo simulation using the Python programming, we unveil that the highest optimal portfolio weight held by TM (42.99%), followed by BMW.DE (32.08%), HYMTF (10.63%), STRH (9.73%), and NSANY (3.84%). The rest of the EV stocks held similar optimal portfolio weight: HMC (0.64%) and MMTOF (0.09%) (see Table 4).

Figure 4 displays the efficient frontier of EV stocks before the pandemic, while Figure 5 displays the plot of maximum Sharpe ratio and minimum variance portfolio. The maximum Sharpe ratio depicts the optimal portfolio, while the minimum variance means the lowest risk stocks portfolio. We could see how; the optimal portfolio EV stocks have the expected return of 123.22% and expected standard deviation of 49.17%. The Sharpe ratio of 0.9355 unveil that the excess return of the stock’s portfolio is 250.62% proportionate to the level of portfolio risk.

Table 4. Optimal Portfolio Weight of Top 7 Market Caps EV Stocks – During Covid-19 Pandemic.

| No. | Name of Stocks | Weight |
|-----|----------------|--------|
| 1   | TM             | 42.99% |
| 2   | STRH           | 9.73%  |
| 3   | HYMTF          | 10.63% |
| 4   | BMW.DE         | 32.08% |
| 5   | HMC            | 0.64%  |
| 6   | MMTOF          | 0.09%  |
| 7   | NSANY          | 3.84%  |

Portfolio Performance

| No. | Sharpe Ratio | 2.5062 |
|-----|--------------|--------|
| 2   | Expected Return | 123.22% |
| 3   | Expected Standard Deviation | 49.17% |

Source: Authors’ Processed Data (2021)
3.4. EV stocks portfolio performance evaluation – before and during the covid-19 pandemic

According to the information displays in Table 5, we could also see how in full period, the EV stocks portfolio shows great performance. The expected return of the optimal EV stocks portfolio from July 2017 to August 2021 is 76.11%, while the expected standard deviation is 48.47%. Overall, the optimal portfolio of EV stocks’ excess returns account for 157.03% over its standard deviation. This result could indicate how during the full research period (July 2017 to August 2021), the EV stocks are investible.

Based on Table 5, we learn that during the Covid-19 pandemic, the optimal portfolio weights changed. Although other stocks differ significantly during the pandemic, TM stock remains the highest weight of stock in the optimal portfolio both before and during the pandemic. Interestingly, the STRH stock’s weight decline significantly from the second highest weight before the pandemic, to the fourth highest weight during the Covid-19 pandemic. Contrarily, BMW.DE stock shows a rapid increase of weight in the optimal portfolio from 2.79% to 32.08%.

The highest optimal portfolio weight held by TM stock both before and during pandemic unveil how, the related stock provides the best risk-return trade-off during entire research period. However, the
differences in optimal portfolio weights show how the risk-return trade-off of stocks are time-varying. Therefore, investors should continuously adjust their portfolio weights to attain optimal result.

From Figure 2 and Figure 4, we could see how the expected return (standard deviation) of EV stocks portfolio is higher (lower) during the pandemic. The growing investment in this field turns out promising prospect of low carbon energy development, especially regarding the electric vehicle, which could create bandwagon effect to other investors. In the long run, this situation might speed up the low carbon footprints that leads to sustainable economy.

**Table 5. Optimal Portfolio Weights and Performances – Full Period, Before, and During the Covid-19 Pandemic.**

| No. | Name of Stocks | Full Period | Before Pandemic | During Pandemic |
|-----|----------------|-------------|-----------------|----------------|
| 1   | TM             | 57.22%      | 49.83%          | 42.99%         |
| 2   | STRH           | 14.47%      | 23.20%          | 9.73%          |
| 3   | HYMTF          | 11.13%      | 20.81%          | 10.63%         |
| 4   | BMW.DE         | 13.39%      | 2.79%           | 32.08%         |
| 5   | HMC            | 2.84%       | 2.56%           | 0.64%          |
| 6   | MMTOF          | 0.14%       | 0.68%           | 0.09%          |
| 7   | NSANY          | 0.81%       | 0.14%           | 3.84%          |

**Portfolio Performance**

|   | Sharpe Ratio | Expected Return | Expected Standard Deviation |
|---|--------------|-----------------|----------------------------|
| 1 | 1.5703       | 76.11%          | 48.47%                     |
| 2 | 0.9355       | 52.64%          | 56.27%                     |
| 3 | 2.5062       | 123.22%         | 49.17%                     |

Source: Authors’ Processed Data (2021)

Due to the COVID-19 pandemic, many countries had imposed a complete lockdown of more than two months, which, in turn, has impacted vehicle production. Manufacturing units around the world were shut down, and vehicle sales have taken a huge hit. and thus, disrupt the production activity of electric [13]. On the bright side, there still a lot of vehicle producers that continuing the production with limited number also health protocols and other necessary measures. However, the production suspension on the initial period of outbreak still have measures to the EV manufacturers [13].

During the latter months of 2020, the demand for electric vehicles increases in total [13]. This phenomenon impacted on the EV production around the world, in which the demand for EVs increasing rapidly due to the government encouragement to use low emission fuel vehicles. In addition to the growing production activity of EV, many countries started to increase their EV charging and hydrogen fuelling stations (for example, China, South Korea, Japan) [13]. Overall, this phenomenon has resulted to the increasing demand for EV in the market from June to the first few months of 2021 [13].

3.5. The Market Dynamics of EV

The Market Dynamics of EV could be analysed through the infrastructures’ readiness, the high-cost spare part, also the government policy on the low emission vehicle.

3.5.1. The Overview of EV’s Market Dynamics. Overall, there is a low number of EV charging stations around the world, which indirectly could lead to the decreasing public interest for electric vehicles [13].
Netherlands, amongst other countries, held the most noteworthy EV charger with thickness per 100km’s [13]. However, different countries employ different standards for fast charging: Japan with CHAdeMO, Europe, US, and Korea with CGS, while China with GB/T. It should also be noted on how US-based electric car maker Tesla uses superchargers that are unique to Tesla and could not be used for other EVs brands [13]. Therefore, the lack of standardization for charging stations may have an impact to the overall demand of EVs around the globe. In addition to the infrastructure for EV usage in a nation, we should also consider the cost of EVs’ spare part. One of the costliest pieces of an EV is EV battery, in which by 2010, the cost of an EV battery was around USD 1,100 for ever kWh. However, due to the recent mass production of EV batteries, the cost of EV batteries have decreased to around USD 137 for every kWh in 2020 [13]. The significant decrease in EV batteries’ price may led to the subtraction of the EV’s cost, which could be less expensive than the regular Internal Combustion Engine (ICE) [13].

By 2050, the nation’s worldwide plan to decrease the vehicle emanations [13]. This policy has led to the development of parts related to the EV charging tasks such as charging links, connectors, and compact chargers. For example, as an element of organization between the U.S. divisions of energy and transportation, a vision for a public quick charging network is to be created started from 2020 [13]. This measure also would be taken by governments around the world; and thus, may help to expand the interest and demand for EVs in the upcoming years [13].

The Electric Vehicle (EV) market in ASEAN is estimated to give a Compound Annual Growth Rate (CAGR) about 20% from 2021 to 2025 [9]. The support provided by local governments in the ASEAN (turn EVs into a more affordable vehicle), encourage the public interest to adopt EVs [9]. Amongst the ASEAN countries, Indonesia and Vietnam are the major two-wheeler markets and also actively promoting the locally manufacture electric scooters and bikes [9]. To boost the production and sales of the EVs, the local governments provide incentives to the manufacturers [9]. This measure has resulting into the revenue growth in the ASEAN EV market during the year 2018 to 2020 (see Figure 6).

![ASEAN Electric Vehicle Market - Revenue (USD Million), 2018-2020](image)

**Figure 6. ASEAN Electric Vehicle - Revenue (in USD Million), 2018-2020.**

3.5.2. The Future of EV Market. The global market of EV is dominated by key players such as Tesla (US), BYD (China), Volkswagen AG (Germany), BMW Group (Germany) and Nissan Motors (Japan). These

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2 Reprinted from Mordor Intelligence, 2021, Retrieved from [https://www.mordorintelligence.com/industryreports/asean-electric-vehicle-market](https://www.mordorintelligence.com/industryreports/asean-electric-vehicle-market). Copyright 2021 by Mordor Intelligence.
companies focused on the Research and Development (R&D) process to develop new items and technologies to the product. They also have solid networks at the worldwide level [13].

Interestingly, the biggest EV market for traveller vehicles held by Asia Pacific, followed by Europe and North America [13]. The EV market in Asia Pacific is dominated by China, then followed by Japan and South Korea. The growing interest of public in Asia Pacific mainly driven by the government support for traveller EVs in these countries. In China, there are sponsorships for the EV purchasers also obligatory laws for the vehicle makers to produce a certain number of EVs. In Japan and South Korea, the administrations have developed the EV charging stations, construct the emanation standards, also set up cut-off times for moving to EVs from the ICE vehicles [13]. Recently, Masyarakat Ekonomi ASEAN (MEA) also begun to build their EVs market and estimated to be the most rapid developing business sector in upcoming years [13].

In ASEAN, vehicle sharing services are updating their vehicle to electric vehicle due to the funding attained by start-ups from EV manufacturers and tech companies [9]. There are several policies drafted by the governments to increase the EV adoption in the region. In Malaysia, the National Automotive Policy (NAP) has set up an initial target to manufacture 85 percent of vehicles produced locally to be EVs by [9]. In Singapore, the government provide additional incentives for the purchase of environmentally friendly vehicles to support the cleaner energy vehicles by 2040 [9].

In Indonesia, the vehicle sharing service plays an important role on the EV market. In January 2020, EV ride hailing start up (Grab and Hyundai) launched the GrabCar Elektrik service [9]. Grab also has raised more than $4.5 billion in investments from automakers such as Toyota, Hyundai Motor, also the tech giants Microsoft [9]. Their electric two-wheeler, GrabWheels, also has secured around USD 30 million funding from the electric bikes manufacturer in Taiwan, KYMCO [9].

In Thailand, the government has set up a new roadmap to promote the EV adoption [9]. It has been announced that through various state agencies, the government targeted to manufacture around 250,000 EVs consist of 3,000 electric buses and 53,000 electric motorcycles [9]. In short, the ASEAN Electric Vehicle market is moderately fragmented, as there are several active players in the market: Hyundai, Toyota Motor Corporation, Honda Motor Company Limited, and STAR 8 Company Limited amongst others [9].

![Figure 7 Market Concentration of ASEAN Electric Vehicle Market.](image)

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4. Conclusion

Utilizing the WHO Covid-19 pandemic announcement on March 11, 2020, we investigate on whether the EV stocks are investible in the ASEAN countries or not. Our efficient frontiers constructed by Monte-Carlo simulation show how the portfolio consist of top 7 EV Enterprises’ stocks exhibit better performance during the pandemic. We also learn that during the research period, TM stock remains the highest portfolio weight among other EV stocks.

Our results support the notion on the growing interest of investment in the EV Stocks of ASEAN (Schroder et al., 2021). Interestingly, the empirical evidence shows that the EV stocks are not affected by market crashes during the pandemic. The lower standard deviation of EV stocks portfolio during the Covid-19 pandemic crisis indicates that, EV stocks portfolio might be a good investment. Nevertheless, it is necessary for each investor to continuously monitor and adjust their portfolio due to the time-varying nature of risk and return trade-off.

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