The Impact of COVID-19 on Exchange Rate: Evidence Through Thai Baht

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การศึกษาในครั้งนี้ ทำการศึกษาเกี่ยวกับผลกระทบของโรคติดเชื้อไวรัสโคโรนา 2019 (โควิด-19) ต่ออัตราแลกเปลี่ยนของประเทศไทย กรณีศึกษาผ่านการเคลื่อนไหวของค่าเงินไทยบาท โดยใช้ข้อมูลรายวันของจำนวนผู้ติดเชื้อ และจำนวนผู้เสียชีวิตจากโรคติดเชื้อไวรัสโคโรนา 2019 ในประเทศไทย รวมทั้งข้อมูลอัตราแลกเปลี่ยนเงินตราระหว่างประเทศ (ดอลลาร์สหรัฐ/บาท) (เยนญี่ปุ่น/บาท) (ยูโร/บาท) ตั้งแต่เดือนมีนาคม พ.ศ. 2563 ถึง เดือนธันวาคม พ.ศ. 2564 โดยทดสอบความสัมพันธ์ระหว่างตัวแปรด้วยการวิเคราะห์ถดถอยแบบ OLS (Ordinary Least Squares) ผลการทดสอบชี้ให้เห็นว่า การเพิ่มขึ้นของจำนวนผู้ตีดเชื่อ และผู้เสียชีวิตจากโรคติดเชื้อโคโรนาไวรัส 2019 มีผลกระทบ อย่างมีนัยสำคัญต่ออัตราแลกเปลี่ยนเงินตราระหว่างประเทศ (ดอลลาร์สหรัฐ/บาท) (เยนญี่ปุ่น/บาท) (ยูโร/บาท)

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This paper illustrates the impact of the COVID-19 pandemic on exchange rate of Thailand by using COVID-19 confirmed cases and deaths to measures how Thai Baht volatile during the pandemic period. To examine the impact of COVID-19 on exchange rate of Thailand, the daily data of COVID-19 confirmed cases and deaths of Thailand also the historical data of Thai Baht exchange rate, determine by USD/THB, JPY/THB, and EUR/THB were collected. All data covers the period from March 1, 2020, to December 31, 2021. This study employed Ordinary Least Squares (OLS) regression to estimate the relationship of the variables. The result demonstrates that an increase in COVID-19 confirmed cases and deaths have a significant and positive impact on USD/THB, JPY/THB, and EUR/THB.

Field of Study:	Business and Managerial Economics	Student's Signature .....
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1. Introduction

The topic of the study would be introduced which is the impact of COVID-19 on exchange rate evidence through Thai Baht. In addition, the research's objectives and motivations would be explained along with the details of the introductory stage for the reader. At last, the results and limitations of the study will be explained.

The epidemic of Coronavirus disease 2019 (COVID-19) began in December 2019. It was discovered in the Chinese city of Wuhan. Because Wuhan is a large city with a dense population, the disease spread rapidly, and the World Health Organization announced the COVID-19 pandemic (Coronavirus Pandemic) on March 11, 2020. Outside China, the number of cases was rapidly increasing, and it spread to more than 190 countries worldwide. The world economy suffered as a result of the coronavirus pandemic, and the crisis pour-out and became the impulse for a much broader global financial crisis.

In response to the outbreak of the Coronavirus disease in Thailand, the Department of Disease Control established the Emergency Operation Center (EOC) on January 4, 2020. Thailand's first case involved a Chinese tourist who entered the country on January 12, 2020. A large epidemic was discovered later on. As a result, the government has increased defensive measures to manage the COVID-19 outbreak in the country. The quarantines and lockdowns required to halt the pandemics spread continue to impact Thailand's economic stability. Given the decline in foreign tourist income over the last two years, it has begun a current account deficit for the first time in 16 years, dating back to 2005 (Krungsri Research, 2020).

The Coronavirus pandemic affects the economic growth and inflation of Thailand. It also results in the vulnerability of Thailand's current account balance. This is because Thailand's economic structure has a ratio of trade and services sectors as high

as 45 percent to GDP (13% is tourism revenues), causing stagnation in tourism revenue during the coronavirus crisis. The pandemic dragged on until 2021 and had a significant impact on foreign currency inflow and decreasing on demand of THB.

The foreign exchange market is one of the important parts of the financial system. Therefore, I will focus on the volatility of Thailand's currency market in this study. Before the Coronavirus pandemic, Thai Baht was one of the best performance currencies among Asia Pacific currencies. In 2019, Thailand has been concerned about Thai Baht strengthening which would cause an exporter negative impact due to an increase of the export price. After the pandemic situation in Thailand started to severe, Thailand had only a little over 34,000 foreign tourist arrivals as of May 2021, compared with over 39 million in 2019, before the pandemic. A decrease in tourist arrivals caused less demand in Thai Baht. In 2021, Thai Baht was reported as the worst performance currency compared to other major Asia Pacific currencies (Vishnu Varathan, 2021).

Motivated with this background, this study draws attention to the new pandemic Coronavirus effects in the context of Thailand currency markets focusing on Thai Bath. This study's objective is to explore the relationship between the COVID-19 outbreak and the movement of the Thai Bath exchange rate. Which measure the Thailand exchange rate by two variables are COVID-19 daily confirmed case and death by using the Ordinary Least Square (OLS) regression to estimate result. Using daily data from March 1, 2020, to December 31, 2021, this paper's empirical findings show that a rise in the number of COVID-19 daily confirmed cases and death truly worsens exchange rate movement.

The limitation of this study is the other variables that might affect the exchange rate of Thailand such as interest rate, government policy, consumer price index (CPI), inflation rate and other factors from overseas countries. Therefore, this paper will focus

only on how the pandemic of COVID-19 affects Thailand's currency market and other variables will indicate as error terms and excluded from the analysis.

This paper is organized as follows. In section 2 is devoted to summarizing the preceding literature, and section 3 presented the data and methodology framework. Section 4 reports on the study's findings, and Section 5 is the conclusion.

2. Literature review

2.1 Theoretical review

Currency exchange is done through a market in which currencies are traded between different currencies, known as the "foreign exchange market" or the foreign exchange market. One foreign currency compared to another is known as the "Foreign Exchange Rates".

The exchange rate fluctuates all the time due to internal and external impacts and other factors affecting exchange rates both economically and financially. This exchange rate must be in the criterion that can be balanced in terms of both imports and exports causing the government to play a role in controlling the exchange rate so that the exchange rate does not fluctuate much to prevent deficits of the country account balance and prevent foreign exchange speculation. There are some important theories related to the exchange rate has been reviewed as follows.

Purchasing Power Parity Theory (PPP): (Gustav Cassel, 1918) said that with the same amount of money should be able to buy the same amount of the same product, which means that the same product sold in each country The selling price is the same when thinking in the same currency The concept of equality in purchasing power can be explained in two ways:

1) Absolute Purchasing Power Parity: this theory is under assuming that the international trading market is completely competitive with no shipping costs and any trade barriers.

2) Relative Purchasing Power Parity: this theory is able to solve the deficiencies of the previous method, that is when using the price index to debug multiple products. However, the price index used is still the component of the product and the importance of the product is not the same. By looking at the rate of change instead to eliminate the problem.

Interest Rate Parity Theory (IRP): represents the relationship between the interest rate factors. that affects the determination of the exchange rate of a currency when compared to another currency. The return on capital in the form of deposit accounts depends on two factors which are the interest rate and the exchange rate. IRP is a comparison of deposit accounts in two currencies that if the factors Interest causes the returns in the form of deposit accounts to differ, and thus will cause the flow of funds in a certain currency with a low yield to another with a significantly higher yield until the return between the two currencies are equal. The lower-yielding currencies will depreciate until they reach a level of equitable treatment interest rate.

A Long-run Exchange Rate Model Based on PPP: long-term exchange rate adjustment theory comes from the concept of purchasing power parity. We can use the concept of money supply and demand to describe long-term exchange rates. By requiring the price to be changed by adjusting the income to the level of full employment found that the exchange rate is also determined by the amount of money and the amount of money demand is determined by interest rates and yields.

This concept suggests that if the supply of Thai Baht is permanently increased as a result, product prices in the country increased in the same proportion in the long term and caused Thai Baht to depreciate by the same proportion in the long term. On the

other hand, if the supply of Thai Baht is permanently reduced as a result, domestic product prices have adjusted. Decreased in the same proportion in the long term and caused the baht to increase in the same proportion in the long term.

Adjustment of exchange rates according to market mechanisms: central bank determines exchange rate policy which has different exchange rate systems, changing in balance of payments, affect exchange rates differently. The exchange rate system used by Thailand is the Managed Floating Exchange Rate.

Managed floating exchange rates allows the exchange rate to follow the market mechanism according to the supply and demand of that currency. But central banks may intervene when speculation or currency exchange rates are too volatile by various interventions such as policy implementation, interest rates to control the inflow of funds, etc., which this system can reflect changes in the balance of payments account.

Fisher Effect theory: this theory explains that the nominal interest rate is equal to the real interest rate plus the inflation rate of that country. The term used to effectively convey the link between inflation and interest rates when using interest rate information from government securities. However, the linkage between inflation and interest rates is not very precise in the long run because the long-term interest rate applied is affected by the level of financial risk hidden in that long-term securities as well.

International Fisher Effects: explain that the instantaneous exchange rate change is the same as the difference the nominal rate of both countries in the opposite direction in the event that the market has to move freely and in a balanced manner.

Consumer Price Index (CPI):

Consumer Price Index is a statistical measure to track changes. of things to be measured or as a means of indicating situations interested in which in different sectors

of the economy, there will be indices that measure different conditions and changes, such as the Consumer Price Index, private Investment index, industrial production index, etc.

Consumer Price Index: statistics used to measure the change in the retail price of a product and the average service a consumer pays to obtain a certain amount of goods or services compared to the base year where the base year is the year in which the Consumer Price Index is determined to be equal to 100. The Consumer Price Index is used as a measure of people's cost of living. It is used to measure the inflation level of the country. It is also used to measure the level of real income of people and groups.

The basic concept of the Consumer Price Index is derived from the concept of the Cost-of-Living index, which requires data on an individual's monthly spending while still maintaining quality of life level which in fact can be difficult to use. Because there are other factors such as consumer income. number of household members, technology, product quality, product price, including tax change Therefore, the consumer price index was used instead. By stipulating that the goods are of constant quality and quantity, and to allow changes in the prices of goods and services only.

The Consumer Price Index data can be used to measure consumer inflation within the country where the value of this index is greater than the forecast shows an increase in inflation results in more money but less in goods. In order to control inflation, the central bank should adjust the rate of interest and value-added local currency when this happens, investors tend to move their investments to the local currency. In the other hand when Consumer Price Index is lower than the expectation which exhibit the deflation, the investor' s demand for local currency will decrease and lead to a devaluation of the local currency.

The Stock Index: is an index that reflects the movement of prices of all securities by calculating from all ordinary shares listed on the stock exchange which will include investment units of property funds listed on the Stock Exchange of Thailand. SET Index calculation can be done using the Market Capitalization Weighted method by comparing the current market value of the securities (CMV) with the stock market value on the base market value (BMV). The index is set to start at 100. Any changes in the stock market index reflects the expectations of investors. Invest both at home and abroad which resulted in the flow of foreign capital result in change in exchange rate.

Money Supply: refers to all stocks of currencies and other liquid instruments with liquidity in the country's economic system at any given time. Money Supply has various type, and the well-known type are divided into 3 categories and have broad definitions as follows:

Money Supply M1: it is a measure of the money supply that focuses on the role of money as a medium of exchange It consists of banknotes and coins that are in the hands of the people and includes current deposits. It is an idea that gave rise to an Automatic Tailor Machine (ATM). And debit cards, that means checking bank accounts are now being considered. It is M1 type of revolving money because it is easy to withdraw, can pay for liquid currency. from them using ATMs and debit cards. M1 cash flow is used to measure the amount of money circulating in a system that has Highest liquidity but not including assets that are close to converting to money.

Money Supply M2: includes current M1 assets as well as near-convertible assets such as fixed deposits which can be converted into cash but are inappropriate medium of exchange as they are less liquid than money circulating type M1.

Money Supply M3: is the money supply in M2 working capital, as well as other less liquid assets, it is often referred to large financial institutions or more in the organization

in terms of the intermediary of volume exchange. M3 working capital is the broadest financial metric.

The amount of money in circulation does not have a high impact on the market and cannot be directly measured, but the central bank can use it as a tool to determine exchange rate policy in the future.

2.2 Literature review

The influence of a pandemic on many economic elements has spawned an abundance of literature. I also examined at previous research on the subject of the impact of the SARS and influenza epidemic on the economy. Few of the studies are cited here; (Hao□ Yen and Ku□ Hsieh, 2009) this paper examines the effect of SARS epidemic on the tourist sector in Taiwan by using a computable general equilibrium model. The paper found that SARS epidemic result in a decrease in the number of visitor arrivals to Taiwan and a drop in visitor spending on the Taiwanese economy. The findings also indicate that a SARS outbreak has a negative impact on GDP and employment rate in Taiwan. Moreover, this paper suggests implications for the policy of Taiwan' s government.

Richard D Smith (2009) illustrates the Influenza pandemic's potential economic impact, corresponding behavioral reactions, shutdowns of schools, and vaccination on the United Kingdom. By using a computable general equilibrium model on the 2004s database of UK economy. The main result found that pandemic Influenza has an impact on the UK economy in many aspects. The costs of ailment solely tend to range from 0.5 percent to 1. 0 percent of UK gross domestic product. Pre-pandemic vaccine vaccination could help the decrease in gross domestic product, as well as two doses of a matched vaccine could reduce the overall financial impact. In conclusion, the author suggests that a policy to balance school shut down and acquiring adequate supplies of

an effective vaccine are crucial factors. The disease itself is less essential in measuring economic impact of a pandemic influenza.

Gen-Fu, Hao-Chang, Qiang Gong, and Chun-Ping (2020) illustrate the COVID-19's significantly effect on exchange rate volatility in 20 countries, as well as the relevant government reaction policies. The method this paper used is system GMM estimation. Data for the testing period was collected from January 13, 2020, to July 21, 2020. This study was decided to used control variables as follows, interest rate, the logarithm of foreign exchange reserves, and the logarithm of the consumer price index of each country as they impact a domestic foreign exchange market. Follow to research results a rising in confirmed COVID-19 cases significantly grew exchange rate volatile. To reduce exchange rate volatility, the action of government on economic response and policy such as lockdown, school closures, fiscal measures, and other restrictions are required.

Khan, K., Zhao H., Zhang H., Yang H., Shan M. H., and Jahanger A. (2020) investigate the impact of the coronavirus pandemic on the stock markets of sixteen countries. The researcher estimated the result by using pooled OLS regression, the conventional t-test, and the Mann-Whitney test. Also, use a weekly panel data set of COVID-19 confirmed cases and stock market returns to estimate. The empirical result reveals an increase of weekly new COVID-19 cases has a negative impact on predicting stock market returns. Then this paper compared the stock market's performance before and after the coronavirus pandemic. The result from comparing concluded that in the first stage of COVID-19 pandemic domestic investors do not respond to the pandemic report. However, after the human-to-human transmission was affirmed, all indices of the stock market significant negative react to the news in both short and long-term event windows. In addition, they found that the Shanghai Composite Index had rebounded during the long term. Therefore, this illustrated that the Chinese government’s policy to halt the

spread of the pandemic and recovered investor confidentiality in the Shanghai Stock Exchange

Libo XU (2021) evaluated a dynamic reaction of stock returns to unexpected changes in COVID-19 cases, also the unpredictability surrounding the pandemic. The paper collected data of COVID-19 cases and stock market returns from Canada and the United States. The empirical result from a study explored that a rising in COVID-19 confirmed cases has a negative impact and asymmetric effects on the returns of Canada's stock market. In addition, an increase and decrease in COVID-19 confirmed cases had caused symmetric responses in the stock returns. The discrepancy could be due to different weights in various industries.

By Lamia and Kaouther (2020), the paper applied a GARCH (1,1) model to evaluate the influence of COVID-19 cases and related deaths on US exchange rate volatile. According to the findings, an increase in the number of COVID-19 confirmed cases and deaths in the United States has a positive impact on the USD/EUR, USD/Livre Sterling, and USD/Yuan exchange rates. Furthermore, this paper employs the GARCH (1,1) a model for forecasting the daily fluctuation of three currency series in relation to the US dollar. These findings are important for anyone looking for forex market volatility forecasts.

Chuanjian L., Zhi-Wei S., Tanzeela Y. and Yumna S. (2021), investigates on COVID-19 and the currency market by comparing an exchange rate movement between China and United State. They investigate on the long-term impact of Coronavirus pandemic on economy. The data of COVID-19 confirmed cases and deaths in China and the United States were collected, period from January 22, 2020, to May 7, 2021. The methodology they used is the ADRL (autoregressive dis- tributed lag) model. From the results, the exchange rate was negative impact from increasing in COVID-19 cases

and deaths. In addition, the impact continues in long run and this was hitting the financial and economy of China and the United States.

Herwany A., Febrian E., Anwar M., & Gunardi A. (2021), investigates the impact of the COVID-19 pandemic on existing sectors, and how the pandemic effects the Indonesian Stock Exchange market. A methodology that this research has used is an event study that employed market model in nine sectors of the Exchange and used the Ordinary Least Square (OLS) regression to estimate the relationship between selected variables. According to the study results, the sector that has a huge effect is the financial sector, secondly is trade, service, and investment sectors. The results also reveal a negative consequence of COVID-19 on the Indonesian stock market by negative market returns.

Takeshi Hoshikawa and Taiyo Yoshimi (2021), explores the effects the impact of the COVID-19 pandemic on South Korea's stock exchange and currency exchange rate. The data of COVID-19 cases and related deaths in South Korea were used, also the data of stock market return and South Korean exchange rate price. The VAR model were used in this study, and they applied Ordinary Less Square (OLS) and GARCH model to estimate the relationship between variables. Empirical results indicated that a spike in the proportion of new cases and deaths as a result of COVID-19 impact South Korean stock market volatile. This lead less confident of foreign investor toward South Korea stock market and as a consequence, the KRW has depreciated in relation to the USD. The Bank of Korea attempted to stabilize the value of Korea Won (KRW) by intervention the foreign exchange market. The intervention has a short-term impact on restoring the value of KRW. However, the long-run effect to Korea economy is still exist.

Philip Ifeakachukwu Nwosa (2020), explores the effect of the COVID-19 disease outbreak on oil prices, exchange rates, and stock market performance, and the implications for Transnational Corporations (TNCs) and Foreign Direct Investment (FDI) inflow in Nigeria. The data was collected from December 2019 to 31 May 2020. This

research used descriptive and causality techniques. The study reveals that coronavirus pandemic had significant impact on oil price, exchange rate price and stock exchange performance in Nigeria. Moreover, this study find that COVID-19 had a greater effect on oil prices, exchange rates, and stock market performance than the global recessions in 2009 and 2016. It was also discovered that the COVID-19 pandemic had an impact on aggregate demand and the supply chain.

Cardona-Arenas, Carlos David and Serna-Gomez, Hector Mauricio (2020), explores the effect of coronavirus outbreak on the market exchange rate of the Colombian peso from February 16 to March 14, 2020. This time period was chosen due to the pandemic spread to South America during this time period and the first case was found in Colombia. Moreover, a shock in the market representative exchange rate was found over the same period. To estimate the effect, a Vector Autoregressive Model (VAR) with no arbitrary constraints was created. This was done due to there is insufficient evidence to suggest a causal relationship between the Colombian exchange rate and COVID-19, as well as between the pandemic and oil prices.

Karan Rai & Bhavesh Garg (2021), explores the effect of the COVID-19 pandemic on dynamic relationships and market volatility between exchange rates and stock prices in the BRIICS economies (the five major emerging economies: China, India, Russia, Brazil, and South Africa). This study employs the volatility modelling and demonstrate that in most BRIICS economies, stock and exchange returns have substantial negative interactive correlations and volatility spillovers. Moreover, during the early days of lockdowns, the relationship grew stronger. Moreover, the empirical results indicate that during the COVID-19 dispersion, significant risk transfers occurred between the two markets. This resulted in a falling domestic stock returns and subsequent capital outflows and cause exchange rates to rise.

Neluka Devpura (2021) , using intra-day data, investigate the relationship between the Euro-United States Dollar (Euro/USD) exchange rate and the price of oil futures. Using a predictive regression model the result shows that the Euro/ USD exchange rate has been affected by the price of oil, but the proof is very confined. Furthermore, when we account for the effect of COVID-19, this relationship disappears. Overall, COVID-19 has an impact on the exchange rate in March 2020. By considering the oil price and exchange rate nexus during the pandemic, the COVID-19 effects on the financial and economic system are examined.

The above review highlighted that most of the research had been done on panel settings, and different financial variables have been targeted also the exchange rate of many developed countries and emerging countries around the world. Thus, this study attempts to focus on the impact of COVID-19 on the exchange rate of Thailand (Thai Baht).

3. Data and Methodology

3.1 Variables and sample

To examine the impact of COVID-19 on exchange rate of Thailand. Firstly, the data of COVID-19 confirmed cases and deaths of Thailand were obtained from https://ourworldindata.org/. Secondly, the daily volatility based on the Thailand historical data of exchange rate, whereas comes from the database of Bank of Thailand (https://www.bot.or.th/) were collected. USD/THB, JPY/THB, and EUR/THB are used to determine the exchange rate of Thailand. Because US Dollar, Japanese Yen, and Euro are the currencies of Thailand's major trading partners, the author then decides to use these currencies pair to determine Thai Baht exchange rate.

All data covers the period from March 1, 2020, to December 31, 2021, which gives 443 observations. For the period of data, I start to collect from March 2020 due to

the pandemic situation in Thailand starting to severe, the government has increased defensive measures to manage the COVID-19 outbreak in the country and the first lockdown has been announced.

3.2 Methodology

In the study of the impact of COVID-19 on exchange rate movement which is time-series data, the necessary step is to consider, whether the time series data is static or not. The time series is co-integrated if they hold a long-run and equilibrium relationship between them. To determine data stability, the study used the unit root test to determine whether the variable under consideration is stationary. Using the Augmented Dickey-Fuller (Dickey & Fuller, 1979, Dickey & Fuller, 1981) test and on non-stationary data to avoid data with mean and variance at different time intervals (ADF).

It will first test data where the order of integration equals 0 or I(0) at levels without trend and intercept, levels with intercept, and levels with the trend and intercept, and then consider the data's stability. By comparing the ADF statistic with the MacKinnon Critical value at a significance level of 0.10. The data, according to MacKinnon Critical, is static. This is changed by comparing the first or subsequent sequences until the data is static, but only if the resulting ADF statistic is low. A value greater than the MacKinnon Critical value indicates stable data.

$$\Delta y_t = \alpha + \delta t + \beta y_{t\,1} + \gamma_j \Delta y_{t-j} + \varepsilon_t$$

Where:

y_t is variables to be tested for Unitroot

α is constant variable

δ, β and γ is coefficient

t is trend

ε_t is error term

The hypothesis in the test are as follows:

$$H_0 : \beta = 0$$

$$H_1 : H_0 \text{ is not true}$$

If β is equal to 0, then y_t has a unit root, i.e., the data is dynamic, the mean and variance change over time. The difference in y_t must be continued until H_0 is rejected. The number of times the difference gives us the order of integration (d) which is at the level [$y_t \sim I(d); d>0$].

When testing the stillness in both the base rank and the first divergence allows to specify the order of the aggregation of the data is static. In the fundamental order, it is called the data as the sequence of the elementary aggregation [I(0)], but if the data is stagnant in the first place then it is called data is the first order of integration [I(1)]. The reason for specifying the order of integration is to use data with the same order of integration to estimate in the system of equations is to reduce the problem of deceptive relationships and the problem of explaining results.

Secondly, this study employed the ordinary least squares (OLS) regression to estimate the relationship between exchange rate volatilities and COVID-19 confirm cases and deaths of Thailand.

3.3 Econometric Model

This study employed Ordinary Least Squares (OLS) regression to estimate the relationship between exchange rate volatilities and COVID-19 confirm case and death of Thailand.

Ordinary least squares (OLS) regression is a statistical technique for calculating the association between one or more independent variables and a dependent variable; the method calculates the relationship by minimizing the sum of the squares of the difference between the actual and predicted values of the dependent variable, which is represented by a straight line. In this entry, we will look at OLS regression in the framework of a bivariate model, specifically, a model in which only one independent variable (X) predicts a dependent variable (Y). The logic of OLS regression, on the other hand, is broadly applied to the multivariate model with two or more independent variables. The models under the framework of OLS methodology are as follows:

$$USDTHB_t = \alpha_0 + \alpha_1 COVID(cases)_t + \mu_t \quad (1)$$

$$JPYTHB_t = \delta_0 + \delta_1 COVID(cases)_t + \mu_t \quad (2)$$

$$EURTHB_t = \partial_0 + \partial_1 COVID(cases)_t + \mu_t \quad (3)$$

$$USDTHB_t = \beta_0 + \beta_1 COVID(deaths)_t + \varepsilon_t \quad (4)$$

$$JPYTHB_t = \gamma_0 + \gamma_1 COVID(deaths)_t + \varepsilon_t \quad (5)$$

$$EURTHB_t = \rho_0 + \rho_1 COVID(deaths)_t + \varepsilon_t \quad (6)$$

Where: (USD/THB), (JPY/THB), and (EUR/THB) denotes the exchange rate of Thailand; $COVID(cases)_t$ is the number of cases (Total cases) and $COVID(deaths)_t$ is the number of deaths (Total deaths) in Thailand at time t.

4. Empirical results

In this chapter will illustrate the reported on results of a study on the relationship between Thai Baht exchange rate movement and COVID-19 new cases and new deaths during the selected period. In this study, the study process and the analysis are divided into two steps, the first step is to test the stationary of the data (Unit Root Test) to test whether the data is stationary or non-stationary. The second step is to perform a variable correlation test to determine whether the variable X defines the variable Y or whether the variable Y defines the variable X. The test results are explained as follows.

The descriptive statistics of daily price of the USD/THB, EUR/THB, and JPY/THB and measures of Covid-19 daily case and death are presented in Table 1. On average 3,284 cases and 33 deaths were reported in Thailand during the selected period. The maximum number of cases was 23,418 13, August 2021 and the maximum number of deaths was 312 reported on 17, August 2021. The minimum number of cases was -10 and the minimum number of deaths was 0 during the period.

In addition, the reason for the negative number of cases were reported due to the make of corrections in the data clean-up has been occurring throughout the pandemic, according to a new release, which is the reason for ten cases being decreases from the COVID-19 confirmed cases data. The explanation is that positive COVID-19 tests confirm and included in daily country case numbers are required to be determined by PCR test. And some of positive antigen test were report incorrectly so the data clean-up was makes to correction the reporting

Table 1: The descriptive statistics of all variables

Variables	*USDTHB*	*EURTHB*	*JPYTHB*	*COVID-19(cases)*	*COVID-19(deaths)*
Mean	31.89	37.19	29.71	3,284.15	33.39
Standard Error	0.05	0.08	0.03	255.87	2.98
Median	31.59	37.22	29.66	122	0
Standard Deviation	1.13	1.67	0.62	5,385.34	62.78
Sample Variance	1.27	2.78	0.39	29,001,843.78	3,940.95
Kurtosis	-1.01	1.92	-0.93	2.37	5.05
Skewness	0.19	-1.11	0.14	1.8	2.34
Range	4.13	8.40	2.66	23,428	312
Minimum	29.97	31.54	28.53	-10	0
Maximum	34.09	39.94	31.19	23,418	312
Sum	14,126.43	16,476.23	13,162.94	1,454,880	14,791
Count	443	443	443	443	443

Figure 1: Thailand COVID-19 new cases during March 1, 2020, to December 31, 2021

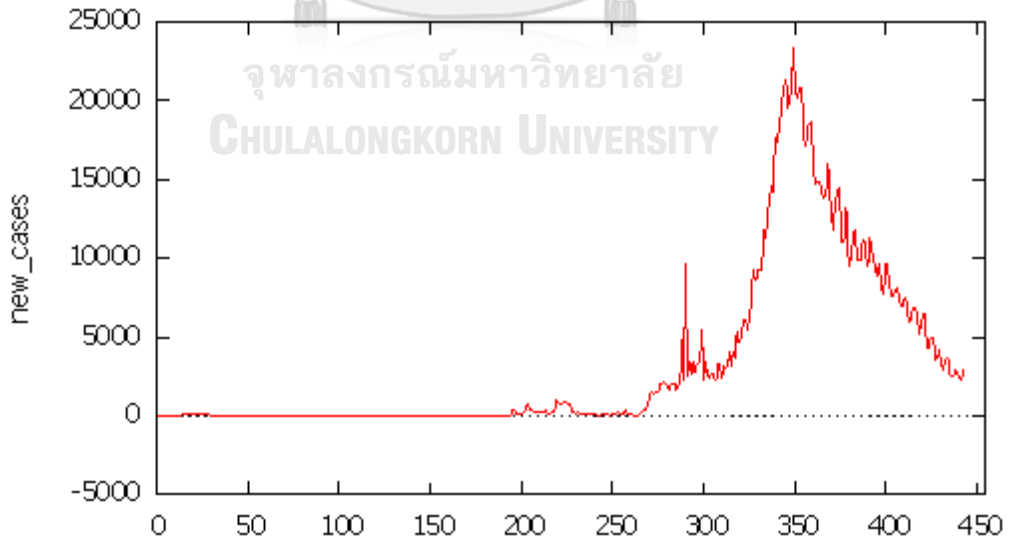

Figure 2: Thailand COVID-19 new deaths during March 1, 2020, to December 31, 2021

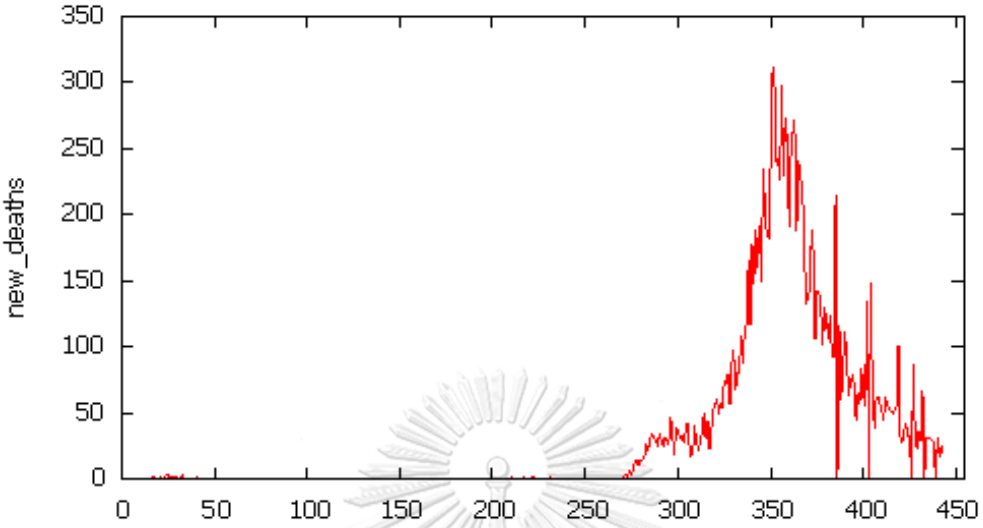

Figure 3: USD/THB exchange rate during March 1, 2020, to December 31, 2021

Figure 4: JPY/THB exchange rate during March 1, 2020, to December 31, 2021

Figure 5: EUR/THB exchange rate during March 1, 2020, to December 31, 2021

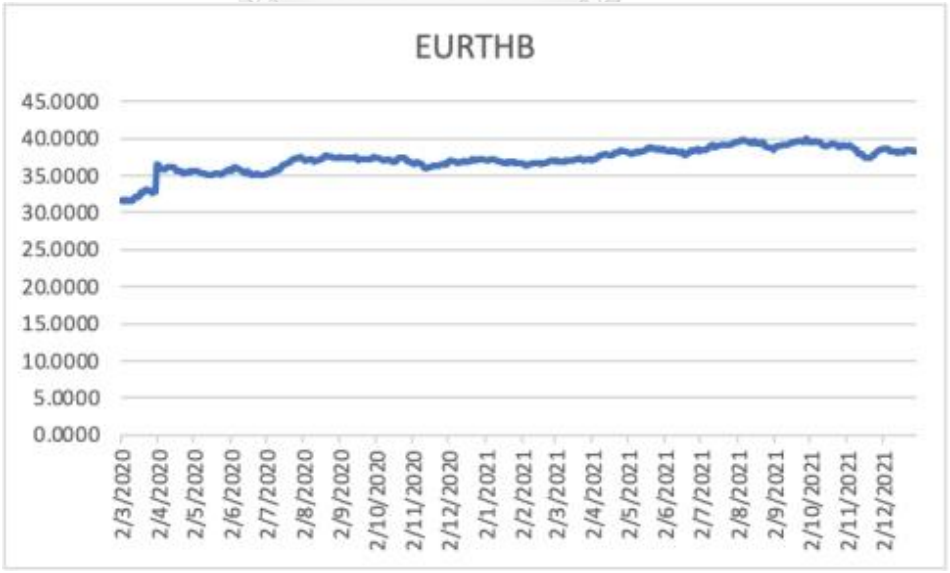

Figure 1 represents the daily price of COVID-19 new cases and figure 2 represents the daily volatility of COVID-19 new deaths, both graphs show a similar pattern. The peak of COVID-19 new cases and new death seems to be in the same period. On day 350 the number of new cases and new deaths were at a peak and then increased slowly.

Figure 3, 4, and 5 presented the daily volatility of the exchange rate prices of USD/THB, JPY/THB, and EUR/THB respectively during March 1, 2020, to December 31, 2021. The figure illustrates a view of Thai Baht volatilities to the main pair currency which were traded in Thailand. And they revealed almost the same patterns, Thai Bath continues dropping against the world's main currencies which in this research are USD (US Dollar), JPY (Japanese Yen), and EUR (Euro) while the confirmed COVID-19 cases and deaths are increasing. The dropping of Thai Baht shows in a figure as the rising of Thai Baht price against main currencies pair. Also, the figures are present the depreciation of Thai Baht during the selected period.

By comparing three currency pair data we will see that the USDTHB and JPYTHB were more volatile than EURTHB. Moreover, USDTHB was the most volatile currency pair during a selected period.

Table 2: Unit Root test using Augmented Dickey-Fuller test results

Variables	t-statistic	p-value	Stability Degree
(USD/THB)	3.507	0.0005 ***	I(1)
(JPY/THB)	4.057	0.0009 ***	I(1)
(EUR/THB)	3.449	0.0119 ***	I(0)

Table 2 presents the results of the Unit Root Test data analysis, considering the Augmented Dickey-Fuller Unit Root Test. Looking at the P-value, the ADF statistics showed that USD/THB, JPY/THB non-stationary result at level and stationary at first difference which has P-value less than the 5% significance level (0.05). In addition, EUR/THB stationary at first difference which has P-value less than the 5% significance level (0.05). Therefore, the variables are stationary and able to apply in the research model.

Table 3: OLS regression results between USD/THB price and COVID-19 cases

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-94005.915	5590.485		-16.815	0.000
USDTHB	3050.983	175.207	0.638	17.414	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.638[a]	0.407	0.406	4150.200	0.407	303.235

Table 3 demonstrates the results of analysis on the relationship between USD/THB price and COVID-19 new cases, the results had a multiple correlation coefficient (Multiple R) of 0.638, a decision coefficient (R-Square) of 0.407, an adjusted decision coefficient (Adjusted R Square) of 0.40, and a standard error in decision-making (Standard Error) equal to 4150.20. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new cases variables on USD/THB price movement. In addition, COVID-19 new cases have a

positive impact on USD/ THB price movement which means that an increase in the number of new cases rises THB prices in terms of USD in other words THB depreciates toward USD while a new case increases.

Table 4: OLS regression results between USD/THB price and COVID-19 deaths

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-970.866	69.838		-13.902	0.000
USDTHB	31.493	2.189	0.565	14.389	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.565[a]	0.319	0.318	51.84572	0.319	207.034

Table 4 demonstrates the results of analysis on the relationship between USD/ THB price and COVID-19 new deaths, the results had a multiple correlation coefficient (Multiple R) of 0.656, a decision coefficient (R-Square) of 0.319, an adjusted decision coefficient (Adjusted R Square) of 0.318, and a standard error in decision-making (Standard Error) equal to 51.84. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new deaths variables on USD/THB price movement. In addition, COVID-19 new deaths have a positive impact on USD/ THB price volatility which means that an increase in the number of new deaths rises THB prices in terms of USD in other words THB depreciates toward USD while a new death increases.

Table 5: OLS regression results between EUR/THB price and COVID-19 cases

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-75161.557	4338.329		-17.325	0.000
EURTHB	2109.187	116.529	0.653	18.100	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.653[a]	0.426	0.425	4083.84895	0.426	327.614

Table 5 demonstrates the results of analysis on the relationship between EUR/ THB price and COVID-19 new cases, the results had a multiple correlation coefficient (Multiple R) of 0.653, a decision coefficient (R-Square) of 0.426, an adjusted decision coefficient (Adjusted R Square) of 0.425, and a standard error in decision-making (Standard Error) equal to 4083.849. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new cases variables on EUR/ THB price movement. In addition, COVID-19 new cases have a positive impact on EUR/THB price volatility which means that an increase in the number of new cases rises THB prices in terms of EUR in other words THB depreciates toward EUR while a new case increases.

Table 6: OLS regression results between EUR/THB price and COVID-19 deaths

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-781.883	54.289		-14.402	0.000
EURTHB	21.920	1.458	0.582	15.032	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.582[a]	0.339	0.337	51.10443	0.339	225.970

Table 6 demonstrates the results of analysis on the relationship between EUR/ THB price and COVID-19 new deaths, the results had a multiple correlation coefficient (Multiple R) of 0.582, a decision coefficient (R-Square) of 0.339, an adjusted decision coefficient (Adjusted R Square) of 0.337, and a standard error in decision-making (Standard Error) equal to 51.10. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new death variables on EUR/THB price movement. In addition, COVID-19 new deaths have a positive impact on EUR/ THB price volatility which means that an increase in the number of new deaths rises THB prices in terms of EUR in other words THB depreciates toward EUR while a new death increases.

Table 7: OLS regression results between JPY/THB price and COVID-19 cases

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-86966.016	11502.554		-7.561	0.000
JPYTHB	3037.378	387.035	0.350	7.848	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.350[a]	0.123	0.121	5050.30790	0.123	61.588

Table 7 demonstrates the results of analysis on the relationship between JPY/ THB price and COVID-19 new cases, the results had a multiple correlation coefficient (Multiple R) of 0.350, a decision coefficient (R-Square) of 0.123, an adjusted decision coefficient (Adjusted R Square) of 0.121, and a standard error in decision-making (Standard Error) equal to 5050.307. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new cases variables on JPY/ THB price movement. In addition, COVID-19 new cases have a positive impact on JPY/THB price volatility which means that an increase in the number of new cases rises THB prices in terms of JPY in other words THB depreciates toward JPY while a new case increases.

Table 8: OLS regression results between JPY/THB price and COVID-19 deaths

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-1011.150	134.219		-7.534	0.000
JPYTHB	35.154	4.516	0.348	7.784	0.000

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.348[a]	0.121	0.119	58.93003	0.121	60.592

Table 8 demonstrates the results of analysis on the relationship between JPY/ THB price and COVID-19 new deaths, the results had a multiple correlation coefficient (Multiple R) of 0.348, a decision coefficient (R-Square) of 0.121, an adjusted decision coefficient (Adjusted R Square) of 0.119, and a standard error in decision-making (Standard Error) equal to 58.93. The probability value of 0.000, which is smaller than 0.001, indicates the significant influence of the COVID-19 new death variables on JPY/THB price volatility. In addition, COVID-19 new deaths have a positive impact on JPY/THB price volatility which means that an increase in the number of new deaths rises THB prices in terms of JPY in other words THB depreciates toward JPY while a new death increases.

In addition, by comparing the coefficient of all currency pairs demonstrates that COVID-19 pandemic has more effect on USDTHB exchange rate price movement than other currencies. In another word, when COVID-19 related cased and deaths increase during the selected period the THB will be more depreciated toward USD more than JPY and EUR.

5. Conclusion

This study investigates a relationship between the COVID-19 pandemic in Thailand and the Thai Baht exchange rate. To examine the impact of COVID-19 on exchange rate of Thailand. Firstly, the data of COVID-19 confirmed cases and deaths of Thailand were obtained. Secondly, the daily volatility based on the Thailand historical data of exchange rate was collected. USD/ THB, JPY/ THB, and EUR/ THB are used to determine the exchange rate of Thailand. Because US Dollar, Japanese Yen, and Euro are the currencies of Thailand's major trading partners, the author then decides to use these currencies pair to determine Thai Baht exchange rate. The variables are stationary after the unit root test and able to apply in the research model. This study employs the Ordinary Least Square regression to estimate a relationship between independent and dependent variables. According to the results, an increase in COVID-19 cases and deaths has a significant and positive impact on USD/THB, JPY/THB, and EUR/THB. This means that the more serious of COVID-19 pandemic will be caused the more depreciation on Thai Baht.

If Thai Baht continues to depreciate in the long run, it will cause a negative impact on Thailand's economy. The country's inflation could rise in the long run and Thai Baht will be a weak currency in the foreign investor aspect. To prevent the following scenario, Thai government should provide an efficient policy to stabilize Thai Baht. Such as vaccination management, enhanced medical service, and providing sufficient medical appliances. In addition, government and senior policymakers should concern

about bringing back tourist confidence to come back to travel in Thailand as tourism revenue is a huge part of the GDP of Thailand.

Moreover, this study has a limitation due to not only the impact from COVID-19 which caused the Thailand exchange rate movement but also have other factors which could cause volatility to Thailand's exchange rate. The factors are interest rate of Thailand, interest rate of foreign countries, CPI (Consumer Price Index), inflation rate, and the author does not include other factors in this study. Also, a period for this study includes only the Coronavirus Delta variant outbreak, not covering the Coronavirus Omicron variant outbreak period.

For the extension of future possible research, as the limitation of research time, this study does not include control variables for exchange rate such as interest rate, inflation rate, government policy, consumer price index (CPI), and other factors from overseas countries in the estimation. Therefore, in the future study of the impact of COVID-19 on the Thailand exchange rate the author will include the control variables that have been mentioned in the model.

On the author's best knowledge, this study is the first to focus on the impact of the COVID-19 pandemic on Thailand's exchange rate. Therefore, I wish this study will fulfill the literature gap and have an advantage over others who would like to explore the Thailand currency market during the pandemic period. In addition to the policymaker to provide more efficient policy to prevent financial market volatility during this pandemic.

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