Testing the Determinants of Stock Exchange Index Comovement in Thailand Stock Exchange

Mr. Nuntapat Asavaroengchai

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นายนันทพัทธ์ อัศวเรืองชัย

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INDEPENDENT STUDY COMMITTEE

..... Chairman

()

..... Advisor

(JUNE CHAROENSEANG)

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A study into the effects of different macroeconomic variables on the comovement between the Stock Exchange of Thailand (SET) Index and the Standard & Poor's 500 (S&P 500). These effects are tested using OLS regression in an annual and quarterly frequency. Real Interest Rate Difference between the two countries is found to have a significant negative effect, likely due to investors turning to Thailand when it has higher real interest rate. Income Level is found to be a significant positive effect, as countries with higher income are more integrated with the US. As the economy naturally grows, it is likely that the comovement will rise. For investors, long term risk diversification and arbitrage opportunities will be fewer, but they will still be present in the short term.

Field of Study:	International Economics and Finance	Student's Signature .....
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I want to thank my advisor for supporting and guiding me in this academic study. It has been an eye opening experience that has taught me a many new things.

Nuntapat Asavaroengchai

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Chapter 1: Background/Rationale/Problems, Objectives, Scope and Organization of Report

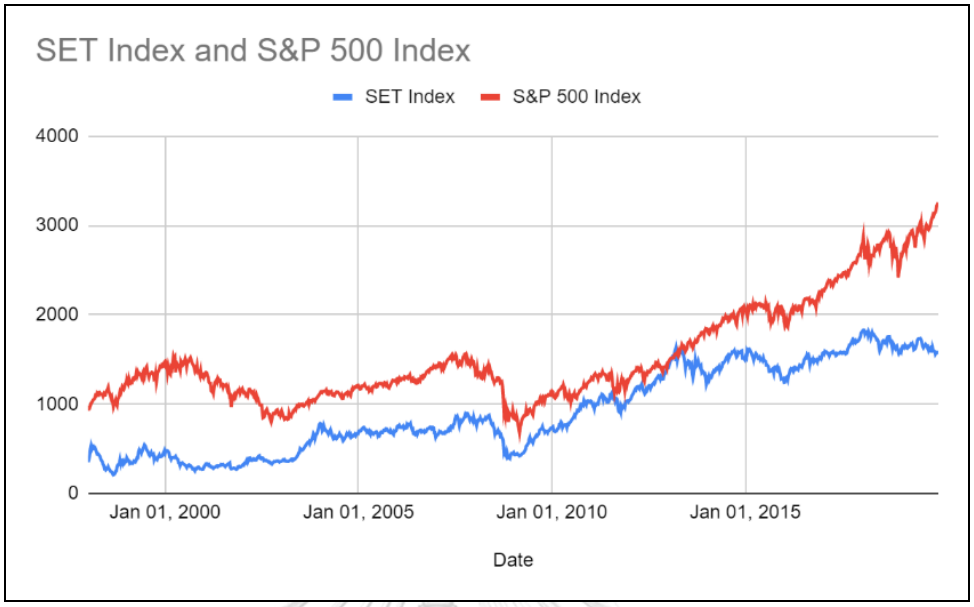
The stock market index of any country can be seen as a representative of the state of its economy, being the combination of all firms listed on the stock market at any given time. The economy, as shown by the stock market index, is affected by all manners of shocks, whether they be political or economic. With the advent of globalization and the increasing ease of transport and communication, the economic distance between countries have been reduced significantly over time. This has led to an increase in the correlation of stock market index returns over time, also known as stock market comovements. The comovement of two stock markets can both be good and bad for the economy, as a negative shock in one country could lead to a negative shock in another, while a positive growth can lead to growth in both countries.

While the comovement of stock markets are seen as good or bad depending on who is looking at it, we can only gain from learning about the determinants of these stock market comovements. In this paper, I would like to study the determinants of stock market comovement found by previous literatures in order to test if the effect holds between Thailand and the United States. For this, I will be using the Stock Exchange of Thailand and the Standard & Poor's 500 to represent Thailand and the United States respectively.

The Stock Exchange of Thailand (SET) is the national stock exchange of Thailand, and is intended to serve as the center for trading of listed securities and to provide any systems needed to facilitate the trading. Studying the comovement of the stock indices noted would allow us to learn if the two different indices are good options for diversification as an investor in Thailand.

On the other hand, the Standard & Poor's 500 (S&P 500) is a stock market index that measures the stock performance of around 500 large companies listed on the stock exchanges in the United States. It is considered one of the best representations of the US Stock Market.

Figure 1 – SET Index and S&P Index



Source: Weekly Historical Data from investing.com

Figure 1 above shows the two stock market indices graphed. Visually, you can see that there are points wherein the two indices move in the same direction, and other times where they do not. Using the comovement of the two indices, we can start to look into the different objectives in order to gain some insight into what determinants cause the comovement.

In this paper, my first objective is to discern whether comovement as a trend exists between the SET and the S&P 500. The second and main objective in this study is to test the different determinants of stock market comovement to see if they hold up in the case of the SET and the S&P 500. The list of variables used has been discerned through reading previous literatures. Finding the magnitude and significance of these determinants of comovement should give some insight into which factors affect the comovement of stock indices, and what policies or warning signs, if any, should be recommended for investors.

This research paper will focus on the Stock Market Indices of Thailand (SET) and the United States (S&P 500). The reason that I am focusing on these two countries is that Thailand is an emerging market that has been growing over

the past few decades, and the United States is a global powerhouse in terms of economic power and political influence. In terms of number of years, the timespan used in this study is between 1998 and 2018. While the data that I am working with reaches back to 1988, however I decided against going back that far due to the fact that the data dates far enough back to be influenced by both the Tom Yum Goong crisis and the fixed exchange rate regime, which would affect the results of the regression. Even in regards to the time frame however, there are several events in both Thailand and the United States that could possibly have affected the stock indices or the comovement between the two indices.

Events that could affect the comovement between the countries are the political events that caused political instability in some way. These events are events such as Thailand's coup d'etats of 2006 and 2014, the airport occupation in 2009, or 2010 and 2013's political protests. These events, as well as the controversial presidential election in 2016 for the US could have an effect on the comovement and stock indices through affecting the different variables we are using in this study, as well as possibly other variables that do affect the comovement that are not in the model such as the different types of risks for investors.

On the other hand, financial crises affecting both the United States and Thailand are likely to affect the comovement and stock indices as well. These financial crises are events such as the bursting of the Dot-Com bubble of 2001/2002, the Global Financial Crisis in 2007/2008, and the Stock Market Fall of 2011 likely affected the way investors looked to invest as well. These events would likely also have tangible effects on the different variables used in this study as well as the indices themselves.

In this paper, there are two models used. The first model will be in annual frequency, while the second model will be in quarterly frequency. The reason that the first model will be in annual frequency is due to the fact that most of the factors used are widely recorded in annual terms, and the lower frequency

is to show the effects more prominently. However, due to the small sample size of the annual model, the second model, which is in quarterly frequency, was created to test the effects of the factors used in the model in a larger sample size.

This report will be organized as follows: In the second chapter, I review the literature that I have studied on the topic, discerning the reasoning and methodology that they used, as well as their findings. The third chapter then be an outline of the methodology that is used in the paper, the conceptual framework used to explain it, and the results that were assumed before the methodology was carried out. The fourth chapter is where I show the results of the methodology, as well as my interpretations of the data. The fifth chapter is where I conclude the paper, what I could have done better, and recommendations I have for any more studies in the subject. The final chapter will be where my references will be.

Chapter 2: Literature Review and Conceptual Framework

Literature Review

The first three papers that I studied are focused on finding the existence of comovement and cointegration between countries (Al Nasser & Hajilee, 2016; Graham, Kiviaho, & Nikkinen, 2012; Paskelian, Nguyen, & Jones, 2013). They did not focus on the determinants as the other papers did, but they noted the patterns and findings that I found helpful in the analysis of my research. These findings are patterns such as the difference in comovement on different frequencies, that shifts in the global economic environment can lead to a shift in trend in comovement, and that many see the financial integration as the way forward for growth. The difference in comovement on different frequencies led to the creation of my quarterly model in order to test this effect. The shifts in global environment finding helped me realize that while the comovement is trending upwards currently, another shift in the environment could also change that as well. The perception that financial integration is the way forward is part of that as well, as a shift in that perception could lead to efforts to lower the financial integration, and thus the comovement.

Graham, Kiviaho and Nikkinen (2012) use wavelet analysis to examine the integration of 22 emerging stock markets with the US market. Literatures referenced find that comovement is high among developed markets. The goods and services provided to the US is about 40% of aggregate GDP for most of the markets included. In this study, economic size is proxied with GDP, while the stock market capitalization to GDP ratio is the proxy for market size. Moreover they find emerging markets to be more volatile than US markets, with an increased comovement after 2006 due to an increasing trend in stock market integration. They find that comovement seems to be a pattern at low frequencies, but not so at higher frequencies.

Nasser and Hajilee (2016) examine 5 emerging stock markets and their cointegration with the US, UK and Germany stock markets. Previous literature that this paper references say that markets are segmented globally, but are

integrated regionally. They did not focus on the determinants, though they did find from their data that German Stock is the only one to have had long run cointegration, while all of them had short run impacts to different markets. They believe that financial integration should be seen as a long term objective for growth.

Paskelian, Nguyen and Jones (2013) explores cointegrating behavior between Middle East, North African (MENA) markets and the US markets using Granger causality test. Emerging markets are emphasized in this paper due to the opportunities for portfolio and money managers to maximise their return. Their results indicated that MENA markets are cointegrated, likely due to the region's effort to remove capital flow barriers and increase financial market integration, as well as the fixed exchange rate systems and dominant oil and gas sectors. The MENA markets do comove, though they do not seem to be integrated with the US market. This is likely because of the differences in economic structure and policy.

The next two papers are focused on measuring the day to day comovement of the stock market indices (Gagnon & Karolyi, 2003; Sheng, Brzeszczyński, & Ibrahim, 2017). These papers focused on price movements based on information and liquidity, and it helped cement the idea that in the higher frequency, stock market comovements will shift with much higher volatility. They find that information based price movements are much more likely to spill over into other countries' markets, while liquidity based price movements are far less so.

Gagnon and Karolyi (2003) tested the stock index comovements as well as the spillover effect between Japan and the US with trading volume and liquidity. Spillover is defined as a high frequency dependence in returns and conditional volatility of returns. If new information concerning expected return on risky assets reaches the market and everyone interprets it the same way, then the prices will change. However, even if there is no new information, but investors become more risk averse due to an external shock, then they will

shift their investment to a riskless asset and lead to a price shift. Information based price movement is defined as price changes associated with low or normal volumes of trade, while liquidity based price movements are associated with high volumes of trade. They find that a positive correlation in daily S&P 500 Index becomes negative following days with high NYSE trading volume.

Sheng, Brzeszczynski and Ibrahim (2017) analyse the comovement between 8 international stock markets using daily data focusing on trading volume between 2004 and 2015. The spillover effects are sensitive to different levels of trading activity and price changes. Asian markets are found to be more prone to information based price movement, American markets are found to be more prone to liquidity based price movements, and Europe is a mix of the two. This is hypothesized to be because Asian markets open first in calendar time during the overnight period of the other two regions. They find that liquidity based price movements are less likely to be transmitted across borders while information based price movements are more likely to transmit across borders.

Another paper studied tested for volatility transmission between the US and Latin American Stock Markets (Cardona, Gutiérrez, & Agudelo, 2017). They question the benefits and detriments of financial integration, as Financial Openness can lead to improved capital sources, international risk sharing and reduced capital costs, but also exposure to volatility transmission. Many of the papers referenced claim that volatility transmissions happen in markets of the same region, while others claim that it is between developed and emerging markets. They find that the US Stock Markets transmit volatility to Latin American Markets mainly, with some return during crises. Another finding is that Brazil transmits volatility to other Latin American Stock Markets, likely due to its size being the largest in the region. This leads to the conclusion that volatility transmission goes from large to small markets.

The last two papers that I studied in preparation for this paper were papers on determinants of comovement (Nguyen, Nguyen, & Schinckus, 2019) and determinants of cointegration (Dorodnykh, 2014). These papers were the ones most heavily referenced in this paper on the methodical side.

Nguyen, Nguyen and Schinckus (2019) investigate the determinants of stock return comovements of emerging markets with the US market using a model including factors such as Trade to GDP Ratio, FDI, FPI, Institutional Quality, and X. The Trade to GDP Ratio, FDI and FPI are proxies for capital flow and trade openness. The Institutional Quality is a mixture of several factors measured in percentage change of Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. X is a mixture of several factors as well, including log GDP per Capita which proxies Income Level, Stock Market Size which is measured by stock market capitalization, Stock Market Liquidity is proxied by stock market turnover ratio, the difference of price level between markets is proxied by inflation difference and interest rate difference, and the rate of change in exchange rate difference is a proxy for the shock from foreign exchange market. They found that a larger stock market size leads to a higher comovement, because the high growth and rate of liquidity leads to greater efficiency and comovement. Inflation and exchange rate differences lead to positive effects on comovement as well, likely due to the uncertainty leading to an increased sensitivity to the US market. Trade Openness and inward FPI flow is found to have a significant negative impact on comovement due to the openness and FPI decreasing the dependence on the US market. It is noted however that FPI can improve the size, efficacy and liquidity of the market and lead to a positive effect as well. Inward FDI has a positive effect due to stimulating the economy and reducing the economic distance. Improvements in the institutional quality is found to lead to a strong positive effect due to the increased market efficiency, similarly to the FPI. Interest rate difference and liquidity are also found to have a negative impact on comovement. This is thought to be because higher rates in emerging markets means investors will be more interested.

Dorodnykh (2014) tested the determinants of stock exchange integration and cooperation across 27 European countries and 22 international stock markets using correlation and cluster analysis. Factors used include Union dummy for trade unions, Currency dummy for monetary unions, Trade Openness, GDP, Stock Market Development proxied by Stock Market Capitalization to GDP, Market Value proxied by stock market value traded to GDP, Liquidity of Stock Market proxied by turnover ratio, Financial Regulations, Type of Stock Market, Average Traded per day, Domestic and Foreign Listed Companies, Trading Platform and Post-Trading variables, Geographic Region, and Correlation variable. The macroeconomic characteristics of the countries shows the likelihood of mergers and acquisition, but larger stock market sizes decrease the probability of cooperation and integration. Improved regulations are shown to improve the likelihood of integration, likely due to the freer capital mobility. The presence of cross membership seems to lead to integration, though market capitalization does not increase the likelihood. This is likely because cross-membership can be a first step towards consolidation of the stock market. Average trade per day seems to be a determinant of integration, but not of a stock exchange project. Higher concentrations of domestic shares confirms a lack of market openness to cross listing, so there is a negative effect. Finally, using the same software and platform leads to an increased probability of a merger project, likely because it shows the presence of network integration prior to a merger.

The main points that were taken from these previous literatures for this paper are as follows. The first main point is that the frequency of data is important, as at higher frequencies there is a larger amount of volatility, and in lower frequencies the trend of comovement, whether upwards or downwards, will be more visible. The second main point is that shifts in the global economic environment can lead to a different comovement trend, which means that more opportunities would be created as the world’s economic climate changes. The third main point is that the writers of the previous literatures found that comovement, which is a side effect of financial integration, see that

it has large benefits and is an good goal to aspire towards (Al Nasser & Hajilee, 2016; Cardona et al., 2017). However, they also warn that there are still drawbacks for the markets in question (Cardona et al., 2017).

Conceptual Framework

Comovement of stock markets is a phenomenon seen when two stock markets move together as the stock market index shifts upwards or downwards due to the factors that affect them. It is believed that due to the increased economic openness and globalization, many stock markets are becoming more cointegrated and are moving up and down together. Most of the factors in this model are the same as Nguyen, Nguyen and Schinckus (2019)'s model because their paper was the basis upon which my model was originally constructed. In the literature I have researched, there have been few that studied the determinants specifically, but I will use the reasonings for the ones that did to explain the reasoning as to why I believe they will have a specific effect on the comovement of the stock markets.

The factors included in the model are Trade Openness, Foreign Direct Investment, Foreign Portfolio Investment, Regulation, Market Size, Exchange Rate, Interest Rate Difference, Inflation Rate Difference , Income Level and SET Liquidity. While I felt that there was quite a large number of variables for the number of observations, I did not want to risk changing the meaning.

The first factor in the model is the Trade Openness, and is proxied in this model by the Trade to GDP Ratio. Trade Openness has been shown to have a negative effect on the comovement through the diversification of the market, which lowers the reliance on the US market. However, it is also found to lead to volatility transmission as well, which increases comovement. Bearing this in mind, Trade Openness will be hypothesized to have an ambiguous effect in this model.

The second factor in the model is Foreign Direct Investment (FDI), which is represented by the FDI to GDP Ratio. It has been found to correlate positively with comovement due to stimulating the economy, which leads to a higher volume of trade between the two countries. Following this logic, it is hypothesized to lead to a positive effect on the comovement in this model through that stimulation.

The third factor used in the model is the Foreign Portfolio Investment (FPI), and is represented by the FPI to GDP Ratio. FPI has been found to have a positive effect on the comovement due to improving the size, liquidity and efficacy of the market, but also a negative effect through the reasoning that the increased inward FPI flow reduces the dependence on the US market. The direction of the variable likely depends on which effect is greater, and in this model, the effects will be considered ambiguous.

The fourth factor within the model is the Regulation factor, proxied in this model using the Regulation variable from the World Governance Index. Regulation has been found to have a strong positive effect, as a higher Regulation variable means that the government's policies are trusted to promote the growth and development of the private sector. This would then lead to a more attractive market that would draw US investors in and have a positive effect on comovement. Following that logic, it could be possible for the increased attractiveness would lead foreign investors from other countries in as well, which could lead to a reduction in the comovement, though no literatures studied found that to be the case.

The fifth factor in the model is the Market Size and is proxied by the Market Capitalization to GDP Ratio. It is found to have a positive effect due to the increased size allowing for better infrastructure and efficacy, which leads to a higher comovement with the US market due to attracting in US Investors. As before, I believe that following that logic means that investors other than US Investors could be drawn to the Thai market as well. However, it has also been shown to have a negative effect for stock market cooperation due to the

larger size making it harder to fully integrate. For the purposes of this model then, it will be assumed to have an ambiguous effect.

The sixth factor in the model is the Income Level and is proxied by the Log of the GDP per Capita. This has been found to have a positive effect on the comovement. This is indicated to be because countries with higher income levels have a higher level of integration with the US market. Thus, a higher Income Level would lead to higher comovement between the two markets.

The seventh factor, Interest Rate Difference, is hypothesized to have had a negative effect on the comovement. This is because a large difference in interest rates leads to investors turning to the emerging market, Thailand in our case, for investment rather than in the US, which leads to a lower amount of comovement. If this logic is correct, then this would lead to a larger and more diversified set of investors from several countries, and thus, lower comovement.

The eighth factor, Inflation Rate Difference, is hypothesized to have a positive effect on comovement. This is reasoned to be because a positive difference in inflation rate between the countries would lead to investors becoming more reactive to the US market, due to the US market being a benchmark for stability, and thus, the comovement between the two countries would increase.

The ninth factor, Rate of Change in Exchange Rate, is hypothesized to have a positive effect. Similarly to the inflation rate difference, this is because a large change in exchange rate difference between the two countries leads to investors becoming more reactive to the US market. This means that a rise in exchange rate difference will lead to a positive effect on the comovement

The last factor included in this model is Market Liquidity. This is hypothesized to have a negative effect on the comovement due to liquid markets being attractive, and thus drawing in a lot of different investors from different countries. However, liquid markets are also noted to be subject to spillover

effects, which leads to comovement. Thus, this will be assumed to have an ambiguous effect.

Table 1: ***Expected Relationships in the Estimation Model***

Independent Variables	**Description of Variables**	**Expected Relationships**	**Explanation for Signs**
Trade to GDP Ratio (T)	Trade as a percentage of GDP. Proxy for trade openness.	+/-	Increased trade openness is believed to lead to a diverse trade pattern with larger, so it would lead to lower comovement on any specific market. However, it is also believed to lead to volatility transmission and thus, higher comovement.
Foreign Direct Investment to GDP Ratio (FDI)	Investment made by a firm or individual in a foreign country.	+	Increased FDI would lead to an improved infrastructure, making the country more attractive to investors abroad.
Foreign Portfolio Investment to GDP Ratio (FPI)	Securities and other financial assets held by foreign investors.	+/-	Increased FPI could lead to an improved infrastructure, but the improvements will draw in investors from other countries as well, leading to diversification of trade and lower comovement.
Regulation Quality (Reg)	Perceptions of the ability of the government to promote private sector development through regulations and policies.	+	An improved regulation quality would mean that people believe that the government can promote the private sector, which makes the country more attractive to investors.
SET Market Capitalization to GDP Ratio (SETMC)	Amount of market capitalization of SET. Proxy for market size	+/-	A larger stock market market size is believed to have higher efficacy and better infrastructure, and is seen as more attractive by American investors, leading to increased comovement. However, larger size makes it harder

			to integrate.
Log GDP per Capita (Income)	GDP per head	+	Countries with higher income levels have a higher level of integration with the US market.
Real Interest Rate Difference (IR_D)	Difference of Real Interest Rate between Thailand and US.	-	A positive difference in interest rates leads to investors turning to the emerging markets for investment rather than in the United States, leading to a lower amount of comovement
Inflation Rate Difference (Inf_D)	Difference of Inflation Rate between Thailand and US	+	A positive inflation rate difference between the two markets leads to investors within the emerging market becoming more reactive to the US market, due to the US market being a benchmark for stability.
Rate of Change in Exchange Rate (FX)	Rate of change in the exchange rate of THB to 1 USD	+	A large change in exchange rate between the two countries leads to investors becoming more reactive to the US market, due to the US market being a benchmark for stability.
SET Liquidity (SETTurn)	Turnover ratio is the value of domestic shares traded divided by their market capitalization.	+/-	Liquid markets are believed to be less dependent on specific stock markets, but are more attractive to American investors. More liquid markets are susceptible to spillover effects.

Chapter 3: Methodology and Data Collection

For this study, I have chosen to use Ordinary Least Squares (OLS) Regression for two main reasons. The first reason is that because we are trying to find the relationship between the comovement of the stock markets and other variables, this would be a good option. The other main reason is that OLS is a simple and straightforward method that I have knowledge of.

To start us off, we would need to find the comovement for each year by taking the change in SET and change in S&P 500 and finding the yearly correlation between the two for all time periods.

$$Comovement = corr(\widehat{SET}, \widehat{SP500})$$

Once we have the comovement, we have two different models that we will be using to test these effects. The first model is a regression to test the effects of the different macroeconomic variables and the Regulation factor in order to see what effects they have on the comovement:

$$corr(\widehat{SET}, \widehat{SP500})_t = \alpha + \beta_1 T_t + \beta_2 FDI_t + \beta_3 FPI_t + \beta_4 Reg_t + \beta_5 MC_t + + \beta_6 FX_t + \beta_7 IRD_t + \beta_8 InfD_t + \beta_9 Income_t + \beta_{10} SETTurn_t$$

The second model will be a quarterly model in order to test the effects of the same variables in a higher frequency. The advantage of using this frequency is the increased sample size, which would allow for more reliable results as well as insight into the differences in how comovement interacts with these variables in a higher frequency. This should show us the effects of these variables on the comovement two stock markets in question while following the logic used in previous literatures to explain each variable. Once we run these regressions, we can find the relationship between the comovement and the variables listed in the equation.

Table 2: Variables, Measurement of Variables, Data and Data Sources

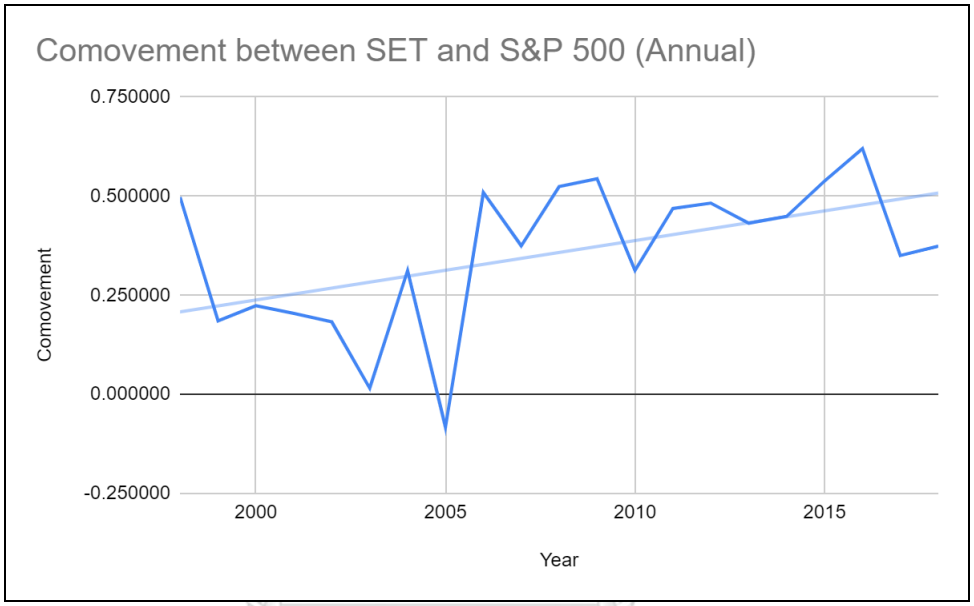
Variables	Measurement of Variables	Data Sources
Comovement (SET and S&P 500)	Correlation of returns between SET and S&P 500 (Annual) (Quarterly)	Calculated from investing.com Data (Annual, Quarterly)
Trade to GDP Ratio (T)	$\frac{Trade}{GDP}$(Annual) (Quarterly)	World Bank (Annual) CEIC Database (Quarterly)
FDI to GDP Ratio (FDI)	Cross Border Investment with Ownership of 10% or More (USD) (Annual) $\frac{FDI}{GDP}$(Annual) (Quarterly)	Calculated from World Bank (Annual) Calculated from CEIC Database (Quarterly)
FPI to GDP Ratio (FPI)	Inflows from Equity Securities not recorded as Direct Investments (USD) (Annual, Quarterly) $\frac{FPI}{GDP}$(Annual, Quarterly)	Calculated from World Bank (Annual) Calculated from CEIC Database (Quarterly)
Regulation Quality (Reg)	Regulation Quality (Annual, Quarterly) Reg(Annual) Annual held constant (Quarterly)	Calculated from WGI Data Catalog (Annual, Quarterly)
SET Market Capitalization to GDP Ratio (SETMC)	Market Capitalization of all listed companies as a ratio to GDP $\frac{MC}{GDP}$(Annual, Quarterly)	CEIC Database (Annual) Calculated from CEIC Database (Quarterly)
Log of GDP per Capita (Income)	A country's GDP divided by its total population. (Annual) $LogGDP$ (Quarterly)	Calculated from CEIC Database (Annual, Quarterly)
Real Interest Rate Difference (IR_D)	Nominal Interest Rate% - Inflation Rate% (Annual, Quarterly) $IR_{TH} - IR_{US}$(Annual, Quarterly)	Calculated from World Bank (Annual) Calculated from CEIC Database (Quarterly)
Inflation Rate Difference (Inf_D)	Thailand Inflation Rate% - US Inflation Rate% (Annual, Quarterly) $Inf_{TH} - Inf_{US}$ (Annual, Quarterly)	Calculated from WDI Data Catalog (Annual) Calculated from CEIC Database (Quarterly)
Rate of Change in Exchange Rate (FX)	THB per 1 USD(Annual, Quarterly) $\frac{FX_t - FX_{t-1}}{FX_{t-1}}$	Calculated from CEIC Database (Annual, Quarterly)
SET Turnover Ratio (SETTurn)	$\frac{Domestic\ Traded\ Value}{Market\ Capitalization}$(Annual) $\frac{Quarterly\ Traded\ Value}{Market\ Capitalization}$(Quarterly)	CEIC Database (Annual) Calculated from CEIC Database (Quarterly)

Sources: World Bank, investing.com, CEIC Database, WGI Data Catalog, WDI Data Catalog

Chapter 4: Research Results

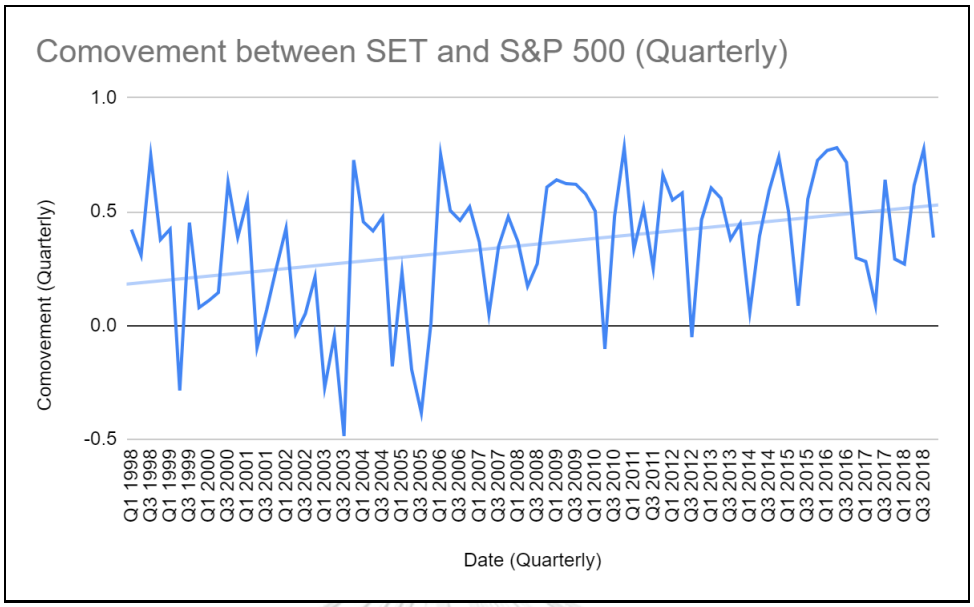
To start with the first objective of this paper, I found the weekly returns of each stock exchange, the SET and S&P 500. Following that, I found the correlation of stock returns, comovement, of each year and then plotted the results on a graph and added a trend line, leading to the graph below:

Figure 2



This graph shows us that there has been a comovement for a majority of the past few decades, and a rising trend of comovement over the years. The big increase in comovement shown on the graph after 2005 aligns with Graham, Kiviaho and Nikkinen (2012)'s findings that there was an increase in comovement after 2006 as well. While it seems that after 2016 there is a drop in the comovement between the SET and S&P 500, I am unsure if we have all the data necessary to make such a statement. This is because the comovement fluctuates quite heavily from year to year, and we cannot say for sure if this is just a temporary drop, or if it will become a new trend.

Figure 3



Like the previous graph, this shows the rise and drop of comovement over the same timeframe. As before, it shows a rising trend of comovement over time, though the sharp increase of comovement in 2016 shown in the annual model is followed by a sharp drop as well. It does show Graham, Kiviaho and Nikkinen (2012)'s conclusion that the pattern of comovement is much more prominent in lower frequencies, as it can be seen that the comovement is very volatile in the quarterly model.

Before starting on the models, I started by running the Augmented Dickey Fuller (ADF) Unit root tests on the variables used for the regression. We find that the majority of them are non-stationary for the annual model.

Table 3: Data Description (Annual)

	Comovement	T/GDP	FDI/GDP	FPI/GDP	IR_D	Inf_D	Δ%FX	SETMC/GDP	SETTurn/MC	loggdppc	Δ%Reg
Obs	21	21	21	21	21	21	21	21	21	21	18
Mean	0.358072	125.12%	3.09%	0.14%	0.33%	0.13%	0.58%	68.82%	77.50%	3.596011	0.2366891789
Median	0.374613	125.92%	3.24%	0.15%	0.16%	-0.47%	-1.11%	72.76%	77.19%	3.650285	0.2179662
Stdev	0.182445	0.111684	0.014005	0.017102	0.023322	0.018405	9.49%	0.278536	0.132882	0.214614	0.107740
Min	-0.082835	100.24%	0.67%	-3.43%	-3.67%	-1.90%	-14.95%	25.00%	57.20%	3.267554	0.10595
Max	0.620006	140.44%	6.43%	4.11%	5.40%	6.44%	32.99%	116.12%	102.84%	3.882407	0.486798
ADF 10%	Non-Stationary	Stationary	Stationary	Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Non-Stationary
ADF 5%	Non-Stationary	Non-Stationary	Stationary	Non Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary
ADF 1%	Non-Stationary	Non-Stationary	Stationary	Non Stationary	Non-Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary

Much like the annual model, the quarterly model has several non-stationary variables. Most of the variables in the quarterly model are calculated and found in the same way, with a few exceptions.

Table 4: Data Description (Quarterly)

	Comovement	T/GDP	FDI/GDP	FPI/GDP	IR_D	Inf_D	Δ%FX	SETMC/GDP	SETTurn/MC	LogGDP	Reg
Obs	84	84	84	84	74	84	84	84	84	84	72
Mean	0.3557284309	124.67%	3.09%	0.14%	0.62%	-0.01%	-0.36%	263.17%	21.58%	4.797799499	0.2366891789
Median	0.4184668431	125.22%	3.25%	0.15%	0.61%	-0.07%	-0.61%	252.01%%	20.11%	4.850515702	0.2179662
Stdev	0.295710	0.123559	0.022534	0.028478	0.018936	0.006400	0.042173	1.081467	0.067173	0.220747	0.107740
Min	-0.4862531338	88.15%	-7.98%	-5.59%	-5.02%	-1.70%	-17.88%	78.09%	11.03%	4.425474061	0.10595
Max	0.7818392616	155.20%	9.13%	7.62%	6.36%	2.04%	11.24%	444.90%	45.04%	5.112799586	0.486798
ADF 10%	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Non-Stationary
ADF 5%	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Non-Stationary
ADF 1%	Stationary	Non-Stationary	Stationary	Non-Stationary	Stationary	Stationary	Stationary	Non-Stationary	Stationary	Non-Stationary	Non-Stationary

The only variables to be treated differently in this regard is the Regulation rate of change variable and the Income proxy, which did not have quarterly data. Thus in order to circumvent this issue, we are holding the Regulation constant for each year due to the lack of quarterly data, and using the log of the quarterly GDP as the income proxy instead.

Annual Model

In this model, I ran a regression to test the effects of the variables using the equation:

$$corr(\widehat{SET}, \widehat{SP500})_t = \alpha + \beta_1 T_t + \beta_2 FDI_t + \beta_3 FPI_t + \beta_4 Reg_t + \beta_5 MC_t + +\beta_6 FX_t + \beta_7 IRD_t + \beta_8 InfD_t + \beta_9 Income_t + \beta_{10} SETTurn_t$$

Dependent Variable: COMOVEMENT
Method: Least Squares
Date: 07/28/20 Time: 22:36
Sample: 1998 2018
Included observations: 19

Variable	Coefficient	Std. Error	t-Statistic	Prob.
T	0.598930	0.906879	0.660430	0.5275
FDI	-2.867260	4.817537	-0.595171	0.5682
FPI	1.703373	2.857486	0.596109	0.5676
REG	-0.991819	0.668433	-1.483797	0.1762
SETMC	-0.228604	0.283955	-0.805073	0.4440
FX	1.128280	0.904918	1.246831	0.2477
IRD	-1.192444	2.198643	-0.542355	0.6024
INFD	-1.224674	5.691258	-0.215185	0.8350
INCOME	0.374571	0.568204	0.659219	0.5283
SETTURN	-0.092362	0.265737	-0.347568	0.7371
C	-1.189844	1.355925	-0.877514	0.4058

R-squared	0.747918	Mean dependent var	0.375261
Adjusted R-squared	0.432815	S.D. dependent var	0.183575
S.E. of regression	0.138253	Akaike info criterion	-0.826561
Sum squared resid	0.152912	Schwarz criterion	-0.279781
Log likelihood	18.85233	Hannan-Quinn criter.	-0.734024
F-statistic	2.373570	Durbin-Watson stat	2.808003
Prob(F-statistic)	0.116717		

In this model, there are no significant variables. The Durbin-Watson stat is also between the critical values, showing the lack of autocorrelation.

Null Hypothesis: RESID01 has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=3)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.062857	0.0002
Test critical values:	1% level	-3.959148	
	5% level	-3.081002	
	10% level	-2.681330	

*MacKinnon (1996) one-sided p-values.
Warning: Probabilities and critical values calculated for 20 observations and may not be accurate for a sample size of 15

I tested for cointegration using the ADF test and found the residual to be stationary. This shows us that this regression is not a spurious regression.

Table 5: Correlation Matrix (Annual)

	COMOVEMENT	INCOME	SETMC	SETTURN	INFD	IRD	FX	T	FDI	FPI	REG
COMOVEMENT	1.000000										
INCOME	0.505635	1.000000									
SETMC	0.197157	0.831380	1.000000								
LIQ	-0.068038	-0.063145	-0.164205	1.000000							
INFD	0.156059	-0.306764	-0.390102	-0.012355	1.000000						
IRD	0.020981	0.095308	0.206686	0.150935	-0.378946	1.000000					
FX	0.251150	-0.349921	-0.361468	-0.108520	0.623898	0.054288	1.000000				
T	0.062711	0.507832	0.309010	0.138563	-0.163430	-0.286793	-0.534611	1.000000			
FDI	-0.272359	-0.521113	-0.480810	-0.044420	0.715218	-0.397839	0.341399	-0.286135	1.000000		
FPI	0.332710	0.301858	0.257572	-0.037751	-0.382293	0.588195	0.109233	-0.258722	-0.386197	1.000000	
REG	-0.589795	-0.380784	-0.215767	-0.007411	-0.220278	-0.055093	0.004076	0.218570	0.026582	-0.169675	1.000000

In order to test for multicollinearity, I created a correlation matrix. As the matrix shows number larger than the R^2 of the regression, shown with the cells highlighted green, there is multicollinearity in this model between the Income and the Market Size variables.

Quarterly Model

In this model, I ran the regression using the equation:

$$corr\left(\widehat{SET}, \widehat{SP500}\right)_t = \alpha + \beta_1 T_t + \beta_2 FDI_t + \beta_3 FPI_t + \beta_4 Reg_t + \beta_5 MC_t + + \beta_6 FX_t + \beta_7 IRD_t + \beta_8 Inf D_t + \beta_9 Income_t + \beta_{10} SETTurn_t$$

Dependent Variable: COMOVEMENT
Method: Least Squares
Date: 07/28/20 Time: 23:11
Sample (adjusted): 11 84
Included observations: 70 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
T	-0.024588	0.472389	-0.052051	0.9587
FDI	-2.638273	1.664361	-1.585157	0.1183
FPI	-0.393564	1.313268	-0.299683	0.7655
REG	-0.397981	0.476654	-0.834947	0.4071
SETMC	-0.091576	0.074932	-1.222118	0.2265
FX	1.353431	1.237414	1.093758	0.2785
IRD	-4.599156	2.252335	-2.041950	0.0456
INFD	-1.093991	6.192154	-0.176674	0.8604
INCOME	1.163326	0.466642	2.492975	0.0155
SETTURN	0.951710	0.602584	1.579382	0.1196
C	-4.982778	2.201837	-2.263009	0.0273

R-squared	0.291072	Mean dependent var	0.376103
Adjusted R-squared	0.170914	S.D. dependent var	0.297933
S.E. of regression	0.271280	Akaike info criterion	0.371997
Sum squared resid	4.341978	Schwarz criterion	0.725332
Log likelihood	-2.019911	Hannan-Quinn criter.	0.512346
F-statistic	2.422422	Durbin-Watson stat	1.641574
Prob(F-statistic)	0.017215		

In this model, we can see that the Interest Rate Difference and Income Level are significant at the 5%, while none of the other variables have significant effects in the model. However, also of note is that the R^2 is exceedingly low compared to the annual model, meaning a large amount of the comovement is not explained with the variables used. The Durbin-Watson stat is between the critical values, so the model is not affected by autocorrelation.

Null Hypothesis: RESID01 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.927637	0.0000
Test critical values:	1% level	-3.530030	
	5% level	-2.904848	
	10% level	-2.589907	

*MacKinnon (1996) one-sided p-values.

I tested for cointegration using the ADF test, and as before, the residuals are stationary. Therefore, this regression is not a spurious regression.

Table 6: Correlation Matrix (Quarterly)

	COMOVEMENT	INCOME	SETMC	SETTURN	INFD	IRD	FX	T	FDI	FPI	REG
COMOVEMENT	1.000000										
INCOME	0.381251	1.000000									
SETMC	0.267833	0.851411	1.000000								
SETTURN	-0.017814	-0.285918	-0.092434	1.000000							
INFD	-0.064094	-0.054537	-0.858890	0.010603	1.000000						
IRD	0.001429	0.468606	0.374358	-0.010140	0.017354	1.000000					
FX	0.081564	-0.011738	-0.065912	-0.201071	0.067699	0.084362	1.000000				
T	-0.057264	0.116888	0.021452	-0.269084	0.286415	0.284716	0.264538	1.000000			
FDI	-0.258138	-0.228699	-0.238280	0.073533	0.077766	-0.207016	-0.182550	0.032549	1.000000		
FPI	0.058450	0.193960	0.165364	-0.060374	-0.060374	0.227298	0.351564	-0.228113	-0.113975	1.000000	
REG	-0.324821	-0.534643	-0.337432	0.172708	0.172708	-0.275334	0.231092	0.211719	0.190017	-0.116026	1.000000

As before, In order to test for multicollinearity, I created a correlation matrix. As the R^2 value is quite low, the correlation matrix shows us a lot of different variables having correlation values higher than the R^2. This could show us that the model suffers from multicollinearity, however I believe that the issue stems more from the low R^2 rather than the multicollinearity, as the correlation numbers are quite low.

Explanation of Results

Overall, the results of the study were different from expected, as many of the variables turned out to have insignificant effects on the comovement of the two stock markets. These differences in results could be due to a number of different reasons, ranging from the small data set in the annual dataset, or the difference in frequency in the datasets between my quarterly model and the previous literature, or simply that the Thai stock market reacts differently from other markets tested.

In the annual model, none of the variables are found to have a significant effect. This can be attributed to the previously mentioned small dataset that made the data unreliable, or that the comovement in this frequency is affected by a different set of variables.In the quarterly model however, the Interest Rate Difference and Income Level variables are found to be significant.

The Income Level is found to have a significant positive effect in the model. This confirms the findings of Nguyen, Nguyen and Schinckus (2019) that countries with higher income are more integrated with the United States'

market. Thus, as the Income Level of Thailand rises, the comovement between Thailand and the United States will rise.

For the Interest Rate Difference, there is a significant and negative effect on the comovement as well. This is in line with Nguyen, Nguyen and Schinckus (2019)'s findings, which state that a positive difference in interest rate leads to investors turning to the emerging market, in this case Thailand, rather than the US, leading to a lower amount of comovement.

Both models used have their own advantages and disadvantages. The main advantage of the annual model is that the regression has a high R^2, as well as a Durbin-Watson stat within the critical range and no multicollinearity. However, it suffers from a very small sample set, leading to results that are unreliable and no significant variables. On the other hand, the quarterly model has a much larger sample size and a Durbin-Watson stat within the range, but an exceedingly low R^2 value which led to the correlation table having many variables marked for a higher correlation value than the R^2.

Chapter 5: Conclusion, Summary, Implications and Recommendation

To bring back the original two objectives of the study, I believe that the existence of comovement on an annual frequency has been shown. This follows the finding by Graham, Kiviaho and Nikkinen (2012) who find that there is an increase in comovement especially after 2006. From my chart, I would say that a trend has been there since before 2006, but with a jump upwards at the specified time. Another part of their finding that has been confirmed is that in any frequencies higher than annual, the fluctuation in comovement is so volatile that there is no discernable pattern, and is very hard to explain with the variables used in this model.

There are several implications that can be garnered from the results of the regressions, which can likely be used in different ways depending on the investor or institution taking these results into question. The first is that as markets become more financially integrated, shown by consistently high comovement between stock indices, negative and positive shocks that affect one market will spill over into other markets that co move with it. However, financial integration bring several benefits such as improved sources of capital, reduced costs of capital and risk sharing between markets, as Cardona, Gutierrez and Agudelo (2017) states. From the results of the model, another implication can be garnered as well that the comovement of stock markets are affected differently by variables based on the frequency of the comovement being tested, shown by the different factors affecting the comovement in the models.

For investors, the implications are that since annual comovement is rising naturally as the economy grows, we can come to the conclusion that the amount of long term risk diversification and arbitrage opportunities will become rarer. This coincides with Nasser and Hajilee (2016)'s conclusion. However, the short term diversification and arbitrage opportunities will still be present. This is in agreement with Graham, Kiviaho and Nikkinen (2012), Nasser and Hajilee (2016), Gagnon and Karolyi (2003), Sheng, Brzeszczynski

and Ibrahim (2017)'s findings. Of course, while these opportunities are present in Thailand, they will be limited for regions with investment barriers, such as cost of access, information or taxation, as shown by Paskelian, Nguyen and Jones (2013) in the MENA region. While Thailand has been quite open to foreign investment, many regions are still not financially open for foreign investors. Thus, changes in the political and economic climate can lead to a shift in the trend of comovement. These shifts can present new opportunities for investors in order to diversify their portfolio, or for arbitrage opportunities.

There are several roadblocks that I have run into over the course of writing this paper, the first of which is the allocation of time. Due to having classes while working on the paper, I have mismanaged my time at several points in the process. Another roadblock I had was the lack of data between Thailand and the US, such as the Regulation variable, which had a few years missing and in the time-frame used in the study. This led to a small sample set as well as unreliable results for the annual model. If I had more time, I would have wanted to expand the research to several countries in order to circumvent the lack of number of observations.

In terms of possible improvements to the study, I would suggest that extending this study to incorporate the regional factor by focusing on the comovement of Thailand and the different ASEAN countries would be much more appropriate. This way, it would allow for a far significantly bigger set of data as well as being able to provide insight into the effects of regional integration on the comovement of stocks. However, given time constraints, I was only able to expand the model into using quarterly data.

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VITA

NAME	Nuntapat Asavaroengchai
DATE OF BIRTH	17 August 1994
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	University of Washington
HOME ADDRESS	323/4 Soi Chon Charoen, Rim Klong Prapa Left Road