ASSESSING THE DYNAMIC RELATIONSHIP OF STOCK MARKET, INTERNATIONAL TRADE AND ECONOMIC GROWTH: EMPIRICAL EVIDENCE FROM WAVELET ANALYSIS

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Abstract

This paper aims to identify the nexus of stock market, trade and economic growth in Thailand. The study used approximately two decades of monthly data from 2000 to 2019. By applying the continuous wavelet transform (CWT) wavelet-based approach, the time-frequency and lead-lag relationships among the variables can be captured. Empirical findings reveal significant coherencies among the variables in the medium and long run with a positive association. Evidence reveals that the Thailand stock market plays a prominent and leading role in international trade. This study offers interesting findings about the lead-lag relationship between the stock market and economic growth, while the significant positive relationships among these two variables are validated. The theoretical implications have been justified, as these relationships are significant. The results obtained are vital for policymakers in framing effective macroeconomic policies regarding the Thailand stock market.

Key Words

Thailand stock market; wavelet coherence map; time-frequency analysis; trade; economic growth.

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INTRODUCTION

Great interest has arisen among economists regarding the linkage between the stock market and economic growth, despite disagreement regarding the degree to which the financial industry can foster economic growth. Traditionally, the questions revolve around whether or not the financial sector has adequate influence on economic changes. Moreover, in crisis, the degree to which the financial sector affects a country's economic growth has also been debated. Although the connections among the stock market and economic growth remain inconclusive, evidence suggests that the innovations and evolution of the stock market influence progress in global financial markets. The stock market has constituted an important channel through which to raise capital in the economy and trigger growth. In the meantime, potential risks to the economy still exist due to market crashes and volatility in stock market returns.

Over the past five decades, the Thai government has focused on its stock market because it is considered a compelling alternative for diversification to stimulate economic growth. In 1962, a private group in a limited partnership established the Thai stock market; it was renamed the Bangkok Stock Exchange Co., Ltd. (BSE) the next year. Despite the well-intended base, its annual turnover was only THB160 million in 1968 and reached an all-time low of just THB26 million in 1972. Due to BSE's failure, proper facilities and procedures for securities trading were established under the Second National Economic and Social Development Plan (1967-1971). In 1972, the Thai government took further action by extending government control and regulation over finance and securities operations. In 1991, the BSE was re-named the Stock Exchange of Thailand (SET), and on 10 September 2014 it became the first Association of Southeast Asian Nations (ASEAN) member and Southeast Asian country to join the United Nations Sustainable Stock Exchange initiative.

The SET had a total of 757 listed companies as of 2018Q2 (Stock Exchange of Thailand, 2019). In 2018, the SET index closed at 1,563.88 points, a decrease of 10.8% from the previous year. In addition, the market capitalisation of SET and the Market of Alternative Investment (MAI) decreased to USD500.3 billion, a decrease of 9.52% from 2017. The average trading value peaked in the second quarter of 2018 and continued to drop in the last quarter of 2018. This weak performance is due to trade war tensions between the United States (US) and China, the global crude oil price fluctuations and contractual monetary policies of major central banks.

The international trade war tension indicates a dynamic relationship between international trade and the Thai stock exchange. Trade war tension affects investors' confidence level, and thus impacts stock market performance. Trinity Securities Executive Director Nuttachart Mekmasin pointed out that the trade war between the US and China is the most critical factor affecting sentiment across global stock markets (Bangkok Post, 2019). Due to trade war tension, the SET suffered a huge equity sell-off and tumbled by around 35 points on 26 August 2019. This indicates that the Thai stock market is sensitive to trade war tension between the leading countries in the

world. This critical issue inspired a closer look into the complex relationships between Thailand's trade and the stock market.

Additionally, the stock market became a vital source of funds for private firms after the Asian financial crisis in 1997 because emerging market equity is considered a compelling diversification alternative. A well-developed stock market is important to ensure the sustainable growth of the national econnomy. Numerous studies have emphasised the vital role of a steady and vibrant stock market in promoting economic growth (e.g. Comincioli & Wesleyan, 1996; Levine & Zervos, 1998). Therefore, this study is motivated to identify the relationships and lead variable associated with the stock market and economic growth in Thailand.

Most studies have focussed on the relationship and causality of stock volatility, stock returns and trading volume (Chen et al., 2001; Mahajan & Singh, 2009; Choi et al., 2012). However, few studies have examined the leading variable and time effect in the stock market. This study aims to do so using wavelet analysis, which few quantitative analyses have employed. Several compelling arguments motivate this research. First, little quantitative analysis has been performed using the wavelet approach in the Thai stock market. Second, the research to date has tended to focus on dynamic relationships and causality effects between the variables rather than investigating the lead and lag relationships between the variables in the stock market. By understanding the time-frequency relationship, industry players can plan better crisis management and improve the short-term capital flow, which in turn can improve policy-making decisions.

LITERATURE REVIEW

In the existing literature, the relationship among economic performance, trade and the stock market is extensively debated. Several researchers have identified an association between economic development and the stock market, including Bencivenga (1996), Demirguc-Kunt and Levine (1996), Puah and Jayaraman (2007), Deb and Mukherjee (2008), Ibrahim (2011), Puah et al. (2015), Ananwude and Osakwe (2017), Banerjee et al. (2017), Alawin et al. (2018) and Mishra and Pan (2018). Specifically, Nghia and Blokhina (2020) also emphasized the importance of stock market efficiency concept for investors and managers on Vietnamese securities market. Carp (2012) stated that a well-established stock market indicates that the significant evolution of the financial sector plays a vital role for sustainable economic development, transforming a country into an attractive economic destination for foreign investors. The empirical finding suggested that the investments stimulate higher economic growth, which indirectly creates optimistic externalities for the stock market. Similarly, Vithessonthi and Kumarasinghe (2016) found that the Indonesian stock market became more attractive to international investors after financial reforms and, thus, attained a higher degree of trade integration.

Deb and Mukherjee (2008) found that the stock market evolution might lead to economic development in India, detecting a causality relationship with

unidirectional properties from the stock market to real gross domestic product (RGDP). Fung (1995) and Choi et al. (2012) conducted similar research for the Korean stock market. They employed trade volume to proxy the information flow and considered it a lagged volume. Their empirical findings showed that a slight increase in trading volume leads to asymmetric volatility in the stock market. Therefore, they concluded that trading volume and stock volatility have a positive relationship and that the trading volume is a useful tool for forecasting Korean stock market price dynamics. On the other hand, Balasubramaniam et al. (2016) and Chin et al. (2020) established that trade integration can be promoted to boost the country's economic growth. International trade globalisation also plays an important role in stock market performance. In addition, Paramati et al. (2017) documented that trade intensity and the stock market have a positive relationship in the long run.

Previous studies such as Laokulrach (2014), Samsi et al. (2019) and Hamzah et al. (2020) have focussed on the relationships between macroeconomic variables and stock market performance in Thailand. The macroeconomic variables consist of GDP, international trade, capital formation, financial crises, terrorism and other key variables. Laokulrach (2014) also suggested that economic growth is strongly influenced by the growth of the stock market and capital formation in Thailand, confirming a bi-directional relationship between economic growth and Thai stock market development. In term of crisis, Hung (2019) and Samsi et al. (2019) consistently provided evidence of the negative impact of crisis on the Thai stock market. Several approaches, including the autoregressive distributed lag model (ARDL) (Tursoy & Faisal, 2018; Bhattacharya et al., 2019; Hamzah et al., 2020), vector error correction model (VECM) (Wanaset, 2018; Samsi et al., 2019; Faduka, 2020), exponential, generalised, autoregressive, conditional heteroscedasticity (EGARCH) (Naik et al., 2018; Tiwari et al., 2019) and panel analysis (Salisu & Isah, 2017) have been employed to examine the relationships between the financial market and macroeconomic factors. Although various approaches have been employed in previous literature, research using wavelet analysis to investigate the Thai stock market is still scant. The more than five decades of trading activities in Thailand's economy presents an opportunity to examine the stock market in different perspectives. Specifically, the lead-lag relationship of these fundamental financial parameters should be examined through wavelet analysis. In general, this study fills this research gap by employing an innovative research methodology for the Thailand stock market.

DATA AND METHODOLOGY

This study employed monthly data from 2000M01 through 2019M06. A wavelet approach was used to identify the lead and lag relationship and time effect on the Thailand stock market using R programming software. The packages implemented in this study include a "biwavelet" package and a "waveslim" package using pseudocode written by Percival and Walden

(2000). Next, the dynamic rolling correlation of continuous wavelet transform can be obtained using the "zoo" package in R. Wavelet coherency has gained popularity in the financial and economic fields, as it deals with interactions between two different time series and their evolution over time and frequency domain, suggesting high-movement regions in time-frequency space. International trade (Trade), economic growth (RGDP) and the Stock Exchange of Thailand (SET) have been investigated in this study. All data are obtained from the CEIC database.

In this study, a wavelet analysis, an econometric tool that uses scale components, was employed to perform multi-resolution analysis (MRA). First, a descriptive analysis was used to reveal the characteristics of the stock market, trade and economic growth of Thailand. The procedure was followed by a rolling correlation analysis performed to understand the time-varying nature of the relationship. A wavelet-based approach was then used to capture the time-frequency-based behaviour of the relationship among the variables. The equation of the continuous wavelet transform (CWT) is expressed as follows:

$$W_x(\tau,u) = \int_{-\infty}^{\infty} x(t)\widetilde{\mathcal{X}}^*_{(\tau,u)}\ (t)dt; u \neq 0;\ \tau,u\ \in \mathbb{R}, \qquad (1)$$

where $x(t)\widetilde{\mathcal{X}}^*_{(\tau,u)}$is the complex conjugate of $\widetilde{\mathcal{X}}^*_{(\tau,u)}(t)$. The transformed output is identified by its scale and translation, which is represented by a matrix of coefficients of order |2×2|. (t) is transformed into a signal with respect to a translation parameter *τ*, the location indicator, and a scaling parameter *u*, the length indicator, where $\tau,u\ \in \mathbb{R},\chi$; the mother wavelet, is denoted by:

$$x(t)\widetilde{\mathcal{X}}^*_{(\tau,u)} = \frac{1}{\sqrt{|u|}}\chi(\frac{t-\tau}{u}) \qquad (2)$$

Based on applicability of the Morlet wavelet in the economics literature, it is well-defined as in Equation (3):

$$\chi^M(t) = \frac{1}{\pi^{0.25}}\exp(i\omega_0 t)\exp(-t^2/2) \qquad (3)$$

The Monte Carlo technique for discovering statistical significance was used since the unknown situation for wavelet coherence in theoretical distribution always exists. Upon determining the statistical significance for the variables, the underlying theories can be applied toward the selection of potential variables (see Table 1).

Table 1: Descriptive statistics

	RGDP	**TRADE**	**SET**
Mean (x100)	0.278	0.300	0.645
Standard Deviation	0.086	0.093	0.304

Maximum	0.437	0.467	1.205
Minimum	0.133	0.130	0.177
Skewness	-0.160	-0.335	0.107
Kurtosis	1.817	1.810	1.676
Jarque-Bera	14.636	18.170	17.544
ADF	-7.486	-9.035	-14.970
PP	-3.868	-30.541	-14.981

ADF: Augmented Dickey-Fuller; PP: Phillips-Perron. At 5% significance level, the critical value for JB test is 5.99.
Source: Own survey.

The coherence of the wavelet is classified as a bivariate framework to observe the interaction between two time series and is expressed as in Equation (4):

$$W_{xy}(\tau, u) = W_x(\tau, u)W_y^*(\tau, u) \quad (4)$$

The lead-lag phase relation within the examined time series is indicated by the arrow located in the wavelet coherence plots. When a difference in zero-phase is indicated, the two time series under examination tend to move together. In the meantime, time series in phases (anti-phase) represented by right (left) arrows express a positive (negative) correlation. Regarding the lead / lag relationships, the position of the leading variables is indicated by an arrow trend upwards or downwards by 90^0.

EMPIRICAL FINDINGS AND DISCUSSION

This study aims to examine the dynamic relationships in the stock market during a crisis and its vulnerability to macroeconomic imbalances and capital inflows. Before discussing the wavelet-based analysis interpretations, the time-varying correlations for both pairs of variables, Trade-SET and RGDP-SET, are demonstrated in Table 2. First, Figure 1 depicts the 36 months (3-year) rolling correlations analysis results. Based on the empirical results, similar characteristics of correlations were found in both pairs of the series. The rolling correlations faced a downturn trend during 2007-2008, corresponding to the global financial crisis. The global financial crisis caused a decline in corporate profits and an increase in business failures. Moreover, spending, production and manufacturing also faced adverse impacts, which might have led to stagnant economic growth. Thailand faced a military coup and its trade-reliant economy was hit by falling exports in 2014; similar rolling correlations results can be observed. This is followed by the descriptive statistics of the rolling correlations in Table 2. When comparing the descriptive statistics of both pairs, the average rolling correlations for the RGDP-SET (0.68) were slightly stronger than for the Trade-SET (0.55). Nonetheless, the standard deviations in the rolling correlations for both RGDP-SET (0.23) and Trade-SET (0.28) are similar. The values of 0.96 and -0.21 depict the maximum and minimum value of Trade-SET and 0.97 and -0.00 show it for RGDP-SET. Both Trade-SET and RGDP-SET show

negative skewness values of -0.71 and -0.97, indicating the left tail of distribution.

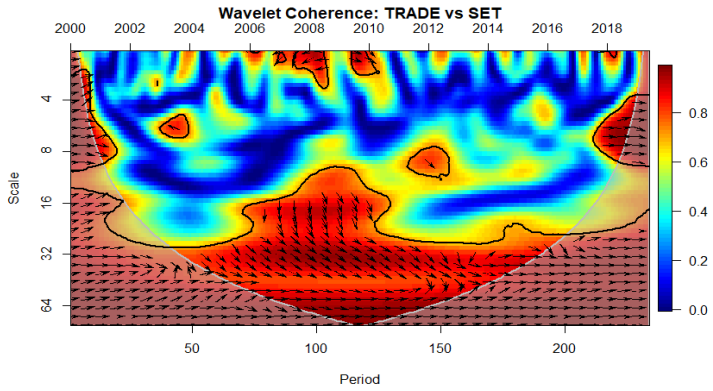
Table 2: Descriptive statistics of 36-month rolling correlation

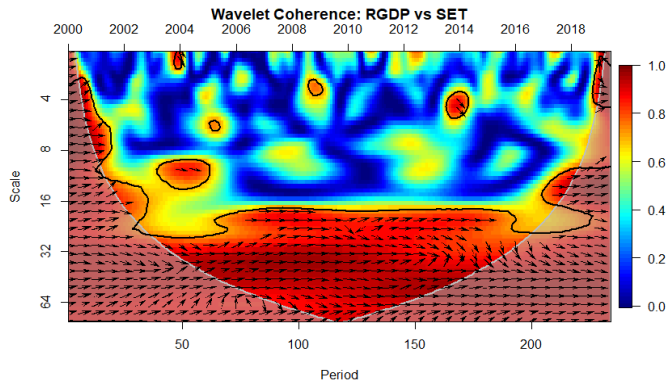
Statistic	Trade-SET	RGDP-SET
Mean	0.545	0.678
Standard Deviation	0.277	0.231
Kurtosis	-0.367	0.087
Skewness	-0.708	-0.970
Minimum	-0.208	-0.000
Maximum	0.956	0.971
Confidence Level (95.0%)	0.039	0.032

Source: Own survey.

Figure 1 illustrates the wavelet coherence maps via a contour plot in a bivariate framework. The vertical scale is presented in months for ease of interpretation; the frequency is denoted as 4 to 64 months. Meanwhile, the horizontal scale denotes the timeline where the number of observations is located at the lower horizontal axis and the corresponding year is located at the upper horizontal axis. The colour bar on the right in the coherence maps signifies the power of the coherence coefficient. Red zones portray stronger evidence of co-movements as the coefficient is closer to 1. In contrast, blue zones signify weaker co-movements among the variables and the coefficient is closer to 0. In the meantime, the black contour in boldface defines the zones which are significant at the 5% level by setting the boundaries. The whitish area, also called the zone of influence, is statistically insignificant and located at the edge region.

Figure 1: Wavelet coherence maps





Source: Own survey.

Equal lengths of two white noise time series are proposed for a Monte Carlo simulation of 1,000 sets to identify the significant coherence zones. The lead/lag relationships are symbolised by the arrow in the wavelet coherence maps. A rightwards (→) arrow expresses a positive relationship whereas a leftwards (←) arrow expresses a negative relationship. As a result of the first variable leading to the second variable, the arrows are presented as upwards (↑), upwards-right (↗) and downwards-left (↙). On the other hand, when the second variable leads to the first variable, the arrows are shown as downwards (↓), downwards-right (↘) and upwards-left (↖) (Jiang et al., 2017; Das et al., 2018; Kumar et al., 2019).

Figure 1 demonstrates the wavelet coherence analysis for Trade-SET, followed by that for RGDP-SET. The empirical findings revealed the significant coherences that exist between the variables in the medium to long term, ranging mainly from 16 to 64 months, as demonstrated in both wavelet coherence maps in Figure 1. The results show that the economic implications of the variables mostly appear in the medium to long term. Both pairs of variables consist of in-phase positive relationships as the arrows are pointing rightwards (→) in the long run. As shown in the results from the lead-lag analysis, the arrows pointing downwards (↓) and downwards-right (↘) indicate that Thailand's stock market plays a leading role in trade. This finding is consistent with Choi et al. (2012), who reported that the volatility in the Korean stock market had a positive association with trading volume.

An interesting result arose for the wavelet coherence of RGDP-SET. In the first part of the sample period, economic growth led the Thai stock market in the medium timeframe, while Thailand's stock market led long-term economic growth. On the other hand, after 2010, Thailand's stock market led medium-term economic growth, while economic growth led the Thai stock market in the long run. These interesting findings support the theoretical connotation between economic growth and financial development. The stock exchange leading economic growth conforms with the "supply-leading" hypothesis (Adeyeye et al., 2015). Moreover, economic growth that stimulates the development of stock exchanges also conforms to the "demand-following" hypothesis. A decline in stock prices indicates poor business sentiment that triggers economic downturn (Kuek et al., 2020). The

persistent declination of the stock market is recognised as the harbinger of an economic slowdown. This also leads to a decrement in investment due to lower consumer confidence, which has an adverse impact on economic growth. Thus, the statistical findings provide sufficient evidence to validate the implications in the hypothesis.

CONCLUSIONS

The diverse scope of the Thailand stock market constituted the chief interest of this study. This study attempted to investigate whether the stock market in Thailand affects international trade and economic growth, or vice versa. The study was motivated by concern that the failure and collapse of major financial institutions in a country can result in adverse impacts on economic growth. The study also considered the fact that both practitioners and academicians have examined the determinants of stock returns and the cause of stock volatility from macroeconomic perspectives. The empirical findings unveil significant positive causal relationships among the Thailand stock market, international trade and economic growth. In addition, economic implications exist, especially in the medium and long run. Thailand's stock market plays a prominent role in trade and economic growth. When the performance of stock returns is optimistic, consumer confidence increases and the business outlook brightens, which leads to more investment. Therefore, additional stimuli should be applied in the Thailand stock market. Despite the trade war, Thailand could also benefit from those companies that want to relocate from China. Also, investment can be boosted via public spending. However, the generalisation of these findings may be somewhat limited, as the variables only include SET, trade and RGDP. Other possible macroeconomic determinants are not examined in the current study. Further study should be conducted to examine those determinants.

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