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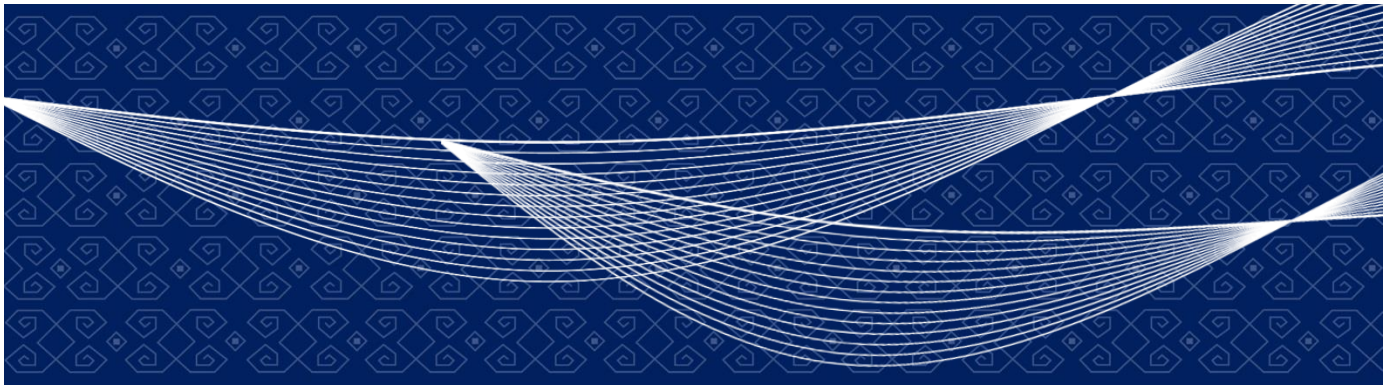

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WORKING PAPER

THE DYNAMICS OF FOREIGN PORTFOLIO INVESTMENT AND EXCHANGE RATE: AN INTERCONNECTION APPROACH IN ASEAN

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The Dynamics of Foreign Portfolio Investment and Exchange Rates: An Interconnection Approach in ASEAN

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Abstract

This paper examines the spatial dependence of foreign portfolio investment (FPI) inflows between ASEAN countries from 2002Q1-2018Q4 utilizing the spatial econometric approach. In particular, to enrich the results of our research we also review the relationship between exchange rates and macroeconomic factors on the FPI in Indonesia. The empirical results show that there is a competitive relationship in FPI between ASEAN countries that indicates crowding out of FPI in the host country is most likely to occur when third-country experiences crowding in its FPI inflow. We also show that the exchange rate dynamics in the host and third country do not significantly affect FPI in the host country. Furthermore, the results indicate that interest rate differential, inflation, economic growth, and government debt rating in host countries, also inflation, economic growth, and government debt rating in neighboring countries are responsible for the inflow of FPI into host countries in ASEAN. In the Indonesia case study, our empirical results show that exchange rates affect bond and equity inflows, and also exchange rate volatility affects foreign equity markets and total portfolio inflows in Indonesia. In addition, we find the importance of interest rate differential and the VIX index for Indonesia's portfolios market.

Key words: Foreign portfolio investment, Exchange rates, Macroeconomics, Spatial panel econometrics, Spillover effects

JEL Classification: F21, F31, F41, C21, R12

1. Background

Most of the countries in Southeast Asia (ASEAN) are developing countries which is require the big funds, such as foreign portfolio investment, to boost their economy. The expansion of foreign portfolios in ASEAN began after the 1990s when the stock market and securities became essential in economic growth in the ASEAN region. The existence of a trade agreement between ASEAN countries, through the signing of the ASEAN Free Trade Area (AFTA) and the implementation of the ASEAN Investment Area (AIA) in 1998 and the ASEAN Comprehensive Investment Agreement (ACIA) in 2012, has increased investment flows to ASEAN and created a liberal, transparent, and competitive investment environment in ASEAN. The removal of trade restrictions and international investment agreements has increased investment by foreign investors. Therefore, the foreign portfolio in terms of liabilities (FPI inflow) to ASEAN increased nearly sixteen times from US $ 3.2 billion in 2001 to US $ 51 billion in 2017. In this regard, Indonesia was the largest FPI recipient country in ASEAN in 2017. However, the volatility of FPI in ASEAN began increasing after the 2008 global economic crisis, indicating its vulnerability to a reversal.

Short-term capital inflows, such as foreign portfolio investment, often have a strong relationship with exchange rate dynamics because their investments tend to be liquid and flexible. There have been debates on the impact of changes in exchange rates towards foreign portfolio investment flows. Studies by Garg & Dua (2014), Srinivasan & Kalaivani (2015), Haider et al. (2016), Wong (2017), Anggitawati & Ekaputra (2020) suggested that an appreciated exchange rate promotes portfolio investments because foreign investors receive an additional return source and encourage them to invest by appreciating the exchange rate. The opposite result was found by Bleaney & Greenaway (2001), which argues that the foreigners will be motivated to invest in the host country when there is a devaluation in the host country currency due to higher return. Studies by Baek (2006), Cenedese et al. (2014), and Singhania & Saini (2018) had different perspective where they found no relationship the exchange rates and portfolio investments by foreign investors. Moreover, Persson & Svensson (1989), Bleaney & Greenaway (2001), and Garg & Dua (2014) found volatility in exchange rate has negative and significant impact on inducing portfolio investment.

Another set of literature also focus on the host country interest rate differential along with the exchange rate. According to the neoclassical theory, foreign capitals are attracted by interest rate between countries. Capital flows from developed countries with abundant capital and low returns to developing countries with capital scarcity and high returns (Ghosh et al., 2014). Qureshi et al. (2012), Garg & Dua (2014), and Ghosh et al. (2014) has found that an increase in the interest rate differential allows a surge in capital inflows. In addition, the literature that analyzes the determinants of portfolio flows discussed the relative significance of domestic factors along with the exchange rate and interest rate differential (e.g., Ahmed Hannan, 2018; Ahmed & Zlate, 2014; Al-Smadi, 2018; Alwafi, 2017; Fratzscher, 2012; Kinda, 2010; Luitel & Vanpée, 2018; Marouane, 2019; Verma & Prakash, 2011).

Economic integration creates interdependence between countries with abundant and lack of capital, driving cross-border asset growth beyond the expansion of goods and services. With higher technology advancement and faster information exchange, geographical distances have become more artificial. Coval & Moskowitz (2016) reported that asymmetric information makes geographic proximity beneficial to investors located near potential investments. They benefit in terms of selecting stocks, meaning that geographic location, informed trade, and asset prices are closely related.

To the best of our knowledge, we documented that the progress of the existing literature was not adequately addressing the spatial inter-relation on FPI between regions within a

country with each other. First, conventional studies, such as traditional panel data model and time-series model, are mostly used in existing study literatures, which in this regard holds the geographical interdependence factors as exogenous when investigate the FPI's behaviors empirically (Ahmed & Zlate, 2014; Garg & Dua, 2014; Haider et al., 2016; Rafi & Ramachandran, 2018; Singhania & Saini, 2018; Srinivasan & Kalaivani, 2015). Traditional panels and gravity models cannot capture the effects of third countries in examining the portfolio flow determinants, hence a spatial panel data model is used to overcome this problem. Due to the relationship or dependence on economic activities between countries, the effects of spatial interaction between countries in a certain region unavoidable. Studies that discuss FPI behavior influenced by third countries are still quite rare. Only two literature studies relate to the spatial relationship of FPI by Chuang & Karamatov (2018) and Jory et al. (2018).

Second, many studies have examined the FPI inflow determinants in an economic union (e.g. Baek (2006) for Asian and Latin American FPI inflow, Singhania & Saini (2018), Fratzscher (2012) for developed and developing countries FPI inflow, Ghosh et al. (2014) and Ahmed & Zlate (2014) for developing countries FPI inflow, and Waqas et al. (2015) for South Asian countries FPI inflow). However, we have not found any research related to the determinants of FPI in Southeast Asia (ASEAN) yet. Besides, the existence of the Master Plan on ASEAN Connectivity (MPAC) 2025 which address the technical regulations for investment in ASEAN Member States (explicitly covers portfolio investment) and also the creating of a new regional dynamic that drives recent investment treaty policies for countries in the ASEAN with other countries (e.g. Australia and New Zealand (2009), Korea (2009), China (2009), and India (2014)) potentially to cause inter-related policy among ASEAN countries that possibly generates the spatial relation in FPI.

Furthermore, this paper contributes to the current literature in two crucial ways. First, this study can be scientifically beneficial by adding and enrich current literature on the geographic investment phenomenon in the aspect of a broader set of spatial econometrics of FPI inflows, especially for ASEAN case. Because of the cross-border investment tends to create the investor’s decision to invest their portfolio in a specific location and establish geographical interconnection between neighboring countries. Jory et al. (2018) argues that due to the intertwined nature of demographic, location-specific, attachment-attributable factors with financial and economic variables, it makes these factors endogenously determine portfolio investment performance. Therefore, the discussions about the existence of spatial distribution of third-country can no longer be ignored. Second, using the spatial spillover effect, this paper adds complexity to the identification of the true nature of portfolio investment performances in ASEAN. We provide new insights for policy practices and financial investors through the evidence of the existence of geographical interdependence on international investment in ASEAN region.

This research also reviews the relationship between exchange rates and macroeconomic factors on FPI because Indonesia is one of the Southeast Asia countries with a fairly rapid growth trend in portfolio investment, especially in the last ten years after the 2008 global economic crisis. Based on Bloomberg, during the 1998 crisis, when Indonesia's spot exchange rate depreciated from 2,879 in 1997 to 10,210 in 1998, portfolio investment inflows decreased from USD 5.0 to USD -1.9 billion in 1996-1998. Before 1994, FPI's movement in Indonesia was dominated by equity stocks and investment funds. After 1994, there was a reversal of the foreign portfolio investment dominance from equity stocks and investment funds to debt securities, boosting FPI's growth. After the 2000s, the equity stocks and investment funds declined with negative growth of -2.5 billion USD and -3.7 billion USD in 2017 and 2018. Therefore, it is vital to examine the factors that influence foreign portfolio inflows to Indonesia.

Based on the background stated above, there are two objectives of this research:

1. This research measures and analyzes the relationship between exchange rate dynamics and several macroeconomic variables on foreign portfolio investment flows in ASEAN countries by including the interconnection relationship between countries.
2. The study also measures and analyzes the exchange rate dynamics and several macroeconomic factors that affect foreign portfolio investment in Indonesia.

2. Literature Studies

Many literature reviews discuss foreign capital inflow, a topic of interest to investors. However, most research related to foreign capital inflows only focuses on foreign direct investment flows. The factors that affect portfolio investment are rarely examined. Research about the determinants of foreign portfolio investment, through the variable debt and equity flows, is used by Chuang & Karamatov (2018), which examines the relationship between the growth of a country's stock market and the amount of connectivity in a network using spatial panels in 21 countries. Focusing on the determinants of foreign portfolio investment through debt and equity flows, the results showed a correlation between the growth of a country's stock market and its closest countries. There was also a positive relationship with the country's international investment, shown by debt securities.

Various approaches are used to examine the determinants of foreign portfolio investment (FPI). The portfolio is often divided into three categories, including country, industry, and firm levels. Most research focuses specifically on the country-level, specifically the relationship between exchange rates and foreign portfolio investment flows, including Garg & Dua (2014), Anggitawati & Ekaputra (2018), dan Caporale et al. (2017), Gumus et al. (2013). Garg & Dua (2014), using a sample of India and the ARDL method, established that portfolio inflows were influenced by lower exchange rate volatility and appreciation, and greater risk diversification opportunities. Furthermore, it also disaggregates FPI into two, Foreign Institutional Investment flows (FII) and American / Global Depository Receipts (ADR / GDR). The FII determinants are similar to aggregate portfolio flows, while ADR / GDR is influenced by returns on domestic equity, exchange rates, and domestic and foreign output growth. This is in line with Anggitawati & Ekaputra (2018)., which established a causal relationship between net foreign investment and the exchange rate in Indonesia using the VAR method. The increase in FPI in form of domestic bonds often strengthens the local exchange rate. Domestic appreciation tends to increase FPI in the bond market. In the domestic stock market, there is only a one-way relationship, where only the domestic exchange rate has a significant impact on FPI movements on the Indonesian stock market. In this regard, the FPI on the stock market does not affect the domestic exchange rate. These results contravene Gumus et al. (2013), which established that FPI is only influenced by the industrial production index, rather than the exchange rate. Furthermore, shocks to portfolio investment affect the Istanbul stock price index and the exchange rate.

French & Vishwakarma (2013) and Rafi & Ramachandran (2018) examined the effect of FPI volatility on exchange rates. Using a sample of the Philippines and the SVARX-GARCH method, French & Vishwakarma (2013) established that a shock in foreign capital flows to the Philippines increased volatility in the stock market significantly over the next two weeks of trading time. Furthermore, the shock also increased the variance of the USD / PHP exchange rate for the next two to three weeks of trading time. This is in line with Rafi & Ramachandran (2018), which examined the relationship between capital flows and exchange rate volatility in developing countries using the VAR panel method. The results show an impulse response to the shock effect in portfolio capital flows on exchange rate volatility, which increases significantly compared to direct foreign inflows. The variance in shocks towards foreign portfolio investment flows has a significant impact on exchange rate volatility. The variations in current account balances, stock prices, and interest rates also affect exchange rate volatility. Caporale et al. (2017), using the GARCH method and the Markov regime-switching, also established that high exchange rate volatility is associated with equity (bond) inflows from Asian countries to the US in all cases, except the Philippines.

Apart from focusing on the exchange rate, several studies also examined other macroeconomic factors influencing FPI flows into a country by dividing them into two push and pull variables. Push factors are represented as determinants of global liquidity conditions and other factors that can drive investment flows into the country. In comparison, domestic pull factors can be represented as risk and return. According to Baek (2006), there were differences in the factors that pushed FPI to enter Asia and Latin America. In Asia, the FPI inflow is driven by investor interest in risk and other external factors, while the pull factor from the domestic can be ignored. Pull and push factors, such as strong economic growth and foreign financial variables are the determining factors for the entry of FPI in America. However, FPI in Latin America is not driven by market risk appetite. The FPI flowing in Asia is "hot" money because it is sensitive to changes in global market conditions and external factors.

Using the ARDL method, Srinivasan & Kalaivani (2015) examined the FII determinants in India. The returns on the Indian equity market have a negative short-term and a positive long-term effect on FII inflows. The returns on US equity markets have a positive and significant effect on FII flows in the long term but a positive and insignificant effect in the short term. Furthermore, the exchange rate and domestic inflation also determine the FII inflow to India. Using a sample of developed and developing countries and comparing static panel models and GMM, Singhania & Saini (2018) examined the FPI determinants. The result, using a static panel in developed countries showed that FPI inflows are determined by interest rate differentials, trade openness, and stock market performance of the host country, while the US stock market return is the significant trend determinant. In developing countries, the index of freedom, differences in interest rates, the stock market performance in the host country, trade openness, returns on the US stock market, and the crisis period (2006-2008) significantly affected FPI inflows. Using the GMM model in 19 countries, a study showed that differences in interest rates, freedom index, US and host country's stock market returns significantly affect portfolio investment.

Ghosh et al. (2014) used the probit method, 2SLS and country fixed effect and established that lower US interest rates, a greater appetite for global risk, and the attractiveness of the country attract capital inflows to developing countries. This is in line with Ahmed & Zlate (2014), which determined the factors influencing capital flows in developing countries using the static panel data method. The study established that driving factors, such as differences in interest rates in developing and developed countries, global risks, and US policies influence capital inflows significantly. Fratzscher (2012) showed that driving factors, such as shocks to liquidity, risk, microeconomic conditions and policies in developed countries, especially the United States, significantly affected capital flows to developing and developed countries during the crisis period. During the 2007-2008 financial crisis period, these factors had a greater influence on foreign capital inflows. Furthermore, the importance of pull factors, such as good economic policies in a country and increased institutional arrangements to reject the risk of external shocks affecting the incoming FPI were discovered.

Using a sample of South Asian country data and the GARCH method, Waqas et al. (2015) determined the FPI flows determinants through pull factors. The results showed that lower volatility in international portfolio flows was associated with high-interest rates, currency depreciation, foreign direct investment, lower inflation, and higher GDP growth rates than the host country. According to Al-Smadi (2018), a good and stable macroeconomic environment in Jordan attract investors. Furthermore, high-risk diversification opportunities, adequate liquidity, and a well-organized environment attract more portfolio investment. According to Haider et al. (2016), GDP and foreign debt are strong determinants of FPI flows to China. Furthermore, the exchange rate and population significantly influence FPI. Bhasin & Khandelwal (2019) established that domestic and global factors most influencing foreign

capital inflows in India include returns from the MSCI index, past FII values, and economic growth rates.

Ouedraogo (2017) specifically examined the factors influencing FPI focusing on the industry-level. The study determined the relationship between portfolio inflows to a country and exchange rate by considering institutional sectors of capital flows (government, banks, and corporations) using the 2SLS method. According to the results, the relationship between real effective exchange rates and portfolio inflows depends on the investment sector flowing. Furthermore, some studies, such as Badawi et al. (2019), specifically focus on a firm-level show that in emerging markets, investment in private companies and institutions that have relatively higher levels of tangible assets are preferred. The government-owned and companies with high liquidity were rejected.

3. Data And Methodology

3.1. Data

This study examines the FPI determinants factors in five countries in the ASEAN region, including Indonesia, Malaysia, Philippines, Singapore, and Thailand. A case study of Indonesia is also reviewed using secondary data. In the ASEAN case study, the data used is quarterly with a time span from 2002Q1-2018Q4. In comparison, the data used in the Indonesian case study is 5-day trade from 15 June 2010 to 29 May 2020. This study uses the spatial data panel method to examine the ASEAN Region and GARCH to research in Indonesia. Table 1 shows the variables and data sources used in the estimation.

Table 1 Variable Description

Variable	Description	Literature Study	Source
ASEAN Case Study			
FPI	Foreign portfolio investment (liabilities) as a percentage of nominal gross domestic product	Rafi & Ramachandran (2018), Rai & Bhanumurthy (2004), Singhania & Saini (2018)	IMF
SXRGROWTH	One-year change from the Spot exchange rate (%)	Ouedraogo (2017)	Bloomberg
IRD	The interest rate differential is the difference between the interest rate on the 10-year country-i government bond and the interest rate on the 10-year US government bond	Rafi & Ramachandran (2018), Singhania & Saini (2018), Bhasin & Khandelwal (2019), Garg & Dua (2014)	CEIC
GDPGROWTH	Real gross domestic product growth (%)	Rafi & Ramachandran (2018), Singhania & Saini (2018), Vardhan & Sinha (2016)	CEIC
EXPSXR and UNEXPSXR	Exchange rate volatility using moving variants for expected exchange rate risk and GARCH models for unexpected exchange rate risk	Rafi & Ramachandran (2018), Byrne & Fiess (2016), Baek (2006) Ndou et al. (2017), Diebold (1988), Yu et al. (2007)	Bloomberg
INF	Inflation (Consumer Price Index (CPI) Growth in%)	Al-Smadi (2018), Fratzscher (2012), Baek (2006), Agarwal (1997)	CEIC
OPENNESS	Trade openness (Total trade as% of nominal GDP)	Singhania & Saini (2018), Alam et al. (2013), Ang (2008), Fratzscher (2012), Qureshi et al. (2012)	IMF
SP	Government Debt Rating Index by Standard & Poor's (S&P), where the scale is from 1 (lowest / D) to 22 (highest / AAA)	Luitel & Vanpée (2018), Fratzscher (2012)	The global economy

Indonesian Case Study			
FPI	Total inflows of foreign portfolio investment (liabilities) are defined as foreign purchases minus foreign sales of Indonesian portfolios and normalized using the average absolute rate for the previous year.	Hau & Rey (2002), Caporale et al. (2017)	Bloomberg
BOND	Foreign inflows into 10-year government bonds, which are normalized	Anggitawati & Ekaputra (2018)	Bloomberg
EQUITY	Foreign inflows from equity, which are normalized	Anggitawati & Ekaputra (2018)	Bloomberg
SXRGROWTH	Monthly change from Spot exchange rate to spot exchange rate (%)	Ouedraogo (2017), Anggitawati & Ekaputra (2018)	Bloomberg
UNEXPSXR	Exchange rate volatility using the GARCH model for risk of unexpected exchange rates	Rafi & Ramachandran (2018), Byrne & Fiess (2016), Baek (2006)	Bloomberg
VIX	The VIX index is used to measure the constant volatility of the United States stock market and the 30-day expectations of the S & P500 index.	Ahmed & Zlate (2014)	CBOE
IRD	The interest rate differential is the difference between the interest rate on the 10-year Indonesian government bond and the interest rate on the 10-year US government bond)	Rafi & Ramachandran (2018), Singhania & Saini (2018), Bhasin & Khandelwal (2019), Garg & Dua (2014)	Bloomberg

In this study, the dependent variable used is foreign portfolio investment (FPI) for ASEAN case, which is represented through data on net foreign portfolio purchases in terms of liabilities divided by nominal gross domestic product (referring to Baek (2006)). The use of FPI in terms of liabilities aims to see the ownership of foreign assets that enter or exist in a country.

3.2. Methodology

3.2.1 Spatial Panel Data Model

The spatial data panel was built due to the relationship or dependence tendencies of economic activities between geographic units. For this reason, the effects of spatial interactions between countries in a certain area were unavoidable. The following equation shows spatial models, also called the Generating nesting spatial model (GNS):

$$Y = \rho WY + \alpha_{lN} + X\beta + WX\theta + v$$

$$v = \lambda W_u + \varepsilon$$

where WY shows the endogenous interaction effect between the dependent variable, WX shows the exogenous interaction effect between the independent variables, and W_u presents the interaction effect between the disturbance term of the different units. ρ is called the spatial autoregressive coefficient, λ is the spatial autocorrelation coefficient, while θ is the same as β,

specifically a vector K X 1 whose parameters are fixed, yet not known. W is a non-negative N X N matrix that describes the spatial configuration or arrangement of units in the sample.

There are six models in the spatial panel data based on Elhorst (2015), including (i) Spatial autoregressive (SAR), a spatial model that contains endogenous interaction effects $WYjt$, (ii) Spatial error model (SEM) which contains interaction effects between Wvit error terms, (iii) Spatial lag of X model (SLX) that contains exogenous interaction effects$WXjt$, (iv) Spatial autoregressive combined (SAC) with interaction effects of $WYjt$ and WVjt, (v) Spatial Durbin (SDM) containing $WYjt$ and $WXjt$, and (vi) the spatial Durbin error (SDEM) model with WXjt and WVjt.

3.2.2 Generalized Autoregressive Conditional Heteroskedasticity (GARCH)

Modeling two or more variables, especially in economic and financial events, which have high volatility in the data, creates a heteroscedasticity problem in errors. Therefore, the error variance modeling is required to provide accurate confidence intervals and a more efficient estimator. The use of ordinary linear models is not sufficient to deal with the heteroscedasticity problem, hence the Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models are used. Importantly, these models are specifically designed to model and estimate conditional variance. The variance of the dependent variable is modeled as a function of past values of the dependent and independent or exogenous variables. There are three different specifications in the ARCH model, the conditional mean, variance, and error distribution. In general, the GARCH model (q, p) is as follows:

$$Y_t = \mu + \sum_{i=1}^{n} \phi_i r_{t-i} + \sum_{j=1}^{n} \beta_j X'_{t-j} + \epsilon_t, \qquad \epsilon_t|\Omega_{t-1} \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2$$

Where μ and ω are constants. $\epsilon_t|\Omega_{t-1} \sim N(0, \sigma_t^2)$ is a conditionally normal innovation with zero mean and variant σ_t^2. ϵ_{t-i}^2 is information on the volatility of the previous period (ARCH term) and σ_{t-j}^2 is the variance of the previous period's forecast. X'_{t-j} is the independent variable on lag j.

3.3 Specifying the Model Estimates

3.3.1 First Model Estimation: Determinants of FPI in ASEAN Countries

This study uses three spatial models, including the spatial autoregressive model (SAR), spatial error model (SEM), and spatial Durbin model (SDM) to measure and analyze the relationship between exchange rate dynamics and several macroeconomic variables on the flow of foreign portfolio investment in ASEAN countries. This is achieved by including the interconnection relationship between ASEAN countries. The use of these three models aims to compare their performance by including the impact of the relationship between the FPI variable in neighboring countries and FPI inflows in the ASEAN region (SAR), the error-term variable for neighboring countries with FPI inflows in the ASEAN region (SEM), and FPI variable and macroeconomics of neighboring countries with FPI inflows in the ASEAN region (SDM).

This study extends the framework of Elhorst (2015) and Rafi & Ramachandran (2018) by examining the effects of third countries on the FPI flow to ASEAN countries. The following equation shows the spatial panel empirical model used in the study:

SAR Model:

$$FPI_{it} = \alpha + \rho \sum_{j=1}^{n} w_{ij} FPI_{jt} + \sum_{k=1}^{K} \beta_k x_{itk} + \mu_i + \gamma_t + \epsilon_{it}$$

SEM Model:

$$FPI_{it} = \alpha + \sum_{k=1}^{K} \beta_k x_{itk} + \mu_i + \gamma_t + v_{it}$$

$$v_{it} = \lambda \sum_{j=1}^{n} w_{ij} v_{jt} + \epsilon_{it}$$

SDM Model:

$$FPI_{it} = \alpha + \rho \sum_{j=1}^{n} w_{ij} FPI_{jt} + \sum_{k=1}^{K} \beta_k x_{itk} + \sum_{k=1}^{K} \sum_{j=1}^{n} \theta_k w_{ij} x_{jtk} + \mu_i + \gamma_t + \epsilon_{it}$$

Where FPI_{it} is the vector Nx1 FPI inflow in the host country ith ($i = 1, \dots, N$) at time t ($t = 1, \dots, T$), μ_i and γ_t are the spatial units of fixed effect and time-period fixed effect). x_{itk} is the characteristic of the ith host country at time tth in the independent variable k($k = 1, \dots, K$), w_{ij} is the spatial weight matrix NxN, where j≠i (j=1,…, N) standardized using row-normalized, where each row equals one total. $\rho . w_{ij} FPI_{jt}$ is spatial autoregression and ρ acts as a spatial autoregressive coefficient to calculate how much impact the incoming FPI in neighboring country j has on the FPI entering the host country i. v_{it} is the Nx1 error-term vector of the host country to -ith at time t. $\lambda . w_{ij} v_{jt}$ is the spatial autocorrelation term. λ acts as the spatial autocorrelation coefficient to calculate how much impact the error-term shock of neighboring country j has on the host country i. The range of values for ρ and λ ranges from -1 to 1.

3.3.2 Second Model Estimation: Determinants of FPI in Indonesia

The GARCH method was used to measure and analyze exchange rate dynamics and several macroeconomic factors affecting foreign portfolio investment in Indonesia. By adopting and expanding the framework of Elhorst (2015) and Rafi & Ramachandran (2018), this research examined the determinants of FPI flows into Indonesia as a country with the largest economic size in ASEAN. To investigate the relationship between exchange rates and several macroeconomic factors on foreign portfolio investment, a linear model was used as a reference specification with the following formula:

$$FPI_t = \mu + \sum_{i=1}^{n} \phi_i FPI_{t-i} + \sum_{j=1}^{n} \beta_1 SXRGROWTH_{t-j} + \sum_{j=1}^{n} \beta_2 UNEXPSXR_{t-j} + \sum_{j=1}^{n} \beta_3 VIX_{t-j} + \sum_{j=1}^{n} \beta_4 IRD_{t-j} + \sigma \epsilon_t \quad (17)$$

Where FPI_t is normalized foreign investment inflows to Indonesia (liabilities) using the absolute value of the last 12 months moving average, and ϵ_t is i.i.d errors with $E(\epsilon_t) = 0$ and $E(\epsilon_t^2) = 1$. $SXRGROWTH_{t-j}$ is the exchange rate growth in twelve months, proxied by $UNEXPSXR_{t-j}$ as exchange rate volatility calculated using the GARCH method (1,1). VIX_{t-j}

is an index for measuring the volatility of the United States stock market. IRD_{t-j} is the difference between the interest rate on the 10-year Indonesian government bond and the interest rate on the 10-year US government bond.

A linear equation model is tested for its suitability to describe the relationship between exchange rates and macroeconomic variables on FPI flows into Indonesia using 5 trading day data, which means it has high volatility. Before testing the model, unit root testing was conducted using the Augmented Dickey-Fuller (ADF) test to show the foreign stationery of each variable, whether at I (0) or I (1). In case of fall variables are stationary at level (I (0)) the OLS ARMA model is used. However, where there is a stationary variable at I (1), the OLS ARIMA model is used.

After determining the model, testing on serial correlation and heteroscedasticity were conducted using the Breusch-Godfrey and ARCH test. Serial correlation testing determines the presence of autocorrelation in errors at the regression model by assessing the validity of some modeling assumptions. Heteroscedasticity testing determines the error variance of the regression depending on the value of the independent variable. The ARCH test rejects the null hypothesis, there is heteroscedasticity in the model and the GARCH method is used to address it. The following is the GARCH formula used:

$$FPI_t = \mu + \sum_{i=1}^{n} \phi_i FPI_{t-i} + \sum_{j=1}^{n} \beta_1 SXRGROWTH_{t-j} + \sum_{j=1}^{n} \beta_2 UNEXPSXR_{t-j} + \sum_{j=1}^{n} \beta_3 VIX_{t-j} + \sum_{j=1}^{n} \beta_4 IRD_{t-j} + \epsilon_t$$

$$\sigma_t^2 = \omega + \sum_{j=1}^{q} \beta_j \sigma_{t-j}^2 + \sum_{i=1}^{p} \alpha_i \epsilon_{t-i}^2$$

3.4 Robustness Test

3.4.1 Robustness Test for Spatial Panel Model

A. Weighting (W) and W Normalization

According to Elhorst (2015), the spatial weight matrix is divided into (i) the p-order binary contiguity matrix, defined as a binary number weighted matrix when the p-state shares boundaries. Suppose p = 1 only the neighboring first order is entered (given number 1). Where p = 2, the first and second-order neighbors are entered, (ii) inverse distance matrix, with or without boundary points, (iii) the q-nearest neighbor matrix, where q is a positive integer, and (iv) a diagonal block matrix, where the interaction between group of spatial units is represented by each block but not by observations in other groups.

This study uses three weighting approaches, where both of them are the spatial weight matrices based on geographic correlation and the last weight is based on economic correlation. The spatial weights are based on geographic correlation, namely the inverse distance matrix (W1) and the 1-order binary contiguity (W2) matrix. The spatial weight based on economic correlation is the economic distance matrix (W3). Specifically, these three spatial weight matrices are structured as follows:

$$W_1 \begin{cases} \frac{1}{d_{ij}}, if\ i \neq j \\ 0\ , if\ i = j \end{cases}$$

$$W_2 \begin{cases} 1, if\ i\ and\ j\ are\ adjacent \\ 0\ ,\ otherwise \end{cases}$$

$$W_3 \begin{cases} \frac{1}{|\overline{GDP_i} - \overline{GDP_j}|}, if\ i \neq j \\ 0 \qquad\qquad , if\ i = j \end{cases}$$

where d_{ij} denotes the great circle distance between country i and country j. $\overline{GDP_i}$ refers to the average GDP of country i during the study period. We adopt the normalization procedure of row-normalized spatial weight matrix of Elhorst (2010) and Kelejian & Prucha (2010) so as to ensure that the rows sum up to 1 and their diagonal elements are set to 0, with $1/r_{min} < \rho < 1/r_{max}$ before normalized and $1/r_{min} < \rho < 1$ after. In the spatial panel model for the case study in ASEAN, six models were used:

Model 1: $f(FPI, SXRGROWTH, IRD, GDP, UNEXPSXR, INF, OPENNESS, SP)$ dengan bobot inverse distance

Model 2: $f(FPI, SXRGROWTH, IRD, GDP, EXPSXR, INF, OPENNESS, SP)$ dengan bobot inverse distance

Model 3: $f(FPI, SXRGROWTH, IRD, GDP, UNEXPSXR, INF, OPENNESS, SP)$ dengan bobot 1-order binary contiguity

Model 4: $f(FPI, SXRGROWTH, IRD, GDP, EXPSXR, INF, OPENNESS, SP)$ dengan bobot 1-order binary contiguity

Model 5: $f(FPI, SXRGROWTH, IRD, GDP, UNEXPSXR, INF, OPENNESS, SP)$ dengan bobot economic distance

Model 6: $f(FPI, SXRGROWTH, IRD, GDP, EXPSXR, INF, OPENNESS, SP)$ dengan bobot economic distance

B. Direct and Indirect Effect (Spillover effect)

Using the spatial panel model, direct and indirect effects can be observed on the model specifications by rewriting the GNS model as follows:

$$Y = (I - \rho W)^{-1}(X\beta + WX\theta) + R$$

Where R is the intercept and error-terms. The matrix from the expected Y value is derived partially with the explanatory variable k from X in units 1 to N as follows:

$$\left[\frac{\partial E(Y)}{\partial x_{1k}} \cdots \frac{\partial E(Y)}{\partial x_{Nk}}\right] = \begin{bmatrix} \frac{\partial E(y_1)}{\partial x_{1k}} & \cdots & \frac{\partial E(y_1)}{\partial x_{Nk}} \\ \vdots & \ddots & \vdots \\ \frac{\partial E(y_N)}{\partial x_{1k}} & \cdots & \frac{\partial E(y_N)}{\partial x_{Nk}} \end{bmatrix}$$

$$= (I - \rho W)^{-1} \begin{bmatrix} \beta_k & w_{12}\theta_k & \cdots & w_{1N}\theta_k \\ w_{21}\theta_k & \beta_k & \cdots & w_{2N}\theta_k \\ \vdots & \vdots & \ddots & \vdots \\ w_{21}\theta_k & w_{N2}\theta_k & \cdots & \beta_k \end{bmatrix}$$

Equation above shows that if a certain independent variable in a certain unit (x_{Nk}) changed, the dependent variable in the unit itself (y_i) and another unit (y_j) also changed. The change in the dependent variable in the unit itself (y_i) is called the direct effect, shown by the diagonal element of the partial derivative matrix (β_k). The changes in the dependent variable

in other units (y_j) are called indirect effects represented by each off-diagonal element ($w_{NN}\theta_k$). The indirect effect does not happen if $\rho = 0$ and $\theta_k = 0$, since all off-diagonal elements are zero. Furthermore, the resulting direct and indirect effects will be different when using various areas/units in the sample.

LeSage & Pace (2008) suggest the direct effect coefficient sometimes differs from the estimates in the model. This is due to the feedback effect of passing through neighboring countries and returning to the state itself (such as 1→2→1 or 1→2→3→2→1). The indirect effect can be interpreted as the impact of changes in certain elements of the independent variables on the dependent ones of all units. Table 2 summarizes the specifications of the direct and indirect effects of each model.

Table 2 Specifications for Direct Effects and Indirect Effects

Model Types	Direct Effect	Indirect Effect
OLS model/SEM	β_k	0
SAR/SAC	The diagonal element of $(1-\delta W)^{-1}\beta_k$	The off-diagonal element of $(1-\delta W)^{-1}\beta_k$
SDM/GNS	The diagonal element of $(1-\delta W)^{-1}(\beta_k + W\theta_k)$	The off-diagonal element of $(1-\delta W)^{-1}(\beta_k + W\theta_k)$
SDEM/SLX	β_k	θ_k

Source: Elhorst & Vega (2017)

3.4.2 Robustness Test for GARCH Model

In the GARCH model for the case study in Indonesia, the total portfolio investment inflows in Indonesia was the dependent variable. However, the variable was divided into two, government bond (BOND) and equity flows (EQUITY), for robustness testing. Since the case study uses 5-day trading data, there are limitations in data collection. Apart from the control variables used, such as FPI, SXRGROWTH, UNEXPSXR, and IRD, which are domestic pull factors, the VIX index control was also used as a global driving factor. The addition of this control variable in looking at global risk appetite and as a proxy for the combination of perceived risk and risk aversion. Here is the equation model used:

Model 1: $f(FPI, SXRGROWTH, UNEXPSXR, VIX, IRD)$

Model 2: $f(BOND, SXRGROWTH, UNEXPSXR, VIX, IRD)$

Model 3: $f(EQUITY, SXRGROWTH, UNEXPSXR, VIX, IRD)$

4. Result and Discussion

4.1 Descriptive Statistical Analysis

Table 3 below shows the sample descriptive statistics of the variables used, including the mean, median, and standard deviation (Std. Dev). The standard deviation of trade openness data (OPENNESS) in ASEAN is very large. This means that the distribution of a data group against the mean is quite large or, data on trade openness in ASEAN countries is heterogeneous.

Table 3 Data Descriptive Statistics

		FPI	EXPSXR	UNEXPSXR	SXRGROWTH	IRD	GDPGROWTH	OPENNESS	INF
Indonesia	mean	1.63	37.71	0.50	1.93	6.37	5.49	48.86	6.71
	median	1.66	19.78	0.30	1.83	5.81	5.20	47.35	6.31
	std. dev	1.62	49.91	0.57	9.57	2.07	0.89	9.55	3.45
Malaysia	mean	1.64	17.63	0.24	0.35	0.35	5.13	165.78	2.33
	median	1.67	9.68	0.20	0.00	0.35	5.37	157.34	2.14
	std. dev	8.19	20.51	0.23	7.13	0.95	2.36	28.49	1.48
Philippines	mean	0.93	12.78	0.23	0.19	2.22	5.55	65.40	3.82
	median	0.76	5.78	0.19	0.77	1.52	6.05	63.03	3.26
	std. dev	2.66	19.79	0.16	6.26	1.90	1.74	9.87	2.04
Singapore	mean	1.64	10.41	0.16	-1.67	-0.71	5.47	373.06	1.68
	median	1.69	6.03	0.13	-2.01	-0.72	5.00	372.24	0.85
	std. dev	4.53	10.81	0.08	4.82	0.60	4.40	38.10	2.17
Thailand	mean	0.82	12.62	0.15	-1.88	0.93	4.06	128.21	2.15
	median	0.87	10.35	0.13	-1.35	0.93	4.48	128.02	2.00
	std. dev	3.02	8.37	0.08	5.61	1.21	3.69	10.96	2.04
ASEAN	mean	1.33	18.23	0.26	-0.22	1.83	5.14	156.26	3.34

median	1.32	9.23	0.17	-0.18	1.09	5.20	127.73	2.98
std. dev	4.60	28.12	0.31	6.98	2.85	2.95	118.67	2.95

Based on Figure 1, the relationship between FPI inflows and several macroeconomic variables in the ASEAN region. The results show that the expected and unexpected exchange rate volatility variables on FPI have a weak negative correlation due to the plots that accumulate over a certain FPI range. The economic growth and government debt rating have a weak positive correlation with FPI. The exchange rate changes, inflation, interest rate differential, and openness do not correlate with FPI because there is no tendency for certain values on these independent variables on FPI.

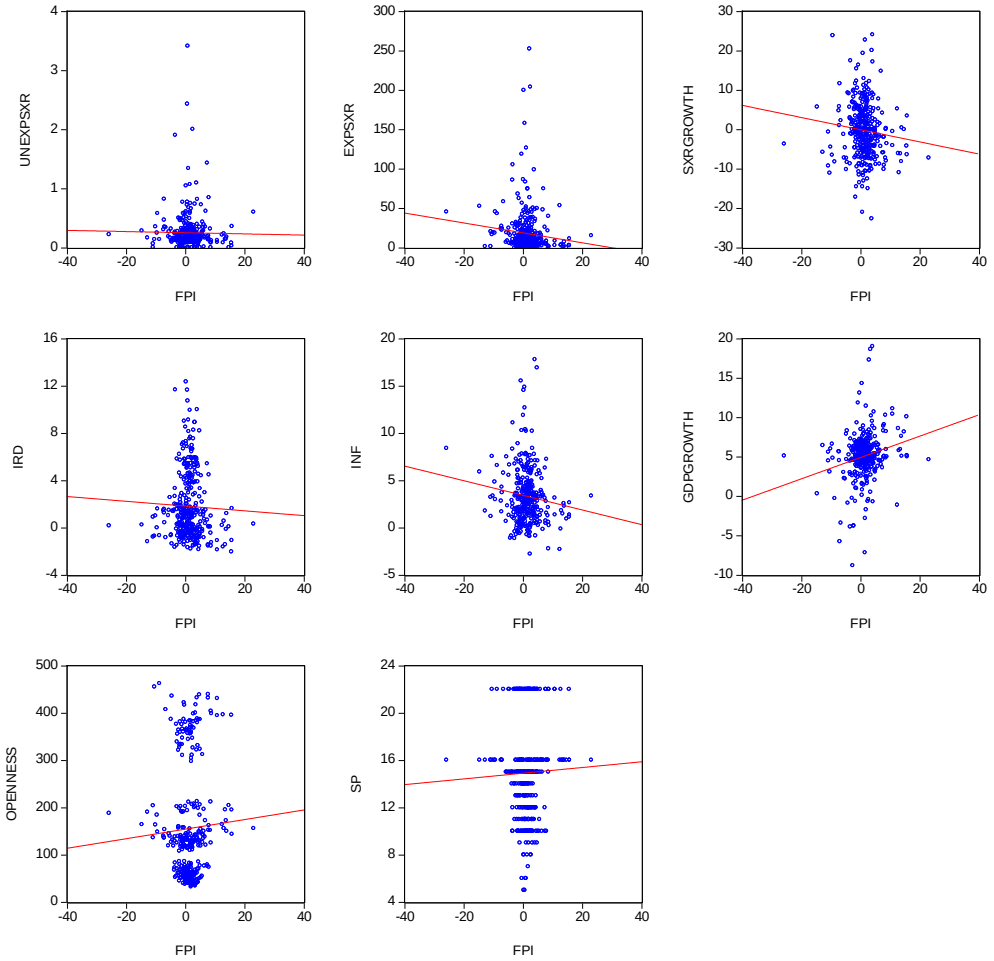

Figure 1 Scatter Plot of Relationship between FPI Inflows and Macroeconomic Variables in ASEAN

Table 4 shows the Pearson correlations between macroeconomic variables and FPI in the ASEAN Region. All macroeconomic variables have a very weak correlation to FPI inflows in the countries in the ASEAN Region. There is a linear relationship because it has a Pearson correlation below 0.25.

Table 4 Pearson Correlation Relationship of FPI Inflow and Macroeconomic Variables in ASEAN

	FPI	UNEXPSXR	EXPSXR	SXRGROWTH	IRD	INF	GDPGROWTH	OPENNESS	SP
FPI	1.00	-0.01	-0.10	-0.10	-0.03	-0.12	0.21	0.04	0.03
UNEXPSXR	-0.01	1.00	0.59	-0.03	0.53	0.39	-0.02	-0.23	-0.34
EXPSXR	-0.10	0.59	1.00	0.09	0.46	0.34	-0.15	-0.21	-0.29
SXRGROWTH	-0.10	-0.03	0.09	1.00	0.25	0.01	-0.22	-0.17	-0.05
IRD	-0.03	0.53	0.46	0.25	1.00	0.66	-0.05	-0.63	-0.73
INF	-0.12	0.39	0.34	0.01	0.66	1.00	0.05	-0.38	-0.55
GDPGROWTH	0.21	-0.02	-0.15	-0.22	-0.05	0.05	1.00	0.05	0.01
OPENNESS	0.04	-0.23	-0.21	-0.17	-0.63	-0.38	0.05	1.00	0.92
SP	0.03	-0.34	-0.29	-0.05	-0.73	-0.55	0.01	0.92	1.00

4.2. Estimation Results on the Relationship of Exchange Rate Volatility and Several Macroeconomic Variables to FPI Inflows with Weighted Inverse Distance

4.2.1 Relationship of Unexpected Exchange Rate and Several Macroeconomic Variables on FPI Inflows in ASEAN

Based on Hausman test, random effect is selected for the SDM model (SDM-RE) for Model 1. The coefficient ρ generated in the SDM-RE estimation is the same as the SAR-FE model, which is significant and negative at the 1% level. The results show that there is a transfer of capital, where an increase in the inflow of FPI to neighboring countries reduces the inflow to the host country. Furthermore, a significant negative sign may also indicate two things. First, due to the continuous selection of the study area without a white spot, the effects of third countries are more visible, though the study focused on certain regions (Regelink & Paul Elhorst, 2015). A negative result on the coefficient ρ was also reported by Regelink & Paul Elhorst (2015) and Garretsen & Peeters (2009) for FDI in European countries, while Ledyaeva (2009) focused on adjacent areas in Russia.

The unexpected exchange rate variable was used to examine the relationship between exchange rate volatility and FPI inflows to ASEAN. The results showed that the exchange rate volatility has no significant effect on FPI inflows to ASEAN. This is in line with Baek (2006), which stated that real exchange rate volatility does not have a significant effect on foreign portfolio investment inflows to countries in Asia and Latin America. The study showed that domestic factors in Asia and Latin America did not affect the entry of FPI. Factors outside the host country, such as world economic growth, United States interest rates, and world portfolio market performance have more influence on FPI in Asia and Latin America. This contravenes Garg & Dua (2014), which established that there is a negative and significant relationship between exchange rate volatility and the entry water portfolio in India.

Similar to the estimation results in the SAR and SEM models, the SDM estimation results of the exchange rate change variable (SXRGROWTH) lacks a significant effect. This is in line with Singhania & Saini (2018), which stated that there is an insignificant relationship between exchange rates and foreign portfolios in developing countries. According to Wong (2017), there is no explanation regarding the relationship between exchange rates and stock price returns in Asia and Europe. Insignificant changes can also be caused by taking points from the daily average to exchange rate variation every quarter. The exchange rate is a very volatile variable, even every minute (Cenedese et al., 2014).

The SDM-RE model in Table 5 shows a positive and significant difference in interest rate coefficient (IRD) at the 1% level. This is in line with Garg & Dua (2014), Ghosh et al. (2014), Verma & Prakash (2011), and Ahmed & Zlate (2014), which established a positive relationship between IRD and FPI inflows. This means that FPI inflows are sensitive to differences in interest rates, one of the attractions of foreign investors towards portfolios. The changes in interest rates affect the amount of interest that investors receive on loans with floating interest rates. The greater the difference in interest rates between the host country and the US encourage the entry of FPI into the host country. According to Qureshi et al. (2012), There is a positive relationship between interest rate differential and FPI. The neoclassical theory suggests that capital flows respond to differences in interest rates between countries. Specifically, capital will flow from countries with low returns (developed with abundant capital) to countries with high returns (developing with limited capital).

The sovereign debt rating index issued by the agency Standard & Poor's (S&P) was used to determine the relationship between a country's credit rating and FPI inflows into ASEAN countries. The government debt rating was numerically coded on a scale of 1 (worst) to 22 (best). The greater the index value, the better the government debt rating. The estimation result

using the SDM-RE model shows that the coefficient on the state debt rating (SP) variable is significant with a positive sign at the 1% level. This is in line with Luitel & Vanpée (2018) research for low-developed countries and Fratzscher (2012), which established that countries with poor government debt ratings experienced 15.2% higher net capital outflows during a crisis. Because government debt ratings help investors weigh risks when assessing sovereign debt investment, a higher (better) rating attract foreign investors to the host country.

The estimation results of the SDM-RE model show that inflation (INF), trade openness (OPENNESS), and economic growth (GDP GROWTH) does not significantly affect FPI inflows in ASEAN countries. This is in line with Fratzscher (2012), which was conducted during the pre-post-time crisis, Waqas et al. (2015) on Pakistan and Sri Lanka based on inflation variable, Kinda (2010) on trade openness in 58 countries, and Baek (2006) for inflation and economic growth in Asian countries.

Table 5 Determinants Estimation Results of ASEAN FPI Inflow Using Unxpected Exchange Rate and Inverse Distance Weights

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.547	0.007	0.463	0.008	0.284	0.052	0.430	0.009	0.332	0.038	1.076	0.000	0.898	0.001
UNEXPSXR	1.341	0.138	0.802	0.304	0.086	0.922	0.971	0.290	0.324	0.719	-1.544	0.260	-1.693	0.183
SXRGROWTH	0.076	0.162	0.057	0.221	-0.030	0.419	0.086	0.114	-0.026	0.548	0.075	0.305	0.079	0.248
INF	-0.440	0.001	-0.215	0.071	-0.318	0.002	-0.220	0.133	-0.379	0.002	0.302	0.135	0.234	0.179
GDPGROWTH	0.050	0.567	0.072	0.345	0.243	0.002	0.104	0.239	0.217	0.010	0.093	0.392	0.138	0.150
SP	0.477	0.070	0.484	0.033	-0.015	0.790	0.538	0.037	-0.008	0.968	1.255	0.009	1.017	0.003
OPENNESS	-0.006	0.610	-0.004	0.728	0.003	0.451	-0.011	0.167	0.002	0.801	-0.001	0.966	-0.018	0.099
W*IRD											3.884	0.015	2.913	0.014
W*UNEXPSXR											-12.308	0.028	-12.476	0.017
W*SXRGROWTH											0.135	0.645	0.139	0.602
W*INF											2.078	0.000	1.907	0.000
W*GDPGROWTH											0.067	0.841	0.215	0.476
W*SP											3.628	0.065	2.601	0.017
W*OPENNESS											-0.006	0.892	-0.043	0.196
W*dep.var.			-0.712	0.000	0.262	0.000					-0.673	0.000	-0.696	0.000
spat.aut.							-0.749	0.000	0.278	0.000				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R^2	0.450		0.643		0.162		0.442		0.162		0.664		0.407	
LM spatial lag	52.865	0.000												

LM spatial error	50.983	0.000						
Robust LM spatial lag	3.182	0.074						
Robust LM spatial error	1.300	0.254						
Wald test spatial lag					23.085	0.002	24.162	0.001
LR test spatial lag					24.137	0.001	24.018	0.001
Wald test spatial error					22.020	0.003	22.623	0.002
LR test spatial error					12.777	0.078	21.250	0.003
Hausman Test (Prob.)			2896.5953 (0.0000)	-591.7256 (0.0000)		7.7790 (0.9323)		

The spatial relationship between the macroeconomic variables of the neighboring countries and the inflow of the host country's FPI, or vice versa is analyzed in Sub-chapter 4.5. This is because the estimation analysis of the spatial relationship between the macroeconomic variables of the neighboring countries and the host country's FPI inflows using the SDM estimation results may produce bias conclusions. According to Elhorst (2014), the indirect (spillover) effect needs to be used in testing the presence of a spatial spillover effect, compared to the estimated coefficient in the spatial durbin (SDM) model. Indirect effects refer to the influence of factors in the host country on the surrounding region. Additionally, the direct effect on SDM is also tested due to the existence of feedback effects on the independent variable of the host on the inflow its FPI. According to Li & Li (2020), the direct effect is important to estimate because it includes two types of effects, namely (1) changes in the independent variable of the host country directly led to changes in the dependent variable of the host country; (2) changes in the independent variable of the host country cause changes in the dependent variable in the surrounding area, and changes in the surrounding area in turn affect the area of the host, thus forming a feedback effect. The direct and indirect effects differ from the SDM estimation results because these effects are calculated by a complex mathematical formula. Their dispersion depends on all estimated coefficients involved (Elhorst, 2014b).

For the robustness test, we compared the estimation results of SDM with SAR and SEM using inverse distance weights. The result is the same as SDM. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 1 can be seen in Table 6 column 2 and Table 6 column 4. Similar with SDM, the estimation results of the SAR-FE model show the coefficient ρ significant 1% with a negative sign, which means that an increase in FPI inflows to neighboring countries will reduce FPI inflows to host countries for the case of the ASEAN Region. The estimation results of the SAR and SEM models also show that FPI inflows are significantly affected by the interest rate differential and government debt ratings at the significant levels of 1% and 5%. Likewise, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

4.2.2 Relationship of Expected Exchange Rate and Several Macroeconomic Variables on FPI Inflows in ASEAN

Based on Hausman test, random effect is selected for the SDM model (SDM-RE) for Model 2. The coefficient ρ generated in the SDM-RE estimation is the same as the SAR-FE model, including being significant and negative. This indicates that an increase in the inflow of FPI to neighboring countries reduces the inflow of FPI to the host country. According to Table 6 column 7, the estimation results of the relationship between the macroeconomic variables of the host country and its flow of FPI are the same as in Model 1. Specifically, only the interest rate differential variable and the government debt rating of the host country have a significant positive effect on FPI inflows to the host country at the significance level of 1%.

For the Model 2 robustness test, we compared the estimation results of SDM with SAR and SEM using inverse distance weights. The result is the same as SDM. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 2 can be seen in Table 6 column 2 and Table 6 column 4. Similiar with SDM, the estimation results of the SAR-FE model show the coefficient ρ significant 1% with a negative sign. The estimation results of the SAR and SEM models also show that FPI inflows are significantly affected by the interest rate differential and government debt ratings at the significant levels of 1% and 5%. Likewise, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

Table 6 Determinants Estimation Results of ASEAN FPI Inflow Using Expected Exchange Rate and Inverse Distance Weights

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.637	0.001	0.518	0.002	0.342	0.014	0.476	0.003	0.395	0.010	1.072	0.000	0.910	0.001
EXPSXR	0.003	0.769	0.001	0.882	-0.009	0.334	0.002	0.834	-0.009	0.345	-0.013	0.487	-0.020	0.198
SXRGROWTH	0.055	0.295	0.044	0.331	-0.033	0.365	0.071	0.181	-0.033	0.445	0.067	0.348	0.070	0.294
INF	-0.414	0.003	-0.196	0.099	-0.312	0.003	-0.193	0.186	-0.369	0.003	0.292	0.146	0.254	0.145
GDPGROWTH	0.060	0.496	0.078	0.305	0.231	0.004	0.109	0.220	0.213	0.011	0.089	0.413	0.137	0.159
SP	0.462	0.083	0.473	0.039	-0.010	0.866	0.533	0.039	-0.023	0.914	1.265	0.010	0.935	0.007
OPENNESS	-0.007	0.600	-0.004	0.721	0.003	0.409	-0.010	0.199	0.002	0.717	-0.001	0.975	-0.015	0.173
W*IRD											3.662	0.025	2.899	0.017
W*EXPSXR											-0.092	0.228	-0.116	0.084
W*SXRGROWTH											0.105	0.722	0.122	0.651
W*INF											2.092	0.001	2.017	0.000
W*GDPGROWTH											0.063	0.852	0.210	0.492
W*SP											3.916	0.055	2.436	0.026
W*OPENNESS											0.003	0.944	-0.036	0.285
W*dep.var.			-0.717	0.000	0.260	0.000					-0.666	0.000	-0.687	0.000
spat.aut.							-0.759	0.000	0.271	0.000				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R^2	0.447		0.645		0.164		0.438		0.163		0.659		0.398	
LM spatial lag	53.268	0.000												

LM spatial error	51.666	0.000						
Robust LM spatial lag	2.525	0.112						
Robust LM spatial error	0.924	0.337						
Wald test spatial lag					19.888	0.006	22.566	0.002
LR test spatial lag					22.344	0.002	21.978	0.003
Wald test spatial error					18.912	0.009	20.727	0.004
LR test spatial error					10.470	0.164	18.398	0.010
Hausman Test (Prob.)			2192.9558 (0.0000)	-632.4818 (0.0000)		8.6743 (0.8939)		

4.3 Estimation Results on the Relationship of Exchange Rate Volatility and Several Macroeconomic Variables to FPI Inflows with 1-order binary contiguity

4.3.1 Relationship of Unexpected Exchange Rate and Several Macroeconomic Variables on FPI Inflows in ASEAN

Based on Hausman test, random effect is selected for the SDM model (SDM-RE) for Model 3. The coefficient ρ generated in the SDM-RE estimation is the same as the SAR-FE model, including being significant and negative. The SDM results using binary contiguity weighting in Model 3 show that the results of the estimation of the effect of the interest rate differential and the host country's government debt rating on FPI flows into the host country are the same as Models 1 and 2, which are positive and significant. Furthermore, exchange rate volatility and changes, as well as host country economic growth insignificantly affect FPI inflows. However, inflation and trade openness in the host country have a significant negative effect on FPI flows into the host country at the significant levels of 1% and 5%. The negative relationship between inflation and FPI inflows was also reported by Waqas et al. (2015) in China and India, as well as Al-Smadi (2018) in Jordan. The higher the inflation in the host country, the lower the real interest rate. This reduces the return of foreign portfolio investors, making them hold their funds to invest in the host country.

Trade openness and FPI inflows have a significant negative relationship. This is in line with Ahmed Hannan (2017), which established a negative relationship between trade openness and FPI. Similarly, Marouane (2019) found a negative relationship between trade openness and FDI. According to Ahmed Hannan (2017), the negative relationship is attributed to the influence of the selection of the period used and not a representative of the expected relationship between capital flows and trade openness. Furthermore, the impact of trade openness may not be captured accurately because indicators, such as disclosure of capital reports, are slow-moving. Coupled with the robustness test using the expected exchange rate as an independent variable, where the fixed effect is selected compared to the random effect in the spatial durbin model. In this regard, the trade openness variable does not significantly affect the FPI inflow. According to Alwafi (2017), the open trade of a country negatively impacts the economy in developing countries that specialize in low-quality export products (primary consumer products), which are vulnerable to trade shocks.

Table 7 Determinants Estimation Results of ASEAN FPI Inflow Using Unexpected Exchange Rate and Weights of 1-order binary contiguity

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.547	0.007	0.521	0.009	0.271	0.071	0.431	0.007	0.248	0.131	0.629	0.006	0.587	0.001
UNEXPSXR	1.341	0.138	1.086	0.225	0.016	0.986	1.270	0.163	0.021	0.982	1.040	0.248	1.285	0.122
SXRGROWTH	0.076	0.162	0.059	0.269	-0.044	0.243	0.082	0.131	-0.035	0.401	0.056	0.283	0.077	0.108
INF	-0.440	0.001	-0.330	0.015	-0.313	0.004	-0.331	0.017	-0.364	0.002	-0.403	0.003	-0.428	0.001
GDPGROWTH	0.050	0.567	0.124	0.153	0.282	0.000	0.122	0.162	0.264	0.002	0.154	0.072	0.141	0.073
SP	0.477	0.070	0.643	0.013	-0.006	0.920	0.450	0.050	-0.181	0.382	0.860	0.002	0.614	0.007
OPENNESS	-0.006	0.610	-0.011	0.382	0.002	0.565	-0.009	0.179	0.007	0.264	-0.011	0.385	-0.013	0.042
W*IRD											-0.917	0.119	0.279	0.321
W*UNEXPSXR											-0.464	0.809	-0.944	0.560
W*SXRGROWTH											0.114	0.082	0.074	0.197
W*INF											-0.554	0.033	-0.311	0.180
W*GDPGROWTH											0.860	0.000	0.743	0.000
W*SP											-0.825	0.269	-0.257	0.145
W*OPENNESS											-0.030	0.179	0.004	0.778
W*dep.var.			-0.193	0.000	0.107	0.036					-0.244	0.000	-0.270	0.000
spat.aut.							-0.270	0.000	0.110	0.034				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R^2	0.450		0.532		0.107		0.446		0.107		0.589		0.286	
LM spatial lag	99.397	0.000												

LM spatial error	95.589	0.000						
Robust LM spatial lag	4.111	0.043						
Robust LM spatial error	0.303	0.582						
Wald test spatial lag					36.165	0.000	23.881	0.001
LR test spatial lag					22.146	0.002	23.251	0.002
Wald test spatial error					34.523	0.000	26.638	0.000
LR test spatial error					19.452	0.007	23.291	0.002
Hausman Test (Prob.)			360.1277 (0.0000)	326.2535 (0.0000)		22.0751 (0.1059)		

By comparing the estimation results of SDM with SAR and SEM we conducted a robustness test in Model 3. The results were the same as SDM, except for the trade openness variable, which did not significantly affect the FPI inflow to ASEAN. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 3 can be seen in Table 7 column 2 and Table 7 column 4. Similiar with SDM, the estimation results of the SAR-FE model show the coefficient ρ 1% significant with a negative sign. The estimation results of the SAR and SEM models also show that FPI inflows are significantly affected by the interest rate differential, inflation and government debt ratings at the significant level of 1% -5%. Likewise, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

4.3.2 Relationship of Expected Exchange Rate and Several Macroeconomic Variables to FPI Inflow in ASEAN

Based on Hausman test, fixef effect is selected for the SDM model (SDM-FE) for Model 4. The coefficient ρ generated in the SDM-FE estimation is the same as the SAR-FE model, which is significant and negative. According to Table 8 column 6, the estimation results of the macroeconomic variable relationship between the host country and its FPI inflows are the same as Model 3, where the interest rate differential, inflation, and host country government debt ratings significantly affect the FPI flows into the host country at the significant level of 1%, except for the trade openness variable that not significant.

By comparing the estimation results of SDM with SAR and SEM, we conducted a robustness test on Model 4. The results were the same as SDM. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 4 can be seen in Table 8 column 2 and Table 8 column 4. Similar with SDM, the estimation results of the SAR-FE model show the coefficient ρ significant 1% with a negative sign. The estimation results of the SAR and SEM models also show that FPI inflows are significantly affected by the interest rate differential, inflation and government debt ratings at the significant level of 1% -5%. Likewise, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

Table 8 Estimation Results of Determinants for FPI Inflow in ASEAN Using the Expected Exchange Rate and Weights of 1-order binary contiguity

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.637	0.001	0.560	0.003	0.343	0.017	0.469	0.002	0.323	0.040	0.644	0.004	0.637	0.000
EXPSXR	0.003	0.769	0.013	0.229	-0.013	0.190	0.011	0.311	-0.014	0.155	0.013	0.221	0.015	0.138
SXRGROWTH	0.055	0.295	0.051	0.329	-0.046	0.211	0.071	0.183	-0.038	0.357	0.059	0.246	0.074	0.117
INF	-0.414	0.003	-0.325	0.017	-0.302	0.005	-0.319	0.022	-0.354	0.003	-0.384	0.005	-0.427	0.001
GDPGROWTH	0.060	0.496	0.125	0.150	0.262	0.001	0.126	0.149	0.247	0.003	0.154	0.072	0.134	0.089
SP	0.462	0.083	0.678	0.010	0.002	0.979	0.461	0.046	-0.190	0.359	0.841	0.002	0.639	0.005
OPENNESS	-0.007	0.600	-0.010	0.398	0.003	0.506	-0.009	0.183	0.008	0.212	-0.010	0.404	-0.013	0.042
W*IRD											-1.143	0.047	0.137	0.617
W*EXPSXR											0.025	0.243	0.016	0.413
W*SXRGROWTH											0.090	0.171	0.058	0.324
W*INF											-0.548	0.043	-0.330	0.176
W*GDPGROWTH											0.873	0.000	0.737	0.000
W*SP											-0.572	0.432	-0.403	0.020
W*OPENNESS											-0.021	0.337	0.015	0.313
W*dep.var.			-0.204	0.000	0.114	0.025					-0.252	0.000	-0.274	0.000
spat.aut.							-0.278	0.000	0.111	0.031				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R^2	0.447		0.534		0.112		0.440		0.113		0.592		0.284	
LM spatial lag	100.593	0.000												

LM spatial error	96.968	0.000						
Robust LM spatial lag	4.181	0.041						
Robust LM spatial error	0.556	0.456						
Wald test spatial lag					37.298	0.000	24.583	0.001
LR test spatial lag					22.971	0.002	23.918	0.001
Wald test spatial error					35.484	0.000	26.934	0.000
LR test spatial error					18.849	0.009	23.268	0.002
Hausman Test (Prob.)			427.9590 (0.0000)	290.7662 (0.0000)			25.3352 (0.0456)	

4.4 Estimation Results on the Relationship of Exchange Rate Volatility and Several Macroeconomic Variables to FPI Inflows with Economic Distance

4.4.1 Relationship of Unexpected Exchange Rate and Several Macroeconomic Variables on FPI Inflows in ASEAN

Based on Hausman test, fixef effect is selected for the SDM model (SDM-FE) for Model 5. The coefficient ρ generated in the SDM-FE estimation is the same as the SAR-FE model, including being significant and negative. The SDM results using economic distance weighting in Model 5 show that the results of the estimation of the effect of the interest rate differential and the host country's government debt rating on FPI flows into the host country are the same as Models 1-4, which are positive and significant. Furthermore, exchange rate volatility and changes, as well as host country economic growth insignificantly affect FPI inflows. However, inflation, economic growth, and trade openness in the host country have a significant effect on FPI flows into the host country at the significant levels of 1%. The negative relationship between inflation and FPI inflows was also reported by Waqas et al. (2015) in China and India, as well as Al-Smadi (2018) in Jordan. The higher the inflation in the host country, the lower the real interest rate. This reduces the return of foreign portfolio investors, making them hold their funds to invest in the host country. The estimation results show a negative relationship between inflation and trade openness with FPI inflows and also a positive relationship between economic growth and FPI inflows. This result is different from the research hypothesis where openness of host trade has a positive impact on FPI inflows. We found no systematic evidence of a negative relationship between trade openness and FPI inflows. However, according to Fratzscher (2012), there are several indications that the more open a country's finances can lead to greater capital outflows.

By comparing the estimation results of SDM with SAR and SEM we perform robustness tests on Model 5. The results are similar to SDM, except for the variables of trade openness and economic growth, where trade openness of the host country significantly affects the inflow of FPI to ASEAN in SEM, but not significant impact on SAR and the economic growth of host countries did not significantly affect FPI inflows to ASEAN in SAR and SEM. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 5 can be seen in Table 9 column 2 and Table 9 column 4. The estimation results of the SAR-FE model show a significant coefficient of 1%. with a negative sign. The estimation results of the SAR model show that FPI inflows are significantly influenced by the interest rate differential, inflation and government debt ratings at the significant level of 1% -5%, while in SEM, interest rate differential, inflation, government bond ratings, and trade openness host countries influence FPI inflows. In addition, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

4.4.2 Relationship of Expected Exchange Rate and Several Macroeconomic Variables on FPI Inflows in ASEAN

Based on Hausman test, fixef effect is selected for the SDM model (SDM-FE) for Model 6. The coefficient ρ generated in the SDM-FE estimation is the same as the SAR-FE model, including being significant and negative. Based on Table 10 column 6, the estimation results of the macroeconomic variable relationship between the host country and the host country's FPI inflows are the same as Model 5, where the variable interest rate differential, inflation, economic growth, government debt rating, and trade openness of the host country are significant on FPI flows into the host country at the 1-5% significant level.

By comparing the estimation results of SDM with SAR and SEM we perform robustness tests on Model 6. The results are similar to SDM, except for the variables of trade openness and economic growth, where trade openness of the host country significantly affects the flow of FPI to ASEAN in SEM, but not significant impact on SAR and the economic growth of host countries did not significantly affect FPI inflows to ASEAN in SAR and SEM. The estimation results of the SAR and SEM models with spatial fixed effects and time periods (SAR-FE and SEM-FE) for Model 6 can be seen in Table 10 column 2 and Table 10 column 4. The estimation results of the SAR-FE model show a significant coefficient of 1% with a negative sign. The estimation results of the SAR model show that FPI inflows are significantly influenced by the interest rate differential, inflation and government debt ratings at the significant level of 1% - 5%, while in SEM, interest rate differential, inflation, government bond ratings, and trade openness host countries influence FPI inflows. In addition, the SEM-FE model shows the results of the coefficient λ which are negative, which means that the error-term in neighboring countries has a negative effect on FPI flows into the host country.

Table 9 Estimation Results of Determinants for FPI Inflow in ASEAN Using the Unexpected Exchange Rate and Weights of economic distance

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.547	0.007	0.591	0.005	0.285	0.053	0.612	0.001	0.345	0.034	0.993	0.000	0.972	0.000
UNEXPSXR	1.341	0.138	1.236	0.187	0.101	0.910	1.441	0.162	0.320	0.723	1.594	0.227	1.559	0.172
SXRGROWTH	0.076	0.162	0.068	0.226	-0.039	0.290	0.086	0.161	-0.024	0.578	0.033	0.639	0.050	0.433
INF	-0.440	0.001	-0.412	0.004	-0.338	0.001	-0.431	0.005	-0.406	0.001	-0.408	0.020	-0.411	0.007
GDPGROWTH	0.050	0.567	0.093	0.309	0.284	0.000	0.167	0.070	0.260	0.002	0.334	0.002	0.325	0.000
SP	0.477	0.070	0.580	0.034	-0.025	0.673	0.714	0.011	-0.066	0.761	1.521	0.000	1.422	0.000
OPENNESS	-0.006	0.610	-0.008	0.552	0.003	0.440	-0.017	0.046	0.004	0.562	-0.040	0.012	-0.038	0.000
W*IRD											1.380	0.050	1.456	0.004
W*UNEXPSXR											0.069	0.978	0.103	0.964
W*SXRGROWTH											-0.144	0.340	-0.130	0.339
W*INF											0.015	0.972	-0.063	0.867
W*GDPGROWTH											1.642	0.000	1.485	0.000
W*SP											2.751	0.001	2.733	0.000
W*OPENNESS											-0.048	0.491	-0.020	0.583
W*dep.var.			-0.262	0.000	0.280	0.000					-0.324	0.000	-0.435	0.000
spat.aut.							-0.503	0.000	0.272	0.000				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R-squared	0.450		0.495		0.146		0.441				0.563		0.278	
LM spatial lag	13.451	0.000												

LM spatial error	16.277	0.000						
Robust LM spatial lag	5.963	0.015						
Robust LM spatial error	8.789	0.003						
Wald test spatial lag					40.956	0.000	46.082	0.000
LR test spatial lag					42.111	0.000	43.312	0.000
Wald test spatial error					34.492	0.000	35.938	0.000
LR test spatial error					31.648	0.000	34.958	0.000
Hausman Test (Prob.)			208.4702 (0.0000)	-353.6599 (0.0000)	107.5210 (0.0000)			

4.5 Direct Effects and Spillover Effects of Several Macroeconomic Variables on FPI Inflows in ASEAN

For robustness testing, analysis of direct effects and indirect effects has been carried out to detect feedback effect and spillover effect between neighboring countries and the host country. The direct effect estimate from Model 1 is significant and positive for the interest rate differential variable with a significant level of 5% and a government debt rating with a significant level of 10%, which is considered statistically less robust. The elasticity value of the interest rate differential is 0.441. The estimated direct effect differs from the estimated SDM-RE coefficient of 0.898 which is shown in Table 5 column (7). This difference is due to the feedback effect that arises as a result of the impact of passing the dependent variable to a neighboring country based on the nonzero element in the matrix W and returning to that country (Jing et al., 2017).

According to Elhorst (2014a), the cause of this feedback effect is partly due to the coefficient of the spatially lagged dependent variable (ρ), the result of which is negative and significant and partly due to the coefficient of the spatially lagged value of the independent variable itself (θ_k). Since the direct effect of the interest rate differential variable is 0.441 and the estimated coefficient is 0.898, the feedback effect is -0.457. In other words, this feedback effect turns out to be relatively large. The negative value of this feedback effect indicates that an increase in the interest rate differential to the host country reduces the impact of increased FPI inflows to the host country as a result of the impact of passing through neighboring countries and returning to the state itself.

When compared with the results of SDM estimates, where empirical evidence is found that the spatial lag coefficient of the independent variables is more supportive of the interference relationship between the independent variables of the host country and the influx of FPI in neighboring countries compared to the indirect effect seen from the significance of each independent variable. This is probably because the calculation of the indirect effect (spillover) depends on three parameters (ρ, β_k, θ_k), so that if one of the three parameters is not significant, then there is a possibility that the indirect effect becomes insignificant (Jing et al., 2017). The estimated spillover (indirect) effect in Model 1 is that inflation is only significant and positive at the 5% significant level. The spillover effect in Model 1 shows that an increase in inflation in the host country to some extent can increase the inflow of FPI in neighboring countries with an elasticity of 1.383.

Table 10 Estimation Results of Determinants for FPI Inflow in ASEAN Using the Expected Exchange Rate and Weights of economic distance

Variable	OLS		SAR_FE		SAR_RE		SEM_FE		SEM_RE		SDM_FE		SDM_RE	
	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
IRD	0.637	0.001	0.665	0.001	0.361	0.010	0.675	0.000	0.431	0.006	1.063	0.000	1.031	0.000
EXPSXR	0.003	0.769	0.005	0.635	-0.012	0.200	0.008	0.527	-0.013	0.187	0.015	0.337	0.013	0.299
SXRGROWTH	0.055	0.295	0.051	0.348	-0.043	0.234	0.071	0.241	-0.032	0.452	0.027	0.704	0.044	0.486
INF	-0.414	0.003	-0.389	0.006	-0.331	0.002	-0.406	0.008	-0.389	0.002	-0.380	0.029	-0.387	0.011
GDPGROWTH	0.060	0.496	0.099	0.277	0.269	0.001	0.171	0.065	0.253	0.002	0.313	0.004	0.308	0.001
SP	0.462	0.083	0.578	0.036	-0.017	0.774	0.733	0.009	-0.086	0.690	1.588	0.000	1.478	0.000
OPENNESS	-0.007	0.600	-0.008	0.549	0.003	0.390	-0.017	0.048	0.005	0.467	-0.040	0.013	-0.039	0.000
W*IRD											1.336	0.046	1.418	0.003
W*EXPSXR											0.026	0.357	0.026	0.303
W*SXRGROWTH											-0.093	0.530	-0.081	0.539
W*INF											0.029	0.948	-0.054	0.887
W*GDPGROWTH											1.496	0.000	1.344	0.000
W*SP											2.984	0.000	2.976	0.000
W*OPENNESS											-0.045	0.508	-0.023	0.534
W*dep.var.			-0.274	0.000	0.273	0.000					-0.335	0.000	-0.444	0.000
spat.aut.							-0.511	0.000	0.265	0.000				
teta					0.997	0.002			0.000	1.000			0.997	0.002
R-squared	0.447		0.494		0.148		0.436				0.562		0.274	
LM spatial lag	13.742	0.000												

LM spatial error	16.624	0.000						
Robust LM spatial lag	7.033	0.008						
Robust LM spatial error	9.915	0.002						
Wald test spatial lag					40.552	0.000	46.082	0.000
LR test spatial lag					41.766	0.000	43.281	0.000
Wald test spatial error					33.712	0.000	35.398	0.000
LR test spatial error					30.669	0.000	34.553	0.000
Hausman Test (Prob.)			210.4253 (0.0000)	-363.4490 (0.0000)			94.8957 (0.0000)	

The estimated direct effects of Model 2 are the same as those of Model 1, where only the interest rate differential variable of the host country has a significant positive effect at the 5% significance level. In the SDM-RE model, the interest rate differential and government debt securities of the host country have a significant effect on the 5% significant level. Furthermore, the feedback effect of interest rate differential is relatively large, with a value of -0.382. The estimated spillover effect (indirect) in Model 2 is that inflation is only significant and positive at the significant level of 1%, with an elasticity of 1.434.

In the estimation of the direct effects of Model 3, the variable interest rate differential, inflation, and government debt rating have a significant effect at the 5% level. This suggests that an increase in the difference in bond interest rates between the host country and the United States, as well as an increase in the government debt rating increase foreign portfolio inflows in the host country, with elasticities of 0.570 and 0.667. Meanwhile, an increase in host country inflation will reduce the inflow of the host country's FPI with an elasticity of -0.405. The feedback effect of variable interest rate differential, inflation, and government debt ratings is relatively small, amounting to -0.017, -0.022, and 0.053. The negative value of the feedback effect on this variable interest rate differential and inflation shows that an increase in the interest rate differential and inflation to the host country reduces the impact of increased FPI inflows to the host country as a result of the impact of passing through neighboring countries and returning to the state itself. Meanwhile, the positive value of the feedback effect on the government debt rating variable shows that an increase in the rating of government debt securities to the host country has an impact on increasing the impact of increased FPI inflows to the host country as a result of the impact of passing through neighboring countries and returning to the state itself.

The estimated spillover (indirect) effect in Model 3 is only significant and positive economic growth, which is the same as the SDM-RE estimate. The spillover effect in Model 3 shows that increased growth in the host country to some extent can increase the FPI inflows in neighboring countries with an elasticity of 0.646. This shows that if the host country experiences an increase in economic growth, it will indirectly have a positive impact on FPI inflows in neighboring countries. This is because investors think that increased economic growth in the host country will increase the economic growth of neighboring countries.

In the estimation of the direct effect of Model 4, the variable interest rate differential and government debt rating have a significant effect with elasticities of 0.797 and 0.932. The feedback effect of the variable interest rate differential and government debt ratings is relatively small, amounting to 0.153 and 0.091. The spillover effect estimate (indirect) in Model 4 is only significant and positive economic growth, which is the same as the SDM-RE estimate. The spillover effect in Model 4 shows that increasing growth in the host country to some extent can increase the inflow of FPI in neighboring countries with an elasticity of 0.760.

In the estimation of the direct effects of Model 5, variable interest rate differential, inflation, government debt rating, and trade openness have a significant effect with elasticities of 0.899, -0.424, 1.321, and -0.038. The feedback effect of variable interest rate differential, inflation, government debt rating, and trade openness is relatively small, amounting to 0.094, -0.016, 0.199, and 0.002. The estimated spillover effect (indirect) in Model 5 is that economic growth and the government debt rating are significant and positive. The spillover effect in Model 5 shows that an increase in economic growth and a government debt rating in the host country can to some extent increase the inflow of FPI in neighboring countries with elasticities of 1.307 and 1.931.

Similiar with Model 5, in the estimation of the direct effects of Model 6, variable interest rate differential, inflation, government debt ratings, and trade openness have a significant effect

with elasticities of 0.970, -0.398, 1.362, and -0.037. The feedback effects of variable interest rate differential, inflation, government debt ratings, and trade openness are relatively small, amounting to 0.093, -0.018, 0.225, and 0.002. The estimated spillover effect (indirect) in Model 6 is that the economic growth and government debt rating are significant and positive. The spillover effect in Model 6 shows that an increase in economic growth and a government debt rating in the host country can to some extent increase the inflows of FPI in neighboring countries with elasticities of 1.175 and 2.094.

Table 11 Direct and Spillover Effects

		Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
		Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.	Coef.	prob.
Direct Effects	IRD	0.441	0.038	0.528	0.022	0.570	0.019	0.797	0.015	0.899	0.012	0.970	0.007
	UNEXPSXR/EXPSXR	0.527	0.553	-0.003	0.790	1.421	0.123	0.010	0.389	1.638	0.232	0.013	0.408
	SXRGROWTH	0.063	0.245	0.055	0.320	0.069	0.228	0.047	0.410	0.046	0.523	0.034	0.617
	INF	-0.110	0.465	-0.061	0.669	-0.405	0.023	-0.332	0.056	-0.424	0.040	-0.398	0.057
	GDPGROWTH	0.113	0.197	0.118	0.203	0.053	0.555	0.060	0.508	0.194	0.105	0.176	0.132
	SP	0.632	0.051	0.631	0.052	0.667	0.039	0.932	0.035	1.321	0.013	1.362	0.013
	OPENNESS	-0.011	0.193	-0.010	0.246	-0.014	0.093	-0.008	0.577	-0.038	0.049	-0.037	0.049
Indirect Effects	IRD	1.815	0.076	1.800	0.068	0.125	0.626	-1.199	0.063	0.890	0.186	0.830	0.176
	UNEXPSXR/EXPSXR	-8.989	0.059	-0.078	0.142	-1.121	0.471	0.020	0.352	-0.409	0.837	0.020	0.399
	SXRGROWTH	0.063	0.745	0.044	0.815	0.051	0.378	0.070	0.320	-0.137	0.306	-0.092	0.458
	INF	1.383	0.012	1.434	0.009	-0.189	0.392	-0.417	0.150	0.132	0.722	0.119	0.740
	GDPGROWTH	0.099	0.644	0.092	0.674	0.646	0.006	0.760	0.005	1.307	0.008	1.175	0.012
	SP	1.530	0.088	1.371	0.111	-0.394	0.084	-0.721	0.340	1.931	0.036	2.094	0.026
	OPENNESS	-0.025	0.296	-0.019	0.428	0.008	0.608	-0.017	0.443	-0.029	0.634	-0.027	0.656
Total Effects	IRD	2.257	0.044	2.328	0.037	0.695	0.075	-0.402	0.484	1.789	0.048	1.800	0.032
	UNEXPSXR/EXPSXR	-8.462	0.078	-0.081	0.154	0.300	0.858	0.030	0.195	1.229	0.668	0.033	0.345
	SXRGROWTH	0.126	0.533	0.099	0.631	0.120	0.100	0.118	0.133	-0.091	0.595	-0.058	0.720
	INF	1.273	0.028	1.373	0.019	-0.594	0.047	-0.749	0.039	-0.291	0.537	-0.278	0.543

GDPGROWTH	0.212	0.377	0.210	0.401	0.700	0.005	0.821	0.004	1.501	0.008	1.351	0.011
SP	2.161	0.050	2.002	0.065	0.273	0.265	0.211	0.722	3.252	0.015	3.456	0.012
OPENNESS	-0.037	0.207	-0.029	0.323	-0.006	0.664	-0.025	0.274	-0.067	0.319	-0.064	0.333

There is evidence that when using the inverse distance matrix as a spatial weight, the resulting feedback effect is relatively large. Meanwhile, when using a 1-order binary contiguity matrix as a spatial weight, the resulting feedback effect is relatively small. Based on research using the spatial durbin model conducted by Elhorst (2014a), by using the weight of a 1-order binary contiguity matrix, the feedback effect is relatively small. This is probably because the use of inverse distance weight makes neighboring countries have a value from the distance between capital cities, hence the effect of passing through neighboring countries and returning to the country is greater. Meanwhile, the weight using 1-order binary contiguity makes only countries that share state boundaries have a spatial impact. Therefore, the effect of passing through neighboring countries and returning to the country is smaller. When considering spatial correlation based on economy (economic distance), the results of the spillover effect show more linkages between the macroeconomic variables of the host country and changes in FPI flows into neighboring countries, when compared to using geographic correlation. This is more understandable because investors consider the economic linkages between neighboring countries more than the geographical linkages to invest in a country.

4.6 The Relationship of Unexpected Exchange Rate and Several Macroeconomic Variables to FPI Inflow in Indonesia

The foreign portfolio is divided into three, including net foreign inflows of equity (EQUITY), 10-year government bonds (BOND), and FPI (bonds plus equity). Augmented Dickey-Fuller (ADF) test shows that the foreign capital inflows in all types of portfolios, changes in exchange rates and volatility, VIX index. The interest rate differential is stationary at I (0), as shown in Table 12. Since all variables are stationary at the level, the OLS ARMA model is estimated. Importantly, the best model is selected by considering the significance of various estimation models from the statistical probability of F-test, the significance of AR or MA coefficients used, the maximum value of log-likelihood function, and the minimum value of AIC and SIC criteria.

First, we estimate a linear model, in which the net inflows of equity (equity), bonds, and FPI (bonds plus equity) are the dependent variables on the OLS standard setting, which is shown in Table 14. In the OLS model, ARMA (2,0) is selected for equity and bonds, and ARMA (2,1) for FPI as the best model. The results indicate that changes in the exchange rate and VIX index in the previous period have a significant negative effect on bonds and FPI, yet not significant on equity. Exchange rate volatility (UNEXPSXR)1 in the past period significantly affected foreign equity inflows to Indonesia only. Meanwhile, the interest rate differential in the previous period has a statistically significant positive effect on bonds and FPI and not significant on equity. To test the robustness of the model, serial correlation and heteroscedasticity tests were conducted in the ARCH effect test for all types of portfolios. The result shows that there is no serial correlation in the model, though there is heteroscedasticity in the ARCH effect test. This shows that a simple linear model is not suitable for capturing the relationship between exchange rates and macroeconomic variables on net inflows of foreign portfolio investment. Therefore, the ARCH-GARCH method is used for estimation.

Table 12 Augmented Dickey-Fuller (ADF) Stationarity Test at Level

Variable	t-Statistic	Prob.*
BOND	-23.660	0.000
EQUITY	-27.782	0.000
FPI	-23.158	0.000

[1] We have also tried using the expected exchange rate data, but the results are negative and insignificant with a very small coefficient.

SXRGROWTH	-2.182	0.028
UNEXPSXR	-4.572	0.000
VIX	-5.846	0.000
IRD	-3.487	0.008

Furthermore, the ARCH-GARCH method produced a better estimate as indicated by the absence of heteroscedasticity in the ARCH effect test and the significant impact of ARCH and GARCH parameters in all cases, as shown in Table 14. GARCH (1,1) was selected as the best model in all types of portfolios. The results show that in all types of portfolios, changes in exchange rates on the previous day (for bonds and FPI) and two days before (for equity) have a significant negative effect. In case the rupiah depreciates (appreciates), foreign investors tend to sell Indonesian portfolios and bonds. This is in line with Anggitawati & Ekaputra (2018) , which examined the exchange rate changes to portfolios in Indonesia in 2011–2016 using the VAR method.

According to Anggitawati & Ekaputra (2018), the impact of negative shocks from changes in exchange rates on net flows in the capital, bond, and equity markets occurs on the second to fourth trading days. Srinivasan & Kalaivani (2015) reported that the exchange rate has a significant negative impact on Foreign Institutional Investment (FII) in India. According to Hau & Rey (2002), there is a negative correlation between the exchange rate and foreign stock market returns, reducing the volatility in exchange rate returns. For this reason, foreign investors are more interested. Furthermore, the negative correlation is also related to the findings of this study. There is an increase in returns or changes in exchange rates, which decreases stock returns. For this reason, foreign investors withdraw their capital, leading to the outflow of foreign portfolio investment.

Table 13 Linear Model Estimation

	BOND		EQUITY		FPI	
Variable	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.
C	0.627	0.061	-0.453	0.416	0.249	0.532
SXRGROWTH(-1)	-0.016	0.014			-0.016	0.019
SXRGROWTH(-2)			-0.004	0.548		
UNEXPSXR(-1)	-0.127	0.422	-0.453	0.045	-0.305	0.078
VIX(-1)					-0.038	0.000
VIX(-2)	-0.053	0.000	0.008	0.421		
IRD(-1)			0.108	0.311		
IRD(-2)						
IRD(-3)	0.146	0.027			0.175	0.026
AR(1)	0.273	0.001	0.195	0.030	0.275	0.000
AR(2)	0.185	0.000	0.129	0.000	0.199	0.000
R^2	0.182		0.069		0.184	
Adj R^2	0.180		0.067		0.182	
LogL	-4544.372		-5807.088		-4630.147	

AIC	3.509		4.481		3.575	
SIC	3.525		4.497		3.591	
Serial Correlation Test	1.239	0.290	0.836	0.433	1.488	0.223
Heteroskedasticity Test	611.243	0.000	11.458	0.001	142.254	0.000

Note: Serial Correlation Test using the Breusch-Godfrey Serial Correlation LM Test and Heteroscedasticity Test using the ARCH LM Test.

There is a negative and significant relationship between exchange rate volatility (UNEXPSXR) in the previous one-day period on the equity market and the foreign portfolio market (FPI) but not significant in bond positions. This means that the higher exchange rate volatility in Indonesia attracts foreign equity and portfolio outflow. This is in line with Garg & Dua (2014), which showed a negative relationship between exchange rate volatility and foreign portfolio inflows because of the higher level of uncertainty in the returns received by investors. Persson & Svensson (1989) showed that the characteristics of risk through exchange rate variability determines the composition of international portfolios and asset trading due to incomplete international asset markets. This contravenes Baek (2006), which showed that real exchange rate volatility does not significantly affect foreign portfolio investment inflows because the domestic factors in the Asian and Latin American regions do not affect the FPI inflows. Additionally, factors from outside the host country are more influential on FPI in Asia and Latin America.

This is shown by the significant VIX index in previous periods with a negative sign for all types of portfolios in Indonesia. When global stock market volatility and investor sentiment increase, investor fear increases, hence investors attract capital flows out of Indonesia. Also, the greater global risk aversion, measured as an increase in VIX, has a significant negative effect on net portfolio inflows (Ahmed & Zlate, 2014).

Table 14 Estimation of the GARCH Model

	BOND		EQUITY		FPI	
Variable	Coef.	Prob.	Coef.	Prob.	Coef.	Prob.
Conditional mean equation						
C	0.514	0.112	0.071	0.869	0.397	0.226
SXRGROWTH(-1)	-0.018	0.024			-0.020	0.010
SXRGROWTH(-2)			-0.021	0.034		
UNEXPSXR(-1)	-0.202	0.376	-0.963	0.001	-0.535	0.025
VIX(-1)					-0.033	0.000
VIX(-2)	-0.051	0.000	-0.032	0.002		
IRD(-1)			0.213	0.046		
IRD(-2)						
IRD(-3)	0.168	0.010			0.171	0.014
AR(1)	0.430	0.000	0.221	0.000	0.512	0.000
AR(2)	0.088	0.000	0.049	0.000	0.080	0.001

Conditional variance equation						
C	1.278	0.000	5.595	0.000	1.187	0.000
RESID(-1)^2	0.174	0.000	0.772	0.000	0.364	0.000
GARCH(-1)	0.096	0.006	-0.040	0.000	0.094	0.021
R^2	0.159		0.048		0.133	
Adj R^2	0.156		0.045		0.130	
LogL	-4341.202		-5676.563		-4407.477	
AIC	3.355		4.383		3.406	
SIC	3.377		4.405		3.429	
Heteroskedasticity Test	2.147	0.092	0.006	0.939	0.080	0.777

Note: Serial Correlation Test using the Breusch-Godfrey Serial Correlation LM and Heteroscedasticity using the ARCH LM Test.

The difference between the 10-year government bond interest rates between Indonesia and the United States (IRD) in previous periods had a positive effect on the flow for all types of foreign portfolios. The low-interest rate on government bonds in the United States has attracted foreign investors to hold assets in developing countries, where the majority have higher interest rates, for a favorable difference (yield). The sensitivity of foreign portfolio inflows in Indonesia to differences in interest rates shows the elasticity of fiscal policy intervention on foreign investment in Indonesia. According to Verma & Prakash (2011) foreign bond investment is directly affected by changes in interest rates through changes in bond prices in the case study of India. The prices of equity can be indirectly affected by changes in interest rates. Ahmed & Zlate (2014) also established that interest rate differentials have a more prominent role in the post-crisis period.

The GARCH estimation results in Table 14 show that BOND (-1, -2), EQUITY (-1, -2), and FPI (-1, -2) through the AR (1) and AR (2) symbols are significant in the mean equation at the 1% level for all portfolio types. This means that today's FPI value can be predicted by the previous day's value. Therefore, the current FPI inflow behavior is influenced by its past behavior. This means that FPI inflows have moderate persistence (Verma & Prakash, 2011). In the variance equation, the coefficient on the residual term (RESID (-1) ^2) on all portfolio types is significant and positive, meaning that the volatility of today's portfolio investment is determined by the residual term from the previous day. The significance of the GARCH coefficient in all types of portfolios shows the persistence of volatility, which can be explained by the GARCH model. The volatility of foreign portfolios in the past predicts volatility patterns of portfolios in the future.

5. Concluding Remarks

5.1. Conclusions

This study shows that the factors that attract foreign portfolio investment flow to host countries are conditionally determined by macroeconomic conditions between the host and neighboring countries. Therefore, the interest rate differential, economic growth, and government debt ratings in the host country have a significant positive effect on the FPI inflow. This shows the important role of the government in regulating the flow of FPI into the country. Furthermore, the negative response of FPI flows to host countries due to inflation shows the Central Bank is essential in maintaining inflation stability to increase the inflow of foreign portfolio investment in the country. However, the expected and unexpected exchange rate risks have been used to model the volatility in influencing the flow of FPI into ASEAN countries. The results show that these variables do not significantly affect ASEAN portfolio flows. Furthermore, changes in exchange rates in the host country did not significantly affect the flow of FPI into the host country.

The estimation results for the relationship between foreign portfolio flows into neighboring and host countries using three weights are negative and significant. This provides additional evidence that supports the effect of competition between countries in ASEAN in attracting FPI, where the inflow of foreign portfolio investment in a particular country is significantly affected by the influx of FPI in the environment or the surrounding countries.

The results of the spillover effect indicate that an increase in economic growth and a government debt rating in the host country promote foreign portfolio investment inflows to neighboring countries or vice versa. The existence of movement in the real sector that increase economic growth in the country will affect to countries bordering these countries and countries that have economic correlation. An increase in the government debt rating of the host country will have an impact on countries with economic correlation. Furthermore, the results of the positive spillover effect on the inflation variable indicate that a country also needs to maintain its inflation. This is because an increase in inflation in the host country attract investment outflows. Therefore, monetary policy to control the increase in inflation in neighboring countries is important in determining the increase in capital flows to the host country due to the spillover effect.

In the case study of Indonesia, the GARCH method is used because the characteristics of daily data have heteroscedasticity problems. To provide robust results, three types of foreign portfolio flows are used, including bonds, equity, and total portfolios (bonds and equity). In case, there is evidence that changes in exchange rates affect the incoming bond and equity portfolio flow. Also, exchange rate volatility affects the foreign equity market and the portfolio market, which adheres to a floating exchange rate regime. Maintaining the exchange rate stability can be an effective tool for policymakers and regulators to stabilize the rupiah exchange rate and increase the flow of foreign portfolio investment.

The significant interest rate differential also shows that the interest rate (yield) of government bonds plays an important role in the inflow of foreign portfolios, both on the bond and equity markets. Global factors, such as the VIX index, also have a negative effect on all types of FPI inflows. This means that when the VIX index increases and indicates high global stock market volatility, foreign investors withdraw their portfolios from Indonesia. Based on the results of GARCH, FPI current inflow behavior is influenced by the past, specifically due to its moderate persistence.

5.2. Policy Implications and Recommendations

Based on the estimation results of the spatial durbin model for the ASEAN case study, the various policy implications are obtained. First, the negative spillover effect of foreign portfolio inflows in neighboring countries implies that there is an effect of competition between countries in ASEAN. There is a mutual withdrawal of foreign portfolio investment entering the country rather than support in investment flows between neighboring regions. In case neighboring countries have better prospects, foreign capital may leave the host and move to neighboring countries. Therefore, it is important for a country to maintain its competitiveness, investment business atmosphere, and macroeconomic conditions. This means it is discouraging for investors to withdraw their funds from the host country.

Second, in order to increase the positive spillover effect of economic growth, there is a need for cooperation between ASEAN countries to increase economic integration in each country, so that it is expected to be able to encourage the inflow of foreign portfolio investment in countries that have borders and have economic correlation. Third, the positive spillover effect on the ratings of host government debt securities implies the importance of increasing government debt securities in the host country to encourage the influx of FPI flows to countries with economic correlation.

Fourth, the positive spillover effect on inflation and the negative result on the host inflation variable implies the importance of a country to maintain its inflation rate because it will result in the movement of foreign capital flows to neighboring countries. In particular, Central Banks play an important role in increasing the inflow of foreign portfolio investment through their duties as providers of their country's currency by maintaining price stability through controlling inflation.

Fifth, the government needs to optimize its performance in maintaining the quality of debt securities and the difference in bond interest rates with the United States to attract foreign investors. The role of the government is important in promoting increased foreign portfolio capital flows to ASEAN countries through differences in interest rates on bonds between them and the United States, as well as the ratings of government bonds. Therefore, the country needs to always improve the quality of government debt securities through the supervision and implementation of existing regulations.

From the estimation results of the GARCH model for the Indonesian case study, various policy implications are obtained. The significant changes in exchange rates and its volatility, and interest rate differential on foreign portfolio inflows indicate the important role of monetary policy. This is achieved by stabilizing of rupiah exchange rate and fiscal policy through differences in bond yields between Indonesia and the United States. The effect of exchange rate changes on foreign investment in all types of portfolios and the exchange rate volatility on the foreign equity market shows the importance of maintaining the stability of the rupiah value to increase the flow of foreign capital. Maintaining a stable exchange rate could be an effective tool for Bank Indonesia to increase the flow of foreign portfolio investment into Indonesia, especially in the flow of foreign equity through intervention in the currency market. However, the absence of a relationship between exchange rate volatility and foreign capital flows in the bond market makes it difficult for monetary policy to stop the outflow of bond capital due to a shock in the volatility of the rupiah exchange rate against the dollar.

The positive relationship between interest rate differentials and inflows of foreign portfolio investment is in line with the neoclassical theory. According to the theory, capital flows respond to differences in interest rates between countries. Capital flow from countries with low returns (developed with abundant capital) to those with high returns (developing with

scarce capital). Due to the importance of differences in interest rates on Indonesian and US government bonds, the government has the flexibility to use its instruments, such as bond interest rates, to modulate the liquidity conditions of foreign portfolio investment that entering Indonesia. Furthermore, there are global factors that influence the flow of foreign bond and equity portfolio investment in Indonesia, including the VIX index, which reflects global stock market volatility. Therefore, policymakers and regulators need to remain vigilant on global pressures that might cause the outflow of foreign capital from Indonesia.

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