

# Granger Causality of Exchange Rates And Stock Indices in 10 Emerging Market Countries: During Quantitative Easing and Tapering Off Period

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**Abstract**—This study was conducted to see the strength of Emerging Market economies (EM) to withstand shocks that arise when The Fed changes the Quantitative Easing (QE) to Tapering Off policy (TO). The EM countries in this study were selected based on trade relations with the US; those are China, India, South Korea, Taiwan, Indonesia, Argentina, Brazil, Mexico, Russia, and Turkey. This study was also conducted by using Granger Causality method and VAR, then comparing the result of each variable (S & P 500 index, EM's stock index, and exchange rate) before and after the implementation of QE and TO (January 1st, 2008 - December 31st, 2017). The Granger Causality test results show that there is a change in direction from QE to TO period in most EM countries. This change reflects that the shock of TO policy did not directly bring down the capital market of EM countries despite capital outflows. EM countries are believed to have strong domestic and regional economies, so there is an economic transmission when the shock occurs.

**Index Terms**—emerging market, exchange rate, quantitative easing, stock indices, tapering off

## I. INTRODUCTION

The global economy is important to be considered by investors. In 2008, global economic conditions experienced a shock that caused sluggish investment and world trade activities. This condition is caused by the Subprime Mortgage crisis in the United States (US) which can be transmitted to the economic conditions of other countries that have strong relations with the US. Although having a major influence on the world economy, not all countries are vulnerable to the impact of the US crisis, especially the Emerging Markets (EM), which have strong regional economic growth. In the 2000s, Emerging East Asia (EEA) countries were not affected by the 2008 economic crisis as experienced by developed countries [1].

In 2008, The Fed (Federal Reserve) has tried to restore the US crisis by issuing a quantitative easing (QE) policy. The QE policy itself is a non-conventional monetary policy used by the central bank to stimulate the national economy when the conventional monetary policy is no longer effective [2]. Mahajan also added that this QE policy is carried out by the central bank by buying financial assets from commercial banks and other financial institutions. The amount of money which has been determined is injected into the economy and expected to stimulate the economic condition.

After implementing the QE policy in three stages, finally, in December 2013 the Federal Open Market Committee (FOMC)

announced to reduce stimulus of the bond purchases or also called the tapering off policy (TO). FOMC would reduce the purchase of bonds from US \$ 85 billion to US \$ 75 billion per month. This TO policy is implemented to prevent the inflation that can weaken the value of the US currency itself.

Based on this background, the writer is interested to see whether in the implementation of the QE or TO policy, the EM country stock market remains influenced by the US stock market or not. This influence can be seen from the causality of variables tested in EM and US countries during QE and TO periods. The ten EM countries tested were selected based on their trade relations with the US through the data from the International Trade Administration (ITA) in 2017. These ten EM countries are Argentina, Brazil, China, India, Indonesia, South Korea, Mexico, Russia, Taiwan, and Turkey. From this trade relationship, it can be seen whether a country has economic dependence with other countries [1]. The data used in his paper is daily time series data from the S & P 500 index, stock indices and exchange rates of each country. The method used in this study is the Granger Causality and Vector Auto Regression (VAR) model.

## II. LITERATURE REVIEW

The US economy is quite dominant in the world. If there is a shock, the impact will spread to both developing and undeveloped countries (contagion effect). According to Yang (2004), the effect of transmission is a phenomenon when a financial crisis that occurs in a country will trigger a financial crisis in other countries. At the time of the 2008 US financial crisis, many countries were affected, with the existence of the QE policy itself potentially affecting global markets including emerging markets. Tillman (2013, 2016) in [3] states that QE policy has a significant influence on the financial condition of EM countries and has a role in explaining the occurrence of capital inflows and stock prices.

To resolve the crisis in 2008, The Fed issued a monetary policy of QE to restore the stability of the US economy. The QE policy itself aims to increase the money supply through the purchase of government bonds or assets to encourage lower interest rates [3]. According to Magavi (2012), this policy can lead to an increase in the capital of financial sector so that the amount of loans that can be given by banks to individual customers and corporates also increases. In addition, Magavi

also mentioned that the effect of this policy could also cause a devaluation of the US currency value so that US exports would be assumed to be more competitive, thus triggering economic growth

The QE policy itself is thought to have caused the high amount of USD in circulation, thus encouraging capital outflows from the US to EM countries. This is the trigger why The Fed decided to decrease the purchase of government bonds in 2013, or it can also be referred as a TO policy. After the implementation of TO policy, there would be a rebound in US government bond yields resulting in capital inflow to developing countries, especially the United States (Rai and Suchanek (2014)). After the announcement of the TO policy, Rai and Suchanek (2014) added, capital flows to EM countries began to slow down, even reverse the direction. Thus, this TO policy is associated with the size of the investor outflow and the reallocation of capital and shares from EM countries (Karolyi and McLaren (2017)).

When a country has no dependency on the world economic turmoil, this condition is also called decoupling. The decoupling theory itself relies on the fact that Asian countries conduct intraregional trading activities higher than with the US [4]. Based on a journal article written by Park, Emerging East Asia (EEA) countries had a high level of economic growth in the 2000s so they were not severely affected during the 2008 economic crisis [1]. But in his research, Park revealed that there was no evidence strong that the EM countries decouple towards the world economy, especially the US. The strength of the domestic and regional economy of the EM countries is only the transmission of the shock that occurs, the world economy itself remains integrated with the economy of the EM country.

### III. RESEARCH METHODOLOGY

The initial stage of this research is to conduct stationary tests on the returns of the stock price index and exchange rate. Both of these variables are considered stationary if the tested data does not contain the unit root which means mean, variance, and covariant are constant all the time. In this research, a stationary test is done by using Unit Root Augmented Dickey-Fuller (ADF) method by comparing the value of ADF statistic with Mackinnon critical value 1%, 5%, and 10%. The test is done at the level with the equation of:

$$Y_t = \rho Y_{t-1} + \epsilon t \quad (1)$$

If  $\rho = 1$ , the variable contains a unit root, which is non-stationary.

If the test results at the level obtained non-stationary data, the researcher then will use first order test (first difference) to obtain stationary data with the equation of:

$$Y_t - Y_{t-1} = \rho(Y_{t-1} - Y_{t-2}) + \epsilon t \quad (2)$$

After performing a stationary test, it is necessary to test the lag to determine the optimal lag length for the VAR model. The determination of the number or length of the optimal lag

uses some of the information criteria that include the Akaike Information Criteria (AIC), Schwarz Criteria (SC), Likelihood Ratio Test (LR), Hannan-Quinn Information Criteria (HQ), and Final Prediction Error (FPE).

Before performing the Vector Auto Regression (VAR) method, to examine the relationship between variables, the researcher will use Granger causality test between US stock index return (S & P 500), stock price index return of ten emerging market countries and exchange rate return with the equation of:

$$Y_t = \alpha + \beta_1 Y_{t-1} + \beta_2 X_{t-1} + \epsilon t \quad (3)$$

If  $\beta_1 = 0$  then  $X_{t-1}$  is not Granger to  $Y_t$  or a variable does not affect other variables, otherwise if  $\beta_1 > 0$  then there is a relationship that  $X$  is Granger to  $Y_t$  or it can be said a variable affect other variables.

Next, after the stationary and the Granger causality test, the research will proceed using the VAR method to see the significant effect (positive/negative between the variables tested with the model as follows:

$$INDICES_t = \beta_0 + \alpha_1 \sum_r SNP_{tk} + \alpha_2 \sum_r KURS_{t-k} \quad (4)$$

Furthermore, in the VAR method, there is the Impulse Response Function (IRF) and Variance Decomposition (VD) test to know whether the occurrence of changes (shock) on the variable  $x$  not only affect the value of variable  $x$  but also affect all the variables tested on the VAR model. From this test, how long the influence of a shock variable to other variables are perceived, also the variable that will give the greatest response to the shock. Then, the final strength indicator is measured from the order of magnitude of each variable. The wider the order of magnitude of a variable or the farther from the point of equilibrium, the stronger the variable responds to the shock of the macroeconomic variable. This power indicator can then be further strengthened by the VD test results.

### IV. RESULTS

Graphically, the S & P 500 Index has increased since the enactment of the QE to TO policy (Figure 1). Whereas in Argentina, the MERV index seemed stagnant during QE policy implementation, but began to increase sharply during the implementation of the TO, as well as the USD/ARS exchange rate which seemed stagnant in Figure 2. In the stock index, the nine other EM countries had different patterns. BVSP index has increased before QE implementation, then smoothly declined after the QE implementation. When TO policy was implemented, BVSP decreases and no longer increases again. The strengthening of the BVSP index after the TO period was followed by the strengthening of the USD against BRL.

Also in Figure 1, the BSESN, JKSE, and TWII indices experienced a similar pattern since the implementation of QE to TO policy, it continues to increase despite fluctuating. The KOSPI and MXX indices in the initial period of QE implementation experienced an increase then stagnated until

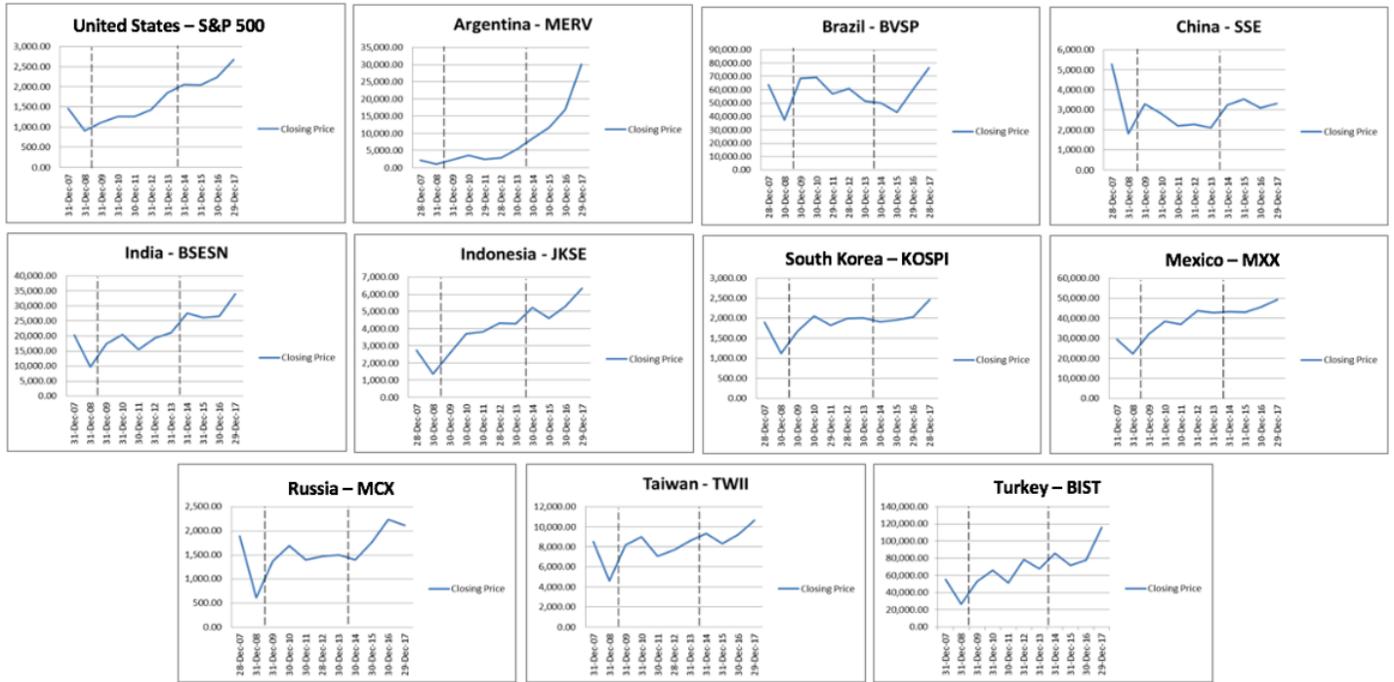


Fig. 1. The movements of S & P 500 and 10 EM indices during 2007–2017.

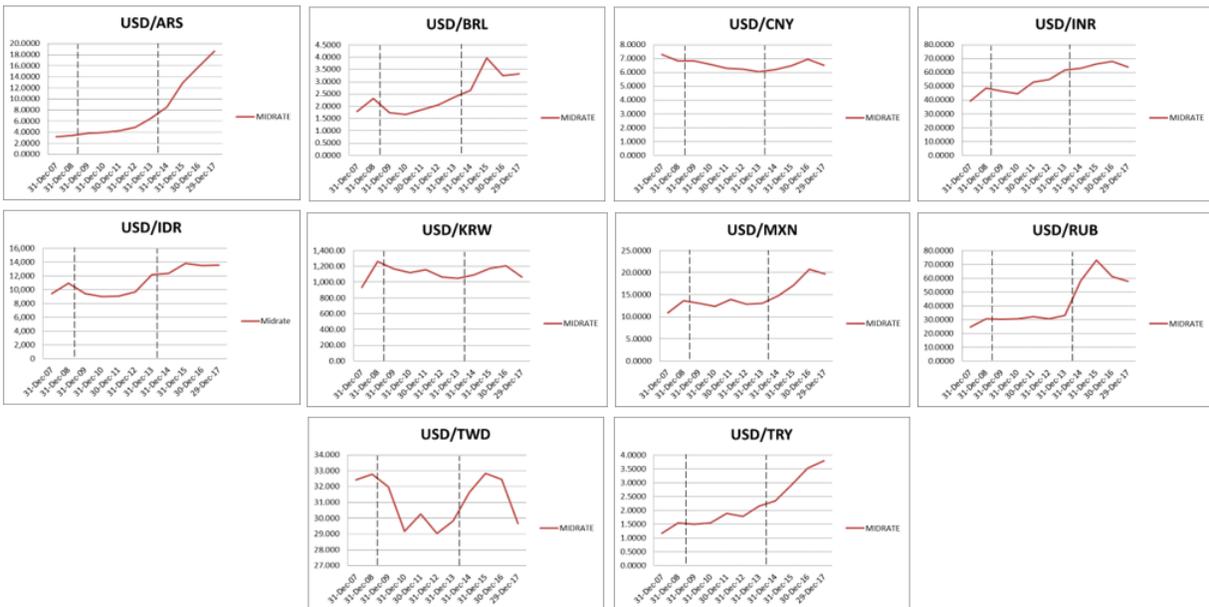


Fig. 2. The movements of EM exchange rates during 2007–2017.

TABLE I  
THE RESULT OF GRANGER CAUSALITY TEST BETWEEN S & P 500 RETURN AND 10 EM INDICES RETURN

Periods	Quantitative Easing			Tapering Off			
	Causality	One-way	Two-way	Causality	One-way	Two-way	Causality
Argentina		✓					✓
Brazil			✓		✓		
China	✓				✓		
India	✓				✓		
Indonesia			✓		✓		
South Korea			✓			✓	
Mexico				✓			✓
Russia			✓		✓		
Taiwan	✓					✓	
Turkey			✓			✓	

TABLE II  
THE RESULT OF GRANGER CAUSALITY TEST BETWEEN STOCK INDICES AND EXCHANGE RATES RETURN

Periods	Quantitative Easing			Tapering Off			
	Causality	One-way	Two-way	Causality	One-way	Two-way	Causality
Argentina			✓				✓
Brazil			✓		✓		
China				✓			✓
India	✓				✓		
Indonesia			✓				✓
South Korea			✓			✓	
Mexico			✓		✓		
Russia	✓						✓
Taiwan	✓				✓		
Turkey			✓			✓	

the TO policy was implemented. Similar to SSE, the MCX index experienced an increase in the initial period of QE implementation, then declined slightly and stagnated until the end of the QE policy, and when implementing the TO policy, it experienced a significant and was followed by the strengthened USD against RUB

To see the further relationship between the exchange rates and US investment in ten EM countries during the QE and TO periods, further testing is needed. First, from the results of stationary test on the variables during QE implementation (January 1, 2008 - December 31, 2013) and TO implementation (January 1, 2014–December 31, 2017), it can be concluded that the return of S & P 500, MERV, BVSP, SSE, KOSPI, BSESN, JKSE, MXX, MCX, TWII, BIST, as well as the return of the USD exchange rate against the currencies of 10 EM countries, USD/ARS, USD/BRL, USD/CNY, USD/KRW, USD/INR, USD/DR, USD/MXN, USD/RUB, USD/TWD, USD/TRY are all stationary at the level with the ADF value greater than the critical value of MacKinnon 1%, 5% and 10% and a significant probability of below 5%.

After the stationary test, the lag test is done using the Eviews program to get the optimum lag so that there is no autocorrelation problem. The results of the lag test in each country in the QE and TO periods shows the number of optimum lags are varied. After determining the optimum lag, the next step is to find the causal direction between

the variables tested through the Granger causality test. This Granger causality test is divided into three, as follows:

- The causality of S & P 500 return and 10 EM stock indices return.  
In QE period, Brazil, Indonesia, South Korea, Russia, and Turkey have two-way causality with US that occurs between the S & P 500 return and BVSP, JKSE, KOSPI, MCX, BIST return (Table I). This two-way causality continues during the TO period only in South Korea and Turkey, while Brazil, Indonesia and Russia only have one-way causality. In other hand, a two-way causality also occurs in Taiwan but only in the TO period, whereas during the QE period only one-way causality occurs.
- The causality of stock indices and exchange rates return.  
During the QE and TO period, the causality between stock indices and exchange rates return can be seen in Table II. The result of Granger causality between the variables during the QE period, Argentina, Brazil, Indonesia, South Korea, Mexico and Turkey have two-way causality with US where the return of MERV, BVSP, JKSE, KOSPI, MXX, and BIST affect the return of USD/ARS, USD/BRL, USD/IDR, USD/KRW, USD/MXN, and USD/TRY. During the TO period, this two-way causality still occurs only in South Korea and Turkey, while the other four countries are changing.
- The causality of exchange rates and S & P 500 return.

TABLE III  
THE RESULT OF GRANGER CAUSALITY TEST BETWEEN EXCHANGE RATES AND S & P 500 RETURN

Periods Causality	Quantitative Easing			Tapering Off		
	One-way	Two-way	Nil	One-way	Two-way	Nil
Argentina			✓	✓		
Brazil		✓				✓
China			✓			✓
India		✓		✓		
Indonesia		✓			✓	
South Korea		✓		✓		
Mexico		✓		✓		
Russia			✓			✓
Taiwan	✓			✓		
Turkey		✓				✓

During the QE and TO period, the causality between the exchange rates and the S & P 500 return can be seen in Table III. The Granger causality test results show that there is a two-way causality during the QE period in Brazil, India, Indonesia, South Korea, Mexico and Turkey where USD/BRL, USD/INR, USD/IDR, USD/KRW, USD/MXN and USD/TRY return affect the S & P 500 return and vice versa. This two-way causality continues until the TO period only in Indonesia, while in the other five countries it is changing.

To support the results of the Granger causality test, VAR estimation is done by comparing the t-statistic value with the t-table, which is 1.96. If the t-statistic value is greater than the t-table value, then variable X significantly affects variable Y, otherwise, if the t-statistic value is smaller than the t-table value, then variable X does not significantly affect variable Y. Just like the Granger causality test, The VAR estimation also divided into three as follows:

- VAR Estimation between S & P 500 and 10 EM Indices Return  
Based on the VAR estimation, the S & P 500 return has a positive and significant effect on the stock indices return of Brazil, Indonesia, South Korea, Russia and Turkey (BVSP, JKSE, KOSPI, MCX, and BIST) during QE period. In the other hand, S & P 500 returns were also positively and significantly influenced by JKSE and MCX returns, but negatively and significantly influenced by KOSPI returns. The other two indices, BVSP and BIST returns did not have a significant effect on S & P 500 return.
- VAR Estimation between Stock Indices and Exchange Rates Return  
Based on VAR estimation between stock indices and exchange rates return, BVSP, KOSPI, and BIST have a positive and significant effect on each exchange rates return, USD/BRL, USD/KRW, and USD/TRY. Otherwise, the effect of those three exchange rates returns negatively and significantly affect the return of those three stock indices return. Other stock indices, JKSE and MXX returns have a negative and significant effect on each

exchange return: USD/IDR and USD/MXN. In contrast, USD/IDR and USD/MXN returns also have a negative and significant effect on JKSE and MXX returns, while MERV returns have a non-significant effect on USD/ARS return and vice versa.

VAR Estimation between exchange rates and S & P 500 return Based on the VAR estimation, the S & P 500 return has a negative and significant effect on the return of USD/BRL, USD/INR, USD/IDR, USD/KRW. On the contrary, USD/BRL, USD/INR and USD/KRW return negatively and significantly affect the S & P 500 return. Only USD/IDR return has a positive and significant effect on S & P 500 return. Reversely, S & P 500 returns also have a positive and significant effect on USD/MXN and USD/TRY return, but on the contrary, USD/MXN and USD/TRY have a negative and significant effect on S & P 500 return.

## V. DISCUSSION

From the result of Granger Causality and VAR estimation, it can be seen that during the QE period countries like Brazil, Indonesia, South Korea, and Turkey have a two-way causality on all variables tested. This causality continues until the TO period, but not in all variables tested. Based on a theoretical review of the decoupling theory, EM countries are believed to have strong domestic and regional economic strength so that they do not have dependency with developed countries. Therefore, when implementing TO policy, the causality could change between the variables tested.

In several studies such as those conducted by Karolyi and McLaren in 2017, during the TO period, investors tend to do capital outflows so that the US currency will strengthen against EM currencies and EM stock indices should be weakened, but in fact, the EM countries' stock indices actually strengthen. In line with Park's research in 2018, this change in causality can be caused by EM countries that having strong regional and domestic economy, both in trade and financial markets. The strength of this regional and domestic economy then becomes an economic transmission when US policy provides a shock in the form of TO policy on the economy of EM countries. Therefore, with the existence of this economic transmission,

when there is a capital outflow during the TO policy, the EM country stock indices still have the opportunity to increase.

## VI. CONCLUSION

The results of this study indicate that EM countries like Brazil, Indonesia, South Korea, Russia, and Turkey are strong enough to withstand the shock from TO policy. EM countries are believed to have strong regional and domestic economy which later become economic transmissions from the shock of the world economy. It could be seen from the change in direction of the causality relationship of each variable tested in QE and TO period. In Figures 1 and 2, most stock indices of EM countries increased during the implementation of the TO policy, both directly and indirectly after the implementation, as well as the USD exchange rate which strengthened against the currencies of EM countries. From this result, we can see that EM capital market is strong enough to hold off the capital outflow. In addition, the capital outflow from EM countries does not mean it was flowing back to US capital market, because during the TO period the causality between the S & P 500 and the exchange rates return of EM countries also experienced a change in causality.

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