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VAR Analysis on Dynamic Relationship Between Exchange Rate of VND/USD and Vietnamese Stock Market Index Returns

Nguyen Xuan Dien
(Academy of Finance, Vietnam)

Abstract: This study is an attempt to explore the dynamic relationship between exchange rate of VND/USD and Vietnamese stock market index. Daily data from 21st Feb 2018 to 21st Feb 2019 is taken, constituting 251 observations. To capture dynamic and stable relationship among these variables, the author uses Vector Autoregressive Model. The results show that, in short run, the results show that each variable is highly affected by changes of value and past value of its and the other variables at different degree. In addition, there exists a long run relationship among Vietnamese stock market index and exchange rate.

Key words: unit root tests; vector auto-regression (VAR), exchange rate; Vietnamese stock market
JEL codes: C32, G1

1. Introduction

The study of the relationship between exchange rates and stocks has been carried out for data of many countries using different techniques and different results obtained. There have been many studies, both theoretically and empirically, on the relationship and the movement between the stock market and the foreign exchange market.

In theoretical study: there are two different approaches in Economic theories to the dependence between stock prices and exchange rates, called the "flow-oriented" approach and "stock oriented" approach (Nguyen Thi Lien Hoa and Luong Thi Thuy Huong (2014)). All of these approaches clearly show that the stock market affects the exchange rate and vice versa.

First, following the "flow-oriented" approach, it is assumed that the change of exchange rate affects the trade balance and the level of international competition. Theoretically, the change of exchange rate will affect the output and ultimately the competitive position of the companies. If a company is in a better competitive position, it will have a direct positive impact on stock prices, because stock prices represent the company's future cash flows. The devaluation of the local currency will help to increase the competitive advantage of domestic companies as their exported goods will be cheaper in international trade. As a result, there will be a positive correlation between stock prices and exchange rates.

The "stock-oriented" approach often considers portfolio equilibrium models, which consider an internationally diversified portfolio. These models suggest that the fluctuation of exchange rates will affect the balance of supply and demand of domestic and international financial assets. Therefore, following this approach

Xuan Dien Nguyen, Ph.D., Academy of Finance; research area/interest: finance. E-mail: nguyenxuandien@hvtc.edu.vn.

an increase in domestic stock prices will cause the domestic currency to appreciate because of the increased demand for local currency by the purchase of domestic securities. A fall in stock prices will reduce the wealth of local investors, leading to a reduction in their demand for money. Banks will respond by lowering interest rates, which would not be attractive for capital flows, resulting in lower demand for the domestic currency and thus a decline in the local currency. Because domestic assets and foreign assets do not have a perfect replacement for effective equilibrium, when investors adjust the ratio between domestic and foreign assets in their portfolio to cope. With the changing economic conditions, the exchange rate will also have to change. Therefore, this “stock-oriented” approach will show the opposite relationship between stock prices and exchange rates.

In empirical study: An empirical study of the interaction and causal relationship between stock prices and exchange rates has yielded various results (positive, negative, and causal and non-existent relations. in cause and effect, one-way causality, ...).

From a micro perspective, the appreciation of the domestic currency could put export companies at a disadvantage in competition, leading to a fall in the stock prices of these companies, suggesting an inverse relationship between the stock and exchange rate returns. On the other hand, importing companies may benefit from the appreciation of the local currency, indicating a positive relationship between the two markets. From a macro perspective, if the local currency interest rate is relatively high compared to the rest of the world, the demand for the domestic currency will be higher, causing the local currency to appreciate. Meanwhile, higher interest rates will also increase borrowing costs of domestic companies, causing stock prices to fall. This shows the opposite relationship between the two markets.

Some empirical studies on the relationship between the stock market and the foreign exchange market can be mentioned as Solnik (l987), Jorion (l99l), Roll (l992), Neih and Lee (2001), Aloui (2007), Yang and Doong (2004), Phylaktis and Ravazzolo (2005), Pan et al. (2007), Zhao (2010), Diamandis and Drakos (2011).

Specifically, using the least squares estimation (OLS) method, Solnik (l987) found a weak positive relationship between exchange rates and securities when using monthly data but the relationship was negative relationship when using quarterly data for 8 Western countries: Canada, France, Germany, Japan, Netherlands, Switzerland, UK, and USA; Euro exchange rates of currencies in 1 month and 3 months. The study period was from July 1973 to December 1983. The author found that after October 1979, the real exchange rate was strongly influenced by interest rates. There was a positive correlation between stock yields and exchange rates especially after 1979. Jorion (l99l) showed that changes in exchange rates will not have a predictable impact on exchange rate fluctuations. Stock returns using the two-factor and multi-factor Arbitrage Pricing Theory to analyze data on US stock and foreign exchange indexes from January 1971 to October 12/1987. Meanwhile, some other studies that used correlation coefficients such as Roll (l992) when studying the impact of the US dollar exchange rate on the stock market index of 24 countries suggested that there was a strong correlation between exchange rate changes and stock market fluctuations. Neih and Lee (2001) examined the dynamic relationship between stock prices and exchange rates of G7 countries from October 1, 1993 to February 15, 1996 based on the daily closing prices of stock market indexes and the exchange rate in USD of G7 countries. Thanks to co-integration testing and vector correction model errors, the authors showed that there was no long-term equilibrium relationship between stock market index and foreign exchange index in these countries. The short-term equilibrium relationship was only found in some countries in the group, such as falling exchange rates, which often drag the German stock market down, but push the stock markets of Canada and the UK the next day up. However, when stock prices rised again, often the price of foreign exchange fell the next day in Italy and Japan. In the US, there was no equilibrium relationship between stock prices and dollar values both in the short and long term. Aloui (2007) studied the spillover and causal effects between the US stock market and the US dollar market and some European countries in the period before the Euro was born and after the Euro was born, using conditional variance of exponential generalized autoregressive conditionally variance (Heteroskedastic - EGARCH). The data studied was the closing price of the exchange rate in US dollars and the stock market index of 5 countries (France, Italy, Germany, Belgium, USA) from December 28, 1990 to February 10, 2005. As a result, there was a pervasive effect and causality of the exchange rate on stock prices when the introduction of the Euro. However, stock prices had no effect on exchange rates in both the periods before and after the Euro. On the same topic, Yang and Doong (2004) studied the asymmetry in the spillover effect between stock prices and exchange rates for seven major industrial countries between May 1, 1979 and January 1, 1999 using the vector auto-regressive model (VAR) and the multivariate EGARCH model; The results showed that there are pervasive effects, asymmetric fluctuations and fluctuations of the stock market price index that affect the future exchange rate fluctuations, but the fluctuations of exchange rates had little effect. more directly to fluctuations in stock market price indexes in the future. On the other hand, Phylaktis and Ravazzolo (2005) studied the short-term and long-term relationship between stock prices and exchange rates using the cointegrating and Granger causality test for countries in pacific gulf region. Specifically, the stock index of 5 countries in the Pacific and the exchange rate of each country with US dollars: Malaysia and Thailand: from January 1980 to December 1998; Hong Kong: from January 1981 to December 1998; Philippines: from May 1986 to December 1998; Singapore: from January 1990 to December 1998. The results showed that the US stock market is an important cause variable in the causal relationship. Stock prices and exchange rates had a positive relationship.

Pan et al. (2007) used Granger causality test, vector self-regression model, variance decomposition, reaction function analysis to test the dynamic relationship between exchange rate and stock price of 7 Asian countries, including Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan and Thailand from 1/1988 to 10/1998. The result was a statistically significant causal relationship with the stock markets of Hong Kong, Japan, Malaysia and Thailand in the pre-crisis period. The authors found empirical evidence on the causal relationship from exchange rates to stock indexes in Hong Kong, Japan, Malaysia, and Thailand ahead of the regional financial crisis. Asia in 1997. There was a causal relationship from the stock market to the financial markets of Hong Kong, South Korea, and Singapore. No country has showed a causal relationship from the stock market to the market during the Asian crisis, but there was a causal relationship from the stock market to the stock market, except Malaysia. Zhao (2010) used monthly data from 1991 to 2009 to examine the dynamic effects of stock prices and exchange rates in China using the VAR and GARCH model. The results showed that there was no long-term equilibrium relationship between the real exchange rate of the Yuan in US dollars and the prices of Chinese stocks. There existed a two-way spread effect between the two markets, i.e. the past fluctuations in the stock market had an impact on the future volatility of the market liquidity and vice versa. Diamandis and Drakos (2011) analyzed the long-term and short-term relationship between exchange rates and stock prices as well as the effects of exogenous shocks on four Latin American countries, including Argentina, Brazil, Chile and Mexico used the co-linking technique and Granger causality test. Monthly data from January 1980 to February 2009 include exchange rates in US dollars and stock market index was investigated. As a result, there was no statistically significant long-term equilibrium relationship between stock prices. However, when combined with the US stock market, the results showed that the prices of stock and exchange rates were positively related to the US stock market, creating favorable conditions for the exchange between exchange rates and stocks in these countries.

2. Methodology and Data Descriptions

About the methodology, in order to examine the relationship between Vietnamese stock market and exchange rate, Vector Auto-regression (VAR) has been used. In this model, all the variables are considered to be endogenous and each endogenous variable is explained by its lagged or past values and the lagged values of all other endogenous variables included in the model. There are no exogenous variables in the model and hence, by avoiding the imposition of a priori restriction on the model the VAR adds significantly to the flexibility of the model. The VAR is commonly used for forecasting systems of interrelated time series and for analyzing the dynamic impact of random disturbances on the system of variables. The VAR approach sidesteps the need for structural modeling by modeling every endogenous variable in the system as a function of the lagged values of all of the endogenous variables in the system.

The mathematical form of a VAR is $y_t = \beta_1 y_{t-1} + \beta_2 y_{t-2} + \ldots + \beta_2 y_{t-p} + \gamma x_t + \varepsilon_t$, where y_t is a k vector of endogenous variables, x_t is a d vector of exogenous variables, $\beta_1, \beta_2, \ldots, \beta_p$ and γ are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated with each other but are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables. Since only lagged values of the endogenous variables appear on the right-hand side of each equation, there is no issue of simultaneity, and OLS is the appropriate estimation technique.

The study has taken the market price of USD in Vietnamese Dong from https://vn.investing.com, the world oil price from https://www.investing.com and VNindex from https://www.vndirect.com.vn from 21st Feb 2018 to 21st Feb 2019 is taken, constituting 251 observations. In the series taken there were some missing data due to holidays and other reasons, these missing values were omitted while data were handled using Microsoft Excel. The variations on indexes is calculated by taking first difference of two successive days, i.e., $V_t = P_t - P_{t-1}$, where P_t is the price of each financial asset at time t.

3. Empirical Results

3.1 Stationarity of Variables

A stationary time series is significant to a regression analysis based on the time series, because useful information or characteristics are difficult to identify in a non-stationary time series. Therefore, a non-stationary time series would lead to a spurious regression. However, most economic time series are non-stationary in practice. Hence, time series should be made stationary after differencing. Useful information or characteristics can still be identified in the time series after differencing. A time series is said to be stationary if its mean and variance are constant and, the co-variances depend on upon the distance of two time periods. At first, we have a look at the graph of EXCHANGE_RATE and VNINDEX in Figure 1.

Figure 1 shows that the index data series are not stationary. We make a try to the graphs of the first difference of the above variables in Figure 2.

Figure 2 shows that the first difference index data series are stationary. The unit root test is used to test the station of variables and the order of integration. The Augmented Dicky-Fuller unit root test (ADF) is often used in this case. For the VAR estimation all the variables included in the model should be stationary. The result of ADF test is presented with lag 4 suggested by Newey-West, including trend and intercept in test equation. Tables 1 and 2, respectively, present ADF tests for series at level and at the first difference.

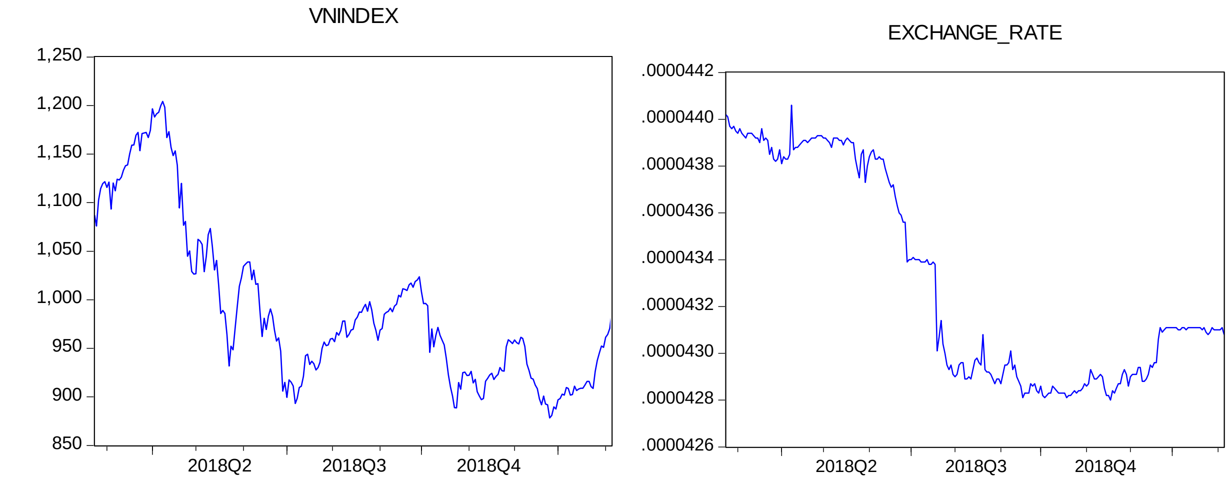

Figure 1 Graph of Exchange Rate and Vnindex at Level

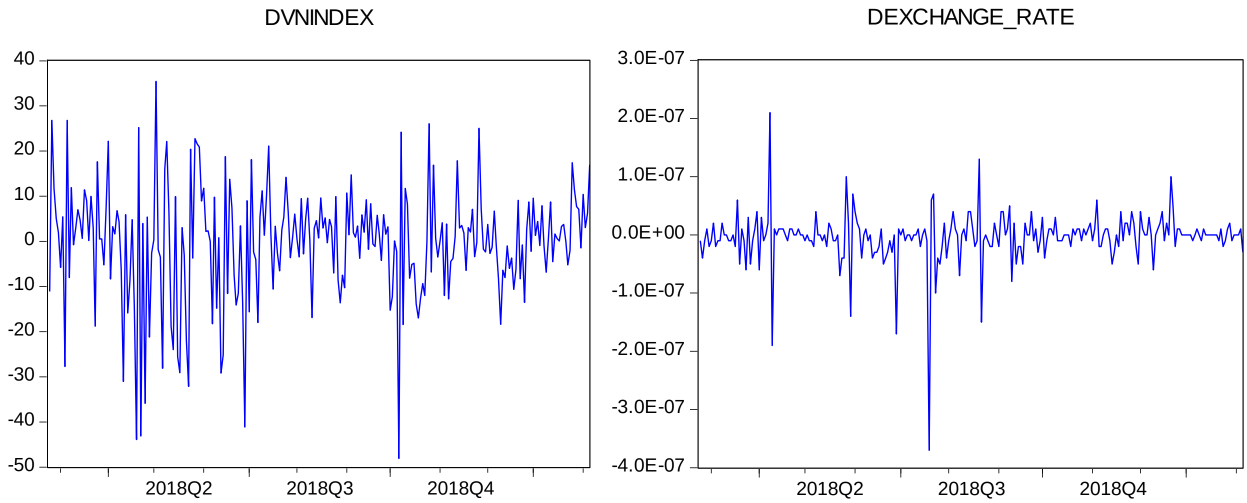

Figure 2 Graph of ExchangeRate and Vnindex at First Difference

Table 1 ADF Test Results for Exchange Rate and Vnindex

Null Hypothesis:	t-Statistic	Prob.
Exchange_Rate has a unit root	-0.441179	0.9856
Vnindex has a unit root	-2.02939	0.5819

Table 2 ADF Test Results for D(Exchange Rate) and D(Vnindex)

Null Hypothesis:	t-Statistic	Prob.
D(Exchange_Rate) has a unit root	-6.276004	0.0000
D(Vnindex) has a unit root	-5.978749	0.0000

The unit root test with first difference and the results shows that all the index data series are not stationary at the level but stationary after the first difference. In other words, all the data series are I(1) which denotes that the time series is integrated at the first difference level. Figures 1 and 2 support this. There are at least two advantages when using the first difference data series to explain the impulse response function. Firstly, it focuses more on the increase or decrease trend rather than the actual change. Because the first difference data series is the increase or decrease between every two consecutive dates, a strengthening or weakening of the trend will be detected by the impulse response function. Secondly, it captures more information on the shocks of gold price, because the first difference data shows the changes in the past two days while the level data shows the changes in one day in impulse response function.

3.2 Selection of Optimal Lag

One of the important aspect of VAR model is to select the optimal lagged term. Traditional way of selecting the lag length was by repeating VAR model by reducing lag length from a large lag term until 0. In each of these models, the smallest value of the Akaike information criterion and the Schwarz criterion are used to select the optimal lag length (Gujarati, 2004). In this study however, five criteria: Sequential modified LR test statistics (LR), Final prediction error (FPE), Akaike information criterion (AIC), Schwarz criterion (SC) and Hannan-Quinn information criterion (HQ). Similarly, the smallest value of these 5 criteria points to the optimal lag length. Table 3 shows the summary results of VAR lag order selection criteria.

Table 3 VAR Lag Order Seclection Criteria

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	2798.922	NA	3.14e-13	-23.11506	-23.08622*	-23.10344*
1	2804.327	10.67698	3.10e-13	-23.12667	-23.04017	-23.09183
2	2811.714	14.46872	3.01e-13*	-23.15466*	-23.01049	-23.09659
3	2813.015	2.526021	3.08e-13	-23.13235	-22.93052	-23.05105
4	2819.671	12.81709*	3.02e-13	-23.15431	-22.89480	-23.04977
5	2823.151	6.643741	3.03e-13	-23.15001	-22.83283	-23.02224
6	2824.422	2.404663	3.10e-13	-23.12745	-22.75261	-22.97645
7	2826.698	4.270662	3.14e-13	-23.11321	-22.68069	-22.93898
8	2829.664	5.515869	3.17e-13	-23.10466	-22.61448	-22.90720

* indicates lag order selected by the criterion

The first left hand column shows the model for which the lag length has been selected using the LR, FPE, AIC, SC and HQ criterion. The numbers are the smallest value in each of criteria. Before selecting the lag length, one must consider that too short a lag length in the VAR may not capture the dynamic behaviour of the variables (Chen & Patel, 1998). Table 3 presents VAR Lag Order Selection Criteria. Based on the results, the study will choose four lag to be appropriate.

3.3 Estimation of VAR and Dynamic Analysis

We also may omit some lags if they are not really necessary. We use VAR Lag Exclusion Wald Test as in Table 4.

The results in Table 4 suggest us to omit lag 3 in the estimation. So we have found the truly relationship between exchange rate and stock market index thanks to VAR Estimation in Table 5.

Impulse response functions and variance decompositions are carried out to examine how shock to the variables bounce back through the system. Before carrying out these analyses, it is important to ensure that the VAR model is stable. We use the AR Root Graph as in Figure 3.

Table 4 VAR Lag Exclusion Wald Tests

VAR Lag Exclusion Wald Tests			
Numbers in [ ] are p-values			
	DVNINDEX	DEXCHANGE_RATE	Joint
Lag 1	1.496456	12.19277	14.83380
	[0.473204]	[0.002251]	[0.005059]
Lag 2	8.093807	3.949949	11.66628
	[0.017476]	[0.138765]	[0.020013]
Lag 3	2.069197	1.991873	4.716908
	[0.355369]	[0.369377]	[0.317597]
Lag 4	4.930117	5.803679	12.47087
	[0.085004]	[0.054922]	[0.014173]
df	2	2	4

Table 5 VAR Estimation Result

Vector Autoregression Estimates		
Sample (adjusted): 2/28/2018 2/06/2019		
Included observations: 246 after adjustments		
Standard errors in ( ) & t-statistics in [ ]		
	DVNINDEX	DEXCHANGE_RATE
DVNINDEX(-1)	-0.057855	1.16E-10
	(0.06370)	(2.2E-10)
	[-0.90820]	[0.53231]
DVNINDEX(-2)	0.177282	1.91E-10
	(0.06457)	(2.2E-10)
	[2.74545]	[0.86316]
DVNINDEX(-4)	0.091822	-3.89E-10
	(0.06390)	(2.2E-10)
	[1.43702]	[-1.77617]
DEXCHANGE_RATE(-1)	18234279	-0.234556
	(1.9E+07)	(0.06406)
	[0.97445]	[-3.66141]
DEXCHANGE_RATE(-2)	-693192.5	-0.143925
	(1.9E+07)	(0.06406)
	[-0.03705]	[-2.24684]
DEXCHANGE_RATE(-4)	-28122699	0.094424
	(1.8E+07)	(0.06306)
	[-1.52681]	[1.49742]
C	-0.464552	-4.62E-09
	(0.80584)	(2.8E-09)
	[-0.57649]	[-1.67613]

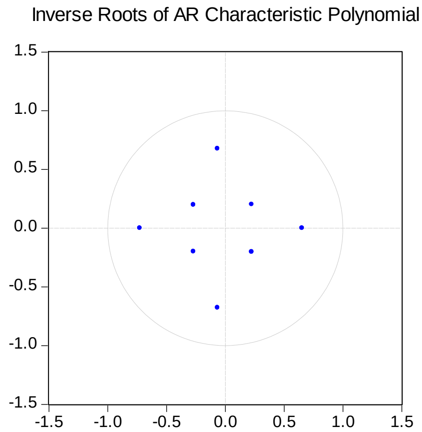

Figure 3 Inverse Roots of AR Characteristic Polynomial

In Figure 3, the model satisfies the stability condition, as there are no roots lying outside the unit circle in the model. Besides, the residual serial is indeed white noise thanks to VAR Residual Serial Correlation LM Tests, with result in Table 6.

Table 6 VAR Residual Serial Correlation LM Test

VAR Residual Serial Correlation LM Tests		
Null Hypothesis: no serial correlation at lag order h		
Lags	LM-Stat	Prob
1	4.417382	0.3525
2	4.990968	0.2882
3	6.840505	0.1446
4	2.881006	0.5779
5	6.669334	0.1544
6	1.961809	0.7428
7	3.008943	0.5563
8	6.659083	0.1550
9	5.307643	0.2572
10	0.929411	0.9203
11	2.797166	0.5923
12	0.530886	0.9704
Probs from chi-square with 4 df.		

Impulse Response Function (IRF) track the response of each variable to innovations in each of the other variables. We can examine the magnitude, direction and length of time that each variable are affected by a shock of a variable in the system, keeping all the other variables constant. The impulse respond functions are in Figure 4.

We can see that, each variable is positively affected immediately by itself on right the first day. There is a common feature is that all effects of each variable on itself and the other variables disappear after a week. Exchange rate shocks have no impact on stock market index on the first day but have effects from the following day until a week passes. However, these effects are low. The stock market shocks have influences on exchange rate right on right the first day. The impulse response of each variable to each other variable is absolutely rational, because if there is one of the financial assets is decrease in price, for example, investor can soon or later buy the others instead. The intensity of response can be seen from Variance Decomposition in Table 7.

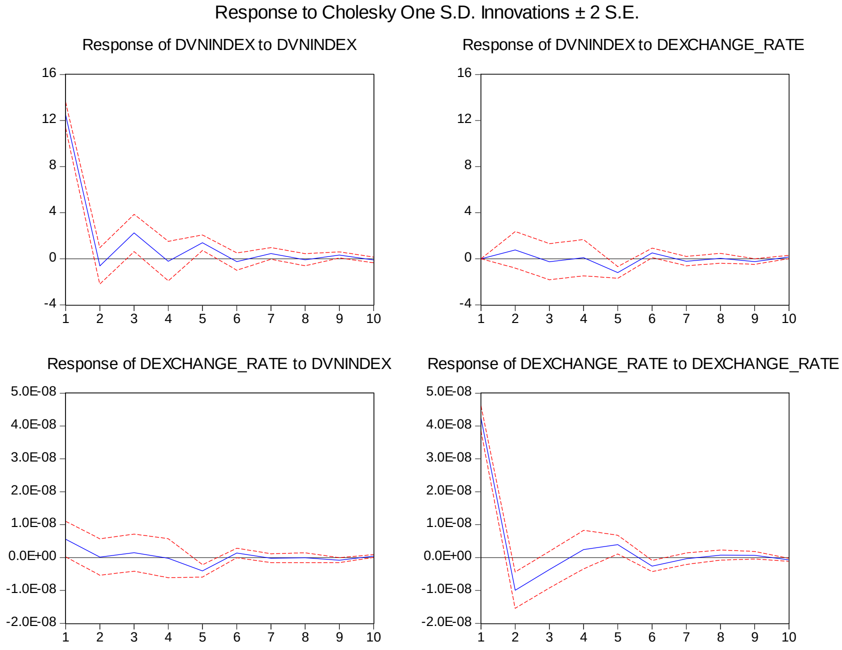

Figure 4 Response to Cholesky One S.D. Innovation ± 2 S.E

Table 7 Variance Decomposition

Period	S.E.	DVNINDEX	DEXCHANGE_RATE
Variance Decomposition of DVNINDEX:			
Period	S.E.	DVNINDEX	DEXCHANGE_RATE
1	12.47244	100.0000	0.000000
2	12.51165	99.61940	0.380604
3	12.71413	99.59118	0.408820
4	12.71625	99.58614	0.413860
5	12.84800	98.73019	1.269815
6	12.86042	98.57826	1.421740
7	12.87018	98.55336	1.446639
8	12.87055	98.55259	1.447412
9	12.87705	98.51750	1.482503
10	12.87844	98.50369	1.496308
Variance Decomposition of DEXCHANGE_RATE:			
Period	S.E.	DVNINDEX	DEXCHANGE_RATE
1	4.27E-08	1.715905	98.28409
2	4.38E-08	1.628828	98.37117
3	4.40E-08	1.727354	98.27265
4	4.41E-08	1.724694	98.27531
5	4.44E-08	2.536901	97.46310
6	4.45E-08	2.619235	97.38076
7	4.45E-08	2.621662	97.37834
8	4.46E-08	2.621245	97.37875
9	4.46E-08	2.651924	97.34808
10	4.46E-08	2.660967	97.33903
Cholesky Ordering: DVNINDEX DEXCHANGE_RATE			

The change of historical exchange rate can explain around 97% variations in the change of itself in about a week. After 10 days, this explanation does not decrease. At the same time, the change of Vietnamese stock market index explain is about 3%. The variation of change of Vietnamese stock market index is explained almost by its historical change (around 98%). Exchange rate innovations explain below 2% of the variation in Vietnamese stock market index. All these findings can also be seen from the impulse response function discussed above.

In order to investigate the relationship between exchange rate and Vietnamese stock market index in long run, the author reach to co-integration test, the results given in Table 8.

Table 8 Result of Johansen Cointegration Test

Included observations: 245 after adjustments				
Trend assumption: Linear deterministic trend				
Series: DVNINDEX DEXCHANGE_RATE				
Lags interval (in first differences): 1 to 4				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.151673	67.60961	15.49471	0.0000
At most 1 *	0.105480	27.30978	3.841466	0.0000
Trace test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.151673	40.29983	14.26460	0.0000
At most 1 *	0.105480	27.30978	3.841466	0.0000
Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

The Johansen Cointegration test showed that there did not existe a long run between exchange rate and Vietnamese stock market.

4. Conclusion

The study has found that the exchange rate and stock market index can sometimes explain the pricing process of the each other. In the currency market, exchange rates are often predicated on the health of a country's economy. If the economy is robust and growing, the exchange rates for their currency reflect that in higher value. The simple relationship between currencies through a single common commodity does not exist and the interconnection between stock price and exchange rates are all complex. This paper aims to establish and validate the dynamic relationship of exchange rate and Vietnamese stock market index. The paper uses daily time series data to explore the impact of fluctuations and interrelationship between them. This paper demonstrated systematically that dynamic relationship using VAR technique with one model to show the dynamic relationship. Due to VAR estimation with lag four, we can see that all these factors can be effectively used by the investors in the analysis of the return generating process. The results of this paper perform the slight relationship between exchange rate and stock market index in Vietnamese financial market. Historical price of each asset is found to be not the only driver of that asset but also the other three other assets. The results of this study also have important implications for the investors. Vietnamese financial market investors should closely follow all of these two assets even when their portfolios contain not all of two assets. Historical exchange rate and Vietnamese stock market index can be used as a good predictor of future prices of all of them in the short run. Investors may minimize the risk of their portfolio by distribute their capital rationally among these markets.

We can see that the fluctuations of each variables are explained almost by itself. Therefore, this study suggests us to try some rational models to study each variable through its historical information such as AR, MA or ARIMA… This will be carried out in near future research by the author.

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