

Impacts of the monetary policy on the exchange rate: case study of Vietnam

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Abstract

Purpose – The purpose of this paper is to evaluate and analyze impacts of the monetary policy (MP) – money aggregate and interest rate – on the exchange rate in Vietnam.

Design/methodology/approach – The study uses data over the period of 2008–2018 and applies the vector autoregression model, namely recursive restriction and sign restriction approaches.

Findings – The main empirical findings are as follows: a contraction of the money aggregate significantly leads to the real effective exchange rate (REER) depreciating and then appreciating; a tightening of the interest rate immediately causes the REER appreciating and then depreciating; and both the money aggregate and the interest rate strongly determine fluctuations of the REER.

Originality/value – The quantitative results imply that the MP affects the REER considerably.

Keywords Exchange rate, Vietnam, Monetary policy, VAR, Time series

Paper type Research paper

1. Introduction

It is likely that the exchange rate (RX) is a sensitive element, which significantly affects various social and economic aspects. Therefore, it plays an important role in the economies generally, and particularly for developing and integrating countries such as Vietnam. Integration stance bolsters the role of the RX as a “bridge” of internal and external economic activities. As the RX is a crucial factor, it is necessary to investigate shocks including monetary shocks on the RX. This could evaluate the fluctuation of the RX and then, predict its impact back to macroeconomics. Besides that, the State Bank of Vietnam (SBV) have changed the way to manage the RX since 2016. The RX mechanism now is more flexible, which goes up/down to reflect the market movement. Therefore, shocks including MP shocks could be more sensitive, evaluating impulse responses and variance decompositions of the RX to these shocks that is needed to stabilize the RX in particular and economy in general. The important role of the RX and the necessary evaluation of monetary shocks on the RX are the reasons why this research was carried out, in order to contribute to the existing literatures.

Besides that, the paper analyzes impacts of the MP on the RX in Vietnam based on two models and the data over the period of 2008–2018. It is far different from the existing studies in Vietnam. First, it focuses on impacts of the MP on the RX in which the RX is the sole

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objective of the analysis. Second, it uses both the monetary aggregate and the interest rate as proxy for the MP. The existing studies in Vietnam such as Le and Pfau (2009), Bui and Tran (2015), Le (2015) and Bach (2017) only provide research on the MP transmission regime through the RX channel. The main purpose of these studies is to analyze impacts of the MP on outputs of the economy such as the growth rate and the price level through the RX channel. This means that existing studies in Vietnam do not analyze the RX as the objective of research. Given this, the paper focuses on impacts of the MP on the RX in which the RX is the sole objective of analysis. In addition, since 1997 Vietnam has been operating the MP based on the broad money M2. However, the Law on the SBV in 2010 has caused a significant change in the MP, which requires the operation of the MP moving gradually from quantitative control (M2) to qualitative control (interest rate). It means that the interest rate plays an increasingly important role in addition to broad money M2. Therefore, the interest rate and the broad money M2 are both used as proxy for the MP in the paper.

The analysis of impacts of the MP on the RX in Vietnam is based on two models. The first model analyses impacts of money aggregate shocks on the RX, and the second model analyses impacts of interest rate shocks on the RX. The first model, which uses the recursive restriction method, shows that money aggregate shocks have a significant effect on the RX. This is consistent with Dornbusch's (1976) overshooting hypothesis. The other model analyses the reaction of the RX to interest rate shocks. RX puzzles appear when the recursive restriction method is applied. However, they disappear when the sign restriction method is used. This shows that interest rate shocks have a significant effect on the RX, and it is also consistent with Dornbusch's (1976) overshooting hypothesis. In short, results of both models reveal that the MP, including money aggregate and interest rate, affects the RX in Vietnam considerably.

The paper starts with the introduction, followed by Sections 2–7. Section 2 mentions the literature review. Section 3 presents the methodology and data in order to identify MP shocks. Section 4 explains the results of models; meanwhile, Section 5 checks robustness. Section 6 discusses policy implications, and Section 7 provides conclusion and future study.

2. Literature review

Dornbusch (1976) represents the RX overshooting hypothesis, which is well-known and is the central theory in existing international macroeconomics. According to it, the tightening MP causes the RX to decrease instantaneously (i.e. appreciation), followed by its gradual increase (i.e. depreciation). Empirical studies show controversial results, some support the overshooting hypothesis, whereas others do not. Studies by Sims (1992), Eichenbaum and Evans (1995), Peersman and Smets (2003), Favero and Marcellino (2004), Mojon and Peersman (2003) and Lindé (2003) are in favor of the overshooting hypothesis. However, other empirical studies reveal abnormal results such as the increase in the RX or the decrease in the RX in a prolonged period due to the tightening MP. Study by Grilli and Roubini (1995) showed the increase in the RX in case of the tightening MP. This phenomenon is known as "RX puzzles." Additionally, the study by Cushman and Zha (1997) shows the decrease in the RX in a prolonged period in the case of the tightening MP. This phenomenon is known as "delayed overshooting or forward discount puzzle."

The common approach used in the above-mentioned studies to estimate quantitatively impacts of the MP on the RX is vector autoregression model (VAR), which is initiated by Sims (1980). However, the VAR model also has a major weakness; it requires identifying simultaneous relationships among variables. Most of VAR studies use (zero) recursive contemporaneous restrictions on the relationship between the MP and the RX. This probably causes abnormal results regarding impulse responses of the RX to MP shocks (Bjornland, 2009). In studies which use (zero) recursive contemporaneous restrictions to evaluate macro-variable interactions, puzzles may appear (Roubini and Grilli, 1996; Cushman and Zha, 1997). They might be less apparent or disappear in the context of identifying structural VAR by (zero)

long-run restrictions or (zero) non-recursive contemporaneous restrictions as these methods allow contemporaneous relationships between the MP and the RX (Bjornland, 2009; Kim and Roubini, 2000). An alternative method to solve puzzles is sign restrictions, which is used by Faust (1998), Canova and De Nicolo (2002), Uhlig (2005) and Peersman (2005).

Kim and Roubini (2000) argued that it is useful to apply (zero) non-recursive contemporaneous restrictions to identify MP shocks. According to (zero) recursive contemporaneous restrictions, in order to get impulse responses of the RX to MP shocks, the VAR ordering is required in which the RX is put after the MP. This means that the MP does not react contemporaneously to RX shocks. Kim and Roubini (2000) believed that it is not convincing for two reasons. First, in small open economies, the increase or decrease in the RX can have large influence on price levels. Therefore, it requires a quick adjustment in the MP to respond to RX shocks. Second, Roubini and Grilli (1996) and Sims (1992) suggested that the depreciation over the period when the tightening MP is applied could be explained as the Central Bank sets up the tightening MP when observing the depreciation.

Bjornland (2009) identified the VAR model by imposing (zero) long-run restrictions. She assumed that MP shocks do not influence the RX in the long run. However, they affect the RX in short run in a free manner. Therefore, impacts of the MP shocks on the RX in the short run would die out in the long run and the RX could return to the initial level. In the literature, this phenomenon is considered as a standard neutrality assumption that is used widely in MP studies (Obstfeld, 1985; Clarida and Galli, 1994).

Fisher and Huh (2016) stated that sign restrictions are preferred to recursive and non-recursive models as they could avoid the strong assumptions, which identify contemporaneous interactions among variables. Based on the sign restriction approach, Faust and Jorgers (2003) did not find robust results for timing of RX peak under the tightening MP. Applying the sign restriction method, Scholl and Uhlig (2008) found robust evidence for RX delayed overshooting. Both studies identified only MP shocks in structural VAR and left other macro-variables' shocks unidentified. This issue may occur in the context that some shocks are not identified in the system. Therefore, the sign assumption for MP shocks could be satisfied by other variables' shocks. In other words, MP shocks in the system would not be uniquely identified. Fry and Pagan (2011) considered its problem as multiple shocks phenomenon. This raises a controversial discussion of whether or not the sign restriction model is efficient to identify "true" impulse responses of the RX to the MP shocks.

Fry and Pagan (2011) mentioned a method to generate "true" impulse responses in sign restrictions. To begin with, it is necessary to run a recursive model and standardize the estimated structural shocks. This gives an initial set of shocks characterized by uncorrelated property, zero mean and unit variance. After that, this first set of shocks would be re-combined to make another set of shocks. This second set of shocks is also characterized by uncorrelated property, zero mean and unit variance. There are two approaches used to re-combine shocks, namely Givens transformation and Householder transformation. Ouliaris and Pagan (2016) suggested another method to generate "true" impulse responses in sign restrictions. Following this approach, impulse response of macro-variables is judged against the sign assumptions. The method combines structural VAR with instrumental variables, thus for getting exact identification, the unidentified coefficients are assigned values. These values are generated randomly. Based on each set of these coefficient values, the structural VAR is investigated and the impulse response will be obtained.

3. Methodology and data

3.1 Methodology

Based on arguments of Eichenbaum and Evans (1995) as well as Christiano *et al.* (1999), the paper investigates impacts of the MP on the RX by two benchmark policy shocks, namely money aggregate and interest rate. A popular approach to estimate macro-economic interactions

is the VAR (as in Sims 1980 among others). In VAR, Cholesky decomposition is used to orthogonalize independent shocks. It is understood that a variable reacts contemporaneously to shocks of variables that are placed ahead and does not respond contemporaneously to shocks of variables that are placed behind. Bernanke and Mihov (1998) stated that non-policy variables should be placed as the first place, followed by policy variables. Besides, Sims and Zha (1995) also argued that variable ordering depends on information delay assumption.

From above-mentioned arguments, two benchmark policy shocks that are evaluated in this paper are as follows.

3.1.1 Monetary policy shocks: money aggregate. Reduced form equation:

$$X_t = AX_{t-1} + e_t,$$

where X_t is the real industrial production (IP), the price level (CPI), the money aggregate (M2), and the real effective exchange rate (REER) at time t , A the coefficient matrices and e_t the shock at time t .

Recursive restrictions (Model 1):

$$\begin{bmatrix} \varepsilon \text{IP} \\ \varepsilon \text{CPI} \\ \varepsilon \text{M2} \\ \varepsilon \text{REER} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \varepsilon \text{IP} \\ \varepsilon \text{CPI} \\ \varepsilon \text{M2} \\ \varepsilon \text{REER} \end{bmatrix}. \quad (1)$$

3.1.2 Monetary policy shocks: interest rate. Reduced form equation:

$$Y_t = BY_{t-1} + u_t,$$

where Y_t is the real industrial production (IP), the price level (CPI), the OMO interest rate (IR), and the real effective exchange rate (REER) at time t , B the coefficient matrices and u_t the shocks at time t .

Recursive restrictions (Model 2):

$$\begin{bmatrix} u \text{IP} \\ u \text{CPI} \\ u \text{IR} \\ u \text{REER} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} \end{bmatrix} \begin{bmatrix} \omega \text{IP} \\ \omega \text{CPI} \\ \omega \text{IR} \\ \omega \text{REER} \end{bmatrix}. \quad (2)$$

3.1.3 Monetary policy shock identifications. In Model 1 and Model 2 above, MP shock identifications are divided into two blocks.

The first block describes the goods market. Kalyvitis and Skotida (2010) assumed that real activity is not affected contemporaneously by price level, monetary aggregate (Model 1) or interest rate (Model 2) and RX. The reason is that although inflation and finance shocks could influence the real activity, an economy cannot adjust contemporaneously its outputs due to inertia and adjustment costs. The second block describes the finance market. Kalyvitis and Skotida (2010) assumed that the Central Bank sets up the MP, namely money aggregate (Model 1) or interest rate (Model 2) based on the ongoing macro-economic situation. As a forward-looking asset price, the RX is put in the final place in VAR ordering and is affected contemporaneously by other variables' shocks. In addition to these endogenous variables, Model 1 and Model 2 also take into account of the two more exogenous variables, including the world price of oil and Federal fund rate (Fedfund rate). Kim and Roubini (2000) argued that these exogenous factors should be included.

To sum up, both exogenous variables including oil price and Fedfund rate are placed prior to endogenous variables in Cholesky decomposition. Next orders are two endogenous variables describing the macro-domestic market: output and price level. Following this, other endogenous variables describing the monetary market such as money aggregate (Model 1) or interest rate (Model 2) are placed. The RX, which is put at last in VAR ordering, contemporaneously responds to all variables' shocks in the system.

3.2 Data

Each model comprises two exogenous and four endogenous variables. The variables' data are monthly data between M1:2008 and M5:2018 and are adjusted seasonally (except financial variables).

3.2.1 Oil price. In the paper, UK Brent oil price is proxy for the world price of oil and is derived from Federal Reserve Bank (FRB).

3.2.2 Foreign interest rate. The Federal fund rate that is extracted from FRB represents foreign MP shocks.

3.2.3 Real industrial output. Real industrial output is used as a variable in models for three reasons. First, as there are not monthly statistics on gross domestic product, the paper uses monthly industrial production data taken from Vietnam General Statistics Office (GSO) as an alternative variable. Second, it accounts for a significant proportion in total output and as such it represents total output in economic analysis. Finally, it has a close relationship with the RX.

3.2.4 Consumer price index. This is an indicator used to measure inflation in Vietnam. CPI data are extracted from GSO.

3.2.5 Monetary variables. In the paper, interest rate and broad money M2 are both used as MP variables, and these data are extracted from SBV and the International Monetary Fund (IMF). Regarding the interest rate, the paper uses the OMO interest rate rather than the base rate as a MP variable when evaluating the impact of the interest rate on the RX. The OMO interest rate is set up by SBV in open market operations when SBV trades securities with credit institutions. It fluctuates between the floor and ceiling interest rates and reflects monetary market movements, whereas the base rate is held almost constant and does not fluctuate in line with the monetary market.

3.2.6 Exchange rate. The SBV publishes daily the average interbank RX over the period of 2008–2015 and the central RX from 2016 onwards. Although they are the official RX, they are frequency fixed for a long period and does not really reflect economic movements. Therefore, instead of using the official RX, the paper uses the REER to evaluate impacts of the MP on the RX. The data to calculate REER are derived from IMF, GSO and SBV.

The formula to calculate REER is as follows:

$$REER_j = \prod_{i=1}^N \left(\frac{d_j e_{ij}}{d_i} \right)^{W_i}$$

where $N=7$ are Vietnam's trading partners including the United States, the Euro Union, China, Japan, Korea, Thailand and Singapore; d_j is the CPI of Vietnam; d_i is the CPI of each trading partner; e_{ij} is the RX between Vietnam and each trading partner; and W_j is the trade weight between Vietnam and each trading partner.

Therefore, $REER < 100$ means depreciation; $REER = 100$ means unchanged; and $REER > 100$ means appreciation.

4. Empirical estimations

4.1 Monetary policy shocks: money aggregate

4.1.1 Unit root test. The augmented Dickey–Fuller (ADF) unit root test is used to determine variable stationarity. ADF results show that only broad money M2 is stationary, whereas

other variables are non-stationary. The system then becomes non-stationary, the roots of system are greater than unit. After taking the natural logarithm of variables (except Fedfund rate), the roots of system now are less than unit, but still closer to unit. However, Sims *et al.* (1990) argued that VAR does not need to be stationary. It means that even if macro-variables are stationary or non-stationary, VAR could be still used to evaluate macro-economic interactions. As a consequence, it is possible to use the level of variables in VAR. In addition, Fujiwara (2003) stated that VAR should be investigated in level instead of taking the first difference. Although taking the first difference is one way to address non-stationarity, this method would throw away important information. Lutkepohl (2005) also confirmed that taking the first difference would eliminate the long-run relationships among variables, which is a great important issue to quantitative analysis. Based on these arguments, the paper takes natural logarithm and uses variable level (except Fedfund rate).

4.1.2 Lag length criteria. Based on criteria AIC, SC, HQ, lag length could be one or two. There are opposing views on how many lag length should be used. On one hand, the lag length is as small as possible because the number of observations is limited, increasing the lag length will make the degree of freedom decrease and then negatively influence the quality of the estimation. This explanation suggests choosing one lag length. On the other hand, Ivanov and Kilian (2005) stated that HQ is more suitable for quarterly data in a large sample size, SC is more suitable for quarterly data in a small sample size, and AIC is more suitable for monthly data. This argument is in favor of two lag lengths. Therefore, in order to decide which lag length is appropriate to the model, the paper runs and compares results between the model with one lag length and the model with two lag lengths. The empirical evidence in the paper shows that the model with one lag length gives more rational and reliable results. It is likely that the model includes broad money M2, which is the operating target of the existing MP as stipulated in the Law on the SBV. Therefore, impacts of broad money M2 on the economy might be quicker. This makes the lag length of system shorter. This is a reason why one lag length for the model would be the best choice.

4.1.3 Impulse responses. In the Cholesky triangle matrix, as the REER is behind the money aggregate, the change of the REER to money aggregate shocks occurs contemporaneously. As expected, the REER decreases immediately (i.e. depreciation) due to broad money M2 shocks, followed by a gradual increase (i.e. appreciation). The interval confidence lines mention that the impulse response of the REER to broad money M2 shocks is significant over 9 months. So if broad money M2 increases, the REER immediately falls out, and this is the peak of depreciation. After that, the REER increases gradually (Appendix 1).

To be more exact, the impulse response of the real effective exchange to money aggregate shocks is significant. In the first month following broad money M2 shocks, the impulse response of the REER is -0.48 percent, meaning that an increase of 1 percent in broad money M2 will cause the REER to decrease by 0.48 percent. Nine months following broad money M2 shocks, the impulse response of the REER is -0.20 percent. These empirical results show that the money aggregate shocks have a significant impact on the REER. They support Dornbusch's (1976) overshooting hypothesis, the RX changes immediately due to MP shocks, followed by the gradual return toward its original level.

Regarding impulse responses of the real industrial production and the inflation to money aggregate shocks, empirical results of the paper show that though the real industrial production does not respond to MP shocks, the inflation reacts to MP shocks significantly over a 24-month period, referring to Vietnamese research on the MP transmission, in which authors use broad money M2 as proxy for MP shocks. Based on the SVAR approach with quarterly data from 1996 to 2005 and using nine variables, Le and Pfau (2009) found that the MP transmission through the RX channel is considerable. Their results show that: first, money aggregate shocks little impact the REER; second, REER shocks have significant

effect on output; and third the relationship between money aggregate and inflation is less clear. Besides, based on the VAR method with quarterly date from 2000 to 2011 and using six variables, Bui and Tran (2015) showed that: first, tightening MP shocks cause output rising in short run, followed by decrease after two quarters, and second, they make price level declining after five quarters as well. Therefore, empirical results of the MP transmission are different as they depend on choosing variables, choosing time periods and choosing quantitative models. Compared to them, empirical results of the paper also are far different due to two reasons: First, the paper focuses on impacts of the broad money M2 shocks, so it includes the money aggregate M2 and excludes the interest rate in the model. Second, the paper focuses on impacts of broad money M2 shocks on the REER, in which the RX is the sole objective of the analysis.

4.1.4 Variance decompositions. The paper uses Cholesky variance over a 24-month period. According to Taylor (2000), it is essential to analyze variance decompositions to reinforce impacts of the MP on the REER, apart from impulse response results. If the impact of MP shocks on the REER is enormous, this implies a strong transmission from money aggregate fluctuations to the REER. However, if broad money M2 impacts negligibly on the variance of the REER, MP shocks are not an important factor to determine the change in the REER. Therefore, analyzing the variance decompositions of the REER is necessary.

The variance decomposition (Appendix 1) shows that among the factors affecting the REER, broad money M2 plays an important role to determine the variance of the REER. Meaning that Vietnam economy has a relatively significant transmission effect from the money aggregate shocks to the REER. Three months following broad money M2 shocks, nearly 10 percent of the REER variance is determined by the broad money M2. One year following broad money M2 shocks, nearly 12.4 percent of the REER variance is determined by the broad money M2. One year following MP shocks is the most significant transmission effect from the money aggregate shocks to the REER. In other words, it confirms the significant role of the MP to the RX.

4.2 Monetary policy shocks: interest rate

4.2.1 Exchange rate puzzle. In this model, two lag lengths gives more rational and reliable results as the model includes the OMO interest rate. This variable plays an increasingly important role in MP, but it still is not an operating target of the existing MP. Therefore, impacts of the OMO interest rate on the economy might be slower. This makes the lag length of system is longer. The paper uses two lag lengths to run impulse responses of the REER. However, empirical results are not expected (Appendix 2). When the OMO interest rate increases due to the tightening MP, the REER decreases (i.e. depreciation). In the literature, this phenomenon refers to the RX puzzle. Compared to other emerging countries, the RX puzzle also appears. Kohlscheen (2014) investigated impacts of the MP on the RX in three developing countries such as Brazil, Mexico and Chile. He finds that there is no empirical evidence to support for Dornbusch (1976) and UIP views that associate interest rate hikes with appreciations.

Regarding impulse responses of the real industrial production and the inflation to OMO interest rate shocks, empirical results of the paper show that though the inflation does not respond to MP shocks, the real industrial production reacts to MP shocks significantly over a 10-month period, from 2nd month to 11th month. Referring to Vietnamese research on the MP transmission, in which authors evaluate the interest rate channel, Le and Pfau (2009) found that the MP transmission through the interest rate channel is small. Their results show that: first, the real output little reacts to interest rate shocks; and second, the inflation increases slightly due to interest rate shocks, followed by decrease after first year. Besides, based on the SVAR method with monthly date from 1998 to 2016 and used four variables, Bach (2017) showed that: first, tightening MP shocks cause output decreasing; however, the impact is temporary and disappears after one year, and second, they make price level

increase slightly in first three months, followed by significant decrease in the next 14 months. Therefore, empirical results of the MP transmission are different. Compared to them, empirical results of the paper are also different due to two reasons: First, the paper focuses on impacts of the interest rate shocks, so it includes the interest rate and exclude the money aggregate M2 in the model. Second, the paper focus on impacts of interest rate shocks on the REER, in which the RX is the sole objective of the analysis.

4.2.2 Exchange rate puzzle explanations. There are several reasons why the impulse responses are puzzles. There are three approaches to address them: sign restrictions, (zero) long-run restrictions and (zero) non-recursive contemporaneous restrictions. The paper focuses on the former due to its advantages over the latter.

Kim and Roubini (2000) also argued that using a recursive model could lead to RX puzzles. Structural shocks are identified by VAR ordering. According to this ordering, in order to evaluate impulse responses of the RX to MP shocks, the latter has to be put ahead of the former. In other words, the interest rate could not react to RX shocks contemporaneously. This is not rational for two reasons. First, small open economies might increase the interest rate very quickly to respond to the RX shocks if these economies are concerned about inflationary pressures due to the depreciation. Secondly, Sims (1992) and Roubini and Grilli (1996) implied that the RX increase in the context of the interest rate increase may be explained as tightening MP is set up when the depreciation is observed. Thus, it is not useful to identify structural shocks that do not allow simultaneous effects between the interest rate and the RX. Bjornland and Halvorsen (2014) also mentioned that when identifying the contemporaneously structural shocks between the RX and the interest rate, studies on traditional VAR usually use recursive restrictions. However, this assumption is not always true. As it prevents the monetary authorities from combining all current information when setting up the interest rate, this is a reason why RX puzzles could appear in the recursive VAR model.

RX puzzles might be less apparent or disappear when identifying structural VAR by (zero) long-run restrictions or (zero) non-recursive contemporaneous restrictions as these methods allow contemporaneous relationships between the MP and the RX (Bjornland 2009, Kim and Roubini, 2000). An alternative method to solve puzzles is sign restrictions (Faust, 1998, Canova and De Nicolo, 2002; Uhlig, 2005; Peersman, 2005). Fisher and Huh (2016) stated that although sign restrictions have a major limitation about multiple shocks that Fry and Pagan (2011) pointed out, they are still more popular than recursive and non-recursive models. The reason is that they avoid strong assumptions in recursive or non-recursive approaches, which require the identification of structural shocks. In addition, at that time there are some approaches to eliminate the limitation of sign restrictions. Due to these above-mentioned arguments, the paper uses sign restrictions in order to address RX puzzle.

4.2.3 Exchange rate puzzle resolution: sign restrictions. Based on arguments of Fisher and Huh (2016), the signs of structural shocks for aggregate supply (AS), aggregate demand (AD), monetary policy (MP) and exchange rate (RX) could be restricted as follows (Table I).

The sign restrictions for AS, AD and MP are standard in studies, for instance, Farrant and Peersman (2006), Finlay and Jaaskela (2014), Jaaskela and Jennings. The lag length for this system is two lags, based on AIC criteria. All shocks, excepting for MP shocks to the

| Shocks/ Variables | Industrial production | Consumer price index | OMO interest rate | Real effective exchange rate |
|----------------------|--------------------------|-------------------------|----------------------|---------------------------------|
| AS | + | – | – | – |
| AD | + | + | + | + |
| MP | – | – | + | ? |
| RX | – | – | – | + |

Table I.
Sign restrictions

RX, are imposed signs. Therefore, sign restrictions remove the problem of multiple shocks and reveal unique structural shocks for the model.

In order to identify the impulse response of the REER to OMO interest rate shocks, the paper does not put any restrictions on the sign of the REER to MP shocks. The paper then would know whether sign restrictions on other macro-economic variables are sufficient to address RX puzzle and give appropriate impulse response of the REER to MP shocks.

In order to identify and distinguish the MP shock from other macro-economic variable shocks, it is essential to restrict signs on other variables to it. For instance, the domestic currency does not depreciate to respond to the REER shocks; therefore, the paper imposes the sign restriction that the OMO interest rate could not rise. The paper then restricts the direction of MP response (i.e. OMO interest rate response) to REER shocks. This separates and distinguishes the MP shocks from the REER shocks.

Impacts of the OMO interest rate to the REER now satisfy the expectation (Appendix 2). When the OMO interest rate increases due to the tightening MP, the REER increases (i.e. appreciation). Specifically, as a result of MP shocks, the impulse response of the REER is 0.19 percent, meaning that an increase of 1 percent in OMO interest rate will cause the REER to increase by 0.19 percent. This is also the peak of appreciation, after that, the REER gradually decreases (i.e. depreciation). This result supports Dornbusch's (1976) overshooting hypothesis, the RX changes immediately after MP shocks, followed by the return toward its original level. In other words, the RX puzzle that appear in above-said recursive restrictions could disappear in case of using sign restrictions.

Regarding variance decompositions, the results show that among the factors affecting the REER, the OMO interest rate plays an important role to determine the variance of the REER (Appendix 2). This means Vietnam economy has a relatively significant transmission effect from the OMO interest rate to the REER. In first month following MP shocks, 9.68 percent of the REER variance is determined by the OMO interest rate. Six months following MP shocks, 10.26 percent of the REER variance is determined by the OMO interest rate. After that time, 10.25 percent of the REER variance is determined by the OMO interest rate. This transmission effect remains for consecutive times. In general, it confirms the significant role of the MP to the RX.

To sum up, using the sign restriction approach could eliminate the RX puzzle in impulse response of the REER to OMO interest rate shocks. The system is consistent with Dornbusch's (1976) overshooting hypothesis. Besides, the paper also gets variance decomposition of the REER, showing that the OMO interest rate plays an important role in order to determine the REER fluctuation.

5. Robustness of results

Regarding the Model 1 that considers the monetary aggregate M2 as proxy for the MP, the paper now changes variables in this model. Instead of using the broad money M2 and the REER, the paper uses the narrow money M1 and the nominal effective RX to check robustness. One lag for (zero) recursive contemporaneous restrictions is used to evaluate the impulse response of the nominal effective RX to narrow money M1 shocks in the robustness model. According to results of impulse response of the nominal effective RX to narrow money M1 shocks, the paper shows the "delayed overshooting" RX. It means that following narrow money M1 shocks, the nominal effective RX decreases (i.e. depreciation); however, it takes some months in order to reach the peak, followed by the increase in the nominal effective RX (i.e. appreciation).

In this impulse response, the interval confidence mentions that results are significant over the period of the 3rd month to the 8th month. Three months following narrow money M1 shocks, the impulse response of the nominal effective RX is -0.43 percent, meaning that an increase of 1 percent in the narrow money M1 will cause the nominal effective RX to

decrease by 0.43 percent. Eight months following narrow money M1 shocks, the impulse response of the nominal effective RX is -0.49 percent. The results from variance decomposition of the nominal effective RX also show that the narrow money M1 is the main factor to determine variance of the nominal effective RX; however, its absolute value is less than that of the baseline model.

Regarding Model 2 that considers the OMO interest rate as proxy for the MP, the paper now changes variables in this model. Instead of using the OMO interest rate and the REER, the paper uses the base interest rate and the nominal effective RX to check robustness. In this model, two lags are used to estimate the impulse response of the nominal effective RX to base interest rate shocks. By using (zero) recursive contemporaneous restrictions, RX puzzles also appears in the impulse response of the nominal effective RX to base interest rate shocks. When the base interest rate increases due to the tightening MP, the nominal effective RX decreases (i.e. depreciation).

Because of the “RX puzzle” appearance, the paper also uses sign restrictions for the model. Two lag lengths are used and signs restrictions are similar to the baseline model. Using the sign restriction approach, the RX puzzle still appears. This is not consistent with Dornbusch’s (1976) overshooting hypothesis. Although the paper uses the sign restriction approach to resolve RX puzzle, it fails to address this puzzle. Empirical results of the paper still appear RX puzzle. This might be explained by the base interest rate property. As the paper mentions in the previous part, the base interest rate seems a reference interest rate for credit institutions to set up their interest rates. However, it is almost hold constant and does not move in line with the monetary market. This means that it does not normally react to the monetary market, in particular, and the economy, in general. This might be reason why although the paper uses different methods to estimate impulse responses of the nominal effective RX to base interest rate shocks, it cannot address the RX puzzle.

6. Policy implications

Regarding to the MP, Vietnam’s MP is multi-target framework based on quantitative control (M2). This is a reason why broad money shocks significantly affect the RX as showed in paper’s results. However, volume control policy is consistent with the early stages of Vietnam economy transformation. This now appears limitations in the new context where Vietnam deeply and widely integrates into the world. Therefore, Law on the SBV represents significant change in the MP, thus gradually transforming the MP from quantitative control (M2) to qualitative control (interest rate). Nevertheless, what interest rate could be chosen as a new anchor for MP is key matter. From paper’s results, it is likely that the OMO interest rate would be more efficient than the base interest rate. The OMO interest rate has a significant impact on the RX; it then influences whole economy through the RX transmission mechanism. Consequently, this interest rate would monitor and orient macroeconomics.

Moving onto the RX, paper’s results related to impulse responses and decompositions of the RX indicate that this factor is significantly affected by MP shocks. Therefore, the management of the MP needs be careful and takes into account of the RX effects. As the RX is a sensitive element, if it has to absorb negative shocks, it thus might influence economy negatively. Additionally, when the MP absolutely swifts to qualitative control (interest rate), the RX should to be more flexible under capital transaction liberation (impossible trinity). Since 2008, the RX mechanism is gradually flexible. The central RX may fluctuate in two directions (upward or downward) instead of going in only one direction as before, and this reflects market movements as well. However, in order to guarantee the stability of the flexible RX, it is essential to enhance the development of the derivatives market, hedge the RX risks for credit institutions and enterprises, and increase liquidity for financial market.

7. Conclusion

The study evaluates empirically impacts of MP shocks on the RX in Vietnam over the period 2008–2018. The research focuses on three matters: whether or not effects of MP shocks on the RX in Vietnam are consistent with Dornbusch theory; how significant the impulse response of the RX to MP shocks is; and how do MP shocks contribute to fluctuations in the RX. To investigate these issues, the paper uses Vector Autoregression to build up two specific models. The (zero) recursive contemporaneous restrictions are applied in the first model to quantify effects of the broad money M2 on the REER. The (zero) recursive contemporaneous restrictions and sign restrictions are applied in the second model to quantify effects of the OMO interest rate on the REER.

The empirical evidence of the paper suggests that in the first model, the REER decreases (i.e. depreciation) as a result of increase in the broad money M2, and then followed by its gradual increase (i.e. appreciation). The result is in line with Dornbusch's (1976) overshooting hypothesis. In addition, the variance analysis suggests that broad money M2 plays an important role in fluctuations of the REER. Therefore, based on impulse response and variance decomposition findings, it can be seen that money aggregate shocks have a significant impact on the REER.

In the second model, results regarding the impulse response of the REER to OMO interest rate shocks reveal RX puzzles in case of using recursive restrictions. However, empirical evidence from the sign restriction approach reveals the disappearance of RX puzzle. Specifically, when the OMO interest rate increases due to the tightening MP, the REER increases (i.e. appreciation), followed by its decrease (i.e. depreciation). This result is also consistent with Dornbusch's (1976) overshooting hypothesis. Moreover, based on results regarding variance decompositions, it can be realized that the OMO interest rate greatly contributes to fluctuations in the REER. This shows a relatively significant transmission effect from OMO interest rate shocks to the REER.

7.1 Future work

The paper focuses only on sign restrictions to address RX puzzles. In the next paper, the author will focus on two other methods including (zero) long-run restrictions and (zero) non-recursive contemporaneous restrictions to deal with these puzzles. In addition, in the next study, the author will compare three methods to resolve RX puzzles to have better assessments on impacts of the MP on the RX in Vietnam.

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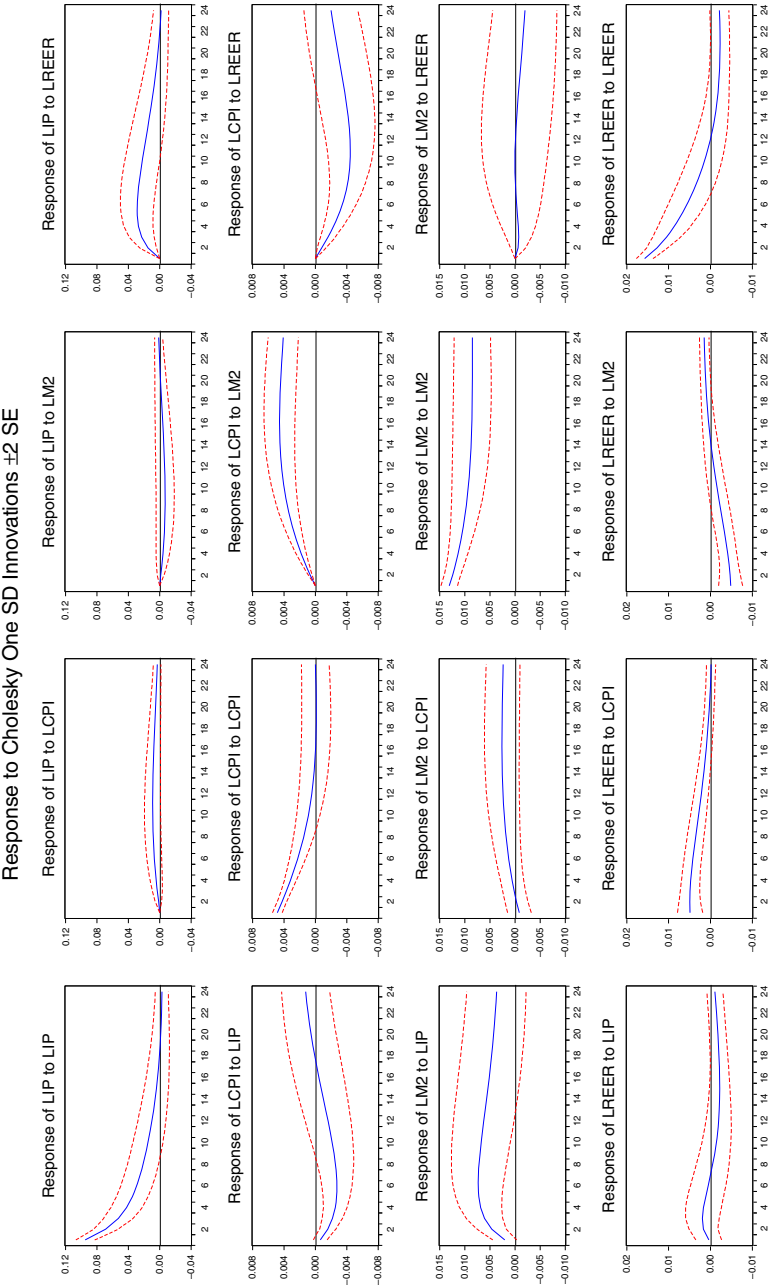


Figure A1.
Impulse responses
of Model 1

Table AI.
Variance
decomposition
of LREER

| Period | SE | LIP | LCPI | LM2 | LREER |
|--------|----------|----------|----------|----------|----------|
| 1 | 0.094721 | 0.055247 | 8.029386 | 7.936050 | 83.97932 |
| 2 | 0.117946 | 0.588092 | 9.488301 | 8.979088 | 80.94452 |
| 3 | 0.131196 | 1.011338 | 10.82753 | 9.840038 | 78.32109 |
| 4 | 0.140504 | 1.215496 | 12.06381 | 10.55146 | 76.16924 |
| 5 | 0.147722 | 1.250355 | 13.20209 | 11.13234 | 74.41521 |
| 6 | 0.153559 | 1.202257 | 14.23864 | 11.59370 | 72.96540 |
| 7 | 0.158342 | 1.149009 | 15.16516 | 11.94344 | 71.74239 |
| 8 | 0.162257 | 1.146633 | 15.97236 | 12.18961 | 70.69140 |
| 9 | 0.165436 | 1.227960 | 16.65275 | 12.34213 | 69.77716 |
| 10 | 0.167984 | 1.405394 | 17.20263 | 12.41353 | 68.97844 |
| 11 | 0.169996 | 1.675117 | 17.62328 | 12.41875 | 68.28285 |
| 12 | 0.171557 | 2.021733 | 17.92121 | 12.37434 | 67.68271 |
| 13 | 0.172743 | 2.422898 | 18.10770 | 12.29735 | 67.17205 |
| 14 | 0.173627 | 2.853509 | 18.19765 | 12.20407 | 66.74478 |
| 15 | 0.174269 | 3.289156 | 18.20811 | 12.10893 | 66.39380 |
| 16 | 0.174726 | 3.708600 | 18.15680 | 12.02378 | 66.11082 |
| 17 | 0.175042 | 4.095244 | 18.06071 | 11.95745 | 65.88659 |
| 18 | 0.175258 | 4.437680 | 17.93516 | 11.91575 | 65.71141 |
| 19 | 0.175404 | 4.729519 | 17.79311 | 11.90171 | 65.57566 |
| 20 | 0.175505 | 4.968755 | 17.64495 | 11.91600 | 65.47029 |
| 21 | 0.175581 | 5.156879 | 17.49851 | 11.95746 | 65.38715 |
| 22 | 0.175645 | 5.297926 | 17.35928 | 12.02357 | 65.31923 |
| 23 | 0.175706 | 5.397579 | 17.23074 | 12.11097 | 65.26071 |
| 24 | 0.175771 | 5.462397 | 17.11477 | 12.21582 | 65.20701 |

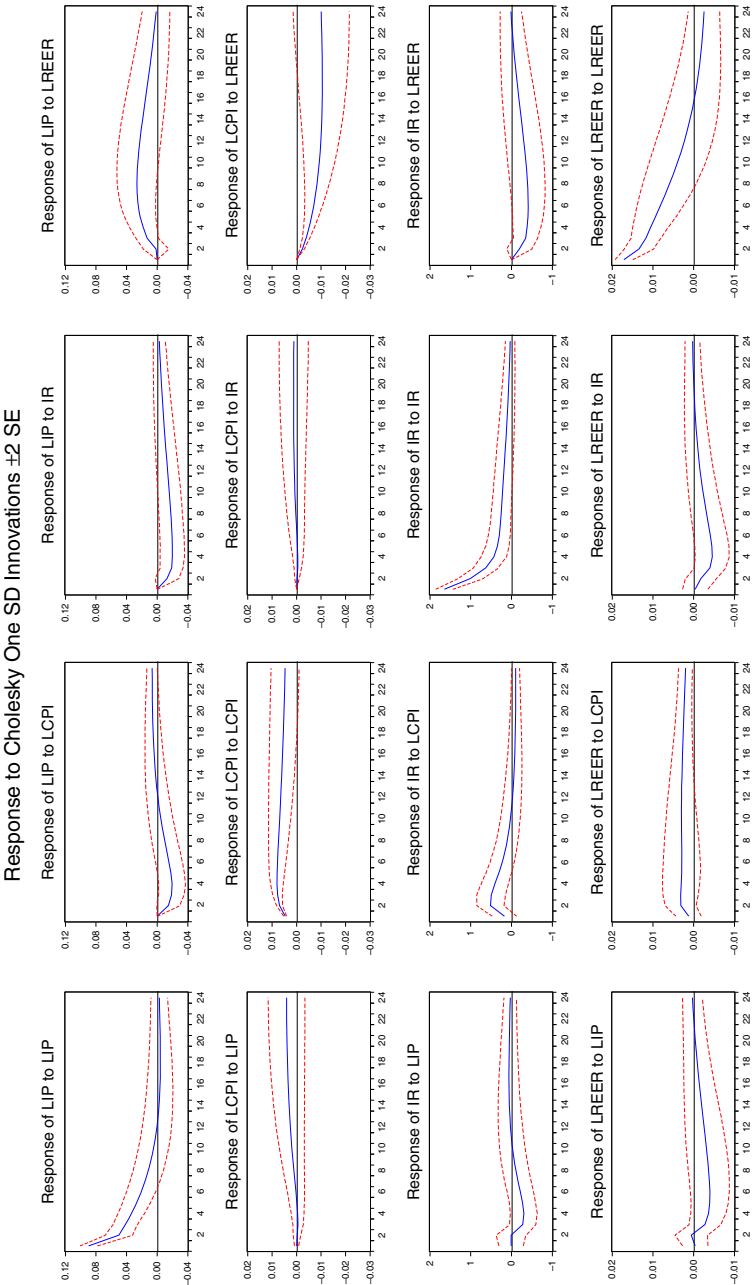


Figure A2.
Impulse responses of
Model 2 (recursive
approach)

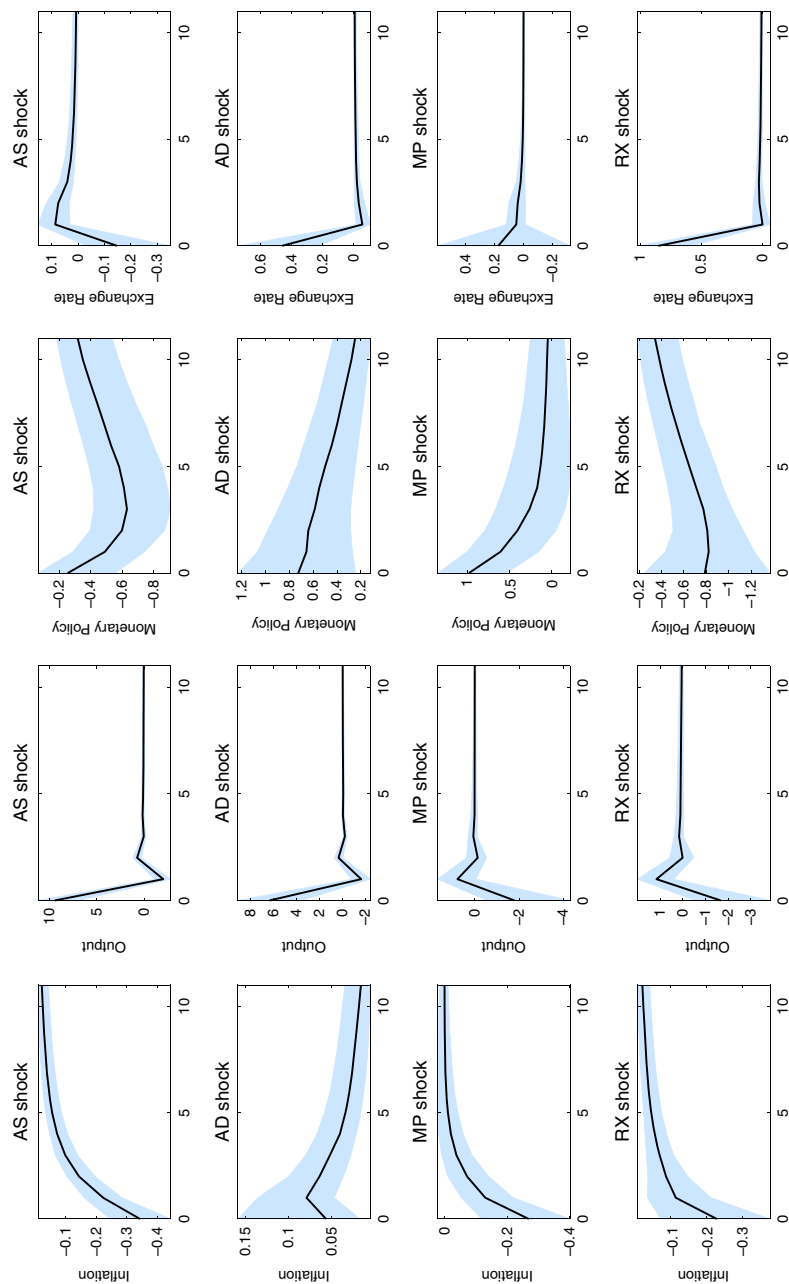


Figure A3.
Impulse responses
of Model 2 (sign
restriction approach)

| | | | | | Impacts of the monetary policy |
|-------|----------|----------|----------|----------|--|
| Month | AS shock | AD shock | MP shock | RX shock | |
| 1 | 0.0176 | 0.1730 | 0.0968 | 0.5869 | <div>237</div> <div> Table AII. Variance decomposition of REER (sign restriction approach) </div> |
| 2 | 0.0285 | 0.1754 | 0.1005 | 0.5703 | |
| 3 | 0.0345 | 0.1745 | 0.1024 | 0.5635 | |
| 4 | 0.0368 | 0.1738 | 0.1022 | 0.5624 | |
| 5 | 0.0387 | 0.1734 | 0.1026 | 0.5623 | |
| 6 | 0.0396 | 0.1737 | 0.1026 | 0.5623 | |
| 7 | 0.0407 | 0.1742 | 0.1025 | 0.5623 | |
| 8 | 0.0413 | 0.1742 | 0.1025 | 0.5622 | |
| 9 | 0.0415 | 0.1742 | 0.1025 | 0.5620 | |
| 10 | 0.0416 | 0.1742 | 0.1025 | 0.5619 | |
| 11 | 0.0419 | 0.1742 | 0.1025 | 0.5618 | |
| 12 | 0.0420 | 0.1742 | 0.1025 | 0.5617 | |
| 13 | 0.0421 | 0.1742 | 0.1025 | 0.5617 | |
| 14 | 0.0421 | 0.1742 | 0.1025 | 0.5616 | |

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