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THE ASYMMETRIC EFFECTS OF EXCHANGE RATE VOLATILITY ON INTERNATIONAL TRADE IN A TRANSITION ECONOMY: THE CASE OF VIETNAM

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ABSTRACT

This study examines the asymmetric effects of Exchange Rate Volatility (*ERV*) on Vietnam's international trade. Using time-series data fitted to the Nonlinear Autoregressive Distributed Lag (NARDL) model, we find that positive changes in *ERV* have a negative impact on the trade balance in the short-run. On the other hand, increases in *ERV* have a positive impact on the trade balance in the long-run. We also find that negative changes in *ERV* do not have any significant effect on the trade balance.

Keywords: Exchange rate volatility; Trade flows; NARDL; Vietnam.
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I. INTRODUCTION

The relationship between Exchange Rate Volatility (*ERV*) and the Trade Balance (*TB*) has been the subject of debate in international economics for several decades. *ERV* can be seen as the exchange rate risk and may have effects on the volume of foreign trade. Theoretically, Hooper and Kohlhagen (1978) argue that higher *ERV* results in higher prices for traders who are unwilling to take risks, and it also reduces international trade. This argument is based on the fact that the *ERV* generates uncertainty about future profits, and thus, decreases the benefits of foreign trade. However, several studies conclude that *ERV* can lead to a positive influence on international trade (see, for instance, Bredin *et al*., 2003; Cheong *et al*., 2005; Rey, 2006). These studies argue that if exporters are highly risk averse, an increase in *ERV* will lead to an increase in the expected marginal profit, thus accelerating exports. These studies assume that *ERV* has symmetric effects on *TB*, implying that a decrease in *ERV* has the same effects on trade as an increase in the volatility with the same size. However, international traders could be risk-averse or risk-takers. Therefore, they react to negative shocks derived from *ERV* in a different way compared to positive shocks, thus resulting in asymmetric effects between *ERV* and *TB* (Dada, 2021). Although the symmetric effects of *ERV* on *TB* has been investigated in many studies, very little is known about the asymmetric effect of *ERV* on *TB* (Chien *et al*. 2020). Moreover, few studies have investigated this issue for Vietnam, which presents characteristics of a transition economy consisting of high institutional uncertainties and a rapidly changing market information profile (see, for example, Vo and Le, 2017; Vo *et al*. 2021).

To fill this research gap, this study investigates the *ERV-TV* relation by using monthly data over the period January 2010 to December 2019 and a nonlinear regression model, namely the Nonlinear Autoregressive Distributed Lag (NARDL) model, is employed. We hypothesize that *ERV* negatively influences Vietnam's *TB* due to higher costs for risk-averse traders.

This study contributes to the literature as follows. First, while most studies in this field explore the symmetric impact of *ERV* on *TB*, our analysis focusses on the asymmetric effects of *ERV* on *TB*. Second, Vietnam is a nice case to test our hypothesis because Vietnam's economy has been in a transitional period with a growing integration with the world economy. We empirically test our hypothesis using time-series data and find that a positive change in *ERV* in the short-run has a significantly negative impact on *TB*. However, over a longer horizon, *ERV* has a significantly positive effect on Vietnam's *TB*. Moreover, the Error Correction Model (ECM) indicates that 92.38% of disequilibria in the short-run converges to the long-run equilibrium within one month. The key implication derived from this finding is that government intervention with respect to exchange rate in transitional economies is needed by pursuing a stable exchange rate policy to sustainably improve the *TB*.

The paper proceeds as follows. The related literature is reviewed in Section II. Section III describes the data employed in the study and discusses the research methodology. Section IV discusses the empirical results. Finally, conclusions are presented in Section V.

II. LITERATURE REVIEW

The impact of *ERV* on international trade has been widely studied and documented in the literature. However, findings from these studies have not reached a consensus. Some studies report negative effects of *ERV* on international trade while others find positive influences of *ERV* on international trade. The empirical studies that belong to the first category comprise Arize *et al*. (2000), Mustafa and Nishat (2004), Rey (2006), Arize *et al*. (2008), Latief and Lefen (2018), Arora and Rakhyani (2020), Dada (2021). Specifically, Arize *et al*. (2000) find that *ERV* has negative effects on export volumes. In addition, Mustafa and Nishat (2004) reveal that the *ERV* has significant and negative effects on trade volumes in the case of Pakistan and her major trading partner countries. Moreover, Rey (2006) finds that *ERV* has negative effects on exports of Algeria, Egypt, Tunisia, and Turkey. Moreover, Arize *et al*. (2008) assert that *ERV* has significantly negative effects on export volumes for eight Latin American countries. Latief and Lefen (2018) investigate the effects of *ERV* on foreign trade in developing countries along "One Belt and One Road" (Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka) using data over the period 1995 to 2016. They also find that *ERV* has a significantly negative effect on foreign trade. Recently, Dada (2021) shows that both positive and negative shocks of *ERV* have significantly negative effects on foreign trade for 17 sub-Saharan African countries.

Some empirical studies have employed the ARDL bound test to measure the impact of *ERV* on *TB*. Sekantsi (2011) reports that *ERV* has a significantly negative effect on South Africa's exports to the U.S. In addition, Srinivasan and Kalaivani (2013) confirm that *ERV* has significantly negative impact on India's real exports, meaning that the higher exchange rate volatility is, the more India's real export volume decreases. Besides, Asteriou *et al*. (2016) examine the long-term and short-term effects of *ERV* on foreign trade for Mexico, Indonesia, Nigeria, and Turkey. They find significant effects of *ERV* on foreign trade for Turkey, Indonesia and Mexico. Moreover, Senadza and Diaba (2017) report that *ERV* has a significantly negative effect on exports in the short-term, but it has a significantly positive effect on exports in the long-term for eleven sub-Saharan African countries.

Contrary to the first category of studies, others claim that *ERV* has positive effects on *TB*. McKenzie and Brooks (1997) find a positive effect of *ERV* on the Germany-United States bilateral *TB*. In addition, Bredin *et al*. (2003) show that *ERV* does not have any significant effects on Irish exports in the short-term, but it has a significant positive effect in the long-term. By focusing on the UK manufacturing industry, Cheong *et al*. (2005) examine the dynamic interrelationship between trade volume, price competitiveness and *ERV*. They document that *ERV* has a positive effect on exports, and thus, influences the country's economic performance. Besides, Rey (2006) finds positive effects of *ERV* on exports for Israel and Morocco.

In sum, most of the empirical studies have investigated the effects of *ERV* on *TB* in emerging or advanced economies. Current literature has a specific gap regarding the effects of *ERV* on *TB* for the transition economy of Vietnam. In addition, most of the studies in this field are based on the assumption that *ERV* has symmetric effects on *TB*. However, this effect on *TB* could be asymmetric, meaning that a decrease in *ERV* has different effects on *TB* compared to an increase in the volatility with the same magnitude. We add to this literature by adopting the NARDL model to determine the asymmetric effects of *ERV* on Vietnam's *TB*.

III. DATA AND METHODOLOGY

A. Data

The dataset employed is primarily the monthly exchange rate, export and import volumes, and Industrial Production Index (IPI) series. To avoid the effects of 2008-2009 financial crisis and the COVID-19 pandemic (2020), the sample period of this study is from January 2010 to December 2019. The data were collected from the Vietnam General Statistics Office (export and import volumes), the World Bank (IPI) and the International Monetary Fund (nominal exchange rate and consumer price index). We compute the real exchange rate of USD/VND as follows:

$$RER = NER * (CPI^{VN}/CPI^{US})$$

where *NER* represents nominal exchange rate of USD/VND and CPI^{VN} and CPI^{US} denotes Vietnam and the United States consumer price indices, respectively.

B. Methodology

Theoretically, Hooper and Kohlhagen (1978) claim that the *ERV* leads to uncertainty about future profits, and thus decreases the benefits of foreign trade. Therefore, higher volatility in the exchange rate results in lower profits for risk-averse traders and less foreign trade. Empirically, several empirical studies confirmed that *ERV* has negative effects on foreign trade (Latief and Lefen, 2018; Arora and Rakhyani, 2020; Dada, 2021). As a result, it is hypothesized that *ERV* has significantly negative effects on Vietnam's *TB*. Regarding the response of *TB* to the exchange rate, some studies have argued that the devaluation of the currency worsens *TB* in the short-run but improves it in the long-run—an outcome commonly known as the J-curve effect (Magee, 1973; Lal and Lowinger, 2002). Therefore, another hypothesis is that the J-curve effect is present in Vietnam. In addition, several studies reported that industrial production growth has a significant impact on foreign trade (Chow, 1987; Fung *et al*., 1994; Arora and Rakhyani, 2020). Based on the findings of previous studies, it is expected that industrial production growth will have a positive effect on international trade. Therefore, we propose the following regression model to examine the effects of *ERV* on *TB* in the case of Vietnam:

$$TB_t = \beta_0 + \beta_1 EVR_t + B_2 LnRER_t + \beta_3 IPI_t + \mu_t \quad (1)$$

where *TB* represents Vietnam's trade balance, which is proxied by the exports to imports ratio; *LnRER* denotes the natural logarithm of the real exchage rate of USD/VND; *IPI* denotes Vietnam's industrial production index; and *EVR* denotes the exchange rate volatility, which we extract from the following GARCH (1,1) specification:

$$LnRER_t = \alpha_0 + \alpha_1 LnRER_{t-1} + \varepsilon_t \approx N(0, h_t) \quad (2)$$

$$h_t = \omega + \delta h_{t-1} + \gamma \varepsilon_{t-1}^2 \quad (3)$$

To test for the asymmetric effects of *ERV* on *TB* of Vietnam in the long-term and short-term, the NARDL bounds testing approach which was proposed by Shin *et al*. (2014) as an extended model of ARDL of Pesaran *et al*. (2001), is employed in this study. In this model, *ERV* is decomposed in positive and negative partial sum series. Motivated by Narayan and Popp (2010, 2013), we evaluate the unit root (UR) property using the structural break test developed by the Zivot and Andrews (1992).

NARDL bound test for cointegration

The bounds test is conducted by the following equation:

$$\begin{aligned}\Delta TB_t &= \beta_0 + \sum_{i=1}^{q_1}\beta_{1i}\Delta TB_{t-i} + \sum_{i=0}^{q_2}\beta_{2i}\Delta ERV_{t-i}^{+} + \sum_{i=0}^{q_3}\beta_{3i}\Delta ERV_{t-i}^{-} + \sum_{i=0}^{q_4}\beta_{4i}\Delta LnRER_{t-i} \\ &+ \sum_{i=0}^{q_5}\beta_{5i}\Delta IPI_{t-i} + \lambda_1 TB_{t-1} + \lambda_2 ERV_{t-1}^{+} + \lambda_3 ERV_{t-1}^{-} + \lambda_4 LnRER_{t-1} + \lambda_5 IPI_{t-1} \\ &+ \varepsilon_t \end{aligned} \quad (4)$$

where Δ represents the first difference of the variables and ERV^{+} and ERV^{-} represent the positive and negative change in *ERV*, respectively.

The null hypothesis (H_0) of the bound test is $\lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = 0$ (no co-integration in the long-run between variables). If the value of the *F*-statistic computed from the bounds test is larger than critical value at a certain level of significance (e.g 5%), the null hypothesis is rejected. This means that variables are cointegrated. If the long-term equilibrium relationship between *TB* and other regressors exists, then the short- and long-run asymmetric relations can be estimated using the following Equations (5) and (6), respectively:

$$\begin{aligned}\Delta TB_t &= \beta_0 + \sum_{i=1}^{q_1}\beta_{1i}\Delta TB_{t-i} + \sum_{i=0}^{q_2}\beta_{2i}\Delta ERV_{t-i}^{+} + \sum_{i=0}^{q_3}\beta_{3i}\Delta ERV_{t-i}^{-} + \sum_{i=0}^{q_4}\beta_{4i}\Delta LnRER_{t-i} \\ &+ \sum_{i=0}^{q_5}\beta_{5i}\Delta IPI_{t-i} + \delta ECM_{t-1} + \varepsilon_t \end{aligned} \quad (5)$$

$$\begin{aligned}TB_t &= \beta_0 + \sum_{i=1}^{q_1}\beta_{1i}TB_{t-i} + \sum_{i=0}^{q_2}\beta_{2i}ERV_{t-i}^{+} + \sum_{i=0}^{q_3}\beta_{3i}ERV_{t-i}^{-} + \sum_{i=0}^{q_4}\beta_{4i}LnRER_{t-i} \\ &+ \sum_{i=0}^{q_5}\beta_{5i}IPI_{t-i} + \varepsilon_t \end{aligned} \quad (6)$$

IV. EMPIRICAL RESULTS

A. Trade Balance of Vietnam and Real Exchange Rate for the Period January 2010 - December 2019

Table 1 provides descriptive statistics of Vietnam's *TB*, *RER* and *ERV* over the period January 2010 to December 2019. It is shown that the average of *TB* is 0.985 indicating that the trade balance of Vietnam is in a deficit over the period of 2010-2019 (see Figure 1). In addition, Table 1 indicates that *TB* fluctuated highly over the sample period, ranging from 0.727 to 1.188, with the standard deviation of 0.082. Moreover, Figure 2 shows that the real exchange rate increased continuously over the sample period. It means that the Vietnamese Dong depreciated against the USD. Furthermore, Table 2 reveals that *ERV* measured by conditional variances ranges from 0.000002 to 0.000051 with a mean of 0.000008.

Table 1.
Descriptive Statistics

This table summarizes descriptive statistics of *TB*, Real Exchange Rate (*RER*) and *ERV* of Vietnam for the period from January 2010 to December 2019.

Variables	Observations	Mean	Minimum	Maximum	Standard Deviation
TB	120	0.985	0.727	1.188	0.082
RER	120	27,523	17,322	33,183	3,920
ERV	119	0.000008	0.000002	0.000051	0.000012

Figure 1.
Plot of *TB*

This figure plots the changes in Vietnam's *TB* during the period January 2010 – December 2019.

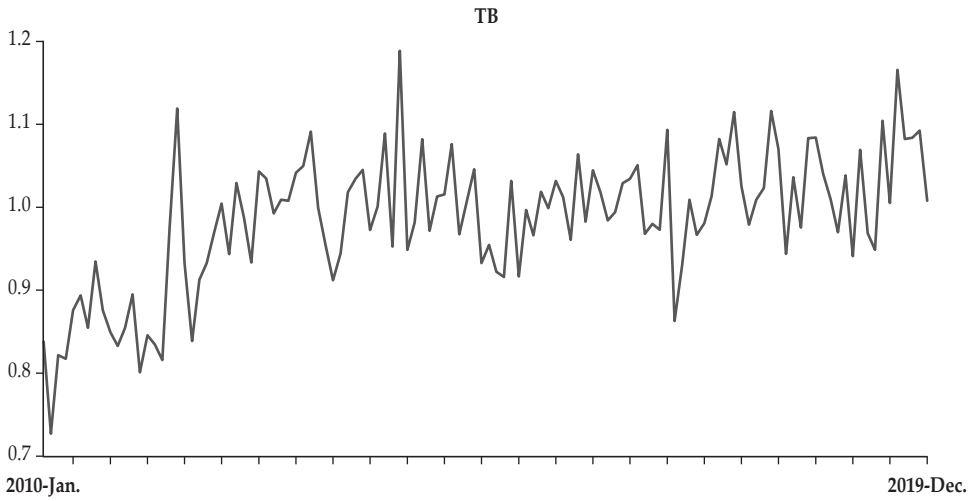
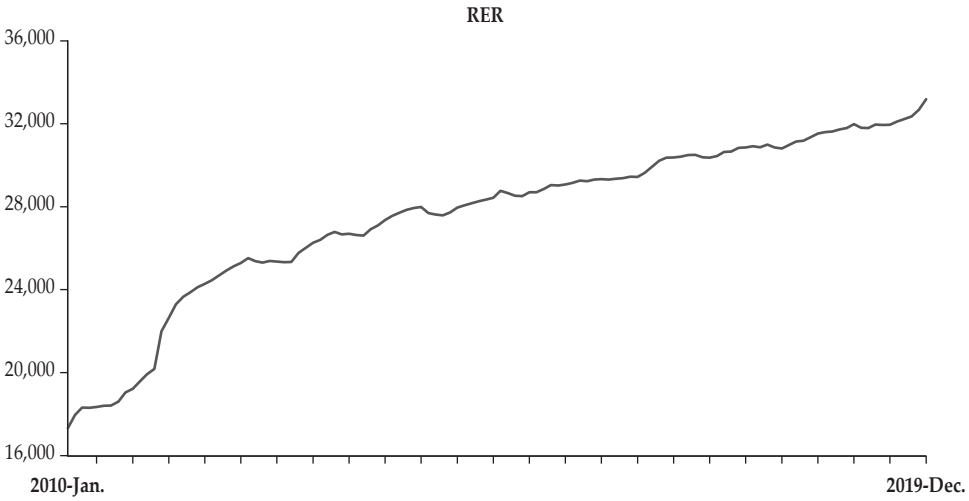


Figure 2.
Real Exchange Rate (USD/VND)

This figure plots the changes of real exchange rate between USD and VND over the period January 2010 to December 2019.



B. The Estimation of ERV

As presented in Section III, we generate *ERV* by using the GARCH(1,1) approach. The results obtained using GARCH(1,1) model are presented in Table 2. Overall, our results confirm that the coefficients of ARCH (γ) and GARCH (δ) are statistically significant and they sum to the value of less than one. Thus, this implies that our model follows stationary process.

Table 2.
Results based on the GARCH (1,1) Model

This table reports results of GARCH(1,1) model. The conditional variance derived from this model is used as a proxy for *ERV* in this study. Lastly, *** represents significance at 1% level.

Variables	**Coefficients**	***t*-statistics**
	Conditional Mean Equation	
Constant	0.1227	127.1100***
$LnRER_{t-1}$	0.9728	3,743.8400***
Observations	120	
	Conditional Variance Equation	
ω	0.0000	0.0900
γ	-0.0427	-42.7900***
δ	1.0416	5,233.9000***

C. Results of the Unit Root Test

The findings of the UR test suggest that LnRER series is integrated of order 1 I(1). In addition, results of the Zivot and Andrews test reveal that *TB, ERV*$^{+}$, *ERV*$^{-}$ and IPI variables are integrated to the order zero [I(0)]. With this evidence, it is concluded that all variables in the model fulfil the requirements of the NARDL bound test.

Table 3.
Results of Zivot and Andrews (ZA) Test

This table presents results of the ZA test for all variables used in the model. The null hypothesis is that a time series is non-stationary. Finally, ***, ** represent significance at the 1% and 5% levels, respectively. The numbers in Column 2 indicate the lag section.

Variables	Lag Length (*k*)	*t*-statistics
TB (level)	4	-4.57**
ERV^+ (level)	4	-7.77***
ERV^- (level)	3	-8,70***
LnRER		
Level	2	-2.77
First difference	3	-5.81***
IPI (level)	0	-5.71***

D. ARDL Bounds Test for Cointegration

We use the bounds testing approach to search for cointegration (see Pesaran *et al*. 2001; and Narayan, 2005). Using Akaike Information Criterion to detect optimal lags, the best model used for the study is ARDL (1,4,0,0,4). The results suggest a long-run relationship between *TB* and the regressors. Therefore, the NARDL model can be employed.

Table 4.
Bounds Test Outcome

This table reports results of the bounds test. The critical values of bounds test are obtained from Pesaran *et al.* (2001), k devotes the number of regressors, and *** indicates statistical significance at the 1% level.

Model	*k*	*F*-statistic	Significance Level	Critical Value	
				Lower Bounds I(0)	Upper Bounds I(1)
ARDL (1,4,0,0,4)	4	19.66***	10%	2.45	3.52
			5%	2.86	4.01
			1%	3.74	5.06

E. Asymmetric Effects of ERV on TB

The asymmetric effects of *ERV* and control variables on *TB* are estimated using an ARDL (1,4,0,0,4) model. The short-term results derived from the model reveal that positive changes of *ERV* have significantly negative effects on *TB* for the 3-month lag at the five percent level significance. The implication of this evidence is that an increase in *ERV* contributes to a decrease in Vietnam's *TB*, consistent with the theoretical model proposed by Hooper and Kohlhagen (1978) that *ERV* is inversely related to trade volumes due to the higher costs for risk-averse traders which is in line with previous empirical findings of Arora and Rakhyani (2020) and Dada (2021). However, the results confirm that, in the short-term, negative changes of *ERV* have no significant effects on *TB*. The error correction coefficient for the model is -0.9238, indicating that 92.38% of the movements into disequilibrium are corrected within one month. The adjustment speed is high, meaning that the system will rapidly get back to the long-term equilibrium after a short-term shock.

Table 5.
The Estimated Short-Run Coefficients

This table presents results obtained from the NARDL cointegrating test that indicates the short-term asymmetric effects of ERV on TB of Vietnam. The lag orders of the model are detected using the AIC procedure, and *** (**) indicate significance at 1% (5%) levels, respectively.

Variables	Coefficients	*t*-statistics
ΔERV^{+}	-26,095.9929	-0.7700
ΔERV_{t-1}^{+}	51,126.5983	1.1500
ΔERV_{t-2}^{+}	4,662.8133	0.1200
ΔERV_{t-3}^{+}	-50,287.9770	-2.3900**
ERV^{-}	1,504.9576	0.8500
$\Delta LnRER$	-1.0199	-1.2300
ΔIPI	-0.0004	-0.8000
ΔIPI_{t-1}	0.0016	2.3800**
ΔIPI_{t-2}	-0.0015	-2.2500**
ΔIPI_{t-3}	0.0014	2.6900***
ECM_{t-1}	-0.9238	-9.8800***

The results of the long-term asymmetric effects of *ERV* on *TB* are shown in Table 6. Specifically, increases in *ERV* positively influence Vietnam's *TB*. The evidence is consistent with previous finding; see Arora and Rakhyani (2020), amongst others. However, in the long-term, reduction of *ERV* has no effects on Vietnam's *TB*.

Table 6.
The Estimated Long-Run Coefficients

This table reports results obtained from the NARDL model for the long-run asymmetric effects of *ERV* on *TB* of Vietnam. Finally, * indicates statistical significance at 10% level.

Variables	Coefficients	*t*-statistics
Constant	5.6112	1.4700
ERV^{+}	26,209.5102	1.7400*
ERV^{-}	1,629.0274	0.8600
LnRER	-1.1040	-1.2300
IPI	-0.0002	-0.5100

F. Diagnostics and Structural Stability Tests

The diagnostic tests used in this study include the Breach-Godfrey test for serial correlation and ARCH test for heteroscedasticity. These tests are employed to determine the validity and reliability of the estimated results. The results of Breusch-Godfrey test presented in Table 7 indicate that serial correlation does not exist among the residuals of the model. In addition, the ARCH test for heteroscedasticity confirms that the residuals are homoscedasticity. The diagnostics tests further ensure the reliability and validity of the studied model as well as the estimated results.

Table 7.
Diagnostic Test Results

This table summarizes the results of Breusch-Godfrey test and ARCH test. These tests are used as diagnostic tests for autocorrelation and heteroskedasticity in error terms of the model.

Diagnostic Test	Statistics	*p*-value	Conclusions
Autocorrelation (Breusch-Godfrey test) *H_0: No serial correlation*	1.733	0.182	Fail to reject H_0
Heteroskedasticity (ARCH test) *H_0: No ARCH effects*	0.227	0.634	Fail to reject H_0

The NARDL model is quite sensitive to structural breaks, especially when we use financial time-series data. Therefore, the stability of the long-term relationship should be determined. We do this by using the cumulative sum of squared recursive residuals test of Brown *et al*. (1975) and find that our model is stable. Plots are available upon request.

V. CONCLUSION

This study empirically examines the asymmetric effects of *ERV*, which is generated through employing a GARCH(1,1) model, on *TB* of Vietnam over the period January 2010 to December 2019. Using the NARDL bounds testing approach, the results reveal that positive changes in *ERV* have a significant effect on Vietnam's *TB* in both the long- and short-run. Specifically, in the long-run, an increase in *ERV* leads to an improvement in the *TB*. However, in the short-run, increases in *ERV* have a significantly negative effect on the *TB*. Moreover, the results reveal that negative changes in *ERV* do not have any effect on the *TB*. Finally, it is found from the ECM that 92.38% of the movements into disequilibrium are corrected within one month. The policy implication that can be drawn from the present study is that Vietnamese policy makers should pursue the stable exchange rate policy to improve and ensure sustainability of Vietnam's *TB*.

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