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Effects of exchange rate volatility on bilateral import performance of Vietnam: A dynamic Generalised method of Moments panel approach

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ABSTRACT
The paper examines to what extent exchange rate volatility affects Vietnam's bilateral import value. The two-step system generalized method of moments (GMM) was employed on panel data over a 10-year period. Exchange rate volatility was generated by two measures, including generalised autoregressive conditional heteroskedastic (GARCH) and moving standard deviation (MOVSD). A variety of diagnostic tests which ensure the consistency of GMM estimates were discussed. The main findings confirm that all explanatory variables demonstrated the expected signs, and exchange rate volatility has positive impacts on Vietnam's import flows. However, there is a large overall difference between the results produced with those two volatility measures.

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1. Introduction

There has been an ongoing concern about exchange volatility affecting import flows after the collapse of Bretton Wood system in the early 1970s. The pull down of this fixed exchange rate system caused exchange rates to float worldwide. The switching over to a floating regime was followed by the development of several speculative works on the import effects of exchange rate volatility in both theoretical and empirical research.

From a theoretical point of view, the impact of exchange rate risk on imports is not clear. Several studies in this area indicate that exchange rate change may have harmful effects on import flows. Arize (1998) explained that this is because the price is agreed at the time of signing contracts, 'but payment is not made until the delivery actually takes place'. If exchange rate change becomes unpredictable, the risks increase the uncertainty of import trade which leads to risk-averse and risk-neutral traders reducing or leaving their trading activities in contracts denominated in a foreign currency which ultimately decreases trade flows (Arize, 1998). In contrast to this, it can be argued that positive trade flow impacts stemming from uncertainty in the exchange rate due to higher risk represent a greater

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opportunity for profit and may, therefore, increase trade (Égert & Morales-Zumaquero, 2008). From an empirical point of view, however, the relationship between exchange rate risk and import trade levels is still mixed. The significance of this relation varies with the choice of different methods of measurement of exchange rate changes, data sets and estimation techniques used in these studies. The majority of previous studies indicate that there is an adverse relation between exchange rate uncertainty and foreign trade (Mckenzie, 1999; Ozturk, 2006). Despite the huge volume of theoretical and empirical studies implemented, there are still no clear-cut answers to the relationship between exchange rate changes and international trade flows. There exists an ambiguity about the relationship between exchange rate variability and import performance which requires that more study with recent methods and data sets should be done in this area.

In Vietnam, imports played an important role in economic development after the country opened its economy and integrated widely into the global economy. In fact, the country has faced trade deficits for decades when import value are larger than export value. Thus, understanding the determinants impact on imports of this country will help policymakers develop suitable policies to encourage trade balance as well as economic growth. Vietnam's ratio of import to its GDP was always high, amounting to between 60% and over 80% (Gso, 2014). This high import to GDP ratio in recent years indicating that its imports and economy were integrating deeper and wider into the global economy, which enables them to face risk and shock in general and exchange rate uncertainty in particular from the world market. Thus, variability in its exchange rates may have a considerable effect on Vietnam's import value as Vietnam is a developing country so its import trade performance is more likely to be sensitive to exchange rate risk. Although there have been some studies focusing on evaluating the performance of Vietnam's import flow, to the best of our knowledge, no or very little empirical research has been implemented to evaluate the impact of exchange rate uncertainty on Vietnam's import value.

Therefore, this study intends to fill the gap by investigating the impact of exchange rate volatility on the bilateral imports of Vietnam with its 50 major import partners. The main objective of this paper is to provide an empirical evidence on the relationship between exchange rate instability and Vietnam's import value. Knowledge of the import impacts of exchange rate variability is crucial for design appropriate exchange rate and trade policies. It is expected that the findings from this study contributing to the current empirical literatures in this research area, as well as provide valuable suggestions for the policy makers of Vietnam. Unlike most of previous studies based on time series data, this study applies recently improved techniques of panel data to analyse trade effects on exchange rate volatility. Through the application of panel data analysis, this study can combine cross-sectional and time series dimensions, to control both temporal effects and heterogeneity across the sample countries, as well as increase the number of observations. To examine this effect, besides using a panel dataset of 50 cross-sectional annually observations for the period from 2003 to 2012, this study applies two measurements of bilateral exchange rate volatility generated from GARCH (Generalised Autoregressive Conditional Heteroskedastic) and MOVSD (Moving Standard Deviation) methods.

The paper is organised as follows. Section 2 documents the changes in Vietnam's exchange rate policy and briefly examines the different exchange rate regimes from the 1980s to the current period. Section 3 briefly provides literature reviews of previous studies on the effects of exchange rate instability on imports, focusing on measures of exchange rate variations, methods and techniques of estimations and results. Section 4 is an exploration of methodology using an empirical research model, including a brief description of model specification, data and estimation methods. Then, Section 5 reports the empirical results of the effects of exchange rate uncertainty on the bilateral import value of Vietnam. Section 6 deals with a summary and conclusion of the study.

2. Vietnam's exchange rate policy

The Vietnamese dong (VND) was established as the official currency in Vietnam in 1978, and this currency has been used to the present. In late 1986, Vietnam implemented its economic reform process, often known as *Doi Moi* (renovation). One of the most important changes was an improvement in trade policies, with price liberalisation, exchange rate unification, tax reform, and modernisation of the financial system. In line with a general economic reform process, the foreign exchange market was formed in the early 1990s. In 1999, the State Bank of Vietnam (SBV) announced that the exchange rate of the VND would be determined by a process based on a basket of currency of countries that are the main trading and loan partners of Vietnam.

Vietnam's exchange rate regime has changed many times due to both political and economic factors. Prior to 1986, Vietnam followed a system of multiple exchange rates, set by Government decree. The State Bank of Vietnam (SBV) set several rates; the Commercial rate, Non-commercial rate and Official rate. As a result, a black market emerged, in which the VND/USD rate was significantly different compared to the official rate.

After the *Doi Moi* economic reform process in 1986, the economy was shifted to a market-oriented and decentralized system. The initial transformation of exchange rate regime into a single announced fixed rate, and thereafter to the current system of a daily adjusted narrow band around the official rate is reviewed and adjusted according to market fluctuations (Nguyen & Nguyen, 2009). During the period 1986–1990, the country moved to a managed exchange rate regime against USD, administrated by SBV. In principle, variables such as inflation and interest rates were the basis for adjustments. However, in practice, the SBV made the adjustments, with commercial banks granted the leeway to modify within a narrow adjustable band for their own transactions. In 1991, the opening of the Ho Chi Minh and Hanoi foreign exchange trading floors led to a daily determination (IMF, 1996).

From 1992 to 2007, the government changed to the crawling pegged exchange rate regime. By anchoring and converting VND into some foreign currencies, which focused on USD, the government allowed commercial banks to decide the exchange rate if it does not move outside bands based on the unified exchange rate. From February 1999, a new approach saw the SBV simply announcing the interbank rate with no option of adjustment rather than an official rate based in part on the previous average interbank rate. However commercial banks were once again permitted to set their own rates within a band, in both buying and selling (Nguyen & Nguyen, 2009).

The official description of exchange rate regime of Vietnam is a managed floating regime, with a slow depreciation of the Vietnam dong (VND) against the US dollar. The official foreign exchange rate is the nominal and bilateral rate between the Vietnamese dong and the United States dollar (VND/USD), of which a rise corresponds to a weakening of the

VND (Table 1). The adjustable band has varied across different periods, increasing from 0.1% in 1999–5% in 2009 before reducing to 1% in 2011 and remaining unchanged until early 2015 (Table 2).

Till this point, a managed floating exchange rate regime had been applied. It is clearly stipulated in the Decree 70/2014/ND-CP that Vietnamese exchange rate regime policy is the floating exchange rate regime managed by State Bank of Vietnamese, determined on the basis of a basket of currencies of countries sharing trade relations, and those investing, making loans, or incurring debt in Vietnam.

3. Literature review

The effect of exchange rate volatility on imports is an important topic of international economic research. As aforementioned, although there are many trade theories in this research area, theory alone cannot determine the significance of the relation of exchange rate uncertainty and import trade. Thus, numerous empirical studies have been undertaken to investigate the exchange variability rate's effect on import trade relations. However, there still exists an ambiguity about the relationship between exchange rate instability and import performance.

The ambiguous results may derive partly from inadequate choosing of exchange rate measurements, data used and estimation methods. In early studies, the measurement of exchange rate volatility was based on the standard deviation of percentage changes in the exchange rate. However, Qian and Varangis (1994) suggested that this might not be the right approach as it may not correctly isolate the random processes involved in exchange rate generation. In addition, this type of measurement may use inefficient estimators for a two-step process (Kroner & Lastrapes, 1993).

There have been some possible drawbacks from the empirical research completed to date. Firstly, many empirical studies applied the gravity model to evaluate the relationship between exchange rate instability and imports; however, this model is more appropriate to estimate intra-industry trade flows between developed-country pairs (Dell'ariccia, 1999). This is because the model comes with assumptions that preferences are identical and homothetic across countries and depends heavily on the concept of intra-industry trade. If this assumption is improper, this will cause distorted results. Secondly, many empirical researches estimated import effects of exchange rate variability only in aggregate data level. According to Bahmani-Oskooe and Hegerty (2007), the aggregated estimation may result in aggregate bias when the bilateral import performance of a country with different import partners delivers positive and negative impacts that offset one another at the aggregate data level. The non-stationarity of data is another limitation of previous researches using panel data. Dell'ariccia (1999) and Baak (2004) both emphasise that problems of non-stationarity and spurious regression may appear with the use of panel data with a long time dimension, even though it may have advantages in examining short term impacts of exchange rate volatility on imports. It should be noted that non-stationarity is a potential problem for a macro-panel with large N (number of cross-sectional observations) and large T (length of time series) (Baltagi, 2001), especially for a T larger than 20.

There is a large amount of literature concerned with this research area accumulated over the last 30 years. Two large and important reviews were implemented by Mckenzie (1999) and Bahmani-Oskooe and Hegerty (2007). These two articles reviewed the literature

Table 1. Nominal exchange rate between VND and USD, 2003–2015.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Interbank rate^	15,608	15,737	15,875	16,054	16,114	16,977	17,941	18,930	20,828	20,828	21,036	21,246	21,890
Change (%)		0.84	0.86	1.13	0.37	5.36	5.68	5.51	10.03	0	1.00	1.00	3.03
Commercial bank rate*	15,674	15,778	15,915	16,051	16,021	17,486	18,479	19,495	21,036	20,860	21,125	21,405	22,540

Source: Compiled by authors from data of: ^SBV, end of period rates; *Vietcombank Head office's selling rate, end of period rates.

Table 2. Adjustable band, 1999–2015.

Time	2/1999	6/2002	1/2007	12/2007	3/2008	6/2008	11/2008	3/2009	11/2009	2/2011–2015
Band	0.1%	0.25%	0.5%	0.75%	1%	2%	3%	5%	3%	1%

Source: Compiled by authors from data of SBV.

about the relationship between exchange rate changes and international trade flows, and they concluded that there was no consensus on this research topic, due to different estimation techniques or varied assumptions leading to different results. Since the last review by Bahmani-Oskooe and Hegerty (2007), the amount of literature about this research topic has increased considerably, with new volatility measures, new estimation methods and new models.

Zhang, Chang, and Gauger (2006) applied a threshold model to evaluate the nonlinear effect of exchange rate risk on import volume of the U.S. from other six G7 countries. They used bilateral monthly data from 1989 to 2002. A grid-searching method and cointegration techniques are employed to estimate import impacts of exchange rate variability with the consideration of possible threshold effects. The findings concluded that threshold effects exist for five out of six countries, and the import–volatility relationship was positive when exchange rate uncertainty surpasses a certain threshold point.

Choudhry (2008) employed the Johansen multivariate co-integration technique and constrained error correction model to analyse the impact of exchange rate uncertainty on real imports of the U.K. from Canada, Japan and New Zealand. Real import flows were modelled as a function of real income, export price ratio and volatility. The study used quarterly data between 1980 and 2003, and the conditional variance of a GARCH model for the real exchange rate in logarithm to proxy exchange rate variability. The results indicated that the impact of real imports from exchange rate volatility was significant and mostly positive.

Bahmani-Oskooee and Hajilee (2011) examined bilateral import impacts of exchange rate risk between U.S. and Sweden. They employed basic regression models in which import volume and import value were modelled as a function of income, the real exchange rate and volatility. Exchange rate variability was determined as the standard deviation of twelve monthly real bilateral exchange rates within that year. Analysing annual data for 87 industries traded between the two countries over the period 1962–2004 using error correction models, they found that while exchange rate changes had significant effects on almost two-third of the industries in the short-run, its impacts in the long-run only accounted for one-third of the industries. Bahmani-Oskooe and Satawatananon (2012) also used a bounds testing approach for co-integration and error correction modelling to evaluate the effects of foreign exchange variability on imports of 41 US importing industries from Thailand, and 118 Thai importing industries from the U.S. The standard deviation of twelve monthly real bilateral exchange rates within that year was applied to a proxy for volatility. Considering one hundred and fifty-nine industries from 1971 to 2006, their findings were in line with Bahmani-Oskooee and Hajilee (2011), as the import–volatility relationship was only significant in the short-run rather than in the long-run in most industries.

Wong, Ho, and Dollery (2012) examined both linear and nonlinear relationships between exchange rate variability and import performance for the U.S. and Malaysia.

A Brock–Dechert–Scheinkman (BDS) test and nonlinear causality tests were employed. Volatility was measured by the standard deviation of the percentage change in the real exchange rate. Their findings indicated that there was no linear co-integration between exchange rate changes and import flows for both selected countries. In terms of linear causal relationship, only the U.S. revealed a weak harmful impact of exchange rate instability on import performance.

Moslares and Ekanayake (2015) investigated the effects of foreign exchange instability on bilateral imports between the U.S. and Spain at disaggregated sectoral data. They applied the method of bounds testing or the Autoregressive Distributed Lag (ARDL) approach to co-integration analysis. Import volume was modelled as a function of income, relative price and volatility. This study used the standard deviation of the first difference of logarithms of the real exchange rate as a proxy for the exchange rate uncertainty. The findings indicated that exchange rate uncertainty had harmful impacts on most selected industries in import flows.

Kim (2017) employed ARDL and VECM approaches to study the relationship between exchange rate changes and seaborne imports of Korea. Import performance was determined by real income, real exchange rate, world commodity price, and volatility. An exponential generalized autoregressive conditional heteroskedastic (EGARCH) model was used to measure the USD/KRW exchange rate volatility. The panel unit root test was applied to test for the existence of unit root in the panel data series before estimates. The results showed that exchange rate risk caused negative effects on imports of Korea.

4. Research methodology

This study employs Generalized Method of Moments (GMM) for Dynamic Panel Data Model to estimate import equations, to evaluate the impact of exchange rate volatility on import performance in Vietnam. As presented in the literature review, most of estimation methods used in previous studies are based on time series data. However, this study uses an alternative approach by employing the estimation method for panel data to analyse trade effects on exchange rate volatility. Due to the importance of trade history when analysing trade flows, trade effects should be estimated in terms of evolvement over time (De Grauwe & Skudelny, 2000). Thus, this study uses a dynamic panel model with lagged dependent variables as an explanatory variable (an import performance variable lagged one period is added to the right-hand side), in order to examine the relationship between exchange rate variability and import performance. However, common panel data estimations, namely fixed effects and random effects approaches, may incur biases when adding lagged dependent variables. The fixed effects estimator is inconsistent due to the correlation of observed covariates and the time-varying errors in each time period (Blundell & Bond, 1998), while the Generalized Least Squares (GLS) estimator of random effects models is also biased in a dynamic model with individual effects (Baum, Schaffer, & Stillman, 2003).

In order to address the problem of dynamic panel bias which is the correlation between lag dependent variables and the fixed effects, a common approach in deriving consistent parameter estimates is the use of instrument variable (IV) procedures (Bond, 2002). However, with the presence of heteroscedasticity, which often occurs in panel data, the generalised methods of moment (GMM) estimator is more efficient than the standard IV estimator (Baum et al., 2003). Therefore, this study applies a GMM estimate approach with the purpose of avoiding bias and inconsistency problems which are inevitable in standard panel data estimations.

4.1. Model specification

The study uses a modified basic trade model to evaluate the impact of exchange rate volatility on the import trade of Vietnam from 50 major import partners on the bilateral data level. The standard import demand equations were estimated and extended to include other factors generally affecting the trade between country pairs, such as bilateral exchange rate and distance between two trading partners.

Besides the variables of major interest mentioned, there are various explanatory variables, suitable for explaining trade effects and it is important to account for these in a manner that is consistent with economic theory. The general form of models used in this study that include a variable of import performance lagged one period can be expressed in log-linear as follows:

$$logM_{i,t}^{b} = \beta_{1i} + \beta_{12}logM_{i,t-1}^{b} + \beta_{13}\log Y_{i,t}^{bd} + \beta_{14}\log RP_{i,t}^{b} + \beta_{15}logRP_{i,t-1}^{b} + \beta_{16}V_{i,t}^{b} + \beta_{17}FTA_{i,t} + \varepsilon_{1i,t} \quad (1)$$

where $M_{i,t}^{b}$ represents bilateral real import values of Vietnam from country i in time t, $M_{i,t-1}^{b}$ denotes bilateral real import values between Vietnam and country i lagged one period, $Y_{i,t}^{bd}$ represents domestic income of Vietnam, $RP_{i,t}^{b}$ denotes real exchange rates between Vietnam and country i, $RP_{i,t-1}^{b}$ represents real exchange rate between Vietnam and country i lagged one period, $FTA_{i,t}$ represents free trade agreements between Vietnam and country i (which takes a value of 1, if these two countries have mutual agreements at time t and 0 otherwise), $V_{i,t}^{b}$ denotes exchange rate volatility between Vietnam and country i, $\varepsilon_{1i,t}$ is error term of import equation, i includes 50 major import partners of Vietnam in the import Equation (1), t denotes time. Detail of variable specifications is presented in Appendix 1.

Exchange rate volatility is the key variable in this research, capturing the uncertainty faced by the international traders due to the unpredictable exchange rate risk. There are many methods to measure exchange rate variability. Currently, the two most popular models used are the Moving Standard Deviation (MOVSD) model, and General Autoregressive Conditional Heteroskedasticity (GARCH) model. This study will apply both these models to calculate exchange rate volatility. Thus, there are two volatility measures for each country pair, being cross exchange rate volatility derived from the moving standard deviation method (MOVSDCE), and cross exchange rate volatility derived from the GARCH method (GARCHCE). This study uses both mentioned measures of exchange rate volatility to assess whether the trade impacts of exchange rate volatility are affected by the measure of volatility used. Thus, where such impact does exist, the extent of the deviation of the results from the different measures of volatility may be recognised.

Alongside the usage of the real import values ($M_{i,t}^{b}$) as dependent variables, this paper also includes the real import values lagged one period ($M_{i,t-1}^{b}$) as explanatory variables for import equations. It is hypothesized that previous trade relationship will enhance trade flows between trading partners. Thus, it is expected that $\beta_{12,}$ is positive. In the equation, if there is an increase in domestic income, which represents a rise in their purchasing power, resulting in Vietnam's import demand increase, so a positive relationship between income and import is expected. Hence, it is expected that $\beta_{13,}$ is positive. If there is depreciation in VND, goods imported to Vietnam become relatively more expensive. The households in this country, therefore, are likely to get fewer goods imported to Vietnam in exchange for a unit of domestic goods. Thus, it is expected that depreciation in VND (the case of observed values increasing) would have a harmful effect on Vietnam's imports. Therefore, it is expected that $\beta_{14,}$ is negative. Besides current real bilateral exchange rate, the import equation also includes real bilateral exchange rate lagged one period. Although the lagged exchange rate variable has been used to evaluate international trade flows in many studies, the effects of lags of exchange rate on international trade performance were ambiguous. Therefore, the sign and significance of the coefficient of the lagged exchange rate term cannot be determined a priori but rather are left to be determined by the data. The import effects of the Free Trade Agreements (FTAs) between Vietnam and its trading partners are analysed by including an FTA dummy variable. It is expected that enforcement of a mutual FTA between Vietnam and its trading partners will enhance imports of Vietnam from these countries. It is assumed that there are lower trade barriers among the members of FTAs promoting intra-member trade; therefore, a positive coefficient (β_{17}) sign would be expected. However, the effect of bilateral exchange rate volatility on bilateral import performance cannot be determined a priori, and the sign of this effect is theoretically ambiguous (Kasman & Kasman, 2005; Siregar & Rajan, 2004; Todani & Munyama, 2005). It is suggested that exchange rate uncertainty may have a positive, negative or no significant impact at all, on the import flows. The sign and significance of these coefficients are the main focus of this empirical study and will receive a great deal of attention in the following subsections (Table 3).

4.2. Data specification

The dataset includes Vietnam and 50 major import partners (A list of import trading partners is presented in the Appendix 2). There are eight data series used in the econometric estimation of the import demand equation including the 50 country pairs analysed: real imports ($M^b_{i,t}$), real imports lagged one period (previous import – $M^b_{i,t-1}$), real domestic income ($Y^{bd}_{i,t}$), exchange rate ($RP^b_{i,t}$), exchange rate lagged one period (previous exchange rate – $RP^b_{i,t-1}$), FTA dummy variable ($FTA_{i,t}$), and bilateral exchange rate volatility ($V^b_{i,t}$) namely: bilateral cross exchange rate volatility derived from the moving standard deviation method ($MOVSDCE_{i,t}$), and bilateral cross exchange rate volatility derived from the GARCH method ($GARCHCE_{i,t}$).

The annual data spanning a 10-year period from 2003 to 2012 was used in the import equation. The import values of Vietnam from 50 major import partners were collected from the Direction of Trade Statistics (DOTS) of the International Monetary Fund (IMF). In order to generate real import variables, the import values were then deflated by the US GDP deflator, which was obtained from the International Financial Statistics (IFS) of the IMF. The domestic income variable was calculated by the domestic GDP of Vietnam weighted by the distance between Vietnam and its trading partners, in which the GDP

Table 3. Definition and summary statistics of variables of the bilateral import equation.

Variable	Measure (from 2003 to 2012)	Expected sign	Obs	Mean	Std. Dev.	Min	Max
Dependent variable ($logM^{b}_{i,t}$)	Current year import values of Vietnam from country *i* deflated by US GDP deflator		500	3.400692	0.7490657	1.066848	5.401726
Explanatory variables							
Previous Imports ($logM^{b}_{i,t-1}$)	Import values of Vietnam from country *i* deflated by US GDP deflator lagged one period	+	450	3.369494	.7521186	1.066848	5.340895
Domestic income ($logY^{bd}_{i,t}$)	Current year GDP of Vietnam weighted by distance between Vietnam and country *i*	+	500	.0004762	.0006544	.0000894	.0042038
Exchange rate ($logRP^{b}_{i,t}$)	Bilateral exchange rate multiplied by the CPI of Vietnam relative to CPI of country *i*	−	500	3.264619	1.140778	.1603062	4.760932
Previous exchange rate ($logRP^{b}_{i,t-1}$)	Bilateral exchange rate multiplied by the CPI of Vietnam relative to CPI of country *i* lagged one period	±	450	3.270764	1.1421	.1603062	4.760932
Free trade agreement ($FTA_{i,t}$)	takes value of 1 if Vietnam and country *i* have mutual agreements at time *t* and 0 otherwise	+	500	0.23	0.421254	0	1
$MOVSDCE_{i,t}$	Bilateral exchange rate volatility derived from the MOVSD method	±	500	.0334465	.0170159	.0001552	.1220844
$GARCHCE_{i,t}$	Bilateral exchange rate volatility derived from the GARCH method	±	500	.0078555	.0197362	1.17e-08	.2024531

Source: Compiled by author.
Note: All variables are in logarithm form (except the FTA dummy variable and exchange rate volatility because this variable is derived from logarithm-transformed exchange rate).

of Vietnam was obtained from the WB, and the distance was collected from the General Statistic Office of Vietnam (GSO). Bilateral exchange rates between Vietnam and its trading partners were collected from the United Nations Conference on Trade and Development (UNCTAD). The consumer price indexes (2005 = 100) of Vietnam and its trading partners, were obtained from the GSO. The FTA between Vietnam and its trading partners was also collected from the GSO.

4.3. Estimation method

The import Equation (1) is a dynamic panel regression in that the right-hand side contains the value of lagged dependent variable ($M^b_{i,t-1}$). The import volume lagged one period ($M^b_{i,t-1}$) is included in the import model to indicate the importance of trade history in terms of current trade, as a country is likely to continue trade with its existing trading partners to avoid entry and exit barriers (Eichengreen & Irwin, 1996).

Following Arellano and Bond (1991), Ahn and Schmidt (1995), Blundell and Bond (1998) and Baum et al. (2003), this study applies a Generalised Method of Moments (GMM) framework to address the aforementioned econometric issues. Furthermore, given that the panel data set in this study is small in time dimension ($T = 10$) and large in cross-section unit ($N = 50$), GMM is the proper estimator in this case.

Specifically, GMM uses additional instruments obtained by utilizing the orthogonal conditions that exist between the lagged dependent variable and the disturbance term. Hence, the advantage of GMM stems from the fact that it optimally exploits all linear moment restrictions specified by the model. The GMM approach starts with the first-differenced version of Equation (1).

$$\begin{aligned} \Delta logM^b_{i,t} &= \beta_{12}\Delta logM^b_{i,t-1} + \beta_{13}\Delta \log Y^{bd}_{i,t} + \beta_{14}\Delta \log RP^b_{i,t} \\ &\quad + \beta_{15}\Delta logRP^b_{i,t-1} + \beta_{16}\Delta V^b_{i,t} + \beta_{17}FTA_{i,t} + \Delta\varepsilon_{1i,t} \end{aligned} \tag{2}$$

In Equation (2), the country-specific effects are eliminated by the difference operation. Assuming that the disturbances are not correlated, it is expected that $\Delta\varepsilon_{1i,t}$ is orthogonal to the past history of the dependent variable ($\log M^b_{i,t}$) and the explanatory variables ($\log M^b_{i,t-s}, \log Y^{bd}_{i,t}, \log RP^b_{i,t}, logRP^b_{i,t-s}, V^b_{i,t}$), so that:

$$\begin{aligned} E(logM^b_{i,t-s}\Delta\varepsilon_{1i,t}) &= 0, E(\log Y^{bd}_{i,t}\Delta\varepsilon_{1i,t}) = 0, E(logRP^b_{i,t}\Delta\varepsilon_{1i,t}) \\ &= 0, E(logRP^b_{i,t-s}\Delta\varepsilon_{1i,t}) = 0 \; and \; E(V^b_{i,t}\Delta\varepsilon_{1i,t}) \\ &= 0, (t = 3, \ldots, T \text{ and } s \geq 2. \end{aligned} \tag{3}$$

Conditions (3) imply a set of linear moment conditions to which the standard GMM methodology applies. GMM estimators indicate negligible finite sample biases and substantially smaller variances than those associated with simpler IV estimators (Arellano & Bond, 1991).

Arellano and Bover (1995) noted that the first-difference GMM (DGMM) may suffer from potential weak instruments, which gives rise to significant efficiency loss. To deal with this issue, Arellano and Bover (1995) and Blundell and Bond (1998) proposed a system-GMM (SGMM) approach that extends the level moment conditions.

$$E(\Delta logM^{b}_{i,t-s}\varepsilon_{1i,t}) = 0, E(\Delta \log Y^{bd}_{i,t}\varepsilon_{1i,t}) = 0, E(\Delta logRP^{b}_{i,t}\varepsilon_{1i,t}) = 0, E(\Delta \log RP^{b}_{i,t-s}\varepsilon_{1i,t}) = 0,\ and\ E(\Delta V^{b}_{i,t}\varepsilon_{1i,t}) = 0, t = 3, \ldots, T \text{ and } s \geq 1. \quad (4)$$

The SGMM estimator is obtained by exploiting the enlarged set of moment conditions in (3) and (4). By using more moment conditions, the SGMM estimator is more efficient than the DGMM estimator that uses only a subset of moment conditions in Equation (3). This study has relied on the SGMM which estimates (1) as a system of equations in both first differences and levels.

The one step and two-step GMM estimators are asymptotically equivalent if the residuals are homoscedastic and not correlated. It is suggested that the two-step GMM estimator might be more efficient in the presence of heteroscedasticity, although simulation studies indicated very limited efficiency gain compared to the one-step GMM estimator (Bond, 2002). The two-step GMM downward biased standard errors can be corrected by applying Windmeijer (2005) correction.

The SGMM estimator is consistent if there is no second-order serial correlation in the residuals of equation. To check the serial correlation property of the level residuals, we relied on the *m1* and *m2* procedure that directly tests for first- and second-order residual autocorrelation (Arellano & Bond, 1991). If the level residuals are serially uncorrelated, then the residuals in equation will follow a MA(1) process which implies that autocorrelations of the first-order are non-zero, but the second or higher order ones are zero. In this case, we imposed the instrument set from a lag of 2 and longer of proposed endogenous variables. Moreover, in order to reduce the possibility of correlation across individual in the idiosyncratic disturbance, a time dummy was included (Roodman, 2009a).

The overall validity of the moment conditions is checked by the Hansen J-statistic that tests the null hypothesis of correct model specification and valid over-identifying restrictions (Baum et al., 2003). It is worth noting that the Hansen test is weak in the case of too many instruments (Roodman, 2009b). This issue often appears in difference GMM as the instrument count quadratic in the time dimension of the panel. According to Roodman (2009b), one typical sign is that the Hansen test generates implausible good *p-values* of 1.000.

The Hansen J-statistic may lack power in a model that contains a very large set of excluded instruments (Baum et al., 2003). In addition, this test is also limited when a researcher suspects the validity of a subset of instruments and wishes to test it. In this case, a difference-in-Sargan/Hansen test, also known as the *C* statistic (Roodman, 2009b), can be used to test the validity of subsets of instruments, such as the subset of instruments in levels. The *C* test has the null hypothesis that the specified variables are proper instruments.

The study employs the two-step system GMM to estimate the equation (1). However, the Hansen tests from this estimation method present a sign of too many instruments with the *p-value* equal to 1.000, indicating that these tests are weak. For the purpose of reducing the number of instruments, we combined the two approaches, namely collapsing instruments and limiting lag depth amounts (Roodman, 2009b). Therefore, the two-step, collapse system GMM is applied to evaluate the relationship between imports and exchange rate volatility.

5. Empirical results of import equation

As mentioned in the subsection of Estimation Method, a *p*-value of 1 for the *Hansen J test* is a clear indicator of instrument proliferation (Roodman, 2009b). Therefore, in order to control for this problem, the two-step, collapse system GMM is applied to evaluate the relationship between imports and exchange rate volatility at bilateral data level.

5.1. Multicollinearity issues

Table 4 presents a correlation matrix of the variables used in the bilateral import Equation (1), since the pairwise correlation coefficients among single pairs of regressors exceed 0.6, the variance inflation factor (VIF) is also computed to detect the extent of multicollinearity between them. The results are reported in Table 5, which shows that the highest VIF for the MOVSD model is 1.99 and for the GARCH models is 1.94. Since no variable of any of the two models exceeds the value of 10, multicollinearity should not be a concern in the import regression (Wooldridge, 2009), and therefore, all discussed proxies can be estimated.

5.2. Diagnostic tests

The results reported in Table 6 indicate the diagnostic applied to test for the relevance and validity of the instrumental variables used in the estimations of both models measuring volatility by MOVSD and GARCH. Relevance of instrumental variables is checked by the significance of the *F-test*. The *F-test statistic* and its *p-value* reported in this table indicate that in both models, the regressors are collectively significant in explaining the variation

Table 4. Pearson pair-wise correlation matrix.

	$logM^b_{i,t}$	$logY^{bd}_{i,t}$	$logRP^b_{i,t}$	$FTA_{i,t}$	$MOVSDCE_{i,t}$	$GARCHCE_{i,t}$
$logM^b_{i,t}$	1					
$logY^{bd}_{i,t}$	0.2533	1				
$logRP^b_{i,t}$	−0.0937	−0.521	1			
$FTA_{i,t}$	0.5572	0.6338	−0.4104	1		
$MOVSDCE_{i,t}$	−0.0845	−0.1366	−0.1676	−0.1468	1	
$GARCHCE_{i,t}$	0.067	0.0094	−0.0498	0.0818	−0.0381	1

Source: Compiled by authors.

Table 5. VIF calculation for selected variables.

MOVSD-derived exchange rate volatility			GARCH-derived exchange rate volatility		
Variable	VIF	1/VIF	Variable	VIF	1/VIF
$logY^{bd}_{i,t}$	1.99	0.50197	$logY^{bd}_{i,t}$	1.94	0.514142
$FTA_{i,t}$	1.72	0.58117	$FTA_{i,t}$	1.71	0.584406
$logRP^b_{i,t}$	1.53	0.655331	$logRP^b_{i,t}$	1.4	0.71657
$MOVSDCE_{i,t}$	1.12	0.890419	$GARCHCE_{i,t}$	1.01	0.988613
Mean VIF	1.59		Mean VIF	1.52	

Source: Compiled by authors.

Table 6. Diagnostic tests results (Dependent variable: Real import values).

	Exchange rate volatility measures used	
Tests and statistic	MOVSDCE	GARCHCE
F-test	81.52 (0.000)	75.68 (0.000)
AR(1) statistic	−2.85 (0.004)	−2.48 (0.013)
AR(2) statistic	0.93 (0.353)	0.60 (0.546)
Hansen *J* statistic	35.83 (0.252)	40.73 (0.198)
Difference-in-Hansen test of exogeneity of the instrument subset for lagged $M^b_{i,t}$	29.09 (0.307)	21.38 (0.375)

Source: Compiled by authors.
Notes: The figures in parentheses are *p*-value for tests and statistic; Specification with bilateral exchange rate volatility derived from the moving standard deviation method (MOVSDCE), and bilateral exchange rate volatility derived from the GARCH method (GARCHCE).

in the dependent variable. The *Hansen J test* of over-identifying restriction was applied to test the validity of instrumental variables. The reported *p-values* show that the *J-test* is insignificant for both models confirming that the instrumental variables used in these regressions are exogenous, and both models have proper instrumentations. The results of the *difference-in-Hansen* test show that the variables of import value lagged one period are valid instruments, as the *C-test* checked the subset of the instrument. The Arellano-Bond (AR) test for serial correlation was also applied to check the consistence of the estimations and is reported in Table 6. The AR test is conducted on the differences of the estimated errors, so the first order correlation in the errors is expected as they are mathematically related as mentioned in the subsection of Estimation Method. Thus, a significant Arellano-Bond test for first-order autocorrelation – AR(1) test statistic for the differenced errors was uninformative. More importantly, in both models, the Arellano-Bond test for second-order autocorrelation – AR(2) is insignificant. Hence, the hypothesis of absence of second-order correlation was accepted, ensuring no second-order serial correlation in the first-differenced errors. It can be concluded that the estimations reported in Table 6 satisfy the entire mentioned diagnostic tests. Therefore, key assumptions of the system GMM estimation are satisfied, and the two-step, collapse system GMM is a consistent estimator in this study.

In order to avoid the danger of instrument proliferation, beside collapsing instruments and limiting lag depth amounts, this study also tried to maintain the number of instruments below the number of observations (Roodman, 2009a). By doing this, it can be ensured that the estimated results are due to variation in the explanatory variables and not because of using too many instruments. As presented in Table 7, the number of instruments is between 46 and 49, far below number of observations (450). Thus, it is likely that the possibility of over fitting endogenous variables does not exist.

5.3. *Empirical results*

The main results of the impacts of exchange rate instability on Vietnam's bilateral imports from the two-step, collapse system GMM regression for the period from 2003 to 2012 are also presented in Table 7.

Estimation results show that exchange rate volatility has positive effects on bilateral imports, regardless of which volatility measure was used, however, while impacts from the MOVSD-derived exchange rate uncertainty are statistically significant at 10% level, these

Table 7. Import estimation result (Dependent variable: Real import values).

	Exchange rate volatility measures used	
Variable	MOVSDCE	GARCHCE
Previous import	0.7225*** (0.0763)	0.5923*** (0.1810)
Domestic income	20.6704 (72.9950)	3.0377 (84.4884)
Exchange rate	−0.9269** (0.4331)	−1.8856* (1.1201)
Exchange rate lagged one period	0.9916** (0.4369)	1.9572* (1.1670)
FTA	0.2987** (0.1124)	0.4531** (0.2184)
Exchange rate volatility	5.5162* (1.1386)	0.2176 (1.0713)
Year dummy	Yes	Yes
Number of instruments	46	49
Number of observations	450	450

Source: Compiled by authors.

Notes: The figures in parentheses are standard errors for coefficients; ***, **, and * in the table denote statistical significant coefficient at 1%, 5% and 10% level, respectively.

Specification with bilateral exchange rate volatility derived from the moving standard deviation method (MOVSDCE), and bilateral exchange rate volatility derived from the GARCH method (GARCHCE).

effects from the GARCH-derived are insignificant. All remaining explanatory variables show the expected signs, and these variables (except for income variables) are significantly correlated with bilateral imports of Vietnam.

The estimation results show that an increase in exchange rate volatility has a positive effect on Vietnam's bilateral imports. However, while this impact from the MOVSD-derived model is significant at 10% levels, the effect from the GARCH-derived model is insignificant. The estimated coefficient of the MOVSD model is 5.52% implying that a 1% increase in the exchange rate volatility is linked with a 5.52% increase in the imports of Vietnam. This finding of different measures of exchange rate volatility cause different effects on import trade is similar to some previous studies such as De Grauwe and De Bellefroid (1987) and Kumar and Dhawan (1991). The possible explanation for the different effects of MOVSD and GARCH measures in the study is due to the formation of these measures. While the MOVSD-derived volatility captures the impacts of exchange rate volatility of 6 years ($m = 6$) around the estimated year, the GARCH-derived volatility takes into account all information of exchange rate volatility in the past. Therefore, the GARCH-derived volatility catches all past volatilities over the period, rather than paying more attention in volatilities of the current period. More specifically, in the case of high volatility in the past and low volatility currently, the exchange rate volatility measured through GARCH model still includes the high volatility in the past, rather than focusing on the current low volatility. However, international trade is often influenced by short or medium impacts. For example, it is unlikely that the exchange rate volatility of 10 years ago has significant effects on current imports. Therefore, the impacts of exchange rate volatility derived from the GARCH model may lose its significance in this study. As a result, the import effects of exchange rate volatility from the MOVSD model are significant, while these effects from the GARCH are insignificant.

The coefficients of previous imports with positive and statistically significant values at 1% levels in both models indicate that an increase in imports of the previous year has a positive impact on current imports of Vietnam. The magnitudes of the effects are 0.59 and 0.72, implying that a 1% increase in the previous imports leads to a growth in current imports of about 0.59 and 0.72% depending on the volatility measures used. These coefficients yield the preliminary expectations of signs and significance, indicating the importance of trade history to trade flows. Importers continue to import from countries with which they have an existing trading relationship because they can earn more profits by saving costs, time and effort for setting up new marketing, distribution and service networks.

The impacts of exchange rate (bilateral spot exchange rate) on imports are inverse and significant at 5% in the MOVSD model and at 10% in the GARCH model. With magnitude of effects at −0.93 and −1.89, given that the exchange rate variables are expressed in logarithms, it can be interpreted that a 1% increase in the exchange rate will reduce bilateral imports of Vietnam by 0.93% and 1.89% depending on the particular volatility measure used. This result is consistent with economic theory in that an increase in exchange rate means a greater VND depreciation, resulting in imported goods to Vietnam becoming relatively more expensive, such that consumers in the country are likely to choose domestic goods over imported products. Thus, import demand decreases, leading to a decline in the imports of Vietnam.

The coefficients of exchange rate lagged one period (previous year's bilateral exchange rate) are significant in these two models with a 10% or better of significance level. The estimation results show that the greater the depreciation of VND in the previous year, the more foreign products were imported to Vietnam this year. The estimation results suggest that imports into Vietnam this year will increase 0.99% and 1.95%, associated with a further 1% depreciation of VND last year. The results make economic sense. As presented in the subsection of exchange rate policy in Vietnam, the VND continuously depreciated over the period. With this trend, since VND depreciated in the last year, import traders afraid that VND will depreciate more in this year, are likely to import more foreign products in order to avoid import goods becoming relatively more expensive, due to the continuous trend in depreciation of VND. For this reason, previous depreciation of VND has positive effects on current bilateral imports of Vietnam.

A positive and significant coefficient of FTA means enforcing mutual FTAs increase the imports into Vietnam from its import partners. The impacts of FTA on bilateral import are significant at the 5% level, regardless of the volatility measure. The estimated coefficient was 0.30 and 0.45. Given that these are dummy variables, it can be interpreted that an increase in bilateral imports of Vietnam by 0.30% and 0.45% is associated with a situation in which this country and its trading partners are members of the FTAs. This finding is consistent with economic theory, since FTAs reduce trade barriers which enhance intra-trade among members.

As expected, the domestic income variables have a positive sign, which show that higher domestic income has a positive impact on bilateral import performance of Vietnam. However, the p-value of these variables in both models suggests that they are not statistically significant. Despite their insignificance, the variables of income of Vietnam were not removed from either model, as removing them may have distorted the signs and explanatory power of the other variables.

6. Conclusion

This study provided an empirical analysis of the determinants of bilateral imports of Vietnam, with a specific focus on the impacts of exchange rate volatility on the performance of the country's imports. The two-step, collapse system GMM was applied to determine the nature of the relationship between exchange rate volatility and import flows. Exchange rate volatility was generated by two measures, namely MOVSD and GARCH. In this bilateral data analysis, many types of diagnostic tests were performed for all the estimated equations. The Arellano–Bond tests for autocorrelation was applied to the residual in differences. In the import equations, the tests confirm that there is no serial correlation of the second-order between $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t}$ and $\varepsilon_{i,t-2}$ in $\Delta\varepsilon_{i,t-2}$. The *Hansen* test of over-identification restrictions and *Difference-in-Hansen* tests of exogeneity of instrument subsets were also conducted on import equations. The tests indicated that the instrument as a group is exogenous and these specified variables are proper instruments.

The findings in this paper make a strong case for more careful macroeconomic management, in order to boost Vietnam's overall trade and economic growth strategy, particularly in the light of Vietnam's many years of persistent trade deficit. The estimation results indicate that in general, an increase in exchange rate volatility increase imports into the country. Thus, increased exchange rate uncertainty may lead to greater trade deficit and a deteriorating trade balance. In practice, macroeconomic policies that limit imports should be implemented. In general, policy makers should develop policies, under which greater stability of exchange rate of VND will be maintained, in order to improve the country's trade balance. This is also recommended in that a stable exchange rate strengthens certainty, enabling investors to plan more accurately and reduce operational risks.

The results also indicate that bilateral spot exchange rate and previous exchange rate have significant impacts on bilateral imports. Moreover, although current depreciation of VND limits imports in the current year, it will have an inverted impact in imports in the following year, even when these effects are more significant compared to the current year. As aforementioned, this phenomenon is due to the continuous depreciation of VND over the long period. Therefore, the importers are likely to import more to avoid the imported products becoming more expensive in domestic currency terms. As a result, there is an increase in current bilateral imports with the depreciation of VND in the previous year. In other words, the devaluation of VND in a particular year will increase imports in the next year. Therefore, it is likely that the policy of devaluation of VND which Vietnam pursues to limit imports is not efficient.

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Appendices

Appendix 1. Variable specifications

Real imports

The real import is one of the most popular dependent variables used in studying the relationship between imports and exchange rate variability at bilateral data level (Bahmani-Oskooe & Hegerty, 2007). In this paper, the real imports of Vietnam from its fifty major import partners are measured. This study also uses the US GDP deflator (USGDPD) to transform the import values in current US dollars to the real import variable. The real imports of Vietnam from country $i(M^b_{i,t})$ is calculated as follows:

$$M^b_{i,t} = \frac{Import_{it}}{USGDPD_t}$$

where $Import_{it}$ is the bilateral import values of Vietnam from country i at time t.

Domestic income

The domestic income of a country is an important indicator in determining a country's import performances. The factor typically presented in determining domestic income, is GDP. Several empirical studies have used income as a key driving force for international trade flow (see, e.g. Brada and Mendez (1988), Arize, Osang, and Slottje (2000), Baak (2004), and Chit, Rizov, and Willenbockel (2010)).

GDP weighted by distance as proxy for domestic income in the import equation. The reason for using distance-weighted GDP as proxy for the domestic income of Vietnam is that GDP of Vietnam remains the same in terms of the different partners, so the estimation results from GMM technique using Stata do not report the results for income variable. In order to generate this variable as different across trading partners, this study used the method suggested by Harris (1954), where the GDP is weighted by the distance between two trading partners. This is because distance plays an import role in international trade on the basis that it is inversely proportional to trade, due to transportation costs. The real domestic income ($Y^{bd}_{i,t}$) of Vietnam with various trading partners is computed as follows:

$$Y^{bd}_{i,t} = \frac{GDP\ of\ Vietnam\ in\ time\ t}{D_i}$$

where D_i denotes distance between Vietnam and country i which is measured in km between the capitals of the two countries.

Exchange rate

The exchange rate variable in this research is the real bilateral exchange rate between Vietnam's currency (Vietnam dong – VND) and the currencies of its trading partners. The bilateral exchange rates for currencies between Vietnam and its trading partners are presented in cross rates. The exchange rate is expressed in terms of the foreign currency per amount of the VND, so if the value increases, this in essence is a depreciation of the VND.

Thus, for example, the bilateral cross exchange rate between the US. and Vietnam ($E_{US,t}$) in this study is as follows:

$$E_{US,t} = \frac{USD_t}{VND_t}$$

The real bilateral exchange rate between Vietnam and its trading partner is constructed according to the study of Baak et al. (2007):

$$RP^{b}_{i,t} = E_{it}\frac{CPI_{it}}{CPI_{VNt}}$$

where E_{it} represents the bilateral cross exchange rate between Vietnam and its trading partner at time t. CPI_{VNt} and CPI_{it} denote the consumer price index of Vietnam and its trading partner, respectively.

Besides current real bilateral exchange rate, the import equation also include real bilateral exchange rate lagged one period. It is assumed that international trading will not respond immediately with movement of bilateral exchange rates (Sukar & Zoubi, 2011). Therefore, a lagged bilateral exchange rate variable should be added to observe the actual bilateral import flows. Furthermore, in international trade, long-term contracts are often signed between two existing trading partners, hence only current exchange rates may not reflect trade effects of exchange rates efficiently. By including lags of exchange rate variable, the potential of causality due to contemporaneous changes of trade and exchange rate is reduced (Berhou, 2008), and the protracted nature of the pass-through of exchange rate variation is accounted for (Kohler, Manalo, & Perera, 2014). Although the lagged exchange rate variable has been used to evaluate international trade flows in many aforementioned studies, the effects of lags of exchange rate on international trade performance were ambiguous. Berhou (2008) suggested a negative impact from the exchange rate lagged one year period on foreign trade flows as an appreciation of this exchange rate depreciates bilateral trade. However, Sukar and Zoubi (2011) stressed that lagged exchange rate can affect trade either positively or negatively. In contrast, Rowbotham et al. (2014) argue that previous exchange rate has no impact on international trade performance. Therefore, the sign and significance of the coefficient of the lagged exchange rate term cannot be determined a priori; it can be a positive and significant coefficient or a negative and significant variable, or even have no statistically significant impact.

Exchange rate volatility

Exchange rate volatility is measured by the two most popular models, namely Moving Standard Deviation (MOVSD) model, and General Autoregressive Conditional Heteroskedasticity (GARCH) model.

- The Moving Standard Deviation (MOVSD)

This measure uses the standard deviation of the first difference of logarithms of the exchange rate as a proxy to the exchange rate uncertainty, based on the assumption that a constant trend would not impact volatility and would be perfectly predictable. Exchange rate volatility measured by moving average standard deviation is defined as:

$$V_{i,t} = \left[\frac{1}{m} \sum_{k=1}^{m} (E_{i,t+k-1} - E_{i,t+k-2})^2 \right]^{1/2}$$

where E_i is the common logarithms of exchange rate of country i at time t, which could be nominal or real, depending on the exchange rate used, m is the order of moving average, which will be set to six years in order to stress the importance of medium run variability.

This measure captures delayed responses of trade to exchange rate volatility, as this is used to test for a stable and significant response of trade to a one per cent change in the standard deviation. There are many studies which have used this method to measure exchange rate volatility, such as Kasman and Kasman (2005), Hondroyiannis et al. (2008), and Serenis (2013).

- Generalised Autoregressive Conditional Heteroskedasticity (GARCH)

In recent years, many authors have captured exchange rate volatility by using the conditional second moment as a proxy (e.g. Chou (2000), Clark, Tamirisa, Wei, Sadikov, and Zeng (2004), Olayungbo, Yinisa, and Akinlo (2011)), on the basis that this volatility measure outperforms other measures (Seabra, 1995). The underlying idea is that part of the exchange rate volatility is conditional upon historical information from previous periods, so that the volatility can be predicted based on past values of the exchange rate. This is because the exchange rate volatility measured by the GARCH measurement allows volatility clustering, meaning the size of past variances generate variances of similar size in the future and that volatility is predicted based on previous movements of the exchange rates.

This measure predicts volatility on the basis of past value. The GARCH model is useful in modelling variability in the exchange rate and inflation, whereas conventional time series and economic models operate under an assumption of constant variance (Hill, Griffiths, & Lim, 2008). This is because it allows the capturing of non-constant time varying conditional variance (Cheong, Mehari, Pattichis, & Williams, 2002).

In this research, the GARCH model is specific as follow:

The mean equation autoregressive order one is:

$$E_{i,t} = \alpha_1 + \alpha_2 E_{i,t-1} + \mu_{i,t}$$

The conditional variance equation is:

$$h_{i,t} = \beta_1 + \beta_2 \mu_{i,t-1}^2 + \beta_3 h_{i,t-1}$$

where the exchange rate is expressed in logs, $\mu_{i,t}$ denotes random error, β_1 is the mean, $\mu_{i,t-1}^2$ (the ARCH term) denotes volatility information from the previous period, measured as the lag of the squared residual from the mean equation, $h_{i,t-1}$ (the GARCH term) denotes the last period's forecast error variance.

Appendix 2. Vietnam's 50 most important import partners in 2012.

Order	Import partners	Import value	Order	Import partners	Import value
1	China	28,785,857,913	26	Lao	444,705,066
2	South Korea	15,535,903,876	27	Belgium	411,592,095
3	Japan	11,602,797,883	28	Switzerland	398,120,296
4	Singapore	6,690,330,106	29	New Zealand	384,858,257
5	Thailand	5,792,324,220	30	Chile	370,073,453
6	US	4,827,257,917	31	United Arab Emirates	303,828,851
7	Malaysia	3,412,468,865	32	Spain	283,735,500
8	Germany	2,377,388,845	33	Sweden	241,184,070
9	Indonesia	2,247,584,591	34	Qatar	233,506,204
10	India	2,161,010,979	35	Pakistan	215,858,758
11	Australia	1,772,171,499	36	Finland	204,323,810
12	France	1,589,117,046	37	Denmark	191,964,604
13	Brazil	1,019,324,669	38	Belarus	167,166,092
14	Italy	972,056,547	39	Poland	163,674,095
15	HongKong	969,514,066	40	Isreal	158,901,672
16	Philippines	964,524,131	41	Austria	157,468,414
17	Argentina	915,541,322	42	Norway	131,281,877
18	Saudi Arabia	886,532,437	43	Mexico	111,831,767
19	Russia	830,595,370	44	South Africa	111,076,847
20	Kuwait	708,665,684	45	Peru	96,594,859
21	Netherland	704,090,500	49	Ukraine	92,353,042
22	Ireland	647,027,766	47	Turkey	90,113,514
23	UK	542,149,264	48	Hungary	63,406,446
24	Cambodia	486,267,478	49	Czech Repulish	62,061,972
25	Canada	455,738,435	50	Greece	22,465,750

Source: Compiled by authors from GSO data.
Notes: Major import partners are select based on system-GMM estimation method. This resulted on 50 countries and accounted for over 90 percent of Vietnam imports.