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Effects of Exchange Rate Volatility on Export Performance In 53 Countries: A Dynamic Generalized Method of Moments Panel Approach

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ABSTRACT

There has been an ongoing concern about exchange rate volatility affecting international trade flows after the collapse of Bretton Wood system in early 1970s. The pull down of this fixed exchange rate system causes exchange rate float worldwide. The switching over to a floating regime leads to several speculations on the international trade effects of exchange rate volatility in both theoretical and empirical research. The aim of this paper is to analyze the impacts of exchange rate variability on export flows of 33 developed and 20 developing countries. A generalized method of moments (GMM) is employed on panel data over a ten-year period from 2003 to 2012. The empirical results suggest that exchange rate uncertainty has a statistically significant positive effect on exports in most cases, and the magnitude of the impact appears to be fairly large. All other remaining independent variables show expected signs as income and population have positive impact on exports whereas impact of relative price is negative. However, the effect of relative price is significant while the impacts of income and population are insignificant.

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INTRODUCTION

The collapse of the Bretton Woods fixed exchange rate system has led to significant fluctuation in exchange rate as the international monetary system moved towards a new regime. The liberalization of capital flows and increase in international financial transactions also contribute to amplify volatility of exchange rates. There were several speculations about the new floating regime when the international exchange rate system switched from fixed to floated system of exchange rates. Economists focused their interest in the study of relationship between exchange rate variability and international trade flows in both theoretical and empirical research.

From a theoretical point of view, the impact of exchange rate risk on international trade is not unambiguous. Several studies in this area claim that exchange rate change may have harmful effects on foreign trade flow. This is because the price is agreed at the time of signing contract but payment is not paid until the delivery actually takes place. If exchange rate variations become unpredictable, the risks of exchange rate increase uncertainty of international trade, which lead to risk-averse and risk-neutral traders reduce or leave their trading activities in contracts denominated in a foreign currency which ultimately decrease the trade flows. 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 opportunity for profit and may increase trade (Égert & Morales-Zumaquero, 2008).

However, from an empirical point of view, a large number of studies have been conducted to evaluate the relationship between exchange rate risk and international trade; it is still difficult to give a general definitive conclusion on whether there is any effect of exchange rate change on international trade flows because the results among those studies are inconsistent. The sign of this relationship vary with the choices of different methods of measurement of exchange rate volatility, data sets and estimation techniques used in these studies.

There exists an ambiguity about the relationship between exchange rate variability and foreign trade performance that requires more studies with different methods. The aim of this paper is to analyze the

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effects of exchange rate variability on export performance of 33 developed and 20 developing countries. In order to examine this impact, a panel dataset of 53 cross-sectional annually observations for the period from 2003 to 2012 is used. Moreover, this paper also generates volatilities of exchange rate by different methods to see whether or not a different method of volatility measurements cause a different trade impact.

The paper is organized as follows. Section 2 briefly reviews the literature on the impact of exchange rate uncertainty on international trade. Then, section 3 discusses about the methodology and data used in this study. After that, section 4 presents and discusses the estimation results. Finally, section 5 presents the conclusions and policy implication of this study.

Literature Review:

Early economic theory states a negative effect of exchange rate volatility on international trade as presented by Clark (1973), Ethier (1973), Hooper and Kohlhagen (1978) and Gagnon (1993), while other theoretical studies suggest a positive impact of exchange rate risk on foreign trade flow as argued by Franke (1991), Secru and Vanhulle (1992), Viaene and de Vries (1992), and Broll and Eckwert (1999). Besides that, theoretical developments stress that exchange rate uncertainty can influence on trade either positively or negatively as studies of Baldwin and Krugman (1989) and Dixit (1989). In addition, Willett (1986) suggest that exchange rate volatility have no impact on international trade. As theory alone cannot determine the sign of the relationship between exchange rate uncertainty and foreign trade, empirical research has studied the relationship between exchange rate change and international trade.

A vast amount of empirical studies has been conducted within and across the countries to reveal whether exchange rate fluctuation causes movements in trade volumes. These studies investigated this issue from the point of total trade as well as from the perspective of export and import discretely. However, from an empirical point of view, the relation between exchange rate risk and international trade levels is still mixed. The sign of this relationship varies with the choices of different methods to measure of exchange rate variability, data sets and estimation techniques used in these studies. Many empirical studies indicate that there is an adverse relationship between exchange rate uncertainty and foreign trade (McKenzie, 1999; Ozturk, 2006). In contrast, there are works proving exchange rate volatility have a positive impact on international trade flows, such as studies undertaken by Brada and Mendez (1988), McKenzie and Brooks (1997) , Olayungbo, Yinisa, and Akinlo (2011), Shehu and Zhang (2012) and Jiang (2014). In addition, there are studies suggesting that the exchange rate risk – trade relationship is not significant as argued by Hooper and Kohlhagen (1978), Bailey, Tavlas and Ulan (1986, 1987), McKenzie (1998), and Tenreyro (2007). Interestingly, some studies conclude that there may have both negative and positive impact of exchange rate variability on trade, namely research of Koray and Lastrapes (1989), Klein (1990), Kroner and Lastrapes (1993) , and Chou (2000).

Bailey and Tavlas (1988) used OLS-based study to investigate the impact of exchange rate uncertainty on trade and investment of the U.S. Two measures were used to proxy exchange rate volatility namely absolute value of quarterly percentage change in real effective rate, and deviation between real effective rate and forward effective rate. They found that exchange rate instability does not have any significant effect on trade flows. Their findings were little support for either hypothesis, which may result from their study ignored incorporate lag effects, so a lack of significant results was due to the model specification itself.

Kroner and Lastrapes (1993) investigated the impact of exchange rate variability on international trade of five industrialised countries by assessing export flows as a function of three lags of export volume, labour costs, relative price and exchange rate. They used a multivariate GARCH-in-mean model of the reduced form of multilateral exports, and found that the GARCH conditional variance has a statistically significant effect on the reduced form equations for all selected economies. In which, the results were mixed with varied signs and magnitudes, as exchange rate risk had a harmful impact on the exports of the USA and UK, while its effect on French and German export volume was positive, but no impact on export quantity of Japan.

Singh (2004) applied error correction model to study the impacts of exchange rate volatility on trade balance, which is measured by the difference between real exports and real import, in India. The authors modelled export (import) as a function of relative price, income and exchange rate uncertainty, which was calculated as the conditional variance of a GARCH model. Quarterly data from 1975 to 1996 is used, and as a result he could not find any significant effect of exchange rate instability on India's trade balance. Kasman and Kasman (2005) also used co-integration and error correction model to study the relationship between exchange rate variability and exports of Turkey with its major trading partners. In this study, they used quarterly data and measured exchange rate uncertainty by moving standard deviation of the logarithm of the real effective exchange rate. They found that the impact of exchange rate risk on trade is significantly positive in the long-run.

Chit, Rizov, and Willenbockel (2010) applied a generalized gravity model and panel data to examine the relationship between exchange rate instability

and exports of emerging East Asian economies. They found that there was a considerable negative impact of exchange rate volatility on trade of these developing nations. Particularly, they reported that when exchange rate increased one standard deviation unit (0.0052) resulting in a reduction by 4.2% in exports in these sample countries. Their findings were similar to Rose (2000) who used a panel random effects model and concluded that a one unit increase in exchange rate uncertainty declined trade flows by 4%.

Jiang (2014) studied export flows impact of the RMB exchange rate variability in China from 1981 to 2012. Similar to other studies applying co-integration procedure to analysis, this paper employed the Engle-Granger test, unit root test, and the ADF stationary test. The author concluded that there was a long-run stable relationship between exchange rate changes and international trade in China, and this was a positive relationship as a volatile currency could increase trade performance.

Model and Data Specification:

1.1. ***Model Specification:***

In this study, the equation for export volume is estimated using Arellano-Bond (1991) estimation method. The models estimated are as follow:

$$logX_{i,t} = \beta_{1i} + \beta_{12} logX_{i,t-1} + \beta_{13} \log Y^{f}_{i,t} + \beta_{14} \log RP_{i,t} + \beta_{15} logP^{f}_{i,t} + \beta_{16} V_{i,t} + \varepsilon_{1i,t}$$

$X_{i,t}$ represents export volume of country i to the rest of the world, $X_{i,t-1}$ denotes export volume of country i to the rest of the world lagged one period, $Y^{f}_{i,t}$ denotes income of country i's trading partners nations (foreign income of country i), $RP_{i,t}$ denotes relative prices of country i to those of its trading partners, $P^{f}_{i,t}$ denotes population of country i's trading partners (foreign population of country i), $V_{i,t}$ denotes exchange rate variability, $\varepsilon_{1i,t}$ is error term of export equation, i include 33 developed countries and 20 developing countries, t denotes time.

The foreign income and relative price variables were drawn from the analytic framework proposed by Bailey, Tavlas and Ulan (1986). The population variable was derived from the gravity model of Brada and Mendez (1988).

It is expected that the relationship between export of a country and income of its trading partners is positive because the demand for country i's exports may increase if its foreign income increases, so it is expected that β_{13} will take positive values. In contrast, if relative price (terms of trade) increases that means export price grow up leading the demand for country i's exports will decrease, so it is expected that β_{14} will be negative. It is likely that if population of country i's trading partners increase, the demand for country i's exports will increase, so it is expected that β_{15} will be positive. However, the effect of exchange rate volatility on export cannot be determined a priori, the sign of those are theoretically ambiguous (Siregar & Rajan, 2002; Kasman & Kasman, 2005; Todani & Munyama, 2005), and they are the focus of this empirical study.

1.2. Data Specification:

At the aggregate data level, the dataset includes fifty three countries, namely: Argentina Australia, Austria, Belgium, Brazil, Brunei, Cambodia, Canada, Chile, China, Cote d'lvoire, Czech Republic, Denmark, Ecuador, Finland, France, Germany, Ghana, HongKong, Hungary, India, Ireland, Italy, Japan, Kuwait, Lao, Malaysia, Mexico, Netherland, New Zealand, Nigeria, Pakistan, Paraguay, Peru, Philippines, Poland, Portugal, Russia, Singapore, Saudi Arabia, Senegal, Slovakia, South Africa, South Korea, Spain, Sweden, Switzerland, Thailand, United Arab Emirates, United Kingdom, United States, Uruguay and Vietnam. For example, aggregate dataset of country 1 as follow: country 1's aggregate exports volume ($EXPORT_1$), foreign income (GDP^F_1) which is constructed by taking the sum of the GDP volume series of country 1's nine most important trading partners (these nine trading partners account for over eighty per cent export of this country), terms of trade serving as relative price (RP_1), foreign population (POP^F_1) which is constructed by taking the sum of the population of country 1's nine most important trading partners and four exchange rate volatilities ($V_{i,t}$) generated from nominal effective exchange rate (NEER) and real effective exchange rate (REER) through the moving standard deviation of the change of effective exchange rate (MOVSD) in logarithm and the conditional variance from the generalized autoregressive conditional heteroscedasticity (GARCH) model for the effective exchange rate in logarithm.

The data used in the export equation was collected annually from 2003 to 2012. The export volume of fifty three countries (Year 2000 = 100) was collected from United Nations Conference on Trade and Development (UNCTAD). The GDP volume data series is used as a proxy of foreign income of fifty three sample countries was collected from the World Bank database (WB). The foreign income is the sum of GDP of top nine important trading partners. In order to aggregate trading partners GDP series, it was necessary to convert them to a common currency (the U.S. dollar is chosen) at constant price. The population data series as a proxy of foreign population of fifty three sample countries are also collected from the WB. The foreign population is sum of population of top nine important trading partners. Term of trade serving as relative price, NEER and REER of fifty three

countries (Year 2000 = 100) are also collected from UNCTAD.

There are eight data series used in the econometric estimation of export demand equation including the fifty three countries analysed: export volume (*EXPORT*), foreign income (GDP^F), relative price (*RP*), foreign population (Pop^F), real exchange rate volatility derived from the moving standard deviation method (*REERMOVSD*), nominal exchange rate volatility derived from the moving standard deviation method (*NEERMOVSD*), real exchange rate volatility derived from the GARCH method (*GARCHREER*), and nominal exchange rate volatility derived from the GARCH method (*GARCHNEER*).

1.3. Exchange rate volatility measures:

Exchange rate volatility captures the uncertainty faced by the international traders due to the unpredictable exchange rate risk (Todani & Munyama, 2005). 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 model to calculate exchange rate volatility.

1.3.1.The moving standard deviation:

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

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

where E_i is the first difference of natural 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 (m = 6 in this study).

1.3.2. Generalised Autoregressive Conditional Heteroskedasticity:

This measure predicts volatility on the basic of past value. The GARCH models 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 allow 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 are expressed in logarithms, $\mu_{i,t}$ denotes random error, β_1 is the mean, $\mu_{i,t-1}^2$ (the ARCH term) denotes news about volatility 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.

2. Estimation Method and Results:

2.1. Estimation Method:

The study applies system generalized method of moment (system-GMM) to investigate the relationship between export trade and exchange rate volatility due to many econometric advantages. Firstly, the system-GMM help to avoid problem of bias and inconsistency, which always occur in ordinary least square, pooled or fixed effects estimation, due to the dynamic nature is only captured by the GMM. Secondly, this estimation method allows considering more explanatory variables in regression without worries of the problem of endogeneity. Thirdly, the system-GMM can get the level values of variables back to the regression so the bias due to the decrease of data variation in the first differences in difference-GMM is corrected (Arellano & Bover, 1995; Blundell & Bond, 1998).

A generalized method of moments is used to estimate the above equation with lagged independent variables acting as instruments. Arellano and Bond develop tests for serial correlation in order to check some lags acting as instruments are valid or not. The Arellano – Bond test is applied to the error terms in difference. If $\varepsilon_{i,t}$ are themselves auto-correlated of order 1 then, for example, $y_{i,t-2}$ is endogenous to the $\varepsilon_{i,t-1}$ in the error term in difference, $\Delta\varepsilon_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$, making it an invalid instrument. Thus, in order to deal with this problem, the deeper lags in dependent variable should apply until there is no second-order serial correlation in differences is found.

Specification with real exchange rate volatility derived from the moving standard deviation method (*REERMOVSD*) are identified with the subscript "a", nominal exchange rate volatility derived from the moving standard deviation method (*NEERMOVSD*) with the subscript "b", real exchange rate volatility derived from the GARCH method (*GARCHREER*) with the subscript "c", nominal exchange rate volatility derived from the GARCH method (*GARCHNEER*) with the subscript "d".

2.2. Estimation Results:

The Arellano – Bond test for autocorrelation has a null hypothesis of no autocorrelation and is applied to the differenced residuals. The test for AR(1) process in first differences usually rejects the null

hypothesis that there is no serial correlation in the regression disturbances. This is because both $\Delta\varepsilon_{i,t} = \varepsilon_{i,t} - \varepsilon_{i,t-1}$ and $\Delta\varepsilon_{i,t-1} = \varepsilon_{i,t-1} - \varepsilon_{i,t-2}$ have $\varepsilon_{i,t-1}$. The test for AR(2) in first differences is more important, because it will detect autocorrelation in levels. The AR(1) and AR(2) tests of autocorrelation for the export equation are presented in Table 1. The results of AR(1) tests show that there is autocorrelation between $\Delta\varepsilon_{i,t}$ and $\Delta\varepsilon_{i,t-1}$. Since $\Delta\varepsilon_{i,t}$ and $\Delta\varepsilon_{i,t-1}$ are mathematically related via the share $\varepsilon_{i,t-1}$, negative first-order autocorrelation is expected in differences and evidence of it is uninformative. Therefore, in order to check for first order autocorrelation in levels, we look for second-order correlation in differences, on the basis that this will detect correlation between $\varepsilon_{i,t-1}$ in $\Delta\varepsilon_{i,t}$ and $\varepsilon_{i,t-2}$ in $\Delta\varepsilon_{i,t-2}$. The results of AR(2) tests show that there is no serial correlation between $\Delta\varepsilon_{i,t}$ and $\Delta\varepsilon_{i,t-2}$ as none of the value of AR(2) tests rejects the hypotheses that $\Delta\varepsilon_{i,t}$ is no autocorrelation to $\Delta\varepsilon_{i,t-2}$.

Table 1: Autocorrelation tests results for export equation

	AR(1)	AR(2)
REERMOVSD	-3.89 (0.000)	0.79 (0.427)
NEERMOVSD	-3.84 (0.000)	-0.86 (0.390)
GARCHREER	-3.88 (0.000)	-0.83 (0.404)
GARCHNEER	-3.85 (0.000)	-0.62 (0.534)

The figures in the parentheses are the p-value.

In the export regression, the second lag is used that means only the second lag of the endogenous variables as instruments. The second lag is required because it is not correlated with the current error term, while the first lag is. The main results of the impact of exchange rate variability on exports from GMM regression for the period from 2003 to 2012 are presented in table 2.

Table 2: Export Estimation Result (Dependent variable: Export volume)

Variables	Exchange rate volatility measures used			
	REERMOVSD	NEERMOVSD	GARCHREER	GARCHNEER
Lagged Export volume	1.0449*** (0.0184)	1.0428*** (0.1869)	1.0610*** (0.0207)	1.0368*** (0.2172)
Foreign Income	0.0030 (0.0211)	0.0008 (0.1665)	0.0057 (0.0172)	0.00076 (0.0189)
Relative price	-0.0386* (0.0226)	-0.0221* (0.1666)	-0.0255 (0.0166)	-0.0378* (0.0204)
Population	0.0050 (0.0102)	0.00036 (0.0091)	0.0057 (0.0066)	0.0080 (0.0077)
Exchange rate volatility	0.9467*** (0.2699)	0.7831*** (0.2560)	0.4403 (0.3686)	0.6775*** (0.1751)

*Notes: The figures in parentheses are standard errors. ***, **, and * in the table denote statistical significant coefficient at 1 per cent, 5 per cent and 10 percent level respectively. Specification with real exchange rate volatility derived from the moving standard deviation method (REERMOVSD), nominal exchange rate volatility derived from the moving standard deviation method (NEERMOVSD), real exchange rate volatility derived from the GARCH method (GARCHREER), and nominal exchange rate volatility derived from the GARCH method (GARCHNEER).*

Results confirm that exchange rate volatility has positive effects on exports. Most estimation results are statistically significant at 1 per cent level, with the exception of model of real exchange rate volatility derived from the GARCH method (GARCHREER). The finding of a positive impact of exchange rate volatility on exports is consistent with some previous studies. All other variables show the expected sign, as the effects on export flows of income, population and previous exports are positive whereas the impact of relative price is negative. While the impacts of lagged export and relative price variables are significant, the effects of income and population variables are insignificant. Since these two mentioned variables are insignificant, the paper will not report them.

The estimation results suggest that 1 per cent increase in exchange rate volatility leads to increase in aggregate exports of fifty three sample countries from 0.44 to 0.95 per cent, depending on the measures of exchange rate variability. This estimation results conform to theoretical postulations that support floating system of exchange rate and appear to be quite consistent with the findings of other empirical papers. For example: Olayungbo et al. (2011) concluded that 1 per cent increase in exchange rate risk would lead to an increase in trade to 1.06 per cent.

The estimation results also show that an increase in exports of the previous year has a positive effect on aggregate present exports of fifty three sample countries. The estimated coefficient is from 1.03 to

1.06. Given that the lagged export variables are expressed in logarithms, it can be interpreted as a 1 per cent increase in the previous exports will lead to a 1.03 to 1.06 percent increase in aggregate present exports of fifty three sample countries.

In contrast, an increase in relative price (terms of trade) of the export nations has a negative impact on their exports. The magnitude of the effect is approximately -0.38, which indicate that 1 per cent increase terms of trade lead to a reduction in exports about 0.38 per cent. This adverse relationship between terms of trade and exports is consistent with economic theory.

3. Conclusions and Policy Implications:

In this aggregate data analysis, two types of diagnostic tests were performed for the estimated equation. The Arellano – Bond tests for autocorrelation are applied to the residual in differences. The tests reflect 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 empirical results suggest that exchange rate variability has a statistically significant positive effect on exports in most cases. Results of this study are in line with other findings in this research area literature, for example De Grauwe (1988) argued that an increase in the exchange rate volatility raises the expected marginal utility of export revenue and hence enhance them to increase exports. In the case of relative price, it has a significant negative effect on exports, which is consistent with economic theory. The empirical results also show that foreign income and population have positive impacts on exports although these effects are not significant.

This result suggests that traders in fifty three selected countries perceive increase in volatility as opportunity for profit making and thus ready to export more in the face of increased exchange rate variability. The findings of this research can be used to formulate exchange rate policies oriented should not to minimize strong fluctuations. This is because exchange rate variability enhances the exports of the countries under analysis. Therefore, governments should not stimulate the use of instruments to reduce exchange rate variability, in order to maximize its positive effects on exports in the case if these countries prefer to increase their exports.

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