THE IMPACT OF CROSS EXCHANGE RATE VOLATILITY ON JAPAN’S FOREIGN TRADE: A GRAVITY MODEL APPROACH

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ABSTRACT

This paper examines Japan’s foreign trade with focus on the impact of cross exchange rate volatility on Japan’s foreign trade volume for the period 1980 to 2012. It uses a gravity equation framework. The result indicates that volatility has a negative and significant effect on Japan’s exports volumes while imports volumes are positively affected by volatility. This paper recommends a shift from float to managed float regime

Key words- Trade, exchange rate, Garch, volatility, Japan, ASEAN
INTRODUCTION

The breakdown of Bretton-Woods order in the early 1970’s marked the beginning of floating exchange rate schemes. Under the floating exchange rate regime, fluctuations in exchange rate are more persistent there by increasing risk and uncertainty in international economic transactions. Sharp fluctuations in the exchange rate increase international economic instability and thus transaction cost. Volatility in exchange rate compounded by the existence of rent seeking speculative capital movements has rendered economic planning extremely difficult especially for developing countries which are heavily reliant on commodity exports. Given the unpredictable distributional effect of exchange rate fluctuations, there has been considerable research in view of identifying potential losers and winners as well as gauging the differential impact of exchange rate volatility on different economic sectors.

Using conditional volatility generated from a GARCH model, this paper employs a gravity model framework to estimate the impact of cross exchange rate fluctuation on Japan’s foreign trade with 171 partner countries. The contribution of this study resides in the fact that unlike some previous studies which used variance or standard deviation of exchange rate fluctuations, this study employs conditional volatility of exchange rate fluctuations. Conditional volatility of exchange rate appears to be a better proxy of uncertainty than variance or standard deviation.

Equally this study is unique in terms of the number of trading partners involved. Consequently the policy implications have greater external validity. Secondly the study is robust in that it uses both a fixed effect identification strategy and Tobit regression in estimating the gravity equation.
LITERATURE REVIEW

Literature on exchange rate volatility and international trade is fairly plentiful. Chowdhury (1993) investigates the impact of exchange rate volatility on trade flows among G7 countries and finds a strong negative effect on export volumes. Tenreyo (2007) in a multi-country study finds no impact of exchange rate variability on trade flow among a broad sample of countries between 1970 to 1997. Arize (1998) on his part finds a negative effect of exchange rate volatility on imports of 6 out of 8 European countries with the exception of Greece and Sweden.

Some studies have focused principally on investigating the effect of one country’s exchange rate volatility on its trading partners. Among them, Zakaria (2013) empirically studies the relationship between export and exchange rate volatility in the case of Malaysia and its major trading partners. He uses a Garch model to generate exchange rate volatility. He concludes that the impact of exchange rate volatility on Malaysia’s exports to the USA is negative while exchange rate volatility had no significant effect on Malaysia’s exports to the UK and Singapore. On their part, Baak, Mamood and Vixathep (2007) finds that exchange rate volatility between the Yen and the currencies of East Asian countries had a negative impact on the exports of these countries to Japan be it in the short or long run.

The last group of studies are on “pure bilateral” trade, where only one specific country and its main trading partner is examined. Nishimura and Hirayama (2013) use an ARCH model to ascertain whether exchange rate volatility inhibits bilateral trade between Japan and China. They find no significant effect of exchange rate volatility on bilateral trade between Japan and China.
Amongst studies which find a positive effect, Gotur (1985) re-examines the Akhtar and Spencer model by including USA, Germany, France, Japan and the UK. He finds a positive and significant effect of exchange rate volatility on trade volumes. McKenzie and Brooks (1997) finds a significant positive effect of exchange rate volatility on the volume of bilateral trade between Germany & USA for the period 1973 to 1992. Kasman and Kasman (2005) find a significant positive impact of exchange rate volatility on Turkey’s export volumes to its major trading partners.

On the other hand a host of studies have found a significant negative effect of exchange rate volatility on trade volumes. Among these studies we have that of Akhtar and Hilton (1984), they analyze exchange rate volatility and bilateral trade volume between Germany & USA. Their results suggest that variability in exchange rate negatively affects German bilateral trade in general and the exports of the USA.

From the above literature survey it appears clearly that there is no consensus on the impact of exchange rate volatility on trade volumes. The contribution of this study resides in the fact that unlike some previous studies which used variance or standard deviation of exchange rate fluctuation, this study employs conditional volatility of exchange rate fluctuations derived from GARCH models. Conditional volatility of exchange rate appears to be a better proxy of uncertainty than variance or standard deviation.

The main result of this study suggests a negative effect of volatility on Japan’s export volume irrespective of the identification strategy and the vector of controls. With regards to import volumes, it appears that on average volatility has a positive and significant effect on Japan’s import.
DATA AND METHODS

Data

To estimate the above gravity equation, we collect relevant data from various international sources. Annual Data is collected for the period 1980 to 2012 for 174 countries trading with Japan. Annual export and import data are collected from IMF’s Direction of Trade Statistics (DOTS). With regards to GDP data, they are collected from the World Bank’s WDI (World Development Indicators). All GDP data are at 2005 constant US. The distance between Japan’s capital city (Tokyo) and the capital city of its 174 trading partners is measured in Kilometers and it is obtained from GEOBYTES.

Method

Measuring Exchange Rate Uncertainty

Developing an appropriate measure of cross exchange rate volatility is central in this study. The GARCH models are widely used to estimate the variance of the unpredictable component in exchange rate uncertainty. Bollerslev (1986) pioneered the usage of this model. The variance of the time varying residuals derived from the estimates of the GARCH model is used as a measure of exchange rate volatility

The GARCH model is specified as follows

Mean Equation

\[ \pi_t = \alpha_0 + \sum_{i=1}^{k} \alpha_i \pi_{t-1} + \varepsilon_t \]
Variance Equation

\[ h_t = \gamma_0 + \sum_{i=1}^{p} \beta_i \varepsilon_{t-1}^2 + \sum_{i=1}^{q} \gamma_i h_{t-i} \] .................................2

Where \( h_t \) represents the conditional variance measuring exchange rate uncertainty.

\[ E(\varepsilon_t | I_{t-1}) = 0 \quad \text{and} \quad E(\varepsilon_t^2 | I_{t-1}) = h_t. \]

\( \pi_t \), is the log difference of cross exchange rate. \( \pi_{t-1} \) is the monthly lag value of \( \pi_t \). \( I_t \) represents the information set available at time \( t \).

In line with the studies of Fountas, (2004) as well as Jiranyakul and Opiela (2010), this study assumes that the mean equation follows an auto regressive process of the conditional mean of the cross exchange rate.

2.2.2 Gravity Model

In other to examine the impact of cross exchange rate volatility on Japan’s foreign trade, this study uses a modified version of the original gravity model propounded by Tinbergen (1962). Our main variables of interest in examining Japan’s foreign trade are: the log of real GDP (\( GDP_{it} \)) and GDP per capita (\( GDP_{PC} \)) of Japan’s trading partner \( t \) at time \( t \) and most importantly volatility in cross exchange rate (\( VOL_{it} \)) i.e between the Yen and the currency of its trading partners. Distance (\( DIST_{it} \)) is proxy for transportation and transaction cost.

Our modified gravity equation is thus specified as:

\[ TRADE_{it} = \beta_0 + \beta_1 GDP_{it} + \beta_2 GDP_{PC}_{it} + \beta_3 VOL_{it} + \beta_4 DIST_{it} + \beta_5 ASEANP3 + \beta_6 G20 + \varepsilon_{it} \] .................................................................3
Where, $i$ represents any of Japan’s 171 trading partners and $\tau$ is time measured in years. $TRADE_{it}$ is volume of real export and import between Japan and country $i$ at time(year) $\tau$. It is measured in US dollars and adjusted using US GDP deflator. The log of real Gross Domestic Product of each of Japan’s trading partners ($GDP_{it}$) represents the economic mass of each trading partner $i$ at time (year)$\tau$. The log of real GDP per capita ($GDPPC_{it}$) of each of Japan’s trading partners represents the purchasing power of citizens in trading partner $i$ at time(year) $\tau$.

$VOL_{it}$ is our main variable of interest. It is a measure of uncertainty (volatility) in exchange rate between the Japanese Yen and the currency of country $i$ at time (year) $\tau$.

In order to gauge the impact of regional trade agreements as well as the impact of trading with the most advanced and emerging economies we include the ASEANP3 and G20 in our gravity equation. Both are dummy variables isolating the impact of trading with a country that is either an ASEAN or G20 member State. As can be seen from the above gravity equation, our identification strategy is essentially fixed effect panel data estimation. The fixed effect identification strategy is effective in eliminating time invariant country specific factors that are potentially correlated with our error term.

Given the result of several studies which points to a positive effect of regional trade agreement on volume of trade, we expect $\beta_5$ to be positive in other words been a member state of the ASEAN community should lead to an increase in the country’s trade volume . The impact of exchange rate uncertainty(volatility) on trade volume is mixed and unclear. Kyriacos (2001), and Shunji(2006) finds no effect of exchange rate volatility on trade volume. Identifying the impact of exchange rate volatility (uncertainty) on the volume of Japan’s foreign trade is the central objective of this study.
RESULTS AND ANALYSIS

Table 1: Results of Gravity model estimation

<table>
<thead>
<tr>
<th></th>
<th>EXPORTS</th>
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<th>IMPORTS</th>
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<tbody>
<tr>
<td></td>
<td>OLS</td>
<td>FIXED EFECT</td>
<td>TOBIT</td>
<td>OLS</td>
</tr>
<tr>
<td>$GDP_{it}$</td>
<td>0.8302</td>
<td>-0.4818</td>
<td>0.8379</td>
<td>0.8965</td>
</tr>
<tr>
<td></td>
<td>(0.0103)**</td>
<td>(0.4313)</td>
<td>(0.0107)**</td>
<td>(0.0129)**</td>
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<tr>
<td>$GDPPC_{it}$</td>
<td>0.1248</td>
<td>1.4050</td>
<td>0.1191</td>
<td>0.1992</td>
</tr>
<tr>
<td></td>
<td>(0.0135)**</td>
<td>(0.3842)**</td>
<td>(0.0139)**</td>
<td>(0.0164)**</td>
</tr>
<tr>
<td>$VOL_{it}$</td>
<td>-0.0140</td>
<td>-0.0342</td>
<td>-0.0136</td>
<td>0.0930</td>
</tr>
<tr>
<td></td>
<td>(0.0064)**</td>
<td>(0.0100)**</td>
<td>(0.0064)**</td>
<td>(0.0340)*</td>
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<tr>
<td>$DIST_{it}$</td>
<td>-0.6390</td>
<td>-</td>
<td>-0.6571</td>
<td>-0.6199</td>
</tr>
<tr>
<td></td>
<td>(0.0537)**</td>
<td>(0.0540)**</td>
<td>(0.0622)**</td>
<td>(0.0640)**</td>
</tr>
<tr>
<td>$ASEANP3$</td>
<td>1.3205</td>
<td>-</td>
<td>1.3026</td>
<td>1.9992</td>
</tr>
<tr>
<td></td>
<td>(0.0918)**</td>
<td>(0.0915)**</td>
<td>(0.0888)**</td>
<td>(0.0898)**</td>
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<tr>
<td>$G20$</td>
<td>0.3081</td>
<td>-</td>
<td>0.2905</td>
<td>0.5594</td>
</tr>
<tr>
<td></td>
<td>(0.0543)**</td>
<td>-</td>
<td>(0.0546)**</td>
<td>(0.0767)**</td>
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<tr>
<td>R-square</td>
<td>0.7781</td>
<td>0.0026</td>
<td>0.3090</td>
<td>0.7636</td>
</tr>
</tbody>
</table>

Notes: (1) Export and Import are the dependent variables. (2) Robust standard errors are represented in parenthesis. (3)***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Analysis

The base line OLS estimation points to a strong negative and significant effect of volatility on Japan’s exports. On the other hand, Volatility appears to have a positive effect on Japan’s imports. The OLS results should be taken with precaution given potential endogeneity problems. The direction and significance of $GDP$ and $GDPPC$ are in line with our intuition. Both GDP and GDPPC appear to have a strong significant positive effect on both Japan’s import and export. Simple OLS estimations equally reveal a negative and significant effect of distance on both import and export. On
average ASEANP3 and G20 countries have a greater effect on Japan’s export and import volumes compared to non ASEANP3 and Non G20 countries. Fixed effect estimation confirms the significant negative effect of exchange rate Volatility on Japan’s exports. It however reveals a strongly significant positive effect of volatility on imports. The signs of the other variables are identical to those revealed by the OLS estimation. The outcome of the Tobit regression estimates is also similar to that of the fixed effect estimations.

In this study we have identified a negative but marginal effect of volatility on Japan’s export volume irrespective of the identification strategy and the vector of controls. With regards to import volumes, it appears that on average volatility has a positive effect on Japan’s import volume. This study reveals that on average higher volatility in cross exchange rate is associated with higher import volumes.

There is no unanimity on the effect of exchange rate volatility on trade volumes. Iwatsubo and Karikomi (2006) found no effect of exchange rate volatility between the Yen and Yuan on the volume of bilateral trade between Japan and China. Ozturk(2006) concludes that there is a mixed effect of exchange rate volatility on trade volumes. He argues that the magnitude and direction of the causality depends on a wide range of such as model specification, proxies for volatility, and countries considered.

**Policy Recommendations**

In line with the above explanations, this study recommends Japan’s monetary authorities to either curb excessive fluctuation of the Yen by adopting a managed floator crawling bandregime.
Secondly a depreciation of the Yen may help in boosting exports and thus restore trade balance. This approach seems to have been adopted by the present government as a way of restoring trade balance

In line with McKenzie (1999), this study recommends further research on the impact of exchange range volatility on trade flows with focus on sector specific analyses. Disaggregating trade data into specific sector and gauging the impact of volatility on each sector will certainly provide more detailed insights on the potential impact of volatility on trade volumes and thus lead to more precise policy recommendation.

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