UK imports, third country effect and the global financial crisis: Evidence from the asymmetric ARDL method[1]

Taufiq Choudhry[2a], Syed Shabi Ul Hassan[a] and Fotios I. Papadimitriou[a]

[a]University of Southampton, School of Management, UK

Forthcoming in International Review of Financial Analysis
Doi (Published version): 10.1016/j.irfa.2013.11.003

Abstract

This paper examines the role of exchange rate volatility in determining real imports. As a robustness check, it further explores the impact of the recent global financial crisis which is a period characterized by heightened exchange rate volatility. More specifically, we investigate the impact of exchange rate volatility on UK real imports from Germany, Japan and the US during the period January 1991 – March 2013. In contrast to most studies which focus on bilateral trade, we additionally explore the third country exchange rate volatility effect on UK imports. To capture the nonlinear features which often characterize macroeconomic data, we employ the asymmetric autoregressive distributed lag (ARDL) approach to cointegration. Our results suggest that exchange rate volatility plays an important role and reveal that there is a significant effect of the recent financial crisis on UK imports. This finding is consistent when we test for the third country volatility effect. Finally, we find that there is a significant causal relationship between exchange rate volatility and UK imports both in bilateral tests and in tests which account for the third country exchange rate volatility.

JEL Classification: F1, F10

Keywords: Real imports, Exchange Rate Volatility, Asymmetric Cointegration, Financial Crisis

[1] We thank two anonymous referees for several useful comments and suggestions. We also thank the participants at the International Conference on the Global Financial Crisis: European Financial Markets and Institutions, in Southampton, UK, 25-26 April, 2013, The Fourth World Finance Conference in Limassol, Cyprus, 1-3 July, 2013, The Warsaw International Economic Meeting in Warsaw, Poland, 4-6 July, 2013, and the 22nd International Business Research Conference in Madrid, Spain, 9-10 September, 2013, for helpful comments and discussions on an earlier version of the paper.
[2] Corresponding author. E-mail: t.choudhry@soton.ac.uk, Phone: +442380599286, Address: School of Management, University of Southampton, Southampton, SO17 1BJ, UK.

1. Introduction

Exchange rate volatility has important implications for both exchange rate and trade policies. As a source of uncertainty, it is one of the main issues of concern for market participants, trade economists and policy makers who seek to determine whether an increase in exchange rate volatility affects international trade flow (see, Arize, 1998; Choudhry, 2005). A theoretical framework seems to indicate a negative relationship between international trade flow and exchange rate volatility. This is because higher exchange rate volatility leads to a higher cost for risk-averse traders and to lesser foreign trade (Arize et al., 2000). Several empirical studies indeed confirm the view that exchange rate volatility reduces international trade flow (see, *inter alia*, Chowdhury, 1993; Arize, 1995, 1998; and Arize et al., 2000). On the other hand, there are a number of papers which suggest that exchange rate volatility imposes a positive effect on international trade (see, Asseery and Peel, 1991; Franke, 1991; Giovannini, 1988; Sercu and Vanhulle, 1992; and Dellas and Zilberfarb, 1993). However, DeGrauwe (1988) argues that the relationship between exchange rate volatility and trade flow is analytically indeterminate.[3] Moreover, Sercu and Uppal (2003) show that the relationship between international trade and exchange rate volatility can be either negative or positive depending on the underlying source for the change in exchange rate volatility.

The conflicting results in the extant literature on international trade pose a very interesting empirical question which requires further empirical work on two dimensions: What is the effect of exchange rate volatility on international trade? Furthermore, what is the impact of the recent global financial crisis on international trade given that this period is associated with higher exchange rate volatility? Within this context, we make the following contributions to the literature.

[3] Some previous studies have also documented little or no significant effect of the exchange rate variability on international trade (e.g., Koray and Lastrapes, 1989; Bahmani-Oskooee, 1991; and Gagnon, 1993).

First, we extend previous work and provide some new insights on the matter by investigating the impact of exchange rate volatility, together with real income and the relative import price, on UK imports from Germany, Japan and the US during the period January 1991-March 2013. The existing work on the relationship between UK imports and exchange rate volatility is rather limited and there is no consensus regarding whether it is positive or a negative one (see, Kroner and Lastrapes, 1993; Chowdhury, 1993; Qian and Varangis, 1994; Doyle, 2001; and Choudhry, 2005). The aforementioned three countries are chosen because they are the major trading partners of the UK.[4] In addition, the fact that they are geographically dispersed, adds value to the generality and significance of our main findings. Hence, it is of importance to investigate the effect of exchange rate volatility on UK trade.

For a more in-depth analysis, we further explore the price elasticity of UK imports from these countries as this is linked to whether the aforementioned relationship is expected to be positive or a negative one. In particular, if imports are price elastic this implies that an increase in the import price relative to the domestic price is expected to decrease the import volume, resulting in an inverse relationship between exchange rate volatility and imports (Cushman, 1986 and Viaene and de Vries, 1992). To estimate the price elasticity of demand for UK imports, we employ the Bahmani-Oskooee and Kara (2005) method.

Second, to our knowledge, this is the first study to explore the impact of the recent financial crisis on UK trade. This is of vital importance and provides new avenues for research especially due to the fact that during the crisis period volatility tends to increase

[4]Direction of trade data (IMF, 2012) reports that UK imports from these three countries represent 27% of its total imports and 34% of its imports from developed countries. Since 1993 Germany has been the top exporter to the UK based on annual imports data. The US was second until 2008 when China replaced it. Japan was the top Asian exporter to the UK until 2002 and has remained second after China ever since. UK imports from Germany, Japan and the US consist mainly of capital goods. Major import sectors include: electrical/electronic equipment; machinery, nuclear reactors and boilers; optical/medical apparatus; precious metals and stones; aircraft/spacecraft and parts thereof; plastic and rubber articles, paper, paperboard, pulp and related articles; pharmaceuticals; vehicles; articles of iron and steel; mineral fuels, oils and distillation products (UN Comtrade, 2013). These sectors constitute more than 75% of UK import volume from these countries, respectively.

(Fratzscher, 2009; Melvin and Taylor, 2009).[5] This part of the study also serves as a robustness check during a period characterized by heightened exchange rate volatility.

Third, unlike the majority of studies which generally focus on bilateral trade, we investigate the effect of the third country exchange rate volatility on UK imports. The third country effect is important from the point of view of competition as every exporting country is competing against other countries. Cushman (1986) argues that the effect of exchange risk on bilateral and aggregate trade flows should be analyzed by accounting for the impact of third-country exchange risk factors in addition to direct bilateral risk. Hence, this aspect of our analysis may have significant implications for understanding the relationship dynamics between exchange rate volatility and trade. Additionally, it allows us to offer some fresh evidence regarding the role of the third country effect and the channels (especially exchange rate volatility) through which the recent financial crisis has affected international trade flows (McKenzie, 1999; Bahmani-Oskooee and Hegerty, 2007; and Abiad et al., 2011).

Fourth, we extend the existing evidence by employing the asymmetric autoregressive distributed lag (ARDL) approach to cointegration advanced by Shin et al. (2013) as an extension of the linear cointegration technique proposed by Pesaran et al. (2001). Despite the well-known fact that macroeconomic variables possess asymmetric and nonlinear features (Keynes, 1936; Kahneman and Tversky, 1979; Shiller 1993, 2005; Shin et al., 2013), research on the relationship between UK trade and exchange rate volatility has been tested only within a linear framework so far.

Our key findings can be summarized as follows. Based on the asymmetric ARDL method, we find significant evidence of cointegration between UK real imports, exchange rate

[5] Along with global trade imbalances and the credit crunch, other factors that can trigger a decline in international trade include: disruption of global value chains, rise in protectionism polices, disproportionate fall in the demand for tradable goods, inventory adjustments and postponement of durable goods purchases (see, Evenett, 2009; Jacks et al., 2011; Alessandria et al., 2010; Yi, 2009; Fratzscher, 2012; Behrens et al., 2013).

volatility, UK real income and relative import prices when Japan and the US are considered as UK's trading partners. This result holds in the pre-crisis period but it is also consistent when the crisis period is included in the sample suggesting the importance of the asymmetric long-run equilibrium relationship between UK real imports and its determinants. When the bilateral representation of the model is modified to account for the third country effect, we find strong evidence of cointegration confirming our prior belief that the third country exchange risk should be included in the model. This is more evident in the case of Germany. The importance of exchange rate volatility and the third country effect is further confirmed by the estimated coefficients of the long-run asymmetric elasticities. Finally, Granger causality tests suggest the importance of the determinant variables on UK imports in the long-run, a result that holds within the pre-crisis period and also when the crisis included in the sample. Accounting for the third country effect, we find significant evidence of short-term causality from the relevant third country exchange rate volatility to UK imports (i.e. from the US dollar/British pound volatility when the US plays the role of the third country or from the Euro/British pound volatility when UK imports from the US are considered).

The remainder of the paper is organized in the following manner. Section 2 provides a discussion which links exchange rate volatility and the recent financial crisis to international trade. Section 3 describes the data and the estimation of the exchange rate volatility while it also includes the unit root tests results. Section 4 offers the methodological approach and discusses the results obtained from the employed models. Finally, the conclusion is presented in section 5.

2. Exchange Rate Volatility, Financial Crisis and the Effect on International Trade

Financial crises have been a consistent element of the economic history. Reinhart and Rogoff

(2009a,b) have reported that since the 1970s debt and financial (banking) crises have been relatively more frequent. Periods of financial turmoil are generally followed by large and persistent declines in output and employment, deep and prolonged asset market downfalls and surge in government debt (see, Baldwin, 2009; and Abiad et al., 2011). However, the empirical evidence on the effects of the financial crisis on international trade is rather limited. Moreover, although periods of financial crises are characterized by heightened volatility which affects macroeconomic variables, very few papers have assessed the impact of such crises on trade flows through exchange rate volatility channels. For example, Abiad et al. (2011) employ data from 153 economies spanning the 1970-2009 period and report that exchange rate volatility is one of the most important intervening variables which can explain changes in imports and exports in pre/post financial crisis scenarios.

During the recent financial crisis highly volatile movements across all asset classes have occurred globally, including foreign exchange markets (Fratzscher, 2009; Melvin and Taylor, 2009). Fratzscher (2009) mentions three main factors which are responsible for the higher exchange rate volatility during this period. First, countries with large financial liabilities relative to the US experienced enormous currency depreciations. The second factor is the size of the foreign exchange (FX) reserves. As Fratzscher (2009) shows, the currencies of countries with FX reserves to GDP ratios below the cross-country average, declined by 23% on average, while the ones with higher than average reserves, depreciated only by 7% against the US dollar since the summer of 2008. Hence, countries with seemingly 'excessive' FX reserves were able to control the pressure on their respective currencies, while economies where certain reserves were accumulated for precautionary motives could not absorb the shocks caused by the financial crisis. The third driving factor is the current account position; Countries with a higher than average current account position faced only a 10% depreciation

against the US dollar whereas those with large current account deficits faced, on average, a depreciation of 22% between July 2008 and February 2009. The importance of the current account position in this context has also been stressed by Chor and Manova (2010). Given the above, our paper aims to fill the gap in the literature by analysing the relationship between UK trade and exchange rate volatility within the context of the recent financial crisis.

3. Data, Exchange Rate Volatility results and Unit Root Tests

The monthly data employed cover the period from January 1991 to March 2013.[6] The price indices are the import price indices for all four countries. The UK real income is represented by the real personal income. The nominal exchange rate applied is defined as the foreign currency per UK sterling. The corresponding real exchange rate is defined as the log of (ex-n)*(PUK/PF), where ex-denotes the nominal exchange rate between the UK pound and the other currencies, PUK is the UK price index and PF is the price index of either Germany, Japan or the US. All data are obtained from the Thompson Financial DataStream.

The real exchange rate volatility is estimated by means of the univariate GARCH(1,1) model.[7] Table 1 presents the univariate GARCH(1,1) estimations for all three real exchange rates.[8] In all cases, the ARCH coefficient (α_1) is found to be significant implying volatility clustering. Moreover, the Ljung-Box (1978) statistic fails to indicate any serial correlation in the standardized residuals and the standardized squared residuals at the 5% level using 6 lags. Absence of serial correlation in the standardized squared residuals implies the lack of need to encompass a higher order ARCH process (Giannopoulos, 1995).

[6] Trade data from Japan and Germany were only available until March 2013.
[7] Kroner and Lastrapes (1993), Caporate and Doroodian (1994), Lee (1999) and Choudhry (2005) also use GARCH models to estimate exchange rate volatility.
[8] We considered different combinations of p and q lags with 2 being set as the maximum lag length. However, the results based on the log-likelihood function and the likelihood ratio tests indicate that the best (p,q) combination is when p=q=1. These results are available on request.

[Insert Table 1 around here]

Figure 1 shows the estimated volatility (conditional variance) with respect to all real exchange rates and log of real imports. The increase in volatility during the crisis period can be clearly observed for all exchange rates. Given this jump in the exchange rate volatilities, it is of interest to empirically examine to what extent UK imports have been affected by large exchange rate movements. Moreover, as it can be seen on all three graphs, there is a decline in real imports when exchange rate volatility increases. These movements based on visual inspection further advocate our empirical investigation. Based on the Jarque and Bera (1987) test, we find that almost all series follow a non-normal distribution. Also, most series exhibit positive kurtosis and negative skewness.[9]

As required by cointegration tests, first the order of integration of each series needs to be determined. This paper applies the augmented Dickey and Fuller (1979) test and the Kwiatkowski et al. (1992) (KPSS) test. The results indicate that most series are level non-stationary and that all first differenced series are stationary. The exchange rate volatilities are found to be stationary in levels and this is true also for the Japanese real income. These results are available on request. Different order of integration between the variables in levels does not pose any problem in the implementation of both the symmetric and the asymmetric ARDL methods we employ in our paper (Pesaran et al., 2001 and Shin et al., 2013).

4. Methodology and Results

4.1. Main Model Employed

This paper employs a model similar to the one used in Arize et al. (2000) and Choudhry (2005). The following relationship is tested to check for the effects of the exchange rate

[9] The descriptive statistics and the unit root test results that follow are available on request.

volatility on UK real imports:

$$\ln(m_t) = \delta_1 \ln(Y_t) + \delta_2 \ln(P_t) + \delta_3 \ln(V_t) + \varepsilon_t \quad (1)$$

where $\ln(m_t)$ is the log of real UK imports from either Germany, Japan or the US, Y_t is the log of real UK income, P_t is a measure of relative imports prices from Germany, Japan or the US to the United Kingdom, V_t is the corresponding exchange rate volatility and ε is the error term. In this paper, the conditional variance of the first difference of the log of the exchange rate is applied as volatility. Equation (1) can be derived as a long-run solution of behavioural demand and supply functions for exports (Gotur, 1985). Based on standard theory, the real income of the importing country should have a positive effect on the import level (Bailey et al., 1986, 1987). Thus, the coefficient on real income (δ_1) is expected to be positive. The relative price is the ratio of the import prices of Germany, Japan or the US to the UK. Changes in the price ratio represent changes in the terms of trade, reflecting the impact of changes in nominal exchange rates, differing rates of inflation among countries and changes in relative prices in each country between its non-traded goods and its exports (Bailey et al., 1986, 1987). According to Arize (1995) and Arize et al. (2000), the coefficient of the price ratio (δ_2) should be negative. As indicated by Bailey et al. (1986, 1987) and Arize (1995), the influence of the exchange rate volatility (V_t) on trade is uncertain. Investigation of the size and direction of the impact imposed by the exchange rate volatility (V_t) on the UK imports before and during the recent financial crisis is one of the main themes of our study. To empirically investigate the effect of the recent financial crisis, we first estimate equation (1) by applying the asymmetric ARDL method during the pre-crisis period (January 1991-June 2007). Subsequently, we add the crisis period to the sample (July 2007-March 2013) to make the total period January 1991- March 2013. This approach serves as a useful robustness check in our study given that the crisis period is characterized by heightened volatility. If

cointegration is confirmed, general-to-specific causality tests are conducted to study the direction of the effect between the variables during both in the long and in the short-run.

4.2 Testing for the Third Country Effect

The literature on international trade predominantly assumes a two-country world (i.e. where the domestic market trades with only one foreign market). Therefore, almost all models are based on the assumption that importers and exporters have to decide between doing business domestically or with the sole trading partner. However, this assumption is restrictive since in reality importers and exporters can select from many markets around the globe and they are not limited to just one trading partner. This modification in the traditional international trade theory warrants the inclusion of the third country effect as suggested by Bahmani-Oskooee and Hegerty (2007). According to Cushman (1986) this is a very important aspect in terms of global competition as changes caused in the trade pattern between two countries could be caused by exchange rate movements of another country's (not involved in the trade) currency against the home country. In other words, the exchange rate movement may divert importers in the domestic country from one trading partner to another. Similarly, exporters in the domestic country may decide to sell their products to another country due to better price prospects.

To investigate the impact of the third country exchange rate volatility on UK real imports, we modify equation (1) in the following manner:

$$\ln(m_t) = \delta_1 \ln(Y_t) + \delta_2 \ln(P_t) + \delta_3 \ln(V_t) + \delta_4 \ln(TCV_t) + \varepsilon_t \qquad (2)$$

where *TCV* is the third country exchange rate volatility. In tests between the UK and Germany or Japan, the third country exchange rate volatility is represented by the pound/dollar exchange rate volatility. In tests between the UK and the US, the third country

volatility is represented by the pound/euro variability. Similar to equation (1) and V_t, the conditional variance of the first difference of the log of the third country exchange rate is applied as volatility (*TCV*). The sign on the coefficient δ_4 is also uncertain just as in the case of δ_3. The other variables are defined as earlier. Equation (2) is also estimated by means of asymmetric ARDL method first for the pre-crisis period (1990-2007) and then the crisis period (2007-2013) is added for a re-estimation. Thus, we also investigate the effect of the crisis via the third country exchange rate volatility. The causality tests are further conducted to study the direction of the effect between the variables.

4.3. Asymmetric ARDL Approach and Results

The long-run relationship between exchange rate volatility and UK's imports is explored using the nonlinear asymmetric ARDL method proposed by Shin et al. (2013).[10] Standard cointegration literature establishes the long and short-run relationship between different the variables. However, it implicitly assumes that this relationship is symmetric and the impact of positive and negative components within each independent variable is similar (Schorderet, 2001; Shin et al., 2013). This has led many researchers to explore asymmetries in the underlying relationship among various macroeconomic variables (Schorderet, 2001; Park and Phillips, 2001; Saikkonen and Choi, 2004; Escribano et al., 2006; Bae and de Jong, 2007; and Shin et al., 2013).

Moreover, one of the main advantages of the ARDL technique over the other cointegration methods is that it is robust to the stochastic behaviour of the variables and does not require any underlying assumptions regarding the order of integration of the variables. Hence, this approach avoids the pre-testing problem associated with the order of integration of variables

[10] This method has also been applied in some recent studies (see, Greenwood-Nimmo and Shin, 2011; Karantininis et al., 2011; Cho, Kim and Shin, 2012; Garz, 2012; Katrakilidis et al., 2012; Katrakilidis and Trachanas, 2012).

that standard cointegration techniques encounter (Pesaran et al., 2001 and Shin et al., 2013). The first step of the Shin et al. (2013) method is to decompose all of the exogenous variables into partial sum processes. The partial sum processes are defined as follows:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_t^+ = \sum_{j=1}^{t} \max(\Delta x_j, \bar{x});\ x_t^- = \sum_{j=1}^{t} \Delta x_t^- = \sum_{j=1}^{t} \min(\Delta x_j, \bar{x}) \quad (3)$$

Here Δx_t are the changes in independent variables (x_t) whereas + and – superscripts indicate the positive and negative processes. In equation (3), the threshold[11] is set equal to the mean of the respective independent variables, which delineates the positive and negative shocks in the independent variables. Although ideally first differenced series should be normally distributed with zero mean, financial time series often tend to have a non-zero mean. In that case, setting a zero threshold may bias the positive/negative partial sums, because the number of effective observations in the negative or positive regime may be insufficient for the OLS estimator. Therefore, setting the threshold as the mean of the respective variables is valid for both types of series i.e. zero and non-zero mean series respectively (Shin et al., 2013). Thus, the long-run relationship between UK imports and its determinants as described in equations (1) and (2) can be rewritten in terms of positive and negative partial sums in the following manner:

$$ln(m_t) = \beta_0 + \beta_1^+ lnY^+{}_{F,t} + \beta_2^- lnY^-{}_{F,t} + \beta_3^+ lnP^+ + \beta_4^- lnP_t^- + \beta_5^+ lnV_t{}^+ + \beta_5^- lnV_t{}^- + u_t \quad (4)$$

$$ln(m_t) = \beta_0 + \beta_1^+ lnY^+{}_{F,t} + \beta_2^- lnY^-{}_{F,t} + \beta_3^+ lnP^+ + \beta_4^- lnP_t^- + \beta_5^+ lnV_t{}^+ + \beta_5^- lnV_t{}^- + \beta_5^+ lnTCV_t{}^+ + \beta_5^- lnTCV_t{}^- + u_t \quad (5)$$

Here all the coefficients with "+" and "-" superscripts indicate the positive and negative partial sums for all the independent variables. These long-run relationships can be further described in terms of the ARDL bounds testing approach to cointegration of Pesaran et al.

[11] Threshold is defined as the separation point between the positive and negative changes in a series.

(2001). Specifically, both level and first differenced variables are replaced by their respective positive and negative partial sum representations. Hence, the error-correction version of equations (4) and (5) can be written as follows:

$$\begin{aligned}\Delta m_t = {} & \beta_0 + \beta_1 \sum_{j=1}^{n1} \Delta m_{t-j} + \beta_2^{+} \sum_{j=0}^{n2} \Delta y_{F,t-j}^{+} + \beta_3^{-} \sum_{j=0}^{n3} \Delta y_{F,t-j}^{-} + \beta_4^{+} \sum_{j=0}^{n4} \Delta \mathrm{p}_{t-j}^{+} + \beta_5^{-} \sum_{j=0}^{n5} \Delta \mathrm{p}_{t-j}^{-} \\ & + \beta_6^{+} \sum_{j=0}^{n6} \Delta \mathrm{V}_{t-j}^{+} + \beta_7^{-} \sum_{j=0}^{n7} \Delta \mathrm{V}_{t-j}^{-} \\ & + \left(\lambda_1 m_{t-1} + \lambda_2^{+} y_{H,t-1}^{+} + \lambda_3^{-} y_{F,t-1}^{+} + \lambda_4^{+} p_{t-1}^{+} + \lambda_5^{-} p_{t-1}^{-} + \lambda_6^{+} V_{t-1}^{+} + \lambda_7^{-} V_{t-1}^{-}\right) + \upsilon_t \end{aligned} \tag{6}$$

$$\begin{aligned}\Delta m_t = {} & \beta_0 + \beta_1 \sum_{j=1}^{n1} \Delta m_{t-j} + \beta_2^{+} \sum_{j=0}^{n2} \Delta y_{F,t-j}^{+} + \beta_3^{-} \sum_{j=0}^{n3} \Delta y_{F,t-j}^{-} + \beta_4^{+} \sum_{j=0}^{n4} \Delta \mathrm{p}_{t-j}^{+} + \beta_5^{-} \sum_{j=0}^{n5} \Delta \mathrm{p}_{t-j}^{-} \\ & + \beta_6^{+} \sum_{j=0}^{n6} \Delta \mathrm{V}_{t-j}^{+} + \beta_7^{-} \sum_{j=0}^{n7} \Delta \mathrm{V}_{t-j}^{-} + \beta_8^{+} \sum_{j=0}^{n8} \Delta \mathrm{TCV}_{t-j}^{+} + \beta_9^{-} \sum_{j=0}^{n9} \Delta \mathrm{TCV}_{t-j}^{-} \\ & + \left(\lambda_1 m_{t-1} + \lambda_2^{+} y_{H,t-1}^{+} + \lambda_3^{-} y_{F,t-1}^{+} + \lambda_4^{+} p_{t-1}^{+} + \lambda_5^{-} p_{t-1}^{-} + \lambda_6^{+} V_{t-1}^{+} + \lambda_7^{-} V_{t-1}^{-}\right) \\ & + \lambda_8^{+} TCV_{t-1}^{+} + \lambda_9^{-} TCV_{t-1}^{-} + \upsilon_t \end{aligned} \tag{7}$$

Similarly to earlier equations, all Greek letters with "+" and "-" superscripts are positive and negative partial sum processes whereas "Δ" denotes the first difference of underlying variables. All other terms are defined as earlier. The long-run estimated coefficients are given by λ_i where i=1,…,7 in equation (6) and i=1, ….,9 in equation (7). The lags of $I(1)$ or first differenced short-run variables, denoted by n_i (where i=1,...,7 in equation (6) and i=1,...,9 in equation (7)), are determined by using the Akaike information criterion (AIC) and the Schwarz's Bayesian information criterion (SBIC).

Following Schorderet (2001) and Shin et al. (2013), asymmetry hypotheses are tested for possible equality between positive and negative coefficients for each variable both in long and short-run scenarios respectively.[12] If the null hypothesis is rejected then these shocks are

[12]Shin et al. (2013) discuss two methods for computing critical *p*-values for hypotheses testing: i) the non-parametric bootstrap method based on Monte Carlo simulations, and ii) the pragmatic approach for selection of the appropriate value for *k* (i.e. number of long-run regressors) which is the same as in the case of the (linear/symmetric) ARDL method by Pesaran et al. (2001). Shin et al. (2013) further show that both approaches lead to the same conclusions and that the pragmatic approach provides a more conservative test for long-run relationships in the context of the nonlinear ARDL approach.

not equal in a statistical sense, which indicates the asymmetric nature of the relationship in the respective time horizon (long or short-run). Specifically, this implies that both positive and negative components of the underlying independent variable have a different impact on the dependent variable and impose different long and short-run equilibrium relationship between the positive and negative shocks with the dependent variable. The asymmetric effects may be associated both with the sign (direction) and the size (sensitivity) of the underlying coefficients. Hence, this approach conveys much more information compared to standard (symmetric) long-run equilibrium models where inference is limited to the average sensitivity among the variables and at times positive and negative changes could cancel out. However, the decomposition of each variable into positive and negative regimes exhibits more flexibility and captures the fluctuations simultaneously under both regimes.

The asymmetric ARDL cointegration results are shown in Tables 2 and 3. Tables 2A and 2B present the pre-crisis and the total period results respectively. Tables 3A and 3B show the corresponding results when we account for the third country effect in our model.

[Insert Tables 2 and 3 around here]

With the exception of Germany during the pre-crisis period, the results in Table 2 reveal that there is a long-run asymmetric cointegration or equilibrium relationship for all the countries across all periods. These results signify that all the variables, including real exchange rate volatility, have a significant impact in the long-run on the UK's demand for imported goods from Japan and the US. This holds across both the pre-crisis and including the crisis samples and in the case of Germany after the inclusion of the financial crisis period. More importantly, these relationships are asymmetric whereby the import demand responds differently to positive and the negative shocks to the independent variables. The cointegration results remain consistent for Japan and the US during both sample periods suggesting the

consistency of the asymmetric long-run equilibrium relationship between the underlying variables. However, the long-run relationship in the case of Germany is significant only after the inclusion of the financial crisis period.[13]

Tables 3A and 3B include the third-country exchange rate risk as an additional determinant of UK's imports. The third country exchange rate risk is represented by the dollar-pound real exchange rate volatility when we consider UK imports from Germany and Japan whereas in case the US is considered as the major trading partner, it is represented by the euro-pound real exchange rate volatility. Our results indicate significant cointegration for all three countries during both pre-crisis period and total period provide strong evidence in favour of the third-country exchange rate risk being an important determinant of UK imports. [14] This is more pronounced in the case of Germany where we fail to find cointegration without the inclusion of the third country exchange rate volatility in the pre-crisis period. The diagnostic tests results reject the null hypotheses of serial correlation, heteroskedasticity and misspecification in all ARDL tests.[15]

4.4 The Normalized Equations and Long-Run Elasticities.

Tables 4 and 5 present the normalized long-run coefficients for the independent variables, under different hypotheses. Tables 4A and 4B tabulate the coefficients estimates from the pre-crisis period and the total period respectively without the third country risk. We only present the Japanese and the US results as no evidence of cointegration was found in the case of Germany. Asymmetric elasticities in the case of Japan and the US are mostly significant at

[13] We have also applied the symmetric ARDL method of Pesaran et al. (2001). The results indicate significant cointegration for Germany and the US during the pre-crisis period and for Japan and the US during the total period. These results are available on request.

[14] The symmetric ADRL test indicates significant cointegration in all tests except for Japan during pre-crisis period. This result is similar to the asymmetric tests result. These results are available on request.

[15] Lucey and Muckley (2011) show that ARCH effects and their variants exert a significant and deleterious impact on the power properties of the Johansen (1988) cointegration test.

the 1% or 5% levels. We report more evidence of an inverse effect of the exchange rate volatility on the UK imports. This result is in agreement with the traditional theoretical inverse relationship between the exchange rate volatility and trade.

[Insert Tables 4 and 5 around here]

As stated earlier, for a more in-depth examination, we further investigate the price elasticity of demand for UK imports by employing the Bahmani-Oskooee and Kara (2005) method. If imports are price elastic this implies that an increase in the import price relative to the domestic price is expected to decrease import volume, resulting in an inverse relationship between volatility and imports. We find that prices are highly elastic in the cases of Germany and the US, suggesting that the demand for UK imports is highly sensitive to the ratio between foreign and domestic goods prices. In the case of Japan, prices are found to be less elastic but they are not inelastic.[16]

Interestingly, after the inclusion of the third-country exchange rate volatility, UK's imports respond differently to the two volatility variables (tables 5A and 5B). For example, in the case of Germany, real exchange rate (Euro-pound) volatility is significant and positive, whereas, the third country (dollar-pound) volatility coefficients are significant and negative. These findings imply that UK's imports from Germany increase with respect to euro-pound volatility while they decline in response to the dollar-pound volatility. The demand for Japanese exports in the UK responds in a similar way. That is, positively to the yen-pound volatility and negatively to the dollar-pound volatility. In the case of the US, real exchange rate (dollar-pound) volatility has a significant negative impact while the third country exchange rate (euro-pound) volatility causes an increase in UK's imports from the US during the pre-crisis period and the period that includes the financial crisis. In terms of absolute value, the third country exchange rate volatility imposes a larger effect for Germany and

[16] Price elasticity results are available on request.

Japan. This finding clearly shows the importance of the dollar/pound exchange rate volatility. It also indicates the importance of taking into consideration the third country effect when investigating the relationship between exchange rate volatility and trade. Finally, the third country exchange rate volatilities become more positive when the crisis period is included in the sample.

The above evidence provides an important insight as to how UK's imports from different countries respond to different exchange rate volatilities. In summary, the UK's imports respond negatively to the dollar-pound volatility whereas, the euro-pound and yen-pound volatilities cause an increase over both sample periods.

4.5. Causality between Real UK Imports and its Determinants.

Cointegration implies that the transitory components of the series can be given a dynamic error correction representation, i.e. a constrained error correction model can be applied that captures the short-run dynamic adjustment of cointegrated variables.[17] The constrained error correction model allows for a causal linkage between two or more variables stemming from a common trend or equilibrium relationship. As long as two or more variables are cointegrated, causality must exist in at least one direction. The methodology applied in this paper follows the Hendry's (1987) "general-to-specific" paradigm.

To preserve space, we only provide a summary of the causality results. In all tests, the estimated coefficient of the error correction term is found to be negative and significant. This result implies that all the determinant variables affect the UK imports in the long run. The speed of adjustment as determined by the size of the coefficient on the error correction term ranges from 0.370 to 0.005 in absolute value. A coefficient of size 0.370 implies that 37% of

[17] See Engle and Granger (1987) for a detailed discussion of the error correction modelling strategy based upon the information provided by cointegrated variables.

the adjustment towards the long-run equilibrium takes per month for UK imports from Japan during the pre-crisis period. The lowest speed of adjustment (0.005) is found in the case of UK imports from Japan in the presence of a third country effect during the pre-crisis period. The inclusion of the third country volatility reduces the speed of adjustment in the case of Japan. In most tests the speed of adjustment increases from the pre-crisis to the total period (i.e. including the crisis period). There is a considerable decrease in the adjustment speed when the third country effect is included in the model. This is true for all countries during both periods. Our findings also provide ample evidence of short term causality from all the determinant variables to UK imports. The positive and negative change of real exchange volatility imposes short term causality on the UK imports for all three countries during both periods. This result provides further evidence which supports the importance of the exchange rate volatility in the estimation of the imports demand. Similar results are obtained when employing the third country exchange rate volatility. Hence, including the third country exchange rate volatility does not diminish the importance of the real exchange rate volatility.

The Wald test is applied to test for the long and short-run asymmetric effect and Tables 6 provides the results.

[Insert Table 6 around here]

The long and the short-run asymmetry hypotheses are tested for possible equality between positive and negative coefficients for each variable and in both long and short-run scenarios respectively. In case the null hypothesis is rejected and these shocks are not equal in a statistical sense, then this suggests the asymmetric nature of the relationship in the respective time horizon (long or short-run). The presence of long and short-run asymmetries imply that the positive and negative shocks to a single variable need to be modelled separately as both will affect the dependent variable differently. This means that asymmetries may exist in terms

of both sign (direction) and size (sensitivity) of the coefficients.

Table 6A presents results without the third country exchange rate volatilities. The Wald-test statistics suggest that most of the positive and negative long-run coefficients (elasticities) for the independent variables are significantly different from each other. This implies that positive and negative partial sums of each of these variables affect UK's imports differently. Hence, the long-run equilibrium relationship between the underlying variables is asymmetric in most of the cases. More evidence of an asymmetric effect is found when the crisis period is added to the sample (Table 6B) and this is more pronounced in the case of the US. The real rate volatility is found to be asymmetric both in the long and in the short-run during both periods. The only exception is the US real exchange rate volatility which is symmetric with respect to the full sample but it exhibits long-run asymmetry within the pre-crisis period.

As shown in Table 7, including the third country effect enhances the evidence of the asymmetric effect. Nevertheless, the third country real volatility is found to be less asymmetric when the crisis period is added to the sample.

[Insert Table 7 around here]

The results presented above with respect to the asymmetric effect, offer a lot more information and a more in-depth examination compared to standard (symmetric) long-run equilibrium models where inference is limited to the average sensitivity among the variables. This is because in the latter case at times the positive and negative changes would cancel out, limiting the inferential or forecasting capability of the underlying model.

5. Conclusion and Implications

One of the major issues since the introduction of the flexible exchange rate is whether an

increase in exchange rate volatility affects the international trade flow. This paper extends a relatively small body of work and investigates the effect of the exchange rate volatility on UK real imports from Germany, Japan and the US using monthly data from January 1991 to March 2013. As our sample includes the recent global financial crisis, it enables us to examine the issue within a period which is inherently associated with higher volatility and thus serves as a useful robustness check. Moreover, unlike most studies which focus on the bilateral trade between two countries, we additionally account for the third country effect (in terms of exchange rate volatility) in our analysis which is an important aspect from the point of view of competition. Moreover, we provide fresh evidence by employing the asymmetric autoregressive distributed lag (ARDL) approach to cointegration by Shin et al. (2013) which, to our knowledge, has not been applied in studies related to international trade. Causality tests are used to study the relationship between real imports and its determinants which are the real UK income, the import price ratio and the exchange rate volatility.

Our results from the ARDL method suggest that the long-run relationship between UK imports from the US and Japan and its determinants is significant and not affected by the financial crisis. This is also true when a third country exchange rate (between the euro and the pound) volatility is included in the relationship. The dollar-pound exchange rate volatility also shows the least volatility increase during the crisis. The demand for the German goods by UK consumers is influenced by the third country effect. A long-run relationship between UK imports from Germany and its determinants is only confirmed when the dollar-pound exchange rate volatility is added as a determinant. Moreover, the normalized elasticity coefficients indicate a significant number of inverse relationships between exchange rate volatilities and the UK imports. The asymmetric elasticities in the case of Japan and the US are mostly significant while fewer are found to be significant with respect to Germany.

Finally, Granger causality tests show that the determinant variables are important factors for UK real imports across all cases. That is, UK real income, the import price ratio between the UK and its trading partner and the corresponding exchange rate volatility, are jointly important in determining UK imports. This result holds both during the pre-crisis period and during the full sample which includes the crisis period. Finally, the third country volatility effect tests reveal a significant short-term effect of the USD/GBP exchange rate volatility on UK imports from Germany and Japan and of the Euro/GBP on UK imports from the US.

The results presented in our paper suggest that considering exchange rate volatility is important when examining UK imports and this is more evident during the recent financial crisis period. Any trade adjustment programmes in the UK that discourage import expansion could be unsuccessful if exchange rates and third country exchange rates are volatile. Therefore, policy makers should take into consideration the volatility of real exchange rates between the British pound and German/Japanese/US currencies so as policy actions aimed at stabilizing import markets can prevent the occurrence of adverse outcomes. Our findings advocate further research in the field of the third country effect using data from other countries.

References

Abiad, A., Mishra, P., & Topalova, P., (2011). How does trade evolve in the aftermath of financial crises? International Monetary Fund.

Akhtar, M.A., & Hilton, R.S., (1984). Effects of uncertainty on German and US Trade. *Federal Reserve Bank of New York Quarterly Review*, 7-16.

Alessandria, G., Kaboski, J.P., & Midrigan, V., (2010). The great trade collapse of 2008–09: An inventory adjustment&quest. *IMF Economic Review* 58 (2), 254-294.

Arize, A.C., (1995). The effects of exchange-rate volatility on U.S. exports: An empirical investigation. *Southern Economic Journal* 62 (1), 34-43.

Arize, A.C., (1998). The Effects of exchange rate volatility on U.S. imports: An empirical investigation. *International Economic Journal* 12 (3), 31-40.

Arize, A.C., Osang, T., & Slottje, D.J., (2000). Exchange-rate volatility and foreign trade: Evidence from thirteen LDC's. *Journal of Business & Economic Statistics* 18 (1), 10-17.

Asseery, A., & Peel, D.A., (1991). The effects of exchange rate volatility on exports: Some new estimates. *Economics Letters* 37 (2), 173-177.

Bae, Y., & De Jong, R.M., (2007). Money demand function estimation by nonlinear cointegration. *Journal of Applied Econometrics* 22 (4), 767-793.

Bahmani-Oskooee, M., (1991). Is there a long-run relation between the trade balance and the real effective exchange rate of LDCs? *Economics Letters* 36 (4), 403-407.

Bahmani-Oskooee, M., & Kara, O., (2005). Income and price elasticities of trade: some new estimates. *The International Trade Journal* 19 (2), 165-178.

Bahmani-Oskooee, M., & Hegerty, S.W., (2007). Exchange rate volatility and trade flows: a review article. *Journal of Economic Studies* 34 (3), 211-255.

Bailey, M.J., Tavlas, G.S., & Ulan, M., (1986). Exchange rate variability and trade performance: Evidence for the big seven industrial countries. *Weltwirtschaftliches Archiv 1* (22), 466-477.

Bailey, M.J., Tavlas, G.S., & Ulan, M., (1987). The impact of exchange-rate volatility on export growth: Some theoretical considerations and empirical results. *Journal of Policy Modeling* 9 (1), 225-243.

Baldwin, R. (2009). The great trade collapse: Causes, consequences and prospects. in, CEPR.

Behrens, K., Corcos, G., & Mion, G., (2013). Trade crisis? What trade crisis? *Review of Economics and Statistics* 95 (2), 702-709.

Bollerslev, T., Chou, R.Y., & Kroner, K.F., (1992). ARCH modeling in finance: A review of the theory and empirical evidence. *Journal of Econometrics* 52 (1), 5-59.

Caporale, T., & Doroodian, K., (1994). Exchange rate variability and the flow of international trade. *Economics Letters* 46 (1), 49-54.

Cho, J., Kim, T.-H., & Shin, Y., (2012). Quantile cointegration in the autoregressive distributed-lag modelling framework.

Chor, D., & Manova, K., (2012). Off the cliff and back? Credit conditions and international trade during the global financial crisis. *Journal of International Economics* 87 (1), 117-133.

Choudhry, T., (2005). Exchange rate volatility and the United States exports: evidence from Canada and Japan. *Journal of the Japanese and International economies* 19 (1), 51-71.

Choudhry, T., (2008). Exchange rate volatility and United Kingdom trade: evidence from Canada, Japan and New Zealand. *Empirical Economics* 35 (3), 607-619.

Chowdhury, A.R., (1993). Does exchange rate volatility depress trade flows? Evidence from error-correction models. *The Review of Economics and Statistics* 75 (4), 700-706.

Cushman, O., (1986). Has exchange risk depressed international trade? The impact of third-country exchange risk. *Journal of International Money and Finance* 5 (3), 361-379.

De Grauwe, P., (1988). Exchange rate variability and the slowdown in growth of international trade. *Staff Papers-International Monetary Fund*, 63-84.

Dellas, H., & Zilberfarb, B.Z., (1993). Real exchange rate volatility and international trade: a reexamination of the theory. *Southern Economic Journal*, 641-647.

Dickey, D.A., & Fuller, W.A., (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74 (366a), 427-431.

Doyle, E., (2001). Exchange rate volatility and Irish-UK trade, 1979-1992. *Applied Economics* 33 (2), 249-265.

Engle, R.F., & Granger, C.W., (1987). Co-integration and error correction: representation, estimation, and testing. *Econometrica: Journal of the Econometric Society*, 251-276.

Escribano, A., Sipols, A.E., & Aparicio, F., (2006). Nonlinear cointegration and nonlinear error correction: Record counting cointegration tests. *Communications in Statistics—Simulation and Computation* 35 (4), 939-956.

Evenett, S.J., (2009). What can be learned from crisis-era protectionism? An initial assessment. *Business and Politics* 11 (3).

Franke, G., (1991). Exchange rate volatility and international trading strategy. *Journal of International Money and Finance* 10 (2), 292-307.

Fratzscher, M., (2009). What explains global exchange rate movements during the financial crisis? *Journal of International Money and Finance* 28 (8), 1390-1407.

Fratzscher, M., (2012). Capital flows, push versus pull factors and the global financial crisis. *Journal of International Economics* 88 (2), 341-356.

Gagnon, J. E., (1993). Exchange rate variability and the level of international trade. *Journal of International Economics* 34 (3), 269-287.

Garz, M., (2012). Unemployment expectations, excessive pessimism, and news coverage. *Journal of Economic Psychology*.

Giannopoulos, K., (1995). Estimating the time varying components of international stock markets' risk. *The European Journal of Finance* 1 (2), 129-164.

Giovannini, A., (1988). Exchange rates and traded goods prices. *Journal of International Economics* 24 (1), 45-68.

Gotur, P., (1985). Effects of exchange rate volatility on trade: Some further evidence. *Staff Papers-International Monetary Fund*, 475-512.

Granger, C., & Yoon, G., (2002). Hidden cointegration. *University of California, Economics Working Paper* (2002-02).

Granger, C.W.J., (1988). Some recent development in a concept of causality. *Journal of Econometrics 39* (1), 199-211.

Greenwood-Nimmo, M., & Shin, Y., (2011). Shifting preferences at the Fed: Evidence from rolling dynamic multipliers and impulse response analysis. *Available at SSRN 1810643*.

Hendry, D.F., (1987). Econometric methodology: A personal perspective. *Advances in Econometrics* 2, 29-48.

Jacks, D.S., Meissner, C.M., & Novy, D., (2011). Trade booms, trade busts, and trade costs. *Journal of International Economics* 83 (2), 185-201.

Jarque, C.M., & Bera, A.K., (1987). A test for normality of observations and regression residuals. *International Statistical Review/Revue Internationale de Statistique*, 163-172.

Kahneman, D., & Tversky, A., (1979). Prospect theory: An analysis of decision under risk. *Econometrica: Journal of the Econometric Society*, 263-291.

Karantininis, K., Katrakylidis, K., & Persson, M., (2011). Price transmission in the Swedish pork chain: Asymmetric non linear ARDL. in 2011 International Congress, August 30-September 2, 2011, Zurich, Switzerland, European Association of Agricultural Economists.

Katrakilidis, C., Lake, A., & Trachanas, E., (2012). Asymmetric effects of inflation on stock market prices: New empirical evidence using Greek data. *Journal of Applied Business Research* 28 (3), 325-332.

Katrakilidis, C., & Trachanas, E., (2012). What drives housing price dynamics in Greece: New evidence from asymmetric ARDL cointegration. *Economic Modelling* 29 (4), 1064-1069.

Keynes, J. M., (1936). The general theory of employment, interest, and money. Macmillan, London.

Koray, F., & Lastrapes, W.D., (1989). Real exchange rate volatility and US bilateral trade: a VAR approach. *The Review of Economics and Statistics* 71(4), 708-712.

Kroner, K.F., & Lastrapes, W.D., (1993). The impact of exchange rate volatility on international trade: reduced form estimates using the GARCH-in-mean model. *Journal of International Money and Finance 12*(3), 298-318.

Kwiatkowski, D., Phillips, P.C.B., Schmidt, P., & Shin, Y., (1992). Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? *Journal of Econometrics 54* (1), 159-178.

Lee, J., (1999). The effect of exchange rate volatility on trade in durables. *Review of International Economics* 7 (2), 189-201.

Ljung, G.M., & Box, G.E., (1978). On a measure of lack of fit in time series models. *Biometrika* 65 (2), 297-303.

Lucey, B.M., & Muckley, C., (2011). Robust global stock market interdependencies. *International Review of Financial Markets* 20 (4), 215-224.

McKenzie, M.D., (1999). The impact of exchange rate volatility on international trade flows. *Journal of Economic Surveys* 13 (1), 71-106.

Melvin, M., & Taylor, M.P. (2009). The crisis in the foreign exchange market. *Journal of International Money and Finance* 28 (8), 1317-1330.

Park, J.Y., & Phillips, P.C., (2001). Nonlinear regressions with integrated time series. *Econometrica* 69 (1), 117-161.

Pesaran, M. H., Shin, Y., & Smith, R.J., (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics* 16 (3), 289-326.

Qian, Y., & Varangis, P., (1994). Does exchange rate volatility hinder export growth? *Empirical Economics* 19 (3), 371-396.

Reinhart, C.M., & Rogoff, K.S., (2009a). The Aftermath of Financial Crises. *National Bureau of Economic Research Working Paper Series No. 14656*.

Reinhart, C.M., & Rogoff, K.S., (2009b). Is the 2007 U.S. sub-prime financial crisis so different? An international historical comparison. *Panoeconomicus* 56 (3), 291-299.

Saikkonen, P., & Choi, I., (2004). Cointegrating smooth transition regressions. *Econometric Theory* 20 (02), 301-340.

Schorderet, Y., (2001). Revisiting okun's law: an hysteretic perspective. Citeseer.

Sercu, P., & Uppal, R., (2003). Exchange rate volatility and international trade: A general-equilibrium analysis. *European Economic Review* 47 (3), 429-441.

Sercu, P., & Vanhulle, C., (1992). Exchange rate volatility, international trade, and the value of exporting firms. *Journal of Banking & Finance* 16 (1), 155-182.

Shiller, R., (1993). Macro markets: creating institutions for managing society's largest economic risks/Robert J. Shiller. Clarendon. in, Oxford.

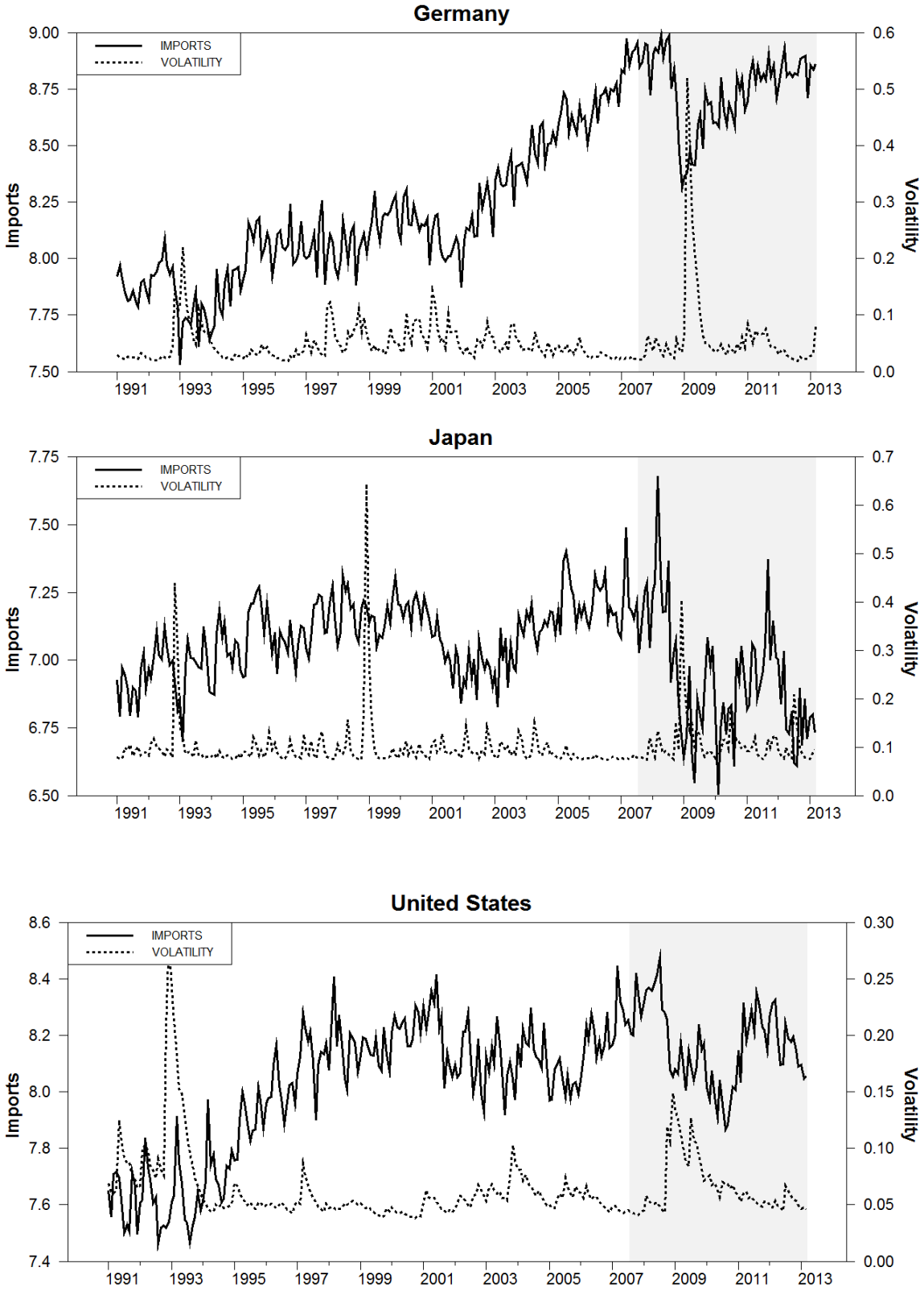
Shiller, R. J., (1981). Do stock prices move too much to be justified by subsequent changes in dividends? in, National Bureau of Economic Research Cambridge, Mass., USA.

Shin, Y., Yu, B., & Greenwood-Nimmo, M., (2013). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. in W. C. Horrace & S. C. Sickles (Eds.), Festschrift in Honor of Peter Schmidt, Vol. Forthcoming, Springer Science & Business Media, New York.

Viaene, J.-M., & de Vries, C.G., (1992). International trade and exchange rate volatility. *European Economic Review* 36 (6), 1311-1321.

Yi, K.-M., (2009). The collapse of global trade: the role of vertical specialization. *The collapse of global trade, murky protectionism, and the crisis: Recommendations for the G 20*, 45-48.

Figure 1: UK Imports and Real Exchange Rate Volatility (Jan-1991 to Mar-2013)



This figure plots in the same space real exchange rates volatility and real UK imports with respect to the three trading partners.

Table – 1: Univariate GARCH(*p,q*) Results for Real Exchange Rate Volatility

Parameters	**Germany**	**Japan**	**US**
μ	0.00117	0.0015	-0.00069
ω	0.00008***	0.0005***	0.00007***
α{1}	0.313***	0.1976***	0.0978***
β{1}	0.563***	0.2412***	0.7917***
L	684.34	573.02	634.86
Std. Resids (Q-Stat,6)	3.077	0.99	4.71
Sq.Std.Resids (Q-Stat,6)	4.827	1.92	1.79

1. ***,** and *: 1%, 5%, 10% imply significant levels respectively
2. L: Log Likelihood Function

This table presents the GARCH results with respect to real exchange rate volatility between the UK and the three trading partners.

Table – 2A: Asymmetric ARDL Results - Impact of Real Exchange Rate Volatility on UK Imports Before Financial Crisis (Jan-1991 to June-2007)

Countries	**F-stat**	**Diagnostics**							
		R^2	**SSE**	**SSR**	**JB**	**LB(12)**	**RESET(3)**	**ARCH(1)**	**ARCH(3)**
Germany	3.79	0.5932	0.00491	0.54489	5.45**	7.125	0.353	0.468	2.363
Japan	6.68***	0.437	0.0059	0.78134	2.78	14.62	1.745	2.26	3.22
US	4.65**	0.435	0.00587	0.41067	0.3722	8.591	0.78	0.216	3.71

Table – 2B: Asymmetric ARDL Results - Impact of Real Exchange Rate Volatility on UK Imports during total period (Jan-1991 to March 2013)

Countries	**F-stat**	**Diagnostics**							
		R^2	**SSE**	**SSR**	**JB**	**LB(12)**	**RESET(3)**	**ARCH(1)**	**ARCH(3)**
Germany	4.14*	0.57	0.21	11.96	0.413	11.90	2.4	1.1	4.56
Japan	10.56***	0.568	0.126	1.69	1.28	10.47	1.52	0.922	1.35
US	4.63**	0.45	0.0783	0.098	1.27	4.67	2.152	0.162	1.27

Note:
***, **, and * rejection of the null of no cointegration at the 1%, 5% and 10% level respectively.
SSE = Standard Error of Estimate, SSR= Sum of Squared Residuals, JB= Jarque-Bera Test, LB(12)= Ljung-Box test for autocorrelation up to 12 lags, RESET(3) = Ramsey's Specification Test, ARCH(1) and (3)= Autoregressive Conditional Heteroskedasticity for 1st and 3rd orders.

Table – 3A: Asymmetric ARDL Results - Impact of Real Exchange Rate Volatility on UK Imports in the presence of Third-Country Exchange Rate Risk Before Financial Crisis (Jan-1991 to June-2007)

Countries	F-stat	Diagnostics							
		R^2	SSE	SSR	JB	LB(12)	RESET(3)	ARCH(1)	ARCH(3)
Germany	5.37**	0.58057	0.00506	0.43029	0.95701	10.20193	1.651	0.980803	4.245099
Japan	10.56**	0.56	0.083	1.69	1.28	10.47	1.52	0.92	1.35
US	3.79*	0.45	0.073	1.27	3.76	4.67	2.15	0.16	1.27

Table – 3B: ARDL Results - Impact of Real Exchange Rate Volatility on UK Imports in the presence of Third-Country Exchange Rate Risk during the total period (Jan-1991 to March 2013)

Countries	F-stat	Diagnostics							
		R^2	SSE	SSR	JB	LB(12)	RESET(3)	ARCH(1)	ARCH(3)
Germany	4.15**	0.54	0.0051	0.855	0.702	13.54	1.27	0.118	1.56
Japan	4.55**	0.47	0.0084	1.17	1.07	4.79	0.239	3.33	4.71
US	5.44***	0.44	0.0054	0.755	1.06	11.89	0.969	0.093	5.43

See notes at the end of Table 2.

Table – 4A Normalized Coefficients - Impact of Real Exchange Rate Volatility on UK Imports Before Financial Crisis (Jan 1991 – June 2007)

Countries	Constant	Real Income		Relative Prices		Real Volatility	
		Positive	Negative	Positive	Negative	Positive	Negative
Japan	6.969***	5.977***	-0.635**	-0.1383	0.7812	-2.007***	0.878***
US	6.785***	2.616**	5.552***	11.723***	12.926***	-26.250	-27.921

Table – 4B Normalized Coefficients - Impact of Real Exchange Rate Volatility on UK Imports during the total period (Jan 1991 – March 2013)

Countries	Constant	Real Income		Relative Prices		Real Volatility	
		Positive	Negative	Positive	Negative	Positive	Negative
Germany	7.55***	6.03***	-1.85***	-2.026***	2.697***	-3.277***	-3.348***
Japan	6.98***	3.35***	0.913***	-215**	0.366***	-0.663***	-0.511***
US	7.62***	-0.438	5.49***	2.261***	-1.557***	-7.535***	-7.52***

Note:
***, **, and * imply significance at the 1%, 5% and 10% level respectively.
Tables 4 (A-B) show normalized long run coefficients for "Positive" and "Negative" components (as discussed in section 4.4) of each independent variables, under Asymmetric ARDL approach suggested by Shin et al. (2013) approach.

Table – 5A Normalized Coefficients - Impact of Real Exchange Rate Volatility on UK Imports in the presence of Third-Country Exchange Rate Risk Before Financial Crisis (Jan 1991 – June 2007)

Countries	Constant	Real Income		Relative Prices		Real Volatility		Third Country Real Volatility	
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Germany	8.605***	-3.42***	2.311*	7.527***	-51.58***	5.403***	6.464***	-9.344***	-9.239***
Japan	7.76***	-2.17***	0.17	1.297***	5.909***	4.477***	1.787*	-15.4***	-14.9***
US	7.736***	2.787***	1.501*	4.379***	27.28***	-9.38***	-9.39***	3.987***	2.808**

Table – 5B Normalized Coefficients - Impact of Real Exchange Rate Volatility on UK Imports in the presence of Third-Country Exchange Rate Risk during the total period (Jan 1991 – March 2013)

Countries	Constant	Real Income		Relative Prices		Real Volatility		Third Country Real Volatility	
		Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Germany	7.72***	-9.9***	-4.15***	4.34***	1.40***	-4.96***	-4.88***	5.23***	3.45***
Japan	7.14***	0.47	-0.45	0.13	1.27***	3.29**	3.05**	1.43**	-0.43***
US	7.79***	1.44**	3.94***	1.60***	-1.74***	-5.67***	-5.03***	5.76***	6.51***

See notes at the end of Table 4.

Table 6A Impact of Real Exchange Rate Volatility on UK Imports before Financial Crisis (Jan 1991 to June 2007)

Countries	Real Income		Relative Prices		Real Volatility	
	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm
Japan	93.77***	19.26***	-	19.4***	104.20***	16.58***
US	3.154*	0.028755	0.039	1.747	30.50***	0.067

Table 6B Impact of Real Exchange Rate Volatility on UK Imports during total period (Jan 1991 to March 2013)

Countries	Real Income		Relative Prices		Real Volatility	
	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm
Germany	8.83***	2.8*	12.6***	0.61	5.73***	18.02***
Japan	6.20***	3.042***	9.21***	4.276***	7.63***	10.27***
US	10.61***	11.88***	11.74***	0.074	0.055	52.107***

Notes:
Tables 6A and 6B show the Wald test results for asymmetry hypotheses, where the null hypotheses posits that the positive and negative components of each independent variables have the same effect on the dependent variable (UK Imports). ***, ** and * imply rejection of the null of non-asymmetric at the 1%, 5% and 10% levels respectively.

Table 7A **Impact of Real Exchange Rate Volatility on UK Imports in the Presence of Third-Country Exchange Rate Risk before Financial Crisis (Jan 1991 to June 2007)**

Countries	Real Income		Relative Prices		Real Volatility		Third Country Real Volatility	
	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm
Germany	22.13***	0.183	29.7***	10.4***	157.3***	--	15.2***	13.925***
Japan	53.69***	8.58***	3.327**	25.1***	17.52***	7.144***	36.2***	10.283***
US	0.568	1.302	16.7***	12.3***	89.96***	8.159***	61.1***	22.159***

Table 7B **Impact of Real Exchange Rate Volatility on UK Imports in the Presence of Third-Country Exchange Rate Risk during the total period (Jan 1991 to March 2013)**

Countries	Real Income		Relative Prices		Real Volatility		Third Country Real Volatility	
	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm	Long-Asymm	Short-Asymm
Germany	4.56**	7.56***	5.47***	6.71**	5.58***	15.57***	7.76***	7.03***
Japan	6.31***	0.049	10.7***	8.39***	9.92***	0.57***	11.5***	9.57***
US	9.07***	9.91***	8.92***	10.58***	7.56***	6.41**	11.7***	7.2***

See notes at the end of Table 6.