Asymmetry, Uncertainty and International Trade

Syed S. Hassan[*] Sarosh Shabi[*] Taufiq Choudhry[**]

** Swansea University, School of Management, UK*
*** University of Southampton, School of Business, UK*

Abstract

This paper studies the role of economic policy uncertainty on the US trade with Canada, China, Germany, Japan and the United Kingdom. This paper contributes to the literature by analysing the asymmetric impact of policy uncertainty on the US trade from December 1989 to December 2016. Results suggest that there is a negative relationship between the economic policy uncertainty and the US trade flows. Further, US trade responds more sensitively to rise in the uncertainty as compared to an equal negative shock, confirming the asymmetric hypothesis both in the short and long run. Comparing the respective uncertainty indices, US EPU has a significantly greater impact on the trade relative to the EPU of its trading partners. These findings have both demand and supply side implications i.e. increase in the economic policy uncertainty can reduce the aggregate consumption significant as well as due to uncertain profit margins, businesses can choose to delay long term investment projects and inventory levels resulting in a wide spread recessionary effect on the US business cycle.

1. Introduction

The effects of uncertainty on international trade remain largely confined to exchange rate volatility (uncertainty) (IMF 2004, Taglioni and Zavacka, 2012). Yet, a reduction in producer and consumer confidence lowers investment and consumption which in turn reduces international trade2016 has been the fifth consecutive year with sluggish international trade trend since the recent global financial crisis (Constantinescu et al. 2017). This may mainly be attributed to long-run structural issues e.g. saturating global value chains, slow trade liberalization, the downturn in global growth and rise in economic policy uncertainty. This paper provides an empirical investigation of the effect of economic policy uncertainty on US international trade.

According to Eberly (1994) and Bertola et al. (2005) if a whole economy experiences a major shock and all economic agents are subject to uncertainty resulting in an aggregated adverse effect on the international trade of the economy.[1] During the latest global financial crisis, the US experienced an exceptional increase in macroeconomic and financial uncertainty (Cesa-Bianchi et al., 2014). During periods of financial crisis, uncertainty arises because of negative news, which lowers expectations of future economic activity.[2] The global financial crisis of 2007-10 resulted in a sharp decline in the output as well as the international trade around the globe. However, the decline in the international trade was much aggressive and strongly disproportionate. The global industrial production reduced by 12% whereas trade volumes dropped by 20% after April 2008. Such shocks were unprecedented since the 1930s (Eichengreen and O'Rourke, 2010, Novy and Taylor, 2014). During the height of the crisis

[1] Examples of such a shock can be the Great Depression of 1920s and the latest global financial crisis.

[2] An increase in economic uncertainty can affect an economy by reducing employment, investment and output through various channels (Bloom, 2009; Baker et al., 2013; Colombo, 2013; Born and Pfeifer, 2014; Jurado et al., 2015). Some of the channels identified in the existing literature are i) real options effect (Bernanke, 1983); ii) precautionary savings effect (Leland, 1968), and iii) financial frictions effect (Gilchrist et Al., 2014).

2008-09, real world trade fell by about 15% exceeding the fall in real world GDP by almost a factor of 4 (Bems, et al. 2013). Further according to Behrens, et al. (2013) this trade collapse was wide-ranging across industries and highly synchronized across OECD countries. This paper uses Asymmetric ARDL cointegration method to study the effects of the economic uncertainty on the international trade between the US and few of its major trading partners such as Canada, China, Mexico, and the UK.

Romer (1990) shows that due to income uncertainty, consumers reduce their spending by analysing the uncertainty hypothesis and its impact on consumer spending specifically during 1930's recession. She shows that the uncertainty proxied by stock market volatility adversely affects consumer spending.

Novy and Taylor (2014) following an inventory model show that importers of intermediate goods hold an inventory due to the fixed cost of ordering. In the presence of time-varying economic uncertainty, importers are constrained to optimally adjust their inventories and by cutting down their foreign orders more strongly than their domestic orders. Novy and Taylor (2014) maintain that the relative difference in reduction of foreign and domestic goods explains differences in contraction and subsequent recovery in international trade flows and domestic economic activity (Novy and Taylor, (2014). Bloom et al (2007) using the stock market volatility as the proxy for economic uncertainty show that firms choose to delay investment projects during higher uncertainty periods. There is an extensive literature which reports mixed results regarding the impact exchange rate volatility as a proxy for uncertainty on the trade flows.[3]

[3] See Choudhry et al. (2014), IMF (2010) for more details.

In addition to studies focussing on the supply side, there is also a considerable amount of literature analysing the impact of uncertainty on the consumer behaviour. For instance, Dixit (1989a) and Romer (1990) state that delaying the purchase of goods might be beneficial for the consumers especially in case of durable goods. Because due to uncertain future income, the consumer may not be able to choose goods optimally to match their income level. At the same time delay in consumption may cause a significant decline in aggregate demand overall.

According to Taglioni and Zavacka (2012), it is the domestic uncertainty on the buyers (importers) that matters. A large effect on the exporters is not expected unless both the uncertainty in the domestic country and abroad are correlated. Thus, if the period of high uncertainty in the domestic country is protracted, local producers could potentially start redirecting their sales towards the foreign markets and thus boost exports. Taglioni and Zavacka (2012) further claim that the effect of the uncertainty on trade should be non-linear based on two reasons. First, the trade will react only if the uncertainty shock is sufficiently high. Second, uncertainty needs to affect most producers and consumers adjust at the same time, and this is because of consumer heterogeneity. Behrens, Corcos and Mion (2013) find the fall in the demand for tradeables (consumer durables and capital goods) as the main reason for the collapse in Belgium’s international trade in 2008/09 and not the supply-side based explanations. Levchenko, Lewis and Tesar (2010) and Bems, Johnson, and Yi (2011) show that trade of intermediate goods was more severely affected during the recent global financial crisis. The reduction in the expenditure by domestic agents will be aggravated by the liquidity constraints and large adjustments in wealth, which usually accompany major economic uncertainty. Finally, countries that specialise in durables or investment goods (high adjustment goods) should experience a heightened impact of uncertainty on exports.

This paper makes few key contributions to the literature. First, we study the effect of both domestic and trading partner's economic policy uncertainty on the US imports. Second, we analyse the effect of the financial crisis on the relationship between EPU and US imports. Finally, we also identify asymmetric long and short run relationship between the underlying variables based on the Asymmetric ARDL model.

Results, based on Asymmetric ARDL, confirm the long-term relationship between US imports and economic policy uncertainty along with other determinant variables such as the US real income, the relative import price ratio and bilateral real exchange rate. Normalized coefficients for the both domestic and trading partner's economic policy uncertainty show a predominant inverse relationship. Other determinant variables such as real income and relative price ratio are also significant in most of the tests. More importantly, the results show strong evidence of asymmetric behaviour in the underlying independent variable for all countries; to our knowledge, no evidence is available in the existing literature to this effect.

The remainder of the paper is organized in the following manner. Discussion in section 2 explains the relationship between economic policy uncertainty and trade. Section 3 describes the data and asymmetric ARDL method as well as the unit root tests results. Section 4 discusses the results obtained. Finally, the conclusion is presented in section 5.

2. Economic Uncertainty and International Trade – Theoretical Framework

The term "Great Trade Collapse" surfaced after global trade volumes dropped by 20% in 2008 due to the global financial crisis. The decline in trade was seen along with the reduction of 12% in the economic output globally. However, the impact was relatively more severe on the international trade flows. This paper aims to analyse why international trade is so volatile in response to economic uncertainty shocks, in the recent crisis as well as in prior episodes. This research utilizes the uncertainty index proposed by Baker et al. (2013). (2015) combined with the Asymmetric ARDL method (Shin et al, 2011) to test the long run relationship and presence of asymmetries, which have been largely ignored in the existing literature.

Theoretically, the relationship between economic uncertainty and international trade flows has been explained in different settings. However, according to Handley and Limao (2017), no significant empirical research has been carried out regarding the implications of the economic policy uncertainty. This paper aims to bridge this gap by analysing the long relationship between US trade flows and economic policy uncertainty. Bernanke (1983) and Dixit (1989) lay down the important theoretical framework by suggesting that investments can be modelled as sunk costs and under uncertainty, an option value may be associated with avoiding irreversible actions. The significance of the option value may be even higher when there are many investment alternatives available. Therefore, a risk-neutral investor will take up an irreversible project only if the expected return is higher than the value of the options to wait. Hence any increase in the economic uncertainty will deter the long-term investments. Bernanke (1983) further maintains that cost of credit intermediation is the major factor causing a decline in investment spending during the height of economic uncertainty. Similarly, Dixit (1989a) and Dixit and Pindyck (1994) attribute such wait-and-see attitude to the irreversibility of investments costs.

We follow Hassler (1996) and Novy and Taylor (2014) approach to model investment under uncertainty to explain the interaction between the economic uncertainty and international trade. Hassler (1996) shows that uncertainty adversely affects the investments. Novy and Taylor (2014) refer the term *investment* to firms' purchase of intermediate goods. Such purchases involve fixed ordering costs. These goods can either be purchased locally or from international markets implying openness of the economy. Novy and Taylor (2014) further allow for unexpected time-varying fluctuations in productivity and demand faced by the firms. This implies that firms may enjoy relative periods of calm with business conditional relatively calm and these firms may go through volatile episodes of larger shocks.

Firm has the a Cobb-Douglas production function, where A is productivity, L is domestic labour and K is an intermediate production input which depreciates at rate δ.

$$F(A, K, L) = AK^{a}L^{1-a}$$

Each firm has an isoelastic demand Q with elasticity ε. B is a measure of demand shifts and P denotes Price. Firm is a price taker both in case of wages as well as prices of intermediate production inputs.

$$Q = BP^{-\varepsilon}$$

The input factor K is an intermediate input factor or composite of such factors. Firm bears fixed ordering costs per shipment *f*, and stores the intermediate input as inventory and follows an s,S (Min,Max) inventory model. Scarf (1959) and Novy and Taylor report that under fixed ordering costs, this policy presents an optimal solution to the dynamic inventory problem. Intermediate inputs can be purchased both locally or internationally. Firm employs labour and intermediate inputs at a constant rate irrespective of the productivity variations. Novy and Taylor (2014) following Hassler (1996) assume that the firm has a target level of inventory of intermediate inputs denoted by M* and proportional to both K and Q. This can be shown as:

$$m^{*} = c + q$$

where c is a constant and m*≡ $\ln(M^{*})$ is log target inventory and q≡ $\ln(Q)$ represents log output level. This setup can be used to show if it is costly for the firm to adjust its production level up or down. Assuming a quadratic loss function that penalizes variations z from the target m* as $\frac{1}{2}z_t^2$ with $z \equiv m - m^*$. As we assume positive ordering costs (*f* > 0) firm has to balance the fixed costs as well as the costs of deviating from the target simultaneously. Optimal inventory problem can be stated as following:

$$\min_{\{I_t z_t\}_0^\infty} \left\{ E_0 \int_0^\infty e^{-rt} \left(\frac{1}{2} z_t^2 + I_t f \right) dt \right\}$$

subject to

$$\begin{aligned} z_0 \quad &= \bar{z}; \\ z_t + d_t &= \begin{cases} free & if\ m_t\ is\ adjusted, \\ z_t + \delta d_t - d_q & otherwise; \end{cases} \\ I_t d_t \quad &= \begin{cases} 1 & if\ m_t is\ adjusted \\ 0 & otherwise. \end{cases} \end{aligned}$$

I_t denotes a dummy variable that takes on the value 1 whenever the firm adjust m_t by paying fixed costs (*f*), r > 0 represents a constant discount rate, and $\delta > 0$ is the depreciation rate for intermediate inputs so that $dK_t/K = \delta dt$.

Now following Bloom (2009), variations are explained in the output, caused by shifts in productivity (A) in eq—and/or demand (B) in eq—. Bloom (2009) terms both these conditions as changes in business conditions. These changes in the output can be represented in the following ways with their respective probabilities, where ε denotes the changes in the output (q)

$$q_t + d_t = \begin{cases} q_t + \varepsilon & with\ probability\ (\lambda/2)d_t, \\ q_t & with\ probability\ 1 - \lambda d_t, \\ q_t + \varepsilon & with\ probability\ (\lambda/2)d_t. \end{cases}$$

The shock ε can be interpreted as a sudden change in the business conditions which leads to adjustment of inventory level to m*. According to Hassler (1996) ε is assumed to be sufficiently large which forces the firm to adjust the inventory level m. This implies that a positive shock to output ($\varepsilon > 0$) increases m* leading to a negative deviation z that triggers to minimum inventory level s. As a results firm restocks m and vice versa. Thus this model allows the firm to both restock and destock depending upon the direction of the shock (ε). λ denotes arrival rate of shocks and a measure of uncertainty. Thus changes in λ can be interpreted as changed in the uncertainty. Hassler (1996) allows the uncertainty λ_w to stochastically switch between two states such that $w \in \{0,1\}$: λ_0 represents low state of uncertainty and a higher state is denoted by $\lambda_1 implying\ \lambda_0 < \lambda_1$. Transition process here follows a Markov process:

$$w_t + d_t = \begin{cases} w_t & with\, probability\ 1 - \gamma_w d_t, \\ \overline{w}_t & with\, probability\ \gamma_w d_t, \end{cases}$$

here $\overline{w}_t = 1$ if $w_t = 0$, and vice versea. Probability of switching uncertainty state in the next dt is $\gamma_w d_t$, where length of the state is γ_w^{-1}. Based on the above we can now optimize the firm's cost for deviating from the target level m* (z) as under:

$$V(z_t, w_t) = \frac{1}{2} z_t^2 d_t + (1 - r d_t) E_t V(z_{t+dt}, w_{t+dt})$$

Here the cost function $V(z_t, w_t)$ is a function of instantaneous loss element from eq(--) and discounted expected cost at time t+dt, which can be separately written as:

$$\begin{aligned} E_t V(z_{t+dt}, w_{t+dt}) = {} & V_z(z_t, w_t) - \delta dt V_z(z_t, w_t) \\ & + \lambda_w dt \{V(S_w, w_t) + f - V(z_t, w_t)\} \\ & + \gamma_w dt \{V(z_t, \overline{w}_t) - V(z_t, w_t)\} \end{aligned}$$

Where V_z is derivative of V w.r.t. z. The expected cost at time t+dt includes depreciation cost over time involving δ. It also considers the probability $\lambda_w dt$ of a shock to firm's business conditions (i.e. both productivity and demand) as well as probability $\gamma_w dt$ of uncertainty regime switching from w_t to $\overline{w}_t$. Novy and Taylor (2014) use numerical methods to determine the parameter values for $\lambda_0, \lambda_1, \gamma_0 and \gamma_1$ in order to show how the s,S inventory bounds change in response to time varying uncertainty. They report that due to uncertainty, probability of a firm hit be shock is positive, which implies that the firm will have to adjust its inventory. Thus higher the shock probability more frequently firm would need to adjust its inventory. Thus firm optimize inventory by setting the return point (S) close to the target level. Similarly, the triggering point (s) is also lowered during higher uncertainty period, as this will reduce firm's inventory adjustment to save the fixed costs of ordering (*f*). This implies option value of waiting for the firm, which has been frequently discussed in the literature on uncertainty (McDonald and Siegel, 1986; Dixit, 1989; Pindyck, 1991). Novy and Taylor (2014) report that trade volumes respond negatively to the uncertainty shocks. Further they show that durable goods are more sensitive to the uncertainty shocks as compared to nondurable goods.

3. Main Model

Trade flows in this paper are modelled as any typical demand function of real income, relative prices and real exchange rates. Policy uncertainty indices both for the US and trading partners are included to analyse their respective effect on the US trade flows over the sample period. Equation 1 presents such a relationship.

$$m_t = \delta_0 + \delta_1 y_{us,t} + \delta_2 p_t + \delta_3 rer_t + \delta_4 EcoU_{us,t} + \delta_5 EcoU_{h,t} + \varepsilon_t \quad (1)$$

$$x_t = \delta_0 + \delta_1 y_{p,t} + \delta_2 p_t + \delta_3 rer_t + \delta_4 EcoU_{us,t} + \delta_5 EcoU_{h,t} + \varepsilon_t \quad (2)$$

Where m_t is the log of bilateral real US imports from sample countries, y_t is the log of US real income, p_t measures the relative prices, rer_t is the real exchange rate. Main variables of interest here are the US and trading partner's economic policy uncertainties denoted by $EcoU_{us,t}$ and $EcoU_{h,t}$. Stochastic errors are captured by ε_t. 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 trade level

(Bailey et al., 1986, 1987). Thus, the coefficient on real income (δ1) is expected to be positive. The relative price is the ratio of the bilateral import prices. 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 (δ2) should be negative.

4. Data description and methodology

4.1. The data

This paper employs seasonally adjusted monthly data from December 1989 to December 2016, from six of the major US trade partners i.e. Canada, China, UK, Germany and Japan. The sample countries are geographically dispersed covering different regions around the globe. Demand for US imports and exports have been modelled based on the real income, relative prices and real exchange rates. Economic policy uncertainty indices for both US and its respective trading partners have been included as the main variables of interest to ascertain their impact on the demand for US imports and exports. Data regarding indices of industrial production (real income), price indices and real exchange rates for respective countries are obtained from Datastream. Economic uncertainty indices for all the countries[4] have been obtained from the Economic Policy Uncertainty website.[5]

Economic Policy Uncertainty Measurement

Until recently economic uncertainty was modelled either using proxies or various statistical measures. However, research interest in the economic uncertainty modelling and its role in predicting macroeconomic fluctuations has revived. According to Jurado et al. (2015)

[4] EU economic policy uncertainty index has been used for both the UK and Germany.
[5] http://www.policyuncertainty.com/

uncertainty is defined as the conditional volatility of a stochastic process that is not forecastable from the perspective of economic agents. Alternatively, Bloom (2009) and Baker et al. (2013) defined uncertainty as a situation where future state of the economy is not known with certainty. This can be triggered by various factors such as changes in the economic fundamentals and policies, heterogeneous future growth prospects and productivity movements, geopolitical scenarios and natural disasters, etc (Baker et al., 2013). They also report that the economic uncertainty is countercyclical i.e. uncertainty on average is much lesser in the expansionary times as compared to the recessions.

Early research shows how politics and economic policy uncertainty influences financial markets and the economy focused on events such as elections or the passage of legislative bills (see Bernhard and Leblang 2006). These types of events are likely to generate economic policy uncertainty and influence the behaviour of individuals in the economy. In this approach, economic policy uncertainty is measured in a discrete fashion, as events occur at a particular point in time. An advantage of this approach is that elections tend to be exogenous with respect to current economic conditions. However, in parliamentary political systems, the timing of an election may be tied to economic conditions: the incumbent government has an incentive to call for an election when the economy is doing well. Alesina et al. (1992) and Heckelman and Berument (1998) provide evidence supporting this idea for OECD countries, so this approach to measuring economic policy uncertainty may not completely resolve the endogeneity issue. A disadvantage associated with using election dates to measure economic policy uncertainty is that this approach does not capture how a new government's policy will be implemented over time. The alternative, an index approach, offers a continuous measure of economic policy uncertainty, and it may, therefore, do a better job capturing the evolution of economic policy uncertainty over time. The measures of economic uncertainty have been researched time and again. Historically economic uncertainty was proxied by various political indicators such as uncertainty surrounding elections or legislative aftermaths. Various researches used these proxies/indicators to view the impact on the volatilities and economy etc. Leblang and Bernhard (2006) examined the impact of policy uncertainty on exchange rate volatility and found evidence that political indicators influence the exchange rate volatility. Other studies used elections as indicators of economic policy uncertainty and find significant effects on the economy. Bialkowski, et. al. (2008) and Boutchkova, et. al. (2012) find increased equity market volatility around elections. Julio and Yook (2012) reported that companies reduce investment around elections. Recently, Baker et al. (2013), proposed an index, which is calculated on the basis of various components that contain information about the economic policy. The movement in the index shows the increase/ decrease in the uncertainty concerning it based on daily news revised on August 7, 2013. Baker et al. calculated indices for the United States, the euro area and Canada as weighted averages of information since 1985 from three sources: (1) an Internet search count of articles in major newspapers that include keywords associated with economic policy uncertainty, (2) as a measure of tax code uncertainty, the Congressional Budget Office (CBO) compilation of the value of tax code expirations ten years forward and (3) the dispersion in forecasts of inflation and government spending taken from the Philadelphia Federal Reserve Bank's Survey of Professional Forecasters. The first component captures uncertainty about who will make economic policy decisions, what economic policy actions will be undertaken and when, and the economic effects of policy actions (or inaction) including uncertainties related to the economic ramifications of ‘‘noneconomic’’ policy matters, for example, military actions, natural disasters, etc.

Asymmetric ARDL Method

The long-term relationship between international trade flows and the economic uncertainty is explored by using the nonlinear asymmetric ARDL method proposed by Shin et al. (2013)[6]. This model provides a flexible and efficient framework for analysing both long- and short-run asymmetries between the variables.

According to Keynes (1936), macroeconomic variables can shift suddenly from an expansionary state to a recessionary form. However, there may be hardly any sharp turning points in the opposite scenario - i.e. when downward movement in these variables is replaced by an upward trend. This dissimilarity in the variables shifting between different states over a period of time has given rise to the need to model asymmetry and nonlinearity in order to improve our understanding of long-term relationships between various macroeconomic variables (Kahneman and Tversky, 1979; Shiller, 1993, 2005; Shin et al., 2013).

Another important issue identified in a similar context has been the time-varying stochastic distribution of time series, whereby these variables demonstrate non-ergodic behaviour, put more simply, these variables are mostly found to be nonstationary (Brooks, 2008; Taylor, 2011). The nonstationary and integration order problem has been discussed in the cointegration literature whereas nonlinearity and asymmetry have been addressed mainly in regime-switching models.

According to Schorderet (2001) and Shin et al. (2013), standard cointegration implicitly assumes a symmetric relationship between the underlying variables; that is, both positive and negative components within each exogenous variable affect the dependent variable in a similar fashion. Many researchers consider this assumption incorrect and have provided evidence of asymmetric relationship among major macroeconomic variables (Park and Phillips, 2001; Schorderet, 2001; Saikkonen and Choi, 2004; Escribano et al., 2006; Bae and De Jong, 2007; Shin et al., 2013). Granger and Yoon (2002) coined the term "hidden cointegration" which

[6] This method has been cited in some of the recent studies such as Greenwood-Nimmo and Shin (2011), Karantininis, Katrakylidis and Persson (2011), Cho, Kim and Shin (2012), Garz (2012), Katrakilidis, Lake and Trachanas (2012), Katrakilidis and Trachanas (2012), Choudhry *et al. (*2014, 2015)

describes the long-term equilibrium relationship between the positive and negative components of the underlying variables.

Regime-switching models, on the other hand, are based on the view that linear models are inadequate to provide a strong inference, or to yield consistent and reliable forecasts, because the linearity assumption may be restrictive in most of the macroeconomic scenarios, hence leading to incorrect forecasts and inferences (Shin et al., 2013). Although over the years various studies have attempted to address these problems of asymmetry, nonlinearity and non-stationarity, the focus of these studies has been limited to only one or some of these problems.

It is shown that the asymmetric nonlinear ARDL method proposed by Shin et al. colleagues (2013) can deal with the above three areas. This model uses the ARDL bound-testing approach (Pesaran et al., 2001) for testing long-term equilibrium relationships between the underlying variables irrespective of the order of integration of the regressors, that is, I(0) or I(1) or a mix of both, and nonlinearity and asymmetry are modelled using the partial sum processes approach (Schorderet, 2001).

The first step under this method is to decompose all the exogenous variables into partial sum processes. This decomposition may be illustrated using the following asymmetric regression (Schorderet, 2001),

$$y_t = \alpha_0 + \beta^+ x_t^+ + \beta^- x_t^- + u_t \qquad (3)$$

where the independent variable x_t is decomposed into partial sum processes x^+ and x^- for positive and negative changes in x_t respectively. This decomposition applies to the variables irrespective of their order of integration and can be used in the cases of both I(0) and I(1) variables. The following defines both processes:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_t^+ = \sum_{j=1}^{t} \max(\Delta x_j, 0);\; x_t^- = \sum_{j=1}^{t} \Delta x_t^- = \sum_{j=1}^{t} \min(\Delta x_j, 0) \qquad (4)$$

Here, $\triangle x_t$ are the changes in x_t whereas + and – superscripts indicate the positive and negative processes. In equation (4) above, the threshold is set to zero, which delineates the positive and negative shocks in the independent variables. Although ideally, the first-difference series should be normally distributed with a zero mean, financial time series often tend to have a non-normal distribution, which implies a non-zero mean for the underlying variables. In that case, depending upon the sign and size of the mean, setting zero as the threshold may bias the positive/negative partial sums, because the number of effective observations in the negative or positive regimes may be insufficient for the OLS estimator. Therefore, setting the threshold as the mean of the respective variables may resolve this issue as it will serve in both types of series, i.e. zero and non-zero mean series (Shin et al., 2013). Thus, equation (4) above may be rewritten in the following manner to set the mean as the threshold level:

$$x_t^+ = \sum_{j=1}^{t} \Delta x_t^+ = \sum_{j=1}^{t} \max\left(\Delta x_j, \bar{x}\right);\ x_t^- = \sum_{j=1}^{t} \Delta x_t^- = \sum_{j=1}^{t} \min\left(\Delta x_j, \bar{x}\right) \tag{5}$$

Thus, the long-term relationship between respective imports and exports with their key determinants can be described in the following manner:

$$\begin{aligned} x_t = {} & \beta_0 + \beta_1^+ y_{H,t} + \beta_2^- {y^-}_{H,t} + \beta_3^+ p_t^+ + \beta_4^- p_t^- + \beta_5^+ {RER_t}^+ + \beta_6^- {RER_t}^- \\ & + \beta_7^+ {EcoU_{US,t}}^+ + \beta_8^- {EcoU_{US,t}}^- + \beta_9^+ {EcoU_{H,t}}^+ + \beta_{10}^- {EcoU_{H,t}}^- \\ & + u_t \end{aligned} \tag{6}$$

$$\begin{aligned} m_t = {} & \gamma_0 + \gamma_1^+ {y^+}_{US,t} + \gamma_2^- {y^-}_{US,t} + \gamma_3^+ \mathrm{p}_t^+ + \gamma_4^- \mathrm{p}_t^- + \gamma_5^+ {RER_t}^+ + \gamma_6^- {RER_t}^- \\ & + \gamma_7^+ {EcoU_{US,t}}^+ + \gamma_8^- {EcoU_{US,t}}^- + \gamma_9^+ {EcoU_{H,t}}^+ + \gamma_{10}^- {EcoU_{H,t}}^- \\ & + u_t \end{aligned} \tag{7}$$

Here all the coefficients with "+" and "-" superscripts indicate the positive and negative partial sums for all the independent variables. These long-term relationships can be further described in terms of the error correction method, where all the level and first-difference variables are replaced by their respective positive and negative partial sums in levels as well as in the first-difference form. Hence, the error-correction versions of equations (6) and (7) are as follows:

$$\Delta x_t = \beta_0 + \beta_1 \sum_{j=1}^{n1} \Delta x_{t-j} + \beta_2 \sum_{j=0}^{n2} \Delta \mathrm{y}_{H,t-j}^{+} + \beta_3 \sum_{j=0}^{n3} \Delta \mathrm{y}_{H,t-j}^{-} + \beta_3 \sum_{j=0}^{n4} \Delta \mathrm{p}_{t-j}^{+} \tag{8}$$

$$+ \beta_5 \sum_{j=0}^{n5} \Delta \mathrm{p}_{t-j}^{-} + \beta_6 \sum_{j=0}^{n6} \Delta \mathrm{RER}_{t-j}^{+} + \beta_7 \sum_{j=0}^{n7} \Delta \mathrm{RER}_{t-j}^{-}$$

$$+ \beta_8 \sum_{j=0}^{n8} \Delta \mathrm{EPU}_{US,t-j}^{+} + \beta_9 \sum_{j=0}^{n9} \Delta \mathrm{EPU}_{US,t-j}^{-} + \beta_{10} \sum_{j=0}^{n10} \Delta \mathrm{EPU}_{H,t-j}^{+}$$

$$+ \beta_{11} \sum_{j=0}^{n11} \Delta \mathrm{EPU}_{H,t-j}^{-} + (\varphi_1 x_t + \varphi_2^{+} y^{+}{}_{H,t} + \varphi_3^{-} y^{-}{}_{H,t} + \varphi_4^{+} \mathrm{p}_t^{+}$$

$$+ \varphi_5^{-} \mathrm{p}_t^{-} + \varphi_6^{+} RER_t{}^{+} + \varphi_7^{-} RER_t{}^{-} + \varphi_8^{+} EcoU_{US,t}{}^{+}$$

$$+ \varphi_9^{-} EcoU_{US,t}{}^{-} + \varphi_{10}^{+} EcoU_{H,t}{}^{+} + \varphi_{11}^{-} EcoU_{H,t}{}^{-}) + u_t$$

$$\Delta m_t = \beta_0 + \beta_1 \sum_{j=1}^{n1} \Delta m_{t-j} + \beta_2 \sum_{j=0}^{n2} \Delta \mathrm{y}_{US,t-j}^{+} + \beta_3 \sum_{j=0}^{n3} \Delta \mathrm{y}_{US,t-j}^{-} + \beta_3 \sum_{j=0}^{n4} \Delta \mathrm{p}_{t-j}^{+} \tag{9}$$

$$+ \beta_5 \sum_{j=0}^{n5} \Delta \mathrm{p}_{t-j}^{-} + \beta_6 \sum_{j=0}^{n6} \Delta \mathrm{RER}_{t-j}^{+} + \beta_7 \sum_{j=0}^{n7} \Delta \mathrm{RER}_{t-j}^{-}$$

$$+ \beta_8 \sum_{j=0}^{n8} \Delta \mathrm{EPU}_{US,t-j}^{+} + \beta_9 \sum_{j=0}^{n9} \Delta \mathrm{EPU}_{US,t-j}^{-} + \beta_{10} \sum_{j=0}^{n10} \Delta \mathrm{EPU}_{H,t-j}^{+}$$

$$+ \beta_{11} \sum_{j=0}^{n11} \Delta \mathrm{EPU}_{H,t-j}^{-} + (\varphi_1 m_t + \varphi_2^{+} y^{+}{}_{US,t} + \varphi_3^{-} y^{-}{}_{US,t}$$

$$+ \varphi_4^{+} \mathrm{p}_t^{+} + \varphi_5^{-} \mathrm{p}_t^{-} + \varphi_6^{+} RER_t{}^{+} + \varphi_7^{-} RER_t{}^{-} + \varphi_8^{+} EcoU_{US,t}{}^{+}$$

$$+ \varphi_9^{-} EcoU_{US,t}{}^{-} + \varphi_{10}^{+} EcoU_{H,t}{}^{+} + \varphi_{11}^{-} EcoU_{H,t}{}^{-}) + u_t$$

Similar to the earlier equations, all Greek letters with "+" and "-" superscripts are positive and negative partial sum processes whereas "△" denotes the first difference of the underlying variables. All other terms are as already defined above. Long-term relationship coefficients are given by $\varphi_{1\ldots7 \text{ or } 9}$. Lags of I(1) or first-difference short-term variables are determined using AIC/BC and the number of lags used in the models are denoted by $n_{1 \ldots 7}$ or $_9$ above.

Following Schorderet (2001) and Shin et al. (2013), the long- and short-term asymmetry hypotheses are tested for possible equality between the positive and negative coefficients for each variable and in both the long- and short-term scenarios. If the null hypothesis is rejected and these shocks are not equal statistically, then this shows the asymmetric nature of the relationship in the respective time horizon (long or short term). It implies that both positive and negative components of the underlying independent variables have different impacts on the dependent variable hence imposing long- and short-term equilibrium relationships between the positive and negative shocks with the dependent variable separately.

The presence of long- and short-term asymmetries implies that the positive and negative shocks to a single variable should be modelled separately as both will have a different effect on the dependent variable. This means that the asymmetry may be found in three different forms i.e. (i) reaction asymmetry associated with $\varphi^{+} \neq \varphi^{-}$ which implies varying long term elasticities for exogenous variables; (ii) impact asymmetry due to inequality of coefficients on the first different terms (iii) adjustment asymmetry, indicated by the patterns of adjustment following an economic shift (dynamic multipliers) This information provides better inference as compared to the standard (symmetric) long-term equilibrium models where inference is limited to average sensitivity among the variables. These models face a series limitation where the positive and negative changes at times would average-out, thereby limiting the inferential or forecasting capability of the underlying model. However, decomposition of the variables into positive and negative regimes creates a great deal more flexibility and captures the fluctuations simultaneously under both regimes.

Asymmetric ARDL Results

Tables 1-2 present the hypotheses test results based on Eqs. (8) and (9) analyzing the impact of the US and domestic economic policy uncertainty on US trade flows with Canada, China, Germany, Japan and the UK. This analysis is based on Asymmetric ARDL model proposed by Shin et al. () based on monthly data (1989m12 to 2016m12). Tables 1 and 2 provide strong evidence at the 1% level of long-term asymmetric relationships among the underlying variables across all the sample countries. This evidence contributes to the literature by identifying the asymmetric effect of the economic policy uncertainty on the US trade flows. This finding implies that US import and exports demand responds differently to positive and negative shocks to both US and partnering countries economic policy uncertainty in addition to other conventional factors such real income, relative prices and real exchange rate movements. The diagnostic test results reject the null hypotheses of serial correlation, heteroscedasticity and misspecification for these asymmetric ARDL estimates.[7]

Imports

Table 1: Bound Test and Long Run Elasticities (Imports)

Countries	F-Stat	Real Income		Relative Prices		Real Ex. Rate		US EPU		Partner EPU	
		+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
Canada	4.49***	0.077***	-0.78**	-1.65***	3.10**	-0.01**	0.098**	-0.09***	-0.06***	-0.04**	0.024**
China	4.83***	0.203**	-0.011	-3.15***	-0.904	-0.068*	-0.51***	-0.05**	-0.001**	-0.002*	0.008*
Germany	7.83***	0.016***	-0.24***	-5.26***	0.139**	0.054***	0.081***	-0.04**	0.006**	-0.001**	-0.004
Japan	4.85***	0.296***	-0.121	-0.47*	-0.194	0.057*	-0.037*	-0.07**	0.003**	-0.007	0.014**
UK	5.89***	0.295***	-0.141**	-2.72***	1.525**	-0.007**	0.003***	-0.01***	0.009**	-0.01*	0.001

Table 2: Bound Test and Long Run Elasticities (Exports)

Countries	F-Stat	Real Income		Relative Prices		Real Ex. Rate		US EPU		Partner EPU	
		+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve	+ve	-ve
Canada	6.17***	0.166	-0.21	-0.62**	4.881**	0.132***	0.057*	-0.045**	0.003	-0.003**	0.001*
China	5.83***	-0.155	0.182	6.445***	0.744	-0.102	-0.51***	0.022	0.001	-0.031**	0.025*
Germany	5.21***	0.073	-0.21***	-5.26***	2.50***	0.14***	-0.003	-0.011**	0.20**	-0.014**	0.003**

[7] Results shown in Tables ().

Japan	4.20***	0.287***	-0.029	0.896	4.40	-0.073	-0.056	-0.077**	0.064**	0.018	0.033*
UK	5.92***	0.809*	-0.117	-2.414	-2.578	-0.143*	0.273**	-0.07**	-0.002	-0.005**	0.011**

Normalized Equations and Long-run Elasticities

Normalized equations here provide inference regarding elasticities of US trade for underlying variables. These estimates (Table 1-2) represent percentage changes in US imports and exports due to a unit change in these independent variables. This paper focusses on the sensitivity of the US trade to the changes in the domestic as well as the partnering countries' economic policy uncertainty. In this case, independent variables are represented by their respective positive and negative partial sums and these have been normalized by the US imports and exports.

Tables 1-2 show the normalized equations estimated from the Asymmetric ARDL method for Canada, China, Germany, Japan and the UK. Long-run coefficients (Table 1) for the US real income show greater positive income elasticities with respect to US imports from China (0.203%), Japan (0.296%) and the UK (0.295%), whereas a more sensitive inverse relationship for negative real income shocks in case of Canada (-0.78%) and Germany (-0.24%). Relative prices show a negative long run impact for all the sample countries with Germany (-5.26%), China (-3.15%) and the UK (2.72%) having the highest negative price elasticities. These elasticities represent the percentage change in the US imports to 1% positive shock to relative price ratio. Similarly, negative price shocks clearly show a significantly positive impact on the US imports from Canada (3.1%), Germany (0.139%) and the UK (1.525%). Positive and negative shocks to the real exchange rates show mixed results. For example, 1% shift above the mean RER reduces the US imports from Canada (-0.01%), China (-0.068%) and the UK (-0.007%), however increases US imports from Germany (0.054%) and

Japan (0.057%). Regarding the economic policy uncertainty, both US and partnering countries' indices show a significantly negative relationship. Our results confirm that a positive uncertainty shock deters the US imports from all the sample countries e.g Canada (-0.09%), China (-0.05%), Germany (-0.04%), Japan (-0.07%) and the UK (-0.01%) and a negative uncertainty shock (stabilizing periods) increases the imports from all of the countries.

Table 2 presents the long run elasticities for the US exports and economic policy uncertainty indices along with other key determinants such as real income, relative price and real exchange rates. These results reaffirm the negative relationship between the positive uncertainty shocks and the US exports to the sample countries with the exception of few instances.

In summary, the results presented provide more evidence of an inverse effect of the economic policy uncertainty on the US trade flows. These results are in agreement with the traditional theoretical inverse relationship between the economic uncertainty and trade. This finding highlights the importance of the economic policy uncertainty for the international trade. It also indicates the importance of taking into consideration the broad and macro level uncertainty while modelling and forecasting the US trade.

ECM and Short-Term Causality

Tables 3 and 4 provides results for ECM and short-term causality based on the equations (). General to specific approach to model specification has been adopted. ECM models have been estimated for both US imports (eq.) and exports (eq.) using up to 12 lags for all variables. The results shown in Tables 3-4 are the final specification obtained by dropping the insignificant coefficients. Diagnostic tests results for various tests such as LM serial correlation, White's heteroscedasticity and Ramsey's specification tests have also been reported for all estimations.

The error correction terms are negative and significant in all the cases. These result confirm that all the determinant variables affect the US imports and exports in the long-run. The speed of adjustment is determined by the size of the coefficient on the error term, ranging from -0.248 to 0.855 in case of US imports whereas for exports the coefficients vary between -0.175 to -0.647. These values represent the per month adjustment towards the long-run equilibrium among the underlying variables. Regarding the robustness of these adjustments, US imports from the UK show very swift adjustment (-0.855) whereas imports from Canada tend to correct relatively at much slower pace (-0.248). Long run adjustment in US exports to Canada show quick recovery (-0.647) in contrast to Japan where such corrections are relative slow (-0.175). Our results show that equilibrium adjustment in case of US imports is generally faster as compared to exports. Results also provide evidence of short-term causality from all the determinant variables towards US imports and exports in most of the cases. Positive and negative components of the US economic policy uncertainty affect its imports from China, Germany, Japan and UK in the short run. However, exports are only affected in case of Japan. Similarly trading partners' EPU have a greater impact on the US imports as compared to the exports, which are only affected in case of Japan and the UK. Similarly, in case of other exogenous variables positive and negative changes in the real income and relative prices show greater impact in case of US imports and exports from/to Germany, Japan and the UK.

Table 3: ECM and Short-Term Causality - US Imports

Canada		**China**		**Germany**		**Japan**		**UK**	
Const.	0.462^{***}	Const.	0.819^{***}	Const.	0.83^{***}	Const.	0.511^{***}	Const.	1.329^{***}
$ECM_{(t-1)}$	-0.248^{***}	$ECM_{(t-1)}$	-0.569^{***}	$ECM_{(t-1)}$	-0.513^{***}	$ECM_{(t-1)}$	-0.267^{***}	$ECM_{(t-1)}$	-0.855^{***}
$\triangle Imp_{(t-1)}$	-0.322^{***}	$\triangle Imp_{(t-1)}$	0.164^{***}	$\triangle Imp_{(t-1)}$	-0.182^{**}	$\triangle Imp_{(t-1)}$	-0.234^{***}	$\triangle Imp_{(t-4)}$	-0.100^{**}
$_{(t-2)}$	-0.214^{***}	$_{(t-2)}$	0.188^{***}	$_{(t-2)}$	-0.361^{***}	$_{(t-2)}$	-0.279^{***}	$\triangle Price^{+}_{(t)}$	-6.936^{***}
$_{(t-3)}$	-0.239^{***}	$_{(t-3)}$	0.424^{***}	$_{(t-3)}$	-0.301^{***}	$_{(t-4)}$	0.155^{***}	$_{(t-3)}$	2.759^{**}
$_{(t-4)}$	-0.366^{***}	$\triangle Price^{+}_{(t)}$	-3.847^{***}	$_{(t-4)}$	-0.248^{***}	$_{(t-5)}$	0.109^{**}	$_{(t-5)}$	2.905^{**}
$\triangle Price^{-}_{(t-6)}$	2.303^{***}	$_{(t-2)}$	-4.39^{***}	$_{(t-6)}$	-0.272^{***}	$\triangle Price^{+}_{(t)}$	-6.399^{***}	$\triangle Price^{-}_{(t)}$	3.146^{***}
$\triangle Income^{-}_{(t)}$	1.554^{***}	$\triangle Price^{-}_{(t-1)}$	2.716^{***}	$\triangle Price^{+}_{(t)}$	-7.482^{***}	$_{(t-2)}$	-2.472^{***}	$_{(t-4)}$	1.933^{***}
$\triangle CPU^{+}_{(t-3)}$	-1.045^{***}	$_{(t-2)}$	2.919^{**}	$\triangle Price^{-}_{(t)}$	3.61^{***}	$_{(t-6)}$	-4.461^{***}	$\triangle Income^{-}_{(t-5)}$	1.494^{**}
$_{(t-4)}$	-0.941^{***}	$_{(t-6)}$	-1.272^{**}	$_{(t-1)}$	2.19^{***}	$\triangle Price^{-}_{(t-1)}$	3.184^{***}	$\triangle RER^{-}_{(t-3)}$	0.066^{***}
		$\triangle Income^{-}_{(t-6)}$	1.727^{**}	$_{(t-5)}$	-2.004^{***}	$_{(t-4)}$	3.255^{***}	$\triangle USPU^{+}_{(t-5)}$	0.022^{*}
		$\triangle RER^{+}_{(t-1)}$	-0.117^{***}	$\triangle Income^{+}_{(t-2)}$	3.349^{***}	$\triangle Income^{+}_{(t-3)}$	-2.002^{*}	$\triangle USPU^{-}_{(t-5)}$	-0.024^{***}
		$_{(t-2)}$	-0.114^{**}	$\triangle Income^{-}_{(t-4)}$	1.402^{**}	$\triangle Income^{-}_{(t-2)}$	1.749^{***}	$\triangle EUPU^{+}_{(t-1)}$	0.0151^{***}
		$\triangle USPU^{+}_{(t-3)}$	-0.029^{***}	$_{(t-5)}$	1.824^{***}	$_{(t-5)}$	1.283^{**}	$_{(t-3)}$	-0.012^{***}
		$_{(t-5)}$	-0.019^{**}	$\triangle RER^{+}_{(t-3)}$	0.077^{**}	$\triangle RER^{-}_{(t-3)}$	0.035^{*}	$_{(t-4)}$	-0.023^{***}
		$\triangle CHPU^{+}_{(t-3)}$	0.0063^{**}	$\triangle USPU^{+}_{(t)}$	-0.0162^{**}	$\triangle USPU^{+}_{(t-3)}$	-0.024^{**}	$_{(t-5)}$	-0.015^{***}
		$_{(t-4)}$	0.0058^{**}	$_{(t-1)}$	-0.020^{***}	$\triangle USPU^{-}_{(t-3)}$	0.025^{**}	$\triangle EUPU^{-}_{(t-4)}$	0.012^{**}
		$\triangle CHPU^{-}_{(t-2)}$	-0.0052^{**}	$_{(t-6)}$	-0.033^{***}	$_{(t-4)}$	-0.012^{**}		
		$_{(t-3)}$	-0.0045^{**}	$\triangle USPU^{-}_{(t-6)}$	0.022^{***}	$\triangle JPU^{+}_{(t-3)}$	0.0104^{**}		
		$_{(t-6)}$	-0.0039^{*}	$\triangle EUPU^{+}_{(t-1)}$	0.0245^{***}	$_{(t-4)}$	0.0084^{**}		
				$_{(t-4)}$	-0.0187^{***}				
Adj.R^2	0.41	**Adj.R^2**	0.5769	**Adj.R^2**	0.6632	**Adj.R^2**	0.5212	**Adj.R^2**	0.5538
LM	0.539	**LM**	1.0576	**LM**	1.6718	**LM**	2.1676	**LM**	1.2358
White	1.3355	**White**	1.3099	**White**	1.0506	**White**	1.9318	**White**	1.1932
RESET	0.6026	**RESET**	0.2589	**RESET**	2.053	**RESET**	0.0172	**RESET**	1.8588

Notes:

1. This table reports ECM and short-term causality results based on equation (). General to specific approach has been used and estimations were carried out using broader specification with up to 6 lags across all variables. This tables shows the final specification for each country with varying levels of persistence for underlying variables.
2. ***,**, and * denote significance at 1%, 5% and 10% respectively.
3. Diagnostics reported include; $R^{2:}$ Adjusted R-Squre; LM: Serial correlation LM Test up to 12 lags; White: White's Heteroscedasticity Test; RESET: Ramsey's specification Test

Table 4: ECM and Short-Term Causality - US Exports

Canada		China		Germany		Japan		UK	
Const.	1.888***	Const.	0.502***	Const.	0.382***	Const.	0.295***	Const.	0.758***
$ECM_{(t-1)}$	-0.647***	$ECM_{(t-1)}$	-0.512***	$ECM_{(t-1)}$	-0.433***	$ECM_{(t-1)}$	-0.175***	$ECM_{(t-1)}$	-0.495***
$\triangle Exp_{(t-3)}$	-0.102**	$\triangle Price^{+}_{(t-3)}$	-7.185***	$\triangle Exp_{(t-1)}$	-0.582***	$\triangle Exp_{(t-1)}$	-0.553***	$\triangle Exp_{(t-3)}$	0.084*
$_{(t-4)}$	-0.374***	$\triangle Price^{-}_{(t)}$	-2.824***	$_{(t-2)}$	-0.455***	$_{(t-2)}$	-0.506***	$_{(t-5)}$	0.115***
$\triangle Price^{-}_{(t-3)}$	-1.864*	$_{(t-3)}$	3.638*	$_{(t-3)}$	-0.327***	$_{(t-3)}$	-0.158***	$\triangle Price^{+}_{(t)}$	-3.459**
$_{(t-6)}$	1.96**	$\triangle RER^{+}_{(t-4)}$	-0.133**	$_{(t-4)}$	-0.471***	$_{(t-5)}$	0.0733*	$_{(t-2)}$	3.282**
$\triangle Income^{-}_{(t-4)}$	1.539***	$_{(t-6)}$	-0.129**	$_{(t-6)}$	-0.216**	$\triangle Price^{+}_{(t)}$	-4.296***	$_{(t-5)}$	2.725*
$\triangle RER^{+}_{(t-1)}$	-0.098*	$\triangle USPU^{-}_{(t-4)}$	-0.022**	$\triangle Price^{+}_{(t-2)}$	2.94**	$_{(t-1)}$	4.080***	$\triangle Price^{-}_{(t-6)}$	-3.507***
$\triangle USPU^{+}_{(t-1)}$	3.732***			$\triangle Income^{-}_{(t-3)}$	0.634***	$_{(t-4)}$	5.634***	$\triangle Income^{+}_{(t-3)}$	-2.091*
$\triangle USPU^{-}_{(t)}$	-1.438**			$_{(t-4)}$	0.822***	$_{(t-5)}$	-5.975***	$\triangle Income^{-}_{(t-3)}$	1.685***
$_{(t-1)}$	-1.674**			$_{(t-5)}$	0.71***	$\triangle Price^{-}_{(t-5)}$	3.478***	$\triangle RER^{+}_{(t-2)}$	-0.111***
$\triangle CPU^{+}_{(t)}$	0.981**			$_{(t-6)}$	2.302***	$\triangle Income^{+}_{(t)}$	0.566*	$\triangle RER^{-}_{(t-3)}$	0.109***
$\triangle CPU^{-}_{(t-3)}$	0.016***			$\triangle RER^{-}_{(t-2)}$	-0.048**	$\triangle Income^{-}_{(t-1)}$	0.317**	$_{(t-5)}$	0.093***
				$_{(t-4)}$	-0.065	$_{(t-3)}$	0.293**	$\triangle EUPU^{+}_{(t-6)}$	0.013**
				$\triangle USPU^{+}_{(t)}$	-0.016**	$_{(t-6)}$	0.451***	$\triangle EUPU^{-}_{(t)}$	0.018***
				$_{(t-4)}$	-0.014*	$\triangle RER^{-}_{(t-5)}$	0.0336*		
				$\triangle USPU^{-}_{(t-1)}$	-0.013**	$\triangle USPU^{+}_{(t-5)}$	-0.013**		
				$_{(t-3)}$	-0.012**	$\triangle USPU^{-}_{(t-4)}$	-0.018***		
				$_{(t-5)}$	0.013**	$\triangle JPU^{+}_{(t-1)}$	-0.007*		
				$\triangle EUPU^{+}_{(t-6)}$	0.0138***	$_{(t-4)}$	-0.008**		
				$\triangle EUPU^{-}_{(t-1)}$	0.0144***				
Adj.R^2	0.5368	**Adj.R^2**	0.322	**Adj.R^2**	0.5163	**Adj.R^2**	0.5627	**Adj.R^2**	0.4746
LM	1.166	**LM**	2.057	**LM**	1.527	**LM**	0.6988	**LM**	0.9319
White	0.9755	**White**	0.545	**White**	0.9211	**White**	0.9183	**White**	0.8804
RESET	0.2615	**RESET**	0.937	**RESET**	0.7387	**RESET**	0.6303	**RESET**	0.3070

Notes:

1. This table reports ECM and short-term causality results based on equation (). General to specific approach has been used and estimations were carried out using broader specification with up to 6 lags across all variables. This tables shows the final specification for each country with varying levels of persistence for underlying variables.
2. ***,**, and * denote significance at 1%, 5% and 10% respectively.
3. Diagnostics reported include; $R^{2:}$ Adjusted R-Squared; LM: Serial correlation LM Test up to 12 lags; White: White's Heteroscedasticity Test; RESET: Ramsey's specification Test

Asymmetric Relationship

Tables 3-4 show the hypotheses tests results for both long and short asymmetric relationship between the underlying variables, whereby US trade flows both imports and exports are affected asymmetrically by the US and partnering countries' economic policy uncertainties over the sample time period. Short run asymmetries are also present in some instances for both US imports and exports. These results confirm the basic hypothesis tested in this paper and adds to the evidence regarding the relationship between the economic policy uncertainty and international trade.

Table 5: Asymmetric Effect (US Imports)

Countries	Real Income		Relative Prices		Real Ex. Rate		US EPU		Partner EPU	
	Long	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**	**Short**
Canada	6.082^{***}	3.082^{*}	7.81^{***}	4.09^{***}	4.41^{***}	3.309^{**}	5.61^{***}	3.209^{*}	4.29^{***}	1.855
China	4.571^{***}	1.148	4.472^{***}	4.141^{***}	12.51^{***}	0.91	4.297^{***}	6.873^{***}	2.75	3.001^{*}
Germany	5.498^{***}	1.511	9.664^{***}	0.5206	12.19^{***}	0.617	4.378^{***}	3.381^{*}	0.7335	0.1104
Japan	0.901	5.567^{***}	0.074	2.836^{*}	0.54	0.993	6.368^{***}	4.259^{***}	2.887	0.7581
UK	4.601^{***}	3.102^{*}	13.31^{***}	0.168	3.17^{*}	2.94^{*}	8.631^{***}	7.033^{***}	13.08^{***}	4.382^{***}

Table 6: Asymmetric Effects (US Exports)

Countries	Real Income		Relative Prices		Real Ex. Rate		US EPU		Partner EPU	
	Long	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**	**Short**	**Long**	**Short**
Canada	0.842	0.119	4.66^{***}	1.828	26.57^{***}	5.34^{***}	10.49^{***}	4.71^{***}	4.13^{***}	4.51^{***}
China	0.994	0.134	11.3^{***}	0.196	21.64^{***}	0.234	1.23	0.376	4.68^{***}	3.68^{**}
Germany	3.75^{**}	2.95^{*}	4.81^{***}	4.73^{***}	5.23^{***}	0.415	0.732	0.034	7.64^{***}	7.422^{***}
Japan	8.01^{***}	0.295	2.96^{*}	0.274	1.61	2.21	4.79^{***}	2.11	1.097	0.176
UK	7.71^{***}	5.39^{***}	0.665	0.284	1.25	0.755	4.91^{***}	5.13^{***}	4.65^{***}	4.41^{***}

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Figure 1: Economic Policy Uncertainty Indices

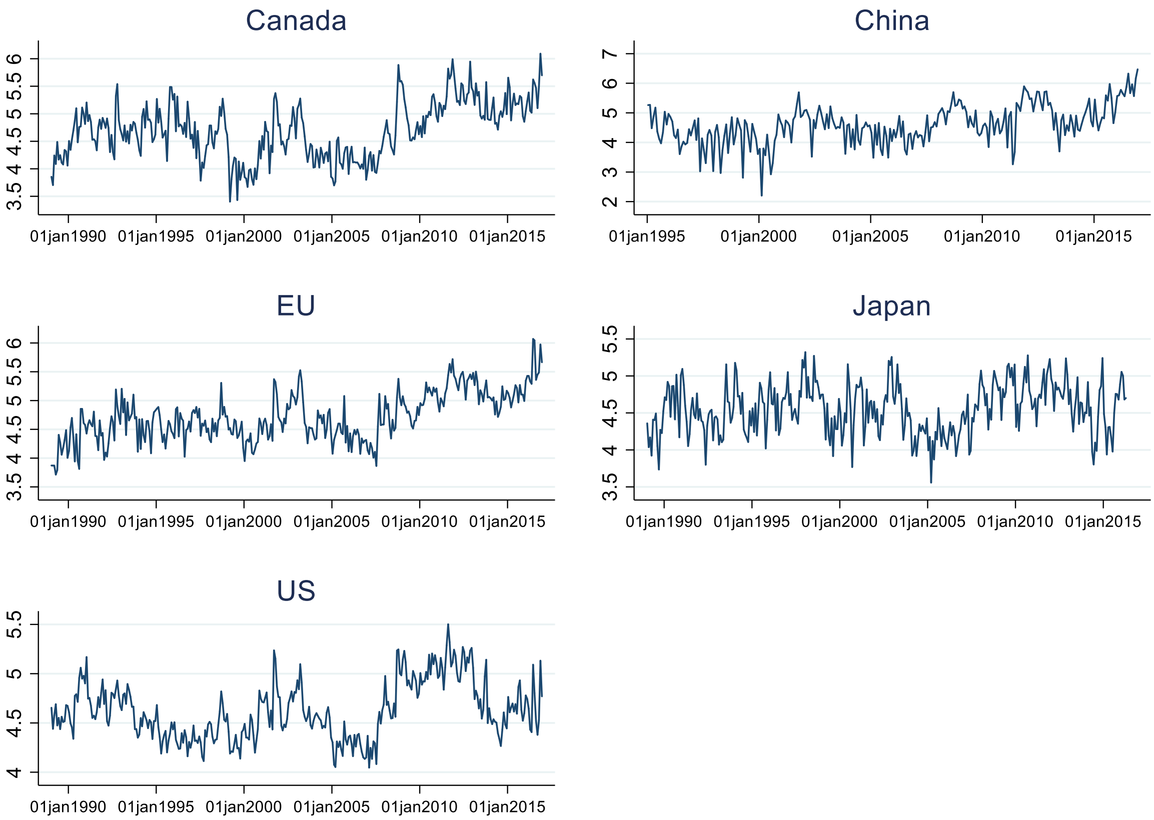

Figure 2: US Imports (Log)

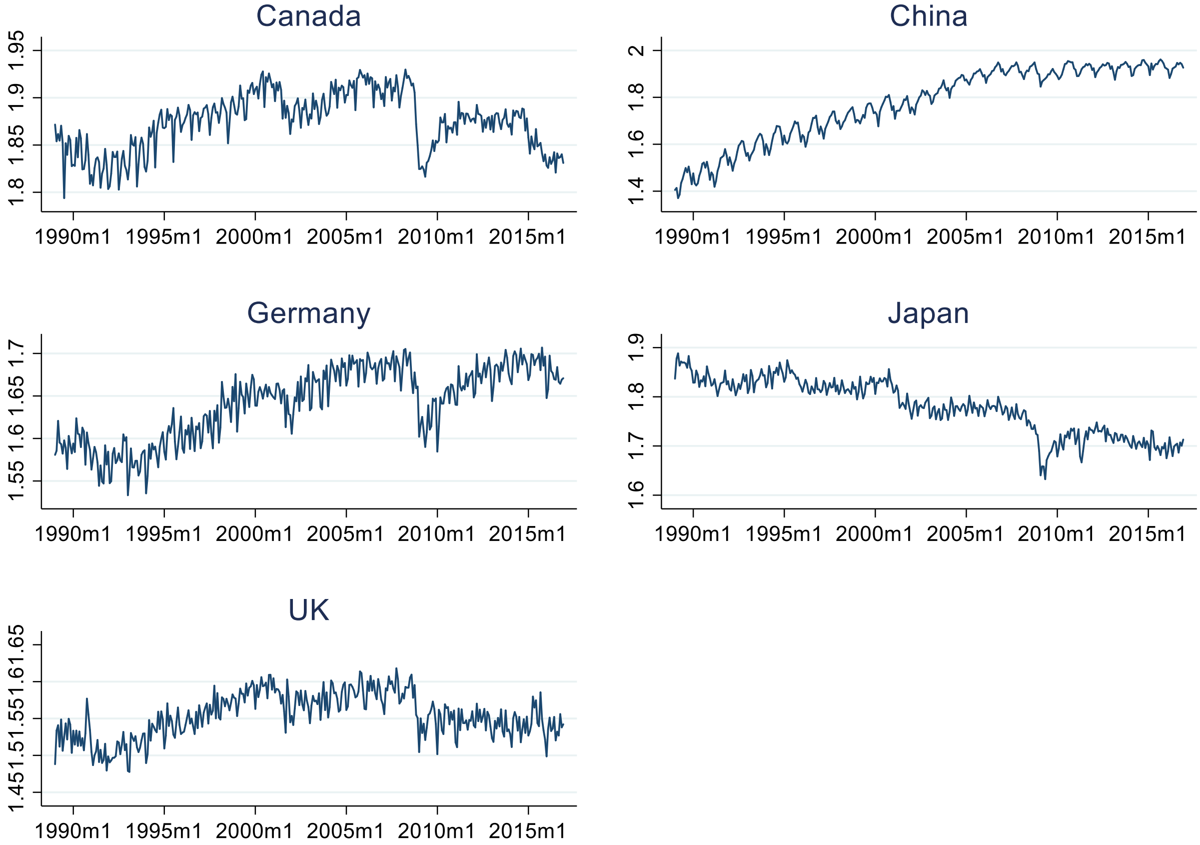

Figure 3: US Exports (Log)