Is the Exchange Rate a Shock Absorber or Source of Shocks? Evidence from the U.S.

Kuhelika De[1] and Wei Sun[2]

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Abstract

We examine the stabilization role of the exchange rate in the U.S. economy using a factor augmented vector autoregression model. We find that exchange rate shock explains a large fraction of the variation in exchange rate and transmits major disturbances to the real economy. Further, we find that demand and supply shocks explain less than a quarter of the exchange rate movement. We provide robust evidence that although the exchange rate plays some role as a shock absorber, its role as an independent source of shocks is more dominant for the U.S. economy. The foreign exchange market breeds its own shocks which are destabilizing not only to the value of the dollar but to the overall economy as well. Our results suggest that policymakers need to take foreign exchange market fluctuations into account when making macroeconomic policy decisions.

Keywords: Open economy macroeconomics, Real exchange rate, Monetary Policy, Factor augmented vector autoregression models, Shock absorber, Source of shock, U.S. economy

JEL Codes: C11, C32, E52, F31, F41

[1] Assistant Professor, Department of Economics, Grand Valley State University. Address: 3072 L. William Seidman Center, 50 Front Avenue SW Grand Rapids, Michigan 49504. Email: dek@gvsu.edu

[2] Corresponding author. Associate Professor, Department of Economics, Grand Valley State University. Address: 3056 L. William Seidman Centre, 50 Front Avenue SW Grand Rapids, Michigan 49504. Email:sunw@gvsu.edu

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"Fixed exchange rates can be better automatic stabilizers than are floating rates when most shocks originate in asset markets; but when goods-market shifts drive macroeconomic fluctuations, floating rates generally have an advantage." – Obstfeld, et al. (1985).

1. Introduction

The floating exchange rate regime was adopted by the United States and other major industrialized countries to replace the incumbent fixed regime in March 1973.[3] The main argument in favor of the floating exchange rate is that it insulates economies from foreign shocks while freeing domestic monetary policy to achieve domestic macroeconomic goals; that is, the floating exchange rate acts as a shock absorber (Johnson, 1969). On the other hand, Buiter (2000) asserts that "under a high degree of international financial integration, market-determined exchange rates are a primary source of shocks and instability." More recently, Gabaix and Maggiori (2015) argue that "exchange rates are sensitive to imbalances in financial markets and seldom perform the shock absorption role that is central to traditional theoretical macroeconomic analysis" and that "the exchange rate can often be the vehicle of transmission of financial shocks to the real economy".

The key to determining whether the floating exchange rate acts as a shock absorber or a source of shocks depends on the extent to which exchange rate fluctuations are driven by underlying real shocks such as demand shocks (balance of payments, income and preferences etc.) and supply shocks (resource endowments, productivity, world oil prices etc.); or nominal shocks such as monetary policy and exchange rate shocks. Existing literature defines exchange rate shock as idiosyncratic disturbances in the foreign exchange market that cannot be explained by macroeconomic fundamentals (An and Kim, 2010; Artis and Ehrmann, 2006; Farrant and Peersman, 2006). If the exchange rate moves significantly in response to real

[3] Under a floating exchange rate regime, the exchange value of a currency is mostly determined by market forces: supply and demand of the currency.

demand and supply shocks, and if a large proportion of the movements in the exchange rate can be explained by these shocks (the exchange rate absorbs a great deal of these shocks), then the exchange rate plays a stabilizing role in the economy and acts as a shock absorber. On the other hand, if exchange rate movements are mainly driven by shocks originating in the foreign exchange market, and if these shocks transmit major disturbances to the real economy (a large proportion of the fluctuations in output can be explained by the exchange rate shock), then the exchange rate acts as a source of shocks (An and Kim, 2010; Artis and Ehrmann, 2006; Farrant and Peersman, 2006).

The literature provides rich yet mixed empirical evidence for the insulation properties of floating exchange rates, however most of this research focuses on small open economies relative to their large neighbour, like the U.S. (see, for example, Lastrapes, 1992; Clarida and Gali, 1994; Enders and Lee, 1997; Bjornland, 2004; Cover and Mallick, 2012; Manalo et al., 2015; Dąbrowski et al., 2016). Clarida and Gali (1994) find that the exchange rate acts as a shock absorber for Germany, Japan, Canada and the UK. An and Kim (2010) find that exchange rate plays the role of a shock absorber in Japan. Cover and Mallick (2012) find that exchange rate tends to stabilize output in the UK. On the other hand, Artis and Ehrmann (2006) document that exchange rate fluctuations are mainly driven by exchange rate shocks which are destabilizing to output and price, and thus the exchange rate acts as a source of shocks for Canada, Denmark, Sweden, and the UK. Farrant and Peersman (2006) also find that exchange rate shocks play a dominant role as a source of shocks rather than a shock absorber for UK, the Euro area, Japan, and Canada.

How much of an insulation role does the U.S. dollar floating exchange rate play to the U.S. economy? Does exchange rate act as a shock absorber or a source of shocks for the U.S.? These questions are important, yet untapped in the literature.[4] These are pressing issues and important to study for the following reasons. First, the U.S. economy is now more open to external shocks both in trade and finance.[5] Second, the dollar's role as a global financial safe asset, international reserve currency, and primary invoice currency in trade (even between non-U.S. countries) exposes the U.S. economy to speculative exchange rate risks in a highly financially integrated global economy.[6] Third, the emergence of other major currencies, like the Euro, the Yen, and the Renminbi in recent years have posed challenge to the dollar's dominant role, creating more uncertainty and volatility in the U.S. dollar exchange rate (Eichengreen and Kawai, 2015; Fratzscher and Mehl, 2014; Galati and Wooldridge, 2006; Goldberg, 2013).

The fundamental contribution of our paper is to fill an important gap in the literature – to examine the insulation properties of the U.S. dollar floating exchange rate to the U.S. economy, that is, whether the U.S. dollar serves the U.S. economy as a shock absorber or a source of shocks. To this end, we employ the factor augmented vector autoregression model of Bernanke et al. (2005) and Stock and Watson (2011), and a rich information set of 171 monthly macroeconomic indicators over the post-Bretton Woods period of 1973 to 2017. Within this framework, we use the sign restrictions strategy of Farrant and Peersman (2006) to identify four structural shocks: U.S. supply shock, U.S. demand shock, U.S. monetary policy shock,

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[4] The long term "benign neglect" of the U.S. dollar's insulation properties could be attributed to two potential explanations. First, the U.S. is traditionally considered a large closed economy in the literature. Second, the U.S. dollar serves as the international reserve and primary invoice currency in trade (even between non-U.S. countries) which makes it more challenging to study the U.S. in traditional open economy macroeconomic settings compared to small open economies. Recently, Liu, Spiegel and Tai (2017) study the impact of exchange rate shock on the broad U.S. economy by modelling the U.S. as a large open economy. We follow a similar approach.

[5] Fischer (2015) asserts that the U.S. economy is becoming increasingly susceptible to external shocks. By 2011 U.S. trade reached 31% of U.S. GDP. By 2014 U.S. foreign direct investments reached 76% of U.S. GDP. By 2015, U.S. total investments abroad and total foreign investment in the U.S. reached 140% and 170% of U.S. GDP, respectively. As Fischer (2015) put it: "the state of the U.S. economy is significantly affected by the state of the world economy. A wide range of foreign shocks affect U.S. domestic spending, production, prices, and financial conditions…"

[6] Late U.S. Treasury Secretary Connally colorfully put: "The U.S. dollar is our currency, but your problem." Many countries have a significant stake in the U.S. dollar today, either because they hold a large amount of the U.S. dollar in reserves, or because they need to preserve the value of the dollar for trade. This external stake in the dollar by other countries runs the world's largest financial market – the foreign exchange market – with an average daily transaction volume of over 5 trillion U.S. dollar, where the dollar is the most traded currency of all.

and a pure exchange rate shock. Further, since the literature documents strong co-movement between exchange rates and global financial markets (see for example Gabaix and Maggiori, 2015), we control for global monetary and financial developments in our model. By explicitly identifying the fundamental macroeconomic shocks (U.S. demand, supply, and monetary policy), while simultaneously controlling for foreign monetary and financial developments, we are able to distinguish movements in the exchange rate as an endogenous reaction to macroeconomic fundamentals and foreign monetary-financial disturbances, from the remaining idiosyncratic shocks originating purely in the foreign exchange market. The residual exchange rate shock identified thus reflects mainly sentiments in the foreign exchange market. It is this pure exchange rate shock whose impact and importance to the U.S. economy we are interested in, and attempt to investigate in this paper.

Using impulse responses, we find that an exchange rate depreciation shock leads to a significant expansion of the economic activity in the short run and a permanent increase in the price level in the U.S., supporting dominance of the expenditure switching effect, consistent with Liu, Spiegel, and Tai (2017). Inflation in the economy prompts monetary contraction in the form of higher interest rate and reduced money supply (consistent with Choudhri and Hakura, 2006; Sun and De, 2019). Using forecast error variance decompositions, we find an important role of nominal shocks in explaining movements in the U.S. dollar real exchange rate. Exchange rate shock alone explains 21-22% of the variation in the real exchange rate at all horizons. Furthermore, exchange rate shock transmits major disturbances to the real economy accounting for 20-27% of the fluctuations in economic activity, 30% in the price level, and 18-19% in the interest rate. On the other hand, real demand and supply shocks jointly explain 20-23% of the exchange rate variations. Consistent with Farrant and Peersman (2006), and Artis and Ehrman (2006), our results suggest that although exchange rate plays some role of a shock absorber, its role as an independent source of shocks is more dominant for the U.S.

To the best of our knowledge our study is the first in the literature to investigate whether the U.S. dollar floating exchange rate serves as a shock absorber or a source of shocks for the U.S. economy. We uniquely identify the exchange rate shock as idiosyncratic movements in the U.S. dollar arising purely from the foreign exchange market (mainly reflecting sentiments in the foreign exchange market) after macroeconomic fundamentals as well as world monetary and financial conditions are all adequately accounted for, in an integrated FAVAR framework. We provide robust evidence that although the dollar plays some role as a shock absorber, its role as a source of shocks is more dominant for the U.S. The primary contribution of our study is documenting evidence in favor of the role of exchange rate as an important independent source of shock for the U.S economy. Our findings suggest a plausible channel through which this happens. Due to excessive worldwide demand as a safe asset, international reserve currency, and primary invoice currency in trade, the dollar holds huge inertia but at the same time is also exposed to high speculative risks in the foreign exchange market. The foreign exchange market ends up breeding its own shocks which are destabilizing to the value of the dollar and the U.S. real economy. Our findings hold important policy implications. Given that the Fed is committed to its dual mandate of full employment and price stability, U.S. policymakers need to monitor and stabilize fluctuations originating from the foreign exchange market while maintaining the dollar's role as the international reserve currency.

The rest of the paper is organized as follows. Section 2 presents the empirical method and describes the data. Section 3 discusses the empirical results. Section 4 conducts the robustness checks. And section 5 concludes.

2. Empirical Method and Data

In this paper we use the Bayesian factor augmented vector autoregression model (FAVAR) in the spirit of Bernanke et al. (2005) and Stock and Watson (2011). Compared with traditional vector autoregression (VAR) models, a FAVAR has multiple distinctive advantages. It is specifically suitable for the study of concepts that are imperfectly observable. For example, "economic activity", "price level", and "monetary policy" are concepts that cannot be perfectly measured by any one single macroeconomic indicator (Bernanke, et al., 2005; Forni and Gambetti, 2008).[7] Many different macroeconomic time series may be informative, and FAVAR models provide a systematic approach for combining multiple time series through factor analysis. Fernald et al. (2014) further argue that the estimated latent factors from a FAVAR framework are more accurate and consistent measures of economic concepts than any individually documented data series. The richer information set in our FAVAR model more closely resembles the true information set used by private businesses and public policy makers.

Let X_t be a n-order vector stochastic process for a set of "informational macroeconomic variables", and F_t be a q- order vector of common latent factors. The informational variables primarily assist in extracting the common latent factors. Λ is the $n \times q$ matrix of "factor loadings". Given a time series realization of X_t and the observable subset of Y_t, we estimate the following factor augmented vector autoregression model of Bernanke et al. (2005) and Stock and Watson (2011), in Equations (1) and (2). The model in state-space form is given by:

$$X_t = \Lambda F_t + v_t \tag{1}$$

$$\begin{bmatrix} F_t \\ Y_t \end{bmatrix} = B(L) \begin{bmatrix} F_{t-1} \\ Y_{t-1} \end{bmatrix} + \begin{bmatrix} \epsilon_{ft} \\ \epsilon_{yt} \end{bmatrix} \tag{2}$$

Eq. (2) can be more compactly written as:

$$Z_t = B(L) Z_{t-1} + \epsilon_{zt} \tag{3}$$

where, Z_t follows the linear dynamic process:

$$Z_t = B_1 Z_{t-1} + B_2 Z_{t-2} \ldots + B_p Z_{t-p} + \epsilon_{zt} \tag{4}$$

[7] Such unobservable concepts can be estimated as latent factors from a large number of related macroeconomic indicators, and augmented into a standard VAR making it a "factor-augmented" VAR. Doing so allows us to condition our empirical analysis on a richer information set without abandoning the statistical advantages of traditional low-dimension VARs. For more details refer to Bernanke et al. (2005) and Stock and Watson (2011).

Z_t is an $m \times 1$ vector of information at date $t = 1, \dots \dots, T$, B_i are coefficient matrices of dimension $m \times m$ and ϵ_{zt} is the one-step ahead forecast error with variance-covariance matrix Σ. The system in Eq. (3) represents the reduced form version of a dynamic structural model. But we are interested in understanding how the variables in the system Z_t respond to aggregate structural shocks; our important objective is to identify the aggregate structural shocks. The structural equivalent to Eq. (3) in moving average form is given by:

$$Z_t = (I - B_z L)^{-1} D_z u_{zt} \tag{5a}$$

$$Z_t = (D_0 + D_1 L + D_2 L^2 + \cdots) u_{zt} \tag{5b}$$

where, u_{zt} is a vector of aggregate structural shocks, and $E u_{zt} u_{zt}'$ is normalized to be the identity matrix. The mapping from the reduced form to the structural form entails restrictions only on the covariance structure:

$$\Sigma = E(\epsilon_{zt}\epsilon_{zt}') = D_z E(u_{zt} u_{zt}') D_z' = D_z D_z' \tag{6}$$

Once we identify the $m \times m$ matrix D_z using this mapping (Equation 6), we obtain the dynamic responses from Equation (1-2) using Equation (3-5b). We need not fully identify D_z, because we are solely interested in four structural disturbances, i.e., U.S. aggregate demand shock, U.S. aggregate supply shock, U.S. monetary policy shock, and exchange rate shock. We therefore impose identifying restrictions only to columns of matrix D_z that correspond to the above four structural shocks.

2.1 Model Specification and the Latent Factors

We estimate the model using the two-step principal component analysis (see for example Stock and Watson, 2011; Bahadir and Lastrapes, 2015; Bagliano and Morana, 2009). The first step is to extract the common latent factors. We partition X_t into five subsets of similar variables and extract a static factor from each of the five subsets: $\hat{F}_{st}, s \in (1,5)$. For each subset s, we estimate F_{st} as the first principal component of X_{st}: $\hat{F}_{st} = \left(\frac{1}{n}\right) \hat{\Lambda}_s{}' X_{st}$, where $\hat{\Lambda}_s$ contains the eigenvectors of X_{st}, normalized so that $\left(\frac{1}{n}\right)\Lambda_s'\Lambda_s = I$. Thus $\{\hat{F}_{1t}, \hat{F}_{2t}, \hat{F}_{3t}, \hat{F}_{4t}, \hat{F}_{5t}\}$ are the estimated common latent factors that serve as a proxy for U.S. economic activity, U.S. price level, U.S. interest rate, U.S. nominal money, and world financial condition, respectively. The FAVAR model Z_t in Eq. (3) includes the above five latent factors $[\hat{F}_{1t}, \hat{F}_{2t}, \hat{F}_{3t}, \hat{F}_{4t}, \hat{F}_{5t}]'$ and the observable real exchange rate for the U.S. economy $[\,Y_t]'$.

X_t in Eq. (1) consists monthly time series of 170 U.S. macroeconomic variables ranging from 1973:01 to 2017:03. The variables are log first differenced or first differenced to induce stationarity. The data is retrieved from FRED, IMF IFS, and ISM.[8] The "U.S. economic activity" factor is extracted from 85 indicators reflecting broadly industrial production, employment, consumption, housing starts, consumer sentiment, and trade activities in the U.S.[9] The "U.S. price level" factor is extracted from 25 U.S. consumer and producer prices as well as import and export prices. The "U.S. interest rate" factor is loaded with 8 U.S. treasury interest rates of various maturities as well as the bank prime loan rate. The "U.S. money supply" factor is loaded with 7 measures of U.S. monetary aggregates. The first four factors measure domestic (U.S.) economic conditions. The fifth factor, the world financial condition factor, is extracted from 45 indicators of short run and long run foreign interest rates (capturing foreign monetary policy and global bond market activities) and stock market prices of major developed countries. As can be seen in Figure 1, the U.S. interest rate and world financial condition are highly correlated, reflecting a dominant role of US monetary policy in the global financial market.

(Figure 1 about here)

[8] They stand for, respectively, Federal Reserve Economic Data housed in the St. Louis Fed, International Monetary Fund's publication of *International Financial Statistics*, and the website of Institute of Supply Management. Detailed information of data description, variables constructing each factor, and factor loadings can be found in Appendix A.

[9] In the spirit of Liu, Spiegel, and Tai (2017), all trade variables (export, import, and current account balance) are added in the "economic activity" factor lending justification to capturing movements in the U.S. external sector.

The literature has long asserted that financial asset prices, like stocks and bonds and exchange rates show strong co-movements (Frankel, 1979; Obstfeld and Rogoff, 1998; Engel and West, 2005; Devereux and Engel, 2002; Gabaix and Maggiori, 2015; among others). Given that the U.S. dollar is the international reserve currency, a global safe financial asset, and the most traded currency in the foreign exchange market, it is imperative to isolate exchange rate movements that are in response to global financial shocks from those that can be attributed mainly to idiosyncratic disturbances (reflecting sentiments) in the foreign exchange market. We therefore use the world financial condition factor as a global financial control variable in our model.

2.2 Identification of Structural Shocks

We use the sign restrictions strategy of Farrant and Peersman (2006) to identify the structural shocks (see Table 1).[10] An increase in the real exchange rate indicates an appreciation of the U.S. dollar.[11]

[10]The primary advantage of the sign restrictions method is that shocks are identified not based on a zero restriction over the short or long run, but rather based on the direction of their impact on the variables in the model. There are numerous criticisms of using short run and long run zero restrictions in identification of structural shocks (see for example Faust and Leeper, 1997; Canova and Pina, 1999). Peersman (2005) shows that if conventional identification strategies (based on zero restrictions) produce impulse responses which conform to the sign restrictions, they can be treated as a single solution and lie in the tails of the distributions of the set of all impulse responses admitted by sign restrictions. Further, sign restrictions are more appealing because it eliminates any kind of puzzling responses by construction. Sign restrictions identification are used by Canova and De Nicolo, 2002; Uhlig, 2005; Peersman, 2005; Dungey and Fry, 2009; Farrant and Peersman, 2006; Scholl and Uhlig, 2008; among others. We therefore use the more robust and less restrictive sign restrictions approach to identify the structural shocks.

[11] We use the "Real Narrow Effective Exchange Rate for the United Sates (RNUSBIS)" from FRED as a measure of real exchange rate in our baseline model. We check the robustness of our results by using the following alternative measures of exchange rate: 1) real trade weighted U.S. Dollar index: broad, goods (TWEXBPA); and 2) real trade weighted U.S. Dollar index: major currencies, goods (TWEXMPA), both are from FRED. In addition, we also check the robustness of our results using the nominal exchange rate instead of the real exchange rate (TWEXB), from FRED. Our findings from the baseline model are robust to using different configurations of the exchange rate. The results are available upon request.

Table 1: Sign Restrictions Strategy (Farrant and Peersman, 2006, pp. 956)

Factors/Observables → Structural Shocks ↓	U.S. Economic Activity (Common Factor)	U.S. Price Level (Common Factor)	U.S. Interest Rate (Common Factor)	U.S. Money Supply (Common Factor)	U.S. Real Exchange Rate (Observable)	World Financial Condition (Common Factor)
Positive U.S. Supply Shock	≥	≤	?	?	?	control
Positive U.S. Demand Shock	≥	≥	≥	?	≥	control
Expansionary U.S. Monetary Policy Shock	≥	≥	≤	≥	≤	control
Exchange Rate Depreciation Shock	≥	≥	≥	?	≤	control

These widely accepted restrictions are based on standard IS-LM and AD-AS models, which remain at the heart of intermediate macroeconomic textbooks (Farrant and Peersman, 2006). For example, a positive demand shock leads to an increase in output and the price level, and an appreciation in the real exchange rate. A positive supply shock leads to an increase in the output and a decrease in the price level. While a depreciation is quite probable in the long run, the short run effect is indeterminate (Clarida and Gali, 1994).

Many studies isolate exchange rate shock from exchange rate's endogenous reactions to monetary policy shocks (Artis and Ehrmann, 2006; Farrant and Peersman, 2006; and Sun and De, 2019). Following the literature, we impose additional restrictions on interest rates to uniquely disentangle movements in the exchange rate that originate purely from the foreign exchange market versus those which are endogenous reactions to innovations in U.S. monetary policy, while controlling for world financial conditions. The restrictions seem plausible given the monetary policy stance of the Fed. First, we impose the restriction that domestic interest rates do not fall following a positive demand shock. Second, domestic interest rates do not fall following an exogenous exchange rate depreciation shock. Both movements conform to Fed's behaviour in response to shocks that are inflationary to the U.S. economy. Finally, we identify an expansionary monetary policy shock as one that does not lead to a decrease in economic activity, price level and nominal money, or an increase in the U.S. interest rate and exchange rate over a selected horizon (consistent with Uhlig, 2005; Farrant and Peersman, 2006; Scholl and Uhlig, 2008; among others). The sign restrictions in Table 1 are consistent with predictions of standard theoretical macroeconomic models, and together with the world financial controls are sufficient to uniquely identify the four structural shocks.

2.3 Estimation

We fit the FAVAR model (with five latent factors and one observable variable) in Equation (1) and (2) with seven lags. We add a constant and a time trend to Eq. (4). The time period over which we impose the sign restrictions to identify the structural shocks is k = 2 months, including the impact period of the shock.[12] We use Bayesian methods (assuming a Gaussian likelihood function and Jeffrey's prior) to estimate the posterior densities of the requisite parameters, conditional on observing the sample data for the baseline model as well as alternative model specifications for robustness check.[13] We report the median, as well as the 16% and 84% quantiles for the sample of impulse responses. We report the forecast error variance decompositions to understand the insulation properties of the exchange rate to the U.S. economy.

3. Empirical Results

3.1 Impulse Responses

Figure 2 shows the accumulated impulse responses of the estimated factors and the real exchange rate to a one standard deviation structural shock.

(Figure 2 about here)

A) Exchange Rate Shock

[12] To check for robustness, we estimate our model with 12 lags and k=6, respectively. We get similar results. The results are available upon request.
[13] We have included the technical estimation details in Appendix B. For complete details of the algorithm also refer to Uhlig (2005, Appendix B.1, pp 409-417) and Rubio-Ramirez, Waggoner, and Zha (2010).

In response to a one standard deviation exchange rate depreciation shock to the U.S. dollar, real exchange rate depreciates, reaching a peak depreciation of .70% over a five month horizon. The domestic economic activity expands over the first five months reaching a peak of .80%, and then makes a gentle descent back to its original long run normal level; the results are statistically significantly for about 15 months before dying out in the long run. The U.S. price level increases permanently by about 1.30%. The expansion in economic activity and increase in price level suggest the expenditure switching effect of the dollar depreciation on the U.S. economy, consistent with Liu, Spiegel, and Tai (2017). The exchange rate depreciation shock leads to a notable increase in the U.S. interest rate and a fall in U.S. money supply over the sample period. This is because, inflation in the economy (reflected in the increase in price level) prompts a contractionary monetary policy, indicating that U.S. monetary policy is leaning against the wind (Choudhri and Hakura, 2006; Sun and De, 2019). The U.S. exchange rate depreciation shock also leads to an increase in the global stock prices and world interest rates as shown by the response of the world financial condition factor. These responses are suggestive of the guiding role of the U.S. dollar, and the U.S. monetary policy in the world financial markets (consistent with the literature).

B) U.S. Monetary Policy Shock

In response to an expansionary monetary policy shock, the U.S. interest rate falls, while nominal money, economic activity and price level all increase, lending justification to our identification strategy. A one standard deviation expansionary monetary policy shock (45 basis point decrease in domestic interest rate on impact) leads to a peak increase in U.S. economic activity and price level by .70% over a five-month horizon. The U.S. real exchange rate depreciates, reaching a maximum depreciation of .85% over a five-month horizon. Following the decline in U.S. interest rate, the world financial condition (stock prices and foreign interest rates) also declines in the short run. Consistent with Farrant and Peersman (2006), our results show that nominal shocks – monetary policy and exchange rate shocks –have significant effects on the real economy and the real exchange rate for the United States.

C) U.S. Real Demand Shock

In response to a positive real demand shock to the U.S economy, domestic economic activity expands, and domestic price level rises. Domestic interest rates rise and nominal money falls, suggestive of a countercyclical monetary policy in the U.S. The real exchange rate appreciates. In the long run, economic activity returns to its original level, the real exchange rate remains appreciated and prices remain permanently higher. These responses are consistent with the findings of a standard open economy "Mundell Fleming model". The world financial condition – stock prices and world interest rates – increases in response to the positive U.S. demand shock. Again, a rising U.S. interest rate triggers the world interest rates to follow suit and can be viewed as a more dominant U.S. economy.

D) U.S. Real Supply Shock

In response to a positive real supply shock to the U.S. economy, domestic economic activity rises and domestic price level falls. The domestic interest rates fall and nominal money rises, suggestive of an accommodative monetary policy. The response of U.S. real exchange rate is ambiguous and insignificant.[14] World financial condition factor falls, though by less than its rise in response to the positive U.S. demand shock. Again, this could be attributed to the falling interest rate in the U.S. triggering the world interest rates to fall.

[14] A positive supply shock that creates a surplus of domestic goods should result in a real exchange rate depreciation. However, Detken et al. (2002) and MacDonald (1998) find that the real exchange rate can appreciate instead of depreciate following a positive supply shock, thus generating a "perverse supply effect". The authors explain that a positive supply shock may additionally lead to an upward shift in the aggregate demand curve (simultaneously along with an upward shift in the supply curve) owing to a rise in domestic real income and home bias in consumption, which could ultimately result in a "perverse supply effect". We find evidence of the perverse supply effect of the U.S. real exchange rate in the short run, but the results are not statistically significant. The real exchange rate (for the U.S.) appreciates for five months before it reverses course to depreciate and remains depreciated.

Overall, the impulse responses are consistent with existing literature and predictions of standard macroeconomic models, suggesting that our baseline model is plausibly identified.

3.2 Variance Decompositions

Forecast error variance decomposition measures the relative importance of macroeconomic shocks in explaining movements in macroeconomic variables. If the exchange rate adjusts rapidly to mitigate the effects of the real shocks on the economy, and if the real shocks explain an important share of the exchange rate movements, then the exchange rate can be considered to play a useful role in stabilizing the economy and act as a shock absorber.[15] On the contrary, if the foreign exchange market breeds its own destabilizing shocks, that is, the exchange rate fluctuates significantly in response to the exchange rate shock, and transmits major disturbances to the real economy, then the exchange rate acts as an independent source of shocks (An and Kim, 2010). Table 2 reports the forecast error variance of the factors at one year and five year horizons that can be explained by the structural shocks for the baseline model.

(Table 2 about here)

Is the U.S. Dollar a Shock Absorber? For the exchange rate to be a shock absorber a) the real exchange rate must respond to the real demand and supply shocks; and b) the real demand and supply shocks must explain a large proportion of the real exchange rate movement. From the impulse responses, we find that U.S. dollar real exchange rate does respond significantly to U.S. real demand shock, but not to U.S. real supply shock (see Figure 2 Panels C and D). Further, real demand shock explains 12-13%, and real supply shock 8-10%, of the forecast error variance of the real exchange rate. These results suggest that the U.S. dollar exchange rate plays a somewhat weak role of shock absorber for the U.S. economy.

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[15] For instance, under a flexible exchange rate, according to the Mundell Fleming model, appreciation of the dollar caused by a sudden exogenous rise in world demand for U.S. goods would “crowd out” additional demand, reducing net exports, and thus reducing the positive impact of the demand shock on the U.S. economy.

Is the U.S. Dollar a Source of Shocks? For the exchange rate to act as a source of shocks a) exchange rate must typically respond significantly to its own shock – the exchange rate shock; and b) the exchange rate shock must explain a large proportion of the fluctuations in the exchange rate and the real economy – economic activity and price level. As can be seen from impulse responses, real exchange rate for the U.S. does respond significantly to the exchange rate shock (see Panel A of Figure 2), and the exchange rate shock explains 21-22% of the exchange rate fluctuations. Further, exchange rate shock explains about 20-27% of fluctuations in economic activity, and about 30% of fluctuations in the price level over short and long horizons. It also explains 18-19% of the movements in the interest rate. Since exchange rate shock transmits a considerable amount of disturbances to the real economy, it appears that the U.S. dollar exchange rate plays a rather important role as an independent source of shocks for the U.S. economy.

In summary, we find that nominal shocks overall – exchange rate shock and monetary policy shock – jointly play a larger role in determining the paths of the real exchange rate and the real economy.[16] The impulse responses and variance decompositions provide evidence that although the exchange rate plays some role as a shock absorber for the U.S. economy, its role as an independent source of shocks is more dominant. Our results are consistent with Farrant and Peersman (2006) and Artis and Ehrmann (2006), who document exchange rate as an independent source of shocks for a number of small open economies. In the next section, we find that these results are robust to different model specifications.

4. Robustness Analysis

To check for robustness of the baseline model results, we estimate the following alternative model specifications while controlling for world financial condition using the same sign

[16] For example, monetary policy shock explains 20- 21% of the fluctuations in the real exchange rate, 14-19% of those in economic activity, and 15% in price level.

restrictions strategy: 1) following An and Kim (2010) we include both real and nominal exchange rates; 2) we adopt the exact model specification of Farrant and Peersman (2006); 3) we analyse two sub-periods 3a) the pre-Great Recession period from 1973 to 2007 and 3b) the Great Moderation period from 1984 to 2007; and 4) we add a global real economic activity factor to control for real economic developments abroad (that could potentially affect the U.S. economy).[17] The global real economic activity factor is computed as the first principal component of industrial production of the top eleven trading partners of the U.S.[18] Figure 3 shows that U.S. economic activity and global economic activity are highly correlated.[19]

(Figure 3 about here)

For all the above robustness models, impulse responses are consistent with those from the baseline model (see online Appendices D through H), lending reliability to our main baseline results. In response to a U.S. exchange rate depreciation shock, the exchange rate depreciates, real economic activity and the price level both rise, world financial condition strengthens, and the U.S. monetary policy is leaning against the wind. Further when we control for real developments abroad, we note that the U.S. dollar depreciation shock leads to a notable increase in the global real economic activity as well, suggesting that the U.S. expansion can boost the economy of its foreign trading partners, regardless of the adverse expenditure switching effect (see online Appendix H). Table 3 presents a summary of the variance decomposition results for all four robustness models.

(Table 3 about here)

[17] Except for the sub-period analysis, we estimate all other models over the given sample period of 1973-2017. We added some discussions of each of these four models in the online Appendix C.
[18] Details of the trading partners are provided in the online Appendix A. We include the major trading partners of U.S., subject to data limitations.
[19] This finding is consistent with Liu, Spiegel and Tai (2017) who document that U.S. local and global condition index are highly correlated.

Is the U.S. Dollar a Shock Absorber? Across all four robustness models, U.S. demand shock explains 11-17%, and U.S. supply shock 4-11% of the movement in the real exchange rate over short and long horizons. Consistent with the baseline model, these results suggest that the U.S. dollar plays a relatively weak role as a shock absorber.

Is the U.S. Dollar a Source of Shocks? Across all four robustness models, the exchange rate shock explains 19-23% of the variation in real exchange rate, 19-29% in economic activity, 24-30% in the price level, and 17-25% in the U.S. interest rate over short and long horizons. Consistent with the baseline results, we find that exchange rate shock explains significant fraction of movement in the exchange rate, and transmit major disturbances to the U.S. economy; thus the exchange rate appears to play an important role as an independent source of shocks for the U.S.

5. Conclusion

In this paper we study an important untapped question in the literature: whether the U.S. dollar floating exchange rate serves as a shock absorber or a source of shocks for the U.S. economy. We utilize a factor augmented vector autoregression framework to conduct the analysis. Within this framework, we uniquely identify the exchange rate shock as idiosyncratic disturbances in the U.S. dollar exchange rate originating purely from the foreign exchange market after accounting for macroeconomic fundamentals and financial developments worldwide. Our exchange rate shock therefore reflects mainly sentiments in the foreign exchange market. Our main contribution is documenting robust evidence in favor of the role of exchange rate as an important independent source of shocks for the U.S. The channel explaining our findings seems to be fairly straightforward. Due to high exposure in the global economy and strong demand as a safe asset, international reserve currency, and primary invoice currency in trade, the U.S. dollar is prone to speculation in the foreign exchange market. The foreign exchange market ends up breeding its own shocks which are destabilizing to the value of the dollar and the U.S. economy. Given that the Fed is committed to its dual mandate of full employment and price stability, U.S. policymakers need to monitor global downside risks and stabilize fluctuations originating from the foreign exchange market while maintaining the dollar's role as the international reserve currency.

We note in closing a limitation of our research and provide suggestions for future research. This paper is purely empirical in nature, and while empirical models can establish a general set of empirical evidence about the data, a calibrated theoretical general equilibrium model could better demonstrate the mechanisms of the channel fitting the empirical evidence. Such a theoretical model is beyond the scope of this paper and forms an avenue for future research. More broadly, perhaps due to the dollar's unique and asymmetric role as a reserve currency, there is a dearth of research on the U.S. economy in the context of traditional open economy macroeconomics and exchange rate literatures. We hope that our research helps stimulate more work utilizing this methodological framework.

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Variance Decompositions – Baseline Model

Factors/Observable	K-step ahead forecast error variance that can be explained by (in %)							
	Exchange Rate shock		*Monetary Policy shock*		*Real Demand shock*		*Real Supply shock*	
	1-year	5-year	1-year	5-year	1-year	5-year	1-year	5-year
Real Exchange Rate	21.60	20.64	20.15	21.03	12.54	13.42	8.01	9.49
Economic Activity	26.94	19.73	14.08	19.21	31.94	26.90	10.07	20.93
Price Level	30.46	29.60	14.80	14.95	20.46	19.95	35.23	33.12
Interest Rate	17.54	19.37	28.82	25.52	31.35	30.44	31.40	26.18
Nominal Money	4.33	4.16	19.02	19.61	5.94	6.47	7.65	8.04
World Financial Condition	11.87	13.54	14.12	12.31	16.82	16.85	17.34	14.25

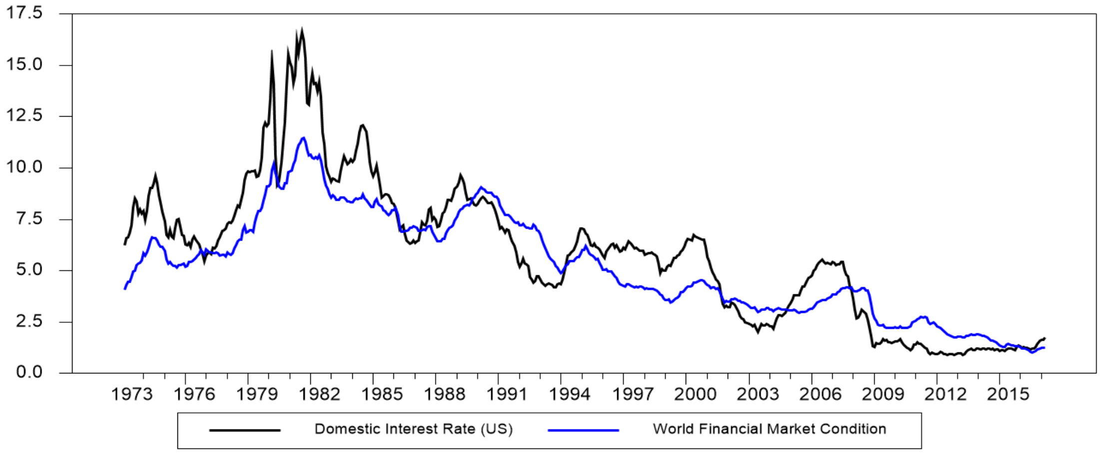
Note: The numbers show the median estimates of the k-step ahead (at 1 year and 5 year) forecast error variance decomposition of the factors (and the observable real exchange rate) to the four structural shocks. Complete results from the posterior distributions can be made available upon request.

Table 3. Variance Decompositions – Robustness Analysis

Factors/Observable	K-step ahead forecast error variance that can be explained by (in %)							
	Exchange Rate shock		*Monetary Policy shock*		*U.S. Demand shock*		*U.S. Supply shock*	
	1-year	5-year	1-year	5-year	1-year	5-year	1-year	5-year
Robustness 1: An and Kim (2010) Model								
Real Exchange Rate	19.72	18.79	18.75	19.56	11.40	12.29	7.79	9.38
Economic Activity	26.83	18.98	13.70	18.41	31.73	25.53	9.73	19.95
Price Level	29.96	28.28	14.62	14.48	20.23	19.26	33.88	30.04
Interest Rate	17.30	19.04	28.28	24.46	30.91	29.42	30.57	24.49
World Financial Condition	11.64	13.89	13.75	11.75	16.93	16.92	16.28	12.18
Robustness 2: Farrant and Peersman (2006) Model								
Real Exchange Rate	22.61	21.82	23.01	23.46	13.08	13.97	8.61	9.70
Economic Activity	28.67	21.44	16.27	20.85	33.16	29.75	10.98	22.21
Price Level	30.49	29.54	26.52	25.68	20.53	20.16	34.56	32.68
Interest Rate	17.39	19.11	28.45	26.48	32.87	32.10	34.81	30.35
World Financial Condition	11.33	13.03	15.24	14.04	17.39	17.53	18.61	15.32
Robustness 3a: Sub-period 1: pre-Great Recession, 1973-2007								
Real Exchange Rate	21.32	20.11	21.52	22.87	14.06	15.44	8.14	11.38
Economic Activity	28.73	19.35	17.64	20.15	32.56	23.97	13.57	27.03
Price Level	27.91	26.81	14.34	14.35	21.58	21.33	38.63	34.39
Interest Rate	22.22	24.65	25.26	21.46	29.04	28.23	25.98	19.83
World Financial Condition	12.30	15.50	14.09	12.81	16.31	18.17	15.17	12.56
Robustness 3b: Sub-period 2: Great Moderation, 1984-2007								
Real Exchange Rate	23.07	21.77	29.39	29.12	15.39	17.06	4.23	7.94
Economic Activity	22.77	18.87	5.97	7.87	23.32	19.83	6.77	9.78
Price Level	24.47	23.56	16.47	17.11	21.97	22.07	35.50	30.34
Interest Rate	23.90	22.17	28.50	24.62	32.01	28.26	33.46	27.36
World Financial Condition	8.47	11.21	8.84	11.25	10.38	14.06	10.44	12.34
Robustness 4: With Global Real Activity as control variable								
Real Exchange Rate	21.14	19.66	19.53	20.33	12.31	13.15	8.12	9.71
Economic Activity	25.12	16.71	12.75	17.55	29.06	22.98	8.69	19.12
Price Level	29.68	28.07	14.67	14.56	19.99	19.01	34.79	31.87
Interest Rate	16.74	17.96	28.58	24.56	30.73	28.94	31.37	25.36
World Financial Condition	10.88	12.20	14.39	11.93	16.33	15.47	16.95	13.35
Global Real Activity	1.41	1.90	2.39	3.26	1.23	1.81	1.13	1.86

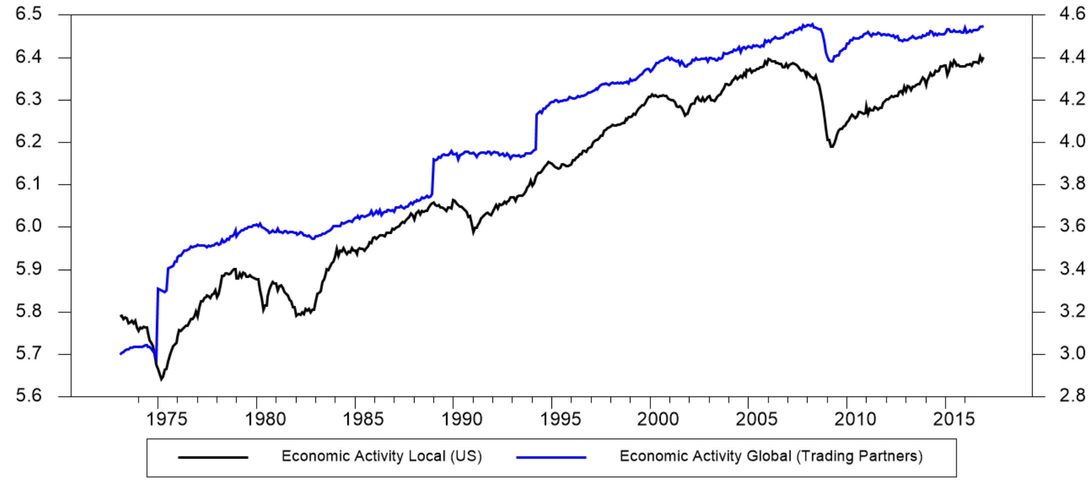
Note: The numbers show the median estimates of the k-step ahead (at 1 year and 5 year) forecast error variance decomposition of the factors (and the observable real exchange rate) to the four structural shocks. Complete results from the posterior distributions can be made available upon request.

Figure 1. U.S. Interest Rate and World Financial Condition



Note: Figure 1 plots the U.S. interest rate and the world financial condition over the sample period, 1973-2017. The black line measures U.S. interest rate while the blue line measures world financial condition, both in percentage points. Both lines are plotted against the left vertical scale. U.S. interest rate and world financial conditions show strong co-movement.

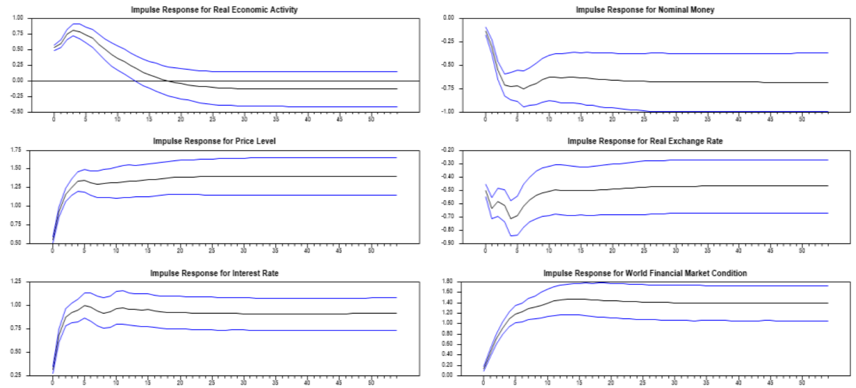
Figure 3. U.S. Economic Activity and Global Economic Activity



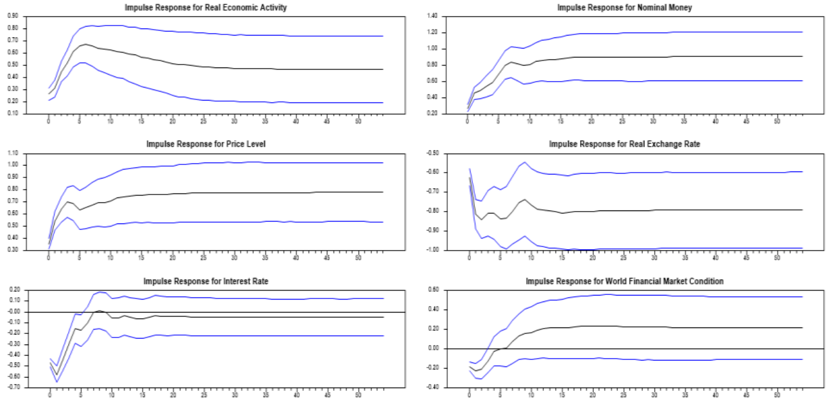
Note: Figure 3 plots the log of U.S. economic activity and global economic activity over the sample period, 1973-2017. The black line plotted against the left vertical scale measures U.S. economic activity, while the blue line plotted against the right vertical scale measures global economic activity. U.S. economic activity and global economic activity show strong co-movement.

Figure 2. Impulse Responses

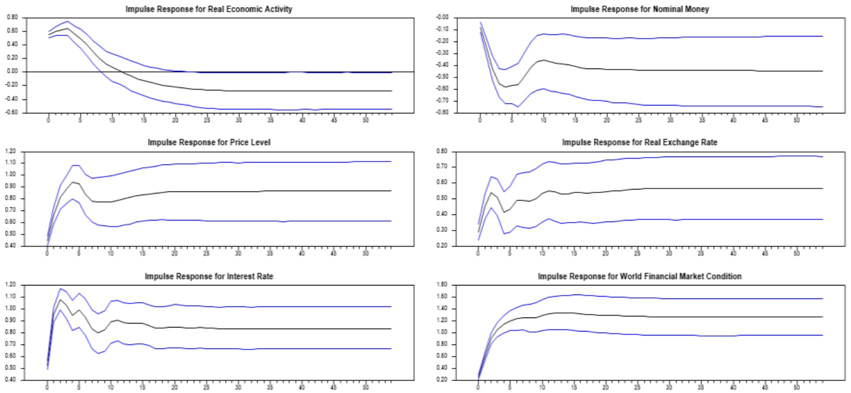
A) The Exchange Rate Shock



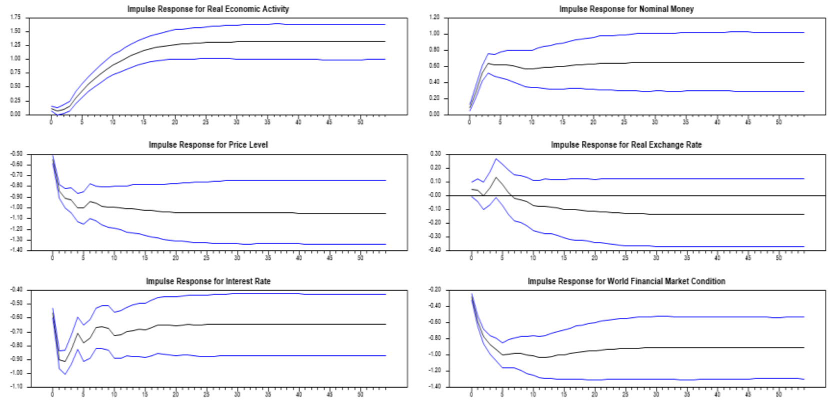
B) Monetary Policy Shock



C) U.S. Real Demand Shock



D) U.S. Real Supply Shock



Note: Figure 2 reports impulse responses of the factors to a one standard deviation of a) exchange rate depreciation shock; b) expansionary monetary policy shock; c) positive aggregate demand shock; and d) positive aggregate supply shock, respectively, for the U.S. economy. The three lines are the 16%, median, and 84% quantile of the posterior distribution.