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Spillover Effects of US Monetary Policy and Macreconomic Conditions in Nigeria: Evidence from Time-Varying Parameter Structural Vector Autoregression (TVP-SVAR)

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Saba Ndayezhin Danladi[1]

Abstract:

Purpose: *This paper examines the effect of U.S monetary policy spillovers on macroeconomic conditions in Nigeria by estimating a time-varying parameter-VAR (TVP-VAR).*
Design/methodology/approach: *The model is applied mainly due to its ability to capture possible nonlinearities and stochastic volatility of real and financial variables used. The impulse response of Nigeria's GDP, CPI inflation, exchange rate and monetary policy to U.S monetary policy proxy by shadow policy rate reveals that the effect on GDP and CPI inflation in Nigeria vary across the three major phases of U.S monetary policies (conventional, unconventional, and normalization).*
Findings: *While the effect appeared to be positive during conventional monetary policy phase, evidence of beggar-thy-neighbour was found during unconventional and monetary policy normalization phases. The negative effect appears to be more significant and last longer than the positive effect. We, therefore, conclude that U.S monetary policy substantially explains the cyclical fluctuations in the Nigeria economy.*
Practical implications: The results may be used by the macroeconomic policy-makers in their attempt to capture U.S. monetary policy spillovers on macroeconomic conditions in Nigeria.

Keywords: *Spillovers effects, monetary policy, macroeconomic conditions, time-varying parameter VAR.*

JEL Classifications: *F33, F41, F42.*

Paper type: *Research article.*

[1]*Department of Economics, ABU Business School, Ahmadu Bello University, Zaria. Nigeria.*
E-mail danladinsaba@gmail.com;

1. Introduction

The unintended effect of monetary policy action in one country on the rest of the world (International monetary policy spillover) has become a central issue among economist and policymakers in the recent time. It has become even more relevant over the past two decades when monetary policy in the major Advanced Economies (AEs) of United States, United Kingdom, Euro Area and Japan become exceptionally expansionary in response to Global Financial Crisis (GFC) and the Great Recession.

Although monetary policy have always had spillover effect but the massive implementation of Unconventional Monetary Policy (UMP) measures in response to the crises rekindled a new interest among researchers (Zorzi, Dedola, Georgiadis, and Jarociński, 2020) and stimulate academic and policy debate regarding the magnitude, directions, determinants and uncertainties surrounding the cross-border monetary policy spillover effect. While policy makers in small open economies (SOE) like Nigeria emphasize that U.S monetary policy could have destabilizing international spillovers through volatility swings in capital flows and asset prices, hence macroeconomic variables. On the other hand, policy makers in advanced economies argue that, while there are indeed risks associated with such policies, they are effective from the domestic point of view and help the global economic recovery (Fratzscher, Lo Duca, and Straub, 2014).

Since then, empirical evidence of such spillover effects and their uncertainties is fast growing over the past decades. Questions regarding whether a monetary expansion in the U.S. lead to recessions or booms in other countries and or whether it improved or worsen the trade balance (or the current account) have long been a subject of academic discussion, though largely mixed. For example Obstfeld and Rogoff (2002) argued that the cross-border effects of domestic monetary policy spillovers were likely to be negligible, even in a fully economically integrated world. on the contrary Maćkowiak (2007), provide evidence that monetary policy shocks explain a larger fraction of the variance in EME's aggregate price level and real aggregate output than in the U.S. itself.

This contention has been put to rest as recent studies suggest that monetary policies and pronouncements by AEs may have a global or regional effect (Bayoumi and Vitek, 2013; Wang and Mayes, 2012; Kishor and Marfatia, 2013; Bowman, Londono and Sapriza, 2015).

However, a number of studies (Mannerson, 2021; Kronick, 2014; Moore, Nam, Suh, and Tepper, 2013; Borda, Manioc, and Montauban, 2000) contend that the effect of monetary policy spillovers depends on a number of country's characteristics such as exchange rate regime, the level of trade and financial integration, the degree of openness, and other structural rigidities such as inflation, GDP and public debt.

While it is believed that floating exchange rate regime enables nominal exchange rate to respond appropriately to external shocks through relative price adjustment (Berg, Borensztein, and Mauro, 2003). On the contrary, it has also been argued that Rey (2014) that capital flows and stock prices in most countries, regardless of their exchange rate regime against the dollar, display strong co-movements with the global cycle. This contentious role of exchange rate has put both monetary policy independence and insulating property of flexible exchange rate into question.

For instance while many studies (di Giovanni and Shambaugh 2008; Hausman and Wongswan 2011; Klein and Shambaugh 2015; Gagnon, Bayoumi, Londono, Saborowski, and Sapriza 2017; Obstfeld *et al.*, 2018; Aizenman, Chinn, and Ito, 2016; Bekaert and Mehl, 2017; Goldberg, 2013) all provide empirical evidences for insulating properties of flexible exchange rates.

On the contrary, evidence of monetary policy spillover in short-term rates even for flexible exchange rates economies has been documented in the recent studies (Takáts and Vela, 2014; Rey, 2016; Tong and Wei, 2011). Most of these empirical studies are not only mixed but mainly based on advanced economies.

Few other studies on small open economy like Nigeria mostly employed techniques that assumes parameter constancy, ignoring possible structural changes which should be of particular interest to researchers. Since ignoring such changes may lead to inaccurate forecasts and misleading policy recommendations. It is against this background that this study seeks to examine the effect of U.S monetary policies on the macroeconomic conditions in Nigeria using a VAR model that feature time varying parameter.

In this paper, we contribute to the literature on spillover of monetary policy and investigate empirically whether U.S. monetary policy decisions are related to economic conditions in Nigeria, and, whether exchange rate play a significant role in the transmission of the effects.

In particular, we follow the arguments presented in the literature and analyze the following three consecutive hypotheses. First, does U.S. monetary policy spills over to developing countries like Nigeria? Second, does U.S monetary policy spillovers affect developing economies through exchange rate channel? Third, does U.S monetary policy spillovers influence the conduct of monetary policy in developing country like Nigeria?

The remainder of the paper is structured as follows. In Section 2, we review the theoretical and empirical literature and outline transmission channels through which U.S. monetary policy can affect other countries' financial conditions, output and inflation. We then describe the model and outline the data of the study and their sources in section 3. In Section 4, we present our preliminary and main results. in Section 5, we conclude the paper.

2. Review of Literature

2.1 Theoretical Literature

The idea that foreign monetary policy may have international effect start with Mundell–Fleming Model (MFM) of international macroeconomics. This model also known as IS-LM-BP model originated in the writings of Robert A. Mundell and Marcus J. Fleming in the early 1960s.The model was first applied to study the transmission of monetary shocks between nations by Frenkel and Razin (1987). Although the MFM precisely portrays a short-run relationship between an economy's nominal exchange rate, interest rate, and output.

However, two of its predictions provide a baseline framework for this study as they explain the mechanism through which domestic monetary policy may have effect on foreign output and indirectly on inflation, asset prices and monetary autonomy. In the first instance, the model predicts that an expansionary monetary policy would depreciate the value of home country's currency and deteriorate its terms of trade. This will leave home goods cheaper for foreign nations leading to a phenomenon called "beggar-thy-neighbour effect" (Bich, Tran, Cam, and Pham, 2020).The offsetting impact may also be positive through home output expansion, thus boosting demand for foreign country exports.

However, which of these impacts dominates is an empirical question. The MFM has also been used to argue that policymakers in an open economy face a macroeconomic trilemma in the sense that an economy cannot simultaneously maintain a fixed exchange rate, free capital movement, and independent monetary policy. Only two of the three may coexist.

The Dornbusch "overshooting" extension (Dornbusch 1976) [2] of the Mundell–Fleming model provides additional insight. This model has two important theoretical implications. First, a change in monetary policy can create large fluctuations in asset prices, particularly exchange rates. Second, an expectation of a future monetary policy change can induce changes in asset prices today, such as exchange rates and stock prices, as financial markets are forward-looking. This framework refers to the exchange rate channel through which an expansionary monetary policy in one country would lower interest rates and appreciate local currencies in the partner countries.

Other theories that provide additional insight includes the uncovered interest rate parity (UIRP) theory, global financial cycle theory and small open economy

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[2] *Dornbusch (1976) presents a dynamic version of the Mundell-Fleming model that explains excess exchange rate volatility in a deterministic perfect foresight setting. The key feature of the model is that the asset market adjusts to shocks instantaneously while goods market adjustment takes time.*

Taylor's rule. For instance, even though the UIRP postulates that the difference in the nominal interest rates between two countries is equal to the relative changes in the foreign exchange rate over the same period. The occurrence of significant transactions costs from closing arbitrage conditions in financial markets, the presence of limits to speculation (Lyons, 2001), and also the effects of central bank intervention, e.g., Mark and Moh (2004) all put the UIRP condition and monetary policy independence into question in SOEs.

This development has implication for open economy Taylor's rule which rest on the argument of Woodford (2012), that central bank's objective function should include a term that captures financial distortions created by constraints on the behaviour of financial intermediaries, households, or firms noting that shocks to real exchange rates and foreign interest rates are major sources of financial instability. It was in this regard that Froyen and Guender (2018) further assert that developments in the theory of optimal monetary policy for open economies taken together with increased instability in world financial markets warrant a re-examination.

This is because it has been argued that in developing countries and small open economies, it is likely that the exchange rate plays an important role as well due to financial dollarization, and high exchange rate pass through. To preserve the independence of monetary policy, flexible exchange rate regime has been advocated. This concern motivates transition of most economies including SOEs from rigidly fixed exchange rate regime or at least dirty/managed float exchange rate regime. Again, this insolating property of flexible exchange rate has been put to question by the global financial cycle (GFC) theory.

The theory postulate that U.S. monetary policy overwhelmingly determined the monetary policy of countries that allowed partial financial integration irrespective of their exchange-rate regimes, thereby reducing the trilemma to a dilemma. According to Rey (2015), the main implication of a GFC is the mutation of the trilemma of international finance into a dilemma, in which the insulating properties of a flexible exchange rate become ineffective in maintaining monetary autonomy.

Hence, a partial explanation for macroeconomic instability particularly inflation. It is in this regard that Small Open-Economy Hybrid version of the famous New Keynesian Phillips Curve (NKPC) used in analysis of pricing behaviour in the recent macroeconomic research becomes relevant for this study.

The SOE version of the NKPC derived in Galí and Monacelli (2005) links inflation dynamics to external-sector macro-variables, such as the terms of trade (ToT), in addition to domestic ones. This enables policy makers, particularly central banks to respond appropriately to the dynamics of inflation in their policy rule.

2.2 International Transmission Channels of Monetary Policy Spillover

According to Miranda-Agrippino (2020), monetary policy operates through multiple complementary channels. These Channels are not mutually exclusive and can work in parallel and as a consequence, they can be difficult to identify (Fratzscher *et al.*, 2014). While some of these channels are discussed in a wide range of theoretical and empirical studies, such discussions are mostly based on channels of interest making the efforts less comprehensive in comparison to this study. For example, Carunana, (2012) in Rohit and Dash (2018) emphasized that the transmission occurs mainly through prices or quantities. Mostly, asset prices like exchange rates, sovereign bond yield, and equity prices, have been identified as significant in the transmission of monetary policy actions originating from AEs (Chen, Filardo, He and Zhu, 2015; Neely, 2015).

Further efforts have been made to classify these channels along conventional and unconventional monetary policy point of views. From the conventional monetary policy point of view, there are three basic channels through which monetary policy stance in one country can affect economic activities of other countries (Ammer, De Pooter, Erceg, and Kamin, 2016).

While the first is the exchange rate channel based on the famous MFM which is further corroborated by Taylor rule prediction of specific role for exchange rate as a key transmission of spillovers of foreign monetary policy to the operation of monetary policy in another economy (Taylor, 2007).

The other two channels in addition to the exchange rate channel, are the domestic demand channel (also refers to as trade channel) and financial channel. while the first two channels (Exchange rate and Domestic demand channels) are a staple of virtually all general equilibrium, intertemporal models of macroeconomic policy transmission that merge Keynesian pricing assumptions and international market segmentation building on the Mundell-Fleming-Dornbusch framework[3] (Iacoviello and Navarro, 2018; Degasperi *et al.,* 2019), the financial channels have been emphasized in some work that has studied the international implications of various types of credit market frictions (Aghion *et al.,* 2004; Gertler *et al.,* 2007).

With the advent of UMPs (both QE and FG) more channels were activated. Some of these channels includes international portfolio rebalancing channel, international signaling channel, and the confidence channel (Woodford, 2012; IMF, 2013; Borrallo, Hernando, and Valles, 2016). Others includes wealth channel, credit channel and a monetary policy reaction channel. Through these channels, adjustments in consumption and investment would take place and ultimately affect production and inflation.

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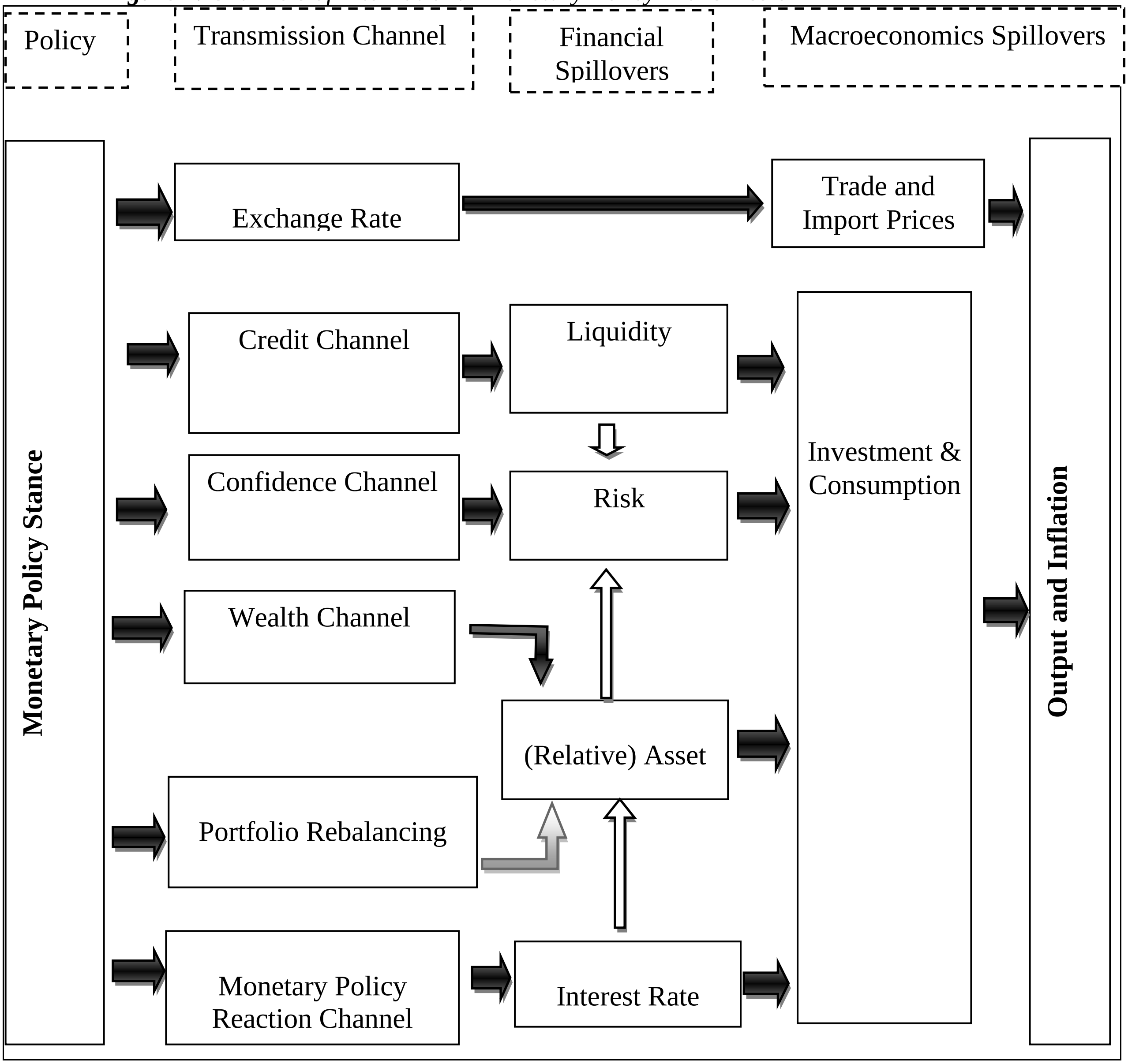
[3]*See for instance the work of Obstfeld & Rogoff (1995) for a modern, micro-founded exposition of this framework.*

Figure 1. *Channels of International Monetary Policy Transmission*



Note: *The gray arrow indicates an indirect effect. The white arrows indicate contemporaneous effects.*
Source: *Adopted from Bluwstein and Canova, (2016) with little modification.*

2.3 Empirical Literature

Empirically, studies investigating the response of small open economies' real variables (output and inflation) to spillover effect of monetary policy from advanced economies, though fast growing but largely contentious. While a strand of the literature documented negative and positive GDP for floaters and pegs respectively, another strand found existence of such spillovers regardless of exchange rate regime. For instance, in a study on the contribution of U.S. monetary policy to Caribbean business cycles using Structural VAR, Borda, Manioc, and Montauban, (2000) finds negative output effect for floaters and positive GDP implication for fixed exchange rate countries in the short-run.

Similarly, in a study of external shocks, U.S. monetary policy and macroeconomic fluctuations in emerging markets, Mackowiak (2007) find that monetary policy shocks from U.S. explain a larger fraction of the fluctuations in the aggregate price level and real GDP of EMEs than what is obtained in the U.S. itself.

The study further reveals that Inflation in a typical emerging market rises in response to a U.S. monetary policy contraction and an increase in the interest rate tends to decrease consumption and investment, hence output. Jannsen and Klein (2011) reported that a contractionary monetary policy shock in the euro area led to a contraction in GDP, exports, and imports of the five countries that do no adopt euro.

Kronick (2014) used SVAR to investigate how contractionary monetary policy shocks originating from Euro Area and U.S, affect sub-Saharan African ("SSA") countries. The study reveals mixed results depending on which of the EU or U.S. shocks, monetary policy and exchange rate regime of the recipient SSA countries. Specifically, floating exchange rate countries have mostly negative GDP response following either shock due to a reliance on capital flows and external debt, and the implications these have for domestic interest rate responses.

Fixed exchange rate countries have mixed GDP responses following the EU shock, as both trade and the effect of capital control usage on interest rates play an important role, while U.S. shocks produce positive GDP responses as aid from the U.S. dominates both trade and interest rates. Georgiadis (2015) argue that the magnitude of spillovers depends on the receiving country's exchange rate regime among other variables. He found among others, that a floating exchange rate reduces the output spillover from US monetary policy shocks.

Contrary to the above findings, another stream of studies has found evidence that exchange rate regime has little or no role in the transmission of monetary policy spillover to SOEs. Canova (2005) uncovered similar output but different inflation and interest rate response for floaters and pegs. It was further revealed that interest rate channel is a crucial amplifier of U.S. monetary disturbances, while the trade channel plays a negligible role.

However, while there are differences in the responses of countries with floating and non-floating exchange rates, these differences have more to do with the magnitude of the effects than with the pattern of transmission. Miniane and Rogers (2007), find no evidence that capital controls are effective in insulating other countries. They also find that the exchange rate regime does not matter much for the macroeconomic transmission of U.S. shocks, with countries having a fixed exchange rate regime being similarly affected as floaters in terms of output and inflation.

In a recent study of international spillovers of U.S. monetary policy shocks on a number of macroeconomic and financial variables for 36 advanced and emerging market economies, Dedola, Rivolta, and Stracca, (2017) similarly do not find evidence of a systematic relation between selected country characteristics (like income level, exchange rate regime, financial openness, trade openness vs. the US, dollar exposure and incidence of commodity exports) and the distribution of cross-country responses to U.S. monetary policy shocks. They reported that U.S. monetary tightening leads to a depreciation of currency in most of the countries and drives them into recession.

Majority of these countries recorded decline industrial production and real GDP. Increased unemployment, improved trade balances and falling Inflation were also observed in majority of those countries.

In a similarly direction, Iacoviello and Navarr (2019) presents new empirical evidence regarding the cyclical response of foreign economies to U.S. monetary policy shocks using a large panel of 50 advanced and emerging economies where the country's GDP response are allowed to vary according to its exchange rate regime, trade openness, and vulnerability index that includes current account, foreign reserves, inflation, and external debt. The study reveals large heterogeneity in the response of advanced and emerging economies to U.S. monetary policy. The traditional Mundell-Fleming-Dornbusch view of foreign spillovers is consistent with the response of advanced economies.

However, such a view appears at odds with the response of emerging economies, where trade and exchange rate exposure to the U.S. do not seem to matter. By contrast, the financial channels are very important for emerging economies, much more so than for advanced economies.

Obi and Igbanugo (2016) in a study of spillover effect of U.S. UMP on Nigerian Economy found beggar-thy-neighbour effect of U.S. UMP on Nigerian economy. They reported that U.S. UMP depresses growth, export and external reserves in Nigeria and the major channel transmission is found to be trade.

Beside these contentious findings, most of these studies do not consider the financial dimension of monetary policy spillovers from advanced economies. It has been widely documented those monetary policies and pronouncement by developed economies such as the United States among others may have a global or regional effect on equity markets (Wang and Mayes, 2012; Kishor and Marfatia, 2013; Bowman, Londono and Sapriza, 2015).

3. Methodology and Data

3.1 The Model: TVP-SVAR

First, we present the methodology and properties of the TVP-VAR with stochastic volatility model. Formally, a vector auto-regression (VAR) process can be defined as

$$y_t = \sum_{i=1}^{p} \beta_i y_{t-i} + \varepsilon_t \qquad \mathrm{E}(\varepsilon_t \varepsilon_t^{\,l}) = \sum, \tag{1}$$

Where y_t is an n-vector of variables, Φ is an n × n matrix, p is the number of lags and $\sum$ is the covariance matrix. The vector y_t is stationary if the roots of the characteristic polynomial Φ (z)=I$_m$ $- \sum_{i=1}^{P}$ $\Phi_i z^i$ are outside the unit circle (Terasvirta, Tjostheim, and Granger, 2010). Under stable conditions, the process in (1) is denoted by the moving average in (2)

$$y_t = \varepsilon_t + \sum_{i=1}^{\infty} \Theta_i \, \varepsilon_{t-i.} \tag{2}$$

The Θ_i matrix represents the response function to shocks (ε_t) of the element of y_t. From (1) and (2) above, it is assumed that the variables impact on each other according to how they are ordered.

$$Ay_t = A_1^* y_{t-1} + \ldots + \mathrm{A}_k^* y_{t-k} + \varepsilon_{t,} \qquad t = k+1,\ldots,T, \tag{3}$$

Where y_t is an k x 1 vector of observed variables and A, A_1^*,…, A_k^* are k x k matrices of coefficients while the innovation term ε_t is a k x k structural shock. Accordingly, (3) which is a structural-VAR can be specified in another form. Consider

$$y_t = c_t + \mathrm{B}_{1,t} y_{t-1} + \ldots + \mathrm{B}_{k,t} y_{t-k} + \varepsilon_{t,} \qquad t = k+1,\ldots,T, \tag{4}$$

Where y_t an n x1 vector of observed endogenous variables, C_t is an n x 1 vector of time-varying intercepts and $\mathrm{B}_{i,t}$, $i = 1,\ldots,k$, are n x n matrices of time-varying coefficients while ε_t are heteroscedastic unobservable shocks with variance-covariance matrix Ω_t. Primiceri (2005) considers the triangular reduction of Ω_t to be defined as: $A_t \Omega_t A_t^{'}$. Hence A_t which is a lower-triangular matrix and Σ_t are defined as

$$A_t = \begin{pmatrix} 1 & 0 & ... & 0 \\ \alpha_{21,t} & 1 & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ \alpha_{n1,t} & \cdots & \alpha \text{nn-1,t} & 1 \end{pmatrix}, \Sigma_t = \begin{pmatrix} \sigma_{1,t} & 0 & \cdots & 0 \\ 0 & \sigma_{2,t} & \ddots & \vdots \\ \vdots & \ddots & \ddots & 0 \\ 0 & \cdots & 0 & \sigma_{n,t} \end{pmatrix},$$

Where Σ_t is a diagonal matrix. There are several ways to model the VAR process for time-varying parameters already proposed in the literature. Equation (3) can be expressed as a reduced-form VAR model which is given by

$$y_t = B_{1,t} y_{t-1} + ... + B_{k,t} y_{t-k} + A^{-1} \Sigma \varepsilon_{t,} \qquad \varepsilon_t \sim N(0, I_k), \tag{5}$$

Whereby, in the context of time-varying parameter (TVP) modelling we have

$$y_t = c_t + B_{1,t} y_{t-1} + ... + B_{k,t} y_{t-k} + A^{-1} \Sigma_t \varepsilon_{t,} \qquad V(\varepsilon_t) = I_n, \tag{6}$$

where A_t is a lower-triangular matrix with ones on the main diagonal and time-varying coefficients below it, Σ_t is a diagonal matrix of time-varying standard deviations and ε_t is an n x 1 vector of unobservable shocks with variance equal to the identity matrix. From (3) we let $B_i = A^{-1} A_i^*$ for $i = 1, ..., k$. Stacking the elements in the rows of the B_i's and defining $X_t = I_k \otimes (y'_{t-1}, ..., y'_{t-k})$, the model can be represented by

$$y_t = X_t \beta + A^{-1} \Sigma \varepsilon_t, \tag{7}$$

Where $\otimes$ denotes the Kronecker product. All the parameters in (7) are constant (time-invariant). TVP-VAR models extends (7) by allowing the parameters to change over time. Again, by stacking in a vector B_t for all the right hand side (R.H.S) coefficients, (6) can be represented more compactly as

$$y_t = X'_t B_t + A_t^{-1} \Sigma_t \varepsilon_t, \tag{8}$$

Where $X'_t = I_n \otimes [1, y'_{t-1}, ..., y'_{t-k}]$ and B_t, A_t and Σ_t are all time varying. Following Primiceri (2005), let $\alpha_t = (\alpha_{21,t}\ \alpha_{31,t},\ \alpha_{32,t},\ \alpha_{41,t}, ..., \alpha_{nn-1,t},)'$ be a stacked vector of the lower-triangular element in A_t and $\sigma_t = (\sigma_{1i}, ..., \sigma_{n,t})'$ be the vector of the diagonal elements of the matrix Σ_t. It suffices to state that allowing the matrix A_t to change over time is crucial in TVP-VAR model analysis. When parameters in (8) follow a random walk (RW) process, the dynamics of TVP are

$$B_t = B_{t-1} + \nu_t,\ \alpha_t = \alpha_{t-1} + \zeta_t,\ \log\sigma_t = \log\sigma_{t-1} + \eta_t. \tag{9}$$

The standard deviations (σ_t) are assumed to evolve as a geometric RW belonging to the stochastic volatility model family. The key difference is that the variances estimated from $\log\sigma_t$ are unobservable components. All the innovation terms in the model are assumed to be jointly normally distributed with the following assumptions on the variance-covariance.

$$V = Var\begin{pmatrix}\varepsilon_t\\ \nu_t\\ \zeta_t\\ \eta_t\end{pmatrix} = \begin{pmatrix} I_4 & 0 & 0 & 0\\ 0 & Q & 0 & 0\\ 0 & 0 & \mathrm{S} & 0\\ 0 & 0 & 0 & \mathrm{W}\end{pmatrix},$$

Where I_4 is a 4-dimensional identity matrix, Q, S, and W are all positive definite matrices. These parameters govern the variance and covariance structure for the innovation terms of the time-varying parameters. Following Primiceri (2005) we assume that S is block diagonal. The priors are calibrated following Primiceri (2005) and Del Negro and Primiceri (2015) with few modifications.

3.2 Data and Sources

Monthly time series data used for this study were obtained from three major sources. While data on output, inflation, monetary policy, and exchange rate for Nigeria were obtained from the International Financial Statistics (IFS) of IMF and Central Bank of Nigeria Database, data on U.S. monetary policy stance proxy by shadow interest rate estimated by Wu and Xia (2016) was extracted from Federal Reserve Bank of Atlanta's website. The sample spans from January 2000 until December 2020. The study period and cut-off dates are based on the desire to stay current and up to date to capture the three phases of U.S. monetary policy stance over time (the Conventional, UMP and Normalization). Data that are not available in monthly frequencies were interpolated to a monthly frequency using a linear match to the last data point.

4. Results and Discussions

4.1 The Statistical Properties of Domestic and U.S. Variables

Table 1 presents the statistical properties of all the real and financial variables used for this study. From the table all the domestic series feature a positive mean value, while U.S. monetary policy shock proxy by shadow policy rate have a mean value of approximately 0.06. The coefficient of skewness indicates that all the variables are fairly symmetrical by the rule of thumb as they are all between -0.5 and 0.5.

Table 1. *Descriptive Statistics of the Data*

Statistics	GDP	CPI Inflation	MPR	Exchange Rate	U.S Shadow Policy Rate
Mean	169.2546	224.4405	12.96875	254.9253	0.058183
Median	165.3316	214.639	13	305.2713	0.420072
Maximum	216.2652	355.9105	14	381	2.530869
Minimum	126.6912	141.9424	11	157.27	-2.98564
Std. Dev.	32.02914	62.80849	0.959201	75.37042	1.67279
Skewness	0.208221	0.366026	-0.36034	-0.10929	-0.33222
Kurtosis	1.532053	1.864427	1.747965	1.516865	1.885194
Jarque-Bera	9.313172	7.301697	8.347825	8.989865	6.737049
Probability	0.009499	0.025969	0.015392	0.011165	0.03444
Sum	16248.44	21546.29	1245	24472.83	5.585577
Sum Sq. Dev.	97457.28	374766.1	87.40625	539666.6	265.8315

Sources: *Authors' Computation 2021.*

Similarly, the value of the kurtosis is found to be platykurtic with coefficient of less than three (3). This implies that the distribution is shorter, tails are thinner, the peak is lower and broader than mesokurtic, the data are light-tailed or free of outliers. However, the less than 0.5 p-value of Jarque-Bera statistics suggest that the series are not normally distributed**.**

4.2 Co-Movement of the Key Domestic Variables with U.S. Monetary Policy Stance

To establish how the domestic variables of interest co-move with the monetary policy stance of the U.S. Fed we perform a contemporaneous correlation. Table 2 below shows the result of the estimated contemporaneous correlation. The result indicates that the policy rate of U.S Fed inversely related to CPI, GDP and Exchange rate but positively related to monetary policy rate in Nigeria.

Table. *Contemporaneous Correlation of the Variables*

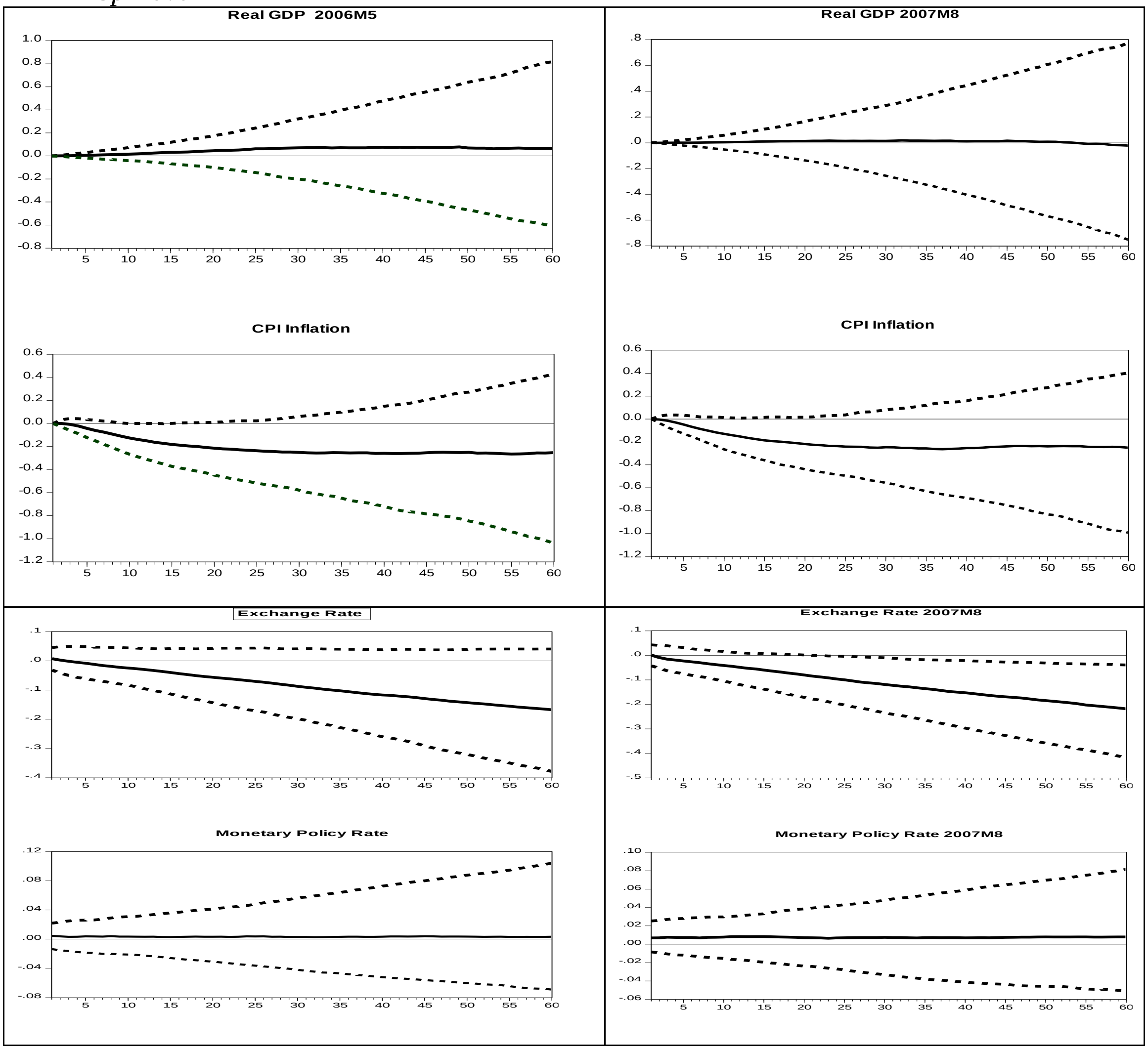
Variables	SSR	CPI	GDP	MPR	EXR
SSR	1.000	-0.33502	-0.40149	0.346403	-0.19942
CPI	-0.33502	1.000	0.983291	-0.15955	0.953463
GDP	-0.40149	0.983291	1.000	-0.28422	0.906627
MPR	0.346403	-0.15955	-0.28422	1.000	-0.02448
EXR	-0.19942	0.953463	0.906627	-0.02448	1.000

Source: *Authors' Computation 2021.*

4.3 U.S. Fed's Conventional Monetary Policy Spillover on Macroeconomic Variables in Nigeria

The response of selected macroeconomic variables in Nigeria to monetary policy shock of U.S. Fed is presented in Figure 1. The response of GDP to US conventional monetary policy appeared to be weakly positive after 10 months. The response of domestic monetary policy is instantaneously positive but weak too. On the contrary, the US Fed's monetary policy shock depresses both exchange rate and domestic CPI inflation. The effects are almost instantaneous and persist at an increasing rate for about 5 years since May 2006.

Figure 1. *Response of Macroeconomic Variables in Nigeria to US Monetary Policy Spillover*

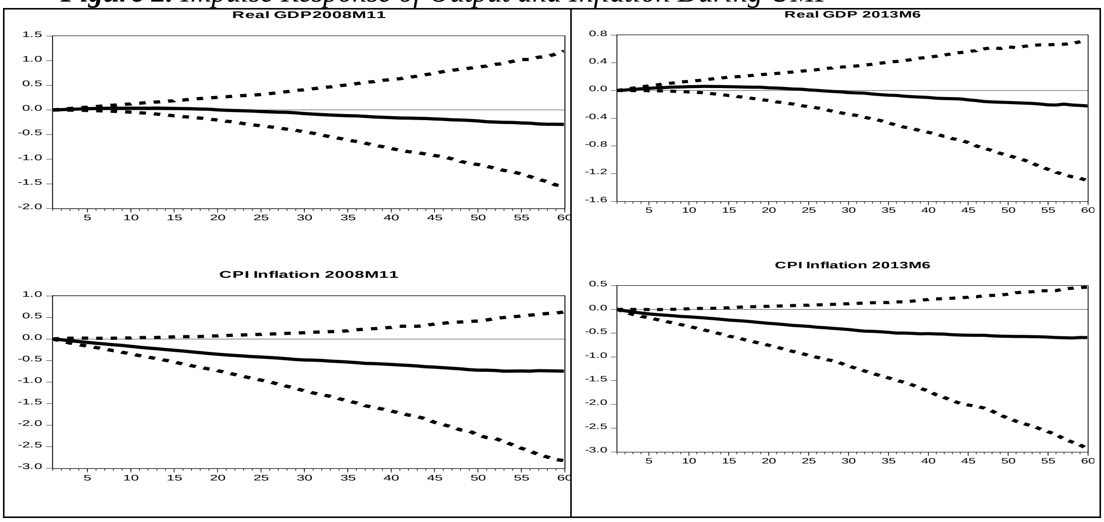


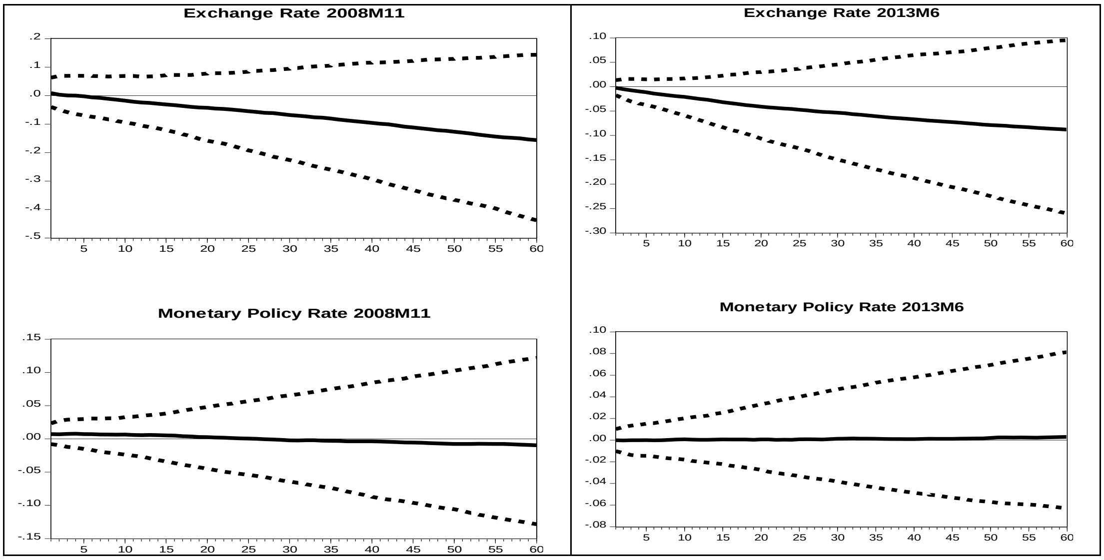
The U.S. Fed's monetary policy stance in August 2007 exert positive but insignificant effect on the Nigerian GDP. This effect started to manifest after 5 consecutive quarters and persists for almost 3 years. The effect on CPI inflation is similar to that of 2006 as it is equally depressing and instantaneous. The strong negative response of exchange rate variable to U.S monetary policy shock suggest that the international monetary policy transmission to Nigerian economy occurred through exchange rate channel with high pass-through to inflation before output. The significant decrease in the exchange rate as shown in the third row of Fig.1 is consistent with the significant decrease in inflation and rise in output in Nigeria over the period.

4.4 U.S. Fed's Unconventional Monetary Policy Spillover on Macroeconomic Variables in Nigeria

The response of selected macroeconomic variables in Nigeria to monetary policy stance of the U.S. Fed during UMP era is presented in Fig.2. Contrary to the conventional monetary policy era, Nigeria's GDP negatively respond to U.S UMP shock. The effect on GDP was quite slow taking about 20 months and lasted for over 3 years. The effect on inflation remained negative and fast too. The taper tantrum of U.S. Fed in June 2013 exerts similar influence on both GDP and CPI inflation in Nigeria.

Figure 2. *Impulse Response of Output and Inflation During UMP*





This suggests that US UMP rather has expenditure switching effect on US domestic economy through exchange rate depreciation. As US demand switches from foreign to domestic commodities, Nigerian export declines, trade balance worsens and economic growth declines. This is consistent with beggar-thy-neighbour prediction of MFM, where expenditure switching effect dominate income absorption effect. This finding is in line with Obi and Igbanugo (2016) and run contrary to what was obtained during UMP era. Like the conventional monetary policy era, the U.S UMP depresses exchange rate significantly while domestic monetary policy continue to track US monetary policy.

4.5 U.S. Fed's Monetary Policy Normalization Spillovers to Real GDP and Inflation in Nigeria

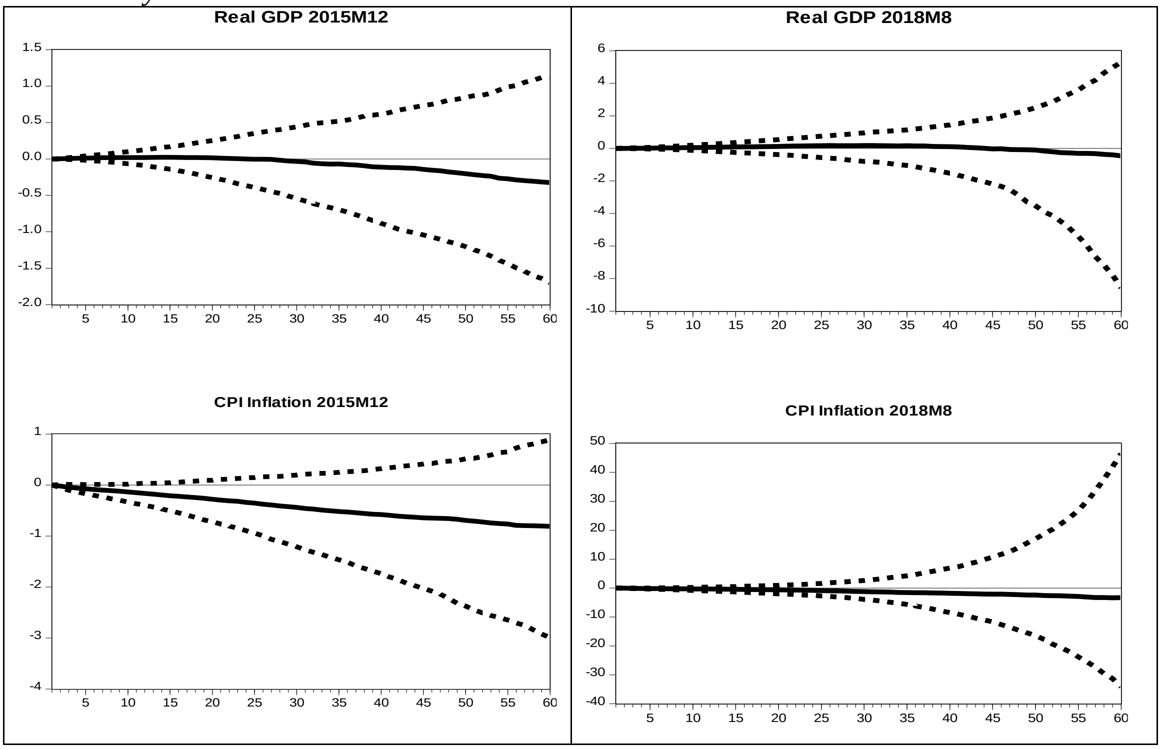
The response of the GDP and CPI inflation to monetary policy normalization of the US Fed is presented in Figure 3. The effect on output in Nigeria was insignificantly positive for about 20 months and after two years the effect becomes negative through 2018. This suggest that the normalization of monetary policy which started with raising of policy rate may exert beggar-thy-neighbour effect on Nigeria GDP. This may be more pronounce when unwinding of asset purchase commences. However, the influence on CPI inflation remained negative throughout the period. This may be due to proactive measures in the foreign exchange market in Nigeria over the years.

5. Summary and Conclusion

This paper studied the transmission of US monetary policy spillovers to Nigeria economy over the three phases of US monetary policy. We use shadow policy rate of

Wu and Xai 2016 estimated for U.S economy as a proxy for US monetary policy. This serves as a consistent measure of U.S monetary policy stance across the three phases of monetary policies.

Figure 3. *Impulse Response of Real GDP and Inflation to Changes in US Monetary Policy*



This was feed into a TV-SVAR model for the Nigeria economy to study the pattern of propagation and measure their contribution to the variability of domestic GDP, CPI inflation, naira exchange rate to US dollar, and monetary policy rate through impulse response function. The model is applied mainly due to its ability and flexibility to capture possible nonlinearities and stochastic volatility of real and financial variables used.

The study reveals that the U.S monetary policy spillover effect on GDP and CPI inflation in Nigeria vary across the three phases of U.S monetary policies (conventional, unconventional, and normalization). The effect on GDP is positive during conventional monetary policy phase. CPI inflation and exchange rate negatively respond to U.S monetary policy stance.

On the other hand, evidence of beggar-thy-neighbour was found during unconventional and monetary policy normalization phases. The negative effect appears to be more significant and last longer than the positive effect. The spillovers affect exchange and CPI inflation faster and stronger compared to GDP and monetary policy rate in Nigeria. We, therefore, conclude that U.S monetary policy substantially explains the cyclical fluctuations in the Nigeria economy.

References:

Aghion, P., Bacchetta, P., Banerjee, A. 2004. Financial development and the instability of open economies. Journal of Monetary Economics, 51(6), 1077-1106.

Aizenman, J., Chinn, M.D., Ito, H. 2016. Monetary policy spillovers and the trilemma in the new normal : Periphery country sensitivity to core country conditions. Journal of International Money 68, 298-330.

Ammer, J., De Pooter, M., Erceg, C.J., Kamin, S.B. 2016. International spillovers of monetary policy (No. 2016-02-08-1). Board of Governors of the Federal Reserve System (US). https://doi.org/10.17016/2573-2129.15.

Bayoumi, T., Vitek, F. 2013. Macroeconomic Model Spillovers and Their Discontents. IMF Working Papers, 13(4), 1. https://doi.org/10.5089/9781475519860.001.

Bekaert, G., Mehl, A. 2017. On the Global Financial Market Integration "Swoosh" and the Trilemma. NBER WP, 23124.

Berg, A., Borensztein, E., Mauro, P. 2003. Monetary regime options for Latin America. Finance & development, 40(003).

Bluwstein, K., Canova, F. 2016. Beggar-thy-neighbor. The Inter'national Effects of ECB Unconventional Monetary Policy Measures. 4QVHT" QDVLRQDO 5RWTQDO RI. HQVTDO-DQNLQJ, 12(3).

Borda, P., Manioc, O., Montauban, J.G. 2000. The contribution of US monetary policy to Caribbean business cycles. Social and Economic Studies, 225-250.

Borrallo, F., Hernando, I., Valles, J. 2016. The Effects of US Unconventional Monetary Policies in Latin America. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.2752888.

Bowman, D., Londono, J.M., Sapriza, H. 2015. US unconventional monetary policy and transmission to emerging market economies. Journal of International Money and Finance, 55, 27-59.

Canova, F. 2005. The transmission of US shocks to Latin America. Journal of Applied econometrics, 20(2), 229-251.

Chen, Q., Filardo, A., He, M.D., Zhu, M.F. 2015. Financial crisis, US unconventional monetary policy and international spillovers. International Monetary Fund.

Dedola, L., Rivolta, G., Stracca, L. 2017. If the FED sneezes, who catches a cold? Journal of International Economics, 108, S23-S41.

Del Negro, M., Primiceri, G.E. 2015. Time varying structural vector autoregressions and monetary policy: a corrigendum. The review of economic studies, 82(4), 1342-1345.

Di Giovanni, J., Shambaugh, J.C. 2008. The impact of foreign interest rates on the economy: The role of the exchange rate regime. Journal of International economics, 74(2), 341-361.

Fratzscher, M., Duca, M.L., Straub, R. 2016. ECB unconventional monetary policy: Market impact and international spillovers. IMF Economic Review, 64(1), 36-74.

Frenkel, J.A., Razin, A. 1987. The Mundell-Fleming Model a Quarter Century Later: A Unified Exposition. Staff Papers - International Monetary Fund, 34(4), 567. https://doi.org/10.2307/3867191.

Froyen, R.T., Guender, A.V. 2018. The real exchange rate in Taylor rules: A Re-Assessment. Economic Modelling, 73, 140-151. https://doi.org/10.1016/j.econmod.2018.03.011.

Gagnon, J.E., Bayoumi, T., Londono, J.M., Saborowski, C., Sapriza, H. 2017. Direct and spillover effects of unconventional monetary and exchange rate policies. Open Economies Review, 28(2), 191-232.

Gali, J., Monacelli, T. 2005. Monetary policy and exchange rate volatility in a small open economy. The Review of Economic Studies, 72(3), 707-734.

Georgiadis, G. 2015. Examining asymmetries in the transmission of monetary policy in the euro area: Evidence from a mixed cross-section global VAR model. European Economic Review, 75, 195-215. ttps://doi.org/10.1016/j.jimonfin.2015.06.010.

Georgiadis, G., Hildebrand, S., Ricci, M., Schumann, B., van Roye, B. 2021. ECB-Global 2.0: a global macroeconomic model with dominant-currency pricing, tariffs and trade diversion.

Gertler, M., Gilchrist, S., Natalucci, F.M. 2007. External constraints on monetary policy and the financial accelerator. Journal of Money, Credit and Banking, 39(2-3), 295-330.

Iacoviello, M., Navarro, G. 2018. Foreign effects of higher U.S. interest rates. Journal of International Money and Finance, 1-19. https://doi.org/10.1016/j.jimonfin.2018.06.012.

Iacoviello, M., Navarro, G. 2019. Foreign effects of higher U. S. interest rates. Journal of International Money and Finance, 95, 232-250. https://doi.org/10.1016/j.jimonfin.2018.06.012.

Jannsen, N., Klein, M. 2011. The international transmission of euro area monetary policy shocks (No. 1718). Kiel Working Paper.

Kronick, J. 2014. Monetary Policy Shocks from the EU and US: Implications for Sub-Saharan Africa. Munich Personal RePEc Archive (59416).

Kishor, N.K., Marfatia, H.A. 2013. The time-varying response of foreign stock markets to US monetary policy surprises: Evidence from the Federal funds futures market. Journal of International Financial Markets, Institutions and Money, 24, 1-24.

Lyons, R.K. 2001. The microstructure approach to exchange rates, Vol. 333. Cambridge, MA: MIT press.

Maćkowiak, B. 2007. External shocks, US monetary policy and macroeconomic fluctuations in emerging markets. Journal of monetary economics, 54(8), 2512-2520. https://doi.org/10.1016/j.jmoneco.2007.06.021.

Mark, N.C. 2009. Changing monetary policy rules, learning, and real exchange rate dynamics. Journal of Money, Credit and Banking, 41(6), 1047-1070.

Mannerson, L. 2021. ECB and US Monetary Policy Spillovers to Sweden: Transmissions Channels and the Effects of Central Bank Information Bias/Unconventional Monetary Policy.

Miniane, J., Rogers, J.H. 2007. Capital controls and the international transmission of US money shocks. Journal of Money, Credit and banking, 39(5), 1003-1035.

Miranda-Agrippino, S., Rey, H. 2020. US monetary policy and the global financial cycle. The Review of Economic Studies, 87(6), 2754-2776.

Moore, J., Nam, S., Suh, M., Tepper, A. 2013. Estimating the impacts of US LSAP's on emerging market economies' local currency bond markets (No. 595). Staff Report. Retrieved from: https://www.newyorkfed.org/medialibrary/media/research/staff_reports/sr595.pdf.

Neely, C.J. 2015. Unconventional monetary policy had large international effects. Journal of Banking & Finance, 52, 101-111. https://doi.org/10.1016/j.jbankfin.2014.11.019.

Obi, K.O., Igbanugo, C. 2016. Spillover Effect of US Unconventional Monetary Policy on Nigerian Economy. International Journal of Research in Management, Economics and Commerce, ISSN 2250-057X, Volume 06, Issue 07.

Obstfeld, M. 2019. Global dimensions of US monetary policy (No. w26039). National

Bureau of Economic Research.
Obstfeld, M., Rogoff, K. 2002. Global implications of self-oriented national monetary rules. The Quarterly journal of economics, 117(2), 503-535. https://doi.org/10.1162/003355302753650319.
Primiceri, G.E. 2005. Time varying structural vector autoregressions and monetary policy. The Review of Economic Studies, 72(3), 821-852.
Rey, H. 2014. International Channels of Transmission of Monetary Policy and the Mundellian Trilemma. London Business School. Washington, DC: International Monetary Fund, 2015. In 15th Jacques Polak Annual Research Conference held on November, 13-14.
Rey, H. 2014. The international credit channel and monetary autonomy. Mundell-Fleming Lecture, International Monetary Fund, 13.
Rohit, A.K., Dash, P. 2018. Dynamics of Monetary Policy Spillover: The Role of Exchange Rate Regimes. Economic Modelling. https://doi.org/10.1016/j.econmod.2018.09.007.
Taylor, J.B. 2007. Housing and monetary policy (No. w13682). National Bureau of Economic Research.
Takáts, E., Vela, A. 2014. International monetary policy transmission. BIS paper, (78b).
Terasvirta, T., Tjostheim, D., Granger, C.W. 2010. Modelling nonlinear economic time series. OUP Catalogue.
Tran, T.B.N., Pham, H.C.H. 2020. The Spillover Effects of the US Unconventional Monetary Policy: New Evidence from Asian Developing Countries. Journal of Risk and Financial Management, 13(8), 165.
Wang, S., Mayes, D.G. 2012. Monetary policy announcements and stock reactions: An international comparison. The North American Journal of Economics and Finance, 23(2), 145-164.
Woodford, M. 2012. Methods of policy accommodation at the interest-rate lower bound.
Wu, J.C., Xia, F.D. 2016. Measuring the macroeconomic impact of monetary policy at the zero lower bound. Journal of Money, Credit and Banking, 48(2-3), 253-291.
Zorzi, M.C., Dedola, L., Georgiadis, G., Jarociński, M. 2020. Monetary policy and its transmission in a globalised world Working Paper Series, 2407.