Monetary Policy, Risk Aversion and Uncertainty in an International Context

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This paper analyses the interaction of monetary policy (both domestic and global), risk aversion and uncertainty for a set of advanced and emerging economies in vector autoregressive (VAR) framework. Variance risk premium (*VRP*) is used as a measure of risk aversion and computed as the difference between the risk-neutral and the physical expectation of the return variance. *VRP* is positive on average for all economies and exhibits significant inter-temporal variation. Results reveal that expansionary monetary policy leads to a short-term increase in risk aversion and a decrease in uncertainty. Central banks respond by reducing the policy rate in response to risk aversion and uncertainty shocks. Both risk aversion and uncertainty exhibit a higher magnitude of response to domestic as compared to the global monetary policy shocks. Further, we find that risk aversion positively affects risk premium and thus, considerably explains variations in excess returns in the market. (JEL: E43, E44, E52, E58)

Keywords: monetary policy; risk aversion; uncertainty; variance risk premium; structural VAR; panel VAR

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(*Multinational Finance Journal*, 2020, vol. 24, no. 3/4, pp. 211–266)

Article history: Received: 26 March 2020, Received in final revised form: 21 July 2020, Accepted: 24 September 2020, Available online: 30 December 2020

I. Introduction

Prior to the global financial crisis of 2008, the importance of ensuring financial stability through monetary policy, which is traditionally used as a tool to minimize business cycle fluctuations and ensure price stability, was less recognized. However, in the aftermath of the crisis, it is widely acknowledged that accommodative monetary policy pursued by central banks of advanced economies for a prolonged period led to increased financial instability in the global economy. It is believed that low interest rates amid expansionary monetary policy for a protracted period encouraged excessive risk-taking behaviour among international investors and financial institutions as they substituted safer investments with riskier portfolios. This is referred to as the ‘search for yield’ hypothesis (see Brunnermeier, 2001; Rajan, 2006), which asserts that investors and financial institutions having abundant liquidity at their disposal engage in risky investments to earn excess returns in a low interest rate environment. Low interest rates due to accommodative monetary policy reduce the risk aversion of investors by positively impacting investment valuations, income and cash flows (see Borio and Zhu, 2012). They reduce the opportunity cost of holding reserves, hence, increasing the leverage (see, Adrian and Shin, 2010). Low interest rates trigger credit boom and create adverse selection problem as banks relax their lending standards and disburse more credit to risky borrowers because they lose incentives to screen and monitor bad loans (see, Dell’Ariccia, Laeven, and Suarez, 2017; Paligorova and Santos, 2017). Akerlof and Shiller (2009) highlight that investors’ appetite for risk rises as they take more risk to earn excess returns during periods of low interest rates due to money illusion.[1]

Monetary policy can affect investors’ risk aversion and uncertainty in the financial market, which in turn may feedback on macroeconomic and financial conditions. Large risk exposure can potentially undermine

1. Money illusion refers to the tendency of investors to undertake investment decisions in nominal terms rather than real terms as they mistakenly perceive an increase in the nominal value due to an increase in the general price level as a rise in the real purchasing power.

the stability of the financial sector of the economy, thereby requiring prudent policy action on the part of monetary authorities. In this light, the present study is an attempt to examine the relationship between monetary policy and risk aversion in an international context. We study the interaction between monetary policy, risk aversion and uncertainty in a Structural Vector-autoregressive (SVAR) framework for a set of advanced and emerging economies during the period January 1999 to May 2019. Further, we augment our SVAR model by including global monetary policy variable, which we proxy by *US* monetary policy, to study the plausible impacts of global monetary conditions on risk aversion and uncertainty in the given economy. We employ the SVAR model with two alternative identification schemes-recursive ordering implemented with Cholesky decomposition of the variance-covariance matrix and sign-restrictions approach of Uhlig (2005) and Mountford and Uhlig (2009). To reinforce the results obtained from country-specific SVAR estimation and exploit the cross-sectional dimension of our data, we apply the Generalized Method of Moments (GMM) Panel VAR (PVAR) approach using our panel data of advanced and emerging countries.

The identification strategy that we use to uncover risk aversion is similar to that of Bekaert, Hoerova, and Duca (2013) in which they disentangle unobserved risk aversion from the risk-neutral option implied volatility by constructing a measure of uncertainty. We extend the analysis of Bekaert, Hoerova, and Duca (2013) to examine the impact of monetary policy on risk aversion and uncertainty in an international setting. Investors' risk aversion is measured by the variance risk premium, which is fundamentally the compensation demanded by investors for bearing the unpredictable future variance. Following Bekaert, Hoerova, and Duca (2013), we define variance risk premium as the difference between risk-neutral and physical (actual) expectation of the return variance. Risk neutral expectation of the return variance is approximated by the squared implied volatility index, while actual variance is approximated by the conditional forecast of the realized variance under the data generating process. Positive variance risk premium indicates that volatility risk is unfavourable for investors as they are willing to pay a premium to hedge against it.

Our results reveal that expansionary monetary policy leads to an initial increase in the risk aversion of investors, which starts declining in the subsequent periods. In addition, monetary policy expansion mitigates uncertainty in the stock markets. The rise in investors' risk aversion and stock market uncertainty evokes central banks to respond by easing the monetary policy. The interactions of monetary policy, risk aversion and uncertainty are broadly consistent with the existing literature. However, Bekaert, Hoerova, and Duca (2013) report that risk aversion declines due to lax monetary policy in the medium to long run after an initial increase in the pre-crisis period. Our results reveal that expansionary monetary policy leads to an initial increase in the risk aversion of investors, which falls subsequently. In contrast to their finding, we do not find evidence of a decrease in risk aversion due to monetary policy expansion. Based on our results, the hypothesis that expansionary monetary policy promotes risk-taking behaviour among investors does not hold for the larger set of economies and the recent data period.[2] Concerning the spillover impact of global monetary policy, we find that both risk aversion and uncertainty exhibit a higher magnitude of response to domestic monetary policy as compared to the global monetary policy shocks. In addition, we establish the relationship between risk aversion and risk premium and find that risk aversion positively affects return risk premium. It implies that the level of risk aversion plays a significant role in explaining the inter-temporal variation in the excess returns in the market.

Our study makes several important contributions to the literature. We investigate the linkages between monetary policy, risk aversion and uncertainty across a set of advanced and emerging economies. Prior work on this strand of the literature focuses mainly on select advanced economies, including the *US* and the Eurozone area. Results reveal that expansionary monetary policy leads to a short-term increase in risk aversion and a decrease in uncertainty across the economies. We also investigate the risk-averse behaviour of investors and uncertainty in the equity markets contributed by global monetary policy changes. Results suggest that both risk aversion and uncertainty exhibit a higher magnitude of response to domestic as compared to global monetary policy shocks. Further, prior work on this strand has relied on simple recursive ordering implemented through Cholesky decomposition of the variance-covariance matrix to identify the structural parameters of the SVAR model. We provide results based on recursive ordering as well as the sign-restrictions approach to alternatively identify the SVAR model along with PVAR estimation to capture the cross-sectional

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2. Bekaert, Hoerova, and Duca (2013) undertake the analysis for the pre-crisis period. However, our data period covers the pre as well as the post crisis period up to May 2019.

dimension of our dataset. Our results remain robust to the alternative identification approaches of the country-specific SVAR model as well as the PVAR model.

The study has important implications for international investors and policymakers. It will help investors in asset allocation and risk management. Understanding risk aversion may help investors in hedging financial securities to avoid excessive risks. The study will also provide important insights to the policymakers about the risk-taking channel of the monetary policy transmission operating through changes in risk aversion and uncertainty in financial markets. This has implications for the stability of the financial sector as well as the economy as a whole and, therefore, will be relevant in formulating effective policy decisions. The study will also contribute to the literature regarding the dynamic behaviour of investors' risk aversion and equity market uncertainty in relation to the monetary policy actions, as well as the feedback responses of central banks due to changes in risk aversion and uncertainty.

The rest of the paper is structured as follows. We begin by providing a brief review of the literature in Section II. Section III presents the description of the data along with the estimation strategy of the variance risk premium and its preliminary analysis. The methodological framework of the study is outlined in Section IV. Section V discusses the empirical results with regard to the relationship between monetary policy, risk aversion and uncertainty obtained from the country-specific SVAR model and GMM-PVAR approach. Section 6 presents the results on the relationship between risk aversion and risk premium. The final section provides concluding remarks and policy suggestions.

II. Related Literature

The risk-taking channel of monetary policy has garnered ample academic attention in the wake of the global financial crisis. Abundant literature studies the relationship between monetary policy and risk-taking by banks (see, for example, Altunbas, Gambacorta, and Marques-Ibanez, 2010; Altunbas, Gambacorta, and Marques-Ibanez, 2012; Borio and Zhu, 2012; Jiménez et al., 2012; Angeloni, Faia, and Duca, 2015; Bruno and Shin, 2015; Drakos, Kouretas, and Tsoumas, 2016; Chen et al., 2017; Delis, Hasan, and Mylonidis, 2017; Dell'Ariccia, Laeven, and Suarez, 2017; Paligorova and Santos, 2017;

Neuenkirch and Nöckel, 2018; Djatche, 2019) and document that monetary expansion increases the bank leverage and thus, induces them to assume more risk. However, little empirical research has been undertaken on investigating the impact of monetary policy on the risk aversion of financial investors. Bernanke and Kuttner (2005) demonstrate that the impact of an easier monetary policy on stock prices in the *US* can largely be attributed to falling risk premium associated with holding stocks, which may be reflected in decreasing volatility or rising appetite of investors to bear the risk. Therefore, examining the empirical links between monetary policy, risk aversion and financial volatility can help uncover the risk-taking channel of monetary policy transmission.

A recent strand of the literature investigates the potential link between monetary policy and investors' risk aversion in the *US* and the Euro area (see Bekaert, Hoerova, and Duca, 2013; Nave and Ruiz, 2015; Inekwe, 2016; Hahn, Jang, and Kim, 2017; Jang, 2020). Bekaert, Hoerova, and Duca (2013) measure risk aversion by computing variance risk premium from option-based implied volatility (i.e., VIX index) and examine its response to changes in Federal Reserve's monetary policy. They find that expansionary monetary policy leads to an initial rise and a persistent decrease in risk aversion in the medium run in the pre-crisis period. Hahn, Jang, and Kim (2017) extend the analysis of Bekaert, Hoerova, and Duca (2013) to the post-crisis period when interest rates reached zero-lower bound in the *US*. Using 'shadow interest rates' as a proxy for unconventional policy measures by Federal Reserve, they find that monetary policy affects risk aversion even in the post-crisis period. In a similar vein, Nave and Ruiz (2015) analyse monetary policy stance and risk aversion in the Euro area and find evidence of an increase in the risk aversion of Eurozone investors to the lax monetary policy of both the Federal Reserve and the European Central Bank when they account for simultaneity between monetary policy and stock market behaviour. They postulate that the relationship between monetary policy and risk aversion established in the previous literature is subject to the assumption that monetary policy does not react contemporaneously to stock market uncertainty. They document that the response of risk aversion is in the opposite direction of monetary policy shock in the Euro area. Inekwe (2016) investigates interlinkages between monetary policy, risk aversion and uncertainty in the financial sector as well as the aggregate economy. The study reports that contractionary monetary policy induces an increase in risk aversion and uncertainty in both the financial sector and the aggregate market; however, the response of financial sector risk aversion and uncertainty are of greater magnitude. Jang (2020) studies the effects of monetary policy on risk aversion and uncertainty by identifying monetary policy shocks with high-frequency external instruments. In contrast to the findings of Bekaert, Hoerova, and Duca (2013) and Hahn, Jang, and Kim (2017), the study shows that risk aversion and uncertainty increases instantaneously to monetary policy shock. Overall, the limited literature on monetary policy and investors' risk aversion also confirms the existence of the risk-taking channel in the financial sector.

Risk aversion is considered as an important driver of asset price by the traditional capital asset pricing models. However, these models mainly focus on characterizing the premium for equity risk and fail to capture the premium associated with variance risk, which is the uncertainty regarding the return variance. A large strand of the literature employs variance risk premium measure as a proxy for risk aversion (see, among others, Bollerslev, Gibson, and Zhou, 2011; Bekaert, Hoerova, and Duca, 2013; Bekaert and Hoerova, 2014, 2016; Lonodo, 2015; Bali and Zhou, 2016; Fassas and Papadamou, 2018). Variance risk premium is the compensation demanded by the market participants for bearing the variations in future realized volatility and hence, is used to characterize risk aversion of the investors. Bekaert, Hoerova, and Duca (2013) use risk-neutral or option implied stock market volatility to obtain the measures of risk aversion and uncertainty. The option-implied variance is decomposed into actual expected volatility, which is associated with uncertainty and a residual, which is the so-called risk aversion. Risk aversion or the variance risk premium is calculated by taking the difference between the option-implied variance and the uncertainty component. A large number of studies investigate the role of variance risk premium in predicting equity returns (see, for example, Bollerslev, Tauchen, and Zhou, 2009; Bollerslev et al., 2014; Bekaert and Hoerova, 2014; Lonodo, 2015; Bali and Zhou, 2016; Fassas and Papadamou, 2018; Zhou, 2018) and demonstrate that it exhibits a robust predictive power for excess stock returns. Recent literature examining the impact of monetary policy on risk aversion has also employed variance risk premium to proxy the latter (see, among others, Nave and Ruiz, 2015; Inekwe, 2016; Hahn, Jang, and Kim, 2017; Jang, 2020).

III. Data

A. Market Indices and Macroeconomic Variables

We consider the Group of 20 (G-20) member countries to analyse the interdependence between monetary policy, risk aversion and uncertainty. G-20 club constitutes major advanced and emerging economies that organize meetings of Finance Ministers and Central Bank Governors regularly to develop joint policy responses to issues such as global economic development, monetary policy and financial market supervision (Hung and Ma, 2017). Hence, working on the G-20 member countries provides an excellent testing ground for examining linkages between monetary policy and risk aversion in an international context. Owing to the data constraints (discussed subsequently), we select a total of 12 member countries of the G-20 group for our analysis. Our sample comprises of 7 advanced countries - Canada (CAN), France (FR), Germany (GER), Italy (ITL), Japan (JPN), the United Kingdom (UK) and the United States (*US*), and 5 emerging economies including Brazil (BRZ), China (CHI), India (IND), Mexico (MEX), and South Korea (SKOR).

The key policy rate set by the central banks of the sample economies to target output and inflation is a primary instrument of monetary policy; hence, it is taken as a proxy for monetary policy. To obtain our measure of risk aversion (variance risk premium) and uncertainty (conditional volatility), we use the daily benchmark stock price index of the sample countries and their underlying implied volatility index. In practice, intraday price data (i.e., prices sampled every 5 minutes, including open and close price) is used to compute variance risk premium as it is found to perform better than the low-frequency data. However, due to the unavailability of the intraday data for all the sample stock indices, we rely on daily data to compute our measures of risk aversion and uncertainty. The sample period under the study is guided by the availability of the underlying implied volatility index of the benchmark stock index for the sample countries, which is limited by the development of their options market. The launch date of the implied volatility by the index provider of the sample stock markets, thus, determines the start date of our sample period, which runs till May 2019. Table 1 lists the policy rate, the benchmark equity index, the underlying implied volatility index along with the sample period considered for each country. All the data has been sourced from

Bloomberg.

The relationship between monetary policy and risk aversion may be driven by a common set of macroeconomic factors. Hence, we account for the plausible macroeconomic factors like real GDP and consumer prices as control variables in our model. The following variables are considered in our empirical model for each country: industrial production index, consumer price index, policy rate, variance risk premium and conditional variance as a proxy for real output (Y_t), price index (P_t), monetary policy rate (R_t), risk aversion (RA_t) and uncertainty (UC_t), respectively. The model input variables and their descriptions are provided in table 2. The industrial production index and the consumer price index for sample countries are retrieved from Bloomberg at monthly frequencies and adjusted for seasonality using the X12-ARIMA procedure. All the variables in the model are expressed in natural logarithm except the policy rate.

To account for the plausible current systematic impact of the *US* monetary policy on the global markets, we include the *US* monetary policy rate as an exogenous factor in the model for the rest of the sample economies. Since the *US* Federal Reserve relied on unconventional policy strategies like Quantitative Easing and Forward Guidance to revive the economy in the aftermath of the global financial crisis, we use the shadow fed funds rate proposed by Wu and Xia (2016) to proxy *US* monetary policy stance. Using the shadow rate allows us to examine the impact of the unconventional monetary policy stance of the Federal Reserve when the federal funds rate was constrained by zero lower bound. In the same spirit, we use the shadow rate of the UK and the European Central Bank (ECB) to capture their unconventional monetary policy strategies4 during the zero lower bound environment provided by Wu and Xia (2016).[3, 4]

B. Variance Risk Premium and its Measurement

Variance risk premium captures the compensation that investors demand for being exposed to variance risk, which is essentially the unexpected movement in the return variance (Fassas and Papadamou, 2018). Hence,

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3. European Central Bank (ECB) conducts the monetary policy operations for Eurozone countries, including France, Germany and Italy that are the sample economies for this study.

4. Shadow rate of Wu and Xia (2016) for the *US*, the UK and the ECB are retrieved from https://sites.google.com/view/jingcynthiawu/shadow-rates (accessed on June 13, 2019).

TABLE 1. Policy Rate, Equity Index and the Corresponding Implied Volatility Index of the Sample Economies

	Advanced Economies			
	Policy Rate	Benchmark Equity Index	Implied Volatility Index	Sample Period
CAN	Overnight Lending Rate	S&P/TSX 60 Index	S&P/TSX 60 VIX	Nov 2009 - May 2019
FR	Wu and Xia (2016) ECB Shadow Rate (unconventional measure) ECB Refinancing Rate (conventional measure)	CAC 40 Index	CAC 40 Volatility Index	Feb 2000 - May 2019
GER	Wu and Xia (2016) ECB Shadow Rate (unconventional measure) ECB Refinancing Rate (conventional measure)	DAX Index	VDAX-NEW Volatility Index	Jan 1999 - May 2019
ITL	Wu and Xia (2016) ECB Shadow Rate (unconventional measure) ECB Refinancing Rate (conventional measure)	FTSE MIB Index	FTSE MIB IVI 30 days	May 2010 - May 2019
JPN	Unsecured Overnight Call Rate	Nikkei 225 Index	Volatility Index Japan	Jan 1999 - Apr 2019
UK	Wu and Xia (2016) Bank of England Shadow Rate (unconventional measure) Official Bank Rate (conventional measure)	FTSE 100 Index	FTSE 100 Volatility Index	Feb 2000 - Apr 2019
US	Wu and Xia (2016) Shadow Fed Funds Rate (unconventional measure) Fed Funds Rate (conventional measure)	S&P500 Index	CBOE SPX Volatility Index	Jan 1999 - May 2019

(*Continued*)

TABLE 1. (Continued)

Emerging Economies				
	Policy Rate	Benchmark Equity Index	Implied Volatility Index	Sample Period
BRZ	Brazil Selic Target Rate	Ibovespa Index	BMF Ibovespa Volatility Index	Jan 1999 - May 2019
CHI	Benchmark Lending rate	FTSE China A50 Index	Alphashares Chinese Volatility Index	Feb 1999 - Nov 2017
IND	Repo Rate	NSE Nifty 50 Index	India VIX	Dec 2007 - May 2019
MEX	Overnight Bank Rate	S&P/BMV IPC Index	Mexico Volatility Index	Apr 2004 - May 2017
SKOR	Official Bank Rate	KOSPI 200 Index	Kospi 200 Volatility Index	Feb 2003 - May 2019

Note: The table lists the policy rate, the benchmark equity index, the underlying implied volatility index and the sample period for each economy. CAN, FR, GER, ITL, JPN, UK, *US*, BRZ, CHI, IND, MEX and SKOR denote Canada, France, Germany, Italy, Japan, the United Kingdom, the United States, Brazil, China, India, Mexico and South Korea, respectively.

TABLE 2. Description of the Variables

Variable	Label	Description
Real Output	*Y*	Log(Index of Industrial Production), adjusted for seasonality using X12-ARIMA procedure
Price Index	*P*	Log(Consumer Price Index), adjusted for seasonality using X12-ARIMA procedure
Monetary Policy Rate	*R*	Key policy rate set by the central bank (refer table 1)
Implied Variance	*IV*	Squared implied volatility index, $VIX^2/12$
Realized Variance	*RV*	Sum of squared returns over a month (approx. 22 trading days)
Conditional Variance	*CV*	Fitted values from the projection of future realized monthly variance onto predictor variables
Variance Risk Premium	*VRP*	Implied Variance - Conditional Variance
Risk Aversion	*RA*	Log Variance Risk Premium i.e. Log(Implied Variance) – Log(Conditional Variance)
Uncertainty	*UC*	Log(Conditional Variance)

the measure of variance risk premium allows us to capture the risk aversion of investors. It can be quantified as the difference between ex-ante risk-neutral expectation and physical (objective) expectation of the return variation over the next month, that is, between period t and one month forward $t+1$.

$$VRP_t \equiv E_t^Q\left(V_{t,t+1}\right) - E_t^P\left(V_{t,t+1}\right) \tag{1}$$

Risk-neutral volatility (or variance), $E_t^Q\left(V_{t,t+1}\right)$, is the option implied stock market volatility (or variance) with a horizon of 30 calendar days. It differs from the actual expected volatility (or variance), $E_t^P\left(V_{t,t+1}\right)$, in the sense that it uses actual state probabilities to measure the physical expected volatility while the probabilities adjusted for the pricing of risk are used to compute the risk-neutral volatility (Bekaert, Hoerova, and Duca, 2013).

Risk-neutral implied volatility embodies critical information about the expectation of the market participants regarding the future price movements of an underlying asset as well as their appetite for bearing risk. Hence, following Bekaert, Hoerova, and Duca (2013) and Bekaert and Hoerova (2014), we decompose the option implied expected volatility of the sample countries into two components to obtain the measure of investors' risk aversion and stock market uncertainty. The option implied variance is decomposed such that we get actual expected volatility, which is associated with uncertainty and the residual, which is the so-called risk aversion. We calculate the variance risk premium (a proxy for risk aversion) as the difference between the model-free option-implied variance and the actual expected variance, which are both not directly observable. In practice, the risk-neutral expectation, $E_t^Q\left(V_{t,t+1}\right)$ is approximated by implied variance, $IV_{t,t+1}$ and physical expectation, $E_t^P\left(V_{t,t+1}\right)$ is approximated by realized variance, $RV_{t,t+1}$, both observable at time *t*.

The model-free implied variance $\left(IV_{t,t+1}\right)$ is computed using a weighted average of European-style put and call options that straddle a 30-day maturity covering a wide range of strikes and doesn't hinge on an option pricing model.[5] On the other hand, conditional variance, which is associated with uncertainty, is taken as a proxy for the actual expected variance. Estimating variance risk premium, thus, requires plausible estimates of the conditional variance of the stock market returns. To select an optimal model, we consider five volatility forecasting models with a different set of predictors, including monthly realized variance, squared implied volatility index, dividend yield and three-month treasury bill rate. We evaluate the models with four different criteria i.e., root-mean-squared error (RMSE), mean absolute error (MAE), mean absolute percentage error (MAPE) and Adjusted R^2. Following Bekaert, Hoerova, and Duca (2013), the five models considered are estimated using ordinary least squares (OLS) regression (with Newey-West heteroscedasticity and serial correlation consistent standard errors) of realized variance on (one-period) lagged predictor variables viz. (i) realized variance, (ii) implied variance, (iii) realized variance and implied variance, (iv) realized variance, implied variance and dividend yield, and (v) realized variance, implied variance, dividend yield and three-month T-bill rate. In contrast to the two-variable model (Model 3) chosen by Bekaert, Hoerova, and Duca (2013),[6] our procedure yields a one-variable model for the UK where realized variance is used as an independent variable (i.e., Model 1) and a

5. Chicago Board Options Exchange (CBOE) pioneered the model-free methodology of estimating implied volatility index (VIX) based on the prices of S&P 500 Index options in 2003. This methodology is generally adopted by other providers of implied volatility index based on different stock index options.

6. Refer Bekaert, Hoerova, and Duca (2013) for an extensive discussion.

four-variable model for the rest of the economies where realized variance, implied variance, dividend yield and three-month T-bill rate are used as predictors (i.e., Model 5). The statistics of the model evaluation using four different criteria (RMSE, MAE, MAPE and Adj. R^2) are presented in appendix A. In addition, the time series of the fitted values obtained from estimating the five regression models are illustrated in appendix B.

We obtain conditional variance by projecting realized monthly variance onto lagged predictor variables chosen on the basis of model selection criteria. Future realized monthly variance ($RV_{i,t}$) is calculated as the summation of daily squared log-returns of the benchmark stock index over the next month (30 calendar days),[7] as in,

$$RV_{i,t} = \sum_{t_i=1}^{N_t} \left(r_{i,t_i} \right)^2, \tag{2}$$

where r_{i,t_i} are the daily log returns within month t.

The fitted values of the following regression equation generate the estimates of conditional variance of the stock market returns ($CV_{i,t}$) which is our measure of uncertainty:

$$RV_{i,t,t+1} = \begin{cases} \gamma_0 + \gamma_1 RV_{i,t-1,t} + \gamma_2 IV_{i,t-1,t} + \gamma_3 DIV_{i,t-1} + \gamma_4 TBILL_{i,t-1} + e_{i,t} \;, \\ \qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad \text{for all except UK} \\ \gamma_0 + \gamma_1 RV_{i,t-1,t} + e_{i,t} \;, \text{ for UK} \end{cases} \tag{3}$$

The estimation results of the regression equation (3), including the estimated coefficient and their robust t-values for all sample economies, are presented in table 3.

The uncertainty component, thus obtained, is subtracted from squared implied volatility index (implied variance) to obtain the variance risk premium, which is our measure of risk aversion, i.e.:

$$VRP_{i,t} = IV_{i,t,t+1} - CV_{i,t,t+1} \tag{4}$$

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7. In practice, intraday 5-minute squared log-returns are used to calculate daily realized variance. Monthly realized variance is, then, computed by summing over the daily observations (i.e., the summation of 5-minute squared log returns in a day) in a month. However, due to the unavailability of the intraday data, we rely on daily log returns to compute realized volatility.

TABLE 3. Estimation Results of Conditional Volatility Regression

$RV_{i,t+1} = \gamma_0 + \gamma_1 RV_{i,t} + \gamma_2 IV_{i,t} + \gamma_3 DIV_{i,t} + \gamma_4 TBILL_{i,t} + e_{i,t}$

	γ_0	γ_1	γ_2	γ_3	γ_4
CAN	27.6215***	0.5608***	0.0384	–7.9686**	0.2627
	(2.98)	(10.31)	(0.60)	(–2.23)	(0.14)
FR	–24.5434*	0.6089***	–0.1355	11.3162***	9.7129***
	(–1.83)	(6.84)	(–1.04)	(2.62)	(3.16)
GER	–11.3235	0.61103***	–0.0289	7.5891	6.2327***
	(–0.76)	(8.05)	(–0.26)	(1.36)	(2.88)
ITL	16.3579	0.3815***	0.1312	1.5577	3.5682
	(1.39)	(4.24)	(1.15)	(0.43)	(0.85)
JPN	19.6843***	0.4169***	–0.0909	6.3423	60.5334**
	(3.09)	(3.31)	(–0.89)	(1.22)	(2.25)
UK	10.9395***	0.6296***	-	-	-
	(6.07)	(7.72)			
US	14.9679	0.7465***	–0.4445	0.3009	0.6908
	(1.17)	(6.07)	(–0.93)	(0.05)	(0.82)
BRZ	49.5859**	0.4655***	0.0049	–7.2794***	0.5291
	(2.25)	(3.56)	(0.20)	(–2.77)	(0.73)
CHI	46.2677***	0.5506***	0.0396	–19.0285***	5.1495*
	(5.13)	(8.28)	(1.15)	(–4.76)	(1.84)
IND	24.6951	0.3804***	0.3853***	–46.8515	6.5265*
	(1.17)	(3.52)	(3.93)	(–1.57)	(1.83)
MEX	–2.3672	0.5856***	0.0674	–1.7772	2.6671***
	(–0.36)	(4.55)	(0.96)	(–0.62)	(3.58)
SKOR	–11.1829*	0.6303***	–0.1069	1.1069	9.4009***
	(–1.65)	(4.13)	(–0.99)	(0.41)	(4.27)

Note: The table reports the estimation results of the regression equation (3). ***/**/* indicate significance of the estimated slope coefficient at .01/.05/0.10 level. Figures in parenthesis ( ) denote robust *t*-statistics computed using Newey-West heteroscedasticity and serial correlation consistent standard errors.

We define log variance risk premium i.e. $\log(VRP_{i,t})$ as $\log(IV_{i,t}) - \log(CV_{i,t+1})$ or $\log(IV_{i,t}/CV_{i,t+1})$. A positive log variance risk premium suggests that market participants are willing to pay a larger premium on an average to hedge against a rise in the variance.

C. Preliminary Analysis

Table 4 provides the summary statistics of implied variance, conditional variance and the variance risk premium for the sample economies. The mean and median of implied variance, as well as the conditional variance, are highest for Brazil and lowest for Canada. The volatility of

TABLE 4. Descriptive Statistics of Implied Variance, Conditional Variance and Variance Risk Premium of the Sample Economies

		Mean	Med	Max	Min	Std Dev	Skew	Kurt	JB	Q Stat	Obsv
CAN	*IV*	23.40	19.15	112.30	1.31	14.31	2.05	8.20	4357.31***	19846.92***	2382
	CV	13.79	11.40	56.04	4.74	7.82	2.17	9.18	5659.08***	23937.81***	
	VRP	9.61	7.51	76.23	–11.96	9.12	2.12	10.03	6687.38***	10797.43***	
FR	*IV*	48.26	35.08	507.70	0.02	45.68	3.36	19.85	67482.82***	46449.26***	4919
	CV	44.35	35.48	407.37	3.79	39.94	3.69	24.83	108821.50***	51969.21***	
	VRP	3.91	2.93	197.10	–259.97	25.32	0.68	18.89	52143.07***	19893.81***	
GER	*IV*	53.78	37.45	577.27	10.05	52.30	3.29	18.57	61428.27***	51048.73***	5159
	CV	47.05	35.38	375.34	4.73	41.10	3.16	17.05	51014.37***	55081.54***	
	VRP	6.73	3.89	292.00	–167.77	25.63	2.43	19.25	61819.31***	22198.85***	
ITL	*IV*	60.22	49.45	343.15	9.19	37.71	2.19	9.29	5595.72***	19847.23***	2283
	CV	52.28	44.13	155.38	23.89	25.34	1.92	6.34	2462.60***	22989.38***	
	VRP	7.94	3.28	234.40	–72.63	22.47	2.25	15.04	15709.86***	8994.41***	
JPN	*IV*	57.24	45.51	788.45	10.03	56.80	5.76	49.41	474793.36***	45776.67***	4984
	CV	48.83	43.66	510.86	8.33	33.62	7.24	80.31	1284668.00***	49018.21***	
	VRP	8.41	2.30	445.49	–86.12	36.17	4.14	32.00	188879.35***	30646.73***	
UK	*IV*	36.91	24.01	516.01	3.20	41.13	4.21	30.55	168080.92***	45589.81***	4861
	CV	29.85	20.97	347.90	12.33	29.42	5.70	48.18	439739.47***	50190.75***	
	VRP	7.06	1.62	292.20	–182.50	22.21	3.31	30.26	159394.85***	19240.32***	
US	*IV*	38.82	27.00	544.86	6.96	42.26	4.75	36.90	264053.22***	49806.37***	5113
	CV	31.54	21.34	482.72	10.22	38.94	6.31	52.57	557341.21***	54619.81***	
	VRP	7.29	3.20	245.12	–209.12	19.98	1.05	24.17	96401.64***	15249.92***	

(*Continued*)

TABLE 4. (Continued)

		Mean	Med	Max	Min	Std Dev	Skew	Kurt	JB	Q Stat	Obsv
BRZ	*IV*	205.24	205.33	833.23	5.84	171.08	0.84	3.62	675.15***	58580.21***	5027
	CV	69.19	60.12	632.80	28.63	45.61	6.68	64.32	821606.28***	38961.32***	
	VRP	136.05	144.96	785.79	–626.53	190.07	0.46	3.52	233.91***	56963.65***	
CHI	*IV*	65.69	37.33	1245.42	10.25	91.25	4.93	36.14	169890.02***	35337.45***	4535
	CV	60.20	47.11	245.69	6.20	43.93	1.64	5.40	2358.39***	36282.23***	
	VRP	5.49	–4.94	1058.45	–206.48	76.93	4.53	36.63	172436.80***	32624.43***	
IND	*IV*	47.14	28.16	603.93	9.10	51.42	3.41	19.88	38992.42***	28114.26***	2822
	CV	41.22	29.47	303.90	5.23	41.18	3.02	14.13	18850.23***	30195.28***	
	VRP	5.92	1.59	325.18	–157.22	27.25	2.83	20.32	39013.46***	14422.13***	
MEX	*IV*	37.35	23.72	386.69	8.57	46.97	3.93	22.35	68696.46***	41957.07***	3298
	CV	31.25	23.07	324.02	5.28	31.02	4.79	34.81	173797.91***	40985.81***	
	VRP	6.10	5.00	254.56	–92.79	28.72	2.75	20.53	53148.27***	34889.43***	
SKOR	*IV*	43.18	28.80	664.54	7.87	51.34	5.12	40.75	256117.76***	40306.21***	4017
	CV	37.56	29.23	437.11	3.19	37.49	4.91	41.62	265712.59***	41914.17***	
	VRP	5.62	1.30	333.34	–120.25	25.70	4.24	33.33	166041.11***	23040.93***	

Note: The table presents the descriptive statistics of the implied variance, the conditional variance and the variance risk premium of the sample countries at daily frequency. *IV*, *CV* and *VRP* denote implied volatility, conditional volatility and variance risk premium, respectively. Med, Max, Min, Std Dev, Skew, Kurt, JB, Q Stat and Obsv denote median, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera, Q-statistic and observations, respectively.

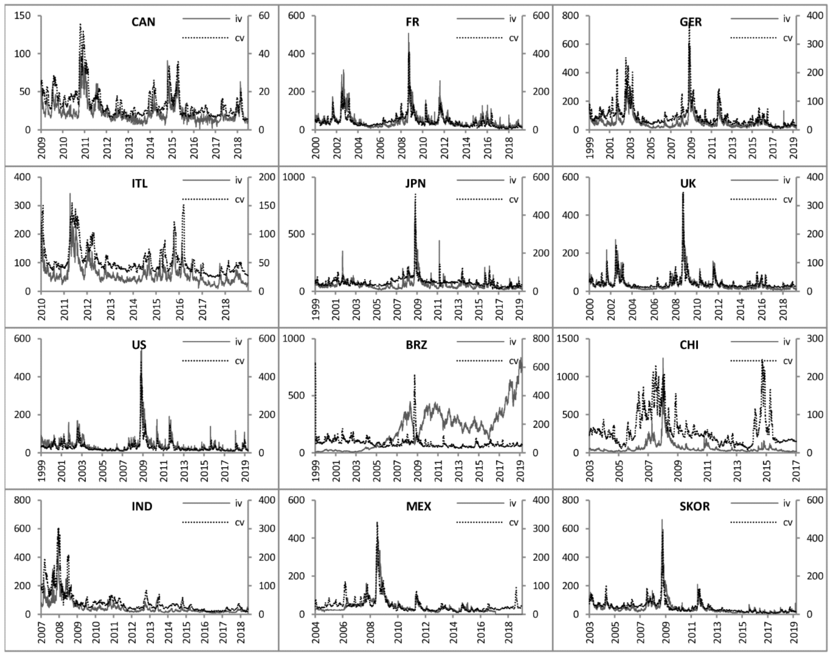

FIGURE 1.— Time Evolution of Implied Variance and Conditional Variance

Note: The figure displays the time evolution of implied variance and conditional variance of the sample advanced and emerging countries. CAN, FR, GER, ITL, JPN, UK and US denote Canada, France, Germany, Italy, Japan, the United Kingdom and the United States, respectively which are the sample advanced economies. BRZ, CHI, IND, MEX and SKOR denote Brazil, China, India, Mexico and South Korea, respectively which are the sample emerging economies. Implied variance is plotted on the primary axis and conditional variance is plotted on the secondary axis. The horizontal axis displays time (in years). Source: Authors' calculations.

both implied variance and conditional variance, as reflected by standard deviation, is also highest for Brazil and lowest for Canada. The variance risk premium is positive on average for all countries suggesting that the average option-implied variance exceeds the average actual expected variance for all countries. Positive variance risk premium confirms risk-averse behaviour in the sample financial markets. It suggests that variance buyers are willing to accept negative average excess returns by taking a long position in the variance swap to hedge against high stock market volatility as they regard increases in the volatility as undesirable for their investment opportunities (Carr and Wu, 2009). The highest

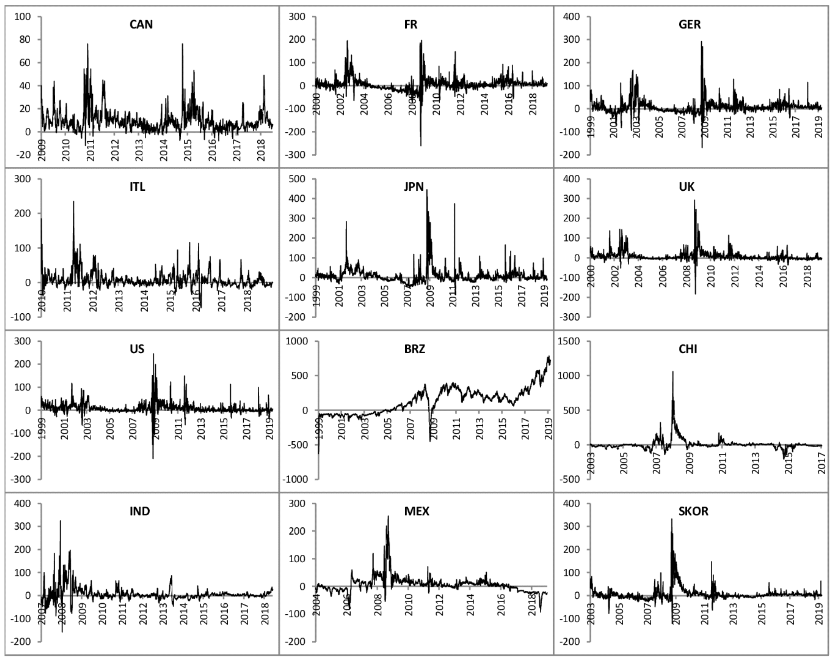

FIGURE 2.— Time Evolution of Variance Risk Premium

Note: The figure displays the time evolution of the variance risk premium of the sample countries, obtained as the difference between implied variance and conditional variance. CAN, FR, GER, ITL, JPN, UK and US denote Canada, France, Germany, Italy, Japan, the United Kingdom and the United States, respectively which are the sample advanced economies. BRZ, CHI, IND, MEX and SKOR denote Brazil, China, India, Mexico and South Korea, respectively which are the sample emerging economies. Source: Authors' calculations.

mean and median of variance risk premium is found in the case of Brazil, followed by Canada, while the lowest mean is found in the case of France and the lowest median in the case of China. The standard deviation of the variance risk premium is found to be highest for Brazil and lowest for Canada. All series are characterized by positive skewness and excess kurtosis, hence are non-gaussian as per Jarque-Bera test statistics. Further, all series exhibit high serial correlation, as suggested by Ljung-Box Q-statistic (at 12th lag).

Figure 1 illustrates the time series of implied variance and conditional variance for all countries considered. Both implied variance and conditional variance vary considerably over time and exhibit abrupt volatility spike around the global financial crisis. The evolution of the variance risk premium is presented in figure 2. As is evident from the figure, the variance risk premium also exhibits significant time-variation. The variance risk premium is generally positive for most of the periods and displays certain episodes of high volatility. A pronounced spike in variance risk premium is observed around the global financial crisis of 2008 for all markets (for which the data is available). The onset of crisis marks a shift in the investors' sentiment as they become more risk-averse and demand a large premium for compensating variance risk.

IV. Methodology

This section describes the empirical strategy pursued in the paper to examine the relationship between monetary policy, risk aversion and uncertainty. We employ the Structural VAR model to investigate their interactions and use two different approaches to recover the structural shocks - recursive identification scheme and sign restrictions approach. We also estimate the Panel VAR model to exploit the cross-sectional dimension of our data and examine the robustness of our results.

A. Structural VAR

The SVAR model, estimated separately for each country, comprises the following vector of variables: $Z_t = \left(R_t^{US}, Y_t, P_t, R_t, RA_t, UC_t\right)'$ where, R_t^{US} is the *US* monetary policy rate, Y_t is the real output, P_t is the price index, R_t is domestic policy rate and RA_t is (log) risk aversion and UC_t is (log) uncertainty. Domestic variables are treated as endogenous in the system and are affected by the global exogenous variable but not vice-a-versa. *US* monetary policy rate $\left(R_t^{US}\right)$ representing the global monetary policy is employed as a foreign variable in the model for all sample economies under investigation. The SVAR model estimated for the *US* does not include the foreign variable.

The structural representation of VAR of order *p* takes the following form:

$$BZ_t = \gamma + \sum\nolimits_{i=1}^{p} \Gamma_i Z_{t-i} + \varepsilon_t \qquad (5)$$

where, Z_t is $(K\times 1)$ vector of endogenous variables, γ is the vector of parameters, B denotes $K\times K$ contemporaneous coefficient matrix and Γ_i

denote $K \times K$ autoregressive coefficient matrices. ε_t is $(K \times 1)$ vector of serially and mutually uncorrelated structural disturbances. The SVAR approach assumes that ε_t are orthogonal structural shocks such that structural disturbances are uncorrelated and variance-covariance matrix (Σ_ε) is constant and diagonal, $E(\varepsilon_t \varepsilon_t') \equiv \Sigma_\varepsilon = I_K$.

Assuming that B^{-1} is known, the reduced form representation of (5) can be written as:

$$Z_t = \alpha + \sum_{i=1}^{p} A_i Z_{t-i} + e_t \tag{6}$$

where, $\alpha = B^{-1}\gamma$, $A_i = B^{-1}\Gamma_i$, and e_t is a vector of reduced-form innovations that are linear combinations of structural errors ε_t, where $e_t = B^{-1}\varepsilon_t$, and are assumed to be white noise processes i.e. $e_t \sim N(0, \Sigma_e)$. Therefore, the dynamic structure represented by structural VAR can be calculated from the reduced-form coefficients and the structural shocks (ε_t) can be derived from the estimated residuals $(\varepsilon_t = Be_t)$.

Firstly, we base the identification of the structural parameters on the Cholesky decomposition of the variance-covariance matrix (i.e. short-run restrictions) which is achieved by imposing restrictions on the contemporaneous matrix, B^{-1} such that the number of unknown structural parameters becomes equal or less than the number of estimated parameters in the residual variance-covariance matrix, $\Sigma_e = E(e_t e_t') = B^{-1}E(\varepsilon_t \varepsilon_t')B'^{-1} = B^{-1}\Sigma_\varepsilon B'^{-1}$.

The system requires a total of n^2 restrictions to achieve the identification of the structural parameters. The structural shocks are assumed to be orthogonal and normalized to have unit variance, which is equivalent to imposing $(n(n-1))/2$ and n restrictions, respectively. SVAR model, thus, requires remaining $(n(n-1))/2$ restrictions to achieve exact identification. For instance, 36 restrictions must be imposed on our 6-variable SVAR model. The assumption of the unit variance of orthogonal structural shocks puts 21 restrictions, and additional 15 restrictions are required for the exact identification of the system. Placing arbitrary restrictions like Cholesky decomposition distorts the estimated dynamic behaviour of the system and may lead to misguided results (Neaime, Gaysset, and Badra, 2018). The Structural VAR approach of Sims (1986) imposes restrictions on the estimated residuals based on the economic theory to recover the underlying structural disturbances.

The identification approach for our structural VAR model is based on recursive ordering. Recursive structure, guided by economic theory, is imposed on the contemporaneous relationship between reduced form VAR innovations and underlying structural disturbances, that is B^{-1} such that, $e_t = B^{-1}\varepsilon_t$.

$$e_t = \begin{pmatrix} e_t^{R^{US}} \\ e_t^{Y} \\ e_t^{P} \\ e_t^{R} \\ e_t^{RA} \\ e_t^{UC} \end{pmatrix} = \begin{pmatrix} b_{11} & 0 & 0 & 0 & 0 & 0 \\ b_{21} & b_{22} & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & b_{33} & 0 & 0 & 0 \\ b_{41} & b_{42} & b_{43} & b_{44} & 0 & 0 \\ b_{51} & b_{52} & b_{53} & b_{54} & b_{55} & 0 \\ b_{61} & b_{62} & b_{63} & b_{64} & b_{65} & b_{66} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{R^{US}} \\ \varepsilon_t^{Y} \\ \varepsilon_t^{P} \\ \varepsilon_t^{R} \\ \varepsilon_t^{RA} \\ \varepsilon_t^{UC} \end{pmatrix} \tag{7}$$

where, ε_t and e_t are the vectors of structural and reduced-form disturbances, respectively. $\varepsilon_t^{R^{US}}$ is the *US* monetary policy or global monetary policy shock, ε_t^{Y} is referred to as output shock, ε_t^{P} is referred to as price shock, ε_t^{R} is domestic monetary policy shock, ε_t^{RA} is referred to as risk aversion, and finally, ε_t^{UC} is uncertainty shock.

The identification scheme for our SVAR model broadly follows the recursive ordering in standard monetary policy SVAR literature (see, among others, Bjornland and Leitemo, 2009; Singh and Pattanaik, 2012; Iglesias and Haughton, 2013; Abouwafia and Chambers, 2015; Suhaibu, Harvey, and Amidu, 2017) and particularly takes account of the literature on the interaction of monetary policy, risk aversion and uncertainty (see, Bekaert, Hoerova, and Duca, 2013; Nave and Ruiz, 2015; Inekwe, 2016; Hahn, Jang, and Kim, 2017). *US* monetary policy is assumed to be exogenous as it is a foreign variable to the domestic economy. Thus, change in the domestic variables does not alter the *US* monetary policy rate. Real economic activity and consumer prices are assumed to respond with a lag to changes in other domestic variables. Domestic monetary policy, on the other hand, is permitted to respond instantaneously to changes in real output and consumer prices. Risk aversion and uncertainty, which are the stock market variables, are allowed to contemporaneously react to monetary policy, while monetary policy responds to them with a lag. Lastly, uncertainty responds contemporaneously to risk aversion, while the latter responds with a lag to the former. This restriction, however, has little relevance with regard to the objective of our study. Hence, we remove this restriction later to check the robustness of our results.

We follow Uhlig (2005) and Mountford and Uhlig (2009) to alternatively identify the SVAR model.[8] The sign-restriction approach involves recovering the structural shocks by imposing restrictions on the signs of impulse response functions while remaining agnostic about the variables of interest. While the recursive ordering approach is easy and straight-forward to implement, it requires a logical sequence of causation, which may not be theoretically plausible. Contrastingly, the sign restrictions approach is invariant to the ordering of the variables. It permits endogenous interaction between variables without determining the series of causation. Further, unlike the identification achieved through the Cholesky decomposition approach, the sign restriction strategy doesn't involve a complete decomposition of one-step-ahead prediction errors into all components due to underlying structural shocks. Hence, it allows for agnostic identification of the structural shocks by imposing minimal structure on the impulse responses. The sign restriction approach accounts for the possible endogeneity among variables by allowing contemporaneous responses to structural shocks. Therefore, it is more suitable than the traditional approach based on exclusion restrictions, which requires the informational ordering of the variables.

We identify four impulse vectors characterized as global monetary policy shock, domestic monetary policy shock, risk aversion shock and uncertainty shock for all economies (except the *US*) via the standard set of sign restrictions. For the *US*, we recover three domestic shocks i.e., domestic monetary policy, risk aversion and uncertainty shocks. We restrict the contemporaneous response of real output and prices to be negative following a domestic (expansionary) monetary policy shock (see, among others, Baumeister and Benati, 2012; Beckers and Bernoth, 2016; Neuenkirch and Nöckel, 2018; Furlanetto, Ravazzolo, and Sarferaz, 2019), while the response of risk aversion and uncertainty are left unrestricted. In other words, an unanticipated expansionary monetary policy shock lowers the policy rate while stimulating output and increasing prices. Further, the response of all variables to risk aversion and uncertainty shocks are also left unrestricted. In addition, we combine sign-restrictions with zero restriction on the contemporaneous matrix by restricting the instantaneous response of

8. See Uhlig (2005) and Mountford and Uhlig (2009) for a detailed description of the methodology.

TABLE 5. Identification Schemes

Cholesky Decomposition	Sign Restrictions
Global Monetary Policy	0
Real Output	+
Consumer Prices	+
Domestic Monetary Policy	–
Risk Aversion	?
Uncertainty	?

Note: The left column summarizes the Cholesky ordering for recursive identification of the structural shocks in the SVAR model. The right column illustrates the sign restrictions for an expansionary monetary policy (i.e. decrease in the policy rate). The restrictions are assumed to hold on impact. '?' indicates that the response variable is left unrestricted.

global monetary policy variable i.e., shadow federal funds rate to be zero due to domestic monetary policy, risk aversion and uncertainty shocks. Table 5 summarizes the two different identification schemes i.e., Cholesky decomposition and sign restrictions.

B. Panel VAR

Originally developed by Holtz-Eakin, Newey, and Rosen (1988), Panel VAR (PVAR) model is a hybrid econometric approach that applies panel data techniques to the standard VAR model. PVAR model permits us to exploit the cross-sectional dimension of the data and reinforces the results obtained from country-specific SVAR estimation. The model builds an endogenous system by allowing endogenous interaction between the variables and produces estimates that are consistent and asymptotically efficient while accounting for the unobserved individual heterogeneity as fixed effects.

Following Love and Zicchino (2006), PVAR model can be specified in the following form:

$$Z_{i,t} = \alpha + \sum\nolimits_{j=1}^{p} A_j Z_{i,t-j} + f_i + \varepsilon_{i,t}; \quad i \in \{1,\ldots,N\}, t \in \{1,\ldots,T_i\} \quad (8)$$

where, $Z_{i,t}$ is a vector of endogenous variables consisting of five variables $Z_{i,t} = \left(Y_{i,t}, P_{i,t}, R_{i,t}, RA_{i,t}, UC_{i,t}\right)'$ and f_i is a vector of time-invariant fixed effects or individual heterogeneity between cross-sectional units. A_j denote autoregressive coefficient vector that is to be estimated. ε_t is a vector of idiosyncratic disturbances such that

$\varepsilon_{i,t} \sim iid\ N(0, \Sigma_i)$. The innovations are assumed to have the following characteristics: $E(\varepsilon_{i,t}) = 0, E(\varepsilon'_{i,t}\varepsilon_{i,t}) = \Sigma$ and $E(\varepsilon'_{i,t}\varepsilon_{i,s}) = 0$ for all $t > s$.

Estimating the parameters of equation (8) through a standard mean differencing procedure to eliminate fixed effects may yield biased estimates due to the potential correlation between fixed effects (f_i) with regressors that are lagged dependent variables (Nickell, 1981; Holtz-Eakin, Newey, and Rosen, 1988). To remove individual country fixed effects, we estimate Panel VAR based on the Generalized Method of Moments (GMM) using forward mean differencing (orthogonal deviations) or Helmert transformation proposed by Arellano and Bover (1995). Forward mean differencing preserves the orthogonality between the transformed variables and the lagged regressors so that the latter can be used as valid instruments to estimate GMM coefficients. It removes the mean of all available future observation instead of using deviations from past realizations as in first differencing (Anderson and Hsiao, 1982), and thus, limits data losses. We use Cholesky decomposition of the variance-covariance matrix to obtain the dynamic responses of a variable to shocks in other variables. The recursive structure imposed on the PVAR model is similar to the one described in equation (7) for each-country SVAR identification.

V. Relationship between Monetary Policy, Risk Aversion and Uncertainty

A. Empirical Results from SVAR

In this section, we present our results obtained from the SVAR model based on two alternative identification schemes - Cholesky decomposition and sign restrictions. We first report our results based on recursive ordering and later reinforce the results with the sign restrictions approach. Impulse response analysis is done to examine the relationship between monetary policy, risk aversion and uncertainty in the sample economies. The orthogonalized impulse responses are generated using Monte Carlo integration with probability bands at 0.16 and 0.84 fractiles based on 1,000 replications. The optimal lag order of the SVAR model is selected on the basis of the Schwarz Bayesian Criterion (SBC) while ensuring the absence of residual autocorrelation at the selected lag length. The responses of real output, consumer prices, risk aversion and uncertainty to monetary policy shock up to 60 months are presented in figure 3(a-d). The monetary policy shock is normalized such that it leads to one percentage (100-basis points) decrease in the policy rate, thereby reflecting expansionary monetary policy shock. We find that expansionary monetary policy leads to dampening of the real economic activity in all major advanced economies as well as China (refer figure 3(a)). While the economic activity worsens upon impact, it tends to recover in the short to medium run, suggesting that accommodative stance by monetary authorities of advanced economies and China stimulates the economic activity (with a lag) in the medium to long run. For the emerging economies (except China), the effect of monetary policy expansion on real output is positive over the entire time horizon. On the other hand, the impact of expansionary domestic monetary policy shock on price level is mainly inconsequential in all advanced and emerging economies except Brazil and Mexico where it causes persistent inflationary and deflationary pressures, respectively (refer figure 3(b)).

Concerning the impact of domestic monetary policy shock on risk aversion, we find that expansionary monetary policy (decrease in the policy rate) increases the risk aversion of investors upon impact in most of the economies (refer figure 3(c)). Risk aversion starts falling thereafter in 2-3 months but remains positive for the majority of them until the impact recedes. The exceptions are Germany and Japan, where risk aversion becomes negative due to expansionary monetary policy in the medium to long run, as well as China, where monetary policy easing leads to a significant reduction in risk aversion. Overall, the response of risk aversion is found to be immediate and persists at least for about 2-3 years for most countries. Our result is in contrast with the findings of Bekaert, Hoerova, and Duca (2013) who report a decrease in the risk aversion due to lax monetary policy in the *US* in the medium to long run with an initial increase in the short-run. Risk aversion rises due to lax monetary policy in the short run and subsequently starts falling, which is in conjunction with Bekaert, Hoerova, and Duca (2013); however, monetary policy expansion does not reduce risk aversion in the medium to long run. Akin to our result, Nave and Ruiz (2015) report that the response of risk aversion is in the opposite direction of monetary policy shock in the Eurozone. Expansionary monetary policy may be an indication of a worsening economic outlook, which makes low-risk bonds more attractive compared to high-risk equities. Lower policy rates and the consequent trickle-down effect in interest rate creates a greater

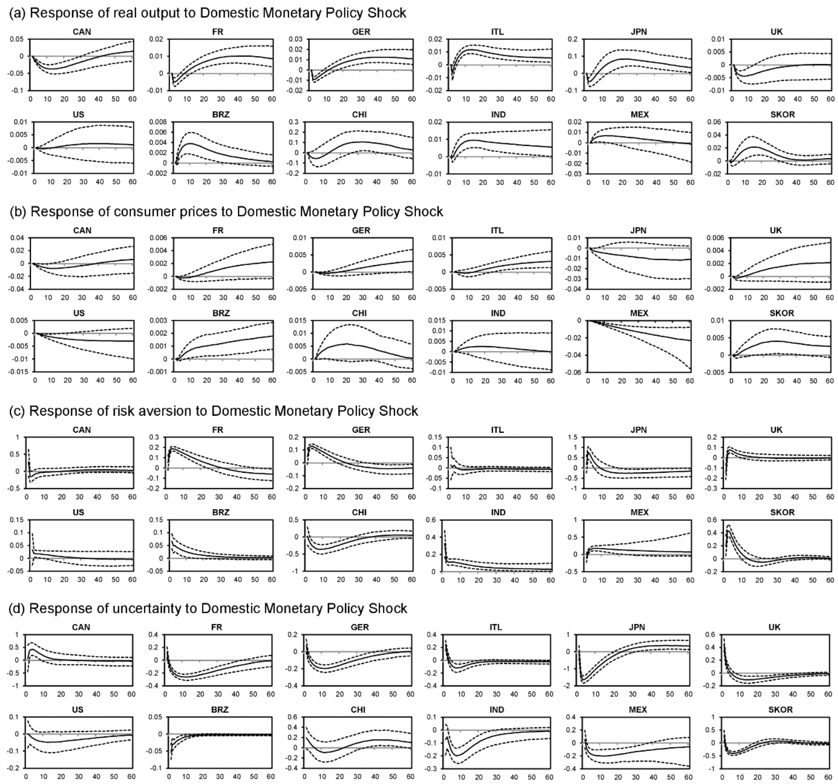

FIGURE 3.— Impulse Responses due to Domestic (Expansionary) Monetary Policy Shock obtained from SVAR Model with Recursive Ordering

Note: Panel a-d of the figure display impulse responses (solid lines) of real output, consumer prices, risk aversion and uncertainty, respectively to domestic (expansionary) monetary policy shock for the sample countries obtained from SVAR model with recursive ordering. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Monetary policy shock is normalized such that it leads to a one percent decrease in the policy rate, implying expansionary monetary policy shock. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).

capital appreciation potential for bonds, thereby making them relatively more attractive than equities. This induces investors to increase their bond exposure, thereby leading to wealth redistribution. The drive towards bonds during the uncertain economic environment is probably reflected in the rising risk aversion of investors. As production expands and economic conditions improve due to monetary policy expansion in the medium to long run, there is an improvement in the value of assets, which encourages investors to seek investments in growth firms and promotes risk-taking behaviour.

Results also suggest that expansionary monetary policy shock induces an instantaneous increase in the uncertainty for most of the economies, only except the *US* and China, where the impact is insignificant over the entire period (refer figure 3(d)). Nevertheless, the impact of policy rate on uncertainty becomes positive for the majority of them by the 3rd or 4th month and remains significant for a period of at least 2 years before the effect starts to recede. Investors perceive expansionary monetary policy as a signal of unfavourable macroeconomic conditions leading to an increase in the stock market uncertainty, which is reflected in the initial rise in uncertainty in response to a reduction in the policy rate. As the economy recovers and investors' sentiment on market condition improves, lax monetary policy is able to mitigate uncertainty in the equity markets.

Figure 4(a-d) illustrates the response of real output, consumer prices, policy rate and uncertainty to risk aversion shock, while the responses of real output, consumer prices, policy rate and risk aversion due to uncertainty shock are presented in figure 5(a-d). The responses displayed are up to 60 months for all economies. The risk aversion/uncertainty shock is normalized such that it leads to a one percent increase in the risk aversion/uncertainty. Results suggest that central banks respond by decreasing the policy rate after a positive risk aversion shock in most of the economies. Risk aversion shock, therefore, evokes monetary authorities to undertake expansionary monetary policy in the majority of the countries. However, the response of the policy rate in the case of Canada, China and Mexico remains insignificant throughout the horizon. The feedback response of monetary authorities due to uncertainty shock is similar to the risk aversion shock. We find that central banks respond by reducing the policy rate in response to the uncertainty shock in all economies. The response of monetary policy is found to be statistically significant and persistent in the long run for all economies. This suggests that central banks respond prudently through expansionary monetary policy to stimulate the economy in times of high uncertainty. Deteriorating economic conditions amid an uncertain environment are reflected in the negative response of real output and prices due to uncertainty shock in most of the economies. Therefore, an increase in uncertainty has implications for long-term macroeconomic outlook, which increases the

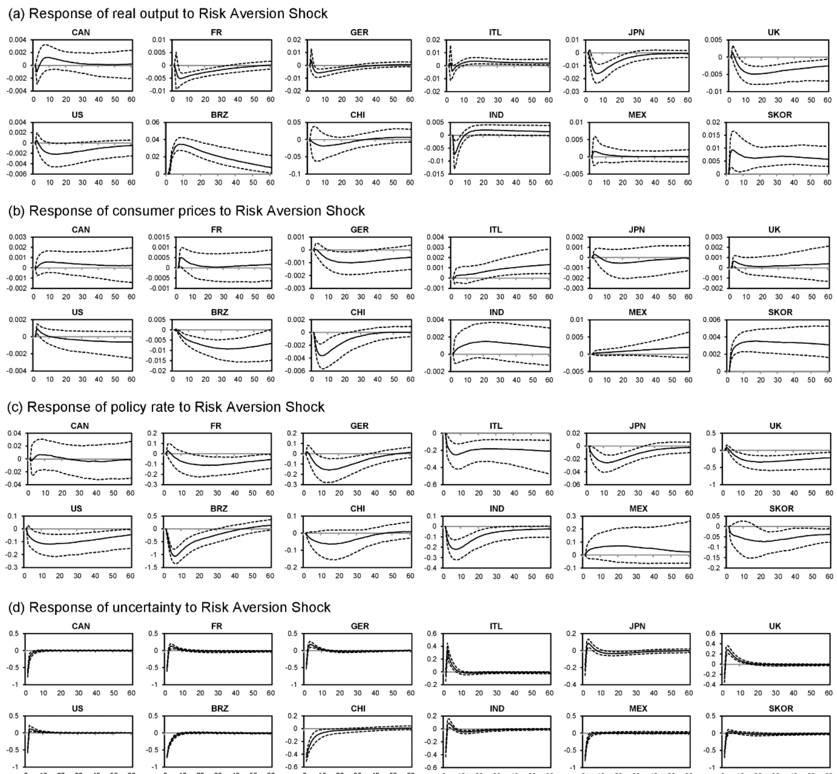

FIGURE 4.— Impulse Responses due to Risk Aversion Shock obtained from SVAR Model with Recursive Ordering

Note: Panel a-d of the figure display impulse responses of real output, consumer prices, policy rate and uncertainty, respectively to risk aversion shock for the sample countries obtained from SVAR model with recursive ordering. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Risk aversion shock is normalized such that it leads to a one percent increase in risk aversion. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).

likelihood of monetary authorities responding to such an environment.

With regard to the interaction of risk aversion and uncertainty, we find that a positive risk aversion shock is followed by a significant contemporaneous decrease in the equity market uncertainty in all economies. For economies like France, Germany, Italy, Japan, the UK and India, the response of uncertainty becomes positive shortly thereafter and reaches its maximum by the 3rd month. Overall, the effect

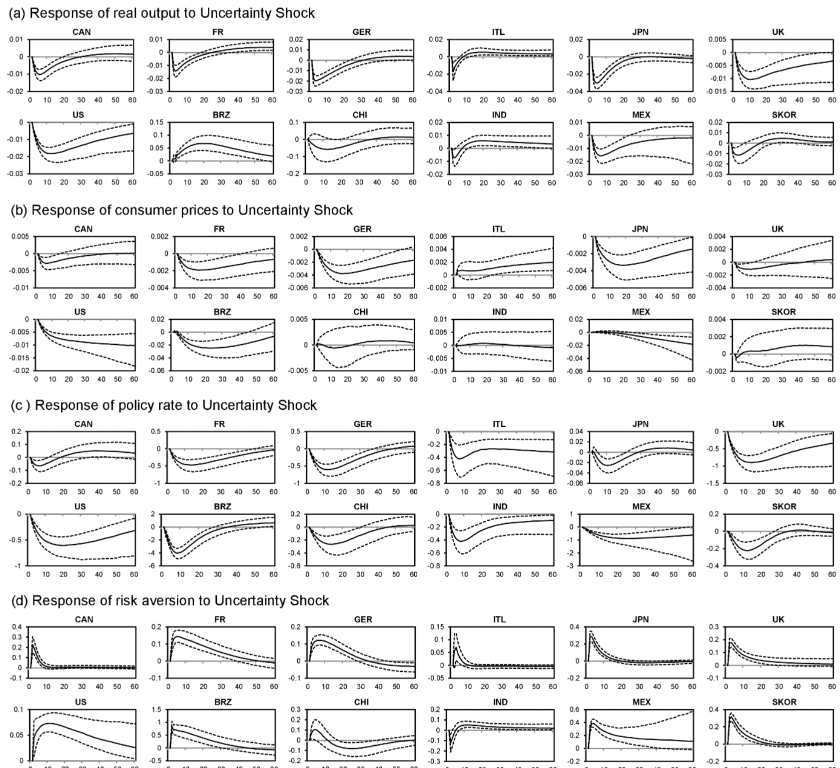

FIGURE 5.— Impulse Responses due to Uncertainty Shock obtained from SVAR Model with Recursive Ordering

Note: Panel a-d of the figure display impulse responses of real output, consumer prices, policy rate and risk aversion, respectively to uncertainty shock for the sample countries obtained from SVAR model with recursive ordering. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Uncertainty shock is normalized such that it leads to a one percent increase in the uncertainty. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).

of risk aversion shock on uncertainty is temporary and starts to recede within a year. On the contrary, the response of risk aversion to uncertainty shock is found to be significantly positive for all economies. The response reaches its peak in the 3rd or 4th month and starts to fall thereafter. High uncertainty, therefore, drives the risk aversion of investors as it deters the investors from taking investment decisions and potentially reduces the economic activity. Pessimism of market participants regarding economic outlook during uncertain times results in their risk-averse behaviour.

The responses of real output, consumer prices, domestic policy rate, risk aversion and uncertainty to *US* monetary policy (shadow federal funds rate) shock up to 60 months are presented in figure 6(a-e). The *US* monetary policy shock is normalized such that it leads to one percentage (100-basis points) decrease in the shadow federal funds rate, thereby reflecting expansionary *US* monetary policy shock. The response of risk aversion of investors following *US* monetary policy shock is largely mixed. An expansionary *US* monetary policy shock is followed by an increase in the risk aversion in most economies. An increase in the level of risk aversion may be due to the contractionary effect of *US* monetary policy expansion on real output in these economies leading to a rise in investors' risk sentiments. Considering the response of uncertainty, we find that expansionary *US* monetary policy induces a decrease in the uncertainty in most economies; however, the impact is significant only for Canada, Italy, Japan, Brazil, China, India and South Korea. Results suggest that global monetary policy also induces significant spillover effects in the majority of the economies by altering the risk-bearing capacity of international investors and equity market uncertainty. Nevertheless, both risk aversion and uncertainty exhibit a higher magnitude of response to domestic monetary policy as compared to the global monetary policy shocks indicating that domestic policy decisions play a substantial role in influencing risk aversion and uncertainty in an economy as compared to global monetary policy.

We examine the robustness of our results by estimating our SVAR model with the alternative ordering of the variables in the Cholesky decomposition approach. We switch the ordering of risk aversion and uncertainty in the alternative model specification such that risk aversion responds contemporaneously to uncertainty, while the latter responds with a lag to the former. Hence, the vector of variables with the following ordering is considered: $Z_t = \left(R_t^{US}, Y_t, P_t, R_t, UC_t, RA_t\right)'$ where, R_t^{US} is the *US* monetary policy rate, Y_t is the real output, P_t is the price index, R_t is domestic policy rate, UC_t is (log of) uncertainty and RA_t is (log of) risk aversion. The responses of risk aversion and uncertainty due to *US* monetary policy as well as domestic monetary policy shocks with the alternate ordering of variables are qualitatively similar to the responses obtained from benchmark model specification, thereby

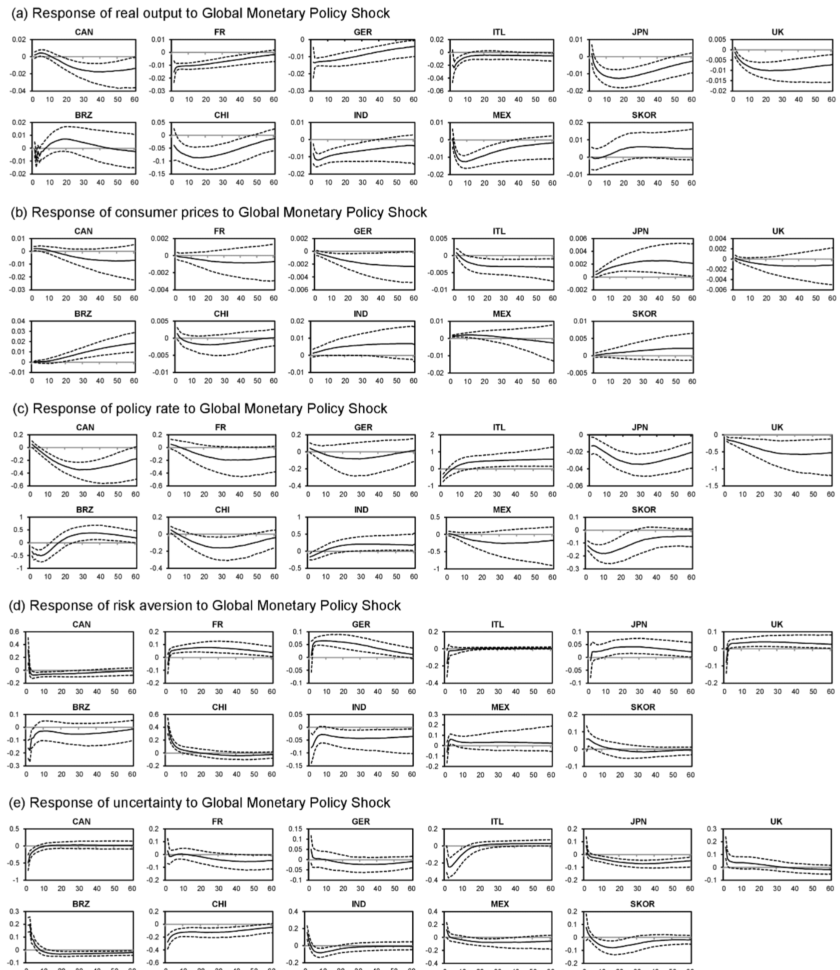

FIGURE 6.— Impulse responses due to Global (Expansionary) Monetary Policy Shock obtained from SVAR Model with Recursive Ordering

Note: Panel a-e of the figure display impulse responses of real output, consumer prices, policy rate, risk aversion and uncertainty, respectively to Global (expansionary) monetary policy shock for the sample economies obtained from SVAR model with recursive ordering. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Global monetary policy shock is normalized such that it leads to a one percent decrease in the shadow federal funds rate, implying expansionary Global monetary policy shock. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).

strengthening our main results.[9] Further, the response of policy rate due to risk aversion and uncertainty shocks remain largely invariant to the ordering of the variables. The alternate ordering of the variables, however, alters the dynamics of the interaction between risk aversion and uncertainty. The response of uncertainty due to risk aversion shock becomes positive for all economies with the new ordering of the variables. Risk aversion now responds negatively due to uncertainty shock; nonetheless, it rises in the subsequent periods to become positive in response to high uncertainty in all economies, except Brazil, China and India. It can be concluded that the interaction of risk aversion and uncertainty is mainly contingent on their ordering thereby implying the possible simultaneity between the variables. Nevertheless, the interaction of risk aversion and uncertainty with the rest of the variables remains consistent with different ordering of the variables.

We further test the robustness of our results by employing the sign restrictions approach based on Uhlig (2005) and Mountford and Uhlig (2009) for identifying the structural parameters of the SVAR model (refer Section IV, Part *A* for identification strategy). In our sign-restriction strategy, an unanticipated expansionary domestic monetary policy lowers the policy rate while increasing the output and prices. In addition, the sign-restrictions are combined with zero restrictions by restricting the instantaneous response of global monetary policy variable to be zero due to the identified domestic shocks. Our results remain robust to the use of alternative identification achieved through the sign restrictions approach. The impulse responses obtained due to *US* monetary policy, domestic monetary policy, risk aversion and uncertainty shocks are presented in appendix C. Results suggest that expansionary domestic monetary policy shock that reduces the policy rate and stimulates output and price level leads to an instantaneous increase in the risk aversion of investors in most of the economies. Uncertainty, on the other hand, declines following an expansionary monetary policy for the majority of the economies (except Canada, China and India). Considering the feedback response of monetary authorities, results indicate that monetary authorities respond by contracting the monetary policy in response to both risk aversion and uncertainty shock in most of the economies, but the response is largely

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9. The impulse responses of *US* monetary policy, domestic monetary policy, uncertainty and risk aversion shocks estimated from the new SVAR model with alternate ordering are not presented due to brevity of space but are available on request.

insignificant. The sign restrictions approach allows for the simultaneous interaction between risk aversion and uncertainty in contrast to the recursive ordering scheme. Results suggest that uncertainty falls due to risk aversion shock in most of the economies, including France, Japan, UK, *US*, Brazil, China, India and South Korea, whereas it rises in Canada, Germany, Italy. Uncertainty reduces the risk aversion of investors instantaneously, but their risk appetite falls gradually as risk aversion rises in the short run. Subsequently, risk aversion becomes positive in response to high uncertainty in Canada, France, Japan, the *US* and South Korea. In the case of Germany and Italy, uncertainty shock induces risk-averse behaviour among investors upon impact. Concerning the impact of expansionary *US* monetary policy, risk aversion rises and uncertainty falls following a reduction in the federal funds rate in most of the economies. These results are principally in line with the results obtained from the Cholesky decomposition approach.

B. Empirical Results from Panel VAR

We generate orthogonalized impulse response functions representing 5 percent and 95 percent confidence bands estimated through Monte Carlo simulation with 1000 iterations based on the Panel VAR model. The optimal lag length of the PVAR model is selected on the basis of moment and model selection criteria (MMSC) developed by Andrews and Lu (2001) for GMM models based on Hansen's J statistic for over-identifying restrictions that are analogous to maximum likelihood (ML) based model selection criteria i.e., Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC) and Hannan-Quinn Information Criteria (QIC). We select first order panel VAR model as the optimal model based on MMSC. Further, our estimated model satisfies the stability condition, which requires moduli of the eigenvalues of the dynamic matrix to lie within the unit circle.[10] Figure 7 depicts the impulse responses obtained through our PVAR model with GMM-style instruments. PVAR estimation results suggest that contractionary monetary policy shock increases uncertainty and reduces risk aversion in the short-run (responses up to 10 months are plotted). The feedback response of monetary authorities to risk aversion and uncertainty shock is mainly inconsequential. Further, results suggest

10. The results of lag selection and Eigenvalue stability condition are not presented due to brevity of space but are available on request.

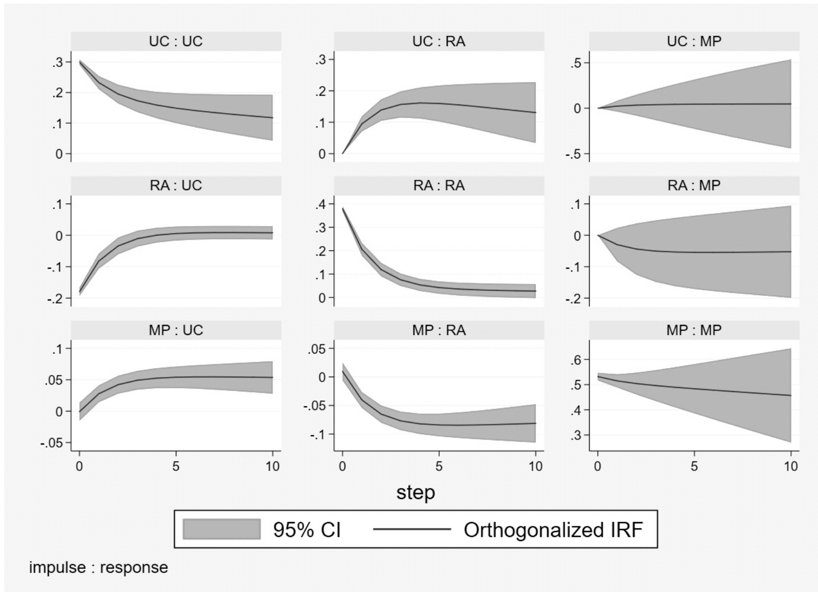


FIGURE 7.— Impulse Responses obtained from Baseline PVAR Model

Note: The figure displays orthogonalized impulse responses of policy rate, risk aversion and uncertainty to Monetary Policy, Risk Aversion and Uncertainty shocks obtained from the baseline PVAR model. Impulse responses are plotted for 10-time horizons (represented on the horizontal axis).

that risk aversion shock reduces uncertainty in the stock market, whereas, uncertainty shock induces risk-averse behaviour among investors. However, the interaction of risk aversion and uncertainty is governed by the ordering of the variables as alternating the order of risk aversion and uncertainty yields different results. The impulse responses obtained from the estimation of the PVAR model with the alternative ordering of variables is presented in appendix D. While the response of other variables remains consistent, uncertainty rises in response to risk aversion shock. Nevertheless, uncertainty induces risk aversion among investors in about 3 months after an initial reduction. This indicates that high stock market uncertainty induces risk-averse behaviour among investors as it reflects a deteriorating economic environment. During times of high uncertainty, investors lower their present consumption to increase precautionary savings as a hedge against unexpected future changes in stock market volatility, thereby resulting in risk-averse behaviour. Therefore, the pessimism of market participants regarding economic outlook during uncertain times results in their risk-averse behaviour. Overall, our PVAR estimation results corroborate the results obtained from individual country SVAR results.

VI. Relationship between Risk Aversion and Risk Premium

Risk aversion of an investor is influenced by the degree of uncertainty in the stock price movements as well as the macroeconomic environment. During an uncertain environment, investors require higher expected excess returns to hold each unit of risk. When risk aversion rises, the expected return to compensate investors for holding the risky asset, i.e., the risk premium should also rise. This is because investors regard an increase in the return variance as unfavourable shock and hence, require a large premium to offset the risk associated with adverse shifts in market volatility. We verify the relationship between risk aversion and risk premium by analysing whether variance risk premium accounts for any substantial variation in excess returns. If there is risk aversion in the market, expected excess returns should reflect the exposure to variance risk i.e. variance risk premium should explain return risk premium in the market. To demonstrate this, we formally test the role of risk aversion measured by the variance risk premium in explaining return risk premium i.e. the market price of risk among the sample economies. The foundation of our analysis is provided by Bernanke and Kuttner (2005) which highlight that the impact of monetary policy on stock prices is majorly ascribed to risk premium associated with holding stocks. Hence, our analysis can help in revealing important insights into the monetary policy transmission mechanism. Additionally, our analysis can help in analysing the extent of compensation or premium required by market participants to bear volatility risk. This has implications for understanding the sensitivity of excess returns to changes in market volatility, which is critical for market participants in developing trading and risk management strategies.

We estimate the following simple linear regression of return risk premium on our measure of risk aversion (i.e., variance risk premium).

$$ER_{i,t} = \alpha_i + \beta_i VRP_{i,t-j} + \varepsilon_{i,t} \quad (9)$$

$ER_{i,t}$ is the excess stock return or the return risk premium defined as: $R^m_{i,t} - R^f_{i,t}$, where $R^m_{i,t}$ is the benchmark stock market index return of the sample economy and $R^f_{i,t}$ is the risk-free rate of that economy. $VRP_{i,t}$ corresponds to the variance risk premium, which is our measure of risk aversion. The optimal lag (j) of VRP_t in the regression is selected based on the Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hannan-Quinn Criterion (HQC). The significance of the estimated slope coefficient (β) is determined by the robust Student's *t*-statistic constructed from Newey-West heteroscedasticity and serial correlation consistent standard errors.

We use the 3-month Treasury bill rate as a proxy for the risk-free rate. Hence, the monthly return risk premium is computed by subtracting the 3-month Treasury bill rate from logarithmic return on the benchmark stock index for the sample countries. The results of the regression, including the estimated coefficients at j^{th} lag, robust *t*-statistic, along with the AIC, SIC and HQC for 0 to 6 month lags for all economies, are presented in table 6.

All three criteria (AIC, SIC and HC) select no lag for Italy, Japan, UK and Brazil, implying that the effect of risk aversion on the risk premium is instantaneous. Lagged effects of risk aversion on return risk premium are observed for the rest of the economies, with 1 lag selected for Canada, France and *US*, 2 lags for India, 4 lags for Germany, China and Mexico, and 5 lags for South Korea. The estimated coefficient at the optimal lag is found to be significant for all economies, except the UK. Results suggest that variance risk premium positively affects return risk premium (excess returns) in all economies, except Italy, Japan and the UK, where the impact is found to be negative. This implies that the level of risk aversion plays a significant role in explaining the inter-temporal variation in the excess returns in the market. Our results are consistent with the standard financial theory that assumes the rational behaviour of investors while making investment decisions. Investors having risk-averse preferences require high compensation for taking risks, hence demand high-risk premium. The positive impact of risk aversion on excess returns, as revealed by our results, suggest that investors' decisions exhibit risk preferences that are consistent with rational behaviour. On the other hand, inconsistent risk preferences of investors not complying with rational behaviour in Italy, Japan and the UK may be explained by the recessionary nature of the macroeconomic environment or bearish market conditions in these economies, leading to the irrationality of investors' decisions.

TABLE 6. Regression Results of Excess Return on Risk Aversion

$ER_{i,t} = \alpha_i + \beta_i VRP_{i,t-j} + \varepsilon_{i,t}$

	Lags (j)	0	1	2	3	4	5	6
CAN	α	0.1542	–1.4627***	–0.7118*	–0.9678**	–0.9464**	–0.7491**	–0.5956
		(0.40)	(–3.18)	(–1.78)	(–2.29)	(–2.34)	(–2.03)	(–1.43)
	β	–0.0765**	0.1042***	0.0158	0.0514*	0.0436	0.0170	–0.0023
		(–2.03)	(3.06)	(0.52)	(1.68)	(1.63)	(0.64)	(–0.07)
	AIC	4.9126	4.8464	4.9423	4.8852	4.8681	4.8721	4.8813
	SIC	4.9604	4.8944	4.9905	4.9338	4.9169	4.9212	4.9307
	HQC	4.9320	4.8659	4.9619	4.9049	4.8879	4.8920	4.9014
FR	α	–1.4497***	–1.6282***	–1.6056***	–1.5643***	–1.5658***	–1.5135***	–1.4866***
		(–2.83)	(–3.45)	(–3.37)	(–3.24)	(–3.17)	(–2.95)	(–2.88)
	β	0.0028	0.0536***	0.0468**	0.0331	0.0375*	0.0231	0.0162
		(0.07)	(3.01)	(0.02)	(1.28)	(1.87)	(1.02)	(0.72)
	AIC	6.2861	6.2234	6.2423	6.2698	6.2670	6.2886	6.2984
	SIC	6.3158	6.2532	6.2722	6.2998	6.2970	6.3188	6.3287
	HQC	6.2981	6.2354	6.2544	6.2819	6.2791	6.3008	6.3106
GER	α	–0.9111	–1.3914***	–1.4842***	–1.2862**	–1.5222***	–1.4282***	–1.3081**
		(–1.46)	(–2.67)	(–2.86)	(–2.40)	(–2.94)	(–2.61)	(–2.31)
	β	–0.0401	0.0469*	0.0688***	0.0345	0.0709**	0.0593*	0.0344
		(–0.75)	(1.87)	(2.78)	(0.95)	(2.54)	(1.87)	(1.21)
	AIC	6.5816	6.5791	6.5508	6.5933	6.5480	6.5635	6.5914
	SIC	6.6101	6.6078	6.5796	6.6222	6.5769	6.5925	6.6205
	HQC	6.5931	6.5907	6.5624	6.6049	6.5597	6.5752	6.6031

(*Continued*)

TABLE 6. (Continued)

$ER_{i,t} = \alpha_i + \beta_i VRP_{i,t-j} + \varepsilon_{i,t}$

	Lags (j)	0	1	2	3	4	5	6
ITL	α	–0.0078	–0.8730	–0.3082	–0.7901	–0.6614	–0.5024	–0.4215
		(–0.01)	(–1.42)	(–0.47)	(–1.09)	(–0.96)	(–0.77)	(–0.57)
	β	–0.1024**	0.0498	–0.0274	0.0532*	0.0197	0.0043	–0.0131
		(–2.35)	(1.21)	(–0.81)	(1.79)	(0.68)	(0.15)	(–0.31)
	AIC	6.4301	6.4873	6.4825	6.4770	6.4870	6.4885	6.4944
	SIC	6.4792	6.5366	6.5322	6.5269	6.5372	6.5391	6.5453
	HQC	6.4501	6.5073	6.5027	6.4972	6.5074	6.5090	6.5150
JPN	α	0.5139	0.0798	–0.0406	0.0382	–0.0477	–0.1556	–0.2372
		(1.32)	(0.18)	(–0.09)	(0.08)	(–0.11)	(–0.35)	(–0.53)
	β	–0.0578***	–0.0021	0.0144	–0.0012	0.0072	0.0231**	0.0297***
		(4.22)	(–0.22)	(1.39)	(–0.08)	(0.61)	(2.52)	(3.51)
	AIC	6.1784	6.3051	6.3018	6.3014	6.3002	6.2852	6.2672
	SIC	6.2069	6.3337	6.3306	6.3302	6.3291	6.3142	6.2963
	HQC	6.1899	6.3166	6.3134	6.3130	6.3118	6.2969	6.2789
UK	α	–2.0462***	–2.2504***	–2.3232***	–2.3505***	–2.2736***	–2.2130***	–2.1914***
		(–4.07)	(–5.36)	(–5.17)	(–5.43)	(–5.23)	(–5.09)	(–4.91)
	β	–0.0457	–0.0067	0.0055	0.0158	0.0045	–0.0027	–0.0043
		(–1.36)	(–0.36)	(0.27)	(0.56)	(0.18)	(–0.15)	(–0.17)
	AIC	5.8722	5.8973	5.9016	5.8927	5.8982	5.8987	5.9013
	SIC	5.9020	5.9271	5.9315	5.9227	5.9282	5.9289	5.9316
	HQC	5.8842	5.9094	5.9137	5.9048	5.9103	5.9109	5.9136

(*Continued*)

TABLE 6. (Continued)

$ER_{i,t} = \alpha_i + \beta_i VRP_{i,t-j} + \varepsilon_{i,t}$

	Lags (j)	0	1	2	3	4	5	6
US	α	–1.3841***	–1.8167***	–1.7454***	–1.7335***	–1.5555***	–1.4222***	–1.3631***
		(–2.64)	(–4.57)	(–4.03)	(–4.31)	(–3.68)	(–3.15)	(–3.04)
	β	–0.0130	0.0529***	0.0459**	0.0434**	0.0158	–0.0008	–0.0109
		(–0.36)	(3.11)	(1.99)	(2.13)	(1.08)	(–0.04)	(–0.47)
	AIC	5.9645	5.9249	5.9327	5.9406	5.9718	5.9741	5.9757
	SIC	5.9930	5.9535	5.9615	5.9695	6.0007	6.0031	6.0048
	HQC	5.9760	5.9364	5.9443	5.9523	5.9835	5.9858	5.9874
BRZ	α	–16.3085***	–15.6087***	–15.4138***	–15.4546***	–15.1758***	–14.9898***	–14.9589***
		(–21.65)	(–20.08)	(–18.67)	(–17.75)	(–17.09)	(–15.73)	(–14.74)
	β	0.0239***	0.0185***	0.0174***	0.0177***	0.0165***	0.0159***	0.0162***
		(8.26)	(7.01)	(5.58)	(5.17)	(4.55)	(3.82)	(3.53)
	AIC	6.7838	6.9329	6.9677	6.9666	6.9758	6.9771	6.9804
	SIC	6.8124	6.9616	6.9965	6.9954	7.0047	7.0061	7.0094
	HQC	6.7953	6.9445	6.9793	6.9782	6.9874	6.9888	6.9921
CHI	α	–2.0156***	–2.0724***	–2.0771***	–2.1146***	–2.1823***	–2.2066***	–2.2328***
		(–2.68)	(–2.66)	(–2.68)	(–2.77)	(–2.87)	(–2.92)	(–2.87)
	β	–0.0064	0.0122	0.0078	0.0081	0.0175**	0.0166**	0.0179***
		(–0.38)	(1.44)	(0.74)	(0.75)	(2.44)	(1.98)	(2.66)
	AIC	7.0792	7.0763	7.0870	7.0887	7.0737	7.0796	7.0806
	SIC	7.1136	7.1109	7.1217	7.1235	7.1086	7.1146	7.1158
	HQC	7.0932	7.0903	7.1011	7.1028	7.0878	7.0938	7.0949

(*Continued*)

TABLE 6. (Continued)

$ER_{i,t} = \alpha_i + \beta_i VRP_{i,t-j} + \varepsilon_{i,t}$

	Lags (j)	0	1	2	3	4	5	6
IND	α	–6.2847***	–7.0958***	–6.8745***	–6.7972***	–6.5412***	–6.7317***	–6.7448***
		(–8.84)	(–14.17)	(–10.97)	(–12.73)	(–10.51)	(–12.32)	(–11.16)
	β	–0.0553	0.1123**	0.0968***	0.0801***	0.0414	0.0728***	0.0876**
		(–1.24)	(2.58)	(3.12)	(2.65)	(1.48)	(3.72)	(2.57)
	AIC	6.6739	6.5140	6.5136	6.5721	6.6365	6.5746	6.5321
	SIC	6.7165	6.5566	6.5564	6.6152	6.6797	6.6181	6.5758
	HQC	6.6912	6.5313	6.5310	6.5896	6.6540	6.5923	6.5499
MEX	α	–4.9934***	–4.9429***	–4.8889***	–5.0835***	–5.1323***	–4.9954***	–5.0430***
		(–10.01)	(–10.29)	(–10.53)	(–11.39)	(–10.76)	(–10.73)	(–10.97)
	β	0.0115	0.0089	–0.0000	0.0327	0.0433**	0.0207	0.0238
		(–0.42)	(0.35)	(–0.00)	(1.57)	(2.23)	(0.97)	(1.08)
	AIC	6.0927	6.0903	6.0982	6.0723	6.0512	6.0999	6.0982
	SIC	6.1279	6.1256	6.1336	6.1079	6.0869	6.1358	6.1343
	HQC	6.1070	6.1046	6.1126	6.0867	6.0657	6.1145	6.1128
SKOR	α	–2.3127***	–2.4503***	–2.4312***	–2.4765***	–2.4421***	–2.5556***	–2.4741***
		(–5.71)	(–5.89)	(–5.76)	(–5.73)	(–5.64)	(–5.82)	(–5.52)
	β	0.0076	0.0497**	0.0564***	0.0552***	0.0421**	0.0655***	0.0384**
		(0.18)	(2.19)	(3.25)	(0.00)	(2.51)	(4.03)	(2.36)
	AIC	6.2485	6.2065	6.1843	6.1750	6.2019	6.1571	6.2102
	SIC	6.2819	6.2401	6.2180	6.2088	6.2358	6.1912	6.2444
	HQC	6.2620	6.2201	6.1980	6.1887	6.2157	6.1709	6.2241

(*Continued*)

TABLE 6. (Continued)

Note: The table presents the regression results of Excess Returns ($ER_{i,t}$) on Variance Risk Premium ($VRP_{i,t}$) upto j=1,…,6 lags. Excess return is computed by subtracting 3-month Treasury bill rate from logarithmic return on the benchmark stock index for the sample countries. The optimal lag is selected based on AIC, SIC and HQC which are highlighted in the bold. ***/**/** indicate significance at .01/.05/.10 level. Values in parenthesis ( ) contain robust-t statistic computed using Newey-West heteroscedasticity and serial correlation consistent standard errors.

In a panel framework, we further examine the impact of risk aversion on risk premium by estimating panel regression of excess returns on variance risk premium with fixed effects to account for unobserved individual heterogeneity. The results obtained from the panel regression are presented in appendix E. Our results suggest that variance risk premium indeed positively impacts return risk premium, and thus, accounts for a substantial variation in excess returns.

VII. Conclusion and Policy Implications

The risk-taking channel of monetary policy was largely neglected prior to the global financial crisis of 2008. There was a dichotomy of monetary policy and financial stability as monetary authorities did not incorporate financial frictions in their monetary policy framework. It was believed that price and output stability would stabilize asset prices, and thus, ensure financial stability. However, the crisis demonstrated that accommodative monetary policy may promote excessive risk-taking and lead to build-up of financial risk, which can potentially undermine macroeconomic and financial stability. The crisis has, therefore, drawn the attention of policymakers and academicians to understand the interaction of monetary policy and risk-taking. Against this backdrop, the paper examines the empirical links between monetary policy, risk aversion and uncertainty for a set of advanced and emerging economies. We study the risk-taking behaviour of investors and uncertainty in the equity markets contributed by both domestic and global monetary policy changes. The variance risk premium, which is the compensation required by the investors for hedging the risk associated with changes in volatility, is used as a measure of risk aversion. It is obtained by decomposing implied variance into two components - one which reflects the stock market uncertainty and other, the residual, which is the variance risk premium. Hence, the variance risk premium is computed as the difference between the risk-neutral expectation and the physical expectation of the return variance. Results reveal that variance risk premium is positive on average for all economies suggesting that the investors regard variance risk as undesirable and are willing to accept negative average returns in order to hedge against variations in the returns. Further, the variance risk premium exhibits significant inter-temporal variation with the magnitude of risk aversion experiencing peaks during the periods of market turmoil.

We employ the Structural VAR model with two alternative identification schemes - recursive ordering and sign-restriction approach to examine the interaction of monetary policy, risk aversion and uncertainty across 12 advanced and emerging economies over the period January 1999 to May 2019. To reinforce the results obtained from country-specific SVAR estimation and exploit the cross-sectional dimension of our data, we apply the GMM Panel VAR approach using our panel data of 12 economies. Our results confirm significant interactions between monetary policy, risk aversion and uncertainty. We find that expansionary monetary policy leads to an initial increase in the risk aversion of investors, which starts declining in the subsequent periods. In addition, monetary policy expansion mitigates uncertainty in the stock markets. The rise in investors' risk aversion and stock market uncertainty evokes central banks to respond by easing the monetary policy. Further, we find that high uncertainty induces risk-averse behaviour among investors. We not only study the impact of domestic monetary policy but also investigate the risk-averse behaviour of investors and uncertainty in the equity markets contributed by global monetary policy changes. Global monetary policy also induces significant spillover effects in the majority of the economies by altering the risk-bearing capacity of international investors and equity market uncertainty. Nevertheless, both risk aversion and uncertainty exhibit a higher magnitude of response to domestic monetary policy as compared to the global monetary policy shocks. Our results are robust to the alternative identification approaches of the country-specific SVAR model as well as the PVAR model. In addition, we establish the relationship between risk aversion and risk premium i.e., market price of risk by investigating whether risk aversion measured by the variance risk premium can explain return risk premium. Results reveal that risk aversion positively affects return risk premium in the market, thereby implying that level of risk aversion plays a significant role in explaining the inter-temporal variation in the excess returns in the market.

To the extent that risk aversion and uncertainty are influenced by monetary policy actions, risk-taking and stock market volatility are important channels of monetary policy transmission. Monetary authorities need to be aware of the impact of their policy decisions on the risk behaviour of investors and uncertainty in the stock market as it has implications for longer-term macroeconomic outlook. It is crucial for them to develop an approach towards risk management while setting monetary policy. Improvement in central bank communication and its predictability with regard to future policy decisions may help in curtailing uncertainty in the stock market. Policymakers are also confronted with the need to respond to fluctuations pertaining to risk sentiments and uncertainty induced by global monetary developments. As a result, international risk spillovers pose a serious challenge for monetary policy going forward. Monetary policy decisions should be supplemented with adequate macro-prudential regulation and enhanced supervision to reduce risk-taking behaviour and build-up of financial imbalances. The macro-prudential policy is particularly relevant in restraining the undesirable effects of monetary policy in terms of macroeconomic outcomes.

Accepted by: *Prof. P. Theodossiou, PhD, Editor-in-Chief* , *September* 2020

Appendix A. Model Evaluation Criteria

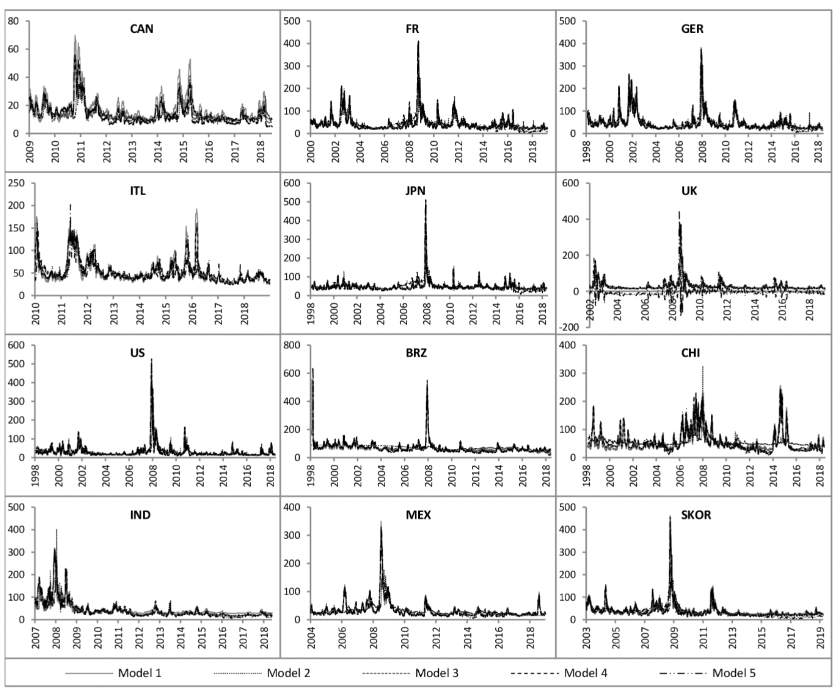
		Model 1	Model 2	Model 3	Model 4	Model 5
CAN	RMSE	37.4347	12.0317	10.5246	10.3656	10.3653
	MAE	14.8576	8.0327	6.7684	6.5978	6.5973
	MAPE	81.8637	91.1597	73.2003	69.2044	69.2350
	Adj. R^2	0.5372	0.1407	0.3423	0.3615	0.3617
FR	RMSE	44.1333	52.9977	45.2047	45.1998	43.7185
	MAE	22.6240	27.2277	23.4133	23.4268	23.7372
	MAPE	81.6853	104.8503	85.6244	85.8055	80.1737
	Adj. R^2	0.4165	0.1988	0.4170	0.4170	0.4545
GER	RMSE	45.2225	51.8332	45.2125	45.2112	44.2604
	MAE	23.5347	26.7149	23.4513	23.4459	23.7108
	MAPE	76.4570	92.3122	75.8443	75.8503	72.8135
	Adj. R^2	0.4393	0.2633	0.4395	0.4394	0.4626
ITL	RMSE	49.3607	44.3324	41.6063	41.5566	41.4764
	MAE	26.6385	29.0413	26.2075	26.1876	26.0650
	MAPE	90.5967	78.2245	67.4058	67.8654	66.2305
	Adj. R^2	0.2112	0.1676	0.2665	0.2680	0.2705
JPN	RMSE	65.3377	70.5861	65.3187	65.3073	64.1026
	MAE	27.7423	29.5427	27.8864	27.9983	28.3923
	MAPE	87.3414	98.4777	88.4684	89.2619	87.1702
	Adj. R^2	0.1850	0.0487	0.1853	0.1854	0.2151
UK	RMSE	35.3749	43.0663	36.1453	37.0114	36.5797
	MAE	16.6806	20.1638	17.3248	17.3068	17.8880
	MAPE	86.4460	113.0926	92.7854	94.7341	103.5894
	Adj. R^2	0.3963	0.1505	0.4015	0.4204	0.4337
US	RMSE	39.6617	50.0078	39.2272	39.2246	39.1898
	MAE	17.3953	21.1221	18.0079	18.0696	18.1036
	MAPE	95.9787	121.5283	107.0488	108.0616	108.9099
	Adj. R^2	0.4907	0.1893	0.4931	0.4931	0.4934
BRZ	RMSE	81.5508	93.2486	81.3166	67.6739	67.6566
	MAE	34.8265	41.3737	34.2984	31.0477	31.0916
	MAPE	63.0765	76.7397	59.9243	55.1917	55.1819
	Adj. R^2	0.2274	0.0252	0.2316	0.3116	0.3118
CHI	RMSE	47.6900	57.0645	47.6307	47.2515	45.5243
	MAE	31.6735	39.0385	31.6442	31.2237	29.7872
	MAPE	100.1553	150.7569	99.3715	98.9913	92.1468
	Adj. R^2	0.3628	0.0909	0.3665	0.3764	0.4645
IND	RMSE	56.8257	60.6070	56.7281	56.4734	55.7121
	MAE	29.7271	26.9015	24.2788	24.0878	23.4780
	MAPE	105.4426	100.1292	85.5619	83.1805	72.2998
	Adj. R^2	0.2112	0.2344	0.3290	0.3348	0.3523

(*Continued*)

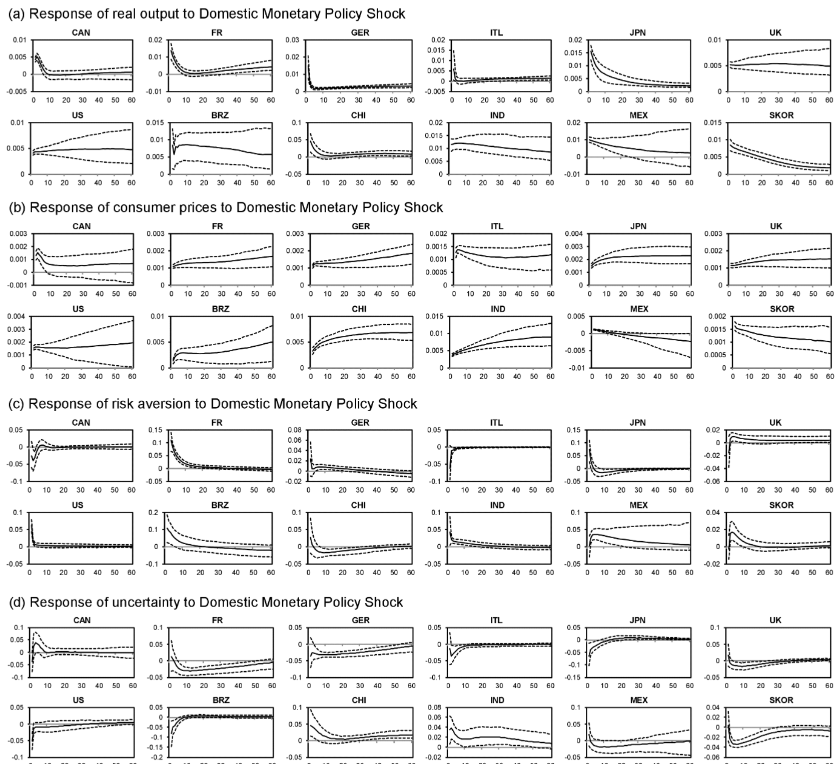
Appendix A. (Continued)

		Model 1	Model 2	Model 3	Model 4	Model 5
MEX	RMSE	35.7242	43.0632	36.0494	36.0350	35.2313
	MAE	19.2079	19.9328	16.8314	16.9234	16.7797
	MAPE	80.2824	102.4620	77.3546	78.6024	75.1949
	Adj. R^2	0.4307	0.1712	0.4190	0.4193	0.4292
SKOR	RMSE	52.4860	50.4951	42.5323	42.4501	41.1555
	MAE	29.2177	22.1128	18.9103	18.9313	18.9138
	MAPE	87.7378	90.0572	73.3242	72.1907	64.1768
	Adj. R^2	0.4594	0.1769	0.4159	0.4180	0.4528

Note: The table reports model statistics i.e. RMSE, MAE, MAPE and Adjusted R^2 for the five volatility models considered for evaluation. Statistics in bold represent the chosen model based on the given criteria. The five models considered are estimated using OLS regression with Newey-West heteroscedasticity and serial correlation consistent standard errors.

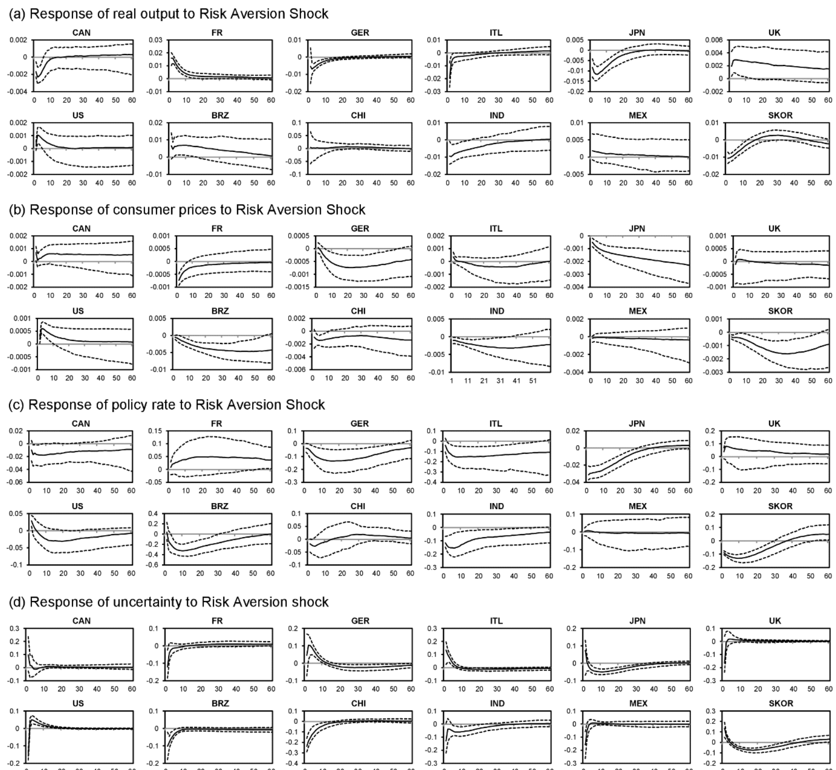


APPENDIX B.—Time Series of the Fitted Values of Five Volatility Models



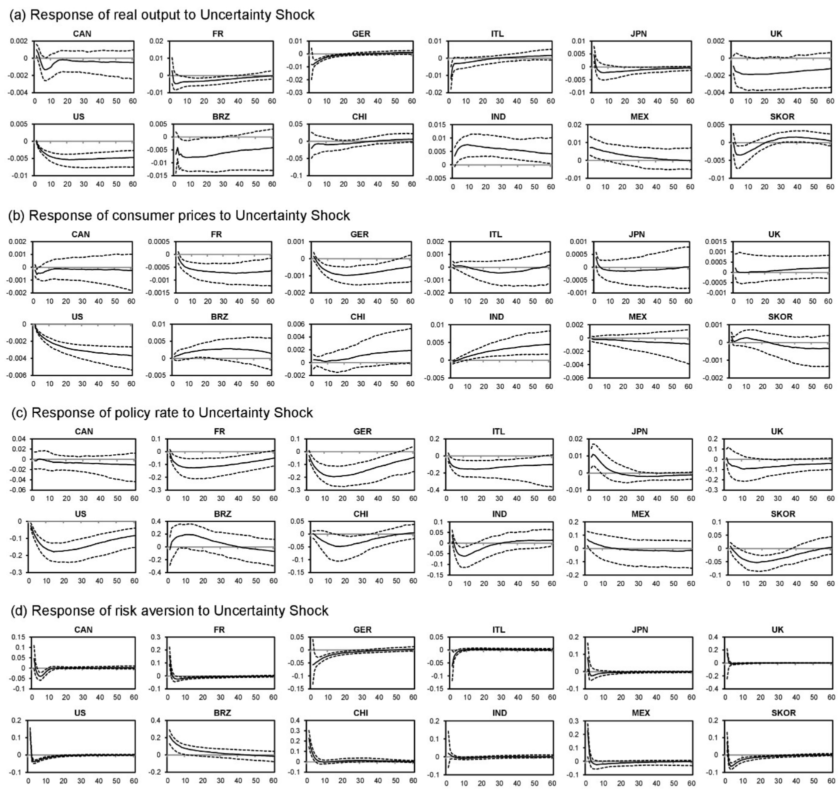
APPENDIX C1.— Impulse Responses due to Domestic (expansionary) Monetary Policy Shock obtained from SVAR Model with Sign Restrictions

Note: Panel a-d of the figure display impulse responses (solid lines) of real output, consumer prices, risk aversion and uncertainty, respectively to domestic (expansionary) monetary policy shock for the sample countries obtained from SVAR model with sign restrictions. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Monetary policy shock is normalized such that it leads to a one percent decrease in the policy rate, implying expansionary monetary policy shock. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).



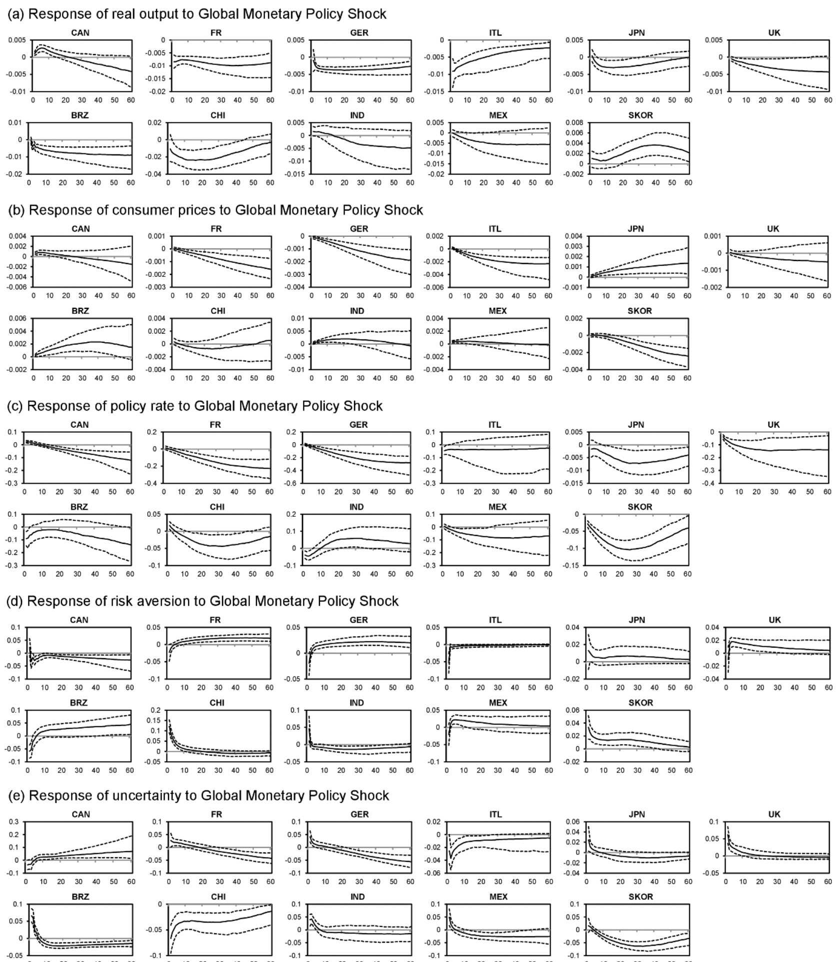
APPENDIX C2.— Impulse Responses due to Risk Aversion Shock obtained from SVAR Model with Sign Restrictions

Note: Panel a-d of the figure display impulse responses of real output, consumer prices, policy rate and uncertainty, respectively to risk aversion shock for the sample countries obtained from SVAR model with sign restrictions. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Risk aversion shock is normalized such that it leads to a one percent increase in the risk aversion. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).



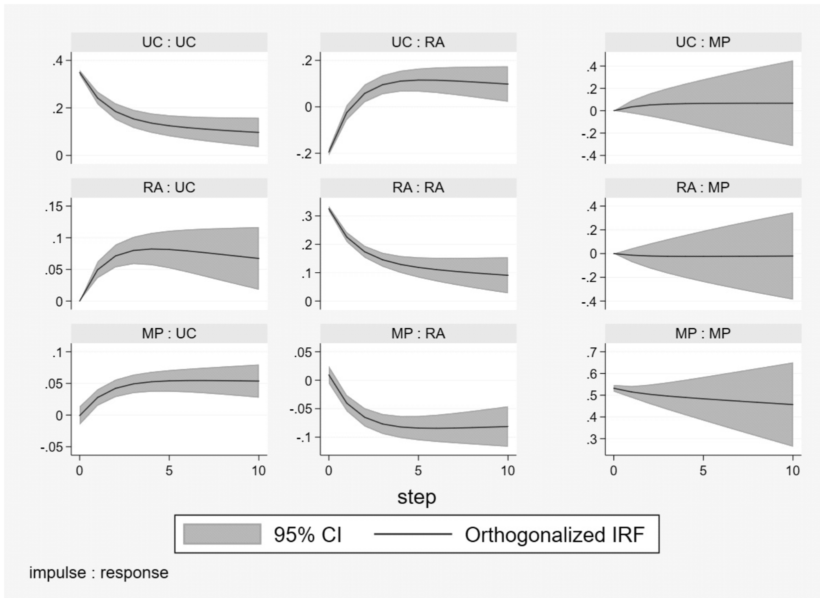
APPENDIX C3.— Impulse Responses due to Uncertainty Shock obtained from SVAR Model with Sign Restrictions

Note: Panel a-d of the figure display impulse responses of real output, consumer prices, policy rate and risk aversion, respectively to uncertainty shock for the sample countries obtained from SVAR model with sign restrictions. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Uncertainty shock is normalized such that it leads to a one percent increase in the uncertainty. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).



APPENDIX C4.—Impulse Responses due to Global (expansionary) Monetary Policy Shock obtained from SVAR Model with Sign Restrictions

Note: Panel a-e of the figure display impulse responses of real output, consumer prices, policy rate, risk aversion and uncertainty, respectively to Global (expansionary) monetary policy shock for the sample economies obtained from SVAR model with sign restrictions. The dashed lines represent probability bands at 0.16 and 0.84 fractiles which correspond to one standard deviation and are estimated using Monte Carlo integration. Global monetary policy shock is normalized such that it leads to a one percent decrease in the shadow federal funds rate, implying expansionary Global monetary policy shock. Impulse responses are plotted for 60 time horizons (represented on the horizontal axis).



APPENDIX D.— Impulse Responses obtained from PVAR Model with Alternative Specification

Note: The figure displays orthogonalized impulse responses of policy rate, risk aversion and uncertainty to Monetary Policy, Risk Aversion and Uncertainty shocks obtained from the PVAR model with alternative ordering of risk aversion and uncertainty. Impulse responses are plotted for 10-time horizons (represented on the horizontal axis).

Appendix E. Panel Regression of Excess Returns on Risk Aversion

Dependent variable: Excess Return		
	coef.	*t*-stat
VRP	0.0163***	8.90
Intercept	–3.4243***	–26.52
No. of observations	2341	
No. of countries	12	
F-statistic	87.05***	
Hausman test statistic	219.50***	

Note: The table presents the results of panel regression with fixed effects of excess returns i.e. return risk premium on variance risk premium. *** indicates significance at 0.01 level.

References

Aastveit, K. A.; Natvik, G. J.; and Sola, S. 2017. Economic uncertainty and the influence of monetary policy. *Journal of International Money and Finance* 76: 50-67.

Abouwafia, H. E., and Chambers, M. J. 2015. Monetary policy, exchange rates and stock prices in the Middle East region. *International Review of Financial Analysis* 37: 14-28.

Adrian, T., and Shin, H. S. 2010. Liquidity and leverage. *Journal of financial intermediation* 19(3): 418-437.

Akerlof, G. A., and Shiller, R. J. 2009. Animal spirits: How human psychology drives the economy, and why it matters for global capitalism. Princeton University Press.

Altunbas, Y.; Gambacorta, L.; and Marques-Ibanez, D. 2010. Bank risk and monetary policy. *Journal of Financial Stability* 6(3): 121-129.

Altunbas, Y.; Gambacorta, L.; and Marques-Ibanez, D. 2012. Do bank characteristics influence the effect of monetary policy on bank risk? *Economics Letters* 117(1): 220-222.

Anderson, T. W., and Hsiao, C. 1982. Formulation and estimation of dynamic models using panel data. *Journal of Econometrics* 18(1): 47-82.

Andrews, D. W., and Lu, B. 2001. Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models. *Journal of Econometrics* 101(1): 123-164.

Angelini, P.; Nobili, A.; and Picillo, C. 2011. The Interbank Market After August 2007: What Has Changed, and Why?. *Journal of Money, Credit and Banking* 43(5): 923-958.

Angeloni, I.; Faia, E.; and Duca, M. L. 2015. Monetary policy and risk taking. *Journal of Economic Dynamics and Control* 52: 285-307.

Arellano, M., and Bover, O. 1995. Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics* 68(1): 29-51.

Balcilar, M.; Bekiros, S.; and Gupta, R. 2017. The role of news-based uncertainty indices in predicting oil markets: a hybrid nonparametric quantile causality method. *Empirical Economics* 53(3): 879-889.

Bali, T. G., and Zhou, H. 2016. Risk, uncertainty, and expected returns. *Journal of Financial and Quantitative Analysis* 51(3): 707-735.

Baumeister, C., and Benati, L. 2012. Unconventional monetary policy and the great recession: Estimating the macroeconomic effects of a spread compression at the zero lower bound. Working paper No. 2012-21. Bank of Canada.

Beckers, B., and Bernoth, K. 2016. Monetary Policy and Asset Mispricing. DIW Discussion Papers No. 1605. Berlin: Deutsches Institut für Wirtschaftsforschung (DIW).

Bekaert, G., and Hoerova, M. 2014. The VIX, the variance premium and stock

market volatility. *Journal of Econometrics* 183(2): 181-192.
Bekaert, G., and Hoerova, M. 2016. What do asset prices have to say about risk appetite and uncertainty? *Journal of Banking & Finance* 67: 103-118.
Bekaert, G.; Hoerova, M.; and Duca, M. L. 2013. Risk, uncertainty and monetary policy. *Journal of Monetary Economics* 60(7): 771-788.
Bernanke, B. S., and Kuttner, K. N. 2005. What explains the stock market's reaction to Federal Reserve policy? *The Journal of Finance* 60(3): 1221-1257.
Bjørnland, H. C., and Leitemo, K. 2009. Identifying the interdependence between *US* monetary policy and the stock market. *Journal of Monetary Economics* 56(2): 275-282.
Bloom, N. 2009. The impact of uncertainty shocks. *Econometrica* 77(3): 623-685.
Bollerslev, T.; Tauchen, G.; and Zhou, H. 2009. Expected stock returns and variance risk premia. *The Review of Financial Studies* 22(11): 4463-4492.
Bollerslev, T.; Gibson, M.; and Zhou, H. 2011. Dynamic estimation of volatility risk premia and investor risk aversion from option-implied and realized volatilities. *Journal of Econometrics* 160(1): 235-245.
Bollerslev, T.; Marrone, J.; Xu, L.; and Zhou, H. 2014. Stock return predictability and variance risk premia: statistical inference and international evidence. *Journal of Financial and Quantitative Analysis* 49(3): 633-661.
Bollerslev, T.; Tauchen, G.; and Zhou, H. 2009. Expected stock returns and variance risk premia. *The Review of Financial Studies* 22(11): 4463-4492.
Borio, C., and Zhu, H. 2012. Capital regulation, risk-taking and monetary policy: a missing link in the transmission mechanism? *Journal of Financial Stability* 8(4): 236-251.
Brunnermeier, M. K. 2001. Asset pricing under asymmetric information: Bubbles, crashes, technical analysis, and herding. Oxford University Press.
Bruno, V., and Shin, H. S. 2015. Capital flows and the risk-taking channel of monetary policy. *Journal of Monetary Economics* 71: 119-132.
Carr, P., and Wu, L. 2009. Variance risk premiums. *The Review of Financial Studies* 22(3): 1311-1341.
Chen, M.; Wu, J.; Jeon, B. N.; and Wang, R. 2017. Monetary policy and bank risk-taking: Evidence from emerging economies. *Emerging Markets Review* 31: 116-140.
Delis, M. D.; Hasan, I.; and Mylonidis, N. 2017. The risk taking channel of monetary policy in the *US*: Evidence from corporate loan data. *Journal of Money, Credit and Banking* 49(1): 187-213.
Dell'Ariccia, G.; Laeven, L.; and Suarez, G. A. 2017. Bank leverage and monetary policy's risk taking channel: evidence from the United States. *The Journal of Finance* 72(2): 613-654.
Djatche, M. J. N. 2019. Re-exploring the nexus between monetary policy and banks' risk-taking. *Economic Modelling* 82: 294-307.

Drakos, A. A.; Kouretas, G. P.; and Tsoumas, C. 2016. Ownership, interest rates and bank risk-taking in Central and Eastern European countries. *International Review of Financial Analysis* 45: 308-319.

Fassas, A. P., and Papadamou, S. 2018. Variance risk premium and equity returns. *Research in International Business and Finance* 46: 462-470.

Furlanetto, F.; Ravazzolo, F.; and Sarferaz, S. 2019. Identification of financial factors in economic fluctuations. *The Economic Journal* 129(617): 311-337.

Hahn, J.; Jang, W. W.; and Kim, S. 2017. Risk aversion, uncertainty, and monetary policy in zero lower bound environments. *Economics Letters* 156: 118-122.

Holtz-Eakin, D.; Newey, W.; and Rosen, H. S. 1988. Estimating vector autoregressions with panel data. *Econometrica: Journal of the Econometric Society*: 1371-1395.

Iglesias, E. M., and Haughton, A. Y. 2013. Interaction between monetary policy and stock prices: A comparison between the Caribbean and the *US*. *Applied Financial Economics* 23(6): 515-534.

Inekwe, N. J. 2016. Financial uncertainty, risk aversion and monetary policy. *Empirical Economics* 51(3): 939-961.

Jang, W. W. 2020. Risk aversion, uncertainty, and monetary policy: Structural vector autoregressions identified with high-frequency external instruments. *Economics Letters* 186: 108675.

Jiménez, G.; Ongena, S.; Peydró, J. L.; and Saurina, J. 2012. Credit supply and monetary policy: Identifying the bank balance-sheet channel with loan applications. *American Economic Review* 102(5): 2301-26.

Konstantinidi, E., and Skiadopoulos, G. 2016. How does the market variance risk premium vary over time? Evidence from S&P 500 variance swap investment returns. *Journal of Banking & Finance* 62: 62-75.

Kontonikas, A.; MacDonald, R.; and Saggu, A. 2013. Stock market reaction to fed funds rate surprises: State dependence and the financial crisis. *Journal of Banking & Finance* 37(11): 4025-4037.

Londono, J. M. 2015. The variance risk premium around the world. International Finance Discussion Papers Number 1035. Available at SSRN 2517020.

Love, I., and Zicchino, L. 2006. Financial development and dynamic investment behavior: Evidence from panel VAR. *The Quarterly Review of Economics and Finance* 46(2): 190-210.

Mountford, A., and Uhlig, H. 2009. What are the effects of fiscal policy shocks? *Journal of Applied Econometrics* 24(6): 960-992.

Nave, J. M., and Ruiz, J. 2015. Risk aversion and monetary policy in a global context. *Journal of Financial Stability* 20: 14-35.

Neaime, S.; Gaysset, I.; and Badra, N. 2018. The eurozone debt crisis: A structural VAR approach. *Research in International Business and Finance* 43: 22-33.

Neuenkirch, M., and Nöckel, M. 2018. The risk-taking channel of monetary policy transmission in the euro area. *Journal of Banking & Finance* 93: 71-91.

Nickell, S. 1981. Biases in dynamic models with fixed effects. *Econometrica: Journal of the Econometric Society*: 1417-1426.

Paligorova, T., and Santos, J. A. 2017. Monetary policy and bank risk-taking: Evidence from the corporate loan market. *Journal of Financial Intermediation* 30: 35-49.

Rajan, R. G. 2006. Has finance made the world riskier? *European Financial Management* 12(4): 499-533.

Singh, B., and Pattanaik, S. 2012. Monetary policy and asset price interactions in India: Should financial stability concerns from asset prices be addressed through monetary policy? *Journal of Economic Integration*: 167-194.

Suhaibu, I.; Harvey, S. K.; and Amidu, M. 2017. The impact of monetary policy on stock market performance: Evidence from twelve (12) African countries. *Research in International Business and Finance* 42: 1372-1382.

Trichet, J. C. 2010. State of the Union: The Financial Crisis and the ECB's Response Between 2007 and 2009. *Journal of Common Market Studies* 48 (1): 7-19.

Uhlig, H. 2005. What are the effects of monetary policy on output? Results from an agnostic identification procedure. *Journal of Monetary Economics* 52(2): 381-419.

Wu, J. C., and 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.

Zhou, H. 2018. Variance risk premia, asset predictability puzzles, and macroeconomic uncertainty. *Annual Review of Financial Economics* 10: 481-497.