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EFFECT OF ECONOMIC POLICY UNCERTAINTY ON STOCK MARKET RETURN AND VOLATILITY UNDER HETEROGENEOUS MARKET CHARACTERISTICS

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Effect of Economic Policy Uncertainty on Stock Market Return and Volatility under Heterogeneous Market Characteristics

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ABSTRACT

This study examines the effect of economic policy uncertainty on stock market return and risk for the group of seven countries. We contribute to the existing literature by incorporating country specific and market condition specific characteristics while examining the relationship. Country specific effect is controlled by a PVAR model with country fixed effect, while a MSVAR model is used to study the relationship under differential market conditions, *viz.*, bull and bear. Both models suggest that a rise in EPU increases volatility at the same time period and that leads to a decrease in return. Thereafter, return increases and volatility falls as a result of a positive uncertainty shock. MSVAR model suggests that the response of risk and return to a shock in EPU is highly asymmetric and it is much higher in bear market than the bull market.

Keywords: Economic Policy Uncertainty, Stock returns, Realized Volatility, MSVAR

JEL Classification: C58, C3, G18, G15

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1. Introduction

The origins of uncertainty literature can be traced back to the landmark work of Markowitz (1952), Roy (1952) and Tobin (1958). Over the last decade, due to the advent of global financial crisis in 2007, the measurement of uncertainty and its impact on economic activity has received renewed focus and a substantial scholarly attention (Bloom, 2009; Lahiri and Sheng, 2010; Bekaert et al., 2013; Orlik and Veldkamp, 2014; Jurado et al., 2015; Baker et al., 2016; Leduc and Liu, 2016; Basu and Bundick, 2017). The general consensus grown out of these studies reveals that uncertainty has a negative impact on the macroeconomic outcomes (Bernanke, 1983; McDonald and Siegel, 1986; Bloom, 2009). This negative relationship can be explained by both demand side and supply side channels (see, for example, Bernanke, 1983; McDonald and Siegel, 1986; Bachmann et al., 2013; Christiano et al., 2014; Gilchrist et al., 2014). On the demand side, with prevalence of high uncertainty in the economy, firms are expected to halt investment demand and throttle projects while households will curtail their consumption levels. From the supply side, uncertainty in the market would push up the hiring cost of labour, leading to a negative impact on the firm's productivity (Dixit et al., 1994; Christou et al., 2017). Similarly, there are ample evidences that suggest financial markets are also responsive to the changes in aggregate uncertainty. Abel (1988), Barsky (1989) and Gennotte and Marsh (1993) argue that the macroeconomic uncertainty affects stock prices through the changes in required rate of return while Boyle and Peterson (1995) points out that it impacts the stock return by varying the expected future dividends. Further, Bansal et al. (2005) using consumption volatility as a measure of economic uncertainty shows that increased uncertainty decreases the valuation of assets in financial markets. Veronesi (1999) and Pastor and Veronesi (2012) find the average impact on stock market returns corresponding to an announcement of policy change is negative. In a follow up paper, using a general equilibrium setting Pastor and Veronesi (2013) further claims that economic uncertainty driven by government policy decisions significantly impacts interest rate and risk premium in an economy.

In the midst of these discussions, researchers have come up with several time varying aggregate uncertainty measures (Bloom, 2009; Jurado et al., 2015; Baker et al., 2016). Among them, a novel measure named economic policy uncertainty index (hereafter EPU), developed by Baker et al. (2016) following the work of Bloom (2009), triggered significant empirical interest among the scholars in this direction of research[1]. Subsequently, a cross country database is constructed taking into account the appearance of words that are frequently used during a policy announcement in leading newspapers *viz*. uncertainty, economy, regulation, congress, among others. Since its conception, among several other uncertainty measures, EPU has taken the centre stage because of its predictability and systematic association with the historical events that dramatically increased uncertainty in the economy. Some of the examples are, the 9/11 terrorist attacks, Gulf wars, the Lehman Brothers bankruptcy and the 2011 debt ceiling dispute, to name a few[2]. In addition to that, this tremendous resurgence of interest is also because of the fact that the proponents made access to this long, historical, cross-country time series data easy and free. As a result, a plethora of empirical studies have emerged in recent times that examined various channels through which policy uncertainty affects macroeconomic outcomes such as growth,

[1] The economic policy uncertainty data is a historical time series data-set, available across developed and developing countries - USA, UK, Germany, Japan, China and India, among many. The data can be accessed from http://www.policyuncertainty.com/.

[2] See Baker et al. (2016), pp 1600, Figure 1.

investment, inflation, unemployment and various financial variables (Aastveit et al., 2013; Colombo, 2013; Kang et al., 2014; Li et al., 2015; Han et al., 2016; Caggiano et al., 2017; Balcilar et al., 2017a,b).

Empirical evidences also substantiate the role of EPU on stock market return and risk. For instance, using multivariate time series analysis Kang and Ratti (2013) and Antonakakis et al. (2013) show a negative relationship between EPU and stock market return. Using a Bayesian model Christou et al. (2017) finds similar evidence between EPU and stock returns for six Pacific-Rim countries. They observe that the relationship remained same in presence of international spillovers. Similarly, borrowing linear and switching models Arouri et al. (2016) establish a negative impact of EPU and argued that the effect is persistent in case of high volatility periods. The study uses a long data from 1900 to 2014. Several other studies have supported these adverse effects of EPU on stock market indicators (e.g. Dzielinski, 2012; Karnizova and Li, 2014; Orlik and Veldkamp, 2014; Li et al., 2015; Liu and Zhang, 2015; Arouri et al., 2016; Christou et al., 2017; Guo et al., 2018; Liow et al., 2018) and given justifications in line with Pastor and Veronesi (2012)'s (hereafter PV) hypothesis. In this paper, Pastor and Veronesi (2012) argue that the impact of policy change depends on how far the shock is predicted to the market. A largely anticipated shock is expected to have an impact of lower magnitude however, the impact would be strong if the market gets hold by it suddenly. Further, they claim that introduction of a new policy whose impact is uncertain increases the volatility of the stochastic discount factor. This, in turn, raises the risk premium that leads to high volatility in stock returns. Liu and Zhang (2015) empirically verified PV hypothesis by investigating whether adding EPU can improve forecasting ability of stock market volatility. They found that EPU has a significant predictive power in terms of forecasting stock market volatility in both in-sample and out-of-sample cases.

Numerous empirical studies have dealt with the causality between EPU and stock return/volatility (see Antonakakis et al., 2013; Karnizova and Li, 2014; Li et al., 2016; Amengual and Xiu, 2018), whereas none of them have addressed the heterogeneous and asymmetric dynamics of the stock markets corresponding to country specific and market condition specific effects. A majority of the studies have analysed the impacts on the basis of a single country data and in most of the cases a special focus has been given to the US. Although, a few studies have used a multi-country setup, the relationship was tested separately for each country. To the best of our knowledge, Christou et al. (2017) alone addressed the country specific effect by considering a panel vector autoregressive (PVAR) model in a slightly different context. Previous studies have ignored the instinctive characteristics of the stock market, "bull" and "bear", in examining the aforementioned relationship in a multivariate framework. However, stock market responsiveness of return and volatility are subject to change if the market conditions are changed. It has been well argued in the literature that dynamics of volatility, return and the spillover effect varies with differential market conditions (Fabozzi and Francis, 1978; Kundu and Sarkar, 2016a,b). Therefore, it is necessary to re-examine the relationship introducing both cross sectional heterogeneity and market condition specific asymmetries[3].

Our contribution to the existing literature is threefold. First, unlike previous studies where country specific data has been considered for the analysis, we employ a PVAR model with country fixed effect to gauge the relationship between EPU and stock market return and risk.

[3]It will always be better to analyse the relationship by a single model which will capture both country fixed effect and regime switching behavior. Due to unavailability of the Markov switching PVAR model, we have addressed these issues separately.

Ignoring country fixed effect may produce misleading results. Secondly, we estimate a two regime Markov switching vector autoregressive (MSVAR) model in which high return stable state and low return volatile state are identified as bull and bear market, respectively (see Maheu and McCurdy (2000)). After identifying those two states we test whether or not the impact of EPU on stock market varies across bull and bear markets. Structural parameters are estimated by Choleskey decomposition to examine the contemporaneous interdependence. Finally, impulse response of return and volatility to a positive EPU shock has been computed and presented for both the models. Note, regime dependent impulse response functions are drawn following Ehrmann et al. (2003).

Broadly, our results from PVAR model suggests that the adverse effect of EPU on stock market volatility and return is present only in the contemporaneous time period which supports the PV hypothesis. However, given a shock in EPU at time t, the future responses of stock returns are positive and the responses of volatilities are negative which contradicts the PV hypothesis. Specifically, in line with PV's hypothesis, we find that the volatility of stock market increases immediately in response to the increase in policy uncertainty and return of the stock market falls consequently. But, in future, those who hold the stock at risky period would demand an extra premium for holding risky assets, leading to a rise in price and return. As a result, following leverage effect hypothesis volatility of the stock will be low due to the positive shock. Although, estimation results of the MSVAR model exhibits EPU has no direct impact on return but it is affecting indirectly through increase in market volatility. The increase is significant in both bull and bear markets for almost all the countries at the same time period. Further, this rise in volatility immediately decreases stock return in accordance with the volatility feedback hypothesis. We find magnitude of the impact is twice in the bear market as against the bull market. As stock prices fall more in the bear market due to uncertainty, expected future return will increase resulting in a fall in future volatility. The regime dependent impulse response function suggests that the response of return to EPU for the next 10 periods is significantly positive and the response of volatility to EPU is significantly negative in bear market. In bull market, however, the response to return and volatility is insignificant except for the USA and the UK. Interesting to note, although significant, the magnitudes are quite low compare to the bear market in both countries. Thus, the impact of policy uncertainty on stock market is highly asymmetric.

The remainder of the paper is structured as follows. Section 2 describes the model and the methods we have used for estimation. Section 3 discusses the data, definition of the variables and summery statistics. Section 4 presents the estimation results, whose broader implications are reviewed in the conclusion in section 5.

2. The Model and Methodology

Our interest is to examine the link between EPU and stock market with heterogeneous market conditions. To do so, we employ several vector autoregressive (VAR) models taking four variables into consideration: stock return (RET), stock market volatility (RV), EPU and global stock return (RETG)[4]. We have included global return to take into account the cross market spillover effect of return and volatility as these financial markets are highly integrated. Note, our main variable – EPU – is constructed based on the appearance of uncertainty related words in the leading news papers. In that way, the constructed EPU index captures macroeconomic and other exogenous shocks. Baker et al. (2016) along with other researchers (see for example, Colombo (2013), Karnizova and Li (2014), Duca and Saving

[4]The details of each variable are given in Section 3.

(2018) have pointed out macroeconomic variables like inflation, unemployment, interest rate spread and output fluctuations are highly correlated with fluctuations in EPU. Specifically, Duca and Saving (2018) finds that 40% of the EPU can be explained by inflation and unemployment and other longer term technological factors. Colombo (2013), Karnizova and Li (2014) have found that EPU is able to capture the fluctuation of price level, output, interest rate spread and many other macro variables. Baker et al. (2016) showed that along with monetary policy fluctuations by central bank, the index also moves with historical events such as the 9/11 terrorist attacks, Gulf wars, the Lehman Brothers bankruptcy and the 2011 debt ceiling dispute etc. Hence, we avoid incorporating other macroeconomic variables to do away with the problem of multiple considerations of variables.

The uses of VAR models are overwhelming in time series literature where all variables are considered to be endogenous. However, separate VAR models for each country do not capture the cross country variation, popularly known as cross sectional heterogeneity (CSH). To eliminate CSH, we use a panel VAR (PVAR) model. Furthermore, a linear VAR model fails to capture the dynamic changes occurred due to the differential market movements like 'bull' and 'bear'. Hence, we adopt a two regime Markov switching VAR (MSVAR) model in which regime determining variable is assumed to be unobserved. We discuss these models one by one in the following sections.

2.1.Vector Autoregressive Model

In economics, VAR models were popularized by Sims (1980). The definitive technical reference for VAR models are Lutkepohl and Poskitt (1991) and updated surveys of VAR techniques are given in Watson (1994), Lutkepohl (2001) and Waggoner and Zha (1999). Applications of the same to financial data are discussed in Hamilton (1994), Campbell et al. (1997), Cuthbertson (1996), Mills and Markellos (2008) and Tsay (2001). The general representation of the VAR model of lag order p is given by,

$$y_t = c + A_1 y_{t-1} + \cdots + A_p y_{t-1} + u_t; \quad t = 1, \dots, T \tag{1}$$

Where$y_t = (y_{1t}, y_{2t}, \dots, y_{kt})'$ denotes a $(k \times 1)$ vector of time series variables, c is the $(k \times 1)$ vector of drift parameters, A_i $(\forall\, i)$ are $(k \times k)$ reduced form coefficient matrices and the $(k \times 1)$ vector of random errors, $u_t \sim N(0, \Sigma)$. It is also assumed that $E(u_t u_s') = 0\ (t \neq s)$. As we are interested to know the contemporaneous impact of EPU on stock market return and realized volatility, we have estimated the structural parameters by decomposing the variance-covariance matrix of the error term using$\Sigma = AD^{1/2}D^{1/2}A'$. To identify the structural equation we have considered Choleskey factorization assuming A to be a lower triangular matrix. The inverse of the matrix A provides the structural parameters. Further, the same factorization has been used to draw the orthogonalized impulse response functions. The number of lag, p, is determined by minimizing Schwarz information criteria.

2.2.Panel Vector Autoregressive Model

To gain further insight, we consider a panel vector autoregressive (PVAR) model following the preliminary VAR model estimation that aims to incorporate country specific fixed effects. The k variable panel VAR model can be represented by the equation

$$y_{it} = A_1 y_{it-1} + A_2 y_{it-2} + \cdots + A_p y_{it-p} + \mu_i + e_{it}; \quad i \in (1,2, \dots, N), t \in (1,2, \dots, T) \tag{2}$$

Where $y_{it}$is a $k \times 1$ vector of dependent variables, $A_j\ (j = 1, \dots, p)$ are the $k \times k$ matrices of coefficients to be estimated, and u_i is $k \times 1$ vector of the panel specific fixed effect. e_{it} is $k \times 1$ vector of the error componentwhere we are assuming that $E(e_{it}) = 0, E(e_{it}e'_{it}) = \Sigma$ and $E(e_{it}e'_{is}) = 0 \;\forall t \neq s$. The number of lag p isselected by Schwarz information criteria. The parameter matrices A_i has been estimated by applying thegeneralized method of moment (GMM) taking two lags of all the variables as instruments. Since the error terms are contemporaneously correlated, we need to orthogonalize the innovations to identify the structural shocks. Standard Cholesky decomposition of Σ has been used to draw the impulse responses correspondingto the orthogonalize shock of each variable.

2.3.Markov Switching Vector Autoregressive Model

Markov Switching vector autoregressive (MS-VAR) class of models provide a convenient framework to analyse dynamic interdependence of several endogenous variables with changes in regime. They admit various dynamic structures, depending on the value of the state variable, s_t, which controls for the switching mechanism between various states. Krolzig et al. (2000) established a common notation to provide simplicity in expressing the models in which various parameters are subject to shifts with the varying state. Accordingly, the most general form of the MS-VAR model is given as

$$y_t = \nu(s_t) + A_1(s_t)y_{t-1} + \cdots + A_p(s_t)y_{t-p} + \varepsilon_t \quad (3)$$

where$y_t = (y_{1t}, y_{2t}, \dots, y_{kt})'$ is a k dimensional time series vector, ν is the vector of intercepts, $A_1, \dots, A_p$ arethe matrices containing the autoregressive parameters for each $s_t = 1, 2$ and $\varepsilon_t$is a white noise vector processsuch that$\varepsilon_t | s_t \sim NID(0, \Sigma(s_t))$. The description of the dynamics is complete after defining a probability rule of how the behavior of y_t changes from one regime to another. It is assumed that the unobserved statevariable s_t follows a first order Markov process implying that the current regime s_t depends only on theregime of the immediate past, *i.e.*, s_{t-1}. In mathematical notation:

$$P\{s_t = j | s_{t-1} = i, s_{t-2} = k, \dots\} = P\{s_t = j | s_{t-1} = i\} = p_{ij} \quad (4)$$

where p_{ij} gives the probability that the state i will be followed by the state j.

As per two regimes are considered, the transition probabilities can be collected in a (2 × 2) matrix, denoted by P. In matrix notation, $P = \begin{bmatrix} p_{11} & 1 - p_{22} \\ 1 - p_{11} & p_{22} \end{bmatrix}$, where p_{ii} is the transition probability fromstate i to state i;$i = 1, 2$.

For two regimes case, if the regime at $t - 1$ is known, optimal forecasts of regime probability at t can beobtained by

$$\hat{\xi}_{t|t-1} = P \cdot \xi_{t-1} \quad (5)$$

where$\xi_{t-1} = (1, 0)'$if $s_{t-1} = 1$ and $\xi_{t-1} = (0, 1)'$if $s_{t-1} = 2$. Given the starting value$\hat{\xi}_{1|0}$ and all theparameters, it is easy to compute the optimal inference and forecast by

$$\hat{\xi}_{t|t} = \frac{\hat{\xi}_{t|t-1} \odot \eta_t}{\mathbf{1}'(\hat{\xi}_{t|t-1} \odot \eta_t)} \quad (6)$$

$$\hat{\xi}_{t+1|t} = P \cdot \hat{\xi}_{t|t} \quad (7)$$

for all $t = 1, 2, \dots, T$, where

$$\eta_t = \begin{bmatrix} f(y_t | s_t = 1, \psi_{t-1}) \\ f(y_t | s_t = 2, \psi_{t-1}) \end{bmatrix} \quad (8)$$

The smoothed inference on the regime probabilities at time *t* is computed as

$$\hat{\hat{\xi}}_{t|T} = \hat{\hat{\xi}}_{t|t} \odot (P'[\hat{\hat{\xi}}_{t+1|T} \div \hat{\hat{\xi}}_{t+1|t}]) \quad (9)$$

The log likelihood function for the observed data and parameter vector θ is given as

$$\ell(\theta) = \sum_{t=1}^{T} \ln f(y_t | \psi_{t-1}; \theta) \quad (10)$$

where $f(y_t | \psi_{t-1}; \theta) = \mathbf{1}'(\hat{\hat{\xi}}_{t|t-1} \odot \eta_t)$. The structural parameter matrix for contemporaneous relationship has been obtained using Choleskey decomposition of $\Sigma(s_t)$ for each $s_t = 1, 2$.

Regime-dependent impulse response functions

The regime-dependent impulse response function, introduced by Ehrmann et al. (2003) analogously describes the relationship between endogenous variables and fundamental disturbances within each Markov-switching regime. The impulse response functions in MSVAR model are conditional on a given regime prevailing at the time of the disturbance and throughout the duration of the response. The validity of regime conditioning depends on the time horizon of the impulse response and the expected duration of the regime. As long as the horizon is not excessive and the transition matrix predicts regimes which are highly persistent, the conditioning is valid and regime-dependent impulse response functions can be a useful analytical tool.

The k variable MSVAR model contains mk^2 regime-dependent impulse response functions, corresponding to the reaction of k variables to k disturbances in m regimes.The regime-dependent impulse responsefunction for regime i is defined in Equation (11). It shows the expected changes in endogenous variables at time $t + h$ to a one standard deviation shock to the k^{th} fundamental disturbance at time t, conditional onregime i. A series of $K-$dimensional response vectors $\theta_{ki,1}, \ldots, \theta_{ki,h}$ predicts the response of the endogenousvariables.

$$\frac{\partial E_t y_{t+h}}{\partial u_{k,t}} | s_t = \cdots = s_{t+h} = \theta_{ki,h} \quad \text{for } h \geq 0 \quad (11)$$

Estimates of the response vectors can be derived by combining the parameter estimates of the Markov-switching unrestricted vector autoregression with the estimate of the matrix A obtained through identification restrictions.

The first response vector measures the impact of the k^{th} fundamental disturbance on the endogenous variables. A one standard deviation shock to the k^{th} fundamental disturbance implies that the initialdisturbance vector is $u_0 = (0, \ldots, 0, 1, 0, \ldots, 0)$, *i.e.* a vector of zeros apart from the k^{th} element which isone. Pre-multiplying this vector by the estimate of the regime-dependent matrix A_i in Equation (3) gives the impulse responses.

The remaining response vectors can be estimated by solving forward for the endogenous variables in Equation (3). The equations (12) and (13) show the solution linking the estimated response vectors with estimated parameters.

$$\hat{\theta}_{ki,0} = \hat{A}_i u_0 \quad (12)$$

$$\hat{\theta}_{ki,h} = \sum_{j=1}^{\min(h,p)} \hat{B}_{j,i}^{h-j+1} \hat{A}_i u_0 \quad (13)$$

3. Data and Variables

The variables we use in our study are monthly stock return, realized volatility, index of economic policy uncertainty and global stock return. Our sample consists of monthly time series data run from January 1998 to August 2018 of G7 countries (Canada, France, Germany, Italy, Japan, UK and USA). The choice of G7 countries were mainly because stock markets in these advanced countries are well behaved, structured, and these have time tested, well established trading rules and also strong regulatory authorities. Given these properties, these stock markets are the foremost trading platform for the international investors. These highly developed seven countries together representing 58% of the global net wealth and more than 46% of global GDP in the nominal values. Further, these countries are interlinked in terms of economic growth, international trade and financial integration. In spite of the similarities, these leading countries are dissimilar in many aspects including population size, economic reforms, government policy and financial regulations.

Major stock indices for G7 countries have been used in this paper to compute our primary variables, *viz.*, return and volatility. Monthly data of S&P TSX Composite (Canada), CAC 40(France), DAX 30 (Germany), FTSE MIB (Italy), NIKKEI 225 (Japan), FTSE (the UK), S&P 500, (the US) have been taken among all the available stock price index. All these indices are collected from Yahoo finance[5]. Note, our analysis has used monthly stock prices even when a higher frequency data is available because the EPU indices (except US and UK) are only available at a monthly basis.

Continuously compounded monthly stock return series is computed as, $RET_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) \times 100$ where P_{it} is the monthly closed price for i^{th}country at t^{th} month. RV is used as a proxy for respective country's stock market risk. The series is constructed using daily stock prices by following Andersen and Bollerslev (1998)'s proposed formula, $RV_{it} = \sqrt{1/n \sum_{i=1}^{n} R_{it}^2} \times 100$ where R_{it} is the i^{th} country's continuously compounded daily return for t^{th} trading day and n is the number of trading days for respective months. The global stock market return series (RETG)[6] is computed as the average monthly stock return of six other countries, $RETG_{it} = \frac{RET_{1t}+\cdots+RET_{i-1t}+RET_{i+1t}+\cdots+RET_{7t}}{6}$.

The EPU index, formulated by Baker et al. (2016)[7], has three components. The first component quantifies the frequencies of appearance of the terms, *inter-alia*, "uncertainty", "economy" and "policy" in ten leading newspapers. The second component is based on the number of tax code provisions set to expire in future years. The third reflects the disagreement among for professional forecasters over future government purchases and consumer price index (CPI) levels.

[5] Though we have used the data from Yahoo Finance which are freely available, there are also other reliable database sources such as DataStream and Bloomberg.
[6] Recently, Morgan Stanley Capital International (MSCI) indices are frequently used to calculate global return. However, we could not make use of it as the data is available only from 2004 while rest of the series in our analysis starts from 1998.
[7] More details about the index and the data can be found here: http://www.policyuncertainty.com/

Table 1 presents the summary statistics of the average monthly stock return and realized volatility, the primary variables of our concern, for all the G7 countries. Monthly average return of stock market is positive for all the countries except Italy. The monthly average return for Italy is -0.001. All the stock return series are found to be negatively skewed and Leptokurtic. Both Skewness and Kurtosis of the stock return is surprisingly highest in case of Canada and lowest in case of Italy. Average value of the stock market realized volatility is lowest in case of Canada and highest in case of Italy. No significant auto correlation is found for the monthly return series except Canada. The Ljung – Box $Q(\cdot)$ statistics for five autocorrelation is found to be -0.086 with $p-$value 0.01. Hence, from monthly average return it can be considered that markets are at least weakly efficient except for Canada. The auto correlations in realized volatility are found to be significant in all the countries. The significant autocorrelation in realized volatility establishes the fact that in financial market large fluctuation is followed by another large fluctuation. The fluctuation of economic policy uncertainty is found to be highest in the UK[8]. The standard deviation of EPU in the UK is 1.04. Augmented Dicky-Fuller test suggests that all the series are stationary.

[8] Summary statistic for EPU and global stock return are not given in the table. These are available upon request.

Table 1: Descriptive Statistics

	USA		UK		Japan		Italy		Germany		France		Canada	
	RET	RV	RET	RV	RET	RV	RET	RV	RET	RV	RET	RV	RET	RV
Mean	0.44	16.34	0.21	15.47	0.18	21.61	0	22.87	0.43	21.12	0.24	20.26	0.36	14.7
Median	0.93	14.19	0.87	13.34	0.75	19.38	0	19.77	1.01	18.13	1	18.28	0.88	12.33
Maximum	10.23	79.24	9.09	71.37	12.09	107.09	0.19	229.01	19.37	77.04	12.59	80.85	11.19	79.55
Minimum	-18.56	4.46	-14.41	4.36	-27.22	6.49	-0.18	6.61	-29.33	6.32	-19.23	6.6	-22.57	4.3
Std. Dev.	4.3	9.88	3.99	8.53	5.61	10.25	0.06	17.41	6.21	11.02	5.29	10.41	4.26	9.12
Skewness	-0.87	2.54	-0.8	2.29	-0.77	3.08	-0.25	7.24	-0.91	1.78	-0.6	1.91	-1.37	2.96
Kurtosis	4.88	13.12	4.12	11.59	4.6	22.42	3.69	82.58	5.96	7.01	3.88	8.46	8.06	16.58
Jarque-Bera	67.74	1330.28	39.47	978.03	51.37	4306.18	7.22	66249.4	124.73	298.44	23.07	460.72	342.13	2267.38
Probability	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.03)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Sum	109.95	4069.46	53.24	3835.76	45.79	5380.04	-0.24	5557.73	106.44	5259.58	60.53	5045.79	88.69	3644.77
Observations	249	249	248	248	249	249	243	243	249	249	249	249	248	248
ADF	-13.09	-5.86	-15.01	-6.77	-13.81	-8.95	-14.64	-3.36	-14.44	-6.18	-14.08	-6.4	-12.46	-5.85
p-value	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Q(5)	-0.01	0.35	0	0.31	0.01	0.26	-0.03	0.1	0.02	0.35	0.03	0.27	-0.09	0.38
p-value	(0.04)	(0.00)	(0.35)	(0.00)	(0.31)	(0.00)	(0.20)	(0.00)	(0.75)	(0.00)	(0.31)	(0.00)	(0.01)	(0.00)

4. Empirical Results

4.1.Estimation results of Linear VAR model

We first discuss the results of estimation of the linear reduced form VAR model for all the countries concerned. Our VAR specifications consist of four variables *viz*., return, realized volatility, EPU and global return. Global stock return is inducted to incorporate the spillover effects among stock markets due to market integration. It is easy to understand that any shock or uncertainty in the international stock market will reflect the global return which in turn would affect the return and volatility of the domestic market. The estimation results of the reduced form coefficients of the return equation of all the countries are given in Table 2. The impact of global stock return is found to be positive for all countries implying a positive spillover from the global market. More specifically, the positive impact of global market on stock return is statistically significant at 1% level for Italy and Germany. It is significant at 5% for the UK and at 10% for Japan and France. The global spillover on return is statistically insignificant in case of the USA and Canada. As New York Stock Exchange (NYSE) is the largest stock exchange of the world in terms of market capitalization of listed companies, it has great influence to the stock markets of other countries. But the impact is not significant in the other way around. Hence, there is an asymmetry in the spillover from global stock market.

Table: 2 VAR estimation for Return Equation

	USA	UK	Japan	Italy	Germany	France	Canada
c	-0.1233	-0.3365	0.2172	-0.0154	0.0974	-0.0960	0.4248
	(0.88)	(0.57)	(0.85)	(0.22)	(0.92)	(0.91)	(0.46)
RET_{t-1}	-0.1029	-0.1978	0.0210	-0.2085	-0.1826	-0.0712	0.1429
	(0.42)	(0.12)	(0.80)	(0.05)	(0.14)	(0.59)	(0.14)
RV_{t-1}	-0.0643	0.0313	0.0584	0.0005	0.0116	0.0120	-0.0098
	(0.05)	(0.36)	(0.15)	(0.26)	(0.78)	(0.75)	(0.77)
EPU^{*}_{t-1}	1.3523	0.4720	-1.3090	0.0014	1.2283	0.4790	-0.0748
	(0.04)	(0.05)	(0.22)	(0.40)	(0.12)	(0.37)	(0.86)
$RETG_{t-1}$	0.2212	0.3325	0.3138	0.0053	0.6217	0.3345	0.1043
	(0.15)	(0.02)	(0.10)	(0.01)	(0.01)	(0.10)	(0.35)

*Detrended EPU for UK, Germany, France and Canada. *p*−values are given in parentheses.

Recall, our main objective is to see the impact of policy uncertainty. We present findings of the same in this section. In context to the lag impact of EPU, the impact is mostly positive except Japan and Canada. However, it is statistically significant only at 5% level in case of the USA and the UK which implies that increase in economic policy uncertainty at $t-1$ period increases the stock return at time t. An insignificant impact is found for rest of the countries considered. Notably, the result contradicts Christou et al. (2017) in the sense that we find a positive significant impact of EPU on stock return while they found it negative.

Now moving on to the estimation results of the country specific volatility equation of VAR model, we find the coefficients corresponding to RV_{t-1} be positive and significant implying the inherent nature of volatility clustering of stock market for all countries. Additionally, the impact of global stock return is found to be negative except for the US. Although the coefficient is found to be significant only in case of Japan and Italy, the negative coefficient reveals that an increase in stock return in the global market will boost the investor's confidence which would finally lead to a reduction of volatility of the domestic market. Looking forward to the impact of EPU on stock market risk we see that EPU Granger causes RV, only in case of the UK and Japan. Notably, the coefficient is positive in case of Japan and negative for the UK. For all other countries the estimated coefficients are found to be statistically insignificant.

Table 3: VAR Estimation for Realized Volatility Equation

	USA	UK	Japan	Italy	Germany	France	Canada
c	6.1986	6.2419	9.6204	9.7581	7.2879	7.2924	3.9607
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RET_{t-1}	-0.4717	-0.1978	-0.0299	15.1010	-0.1268	-0.3605	-0.1217
	(0.01)	(0.33)	(0.82)	(0.38)	(0.39)	(0.04)	(0.38)
RV_{t-1}	0.6963	0.6029	0.3693	0.6070	0.6609	0.6442	0.7318
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
EPU^{*}_{t-1}	-0.9062	-0.6168	3.8008	0.0106	-0.6005	-0.7316	-0.9051
	(0.33)	(0.09)	(0.02)	(0.99)	(0.53)	(0.31)	(0.15)
$RETG_{t-1}$	0.0675	-0.2122	-0.6063	-0.8186	-0.4264	-0.0470	-0.0881
	(0.76)	(0.33)	(0.00)	(0.04)	(0.12)	(0.86)	(0.57)

*Detrended EPU for UK, Germany, France and Canada. p −values are given in parentheses.

It is not surprising that the EPU in both the equations are statistically insignificant for most of the countries. The impact of aggregate uncertainty on stock market may have a contemporaneous impact which possibly would not reflect in the lag values of EPU. Considering an internet search based uncertainty measure Dzielinski (2012) finds similar evidence. The author argues that an increase in aggregate uncertainty lowers stock return immediately but it reverts back after a week. To check this contemporaneous impact of EPU, we make use of structural VAR decomposition using Cholesky factorization[9] of the covariance matrix. The estimation results are presented in Table 4. Here, β_{ij} represents the impact of i^{th} variable on j^{th} variable. For example, β_{23} represents the impact of EPU on RV which is found to be significant for all countries except Italy and the UK. Note, the negative coefficient implies that a rise in EPU immediately enhances the volatility of the stock market for all countries. Again, the impact of RV on RET, denoted by β_{34} , is positive for six countries apart from the USA. It is found to be statistically insignificant in case of France and the USA but significant for rest of the countries at 5% level. The estimated sign of the coefficients, except for the USA, disclose a negative impact of RV on RET. Combining the estimation results of these two parameters, our VAR analysis supports the PV hypothesis which states that "*introducing new policies with an uncertain impact increases the volatility of the stochastic discount factor. The increase in the volatility of the discount factor leads to increase in risk premia which in turn result in high volatility in stock market*" (See, Liu and Zhang (2015)). Further, as a result of volatility feedback, return of the stock market decreases.

In Table 4 values corresponding to β_{12} , β_{13} and β_{14} reflects the impact of global stock return on the EPU, volatility and return for all seven countries. The positive sign of β_{12} says that a positive

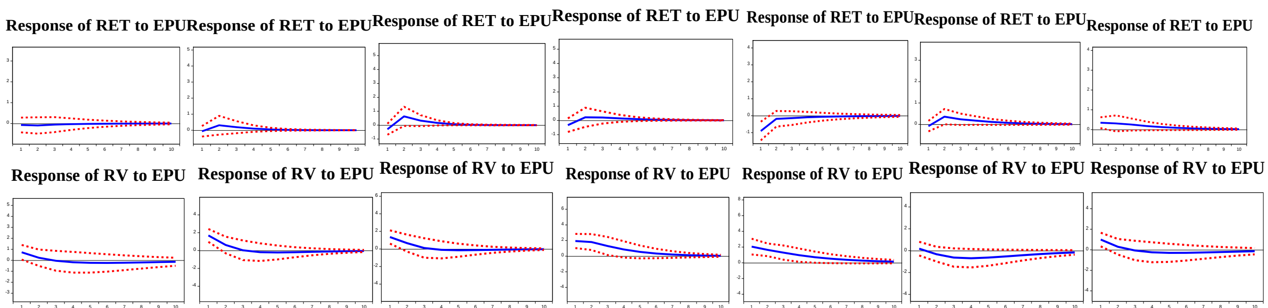
[9] Under the structure of lower triangularity of A in Equation (1) as an identification criteria, we have chosen the order of the variable as RETG, EPU, RV and RET to see the impact of EPU on both RV and RET.

change in global return significantly decreases the policy uncertainty. The $p-$ values of β_{12} are 0.10, 0.06 and 0.02 for the UK, France and Italy respectively and for all other countries it is 0.00. Similarly, the global stock return has a significant negative impact on RV. It should be noted that the β_{14} is positive with a $p-$ value of 0.00 for all the countries. Hence, an increase in global stock return has a significant positive spillover to all the countries leading to an increase in stock return and a reduction in stock market volatility.

Table 4: Structural Coefficient for Linear VAR Model

	USA	UK	Japan	Italy	Germany	France	Canada
β_{12}	0.0335	0.0204	0.0151	0.0107	0.0304	0.0193	0.0223
	(0.00)	(0.10)	(0.00)	(0.02)	(0.00)	(0.06)	(0.00)
β_{13}	0.9242	1.0181	0.7708	1.0349	1.1756	1.1809	0.7810
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{14}	-1.0667	-0.8700	-0.7841	-0.0110	-1.4793	-1.2884	-0.7562
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{23}	-3.1464	-0.2518	-9.2554	-4.4205	-2.9805	-3.0187	-1.4973
	(0.00)	(0.55)	(0.00)	(0.15)	(0.00)	(0.00)	(0.04)
β_{24}	-1.0322	0.0981	2.7276	0.0082	0.4513	0.0833	-0.1071
	(0.02)	(0.56)	(0.02)	(0.28)	(0.31)	(0.78)	(0.78)
β_{34}	-0.0192	0.0608	0.1457	0.0006	0.0651	0.0284	0.1265
	(0.47)	(0.02)	(0.00)	(0.00)	(0.05)	(0.34)	(0.00)

Now, we ask what will be the impact of stock market for future time period if a positive shock is given to EPU. The responses of RET and RV are depicted in the impulse response functions (IRF) given one SD shock in EPU. Figure 1 represents the IRF of return and volatility separately for each country. Here, we can see that the responses of RET is statistically insignificant for all countries for all future horizon except Japan. In case of Japan, the response of RET is negative and significant at the first horizon. Thereafter, it increases and become statistically insignificant. The response of RV due to one standard deviation shock in EPU is positive in the first horizon for five countries *viz.*, Canada, France, Germany, Japan and the USA. After the first horizon, the responses die down and become statistically insignificant. Hence, the impulse response results imply a very short run and non-persistence impact of policy uncertainty on both return and volatility.



(a) Canada (b) France (c) Germany (d) Italy (e) Japan (f) The UK (g) The USA

Figure 1: Response of RET and RV to one SD shock in EPU

4.2.Estimation results of Panel VAR model

This subsection describes the results of PVAR model. Prior to estimation, we test the null hypothesis of unit root against the alternative of stationarity taking all countries together for each variable. Table 5 shows the Im-Pesaran-Shin panel unit root test results. Here we see that the null hypothesis of unit root has been rejected at 1% level of significance for all variables which establishes the fact that all four variables are stationary.

Table 6 presents the results of PVAR model. Using Schwarz information criteria (SIC) of lag selection, we have considered the first lag of each variable as regressor. Our estimated reduced form PVAR model shows that the lag value of EPU does have a significant positive impact on stock return with the probability value 0.03. Again, the lag value of EPU reduces the current volatility of stock market which is statistically significant at 0.01% level. In addition, return of the global stock market has a significant negative impact on both EPU and RV, while it significantly increases the return of the domestic stock market in one period ahead.

Table 5: Results of Panel Unit Root Tests

Im-Pesaran-Shin unit-root test				
	RETG	EPU	RV	RET
Test Statistics	-28.3072	-12.0325	-11.897	-28.0737
p-value	(0.00)	(0.00)	(0.00)	(0.00)

Table (6) Estimation results of Panel VAR Model

	RETG	EPU	RV	RET
$RETG_{t-1}$	0.222991	-0.01613	-0.48042	0.212428
	(0.00)	(0.00)	(0.00)	(0.00)
EPU_{t-1}	0.707082	0.990011	-1.21672	0.620576
	(0.00)	(0.00)	(0.01)	(0.03)
RV_{t-1}	0.025378	-0.00252	0.546671	0.033494
	(0.13)	(0.22)	(0.00)	(0.12)
RET_{t-1}	0.048138	0.00039	-0.16709	0.068606
	(0.13)	(0.10)	(0.02)	(0.11)

$p-$values are given in parentheses.

Previously, from separate VAR model estimation we found that the impact of EPU on stock return was mostly positive, but there was heterogeneity in terms of the sign and statistical significance. The coefficients were negative in case of Japan and Canada. Besides, statistically significant impact was only found for countries like the USA and the UK. Similarly, in case of volatility equation of the linear VAR model, we have seen significant impact of EPU only in case of the UK and Japan. Though the estimated sign was mostly negative, positive coefficient was found for Japan and Italy. The insignificant and unclear results may be due to the country specific heterogeneity. The fixed effect PVAR model eliminates the heterogeneity and improves the estimation of the relationship in terms of overall scenario and statistical significance. Results of multivariate Granger causality, known as block exogeneity test, are given in Table 7. This test is an improvement over the bivariate Granger causality test as it includes all other explanatory variables in the model in both null and alternative hypothesis when testing whether a particular variable Granger causes another variable or not. The result suggests that EPU Granger causes both volatility and stock return, which is similar to the results given in Table 6.

Table 7: Results of Granger causality from Panel VAR model

Equation\ Excluded	RETG	EPU	RV	RET	ALL
RET	21.583	5.044	2.427		25.342
	(0.00)	(0.03)	(0.12)		(0.00)
RV	25.396	7.986		5.678	77.516
	(0.00)	(0.01)		(0.02)	(0.00)

p −values are given in parentheses.

In consistent with the previous VAR model, we do the structural decomposition and depict the impulse response functions to get an idea of the contemporaneous relationship and future responses for a positive one SD shock in EPU. Similarly, a same order Cholesky decomposition of the covariance matrix is also performed for the related variables. IRFs are produced for $h(h = 0, 1, \ldots, 10)$ period ahead in Figure 2. We do not present the structural coefficient matrix separately however it can be seen in the impulse response analysis with $h = 0$. In Figure 2, first and second IRF in third row provides responses of return and volatility against a one SD shock in EPU, respectively.

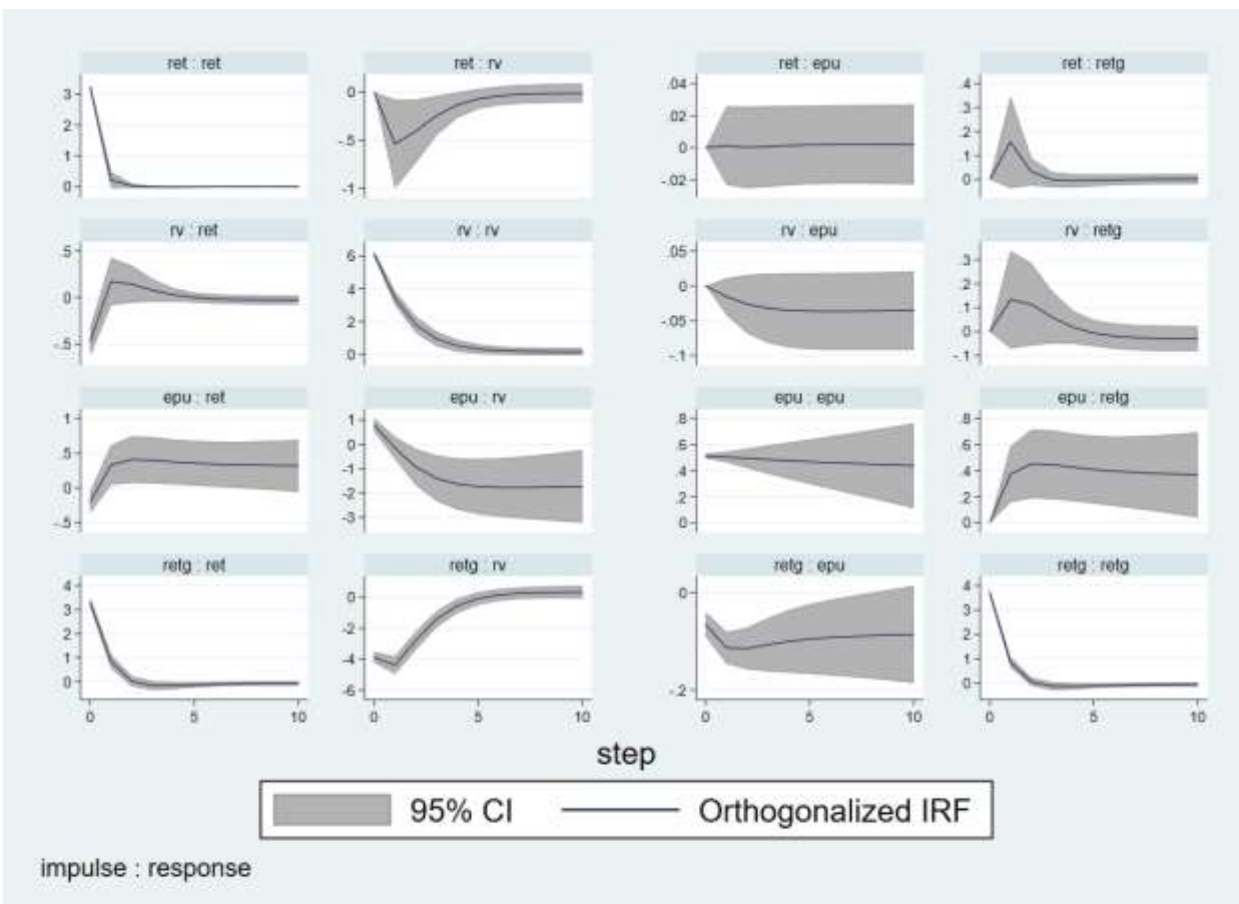


Figure 2: Impulse Response function of all variables

It is evident from the figure that increase in EPU increases the volatility of stock market and reduces the return for the same time period. Further, after one period, the response of return due to a shock in EPU will be positive and persist after third period. The response of RV started falling to negative when we move from $h = 0$. Beside, the response of RET due to a positive shock in RV for the same time period is also negative. The impulse response analysis of PVAR supports our claim that the hypothesis given by PV is correct only for contemporaneous time period. For the future time period, investor will demand higher return as a risk premium for holding the risky asset in an uncertain period which leads to a reduction in the market volatility.

4.3. Estimation results of Markov Switching VAR model

As mentioned in section 1, the cyclical variation like bull and bear market condition is an intrinsic characteristic of all the stock markets. Therefore, the impact of EPU on stock market return and volatility is subject to vary across bull and bear markets. The main objective and contribution of this study is to see whether such heterogeneity exists with regard to the impact of EPU on stock market return and volatility. To capture this asymmetric impact, we estimate a two regime MSVAR model taking same variables for all the countries. Regimes are identified as 'bull' and 'bear' in financial context – high-return stable state is labeled as bull market and low-return volatile state is labeled as bear market. Looking at the estimated constant and error variance of return equation we see that the estimation typically provides high $\hat{c}$with low error variance in one regime and low $\hat{c}$ with high error variance in another for all seven countries. Hence, we identify the former regime as bull and the later as bear.

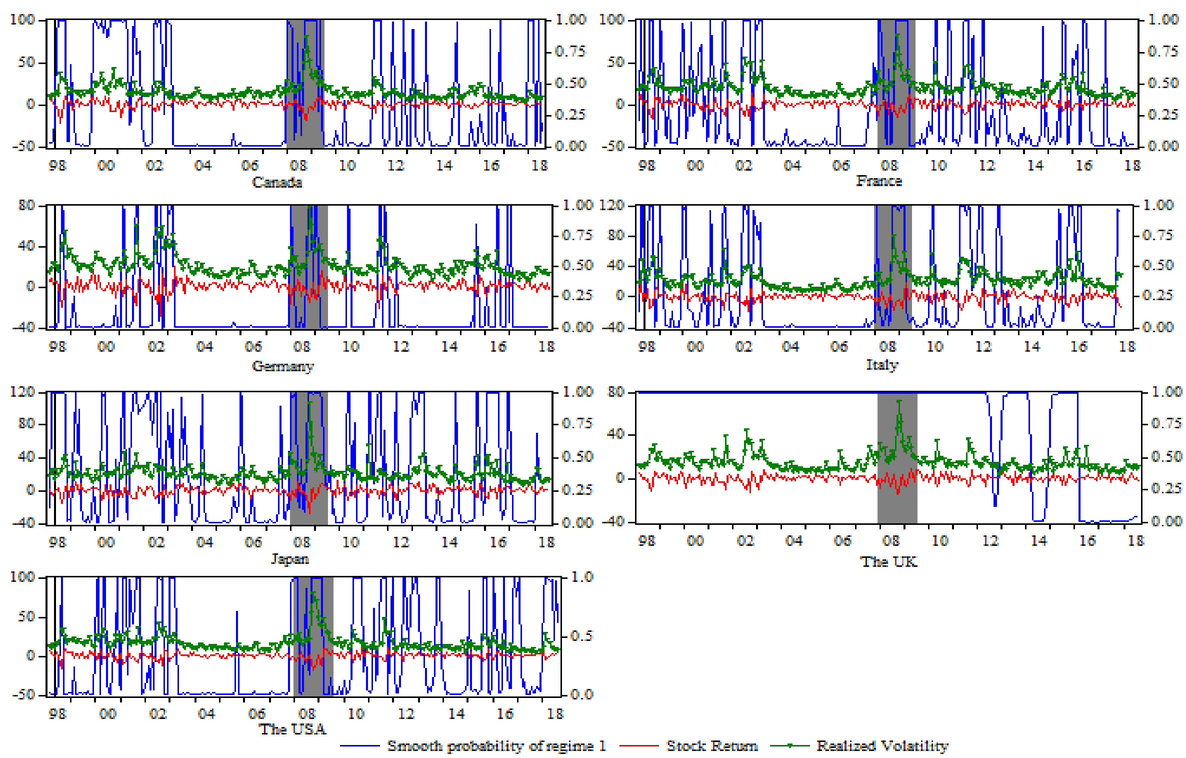


Figure 3: Return, Volatility and smoothing probability

In Figure 3 we have drawn the smoothing probabilities of Regime-I, stock market return and realized volatility together for each country to identify the bull and the bear. The shaded area represents the period of global financial crisis which started from December 2007 to June 2009. It is clear from the graph of RV that the market was quite stable since 2003 to the end of 2007. The smoothing probabilities were almost coinciding with the horizontal axis for almost all countries except The UK. Thereafter, in the beginning of global financial crisis return falls and market volatility increases for all countries following ups and downs for both return and volatility series in the initial months of 2008. Correspondingly, the smoothing probability of Regime-I also reaches to 1 and goes down. Between mid of 2008 and mid of 2009 volatility reaches its maximum and return decreases. As a result, the probability of Regime-I also increases to 1. Hence, it must be clear from the graph, the low return coupled with high volatility comes under Regime-I and that is identified as the bear market. The significance of regime switching models is, it typically incorporates the crisis period as bear market.

As mentioned in Section 1 that the cyclical variation like bull and bear market condition is an intrinsic characteristic of all the stock markets, the impact of EPU on stock market return and volatility is subject to vary between bull and bear market. The main objective and contribution of this study is to see whether or not the impact of EPU on stock market return and volatility varies with different market conditions. To address the asymmetric impact we estimate a two regime MSVAR model taking same variables for all the countries. Regimes are identified as 'bull' and 'bear' in financial context. High-return stable state is labeled as bull market and low-return volatile state is labeled as bear market. Looking at the estimated constant and error variance of return equation we see that the estimation typically provides high $\hat{c}$ with low error variance in one regime and low $\hat{c}$ with high error variance in another for all seven countries. Hence, we identify the former regime as bull and the later as bear. Table 8 and 9 provides the estimated results of the return equation in bull and bear market respectively, whereas the results of RV equation for both the market conditions are given in Table 10 and 11.

Table 8: Coefficient of Return equation in bull Market

	Canada	France	Germany	Italy	Japan	The UK	The US
c	0.438329	1.853645	0.352953	0.216714	0.236844	0.213669	0.462802
	(0.62)	(0.00)	(0.00)	(0.00)	(0.00)	(0.09)	(0.00)
RET_{t-1}	-0.05021	-0.11977	-0.14159	-0.22127	-0.18268	-0.33214	-0.04118
	(0.72)	(0.49)	(0.19)	(0.21)	(0.05)	(0.03)	(0.70)
RV_{t-1}	0.086774	0.194688	0.353298	0.399101	0.144015	0.370298	0.388388
	(0.06)	(0.00)	(0.00)	(0.00)	(0.17)	(0.03)	(0.00)
EPU_{t-1}	-0.37214	0.430324	0.116204	-0.05564	0.040814	0.091938	0.217247
	(0.20)	(0.20)	(0.04)	(0.49)	(0.66)	(0.03)	(0.00)
$RETG_{t-1}$	0.256772	0.050892	0.045964	0.233418	0.251582	0.15158	-0.09751
	(0.10)	(0.87)	(0.71)	(0.16)	(0.00)	(0.50)	(0.37)

From the MSVAR model it is very clear that the impact of EPU on stock market return and volatility is asymmetric for almost all the countries. From Table 8 and 9 we have seen that in case of Canada an increase in EPU at time $t-1$ increases the stock market return only in the bear market. The impact is negative but statistically insignificant in case of the bull market. In case of Germany, the UK and the US, the positive future impact of EPU is significant in both market conditions, but the coefficient is much higher in case of the bear market. For other countries *viz*., France, Italy, and Japan the impact is statistically insignificant in both the market conditions.

Table 9: Coefficient of Return equation in bear Market

	Canada	France	Germany	Italy	Japan	The UK	The US
c	-5.11714	-3.79208	-0.98395	-1.64266	-0.46595	0.013829	-0.54145
	(0.02)	(0.00)	(0.00)	(0.00)	(0.01)	(0.68)	(0.00)
RET_{t-1}	0.599053	0.16306	-0.23599	-0.25223	0.389581	-0.22958	-0.83691
	(0.04)	(0.52)	(0.35)	(0.31)	(0.06)	(0.08)	(0.00)
RV_{t-1}	-0.0054	0.025883	0.043571	0.69651	0.20191	0.038692	-0.36495
	(0.91)	(0.74)	(0.81)	(0.01)	(0.12)	(0.69)	(0.00)
EPU_{t-1}	1.996212	0.830479	0.409597	0.183933	0.043171	0.20304	0.25716
	(0.06)	(0.29)	(0.03)	(0.28)	(0.75)	(0.09)	(0.03)
$RETG_{t-1}$	-0.31017	0.336417	0.478246	0.506501	-0.09424	0.350512	0.797397
	(0.30)	(0.25)	(0.05)	(0.05)	(0.64)	(0.01)	(0.00)

Next, we discuss about the impact of EPU on stock market volatility in both the market conditions. Table 10 provides the estimated results of the RV equation in case of bull market while the same in bear market condition is given in Table 11. The impact of EPU is found to be significant in bull market in case of Canada, France and Italy whereas the impact is statistically significant for Canada, France and the US in bear market condition. Except Italy in bull market, the coefficients are found to be negative wherever significant implying a reduction of market volatility in the next period. The magnitude of the negative effect is high in bear market condition compared to bull market.

The structural coefficient describing contemporaneous impact of EPU on stock return and volatility in both the market conditions. As the computer program provides upper triangular matrix of the Cholesky decomposition, we have chosen the order of the variables in a reverse way to keep the logical consistency, i.e., $y_t = (RET, RV, EU, RETG)'$. Table 12 and 13 provides the structural coefficients of the contemporaneous relationships in bull and bear market respectively, where coefficient β_{ij}^{s} implies the impact of i^{th}variable to j^{th} variable in s^{th} market condition in which $s = bull, bear$.

Here, the impact of EPU on RV *i.e.,*β_{32} is positive, as the estimated sign of the coefficient is negative, for almost all the countries considered except Canada in bull market and Italy in bear market conditions. The coefficient is significant for the USA, the UK, Japan, Italy and Germany in bull market, whereas the same coefficient is only significant for the USA and Germany for bear markets. Thereafter, β_{21}s are found to be positive and statistically significant for all countries in bear market and statistically significant in five countries except the UK and Italy. It is clear from the results that the magnitude of β_{21}^{bear} is much higher or almost twice than of β_{21}^{bull} establishing a clear asymmetry in the relationship. β_{21}^{s} for $s = bull, bear$is mostly statistically insignificant except a few supports PV in a sense that the policy uncertainty affect the market return through market volatility.

Table 10: Coefficient of RV equation in bull Market

	Canada	France	Germany	Italy	Japan	The UK	The US
c	6.328783	-1.92343	-0.14626	-0.11136	-0.24476	-0.43575	-0.1102
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
RET_{t-1}	0.028574	-0.49301	-0.16628	0.048132	-0.05249	-0.23563	-0.31321
	(0.69)	(0.00)	(0.01)	(0.45)	(0.30)	(0.15)	(0.00)
RV_{t-1}	0.536428	0.587288	0.678844	0.526311	0.483199	0.327482	0.70051
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.08)	(0.00)
EPU_{t-1}	-0.90441	-0.56767	-0.02955	0.092399	0.033556	-0.03242	-0.01179
	(0.00)	(0.10)	(0.43)	(0.00)	(0.57)	(0.50)	(0.79)
$RETG_{t-1}$	-0.01103	0.429775	0.075284	-0.07886	0.015582	0.342224	0.191724
	(0.79)	(0.09)	(0.26)	(0.19)	(0.70)	(0.18)	(0.01)

Table 11: Coefficient of RV equation in bear Market

	Canada	France	Germany	Italy	Japan	The UK	The US
c	13.90631	6.425332	0.728246	1.480238	0.545892	0.039422	0.267871
	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.35)	(0.02)
RET_{t-1}	-0.45258	-0.17612	0.007084	-0.12427	0.086169	-0.01286	0.089127
	(0.40)	(0.83)	(0.91)	(0.87)	(0.61)	(0.85)	(0.66)
RV_{t-1}	0.68698	0.407067	0.409004	-0.34592	0.205396	0.588302	0.66224
	(0.00)	(0.00)	(0.00)	(0.71)	(0.08)	(0.00)	(0.00)
EPU_{t-1}	-3.25999	-2.71051	-0.21571	-0.44013	-0.13531	-0.05523	-0.18307
	(0.04)	(0.05)	(0.12)	(0.32)	(0.30)	(0.51)	(0.07)
$RETG_{t-1}$	-0.14136	-0.71188	-0.29112	-0.37583	-0.57076	-0.1816	-0.26917
	(0.82)	(0.42)	(0.02)	(0.69)	(0.00)	(0.02)	(0.18)

The positive effect of EPU on stock market return and negative effect in volatility as found in reduced form MSVAR model (Table 8 to 11) may have the following interpretation. An increase in EPU increases the volatility of the stochastic discount factor of an asset in the same time period which leads to an increase as market volatility (see Pastor and Veronesi (2012) for details). This increase in uncertainty lowers the market return (Dzielinski (2012)) at the same time. But thereafter, investors who are holding the assets may demand higher prices as an opportunity cost of holding a risky asset with high uncertainty. Therefore, in the next period, price of the stock increases as well as the return. Hence, the volatility of the market will decrease consequently. The opportunity cost of holding a risky asset will be much higher in a bear market situation. As a result the asset price will increase more in the bear market.

4.3.1. Regime Wise Impulse Response Analysis

The regime dependent impulse response function has been drawn to summarize all the information found from the estimation of MSVAR model. Figure 4 below shows the response of all four variables given one unit shock in EPU at time t. In Figure 4, regime 1 and 2 refer to the bull and bear market conditions respectively. The response of stock market return to EPU is mostly insignificant in all horizons. In case of the UK, the response in bull market is significant and positive but these are much lower than the response of bear market. In bear market condition the responses of stock return given a shock in EPU is significantly positive except for Japan. The positive impact of the given shock is slowly dying down after few months except for Canada and France.

Table 12: Structural coefficients in the bull market

	USA	UK	Japan	Italy	Germany	France	Canada
β_{21}^{bull}	0.2321	0.2028	0.2012	0.1219	0.2099	0.4526	0.4643
	(0.00)	(0.26)	(0.06)	(0.37)	(0.00)	(0.00)	(0.00)
β_{31}^{bull}	0.0547	-0.1969	0.0124	-0.0777	-0.0197	-0.0053	0.0094
	(0.40)	(0.00)	(0.91)	(0.13)	(0.63)	(0.99)	(0.99)
β_{32}^{bull}	-0.1507	-0.9154	-0.1826	-0.3166	-0.14	-0.0226	0.0139
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)	(0.96)	(1.00)
β_{41}^{bull}	-0.7439	-0.2114	-0.387	-0.6698	-0.7773	-0.5115	-0.5878
	(0.00)	(0.19)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{42}^{bull}	0.3328	0.5301	0.2148	0.6364	0.1769	0.104	0.1079
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.37)	(0.12)
β_{43}^{bull}	0.1653	-0.0034	-0.1629	-0.0493	-0.0213	-0.1113	0.7222
	(0.00)	(0.99)	(0.00)	(0.37)	(0.72)	(0.00)	(0.00)

Table 13: Structural coefficients in the bear market

	USA	UK	Japan	Italy	Germany	France	Canada
β_{21}^{bear}	0.4333	0.4364	0.4599	0.3051	0.4356	0.8311	0.6335
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
β_{31}^{bear}	-0.0294	0.0737	0.1512	0.4091	0.023	-0.0022	0.0039
	(0.57)	(0.43)	(0.02)	(0.00)	(0.56)	(1.00)	(1.00)
β_{32}^{bear}	-0.3789	-0.0742	-0.1016	0.1604	-0.2911	-0.0313	-0.0099
	(0.00)	(0.50)	(0.22)	(0.22)	(0.00)	(0.99)	(1.00)
β_{41}^{bear}	-0.6591	-0.8264	-0.688	-1.2668	-0.7322	-0.52	-0.628
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
β_{42}^{bear}	0.2925	0.1352	-0.0849	-0.1679	0.1645	0.1104	0.0801
	(0.00)	(0.00)	(0.20)	(0.13)	(0.00)	(0.60)	(0.51)
β_{43}^{bear}	0.1821	0.033	0.0591	-0.0827	-0.0037	-0.9355	-0.4978
	(0.00)	(0.13)	(0.19)	(0.17)	(0.96)	(0.00)	(0.00)

The negative responses of RV for the subsequent periods are negligible in the bull market condition. Only in Japan the response of RV in bull market is positive. For all countries the IRF is negative and significant in bear market.

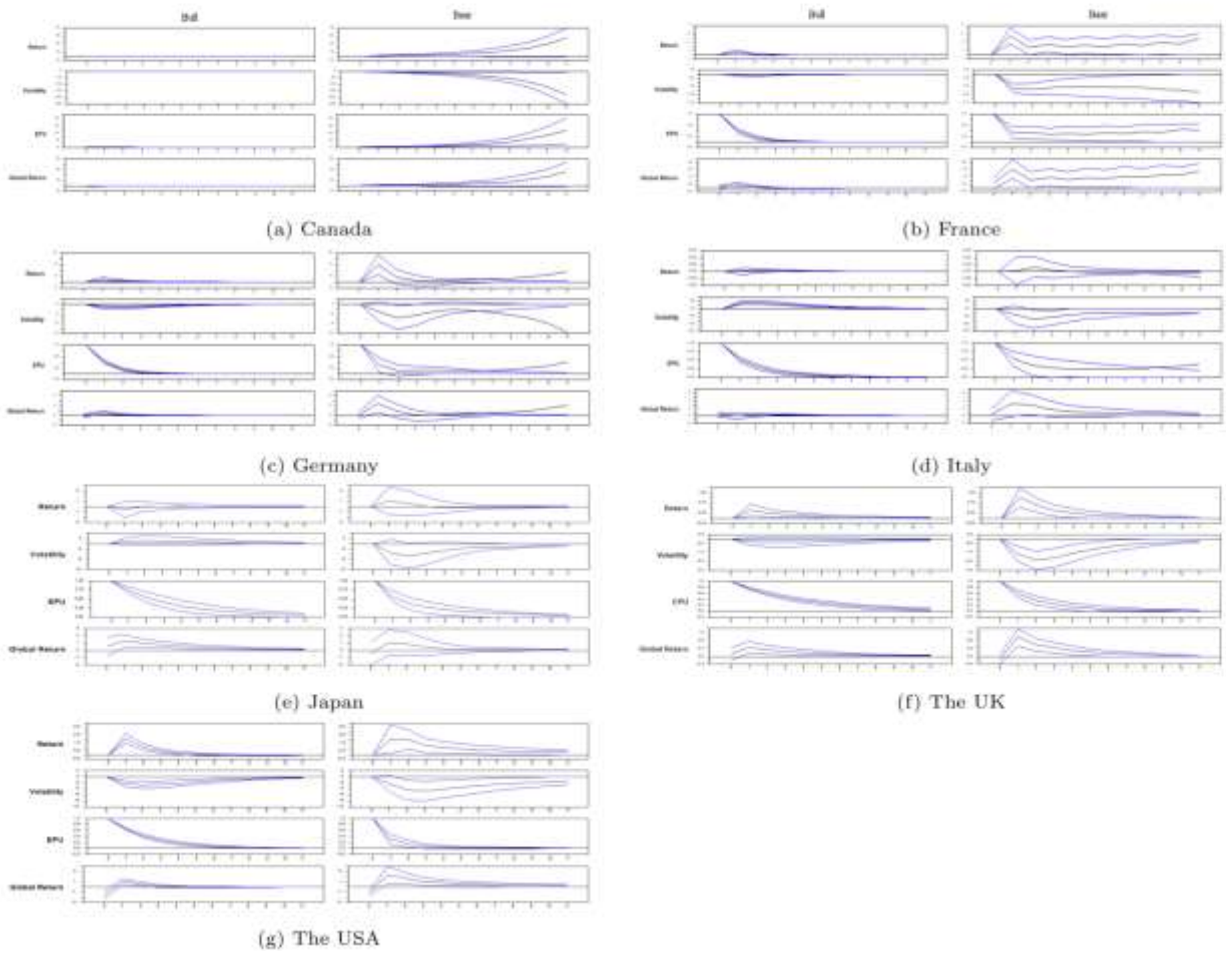


Figure 4: Response of all variable to unit shock in EPU

4.4. Diagnostic Tests

After the estimation of MSVAR model for each of the countries, we have done a set of diagnostics for each residual series. Table 14 presents the Ljung-Box $Q(\cdot)$ tests and ARCH LM test to check the presence of autocorrelations and conditional heteroskedasticity in the residuals. $Q(s)$ denotes the test statistic under H_0 that the first s number of autocorrelations are jointly zero, i.e., $H_0 = r_1 = r_2 = \cdots = r_s = 0$ against the alternative that at least one autocorrelation coefficient is non-zero. We have reported the joint test for $s = 5$ and 10. Overall, the $Q(\cdot)$ test suggests that there is no auto correlation in the four residual series for all the countries considered. There are few sporadic cases where the autocorrelations are found to be statistically significant. Out of 56 cases, there are only 9 cases where $Q(\cdot)$ statistic is statistically significant at 5% level of significance. Hence, we conclude that our model specification is correct at least in terms of the conditional first moments. We also computed the ARCH LM test for the residuals of return, EPU and global return. Here we see a number of cases where the presence of conditional heteroskedasticity is statistically significant. The result implies that our estimation of the parameters are consistent but there are scopes to improve the efficiency by including GARCH type model for the residuals. We have excluded the realized volatility series from the ARCH LM test as the rejection of null hypothesis implies that the fourth order conditional moment of the return series is not constant, which is beyond the scope of the discussion.

Table 14: Diagnostic tests for MSVAR model

	Canada	France	Germany	Italy	Japan	The UK	The USA
eRET							
Q(5)	0.073	0.028	-0.096	-0.013	-0.046	0.022	0.039
	(0.07)	(0.34)	(0.44)	(0.42)	(0.82)	(0.22)	(0.87)
Q(10)	0.085	0.044	-0.094	-0.05	0.024	-0.095	-0.094
	(0.10)	(0.42)	(0.23)	(0.46)	(0.73)	(0.28)	(0.92)
ARCH LM	3.122001	1.122044	0.418098	2.297654	2.580027	5.847712	3.908975
	(0.02)	(0.35)	(0.80)	(0.06)	(0.04)	(0.00)	(0.00)
eRV							
Q(5)	0.133	-0.016	0.087	0.127	0.1	0.04	0.095
	(0.07)	(0.70)	(0.01)	(0.10)	(0.29)	(0.81)	(0.11)
Q(10)	-0.037	0.113	0.131	0.084	0.017	0.094	-0.002
	(0.10)	(0.61)	(0.01)	(0.15)	(0.25)	(0.28)	(0.21)
eEPU							
Q(5)	0.073	0.155	0.095	0.011	0.065	0.247	0.103
	(0.07)	(0.06)	(0.12)	(0.00)	(0.05)	(0.00)	(0.20)
Q(10)	0.085	-0.036	0.071	0.075	0.105	-0.097	0.079
	(0.10)	(0.11)	(0.34)	(0.01)	(0.02)	(0.00)	(0.21)
ARCH LM	0.342932	6.190676	0.325493	1.346727	5.552125	9.260637	0.639987
	(0.85)	(0.00)	(0.86)	(0.25)	(0.00)	(0.00)	(0.63)
eRETG							
Q(5)	-0.007	-0.086	-0.115	-0.029	-0.042	-0.021	0.001
	(0.28)	(0.35)	(0.33)	(0.32)	(0.04)	(0.39)	(0.40)
Q(10)	-0.038	-0.037	-0.059	-0.081	-0.127	-0.042	-0.086
	(0.42)	(0.41)	(0.40)	(0.42)	(0.09)	(0.62)	(0.56)
ARCH LM	4.153321	1.329649	0.223872	1.945554	2.918296	1.90484	2.419647
	(0.00)	(0.26)	(0.92)	(0.10)	(0.02)	(0.11)	(0.05)

5. Conclusion

In this paper, we have examined the impact of economic policy uncertainty on stock return and volatility for the group of seven countries. For this purpose, we have used different structural vector autoregressive models and impulse response functions. We begin with a linear SVAR model where all the variables considered are endogenous. The structural coefficient, capturing the impact of EPU on stock market return is found to be negative in most of the countries concerned. However, in case of reduced form coefficient we have seen a positive relationship between lag EPU and stock market return.

Further, we have used PVAR with country fixed effect to capture the country specific heterogeneity while estimating the relationship. The result shows that the EPU increases the volatility of stock market and reduces the return at the same time period. Again the impulse response analysis of PVAR model has found that that in future the responses of return is positive and the responses of volatility is negative.

To capture the asymmetric impact of EPU in two different market conditions *viz.*, bull and bear market, we have estimated MSVAR model. Regime dependent impulse response function has been analysed to see the responses of stock market variables given one unit shock on EPU. The estimation results and regime dependent IRF established that the impact of EPU is higher in the bear market and has insignificant impact in the bull market. Increase in EPU positively affects the volatility of the stochastic discount factor of an asset contemporaneously, that leads to an increase in the market volatility. This, in turn, lowers the market return as well. However investors, who are holding the assets, may demand higher prices afterwards as an opportunity cost of holding risky assets in a market with high uncertainty. Following which, the price of the stock increases as well as the return. Hence, the volatility of the market will decrease consequently as per the leverage effect. The opportunity cost of holding a risky asset will be much higher in a bear market situation where average return is low. As a result the asset price will increase more in the bear market.

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