Economic Modelling 60 (2017) 122–131

Contents lists available at ScienceDirect

Economic Modelling

journal homepage: www.elsevier.com/locate/econmod

# The source of global stock market risk: A viewpoint of economic policy uncertainty

I-Chun Tsai

*Department of Finance, National University of Kaohsiung, No. 700, Kaohsiung University Rd., Nanzih District, 811 Kaohsiung, Taiwan, R.O.C*

A R T I C L E I N F O

*JEL classification:*
F30
F65
G15

*Keywords:*
Economic policy uncertainty
Regional systematic risk
Spillover
Volatility
The global stock market

A B S T R A C T

This study explores the effect of economic policy uncertainty (EPU) in four countries or regions (China, Japan, Europe, and the *United States*) on the contagion risk of investments in the global stock market. The stock returns of 22 stock markets worldwide are analyzed to determine which region's EPU exhibits the greatest effect on regional systematic risk in the global stock market and on volatility risk in individual stock markets. First, all of the samples, the markets of different continents and the spillover indices of the developed and emerging markets, are calculated to observe the dynamic correlation among these markets with the aim of quantifying regional systematic risk and further examining the contagion *risk effect of EPU. The results indicate the following: EPU in China is the most influential, and its contagion risk spreads to different regional markets, except for Europe; the effect of EPU in the United States is inferior to that in China*; EPU in Japan merely influences contagion risk in emerging markets; contagion risk in European markets is not influenced by the four EPU indices; and EPU in Europe is not influenced by contagion risk in the global stock market. However, according to the volatility risk in each market, the EPU in Europe and China respectively influence Asian countries and European countries the most. These results may be attributable to the extremely high trade dependence among these countries because the performance of international enterprises is mainly determined by the economic policies of their trading partners.

## 1. Introduction

Since 2010, numerous studies have discussed the individual and overall effects of economic policy uncertainty (EPU). Regarding the individual effects, the behaviors of enterprises are influenced by economic policies, and thus the operational risk of enterprises increase under EPU. Similarly, when public investors are incapable of judging future market and policy developments when making investments, they may withdraw from markets or request high *expected rates of return* to subsidize investment risk. Overall, policy uncertainty influences the effectiveness of policy intervention on the overall economy. For example, examining whether EPU moderates the effect of monetary policy on an overall economy, Aastveit et al. (2013) reports that, if EPU is high, then the effectiveness of monetary policy decreases because the effect of *monetary* shocks on economic activities is weakened.

Some studies discuss the effect of EPU on the overall economy from the perspective of structural vector autoregressive (VAR), such as the studies conducted by Alexopoulos and Cohen (2009), Bloom (2009), Caggiano et al. (2014), Leduc and Liu (2015), and Nodari (2014). These studies all adopt the VAR model to estimate the effect of the uncertainty shocks of a variable on other overall variables. However, this research method merely observes the unexpected changes resulting from a policy or sector and cannot explain the changes caused by the overall EPU. Baker et al. (2013) construct the indicators of EPU. Through these substitute variables, subsequent studies can determine the overall economic changes caused by EPU from an objective and overall perspective.

Thus far, numerous studies have employed various indicators of EPU to explore the effect of EPU on crucial topics such as corporate governance (Zhang et al., 2015), investment behavior (Wang et al., 2014), economic development (Scheffel, 2015), monetary policy effects (Aastveit et al., 2013), commodity markets (Wang et al. 2015), the relationship between stock and bond markets (Li et al., 2015), stock price (Ko and Lee, 2015), and stock market volatility (Liu and Zhang, 2015). For the public, if the EPU in an economy is high, then the economic policies are difficult to anticipate, which indicates a high investment risk. All of the aforementioned studies explore the effect of a single country's EPU on that country or on relevant markets. However, the present study aims to analyze which country's EPU exhibits contagion risk effects on the global market and to further explore, from the perspective of global investment, which economy's policy risk causes stock market volatility. We adopt the EPU indices of four countries and regions constructed by Baker et al. (2015) to observe their effect on regional systematic risk in the global stock market and on volatility risk in individual markets.

With the increased liberalization of international trade, interactions among the real economies of all countries have grown in intensity. In addition, the circulation of a single currency in Europe has established

http://dx.doi.org/10.1016/j.econmod.2016.09.002
Received 10 June 2016; Received in revised form 2 August 2016; Accepted 3 September 2016
0264-9993/ 

the transnational integration of European currency and promoted trade cooperation among other regions. This trend of international integration has rendered the economic performance of each country, whether large or small, prone to the influences of other countries' policies. The global upsurge of transnational financial investments since 2000 substantially increased the systematic risk in financial markets, particularly stock markets, in all countries. Consequently, the financial crises that have occurred since 2000 (e.g., the subprime mortgage crisis in the United States in 2007, the financial crisis precipitated *by* the collapse of Lehman Brothers in 2008, and the European debt crisis in 2010) were not merely national or regional financial crises but crises that severely hit the global economy.

The global economy is not merely influenced by financial crises. The United States, Europe, Japan, and China have implemented expansionary policies in response to possible long-term economic recession caused by the aftermath of financial crises. However, devaluation policies such as the expansionary fiscal policy, an easy-money policy, or the beggar-thy-neighbor policy all interfere with the global economy. Since 2011, the International Monetary Fund has repeatedly warned in the World Economic Outlook Report and Global Financial Stability Report that the hot money derived from expansionary policies may lead to another financial crisis; particularly, if the bubbles caused by overinvestment in China's housing market were to burst, then another financial crisis would occur (International Monetary Fund, 2011, 2012).

China's stock market crash occurred in June 2015.[1] The global stock market was also affected by a black swan event that occurred two months later on August 24, 2015, during which China's two major composite indices underwent a one-day drop that exceeded 8%, the Dow Jones stock index in the United States plunged more than 1000 points in the opening minutes, and stock indices in Japan and European countries had also dropped more than 4%. Although the one-day event was experienced the worst in China, the cause of the collapse, according to *The New York Times* of the United States and the *Financial Times* of the United Kingdom, was because plans by the US *Federal Reserve* System ("the Fed") to raise interest rates caused investor panic (i.e., an occurrence of taper tantrum). From this perspective, EPU in a large country can be internationally contagious.

Previous studies researching the relationship between EPU and stock markets have focused on exploring a country's EPU and its relationship with the local stock market and have mainly centered on EPU in the United States (e.g., Liu and Zhang, 2015). Studies on the transnational effect of EPU have focused on the effect of EPU in the United States on Europe (e.g., Sum, 2012; Colombo, 2013). The US economy and the European stock market have always been highly correlated; however, with the occurrence of several global financial crises, which region's EPU influences the global stock market the most? Does EPU affect regional systematic risk or influence volatility risk in individual markets? Does contagion risk in developed and emerging markets originate from the same source? This study aims to answer these questions.

Uncertainty increases economic upheaval and thus heightens stock market investment risk. The effect of EPU in a large economy on investment risk in the global stock market can be considerable. In addition to the increased operational risk of enterprises listed on stock markets, the rapid flow of transnational investment funds because of uncertainty also causes stock market volatility. The policies of a large economy can result not only in the bubble and collapse of one country but also in a global financial crisis. Therefore, understanding whether a large economy is experiencing stable growth is critical to stock market investors for minimizing investment risk. However, which type of economic uncertainty is most influential? From the upheaval of which economy does the investment risk in different stock markets originate? Following the occurrences of several global financial crises, we must determine what sources of economic uncertainty mainly influence different stock markets, in order to accurately assess the risk of investing in a market.

This study analyzes 22 stock markets from January 1995 to September 2015 in Asia, Europe, the Americas, and other regions to explore the effect of EPU in China, Japan, Europe, and the United States on these stock markets. We research two types of risk that may affect stock markets: (1) The first type of risk indicates that, if several stock markets are influenced by a country's EPU, then systematic risk in these stock markets is heightened. Therefore, we first explore the dynamic correlation among stock markets and their causal relationships with EPU. (2) The second type of risk involves the risk in individual stock markets. By estimating the relationship between EPU and the conditional volatility of individual stock markets, we can examine whether contagion risk from EPU in these four regions spreads to the stock markets of every country.

Section 2 explains how we measure the contagion risk effect of EPU on regional systematic risk and on volatility risk in individual stock markets. Section 3 explains the samples pooled in this study and the empirical results. Finally, Section 4 concludes the study.

## 2. Empirical methodology

### 2.1. Economic policy uncertainty and regional systematic risk

We aim to analyze which region's policy uncertainty mainly influences investment risk in the global stock market. First, regional systematic risk is measured. To measure changes in systematic risk, the correlation among regional stock market returns must be estimated. The measurement of market spillover effects proposed by Diebold and Yilmaz (2012) is employed because it can be used to quantitatively analyze information transfer effects among various markets.

This study follows Diebold and Yilmaz (2012) in constructing the VAR models based on a generalized VAR framework in which variance decompositions are invariant to the variable ordering. This method parses the forecast error variance into parts that are attributed to various shocks. This variance decomposition enables us to investigate the directional spillovers across markets. By using rolling windows of data, we can estimate the rolling spillover index. This study used a 24-month rolling estimation window. The dynamic spillover charts can examine how spillovers across the stock markets change through time. Changes in spillover indices reveal dynamic information transfer among regional stock markets and the high or low correlation among them. The methodology is described as follows.

To estimate the correlation among the number of $N$ stock markets, a covariance stationary $N$-variable VAR($p$) model is first constructed:

$$R_t = \sum_{i=1}^{p} \psi_i R_{t-i} + \varepsilon_t, \tag{1}$$

where $R_t$ is a vector of stock market returns and $\varepsilon \sim (0, \Sigma)$ is a vector of the disturbances distributed independently and identically. This expression can be rewritten as the moving average representation expressed as

$$R_t = \sum\nolimits_{i=1}^{\infty} B_i \varepsilon_{t-i}, \tag{2}$$

where $B_i$ represents the $N \times N$ coefficient matrices following $B_i = \varphi_1 B_{i-1} + \varphi_2 B_{i-2} + \cdots + \varphi_p B_{i-p}$, with $B_i = 0$ for $i < 0$ and $B_0$ as an $N \times N$ identity matrix. Then by the variance decompositions, the model calculates the fraction of the error variance in forecasting $R_i$, which is due to shocks to $R_j$, where$\forall\, j \neq i$ for each $i$. The respective variance shares are defined as the fraction of the $H$-step ahead error variances in forecasting $R_i$ that are due to $R_i$, for $i = 1, 2, \cdots, N$. Here, the cross

[1] The Composite Index of the Shanghai Stock Exchange (abbreviation: SSE Composite Index) in China dropped almost 35% from June 12, 2015, to July 9, 2015; simultaneously, the Composite Index of the *Shenzhen Stock Exchange* (abbreviation: SSE *Composite Index) in China dropped* 40%.

variance share is defined as the fraction of the $H$-step-ahead error variance in forecasting $R_i$ that are due to $R_j$, for $i, j = 1, 2, \cdots, N$ such that $i \neq j$. Under this framework, Diebold and Yilmaz propose the $H$-step-ahead forecast error variance for $H = 1, 2, \cdots$ H = 1, 2,…using the following expression:

$$\theta_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} (e'_i B_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e'_i B_h \Sigma B'_h e_j)}, \tag{3}$$

where is the variance matrix for the error vector, , is the standard deviation of the error term for the $j$th equation, and is the selection vector with 1 as the $i$th element and 0 otherwise. Each entry of the variance decomposition matrix is normalized by the row sum to calculate the spillover index as the sum of the elements in each row of the variance decomposition matrix is not equal to 1. The normalized variance decompositions is given by

$$\tilde{\theta}_{ij}(H) = \frac{\theta_{ij}(H)}{\sum_{j=1}^{N} \theta_{ij}(H)}, \tag{4}$$

where $\sum_{j=1}^{N} \tilde{\theta}_{ij}(H) = 1$ and $\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H) = N$.

Using Eq. (4), Diebold and Yilmaz (2012) propose the total spillover index using the expression

$$Spillover(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{ij}(H)}{N} \times 100. \tag{5}$$

The total spillover index indicates the contribution of the spillovers among stock markets. Estimating the magnitudes of the return spillovers can help differentiate the transmission mechanism of the information between these stock markets over different time spans. Following the analysis of Diebold and Yilmaz (2012), this study used the 10-step-ahead forecasts ($H$=10) to separately calculate the spillover indices.[2] This study estimates the spillover indices of all the samples pooled from Asia, Europe, the Americas, developed markets, and emerging markets in an aim to observe the following: whether these regions are correlated, whether changes in information transfer occur within the sample duration, and which economy's EPU is most strongly associated with the changes in correlation.

After the systematic risks in different regions (spillover effects) are estimated and obtained, we subsequently analyze the short-run causal relation to test the lead–lag connections between the spillover index and EPU. The following equations are estimated:

$$Spill_t = \alpha_0 + \alpha_1 Spill_{t-1} + \ldots + \alpha_i\, Spill_{t-i} + \beta_1 EPU_{t-1} + \ldots + \beta_i EPU_{t-i} + \varepsilon_t, \tag{6}$$

$$EPU_t = \alpha_0 + \alpha_1 EPU_{t-1} + \ldots + \alpha_i\, EPU_{t-i} + \beta_1 Spill_{t-1} + \ldots + \beta_i Spill_{t-i} + \varepsilon_t, \tag{7}$$

where *Spill* refers to the regional spillover effects calculated from Eq. (5). The reported F-statistics is the Wald statistics for the joint hypothesis:

$$\beta_1 = \beta_2 = \ldots = \beta_i = 0. \tag{8}$$

The null hypothesis is that *EPU* does not include the Granger-Cause *Spill* in the first regression and that *Spill* does not include the Granger-Cause *EPU* in the second regression. The lag length of the models used to estimate the causality test is selected by the Schwarz Information Criterion.

*2.2 Economic policy uncertainty and volatility risk in individual stock markets*

Market risk resulting from EPU may cause an increase of volatility in a single stock market because policy uncertainty causes the information obtained by traders to change considerably or because repeatedly imposed policies cause market volatility, both of which are possible reasons for increased stock market volatility. Subsequently, we explore whether risk in a single market is affected by EPU from other countries. Subsequently, the generalized autoregressive conditional heteroskedasticity (GARCH) model was used to elucidate the information transfer between stock market and EPU.

Let $R_{it}$ denote the $i$ stock market return on time $t$. If the error process obtained from a constant mean for $R_{it}$ follows GARCH(p,q) model then it can be specified as:

$$R_{it} = a_0 + a_1 R_{it-1} + \varepsilon_t \tag{9}$$

$$\varepsilon_t | \Omega_{t-1} \sim N(0, h_t) \tag{10}$$

$$h_t = \omega_0 + \sum_{i=1}^{p} \beta_i h_{t-i} + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 \tag{11}$$

where $h_t$ is the heteroskedastic conditional variance, which is correlated with the lagged error terms and conditional variance. To estimate the influence of EPU on the volatility of $R_{it}$, we modify the conditional variance:

$$h_t = b_0 + b_1 \varepsilon_{t-1}^2 + b_2 h_{t-1} + b_3 ChinaEPU_{t-1} + b_4\, JapanEPU_{t-1} + b_5 USEPU_{t-1} + b_6\, EuropeEPU_{t-1} \tag{12}$$

## 3. Data and empirical results

### 3.1. Data

The stock returns of 22 stock markets worldwide are analyzed to determine the effect of EPU in China, Japan, Europe, and the United States on investment risk in these stock markets and to determine the source of uncertainty that is most prone to causing global stock market volatility. These 22 stock markets comprised developed (i.e., Hong Kong, Japan, and Singapore) and emerging (i.e., China, Malaysia, the Philippines, South Korea, Taiwan, and Thailand) markets in Asia, developed markets in Europe (i.e., Belgium, France, Germany, the Netherlands, Spain, Switzerland, and the United Kingdom), developed (i.e., Canada and the United States) and emerging (i.e., Brazil and Mexico) markets in the Americas, and developed (i.e., Australia) and emerging (i.e., Republic of South Africa) markets in other regions. The classification of the aforementioned markets into developed or emerging markets was based on the method proposed by Morgan Stanley Capital International. The stock market index data were retrieved from the Datastream database. [3]

The sample data are monthly observations from January 1995 to September 2015, during which the world experienced the following regional and global financial crises: the 1997 Southeast Asian financial crisis, the 2000 dot-com bubble in the United States, the 2007 subprime mortgage crisis, the 2008 bankruptcy of Lehman Brothers, the 2010 European debt crisis, and the 2015 stock market crash in China. Some of these financial crises occurred in Asia, Europe, and the Americas, and some occurred in developed and emerging markets. Previous studies have focused on analyzing the severe impacts of financial crises on stock markets. In the present study, we explain that these financial crises will definitely result in policy changes in large

[2] The studies conducted by Diebold and Yilmaz (2009, 2012) estimated expected errors for 10 periods. The number of periods used was identical to that typically used during the general empirical estimation of a VAR model.

[3] The stock price indices employed in this study are as follows: Hang Seng Index-Hong Kong, NK-225 Index(Tokyo), FTSE Straits Times Index, Shanghai Synthesis Index, Kuala Lumpur-Stock Index, Manila-Stock Index, South Korea-KOSPI Index, TSE Weight Stock Index, Bangkok Set Stock Index, Brussels Bel 20 Stock Index, France Paris CAC40 Index, Germany DAX Index, Amsterdam AEX Stock Index, Madrid Stock Index, Zurich Market Stock Index, London-FTSE-100 Index, S & P/TSX Composite Index, N.Y. S & P 500 Stock Index, Brazil Bovespa Index, Mexico IPC Index, Sydney All Ordinaries Stock, and Johannesburg Stock Index.

**Table 1**
Descriptive statistics and unit root tests for Asian stock market indices.

| Variables | Developed market | | | Emerging market | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hong Kong | Japan | Singapore | China | Malaysia | Philippines | South Korea | Taiwan | Thailand |
| Mean | 16,389.0400 | 13,872.9700 | 2373.5260 | 1987.3940 | 1101.1060 | 3083.8160 | 1227.1280 | 7071.3030 | 796.8911 |
| Std. Dev. | 5432.3790 | 3820.9360 | 678.4041 | 973.3068 | 398.1769 | 1820.4280 | 565.5254 | 1501.6000 | 395.8539 |
| Skewness | 0.2850 | 0.2128 | 0.0462 | 1.2477 | 0.3957 | 1.1386 | 0.2157 | −0.1421 | 0.4855 |
| Kurtosis | 1.9332 | 1.9023 | 1.9038 | 5.0560 | 2.0626 | 3.2623 | 1.5365 | 2.1005 | 2.0155 |
| Unit root test (Variables in level) | | | | | | | | | |
| ADF test | −2.3140 | −1.6612 | −1.6720 | −2.2061 | −1.4436 | −0.3146 | −1.2627 | −2.4455 | −1.1795 |
| | (0.1684) | (0.4498) | (0.4443) | (0.2047) | (0.5606) | (0.9194) | (0.6472) | (0.1304) | (0.6838) |
| Lag Length | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| PP test | −2.3140 | −1.9594 | −1.9146 | −2.3672 | −1.4428 | −0.4122 | −0.9761 | −2.7880 | −1.2573 |
| | (0.1684) | (0.3048) | (0.3252) | (0.1522) | (0.5610) | (0.9037) | (0.7621) | (0.0614) | (0.6496) |
| Lag Length | 0 | 6 | 3 | 7 | 3 | 1 | 0 | 3 | 2 |
| Unit root test (Variables in differenced) | | | | | | | | | |
| ADF test | −15.0536 | −13.7337 | −13.8092 | −8.7646 | −13.1346 | −13.9694 | −13.1853 | −9.1402 | −14.9056 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| PP test | −15.0531 | −13.8074 | −13.8037 | −14.8820 | −13.0714 | −13.9499 | −13.1252 | −14.6023 | −14.9056 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 4 | 4 | 1 | 7 | 8 | 4 | 5 | 0 | 0 |

*Notes*: ADF and PP tests are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. The entry in parenthesis stands for the *p*-value.

**Table 2**
Descriptive statistics and unit root tests for European stock market indices.

| Variables | Developed market | | | | | | |
|---|---|---|---|---|---|---|---|
| | Belgium | France | Germany | Netherlands | Spain | Switzerland | United Kingdom |
| Mean | 2749.4540 | 3972.1380 | 5696.2940 | 474.9011 | 916.3817 | 6503.6530 | 5367.1560 |
| Std. Dev. | 737.4060 | 1118.8260 | 2169.5140 | 192.8075 | 313.3173 | 1627.1980 | 998.0192 |
| Skewness | 0.3803 | 0.1332 | 0.4670 | 1.7563 | 0.1558 | -0.4132 | -0.4380 |
| Kurtosis | 2.8478 | 2.6630 | 2.9482 | 6.3833 | 3.2513 | 2.6998 | 2.1491 |
| Unit root test (Variables in level) | | | | | | | |
| ADF test | −2.6529 | −2.4220 | −1.8979 | −1.6814 | −2.8332 | −2.9803 | −2.7859 |
| | (0.0839) | (0.1367) | (0.3330) | (0.4395) | (0.0551) | (0.0382) | (0.0617) |
| Lag Length | 1 | 0 | 0 | 0 | 0 | 1 | 0 |
| PP test | −2.6091 | −2.4948 | −1.9525 | −1.9337 | −2.7965 | −2.9713 | −2.8356 |
| | (0.0924) | (0.1180) | (0.3079) | (0.3165) | (0.0602) | (0.0390) | (0.0548) |
| Lag Length | 8 | 5 | 4 | 7 | 4 | 4 | 7 |
| Unit root test (Variables in differenced) | | | | | | | |
| ADF test | −12.5160 | −14.2474 | −14.6692 | −15.4475 | −14.1194 | −13.3930 | −15.5009 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| PP test | −12.7998 | −14.3020 | −14.6914 | −15.5520 | −14.1434 | −13.3993 | −15.5545 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 7 | 4 | 3 | 6 | 4 | 1 | 6 |

Notes: ADF and PP tests are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. The entry in parenthesis stands for the *p*-value.

economies and that the uncertainty generated from these changes will influence stock market investments in the long-term. Repeatedly implemented economic policies may cause stock markets to buddle and collapse. Data spanning the last 20 years is analyzed to determine which region mainly influences the uncertain factors of investment risk in the global stock market.

Each of Tables 1–4 respectively displays a simple statistical table and the unit root test results for the main stock price indices of the stock markets in Asia, Europe, the Americas, and other regions. Two types of unit root tests, namely the Augmented Dickey–Fuller (Said and Dickey, 1984) and Phillips–Perron (Phillips and Perron, 1988) tests, are adopted to examine whether the stock price indices are stationary.

**Table 3**
Descriptive statistics and unit root tests for stock market indices in the Americas.

| Variables | Developed market | | Emerging market | |
|---|---|---|---|---|
| | Canada | United States | Brazil | Mexico |
| Mean | 9854.1640 | 1219.5930 | 32,766.9300 | 19,328.3600 |
| Std. Dev. | 3173.3850 | 355.4726 | 22,231.1100 | 14,987.7300 |
| Skewness | −0.0133 | 0.3884 | 0.2179 | 0.3966 |
| Kurtosis | 1.7269 | 3.2601 | 1.4559 | 1.5574 |
| Unit root test (Variables in level) | | | | |
| ADF test | −2.1694 | −2.5190 | −1.9751 | −1.5110 |
| | (0.2182) | (0.1122) | (0.2978) | (0.5266) |
| Lag Length | 1 | 0 | 0 | 0 |
| PP test | -2.1423 | -2.5042 | -1.9721 | −1.5363 |
| | (0.2284) | (0.1157) | (0.2991) | (0.5137) |
| Lag Length | 3 | 6 | 5 | 2 |
| Unit root test (Variables in differenced) | | | | |
| ADF test | −12.9931 | −14.5050 | −15.7640 | −17.1749 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 0 | 0 | 0 | 0 |
| PP test | −12.9931 | −14.5896 | −15.7639 | −17.0739 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 0 | 5 | 5 | 5 |

*Notes*: ADF and PP tests are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. The entry in parenthesis stands for the *p*-value.

Because almost all the stock price indices are nonstationary[4] and the stock price index returns are stationary, the stock price index returns are hence used for estimations in this empirical study.

Table 5 displays a simple statistical table and the unit root test results for EPU in China, Japan, Europe, and the United States. Fig. 1 shows the EPU time series. [5] The EPU index used in this study is constructed in Baker et al. (2015) on the basis of newspaper coverage frequency. For example, Baker et al. (2015) constructs an EPU index for the United States on the basis of six major US newspapers published throughout the last century and develops an EPU index for a group of ten economies by following the same method. A high index reveals that the policies are highly uncertain. Fig. 1 displays the changes in EPU. EPU in China underwent a substantial change, in which the EPU index clearly peaks at four points: 2002, 2009, 2012, and 2015. The EPU index peaked in 2002 because of the September 11 attacks, in 2009 because of two US financial crises (in 2007 and 2008), and in 2012 because of the European debt crisis. The rises in the EPU index during these three periods were all influenced by international events. China is highly dependent on exports to the United States and Europe; however, protectionism emerged during these three periods mainly because of international events. The rise in the EPU index was possibly caused by Chinese policy adjustments that were due to the effects of global protectionism. For example, protectionism emerged neither during the 1997 Southeast Asian financial crisis nor during the 2000 US dot-com bubble, and thus these events did not produce substantial changes in China's economic environment.

The changes in the EPU index for Japan are regular and small. This is possibly because the government has continued to implement expansionary fiscal, monetary, and foreign exchange policies since the 1990 economic recession. Thus, the public may have expected the economy to improve when these policies were first launched; however, their expectations have declined over time.

The EPU index for Europe is a summation of EPU in many European countries and is mainly influenced by *the* European debt crisis and the euro crisis. The EPU index for Europe has remained high since 2011. The EPU index for the United States peaked twice during two periods: (1) after the September 11 attacks and (2) between 2008

[4] Only the stock price index in Switzerland remains stationary when the original index is used for estimation.

[5] More information for EPU data are available on www.policyuncertainty.com.

**Table 4**
Descriptive statistics and unit root tests for other stock market indices.

| Variables | Developed market<br>Australia | Emerging market<br>Republic of South Africa |
|---|---|---|
| Mean | 3945.5260 | 19,446.8500 |
| Std. Dev. | 1196.3150 | 12,898.8500 |
| Skewness | 0.2225 | 0.5846 |
| Kurtosis | 1.9716 | 2.0253 |
| Unit root test (Variables in level) | | |
| ADF test | −2.1142 | −0.6286 |
| | (0.2393) | (0.8605) |
| Lag Length | 0 | 0 |
| PP test | −2.1011 | −0.6266 |
| | (0.2445) | (0.8610) |
| Lag Length | 6 | 1 |
| Unit root test (Variables in differenced) | | |
| ADF test | −14.7021 | −15.7814 |
| | (0.0000) | (0.0000) |
| Lag Length | 0 | 0 |
| PP test | −14.8409 | −15.7814 |
| | (0.0000) | (0.0000) |
| Lag Length | 5 | 1 |

*Notes*: ADF and PP tests are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. The entry in parenthesis stands for the *p*-value.

**Table 5**
Descriptive statistics and unit root tests for EPU indices.

| Variables | China EPU | European EPU | Japan EPU | US EPU |
|---|---|---|---|---|
| Mean | 111.2252 | 123.8748 | 102.2057 | 110.1416 |
| Std. Dev. | 65.9354 | 49.4936 | 35.1909 | 43.9844 |
| Skewness | 1.3429 | 0.9440 | 0.6487 | 1.2696 |
| Kurtosis | 4.9700 | 3.4026 | 2.9813 | 4.5875 |
| Unit root test (Variables in level) | | | | |
| ADF test | −3.3557 | −4.0471 | −5.6907 | −5.6241 |
| | (0.0135) | (0.0014) | (0.0000) | (0.0000) |
| Lag Length | 3 | 1 | 1 | 0 |
| PP test | −9.8855 | −4.8991 | −7.8151 | −5.3810 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 9 | 5 | 4 | 2 |
| Unit root test (Variables in differenced) | | | | |
| ADF test | −14.7652 | −12.6849 | −22.5741 | −12.3802 |
| | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| Lag Length | 2 | 2 | 0 | 2 |
| PP test | −32.9052 | −29.5489 | −46.7468 | −26.8747 |
| | (0.0001) | (0.0000) | (0.0001) | (0.0000) |
| Lag Length | 8 | 18 | 48 | 23 |

*Notes*: ADF and PP tests are adopted for testing the null hypothesis of a unit root in the series. The intercept is included in the testing equation, and the lag length of the unit root models is selected by using the Schwarz information criterion. The entry in parenthesis stands for the *p*-value.

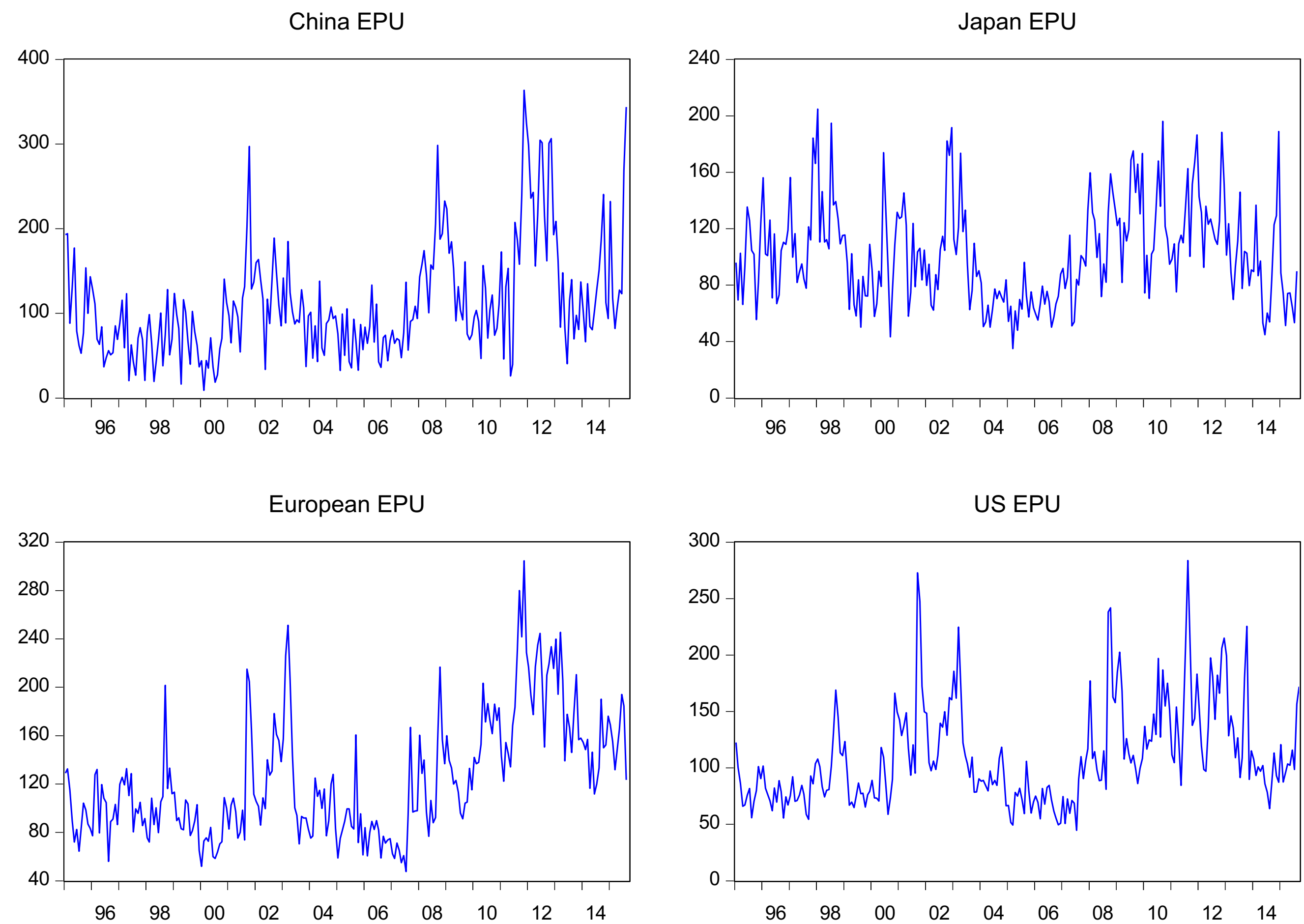


**Fig. 1.** EPU indices.

and 2013 (EPU continually increased after 2008 but began to decrease gradually in 2013).

As shown in Table 5, the results of the two types of unit root test both verify that the four EPU indices are in stationary series, thus indicating that the original EPU indices can be analyzed for conducting the empirical study. For the empirical study, we observe the effect of the two types of risk on stock returns and the relationships among the EPU indices.

### 3.2. Spillover indices and EPU indices

To measure the systematic risk in various stock markets, we first use Eq. (5) to calculate the spillover indices for various stock market returns because changes in these indices reveal the information transfer effects among the stock markets. A high spillover indicates that the connectivity among the stock markets and the dynamic correlations among the returns are high; therefore, the systematic risk is also high. In this study, spillover indices are used as the substitute variables for analyzing the systematic risks in various stock markets. Once negative information influences a stock market, the spillover effect on stock returns can be viewed as the spreading of a stock market crisis. Fig. 2 illustrates the six types of spillover indices, which are based on the following samples: all samples; samples from Asia, Europe, and the Americas; and all samples of the developed and emerging markets. Fig. 2 indicates that the largest event influencing stock market systematic risk occurred in 2008. Regardless of which of these classifications is adopted for dividing the regions, all regional systematic risk continually increased in 2008. Because a global financial crisis issued from the United States in September 2008, we attribute increased regional systematic risk in 2008 to a contagion effect of the crisis. Except for in 2008, stock market connectivity in European regions has continually increased since 2000, possibly because the circulation of a single currency reduced foreign exchange risk and increased transnational trade and financial investment in European regions. Consequently, the connectivity among stock markets continually increased.

Except for the regional risks of all of the pooled samples, the results of the samples divided into different categories all reveal that regional spillover effects declined after 2013. However, the estimation results obtained from the 22 stock markets reveal that the regional spillover effects in 2014 still increased abruptly and substantially. Therefore, the results indicate that global systematic risk is increasing but that systematic risk in regional, developed, and emerging markets is declining. This phenomenon indicates that information transfer among stock markets in 2014 was cross-regional and cross-market. For example, the strong connectivity between markets in China and Europe as well as the effect of the United States on emerging markets in Asia could all produce this phenomenon. To explore which factor of uncertainty mainly causes regional spillover effects (the substitute variables for systematic risk), we investigate which country mainly controls investments in the global stock market. Hence, causality tests for the spillover indices and EPU indices are conducted.

Table 6 displays the causality test results obtained from Eq. (6) and presents which economy's EPU mainly induces systematic risk in various regions. The results (Table 6) indicate that the stability of China's economic policy is the main factor influencing regional systematic risk. Except for the systematic risk in European regions, the systematic risk in the other categories, involving the systematic risk in stock market connectivity observed from all of the pooled samples, are all influenced by the EPU index for China. In other words, China's

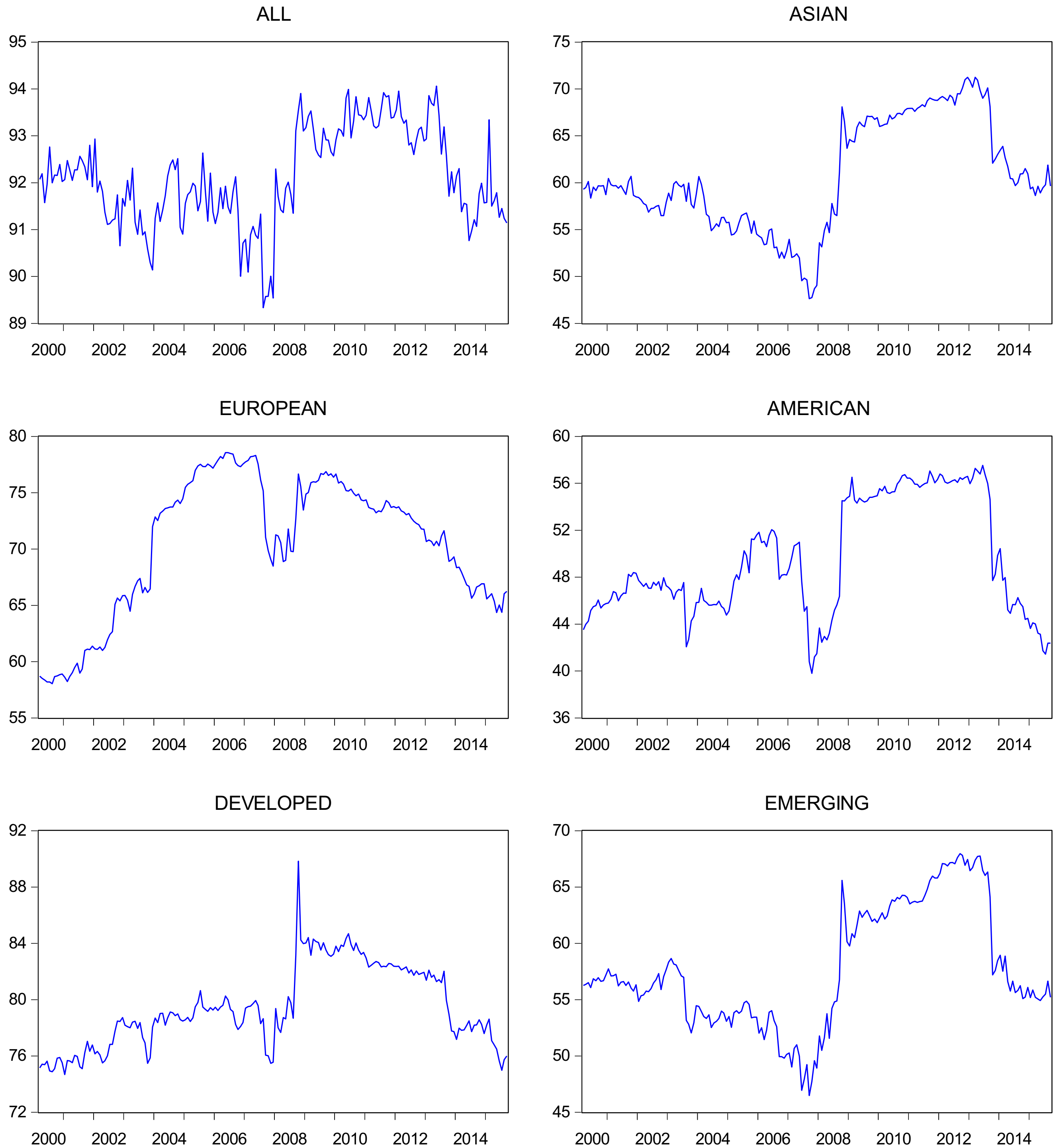


**Fig. 2.** Spillover indices.

EPU index causes information to exert a spillover effect on stock returns.

Regional risk in Europe is not influenced by the EPU index for China but neither is it relevant to the EPU indices for other regions (including Europe); in fact, the EPU index for Europe is irrelevant to all types of systematic risk. The results indicate that connectivity among European stock markets is more influenced by the policies that are or will certainly be implemented in local countries than by EPU.

We previously considered US policies to exert a strong effect on stock markets in other countries, particularly in Europe. However, we determine that the EPU index for the United States affects systematic risk in developed markets the most. This may result from the continuous implementation of US expansionary economic policy after 2007 because of the financial crisis. Specifically, the following simultaneously influence the funds of developed markets and exports from Asian countries: (1) the flow of US hot money (investment funds) and (2) the sporadic implementation of US policies that are more relaxed and the occasional constricted US attitudes toward trade negotiations. These markets are simultaneously influenced by whether changes occur in US policies. The EPU index for Japan has a strong effect on systematic risk in emerging markets; this can be determined by whether the adjustment of *quantitative* easing monetary policy influences the funds of emerging markets. In summary, emerging markets are most typically affected by EPU from other countries.

Table 7 displays which regional risk affects which EPU index and lists the causality test results obtained from Eq. (7). The Chinese stock market and global stock market crashed on August 24, 2015, leading the Fed to suspend raising interest rates in September 2015. The Fed's decision heightened the public's expectation of policy uncertainty. This event reveals that the fall of stock markets that share dynamic relationships can certainly lead to policy changes and cause economic policies to become increasingly uncertain. The results in Table 7 verify that the EPU indices for Japan and Europe are all influenced by high and low systematic risk in the Asian and emerging markets. This indicates that the policies implemented in these countries will change if financial crises are considered likely to occur in Asian and emerging markets. However, the EPU indices for China and the United States are exogenous and thus are not influenced by regional systematic risk.

### 3.3. Volatilities of stock markets and EPU indices

This study estimates the relationship between EPU and conditional volatility in individual stock markets to explore whether contagion risk spreads to stock markets in other countries when policies in China, Japan, Europe, and the United States undergo substantial changes. Table 8 lists the factors that affect the volatility of the Asian stock markets, with the coefficients $b_3$, $b_4$, $b_5$, and $b_6$ explaining the respective effects of EPU in China, Japan, the United States, and Europe on stock market volatility. The results in Table 8 indicate that the EPU indices for Japan and the United States are the main factors influencing Asian stock markets and that stock market volatility in Japan, China, and Malaysia are all influenced by these EPU indices. However, stock market volatility in Japan, Singapore, and Malaysia decreases as EPU in Europe increases.

Similar results are obtained from the stock markets in European countries. Table 9 indicates that EPU in China is the main factor influencing stock market volatility in European counties and that stock market volatility in Germany, Spain, and Switzerland are influenced by EPU in China. Stock market volatility in Spain and Switzerland, but not in Germany, decreases as EPU in China increases. Regarding systematic risk, we determine that contagion risk in European markets is not influenced by the EPU in China, Japan, Europe, or the United States and that the contagion risk effect of EPU in Europe will not spread to the global stock market. However, Tables 8 and 9 reveal that EPU in Europe and in China respectively influence Asian and European countries the most. We attribute this to extremely high trade dependence among these countries. A rise in EPU among trading partners may reduce stock market volatility because of trade competition instead of trade cooperation among these countries. Therefore, the revenues of local enterprises are stable when other markets are unstable.

Table 10 indicates that stock markets in the Americas are mainly influenced by the policies implemented in Japan; specifically, when EPU in Japan rises, stock market volatility in the United States and Brazil increases substantially. This indicates that the stock markets in these two countries are closely connected to Japanese policies. When Japan's polices are uncertain, volatility rises in the two markets. Table 11 reveals that stock market volatility in Australia is mainly influenced by the policies implemented in Japan and stock market in the Republic of South Africa is not influenced by the four EPU indices.

**Table 6**
Granger Causality Tests: EPU indices does not Granger Cause Spillover indices.

| Caused | Causing | | | |
|---|---|---|---|---|
| | China EPU | Japan EPU | European EPU | US EPU |
| All | **3.6442** **(0.0281)** | 2.6033 (0.0768) | 1.7442 (0.1777) | 3.0024 (0.0522) |
| Developed | **3.8326** **(0.0235)** | 0.3745 (0.6882) | 0.4870 (0.6153) | **3.0510** **(0.0498)** |
| Emerging | **5.5114** **(0.0048)** | **3.6870** **(0.0270)** | 1.2344 (0.2935) | 0.1041 (0.9012) |
| Asia | **3.6511** **(0.0279)** | 2.2845 (0.1048) | 0.8272 (0.4389) | 0.3364 (0.7148) |
| Americas | **3.9753** **(0.0205)** | 2.1412 (0.1205) | 0.3418 (0.7110) | 0.0492 (0.9520) |
| Europe | 0.7758 (0.4619) | 0.8533 (0.4277) | 0.6514 (0.5226) | 0.0241 (0.9762) |

*Notes*: The entry in parenthesis stands for the *p*-value. The number in bold denotes significance at the 5%.

## 4. Conclusion

This study explores whether EPU in China, Japan, Europe, and the United States results in contagion risk effects in the global stock market. The stock returns of 22 stock markets worldwide from 1995 to 2015 are analyzed to determine the sources of policy uncertainty that affect regional systematic risk in stock market investments and volatility risk in individual stock markets. In other words, we determine which economy has the most control over policies that affect stock market performance.

The empirical results answer the following questions:

1. Which region's EPU influences the global stock market the most?
   We determine that EPU in China is the most influential because, in addition to influencing Europe, it spreads contagion risk to all

**Table 7**
Granger Causality Tests: Spillover indices does not Granger Cause EPU indices.

| Causing | Caused | | | | | |
|---|---|---|---|---|---|---|
| | All | Developed | Emerging | Asia | Americas | Europe |
| China EPU | 0.6379 (0.5296) | 0.4494 (0.6387) | 1.4552 (0.2361) | 0.9621 (0.3840) | 0.0980 (0.9067) | 0.3864 (0.6801) |
| Japan EPU | 1.1756 (0.3110) | 1.3978 (0.25) | **4.1808** **(0.0168)** | **3.8045** **(0.0241)** | 1.3925 (0.2511) | 0.3033 (0.7388) |
| European EPU | **3.2533** **(0.0409)** | 0.7904 (0.4553) | **5.7244** **(0.0039)** | **4.4502** **(0.0130)** | 1.8231 (0.1645) | 0.0416 (0.9593) |
| US EPU | 0.5768 (0.5627) | 0.5200 (0.5954) | 1.6836 (0.1886) | 1.1741 (0.3115) | 0.6008 (0.5495) | 0.2570 (0.7736) |

*Notes*: The entry in parenthesis stands for the *p*-value. The number in bold denotes significance at the 5%.

**Table 8**
Estimations for Asian stock market volatilities.

| Variables | Developed country | | | Emerging market | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Hong Kong | Japan | Singapore | China | Malaysia | Philippines | South Korea | Taiwan | Thailand |
| Mean equation | | | | | | | | | |
| $a_0$ | 0.0071 (0.0919) | −0.0028 (0.4940) | −0.0060 (0.2556) | 0.0026 (0.5637) | 0.0043 (0.4419) | 0.0075 (0.0798) | 0.0045 (0.2590) | 0.0061 (0.1052) | 0.0050 (0.2297) |
| $a_1$ | 0.0892 (0.2762) | -0.0195 (0.7951) | 0.1782 (0.0612) | 0.1132 (0.1002) | 0.0308 (0.7770) | 0.1134 (0.1634) | 0.0621 (0.4250) | −0.013 (0.8596) | 0.0842 (0.2318) |
| Variance equation | | | | | | | | | |
| $b_0$ | 0.0002 (0.2701) | 0.0021** (0.0184) | 0.0019*** (0.0035) | 0.0002 (0.5342) | 0.0021*** (0.0001) | 0.0001 (0.3348) | 0.00003 (0.7990) | 0.0003** (0.0485) | 0.0001 (0.6276) |
| $b_1$ | 0.1723*** (0.0018) | 0.1287*** (0.0000) | 0.2643*** (0.0033) | 0.1510*** (0.0068) | 0.2315*** (0.0000) | 0.0725*** (0.0047) | 0.1087 (0.0757) | 0.3001*** (0.0075) | 0.1857*** (0.0005) |
| $b_2$ | 0.7719*** (0.0000) | 0.5101*** (0.0023) | 0.5136*** (0.0000) | 0.7817*** (0.0000) | 0.5496*** (0.0000) | 0.9079*** (0.0000) | 0.8443*** (0.0000) | 0.6647*** (0.0000) | 0.7988*** (0.0000) |
| $b_3$ | 0.0007 (0.1633) | 0.0009 (0.0915) | −0.0001 (0.8144) | 0.0004 (0.2565) | −0.0008*** (0.0008) | −0.0004 (0.2446) | 0.0005 (0.1064) | 0.0006 (0.1323) | 0.00003 (0.9417) |
| $b_4$ | −0.0009 (0.2611) | −0.0040*** (0.0025) | −0.0002 (0.8594) | 0.0036** (0.0119) | −0.0042*** (0.0009) | 0.0013 (0.2695) | 0.0017 (0.1677) | −0.0018*** (0.0045) | 0.0022 (0.1147) |
| $b_5$ | −0.0012 (0.8595) | 0.0266*** (0.0005) | 0.0271*** (0.0000) | −0.0336*** (0.0015) | 0.0194*** (0.0001) | 0.0059 (0.3478) | −0.0064 (0.2367) | −0.0044 (0.1891) | −0.0033 (0.6999) |
| $b_6$ | 0.0011 (0.3847) | −0.0052*** (0.0001) | −0.0066*** (0.0000) | 0.0024 (0.3331) | −0.0044*** (0.0000) | 0.0001 (0.9268) | 0.0014 (0.3371) | 0.0017 (0.1552) | 0.0003 (0.8655) |
| R-squared | −0.0032 | −0.0082 | 0.0025 | 0.0025 | 0.0089 | 0.0105 | 0.0171 | −0.0074 | −0.0013 |
| Log likelihood | 323.2691 | 344.4191 | 341.2560 | 281.8330 | 346.7673 | 319.0872 | 312.7243 | 330.9484 | 292.6071 |
| Akaike AIC | −2.5550 | −2.7270 | −2.7013 | −2.2182 | −2.7461 | −2.5210 | −2.4693 | −2.6175 | −2.3057 |
| Schwarz SC | −2.4268 | −2.5987 | −2.5730 | −2.0899 | −2.6178 | −2.3928 | −2.3411 | −2.4892 | −2.1775 |

*Notes*: Numbers in parentheses are standard errors.
** indicates significance at the 5% level.
*** indicates significance at the 1% level.

**Table 9**
Estimations for European stock market volatilities.

| Variables | Developed country | | | | | | |
|---|---|---|---|---|---|---|---|
| | Belgium | France | Germany | Netherlands | Spain | Switzerland | United Kingdom |
| Mean equation | | | | | | | |
| $a_0$ | 0.0055 (0.1577) | 0.0062 (0.0727) | 0.0079** (0.0431) | 0.0003 (0.9827) | 0.0122** (0.0425) | 0.0051 (0.3860) | 0.0040*** (0.0015) |
| $a_1$ | 0.2212*** (0.0034) | 0.0367 (0.6200) | −0.0352 (0.6465) | 0.0111 (0.9461) | 0.1300 (0.1495) | 0.0913 (0.3441) | −0.1920*** (0.0080) |
| Variance equation | | | | | | | |
| $b_0$ | 0.0014** (0.0375) | 0.0004 (0.0778) | 0.0011*** (0.0072) | 0.0053 (0.4160) | 0.0025 (0.2414) | 0.0017 (0.2319) | 0.0001 (0.1640) |
| $b_1$ | 0.0676** (0.0364) | 0.1736** (0.0226) | 0.1085** (0.0345) | −0.0247*** (0.0000) | −0.0145 (0.8367) | 0.0475** (0.0131) | 0.1497** (0.0105) |
| $b_2$ | 0.5545** (0.0104) | 0.6813*** (0.0000) | 0.5764*** (0.0000) | 0.5944 (0.2607) | 0.5881 (0.1520) | 0.5926 (0.0946) | 0.706*** (0.0000) |
| $b_3$ | −0.0005*** (0.0000) | 0.0003 (0.2902) | 0.0009*** (0.0000) | −0.0004 (0.8601) | −0.001*** (0.0000) | −0.0008*** (0.0079) | 0.0003 (0.0956) |
| $b_4$ | −0.0007 (0.4572) | 0.0016**(0.0490) | 0.0011 (0.1976) | −0.0006 (0.9236) | −0.0009 (0.4966) | −0.0006 (0.5208) | 0.0011*** (0.0018) |
| $b_5$ | 0.0100 (0.1213) | 0.0041 (0.3794) | 0.0162*** (0.0047) | −0.0003 (0.9944) | 0.0071 (0.3855) | 0.0013 (0.9110) | −0.0052 (0.0781) |
| $b_6$ | −0.0026*** (0.0049) | −0.0019** (0.0352) | −0.0042*** (0.0000) | −0.0002 (0.9717) | −0.0004 (0.8880) | −0.0007 (0.6172) | 0.0007 (0.2494) |
| R-squared | 0.0452 | 0.0030 | -0.0062 | 0.0001 | −0.0088 | 0.0196 | −0.0406 |
| Log likelihood | 401.6747 | 383.8233 | 356.8595 | 260.3424 | 340.1475 | 393.7927 | 457.4675 |
| Akaike AIC | −3.1925 | −3.0473 | −2.8281 | −2.0434 | −2.6923 | −3.1284 | −3.6461 |
| Schwarz SC | −3.0642 | −2.9191 | −2.6999 | −1.9152 | −2.564 | −3.0002 | −3.5178 |

*Notes*: Numbers in parentheses are standard errors.
** indicates significance at the 5% level.
*** indicates significance at the 1% level.

other regions. Regarding the effect of EPU in China on individual stock markets, European stock markets are most vulnerable to its effect. Different from other previous studies that have mainly explored the effect of EPU in the United States, we find that political and economic situations in China spread contagion risk in the global stock market, possibly because this study focuses on exploring the effect of policy uncertainty on risk in stock markets. Although the United States is the largest economy in the world, the stability of US policy is high, and the policies are implemented under consideration of the global economic situation, thus preventing the Unites States from spreading risk from EPU to stock markets. By contrast, EPU in China is relatively more exogenous, and thus policy uncertainty did not result from China's responses to situations in other countries. Therefore, risk from EPU in China easily spreads to other countries.

2. Does EPU influence regional systematic risk or volatility risk in individual stock markets?

   EPU in China spreads its systematic risk easily, and EPU in Europe easily spreads volatility risk in individual markets. The

**Table 10**
Estimations for stock market volatilities in the Americas.

| Variables | Developed market | | Emerging market | |
|---|---|---|---|---|
| | Canada | United States | Brazil | Mexico |
| Mean equation | | | | |
| $a_0$ | 0.0054** (0.0471) | 0.0079*** (0.0016) | 0.0100** (0.0467) | 0.0142** (0.0148) |
| $a_1$ | 0.0987 (0.1953) | −0.0372 (0.6471) | 0.0776 (0.3390) | −0.0567 (0.4614) |
| Variance equation | | | | |
| $b_0$ | 0.0001 (0.3945) | 0.0001 (0.3670) | 0.0005 (0.2008) | 0.0027** (0.0219) |
| $b_1$ | 0.1186*** (0.0047) | 0.1711*** (0.0054) | 0.1399 (0.0742) | 0.0402 (0.4825) |
| $b_2$ | 0.8080*** (0.0000) | 0.7632*** (0.0000) | 0.7200*** (0.0000) | 0.5334*** (0.0036) |
| $b_3$ | 0.0004 (0.0524) | 0.0002 (0.1474) | 0.0020** (0.0430) | −0.0008** (0.0285) |
| $b_4$ | 0.0002 (0.6649) | 0.0010*** (0.0096) | 0.0046*** (0.0098) | 0.0022 (0.0502) |
| $b_5$ | −0.0029 (0.4282) | 0.0023 (0.3831) | −0.0185 (0.1390) | 0.0131 (0.1743) |
| $b_6$ | 0.0005 (0.3255) | −0.0004 (0.4963) | 0.0010 (0.6579) | −0.0052*** (0.0041) |
| R-squared | 0.0252 | −0.0094 | −0.0074 | −0.0018 |
| Log likelihood | 439.5120 | 440.9577 | 268.8045 | 321.8824 |
| Akaike AIC | −3.5001 | −3.5119 | −2.1122 | −2.5438 |
| Schwarz SC | −3.3719 | −3.3836 | −1.9840 | −2.4155 |

*Notes*: Numbers in parentheses are standard errors.
** indicates significance at the 5% level.
*** indicates significance at the 1% level.

**Table 11**
Estimations for other stock market volatilities.

| Variables | Developed country | Emerging market |
|---|---|---|
| | Australia | Republic of South Africa |
| Mean equation | | |
| $a_0$ | 0.0070*** (0.0016) | 0.0100 (0.0963) |
| $a_1$ | −0.0198 (0.8019) | −0.0700 (0.5338) |
| Variance equation | | |
| $b_0$ | 0.0003*** (0.0003) | 0.0023 (0.1944) |
| $b_1$ | 0.2201*** (0.0038) | −0.0482 (0.0737) |
| $b_2$ | 0.4922*** (0.0000) | 0.5915 (0.0637) |
| $b_3$ | 0.0003 (0.1758) | −0.0002 (0.7971) |
| $b_4$ | 0.0011*** (0.0014) | 0.0002 (0.9051) |
| $b_5$ | −0.0033 (0.2341) | 0.0122 (0.4293) |
| $b_6$ | 0.0009 (0.0784) | 0.0015 (0.6006) |
| R-squared | −0.0090 | −0.0040 |
| Log likelihood | 473.6660 | 354.0119 |
| Akaike AIC | −3.7778 | −2.8050 |
| Schwarz SC | −3.6495 | −2.6767 |

*Notes*: Numbers in parentheses are standard errors.
*** indicates significance at the 1% level.

results reveal that volatility risk in the individual markets of Europe and Asia are highly correlated with EPU. We attribute this to their trade connectivity.

3. Does contagion risk in developed and emerging markets originate from the same source?

We determine that emerging markets are most easily influenced by EPU from other countries because of the following reasons: (1) high economic autonomy in emerging markets and (2) both the funds for trade and stock market investment in emerging markets are easily influenced by the policies of developed countries. Contagion risk, particularly since 2013, has been associated with a trend of cross-continental and cross-market classifications (the developed and emerging markets). For example, EPU in China influences European stock markets. We consider that this trend can explain the effects of the upsurge in international investment. Consequently, investors must look beyond regional perspectives when judging and assessing stock market investment risk.

By addressing these questions and determining the empirical results, we reiterate the effect of contagion risk from EPU on countries worldwide. Investors in different regions must consider the risks associated with the policies implemented by large economies. The results reveal that, if the policies implemented in every country are unstable, then the frequency and magnitude of a global financial crisis may increase. Transnational financial organizations such as the International Monetary Fund and the World Bank should enhance their assessments of policy risk in large economies.

## Acknowledgement

I would like to thank Professor Paresh Narayan (Co-Editor) and the anonymous referee for the constructive comments of this paper.

## References

Aastveit, K., Natvik, G.J., Sola, S., 2013. Economic Uncertainty and the Effectiveness of Monetary Policy. Norges Bank Working Paper, Oslo, Norway.
Alexopoulos, M., Cohen, J., 2009. Measuring our ignorance, one book at a time: new indicators of technological change, 1909–1949. J. Monetary Econ. 56 (4), 450–470.
Baker, S.R., Bloom, N., Davis, S.J. Measuring economic policy uncertainty. Chicago Booth Research Paper 13-02 2013
Baker, S.R., Bloom, R.N., Davis, S.J. 2015.Measuring Economic Policy Uncertainty. NBER working paper series. ⟨http://www.nber.org/papers/w21633⟩
Bloom, Nicholas, 2009. The impact of uncertainty shocks. Econometrica 77 (3), 623–685.
Caggiano, G., Castelnuovo, E., Groshenny, N., 2014. Uncertainty shocks and unemployment dynamics in U.S. recessions. J. Monetary Econ. 67, 78–92.
Colombo, V., 2013. Economic policy uncertainty in the US: does it matter for the Euro area? Econ. Lett. 121 (1), 39–42.
Diebold, F.X., Yilmaz, K., 2009. Measuring financial asset return and volatility spillovers, with application to global equity markets. Econ. J. 119 (1), 158–171.
Diebold, F.X., Yilmaz, K., 2012. Better to give than to receive: predictive directional measurement of volatility spillovers. Int. J. Forecast. 28 (1), 57–66.
Ko, J.-H., Lee, C.-M., 2015. International economic policy uncertainty and stock prices: wavelet approach. Econ. Lett. 134, 118–122.
Leduc, S. and Liu, Z. 2015. Uncertainty Shocks are Aggregate Demand Shocks. Federal Reserve Bank of San Francisco Working Paper, ⟨http://www.frbsf.org/economic-research/files/wp12-10bk.pdf⟩
Li, X.-M., Zhang, B., Gao, R., 2015. Economic policy uncertainty shocks and stock–bond correlations: evidence from the US market. Econ. Lett. 132, 91–96.
Liu, L., Zhang, T., 2015. Economic policy uncertainty and stock market volatility. Financ. Res. Lett.. http://dx.doi.org/10.1016/j.frl.2015.08.009.
Nodari, G., 2014. Financial regulation policy uncertainty and credit spreads in the US. J. Macroecon. 41, 122–132.
Phillips, P.C.B., Perron, P., 1988. Testing for a unit root in time series regression. Biometrika 75 (2), 335–346.
Scheffel, E.M., 2015. Accounting for the political uncertainty factor. J. Appl. Econom.. http://dx.doi.org/10.1002/jae.2455.
Sum, V., 2012. Economic policy uncertainty in the United States and Europe: a cointegration test. Int. J. Econ. Financ. 5 (2), 98–101.
Wang, Y., Zhang, B., Diao, X., Wu, C., 2015. Commodity price changes and the predictability of economic policy uncertainty. Econo. Lett. 127, 39–42.
Wang, Y., Chen, C.R., Huang, Y.S., 2014. Economic policy uncertainty and corporate investment: evidence from China. Pacific-Basin Financ. J. 26, 227–243.
Zhang, G., Han, J., Pan, Z., Huang, H., 2015. Economic policy uncertainty and capital structure choice: evidence from China. Econ. Syst. 39 (3), 439–457.
Said, S., Dickey, D., 1984. Testing for unit roots in autoregressive-moving average model of unknown order. Biometrika 71, 599–607.