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PIER PUEY UNGPHAKORN INSTITUTE FOR ECONOMIC RESEARCH

# Dynamic Connectedness in Emerging Asian Equity Markets

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# Topics of Presentation

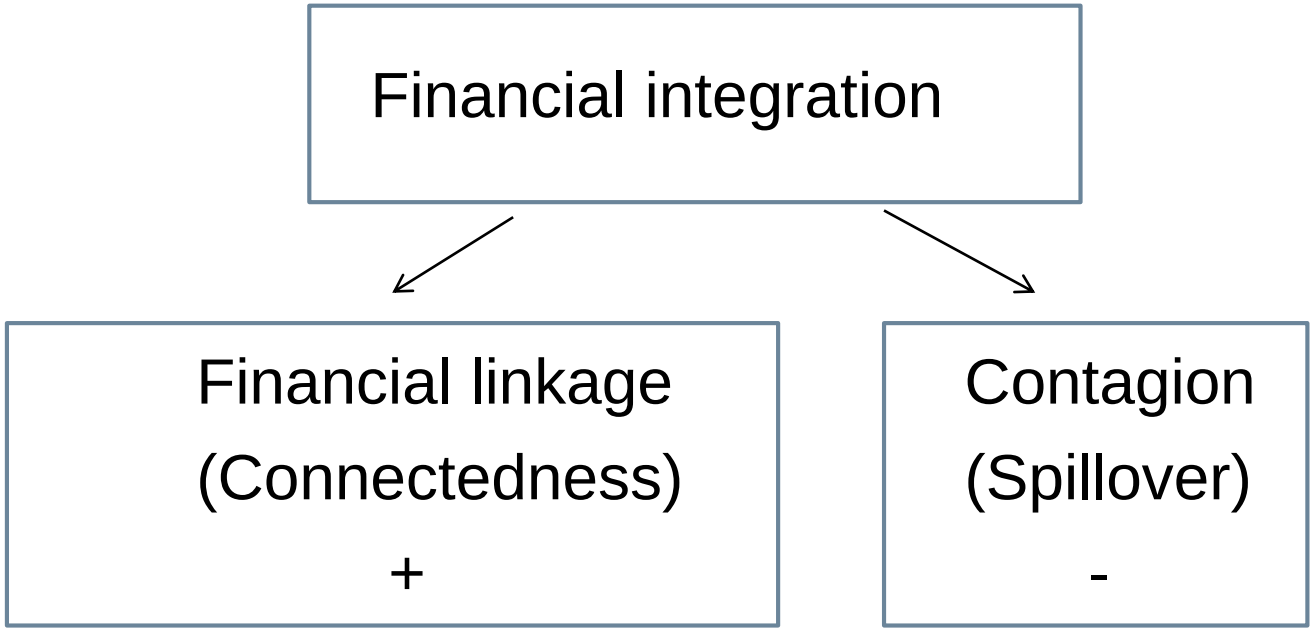


- Introduction
- How to measure return and volatility spillovers
- Pattern of spillovers in emerging Asian equity markets
- The role of uncertainty on dynamic connectedness

# Motivation



Key Feature in International Financial Market



# Motivation



Conventional features of International financial market

- Increasing degree of financial linkages, especially those between advanced and emerging markets.
- Even though, emerging countries are quickly integrated into global financial markets (especially, emerging Asian countries). The degree of financial integration are still lower than those of linkages between advanced markets.
- Spillovers of shocks are asymmetries (Spillover are usually found in one directional from advanced to emerging markets)

# Testing & Measurements



Econometrics tests & measurements of connectedness & spillover

- VAR results: Impulse response, causality tests (mean spillovers)
- GARCH results: Univariate GARCH with exogenous variables, Multivariate GARCH (variance spillover)
- Correlation coefficients

(degree of connectedness, no directional of linkages)

  - Statics
  - Dynamic (e.g. DCC-GARCH)

- Network measures
- Variance decomposition

# Dynamic Connectedness in Asia



- In the last two decades, the rapid trade and financial integration makes emerging Asia an important part of world economy and financial system.
- Therefore, spillover measures provide important information for monitoring the risk of financial crisis over time & provide crucial information for explaining contagion mechanism.

# Objectives of the study



- This paper examines dynamic connectedness for international equity market with a focus on emerging Asia.
- We not only investigate the pattern of spillovers but also examine the role of economic policy uncertainty on dynamic of market connectedness.

# Literature Review



Measurement of dynamic connectedness

1. Multi Variate GARCH apporch

- BEKK GARCH (Karolyi,1995; Kanas, 1998)

- Dynamic Conditional Correlation GARCH (Savva et al, 2009; Bilio & Coporin, 2010; Chiang et al 2007; Yiu et al, 2010)

2. VAR approach

- Dynamic connectedness index (spillover index), Diebold – Yilmaz (2009, 2012, 2014, 2018)

The risk factor in global market are usually found to be determinant of spillover,

- Min & Hwang (2012) – VIX index, TED spread, Market Cap
- Chiang et al (2007) – Country credit rating
- Hwang et al (2013) – CDS spread TED spread, VIX

# How to measure spillovers?



- Diebold and Yilmaz (2009) proposed a quantitative measure of spillovers based on the information from Variance Decomposition (VD) of forecast error associated with the *N*-variables Vector AutoRegressive (VAR) model

- Cholesky decomposition and the generalized VAR framework of Koop, Pesaran, and Potter (1996) and Pesaran and Shin (1998) (KPPS, henceforth) are used to calculate Variance Decomposition.

# How to measure spillovers?



- The econometric methodology of Diebold and Yilmaz (2009, 2012) can be summarized as follows

Consider the simple case of the standard the p-lag N-variable stationary VAR model,

$$X_t = \Phi_1 X_{t-1} + \cdots + \Phi_p X_{t-p} + Bc + \varepsilon_t$$

where $X_t = \{X_{1,t}, X_{2,t}, \ldots, X_{N,t}\}$ is a matrix of endogenous variables

# Dynamic Connected Index



- The VDs represent the contribution of a one-standard deviation shock of $X_j$ to the variance of the *H*-step ahead forecast error of $X_i$.

- The total spillover index that measures the contribution of spillovers across *N* variables to total forecast error variances is then calculated as follow,

$$TS(H) = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{i,j}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{i,j}(H)} \times 100 = \frac{\sum_{i,j=1,i\neq j}^{N} \tilde{\theta}_{i,j}(H)}{N} \times 100$$

- where $\tilde{\theta}_{i,j}(H)$ represent variance decomposition the contribution of a one-standard deviation shock of $X_j$ to the variance of the H-step ahead forecast error of $X_i$.

# Dynamic Connected Index



- The directional spillovers gauge the direction spillovers GIVEN by country i to all other countries j ($DS_{i\rightarrow}.(H)$)

$$DS_{i\rightarrow}.(H) = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\theta}_{j,i}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{j,i}(H)} \times 100 = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\theta}_{j,i}(H)}{N} \times 100$$

- The amounts of spillovers RECEIVED by country i from all other countries j ($DS._{\rightarrow i}(H)$) can be measured by

$$DS._{\rightarrow i}(H) = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\theta}_{i,j}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{i,j}(H)} \times 100 = \frac{\sum_{j=1,j\neq i}^{N} \tilde{\theta}_{i,j}(H)}{N} \times 100$$

# Dynamic Connected Index



- Specifically, the directional spillover indices separate the total spillover into those coming from (or to) a particular source.

- Diebold and Yilmaz (2012) also introduce the net spillovers and net pairwise spillovers indices. However, our paper will focus on the total spillovers as the indicators of global financial conditions and the directional spillovers for investigating the determinants of spillovers in both directions.

# Dynamic Connected Index



Table 3

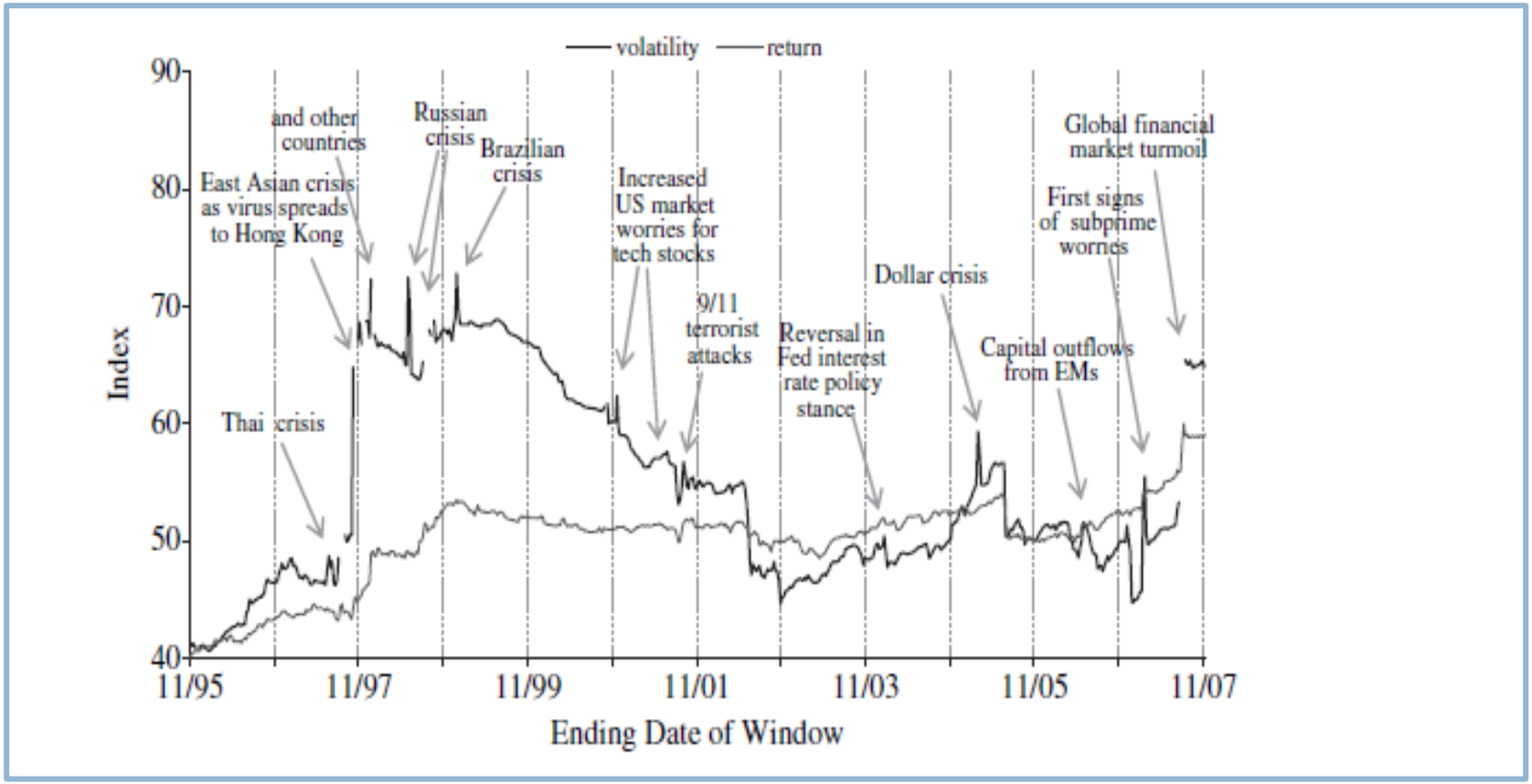
*Spillover Table, Global Stock Market Returns, 10/1/1992–23/11/2007*

| | From | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| To | US | UK | FRA | GER | HKG | JPN | AUS | IDN | KOR | MYS | PHL | SGP | TAI | THA | ARG | BRA | CHL | MEX | TUR | Contribution From Others |
| US | 93.6 | 1.6 | 1.5 | 0.0 | 0.3 | 0.2 | 0.1 | 0.1 | 0.2 | 0.3 | 0.2 | 0.2 | 0.3 | 0.2 | 0.1 | 0.1 | 0.0 | 0.5 | 0.3 | 6 |
| UK | 40.3 | 55.7 | 0.7 | 0.4 | 0.1 | 0.5 | 0.1 | 0.2 | 0.2 | 0.3 | 0.2 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.0 | 0.4 | 0.5 | 44 |
| FRA | 38.3 | 21.7 | 37.2 | 0.1 | 0.0 | 0.2 | 0.3 | 0.3 | 0.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.3 | 0.1 | 0.1 | 0.1 | 0.1 | 0.3 | 63 |
| GER | 40.8 | 15.9 | 13.0 | 27.6 | 0.1 | 0.1 | 0.3 | 0.4 | 0.6 | 0.1 | 0.3 | 0.3 | 0.0 | 0.2 | 0.0 | 0.1 | 0.0 | 0.1 | 0.1 | 72 |
| HKG | 15.3 | 8.7 | 1.7 | 1.4 | 69.9 | 0.3 | 0.0 | 0.1 | 0.0 | 0.3 | 0.1 | 0.0 | 0.2 | 0.9 | 0.3 | 0.0 | 0.1 | 0.3 | 0.4 | 30 |
| JPN | 12.1 | 3.1 | 1.8 | 0.9 | 2.3 | 77.7 | 0.2 | 0.3 | 0.3 | 0.1 | 0.2 | 0.3 | 0.3 | 0.1 | 0.1 | 0.0 | 0.0 | 0.1 | 0.1 | 22 |
| AUS | 23.2 | 6.0 | 1.3 | 0.2 | 6.4 | 2.3 | 56.8 | 0.1 | 0.4 | 0.2 | 0.2 | 0.2 | 0.4 | 0.5 | 0.1 | 0.3 | 0.1 | 0.6 | 0.7 | 43 |
| IDN | 6.0 | 1.6 | 1.2 | 0.7 | 6.4 | 1.6 | 0.4 | 77.0 | 0.7 | 0.4 | 0.1 | 0.9 | 0.2 | 1.0 | 0.7 | 0.1 | 0.3 | 0.1 | 0.4 | 23 |
| KOR | 8.3 | 2.6 | 1.3 | 0.7 | 5.6 | 3.7 | 1.0 | 1.2 | 72.8 | 0.0 | 0.0 | 0.1 | 0.1 | 1.3 | 0.2 | 0.2 | 0.1 | 0.1 | 0.7 | 27 |
| MYS | 4.1 | 2.2 | 0.6 | 1.3 | 10.5 | 1.5 | 0.4 | 6.6 | 0.5 | 69.2 | 0.1 | 0.1 | 0.2 | 1.1 | 0.1 | 0.6 | 0.4 | 0.2 | 0.3 | 31 |
| PHL | 11.1 | 1.6 | 0.3 | 0.2 | 8.1 | 0.4 | 0.9 | 7.2 | 0.1 | 2.9 | 62.9 | 0.3 | 0.4 | 1.5 | 1.6 | 0.1 | 0.0 | 0.1 | 0.2 | 37 |
| SGP | 16.8 | 4.8 | 0.6 | 0.9 | 18.5 | 1.3 | 0.4 | 3.2 | 1.6 | 3.6 | 1.7 | 43.1 | 0.3 | 1.1 | 0.8 | 0.5 | 0.1 | 0.3 | 0.4 | 57 |
| TAI | 6.4 | 1.3 | 1.2 | 1.8 | 5.3 | 2.8 | 0.4 | 0.4 | 2.0 | 1.0 | 1.0 | 0.9 | 73.6 | 0.4 | 0.8 | 0.3 | 0.1 | 0.3 | 0.0 | 26 |
| THA | 6.3 | 2.4 | 1.0 | 0.7 | 7.8 | 0.2 | 0.8 | 7.6 | 4.6 | 4.0 | 2.3 | 2.2 | 0.3 | 58.2 | 0.5 | 0.2 | 0.1 | 0.4 | 0.3 | 42 |
| ARG | 11.9 | 2.1 | 1.6 | 0.1 | 1.3 | 0.8 | 1.3 | 0.4 | 0.4 | 0.6 | 0.4 | 0.6 | 1.1 | 0.2 | 75.3 | 0.1 | 0.1 | 1.4 | 0.3 | 25 |
| BRA | 14.1 | 1.3 | 1.0 | 0.7 | 1.3 | 1.4 | 1.6 | 0.5 | 0.5 | 0.7 | 1.0 | 0.8 | 0.1 | 0.7 | 7.1 | 65.8 | 0.1 | 0.6 | 0.7 | 34 |
| CHL | 11.8 | 1.1 | 1.0 | 0.0 | 3.2 | 0.6 | 1.4 | 2.3 | 0.3 | 0.3 | 0.1 | 0.9 | 0.3 | 0.8 | 2.9 | 4.0 | 65.8 | 2.7 | 0.4 | 34 |
| MEX | 22.2 | 3.5 | 1.2 | 0.4 | 3.0 | 0.3 | 1.2 | 0.2 | 0.3 | 0.9 | 1.0 | 0.1 | 0.3 | 0.5 | 5.4 | 1.6 | 0.3 | 56.9 | 0.6 | 43 |
| TUR | 3.0 | 2.5 | 0.2 | 0.7 | 0.6 | 0.9 | 0.6 | 0.1 | 0.6 | 0.3 | 0.6 | 0.1 | 0.9 | 0.8 | 0.5 | 1.1 | 0.6 | 0.2 | 85.8 | 14 |
| Contribution to others | 292 | 84 | 31 | 11 | 81 | 19 | 11 | 31 | 14 | 16 | 10 | 8 | 6 | 12 | 21 | 9 | 3 | 8 | 7 | 675.0 |
| Contribution including own | 386 | 140 | 68 | 39 | 151 | 97 | 68 | 108 | 86 | 85 | 73 | 51 | 79 | 70 | 97 | 75 | 68 | 65 | 92 | Spillover index = 35.5% |

- Source: Diebold-Yilmaz (2009)

# Dynamic Connected Index






- Source: Diebold-Yilmaz (2009)

# Data



- Weekly data of the main equity market from D 3 groups of countries (15 countries altogether) are used in this study.

1. Emerging Asia

- China (CHN), India (IND), Indonesia (IDN), Malaysia (MYS), the Philippines (PHL), and Thailand (THA)

2. Advanced Asia

- Australia (AUS), Hong Kong (HKG), Japan (JPN), South Korea (KOR), Taiwan (TAI)

3. Other advanced economies

- France (FRA), Germany (GER), the United States (US), the United Kingdom (UK)

# Return Spillover Table



Spillover Table, International Equity Market Returns:

| To | From | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THA | MYS | IDN | PHL | HKG | KOR | IND | JPN | CHN | TAI | AUS | GER | UK | FRA | US | Contribution from others |
| THA | 33.9 | 6.0 | 7.9 | 7.8 | 6.7 | 6.4 | 2.7 | 3.1 | 0.2 | 3.7 | 4.6 | 4.4 | 4.7 | 4.3 | 3.8 | 66 |
| MYS | 7.7 | 40.1 | 8.2 | 6.7 | 7.4 | 3.7 | 2.3 | 2.9 | 0.1 | 4.0 | 3.9 | 3.7 | 3.4 | 3.1 | 2.9 | 60 |
| IDN | 8.3 | 7.0 | 34.4 | 8.2 | 6.3 | 4.8 | 3.7 | 3.7 | 0.4 | 3.0 | 4.9 | 4.0 | 3.8 | 4.0 | 3.3 | 66 |
| PHL | 8.5 | 5.9 | 8.4 | 34.3 | 7.4 | 3.5 | 2.4 | 3.0 | 0.1 | 4.1 | 5.7 | 4.0 | 4.6 | 4.1 | 4.0 | 66 |
| HKG | 4.9 | 4.5 | 4.4 | 5.0 | 25.0 | 5.7 | 3.4 | 5.1 | 0.2 | 4.9 | 7.7 | 7.1 | 8.1 | 7.3 | 6.7 | 75 |
| KOR | 6.3 | 2.9 | 4.0 | 2.8 | 7.4 | 33.0 | 4.1 | 6.0 | 0.2 | 5.3 | 5.6 | 5.8 | 5.6 | 5.6 | 5.1 | 67 |
| IND | 3.3 | 2.3 | 4.0 | 2.9 | 5.8 | 5.1 | 39.1 | 4.8 | 0.9 | 3.7 | 5.2 | 6.2 | 5.8 | 6.2 | 4.8 | 61 |
| JPN | 2.7 | 2.1 | 3.1 | 2.7 | 6.1 | 5.5 | 3.6 | 29.7 | 0.3 | 4.0 | 8.4 | 7.6 | 7.7 | 8.4 | 8.0 | 70 |
| CHN | 0.6 | 0.7 | 1.2 | 0.5 | 1.4 | 0.5 | 1.9 | 0.9 | 84.8 | 1.4 | 1.4 | 1.4 | 1.0 | 1.2 | 1.0 | 15 |
| TAI | 4.1 | 3.8 | 3.0 | 4.3 | 7.5 | 5.9 | 3.3 | 5.0 | 0.4 | 37.7 | 4.8 | 5.7 | 4.6 | 5.4 | 4.6 | 62 |
| AUS | 3.3 | 2.4 | 3.3 | 3.8 | 7.5 | 4.3 | 3.2 | 6.9 | 0.2 | 3.2 | 24.5 | 8.2 | 10.1 | 9.5 | 9.6 | 75 |
| GER | 2.6 | 1.7 | 2.4 | 2.3 | 5.9 | 3.8 | 3.2 | 5.3 | 0.1 | 3.0 | 6.9 | 21.2 | 13.4 | 16.4 | 11.9 | 79 |
| UK | 2.8 | 1.6 | 2.2 | 2.7 | 6.6 | 3.5 | 2.9 | 5.4 | 0.1 | 2.4 | 8.5 | 13.2 | 20.9 | 14.9 | 12.4 | 79 |
| FRA | 2.5 | 1.4 | 2.3 | 2.4 | 5.8 | 3.5 | 3.1 | 5.7 | 0.1 | 2.6 | 7.8 | 15.8 | 14.6 | 20.5 | 11.7 | 80 |
| US | 2.3 | 1.4 | 2.1 | 2.5 | 5.8 | 3.6 | 2.6 | 5.9 | 0.1 | 2.5 | 8.6 | 12.8 | 13.6 | 13.1 | 23.0 | 77 |
| Contribution to others | 60 | 44 | 56 | 54 | 88 | 60 | 43 | 64 | 4 | 48 | 84 | 100 | 101 | 104 | 90 | 998 |
| Contribution including own | 94 | 84 | 91 | 89 | 113 | 93 | 82 | 93 | 88 | 86 | 109 | 121 | 122 | 124 | 113 | Spillover index 66.5% |

# Volatility Spillover Table



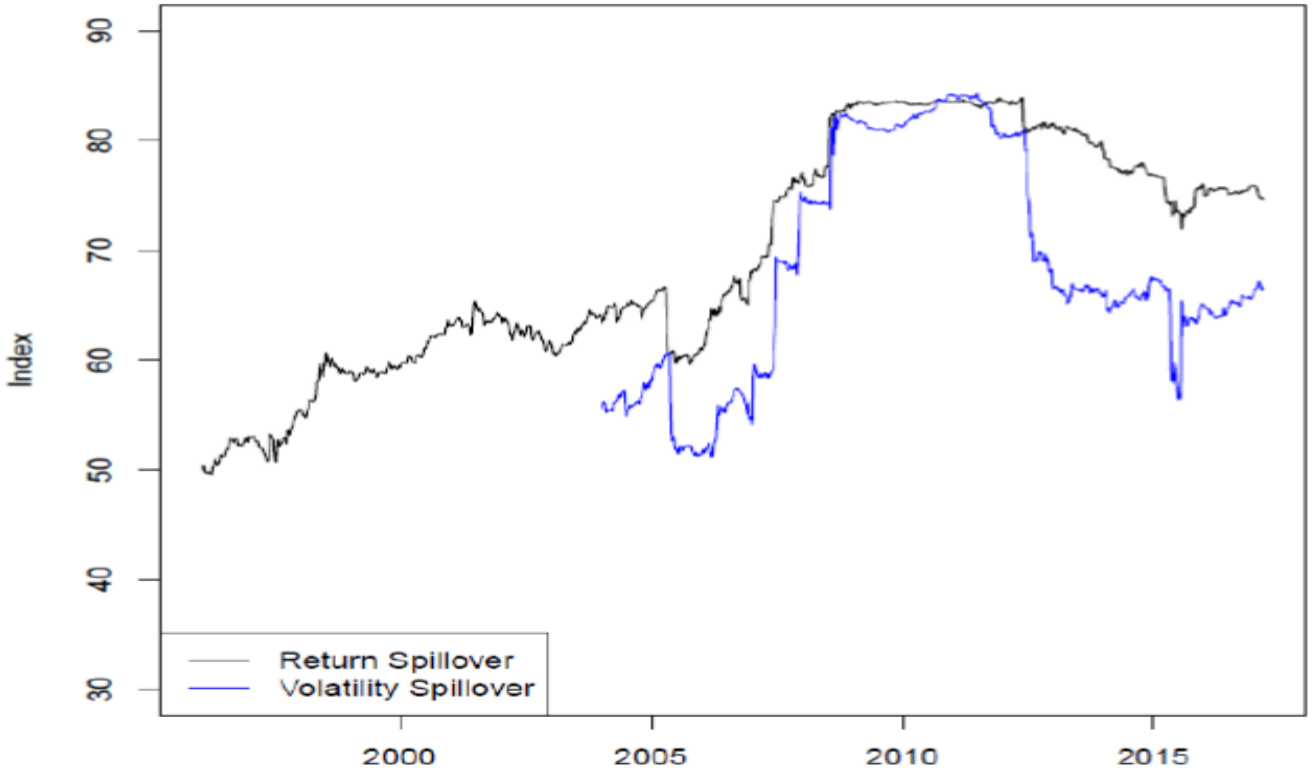
Spillover Table, International Equity Market Volatility:

| To | From | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THA | MYS | IDN | PHL | HKG | KOR | IND | JPN | CHN | TAI | AUS | GER | UK | FRA | US | Contribution from others |
| THA | 34.2 | 4.3 | 5.6 | 3.9 | 7.1 | 6.4 | 6.6 | 4.1 | 0.6 | 5.0 | 2.7 | 4.1 | 5.3 | 4.4 | 5.6 | 66 |
| MYS | 3.8 | 29.7 | 4.1 | 2.9 | 8.4 | 5.9 | 6.1 | 3.7 | 1.3 | 6.9 | 3.1 | 5.1 | 7.2 | 5.7 | 6.2 | 70 |
| IDN | 3.6 | 3.7 | 36.7 | 2.5 | 7.3 | 6.0 | 5.8 | 3.6 | 1.4 | 5.0 | 3.6 | 3.8 | 5.7 | 3.8 | 7.5 | 63 |
| PHL | 4.5 | 4.1 | 3.9 | 44.6 | 5.2 | 3.9 | 2.8 | 3.1 | 2.5 | 4.5 | 4.3 | 2.6 | 4.4 | 3.8 | 5.7 | 55 |
| HKG | 3.3 | 4.4 | 4.5 | 2.0 | 19.5 | 7.9 | 6.0 | 5.6 | 1.6 | 7.4 | 6.8 | 6.2 | 9.2 | 6.8 | 8.9 | 80 |
| KOR | 3.0 | 3.3 | 3.6 | 1.7 | 9.1 | 23.1 | 4.9 | 5.1 | 0.8 | 8.9 | 3.7 | 7.8 | 8.0 | 7.3 | 9.8 | 77 |
| IND | 3.2 | 4.1 | 6.4 | 2.2 | 10.4 | 7.9 | 31.6 | 4.9 | 0.5 | 6.7 | 3.9 | 3.6 | 5.0 | 3.5 | 6.0 | 68 |
| JPN | 2.8 | 2.4 | 3.1 | 1.6 | 8.5 | 6.5 | 4.1 | 24.2 | 0.6 | 4.3 | 5.7 | 8.4 | 9.4 | 8.3 | 10.1 | 76 |
| CHN | 1.5 | 2.6 | 5.3 | 3.3 | 7.1 | 2.0 | 1.7 | 1.3 | 57.6 | 3.4 | 5.5 | 1.8 | 2.2 | 1.6 | 3.2 | 42 |
| TAI | 2.4 | 4.7 | 3.6 | 2.1 | 9.3 | 12.2 | 4.9 | 3.8 | 1.1 | 26.0 | 3.5 | 6.2 | 6.4 | 6.0 | 7.9 | 74 |
| AUS | 1.9 | 2.7 | 3.6 | 2.3 | 8.4 | 4.2 | 3.4 | 4.5 | 1.7 | 4.0 | 24.3 | 7.0 | 11.4 | 9.2 | 11.4 | 76 |
| GER | 1.8 | 1.6 | 1.9 | 1.0 | 4.9 | 5.3 | 1.6 | 4.6 | 0.7 | 4.2 | 5.2 | 20.8 | 16.0 | 18.2 | 12.2 | 79 |
| UK | 1.9 | 2.3 | 2.5 | 1.4 | 6.2 | 5.2 | 2.3 | 4.5 | 0.7 | 4.4 | 6.7 | 13.4 | 20.0 | 15.9 | 12.5 | 80 |
| FRA | 2.1 | 1.8 | 1.9 | 1.3 | 4.8 | 4.6 | 1.5 | 4.1 | 0.7 | 4.0 | 6.2 | 16.4 | 16.9 | 20.7 | 13.1 | 79 |
| US | 2.5 | 2.0 | 3.1 | 2.0 | 6.5 | 6.8 | 2.3 | 4.8 | 0.9 | 5.5 | 6.8 | 10.7 | 13.2 | 12.7 | 20.4 | 80 |
| Contribution to others | 38 | 44 | 53 | 30 | 103 | 85 | 54 | 58 | 15 | 74 | 68 | 97 | 120 | 107 | 120 | 1067 |
| Contribution including own | 73 | 74 | 90 | 75 | 123 | 108 | 86 | 82 | 73 | 100 | 92 | 118 | 141 | 128 | 140 | Spillover index 71.1% |

# Return and Volatility Spillover Indices



Spillover Plot, International Equity Market Returns and Volatility:

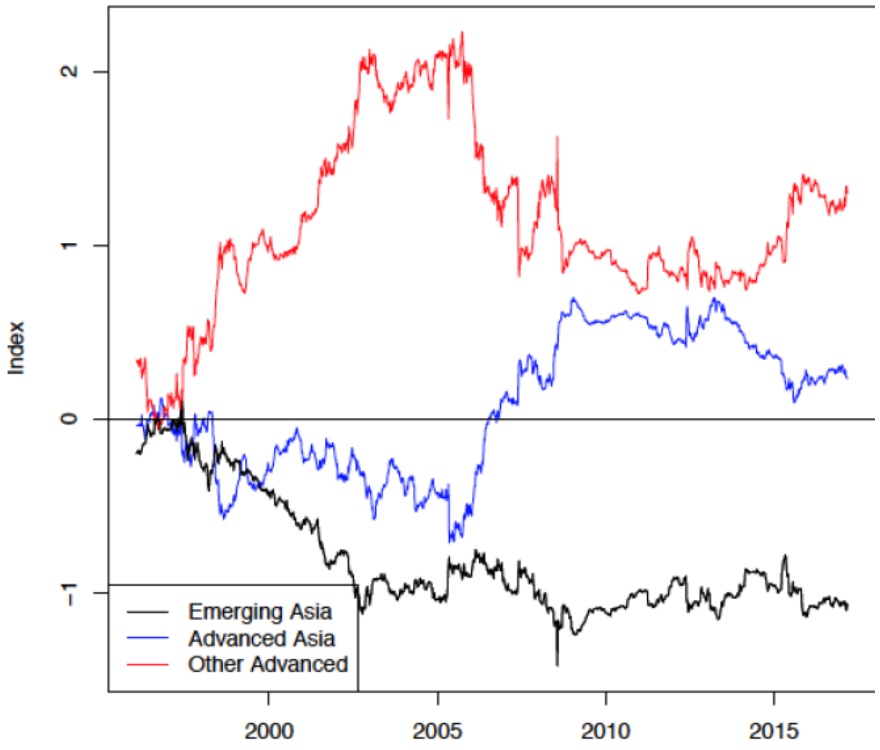



Note: Plotted are total return and volatility spillover indices based on a 200-week rolling estimation window. The corresponding date in the plot denotes the end of the rolling estimation window.

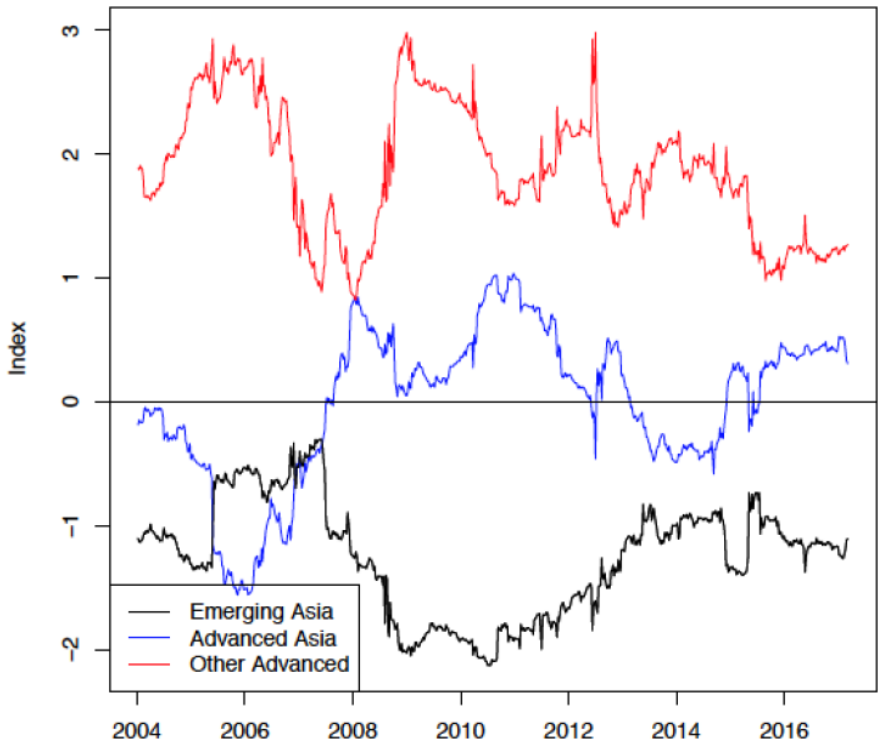
# Return and Volatility Spillover Indices



Spillover Plot, Net Spillover (Give – Receive) Indices in Each Group




Return




Volatilities

**Figure 1A.** Net Return Spillovers By Country

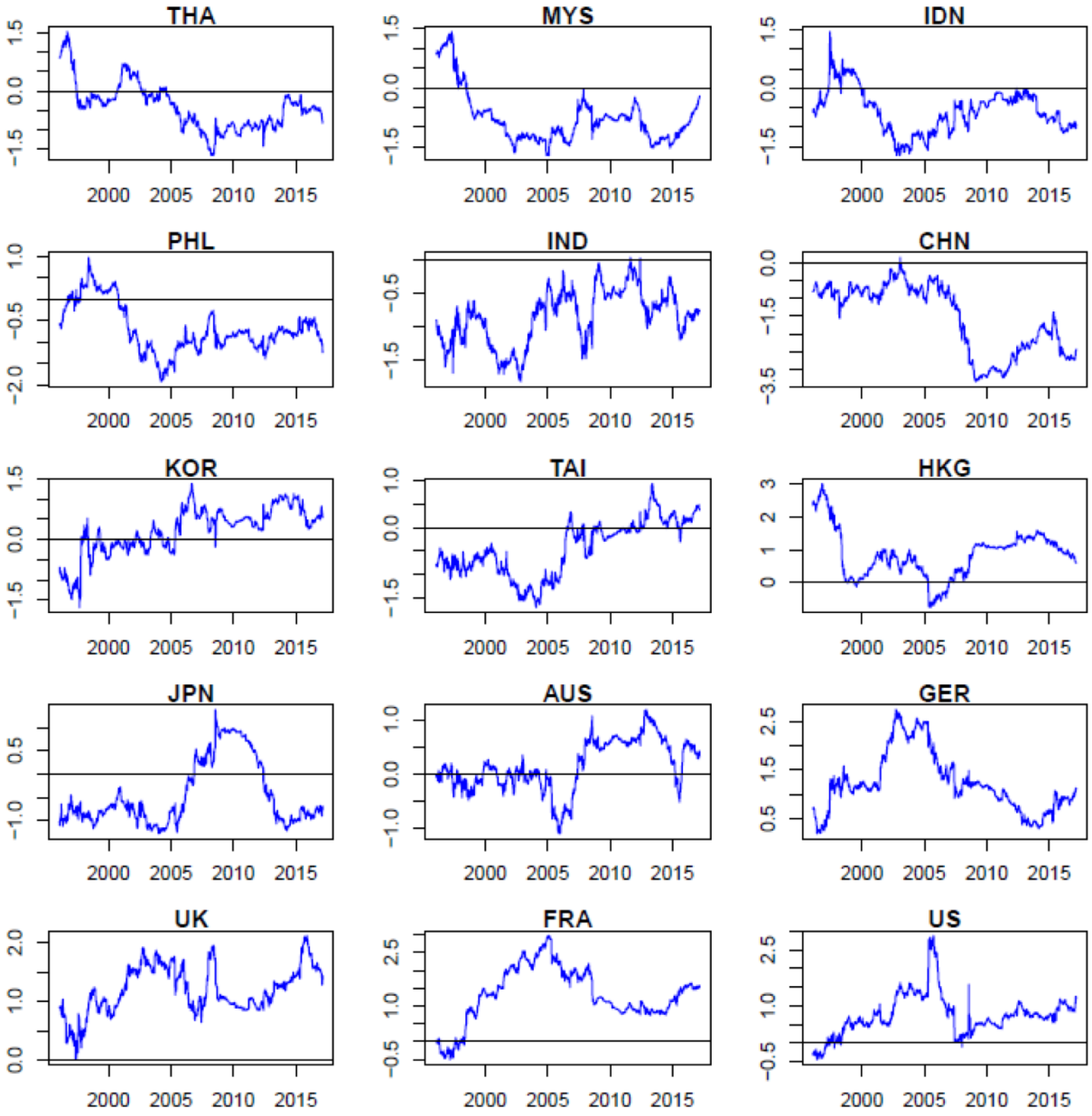


**Figure 1B.** Net Volatility Spillovers By Country

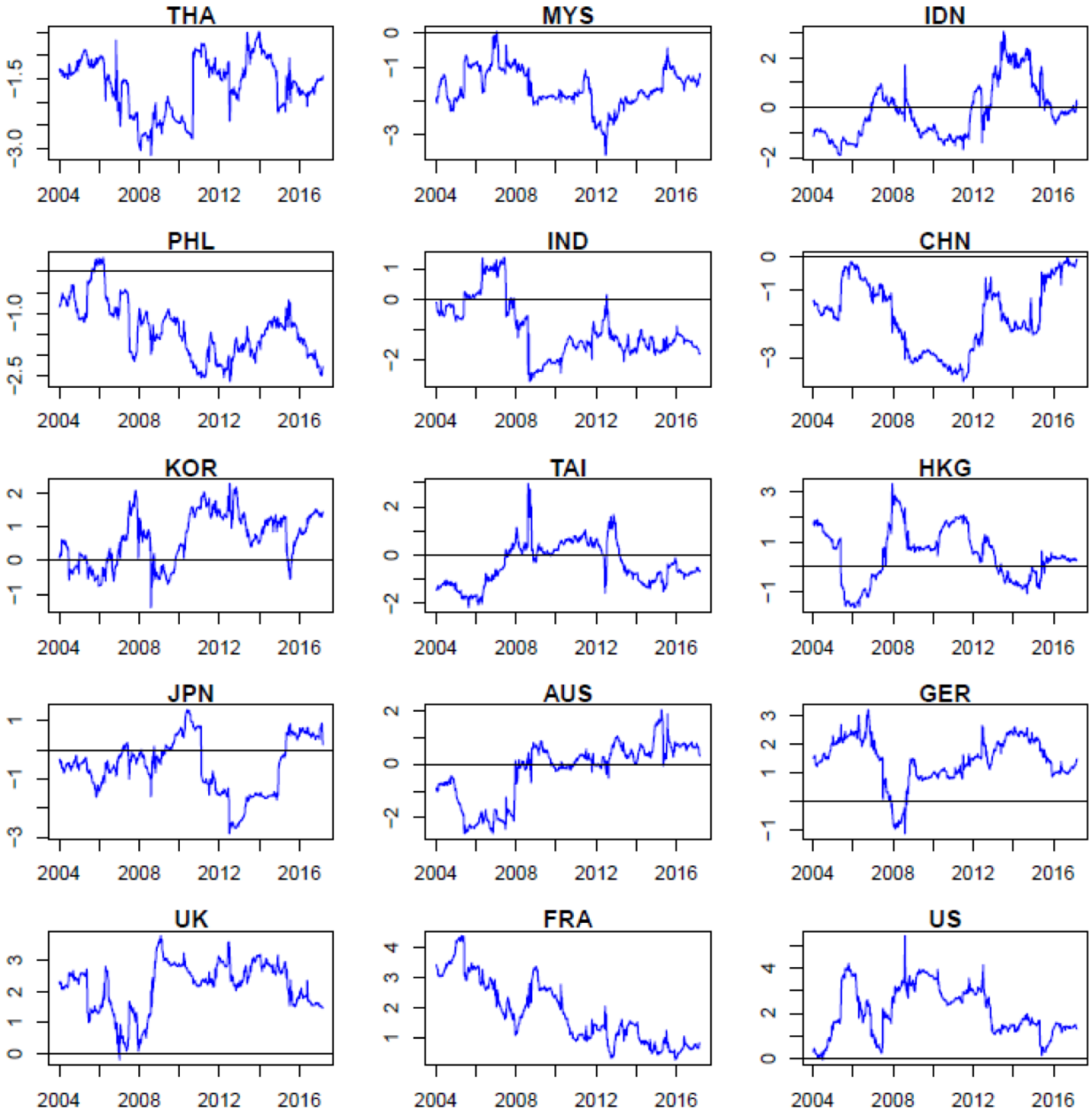
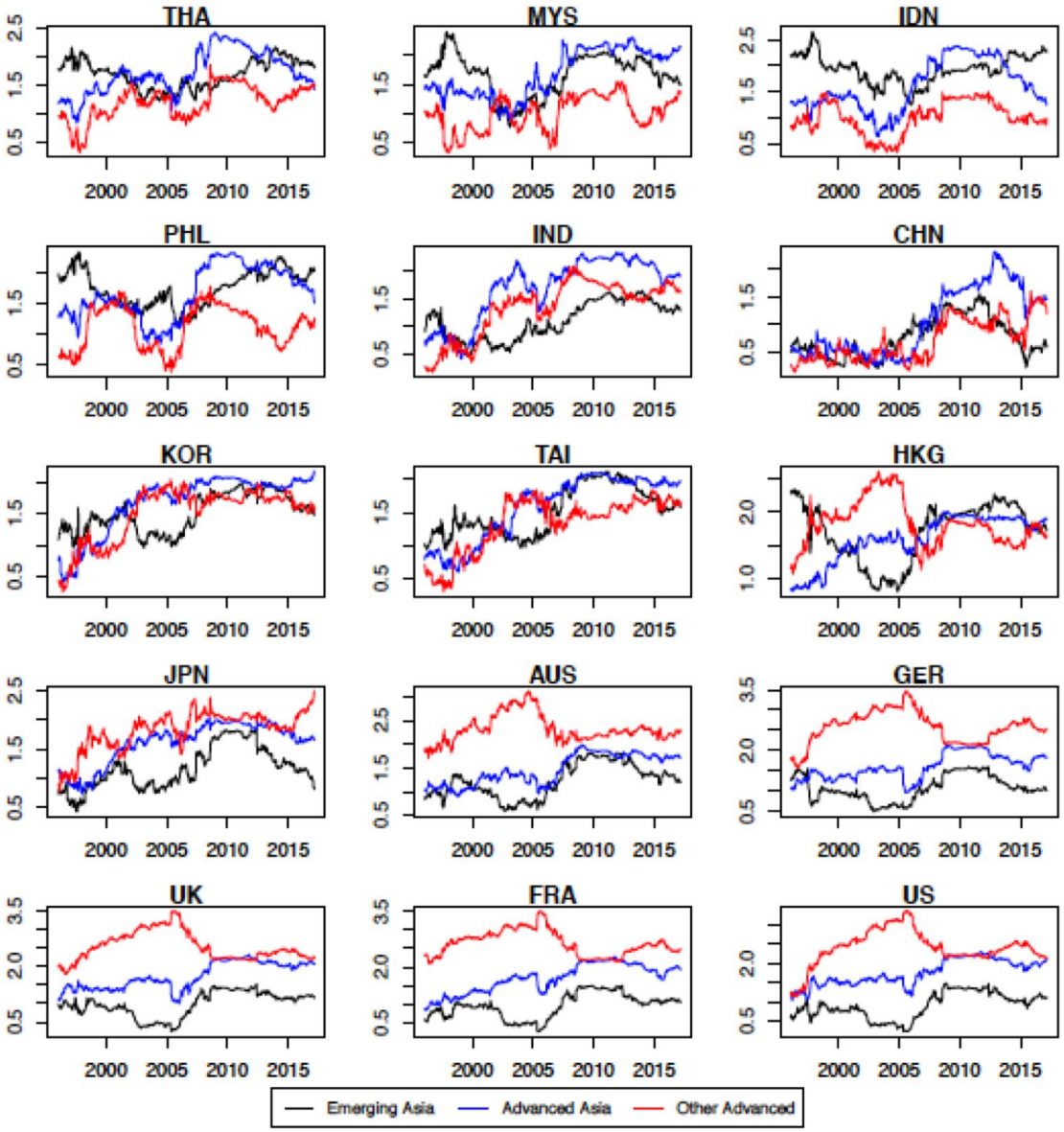


**Figure 4. Contributions of Return Spillover Shocks by Country Group.**




Note: Plotted is the sum of directional shocks received by each country, classified by country group.

# Uncertainty and Connectedness



- Past studies tend to focus on the effect of economic fundamentals and the implications for stock market *returns*

*(Connolly et al., 2005; Giot, 2005; Sum and Fanta, 2012; Antonakakis et al., 2013; Liu and Zhang, 2015; Sum, 2012; Momin and Masih, 2015)*

- Those focusing on connectedness utilize pairwise correlations or *monthly* data

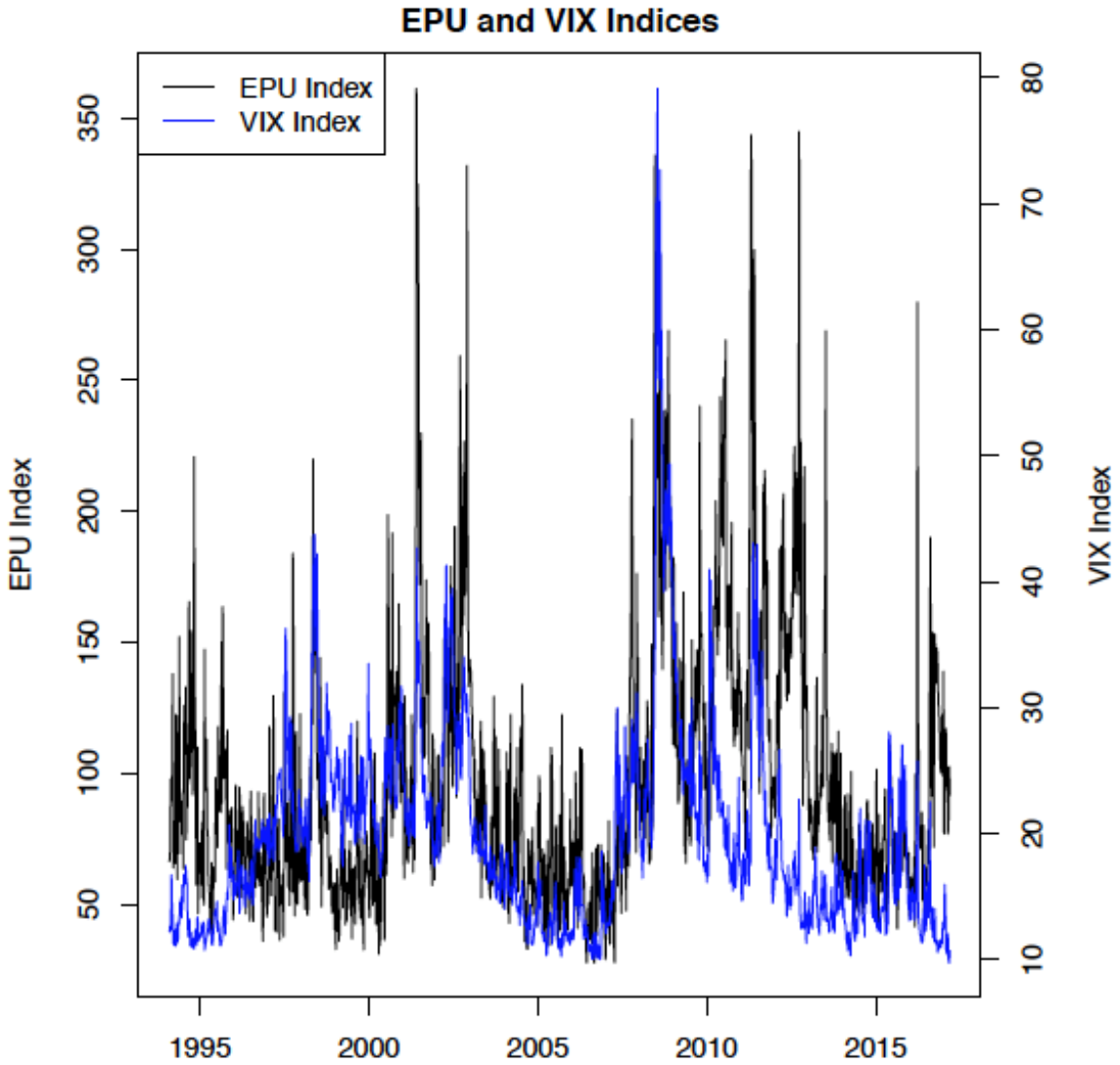
*(Beirne et al., 2009; Tsai, 2017)*

- Strong evidence of how financial and policy uncertainty has generated strong synchronized movements across equity markets worldwide

→ To what extent are spillovers *received* by stock markets driven by uncertainty in the US?

# Financial vs. economic policy uncertainty





# Empirical Model



- For each country i, we estimate the following VAR:

$$Y_{it} = \Phi_1 Y_{i,t-1} + \cdots + \Phi_p Y_{i,t-p} + \varepsilon_t$$

where Y includes the estimated total return spillover *received* for country *i*, VIX and EPU.

**Table 4.** Correlation Table

| Correlation | Country | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | THA | MYS | IDN | PHL | HKG | KOR | IND | JPN | CHN | TAI | AUS | GER | UK | FRA | US |
| VIX | 0.140 | 0.112 | 0.175 | 0.251 | -0.068 | -0.008 | -0.116 | -0.072 | 0.027 | 0.103 | 0.082 | 0.068 | 0.024 | 0.053 | 0.019 |
| EPU | 0.453 | 0.368 | 0.291 | 0.354 | 0.351 | 0.370 | 0.307 | 0.317 | 0.398 | 0.459 | 0.433 | 0.406 | 0.348 | 0.398 | 0.342 |

Note: Reported are the pairwise correlation coefficients between the time-varying spillover of stock returns received by each country and the VIX and EPU indices.

# Empirical findings



**Table 5.** Granger Causality Tests Results

| Country | **VIX** | **EPU** |
|---|---|---|
| THA | 7.512 (0.482) | 18.403*** (0.018) |
| MYS | 1.609 (0.900) | 10.920** (0.053) |
| IDN | 1.117 (0.891) | 7.018 (0.134) |
| PHL | 2.813 (0.589) | 8.765* (0.067) |
| IND | 6.642 (0.355) | 2.392 (0.880) |
| CHN | 3.396 (0.493) | 1.799 (0.772) |
| TAI | 5.622 (0.584) | 13.277* (0.065) |
| KOR | 8.267 (0.689) | 15.780 (0.149) |
| JPN | 14.327** (0.026) | 13.137** (0.0409) |
| HKG | 9.816* (0.080) | 15.816*** (0.007) |
| AUS | 4.549 (0.473) | 9.613* (0.087) |
| GER | 10.067* (0.073) | 11.983** (0.035) |
| FRA | 14.077*** (0.015) | 16.248*** (0.006) |
| UK | 11.924** (0.035) | 11.929** (0.035) |
| US | 10.238* (0.068) | 8.906 (0.112) |

Note: Reported are the Chi-square test statistics associated with the Block exogeneity Wald test with the corresponding null hypothesis that all lags of the EPU and VIX can be excluded from each equation in the VAR system. The corresponding p-values are reported in parentheses and *,**,*** denotes statistical significance at the 10, 5, and 1 percent levels respectively.

# Discussion



- Joins a growing literature which finds that US EPU shocks can significantly influence real variables

*(IMF, 2013; Gauvin et al. 2014; Colombo, 2016; Biljanovska et al. 2017)*

- Uncertainty and the *type of uncertainty* matters for spillovers received
- The effect of VIX and EPU shocks depends on region and level of development

# Conclusion



- International equity markets are tightly integrated
- Connectedness have increased over time, with a burst during GFC
- Advanced countries are net transmitters of shocks while emerging Asian countries are consistently net receivers
- Advanced markets are more connected amongst themselves while intraregional connectedness within Asia is strong
- EPU from the US has a significant impact on global markets while the effect of VIX is relatively contained for advanced economies