Market Volatility Transmission

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February 16, 2020

Motivation

What is Volatility Transmission?

Volatility transmission captures the linkage between two or more economic variables, it measures the magnitude of the volatility impacted by externalities of economic activity.

Why do we want to investigate volatility transmission?

1. Integration among global markets has been increasing during recent twenty years.(Cetorelli and Goldberg, 2011; Bekaert et al., 2014)
2. Understanding the nature of volatility transmission would benefit to investors and policy makers.

BEKK-GARCH Model

Engle and Kroner (1995) and Engle (2002) propose the BEKK-GARCH model and its decomposition:

$$R_t = \Omega + \Theta(L)R_{t-1} + \epsilon_t, \epsilon_t = z_t H_t^{0.5}$$

where the R_t is a $N \times K$ vector of assets return at time t, $\Theta(L)$ is the lag polynomial matrix, The H_t is the corresponding $K \times K$ conditional co-variance matrix, it also can be given below:

$$H_t = M'M + A'e_{t-1}e'_{t-1}A + B'H_{t-1}B$$

where M is a $K \times K$ triangular matrix. A and B are $K \times K$ coefficient matrices that capture the exogenous innovation on volatility and past conditional variances, respectively.

For three variables system,

$$M = \begin{bmatrix} \omega_{11} & \omega_{12} & \omega_{13} \\ 0 & \omega_{22} & \omega_{23} \\ 0 & 0 & \omega_{33} \end{bmatrix} \quad A = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \quad B = \begin{bmatrix} b_{11} & b_{12} & b_{13} \\ b_{21} & b_{22} & b_{23} \\ b_{31} & b_{32} & b_{33} \end{bmatrix}$$

Under the framework of Diebold and Yilmaz (2012), we have measurement of total volatility transmission(TVT), volatility transmitter(VT), and volatility receiver(VR).

$$TVT = \frac{\sum_{i,j\neq i}^{K} b_{i,j}^2}{\sum_{i,j}^{K} b_{i,j}^2} \cdot 100$$

$$VT(n) = \frac{\sum_{i=n,j\neq i}^{K} b_{i,j}^2}{\sum_{i=n,j}^{K} b_{i,j}^2} \cdot 100$$

$$VR(n) = \frac{\sum_{j=n,j\neq i}^{K} b_{i,j}^2}{\sum_{j=n,i}^{K} b_{i,j}^2} \cdot 100$$

$$\mathrm{B} = \begin{bmatrix} 0.9509 & 0.0340 & -0.0242 \\ -0.0259 & 0.9472 & -0.0295 \\ 0.0169 & -0.0081 & 0.9884 \end{bmatrix}$$

$$\mathrm{B} = \begin{bmatrix} 0.9509 & 0.0340 & -0.0242 \\ -0.0259 & 0.9472 & -0.0295 \\ 0.0169 & -0.0081 & 0.9884 \end{bmatrix}$$

Data Description

Data

1. Countries: US Canada Germany UK France Japan Hong Kong and India UK-1 US-1 Hong Kong UK US
2. Period: January 4,2013-January 4,2017
3. Data frequency: 15 minutes, hourly, daily
4. Resource: Thomson Reuters

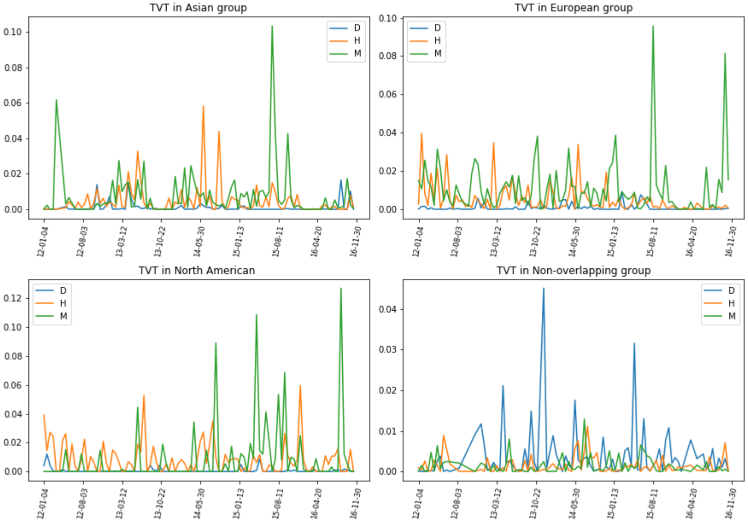
Sample result for total volatility transmission

The total volatility transmission table is calculated from Jan to March, 2017.

Table: Total Volatility Transmission, %

	AS	EU	NA	NO
D	0.02172	0.00190	0.05622	0.75371
H	0.15475	0.37071	0.00468	0.12324
M	0.16551	0.91207	2.82536	0.09902

The greatest value in the same group has been highlighted.


TVT in Asian group
TVT in European group
TVT in North American
TVT in Non-overlapping group
D
H
M
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11
16-04-20
16-11-30

For three variables system, with the notation we have:

$$h_{11,t} = b_{11}^2 h_{11,t-1} + b_{21}^2 h_{22,t-1} + b_{31}^2 h_{31,t-1} + b_{11} b_{21} h_{21,t-1} +$$

$$\mathrm{b}_{11} b_{21} h_{12,t-1} + b_{11} b_{31} h_{31,t-1} + b_{11} b_{31} h_{13,t-1} + b_{21} b_{31} h_{32,t-1} + b_{21} b_{31} h_{23,t-1}$$

$$h_{22,t} = b_{12}^2 h_{11,t-1} + b_{22}^2 h_{22,t-1} + b_{32}^2 h_{33,t-1} + b_{12} b_{22} h_{12,t-1} +$$

$$\mathrm{b}_{12} b_{22} h_{21,t-1} + b_{12} b_{32} h_{31,t-1} + b_{12} b_{32} h_{13,t-1} + b_{22} b_{32} h_{23,t-1} + b_{22} b_{32} h_{32,t-1}$$

$$h_{33,t} = b_{13}^2 h_{11,t-1} + b_{23}^2 h_{22,t-1} + b_{33}^2 h_{33,t-1} + b_{13} b_{23} h_{21,t-1}$$

$$+\mathrm{b}_{13} b_{23} h_{12,t-1} + b_{13} b_{33} h_{31,t-1} + b_{13} b_{33} h_{31,t-1} + b_{23} b33 h_{23,t-1} + b_{23} b_{33} h_{32,t-1}$$

$$Self_i = \frac{b_{i,i}^2}{(\sum_{i,j} |b_{i,j}|)^2}$$

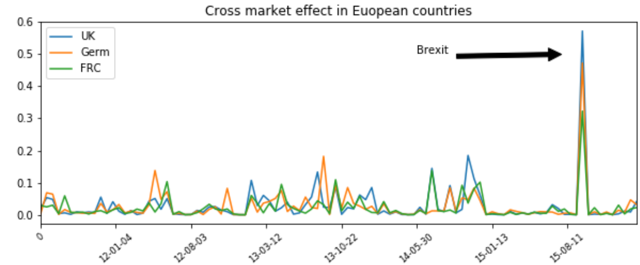
$$direct_i = \frac{\sum_{i,j \neq i} b_{j,i}^2}{(\sum_{i,j} |b_{i,j}|)^2}$$

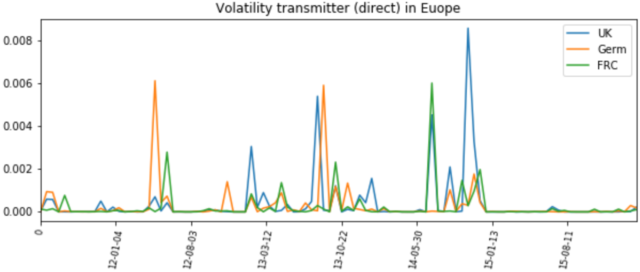
$$cross - market_i = \frac{\sum_{i,j \neq k} 2|b_{j,i}||b_{k,i}|}{(\sum_{i,j} |b_{i,j}|)^2}$$

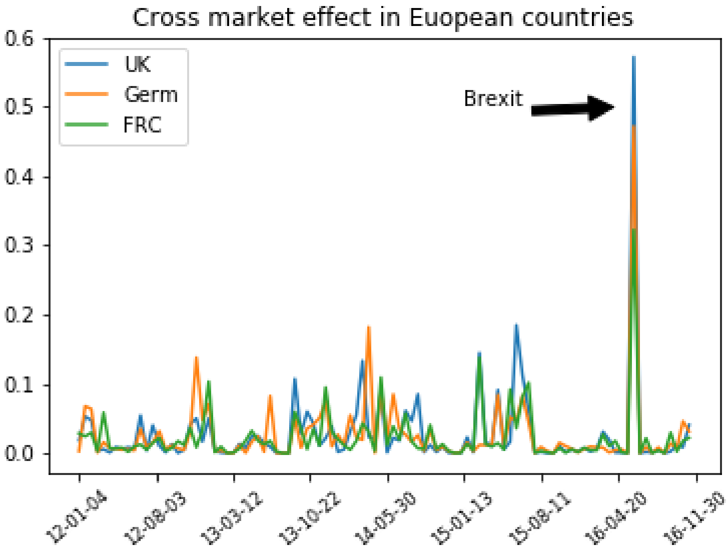
Volatility Components

Table: Volatility components in Asian Market

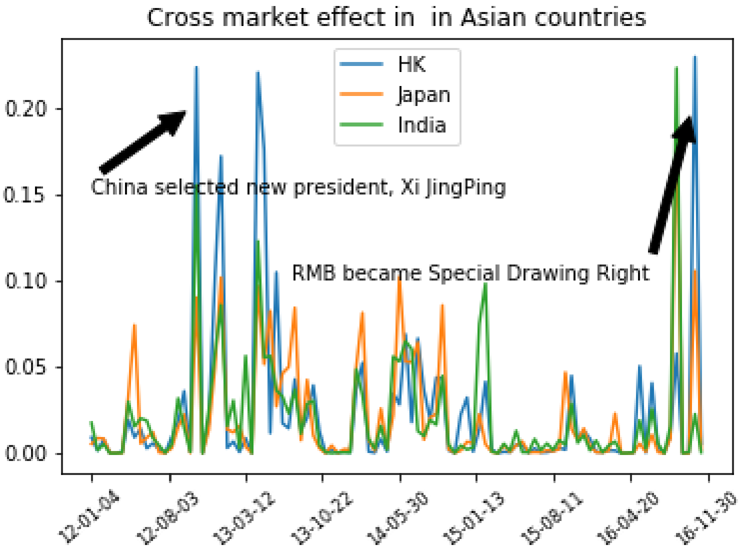
		HK	Japan	India
D	self	95.1743%	97.9237%	98.5194%
	direct	0.0505%	0.0082%	0.0039%
	cross	4.7752%	2.0682%	1.4767%
H	self	87.5301%	93.0948%	91.7509%
	direct	0.2181%	0.1039%	0.0960%
	cross	12.2518%	6.8014%	8.1532%
M	self	90.2398%	95.3608%	89.5780%
	direct	0.2452%	0.0453%	0.1580%
	cross	9.5150%	4.5939%	10.2640%


Cross market effect in Euopean countries
UK
Germ
FRC
Brexit
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11

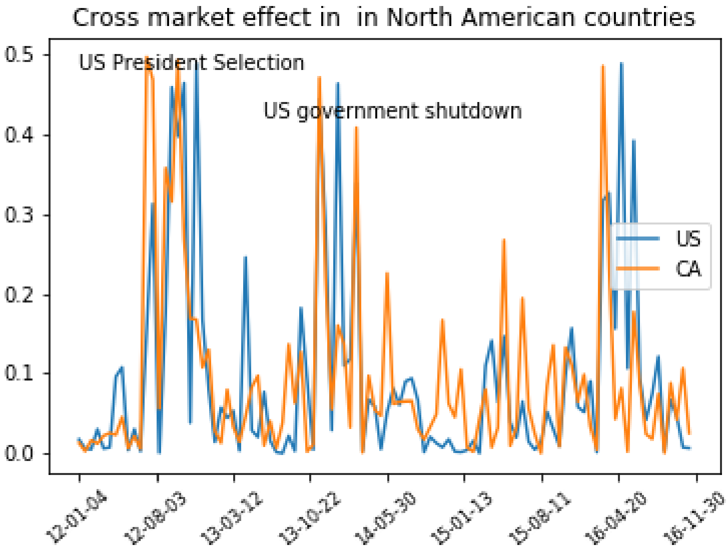

Volatility transmitter (direct) in Euope
UK
Germ
FRC
0.008
0.006
0.004
0.002
0.000
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11



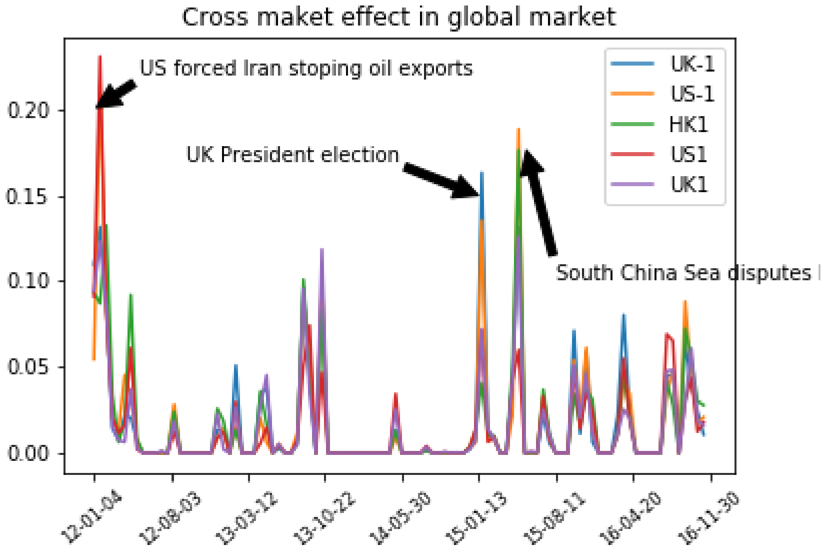
	UK	Germ	FRC
Average on cross effect	0.02886	0.02743	0.02341



	HK	Japan	India
Average on cross effect	0.02424	0.02120	0.02118



	US	Canada
Average on cross effect	0.09774	0.09641


Cross maket effect in global market
US forced Iran stoping oil exports
UK President election
South China Sea disputes
UK-1
US-1
HK1
US1
UK1
0.20
0.15
0.10
0.05
0.00
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11
16-04-20
16-11-30

Thank You

Bekaert, G., M. Ehrmann, M. Fratzscher, and A. Mehl (2014). The global crisis and equity market contagion. *The Journal of Finance 69*(6), 2597–2649.

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Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics 20*(3), 339–350.

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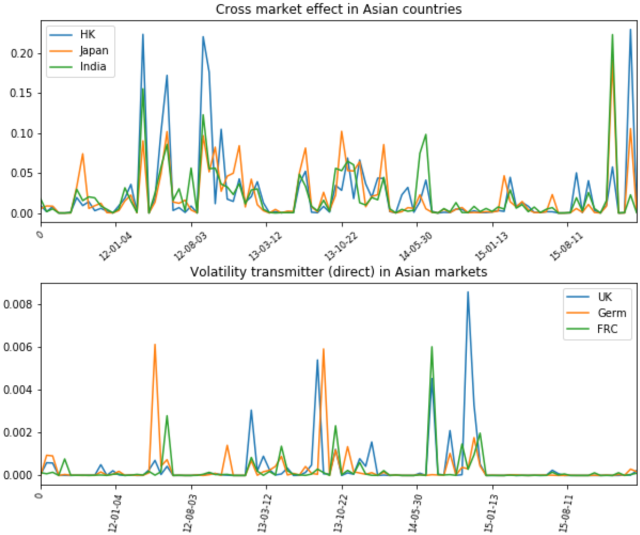
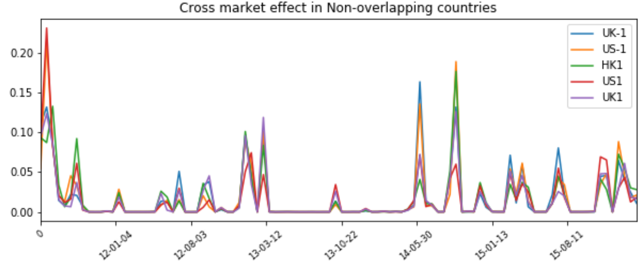
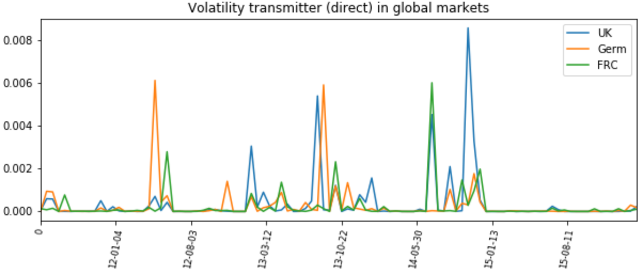
Appendix



Cross market effect in Asian countries
HK
Japan
India
0.20
0.15
0.10
0.05
0.00
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11
Volatility transmitter (direct) in Asian markets
UK
Germ
FRC
0.008
0.006
0.004
0.002
0.000
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11

Appendix


Cross market effect in Non-overlapping countries
0.20
0.15
0.10
0.05
0.00
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11
UK-1
US-1
HK1
US1
UK1


Volatility transmitter (direct) in global markets
0.008
0.006
0.004
0.002
0.000
0
12-01-04
12-08-03
13-03-12
13-10-22
14-05-30
15-01-13
15-08-11
UK
Germ
FRC