Global financial spillovers: A non-linear assessment of the uncertainty channel[1]

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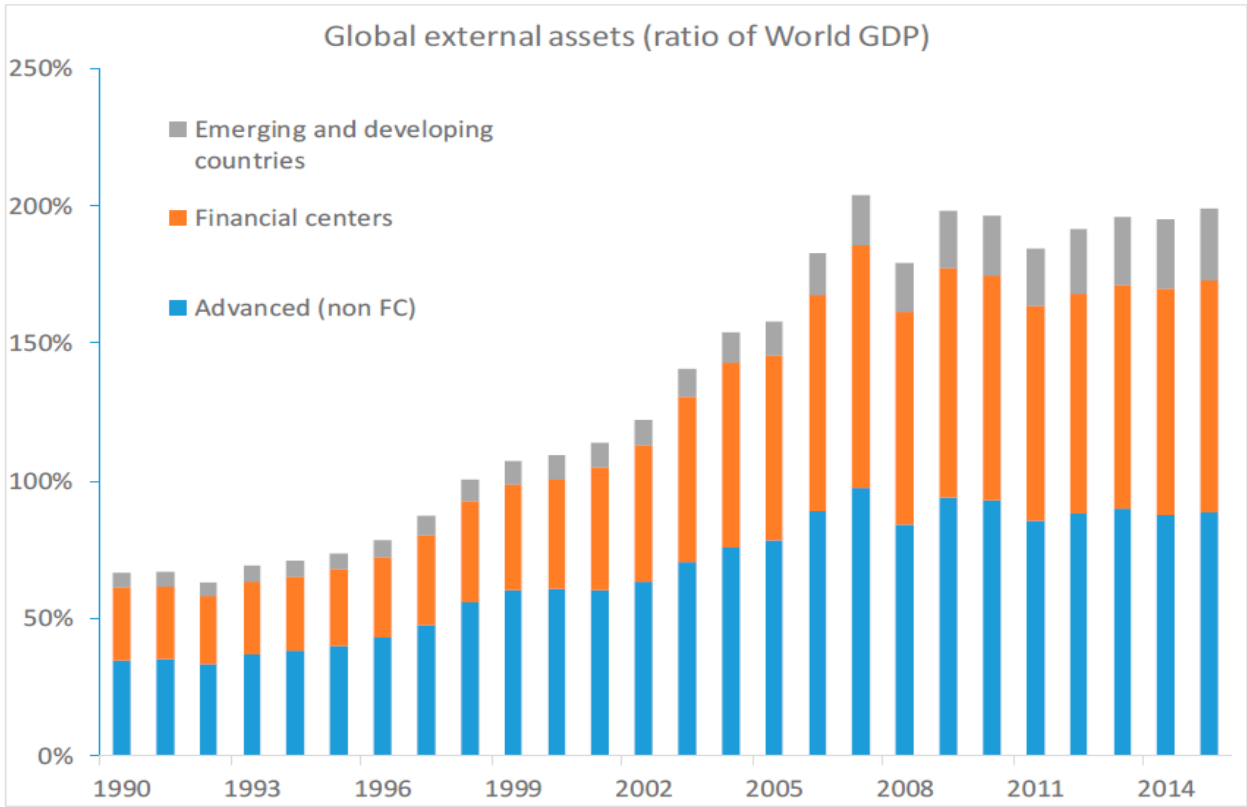
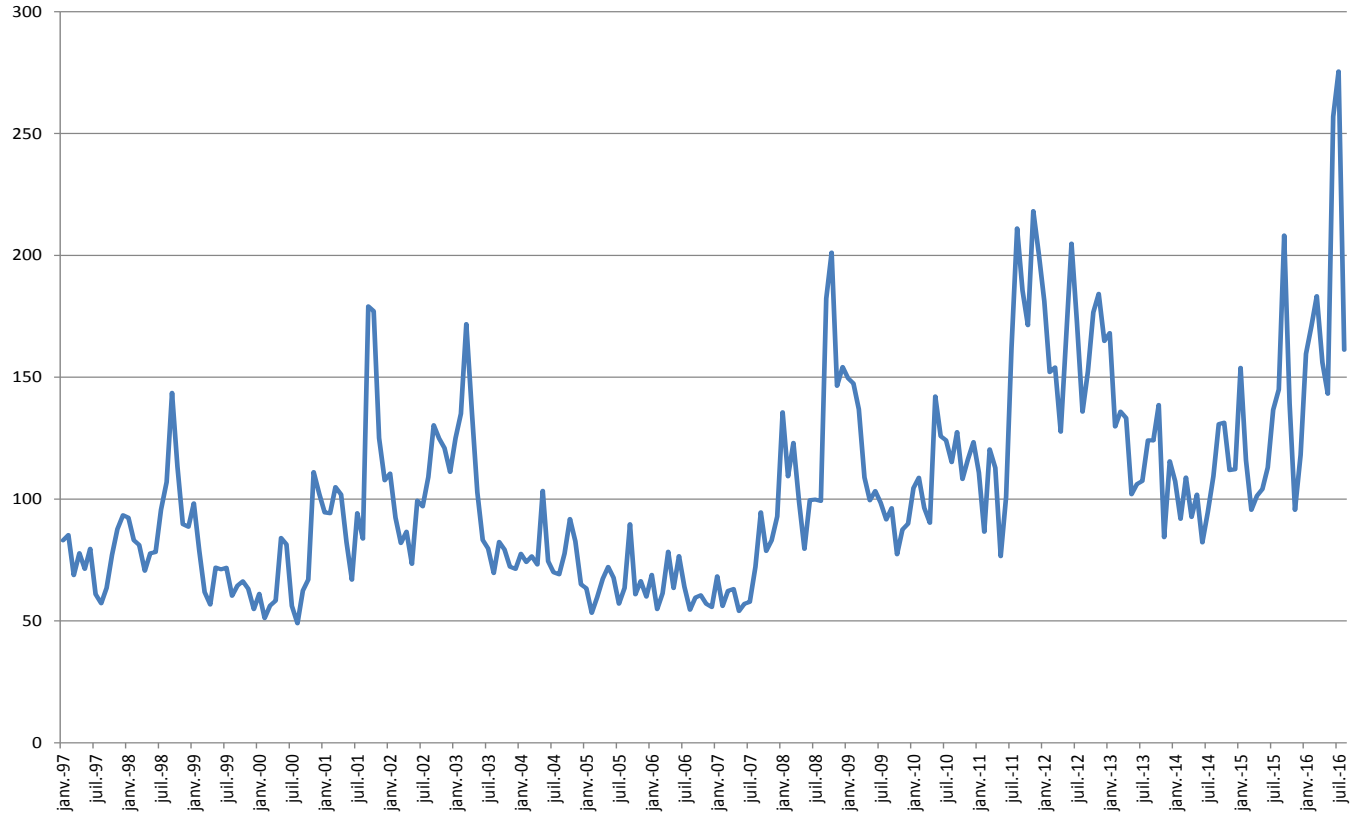
[1] The views expressed here are those of the authors and do not necessarily reflect those of the Banque de France.

Stylized Fact 1: A rise in financial integration (source Milesi Ferretti and Lane, 2016)



Stylized fact 2: A rise in Global Uncertainty (source Davis, NBER WP 2016, Global EPU, PPP weights)



Motivations

- Rise in global financial integration leads to more rapid and stronger contagion within the financial system
- At the same time, a rise in global uncertainty, with some peaks
- Question that we aim at tackling: Is there an effect of uncertainty on financial contagion?

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- Answer:

Motivations

- Rise in global financial integration leads to more rapid and stronger contagion within the financial system
- At the same time, a rise in global uncertainty, with some peaks
- Question that we aim at tackling: Is there an effect of uncertainty on financial contagion?
- Answer: **YES** high uncertainty tends to generate more spillovers among financial markets

What we do and what we get

- Use and extend the theoretical model of Kodres and Pritsker (2002, JoF) to explain why uncertainty can have an effect on financial spillovers
- Empirically, we extend the Diebold-Yilmaz's (2009, EconJ) approach for measuring financial spillovers by allowing for non-linearity
- Uncertainty is supposed to be the driver of this connectedness and thus is taken as transition variable in a Threshold VAR approach
- We get that higher uncertainty generates more financial spillovers on equity markets
- The source of uncertainty can have differentiate effects on contagion

An empirical issue: Uncertainty is unobservable

Measuring uncertainty: Various approaches

- Financial volatility indexes: VIX measures
- Macroeconomic uncertainty as measured by deviation to expectations (Scotti, 2013, Jurado et al., 2014, Rossi and Sekhposyan, 2015)
- News-based metrics : number of articles containing a specific word (EPU indexes by Baker, Bloom and Davis, QJE 16)
- Distinction between uncertainty and risk (Knight, 1921, Rossi, Sekhposyan and Soupre, 2016)

Many papers are dealing with macro effects of uncertainty but few with financial effects (Alfaro, Bloom and Lin, 2016)

Contagion: Definition and channels

Definition (KP context)

Contagion/Financial spillovers: price movement in one market/country resulting from a shock in another market/country.

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In the litterature, the jury is still out on the causes of cross-border spillovers but instead various channels of transmission are possible:

- Common shocks / Global shocks (e.g. Commodities)
- Trade channel (Glick and Rose, 1998)
- Common lenders, International banking (Weder and van Ricjkenghem, 2001)

But those macro fundamentals not always explain contagion specially within emerging countries with no specific macro linkages

Contagion:Channels

Investor's behaviour is able to explain contagion through various channels:

- Correlated information channel : price changes in one market are perceived as having implications for values of assets in other markets
- Correlated liquidity shock channel: when investors need to liquidate some assets to get cash, they choose to liquidate assets in many markets

Contagion:Channels

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- **Cross-market portfolio rebalancing channel**: Optimal portfolios adjusment facing a shock in one market, with information asymmetries (Kodres-Pritsker 2002)

Theoretical framework: Kodres and Pritsker (2002)

Set up

- Static model:
  1. N risky assets (fixed supply) a riskless asset (perfectly elastic).
  2. 3 investors: informed (μ_I), uninformed (μ_{UI}), noise traders. effects).
- Period 1: trading; Period 2: consumption of the liquidation value of assets (price return).

From KP:
Investors' uncertainty about future asset values comes from their uncertainty about the future macroeconomic state as measured by the realizations of the macroeconomic factors

Theoretical framework: Kodres and Pritsker (2002)

Extension

Cross-market portfolio rebalancing

(macro risk factor of global eco
shape contagion $u_t = B.f_t + \eta_t$)

$$\nu_t = \theta + B.f_t + \eta_t$$

$$\downarrow$$

Extensions

Dynamic VAR model

(propagation of shock is dynamic
Hypo:$f_t = \nu_{t-1}$)

$$\nu_t = \theta + B(L).\nu_{t-1} + \eta_t$$

$$\downarrow$$

Non-linear TVAR model

(shifts contagion with respect to uncertainty)

$$\nu_t = \theta + B_1(L).\mathbf{1}(u_t > \mu).\nu_{t-1} + B_2(L).\mathbf{1}(u_t \leq \mu).\nu_{t-1} + \eta_t$$

Empirical approach: Benchmark Diebold-Yilmaz approach

- Assume the N assets (ν_t) follow a stationary VAR(p):

$$\nu_t = \sum_{j=0}^{p} B_j \nu_{t-j} + \xi_t$$

rewritten as a VMA(∞)

$$\nu_t = \sum_{l=0}^{\infty} \Phi_l \xi_{t-l}$$

.

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- For a given horizon H, compute the H-step-ahead Forecast Error Decomposition Variance FEDV

$$\varphi_{ij}(H) = \frac{\sigma_{jj}^{-1} \sum_{h=0}^{H-1} \left(e_i' \Phi_h \Sigma e_j\right)^2}{\sum_{h=0}^{H-1} \left(e_i' \Phi_h \Sigma \Phi_h' e_j\right)}$$

Empirical approach: Benchmark Diebold-Yilmaz approach

- After normalization of the $\varphi_{ij}(H)$:

$$C_{i\leftarrow RoW}(H) = \frac{1}{N}\sum_{j=1,j\neq i}^{N}\tilde{\varphi}_{ij}(H) \quad ; \quad C_{j\rightarrow RoW}(H) = \frac{1}{N}\sum_{i=1,i\neq j}^{N}\tilde{\varphi}_{ij}(H)$$

- For any country i the **NET** contribution is:

$$C_i(H) = C_{i\rightarrow RoW}(H) - C_{i\leftarrow RoW}(H)$$

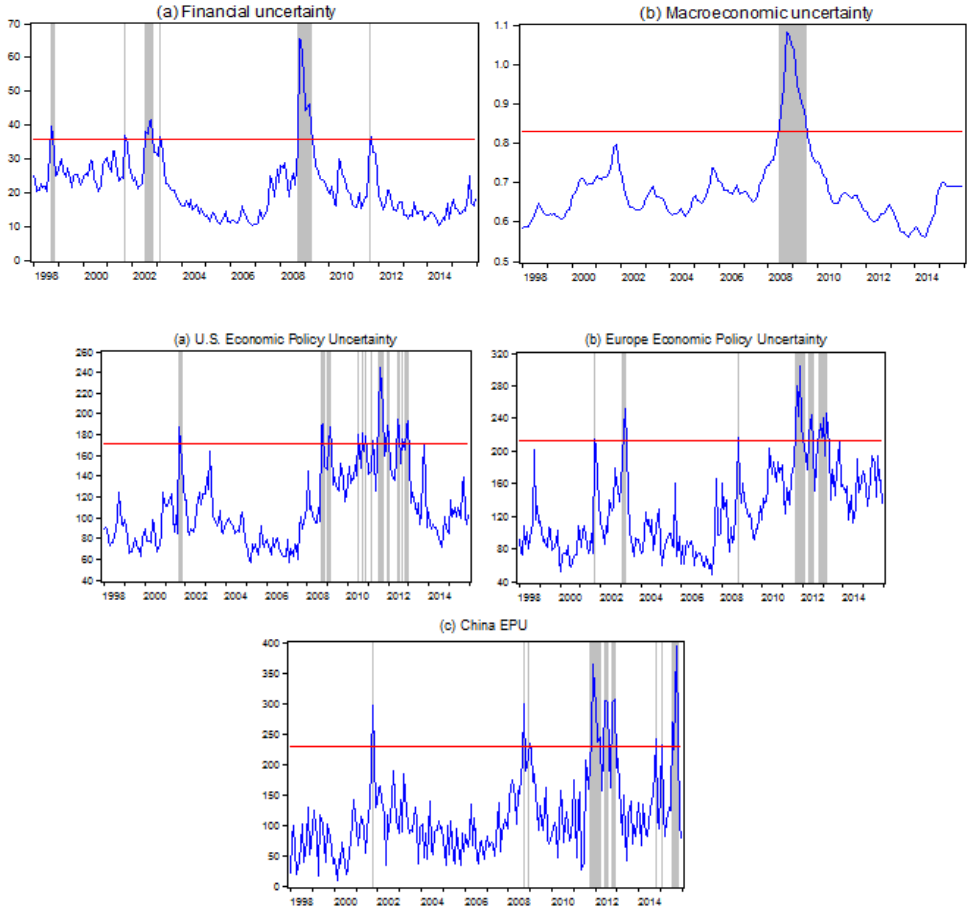
- A system-wide connectedness measure:

$$C(H) = \frac{1}{N}\sum_{i=1}^{N} C_{i\leftarrow RoW}(H) = \frac{1}{N}\sum_{j=1}^{N} C_{j\rightarrow RoW}(H)$$

Data

- Monthly data 1998m1-2015m12 of 13 equity markets (US, UK, Euro, BRICs).
- We consider 5 various sources of uncertainty:
  - Financial: VXO implied volatility (Connoly et al. 2005, Bloom 2009).
  - Macroeconomic US: conditional volatility of macro factors (Jurado et al. 2015).
  - Economic Policy for US : newspaper metrics (Baker et al. 2016).
  - Economic Policy for EU : newspaper metrics (Baker et al. 2016).
  - Economic Policy for China : newspaper metrics (Baker et al. 2016).

Uncertainty measures



Benchmark linear Diebold-Yilmaz approach: Global

Degree of connectedness of the global equity system: 64%
US and UK are net givers to the global system
Germany and China have a neutral position

	US	UK	GE	FR	IT	NL	ES	PR	GR	CH	BR	RU	IN	from
US	87.6	1.4	3.6	0.1	1.0	1.4	0.4	0.6	0.1	2.0	0.5	1.2	0.1	12
UK	62.0	27.7	3.0	0.4	0.8	0.8	0.5	1.0	0.1	2.7	0.1	0.5	0.4	72
GE	61.1	7.5	24.1	0.5	0.3	1.1	0.5	0.8	0.1	1.4	0.9	1.6	0.3	76
FR	62.3	12.5	11.7	9.4	0.2	0.3	0.2	0.5	0.1	1.6	0.3	0.6	0.2	91
IT	46.5	14.7	12.4	9.1	14.5	0.3	0.1	0.7	0.1	0.8	0.2	0.2	0.4	85
NL	58.7	14.4	8.7	2.5	0.4	10.9	0.4	0.3	0.2	2.4	0.1	0.5	0.3	89
SP	47.9	15.1	6.9	7.6	4.0	0.2	15.3	0.7	0.3	0.8	0.3	0.2	0.7	85
PR	33.2	18.0	8.7	12.1	2.3	0.6	2.1	20.1	0.5	1.1	0.5	0.1	0.7	80
GR	27.5	13.9	4.5	7.8	1.8	0.3	3.8	1.5	33.5	2.3	0.3	0.5	2.2	67
CH	7.7	1.9	1.6	1.0	0.5	0.2	0.4	2.8	1.9	79.6	0.7	0.7	1.0	20
BR	39.5	8.4	1.7	0.6	0.4	2.8	1.5	0.8	1.3	1.6	40.6	0.1	0.8	59
RU	29.5	5.0	1.2	0.4	0.7	3.4	2.0	1.3	1.8	1.1	8.3	43.2	2.0	57
IN	25.0	6.1	1.2	0.4	4.6	1.2	0.6	1.9	1.5	4.1	2.5	0.6	50.3	50
to	501	119	65	42	17	13	12	13	8	22	15	7	9	**64.9**
net	489	47	-11	-49	-68	-76	-73	-72	-59	2	-44	-50	-41	

Benchmark linear Diebold-Yilmaz approach: ADVs

ADV economies are much more connected than the global system.
US and UK are net givers to the sub-system of ADV countries

	USA	UK	GER	FRA	ITA	NLD	SPA	PRT	GRC	FROM
USA	91.9	1.6	3.7	0.2	1.1	1.5	0.3	0.6	0.1	9
UK	64.6	29.2	2.9	0.5	0.7	0.9	0.4	0.8	0.1	71
GER	64.0	7.5	25.5	0.5	0.3	1.1	0.3	0.7	0.1	75
FRA	64.4	12.9	12.1	9.8	0.2	0.3	0.1	0.3	0.0	90
ITA	46.4	15.4	12.2	9.7	15.3	0.3	0.0	0.5	0.1	85
NLD	60.9	15.4	8.8	2.7	0.6	11.2	0.2	0.1	0.1	89
SPA	48.8	15.5	6.9	7.6	4.1	0.2	15.9	0.5	0.4	84
PRT	33.2	19.4	8.2	12.2	2.5	0.5	2.5	21.0	0.5	79
GRC	29.0	15.5	4.2	8.1	2.1	0.3	3.6	1.1	36.2	64
TO	411	103	59	41	12	5	7	5	1	**71.7%**
NET	402	32	-16	-49	-73	-84	-77	-74	-63	

Benchmark linear Diebold-Yilmaz approach: EMEs

Less degree of connectedness within EMES
China and Brazil are net givers to the sub-system of EME countries

	CHN	BRA	RUS	IND	FROM
CHN	98.0	0.7	0.5	0.8	2
BRA	9.0	90.3	0.2	0.5	10
RUS	6.6	35.6	56.7	1.1	43
IND	12.0	21.1	0.9	66.0	34
TO	28	57	2	2	**22%**
NET	26	47	-41	-32	

Non-linear Diebold-Yilmaz approach: Testing

Evidence of non-linearity using uncertainty measures as transition variable for the 2 regimes of high and low uncertainty.

Example of the global equity system:

Threshold variables	Threshold value	Wald Statistics Sup-Wald	Avg-Wald	Exp-Wald	% high uncertainty	Average duration (in months)
VXO	22.375	773.77*	605.34*	382.27*	41.01%	6.4
Macro US	0.714	847.45*	678.49*	419.11*	19.36%	7.3
EPU US	104.89	576.77*	500.09*	283.77*	49.77%	7.4
EPU Europe	138.42	779.95*	592.92*	385.36*	39.17%	5.5
EPU China	150.27	609.85*	514.33*	300.35*	23.50%	3.5

Non-linear Diebold-Yilmaz approach: Results

Strong increase in the degree of connectedness in the high uncertainty regime

EPU in China and macro US are the 2 sources of uncertainty leading to the highest degree of connectedness

	Low uncertainty	High uncertainty
Financial uncertainty	65.3 %	74%
Macro uncertainty	63.1%	89.1%
Eco Pol Uncertainty US	64%	75%
Eco Pol Uncertainty EU	64%	77.7%
Eco Pol Uncertainty China	61.2%	86.6%

How the net contributors change from one regime to the other?

Evolution in net contributions in case of financial uncertainty

Table 10: Nonlinear Diebold-Yilmaz spillover index in international equity markets under financial uncertainty

low uncertainty

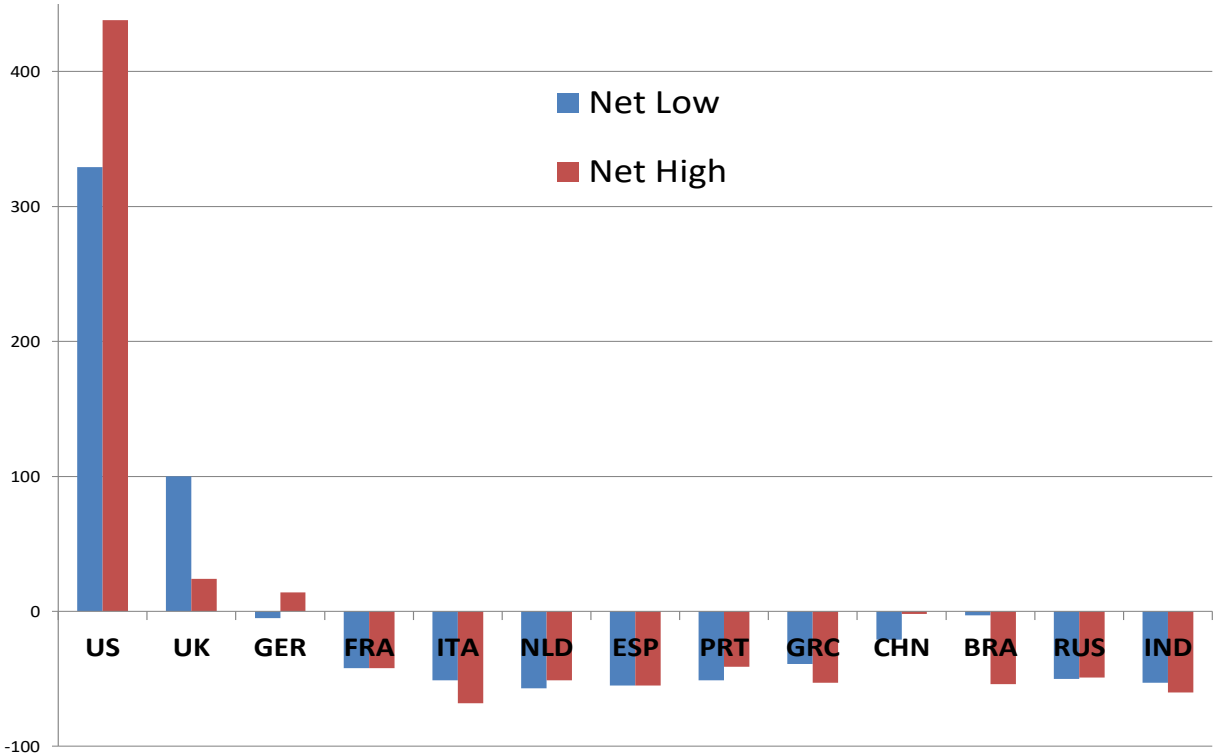
	USA	UK	GER	FRA	ITA	NLD	SPA	PRT	GRC	CHN	BRA	RUS	IND	FROM
USA	85.6	0.3	3.2	0.2	3.5	2.0	0.6	1.6	0.2	0.9	0.3	1.3	0.3	14
UK	45.2	34.5	5.3	1.2	0.7	1.7	1.0	2.8	2.0	0.3	4.9	0.1	0.3	65
GER	47.6	14.8	25.8	0.2	1.1	0.8	1.4	2.5	0.8	0.4	1.8	1.7	1.2	74
FRA	45.2	19.4	9.7	10.3	1.8	2.3	1.8	2.8	2.3	0.6	2.9	0.4	0.4	90
ITA	29.3	19.7	9.0	10.9	17.6	2.4	1.6	2.6	1.5	1.0	4.2	0.3	0.0	82
NLD	44.2	17.1	10.2	4.1	3.2	11.7	2.3	2.6	0.8	0.1	2.9	0.3	0.4	88
SPA	30.3	21.1	5.3	6.6	6.2	2.3	18.6	1.6	3.8	0.9	2.9	0.5	0.1	81
PRT	21.5	24.8	5.4	9.6	4.9	1.7	2.4	20.5	1.2	1.2	4.8	1.3	1.1	80
GRC	19.3	16.8	6.2	3.4	6.1	0.8	5.0	2.3	34.0	1.2	2.5	1.2	1.3	66
CHN	4.0	4.1	8.0	2.5	0.4	2.3	2.3	2.8	4.3	67.5	0.7	1.0	0.2	33
BRA	23.6	14.1	1.1	1.4	0.8	5.2	2.2	1.2	3.9	2.5	42.8	0.2	0.8	57
RUS	12.5	9.1	1.9	3.2	1.2	7.4	0.5	3.5	6.0	1.2	11.5	41.7	0.4	58
IND	20.0	3.5	3.8	4.5	1.0	1.6	4.6	3.0	0.6	1.7	14.7	0.4	40.3	60
TO	343	165	69	48	31	31	26	29	27	12	54	8	7	65.3%
NET	329	100	-5	-42	-51	-57	-54	-37	-6	-21	-3	-50	-53	

high uncertainty

	USA	UK	GER	FRA	ITA	NLD	SPA	PRT	GRC	CHN	BRA	RUS	IND	FROM
USA	70.7	2.5	8.9	1.4	0.8	1.9	1.5	3.9	0.7	3.8	1.4	2.2	0.2	29
UK	56.9	21.1	5.1	0.6	2.7	1.0	2.3	3.7	0.2	3.4	1.1	1.7	0.1	79
GER	53.1	6.6	22.4	1.2	0.5	3.4	2.0	2.0	1.7	2.2	1.6	2.9	0.4	78
FRA	56.0	8.6	13.5	7.1	0.9	2.3	2.5	1.3	1.2	3.8	0.8	2.1	0.0	93
ITA	44.2	10.6	14.5	5.6	9.7	3.8	1.7	2.8	1.0	2.8	1.5	1.7	0.2	90
NLD	51.5	13.5	10.9	2.4	0.8	10.1	1.7	1.7	1.4	4.3	0.3	1.1	0.3	90
SPA	45.5	10.8	8.1	6.6	2.6	3.8	12.6	2.7	1.8	1.2	1.8	1.8	0.8	87
PRT	30.2	13.3	11.0	11.7	2.7	3.7	6.4	14.0	3.5	1.2	0.5	1.3	0.6	86
GRC	27.5	10.9	6.8	12.2	0.8	2.2	5.2	2.7	24.7	3.0	1.5	1.7	0.8	75
CHN	11.2	3.7	2.1	2.3	0.3	2.4	1.4	8.2	4.5	59.1	2.9	0.2	1.6	41
BRA	37.3	9.0	4.5	2.6	1.0	5.6	2.3	4.6	2.1	2.8	25.2	0.7	2.4	75
RUS	34.4	4.3	3.4	1.5	2.0	2.7	4.0	6.2	0.7	2.0	2.9	32.2	3.8	68
IND	19.1	8.9	3.1	2.7	6.8	5.8	0.9	5.4	3.5	8.7	4.8	1.7	28.5	71
TO	467	103	92	51	22	39	32	45	22	39	21	19	11	74.0%
NET	436	24	14	-42	-68	-51	-55	-41	-53	-2	-54	-49	-60	

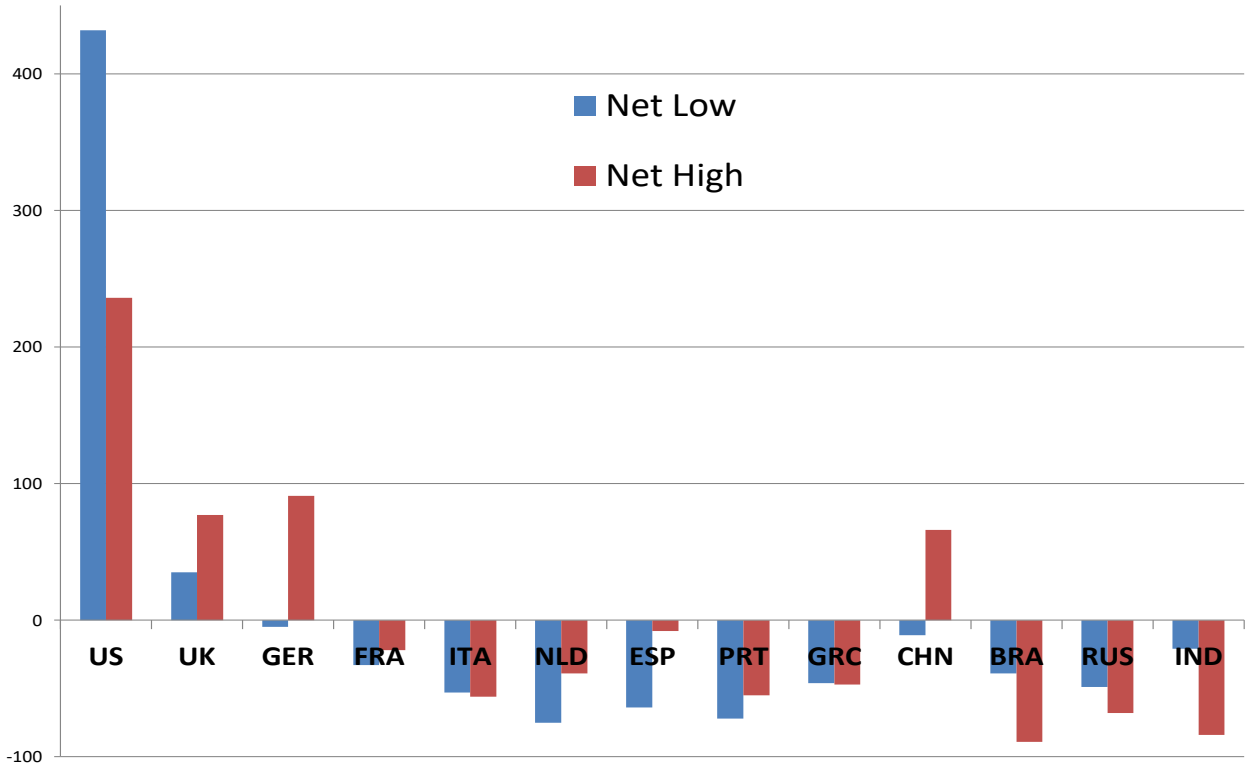
Non-linear Diebold-Yilmaz approach: Results

Evolution of contributions for financial volatility
US more a net contributor to the global system



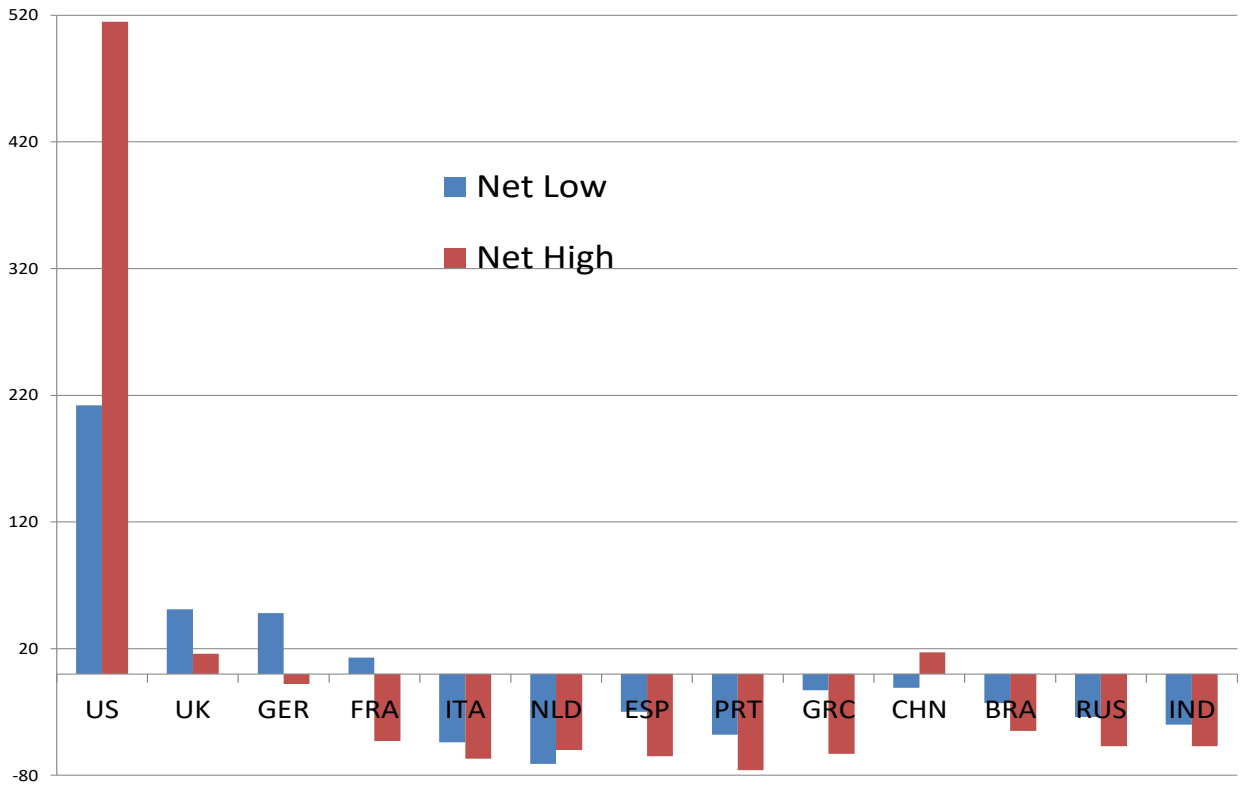
Non-linear Diebold-Yilmaz approach: Results

Evolution of net contributions for US macro uncertainty (ie around recessions)
Net givers in red: US/UK/US/China
A shift-away from the US



Non-linear Diebold-Yilmaz approach: Results

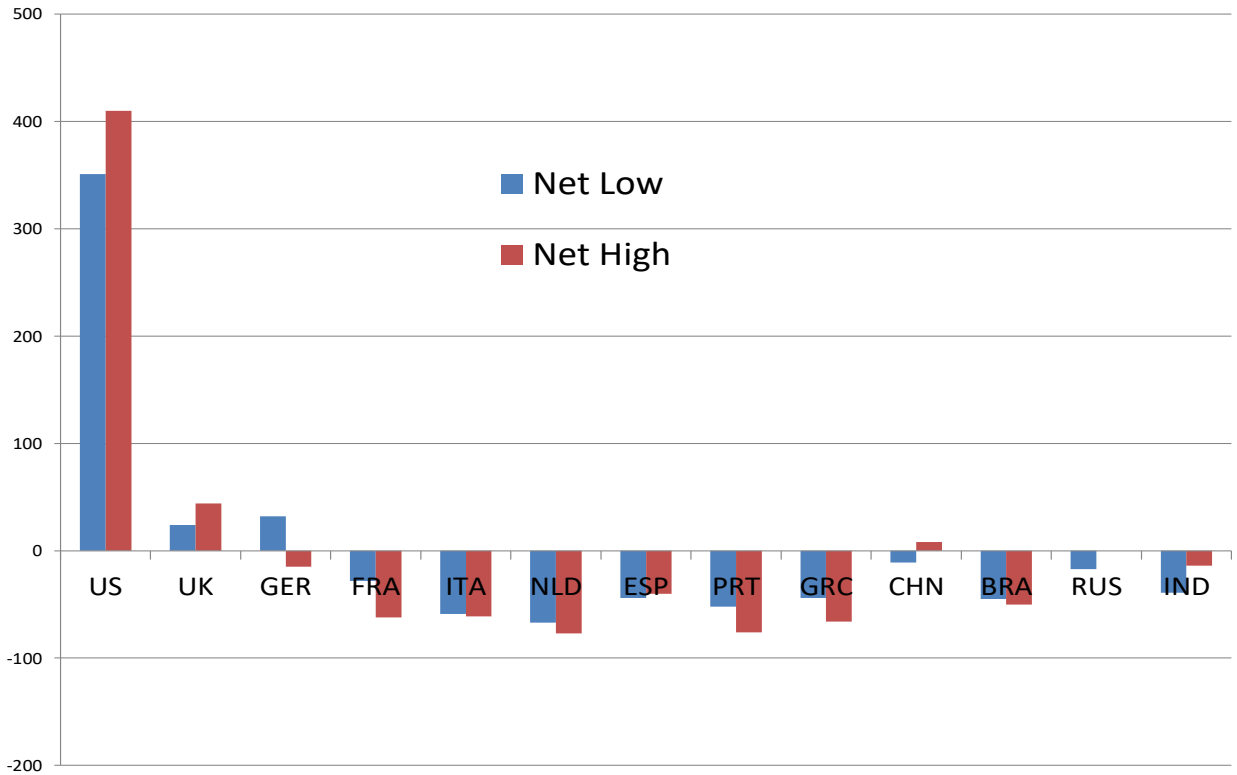
Evolution of net contributions for EPU US
US more a net contributor to the global system



Non-linear Diebold-Yilmaz approach: Results

Evolution of net contributions for EPU Europe

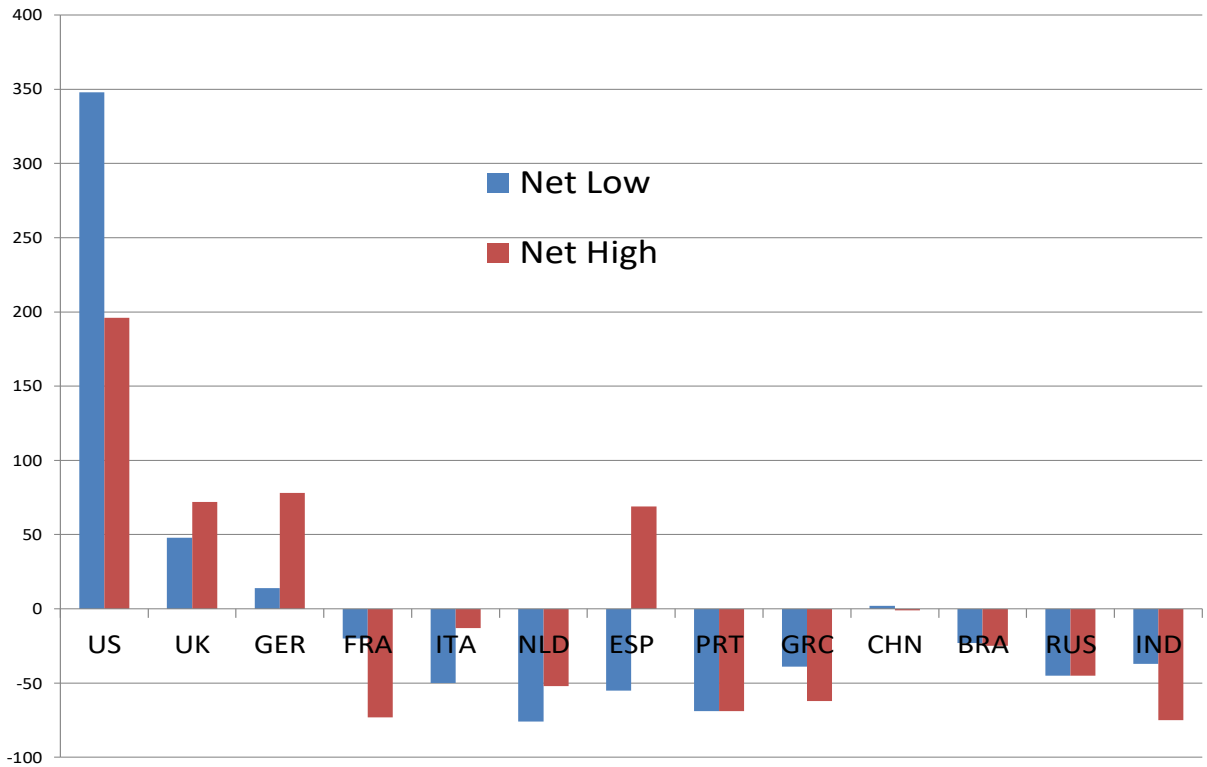
No major changes in the contributions



Non-linear Diebold-Yilmaz approach: Results

Evolution of net contributions for EPU China

Global rebalancing in contributions, no effect on Chinese contribution



Conclusions

Preliminary version of the paper: still time for suggestions !!!

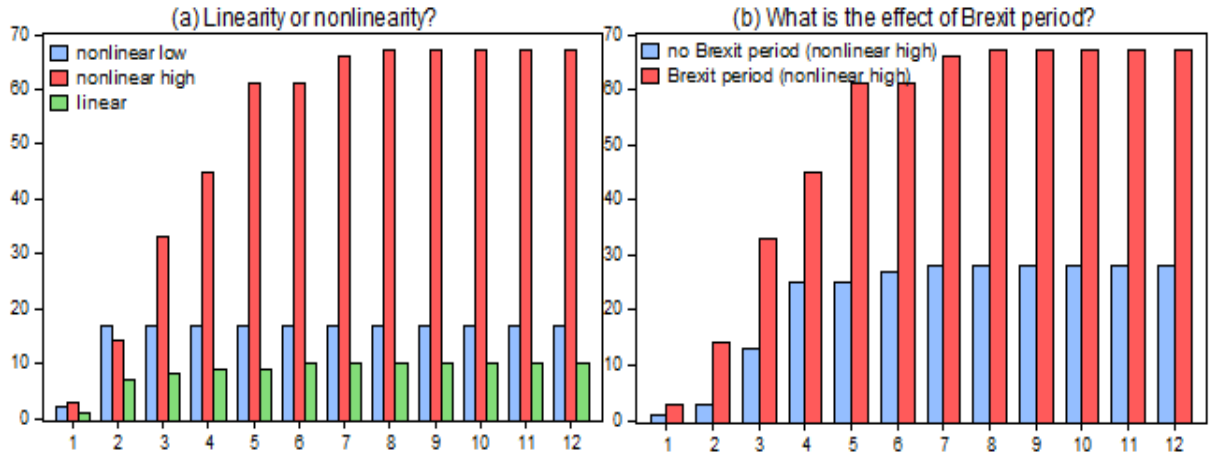
- Less financial spillovers within EMEs
- Higher uncertainty leads to more contagion (robust results to various measures)
- But the drivers differ according to the sources of uncertainty (US macro vs US Economic Policy)
- Policy recommendations

APPENDIX

Additional result: Effect of the Brexit on EA financial connectedness

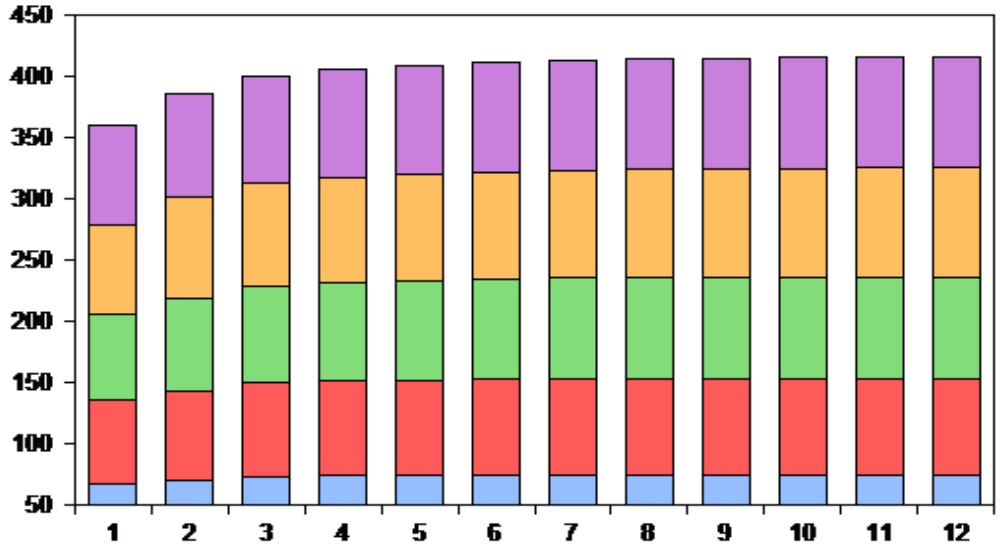
1/ Comparison between benchmark DY vs non-linear connectedness using UK EPU as transition variable (left panel): *Much stronger contagion in the high uncertainty regime*

2/ Inclusion of the Brexit period leads to *much stronger contagion in the high uncertainty regime* (right panel)



Note: The figures depict contribution of UK EPU on European markets' spillover from 1 month to 12 months predictive horizon for the variance

Global spillovers for various horizons H



Note: We plot global spillover index (in %) for international equity markets in high uncertainty regime for financial, macroeconomic, and economic policy uncertainty respectively over horizon going from 1 month to 12 months. Blue and purple lines are financial and macroeconomic uncertainty respectively; green, red and orange lines are respectively EPU for the U.S., Europe, and China.