Financial Connectedness

Frequency connectedness and cross section of stock returns

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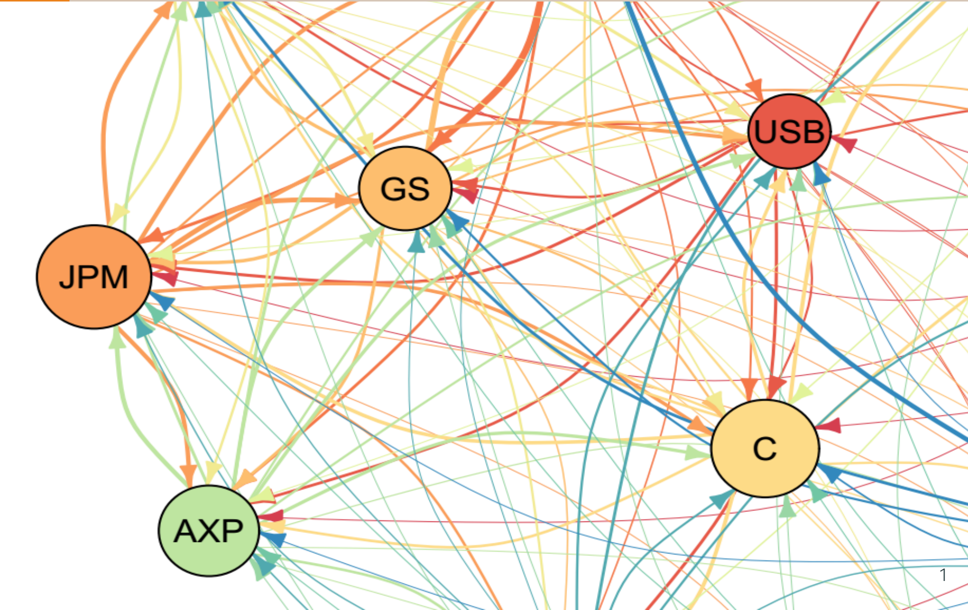
Connectedness network model of main U.S. financial institutions, 2000 - 2016. (illustrative figure)



Introduction

Financial Connectedness

FINANCIAL MARKET INTERDEPENDENCE / PROPAGATION OF SHOCKS / VOLATILITY TRANSMISSION / SPILLOVER INDEX / CONNECTEDNESS

Financial connectedness can be used to reveal possible systemic risk in the financial system. This study demonstrates sources of such risks in a network model.

- How to measure the volatility transmissions across financial markets?
- How to identify the first signs of beginning crisis to take appropriate steps to mitigate its adverse consequences ?

These questions are stressed both in the empirical research as well as it is a central concern of policy-makers since the global financial crisis in 2008.

Systemic Risk & Equity Risk Premium

- FINANCIAL SYSTEM CHARACTERIZATION IN A NETWORK MODEL CAPTURES THE CONNECTEDNESS AT VARIOUS INVESTMENT HORIZONS.
  This novel model allows to study the financial system as a network of companies forming ***different linkages at short-, medium-, and long-frequencies.***

- EXPLOITS THESE NETWORKS' LINKAGES CHARACTERISTICS AS A PROXY FOR EQUITY RISK PREMIUM.
  Frequency domain tools provide ***new evidence about the pricing of economic risks*** *that is both stronger and more statistically powerful than previous methods [Dew-Becker and Giglio, 2016].*

Frequency Connectedness Network Model

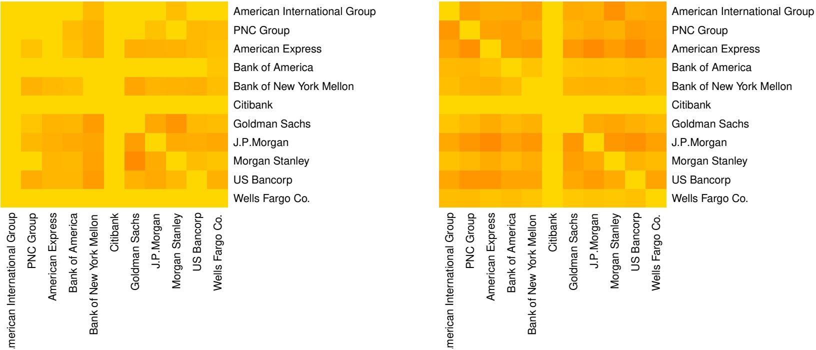
THE CONNECTEDNESS NETWORK MODEL employs the novel framework of [Baruník and Křehlík, 2018] based on the spectral representation of variance decompositions to capture a frequency dynamics of financial connectedness at various investment horizons (changes in the connectedness linkages - their strengths and directions - at different frequencies at a granular level)

Variance decomposition of forecast errors is computed from moving average coefficients of VAR approximating model and the spectral quantities are estimated using standard discrete Fourier transforms. At the desired frequency band is estimated the decomposition of the impulse response function and calculated generalized variance decomposition on the frequency band, answering the question: *HOW MUCH OF I-TH VARIABLE FUTURE UNCERTAINTY IS GENERATED BY SHOCKS TO J-TH VARIABLE IN THE SYSTEM AT VARIOUS INVESTMENT HORIZONS?*

Data

The data consist of high-frequency (five-minute) data of stock returns of 11 major U.S. financial institutions (Wells Fargo Co. (WFC), US Bancorp (USB), Morgan Stanley (MS), J.P. Morgan (JPM), Goldman Sachs (GS), Citibank (C), Bank of New York Mellon (BK), Bank of America (BAC), American Express (AXP), American International Group (AIG), and PNC Group (PNC).) and cover period from 4 January 2000 to 15 December 2016, with 4216 trading days. The original raw stock return data were obtained from TICK Data and www.price-data.com and was provided by IES FSV UK.

Heatmap: short / long frequency connectedness



(a) Pairwise connectedness, short frequency (b) Pairwise connectedness, long frequency

Figure 1: The heat maps show a simple representation of connectedness tables, clearly illustrating an increasing level of financial institutions' interconnections strengths with darker colors towards long-term frequency

Research Objectives

The study examines whether the network graph linkages distinguish between the representation of short-term, medium-term and long-term frequency connectedness.

The characteristics of these linkages and their changes are then used to as risk factors to asses if they price risk premium differently at specific frequency bands.

Results

Results

The main result of the paper is that the long-term component drives the total connectedness of the system. The network linkages attributes are significant risk factors, pricing the risk premium differently in the short-run and long-run.

$E(R^{e_i}) \sim \beta_{i,d}$	λ	Std. Error	t-Stat	Pr($>$ $\|t\|$)	adj. R^2	F-statistic
short frequency	-1.364476	0.2794810	-4.882	0.000869	0.6955	23.84
medium frequency	-0.261532	0.2805171	-0.932	0.3755	-0.0133	0.869
long frequency	2.055751	0.3454839	5.950	0.000215	0.7748	35.41

Table 1: Asset pricing, step 2: cross sectional model.

Asset pricing | 1st steps regressions

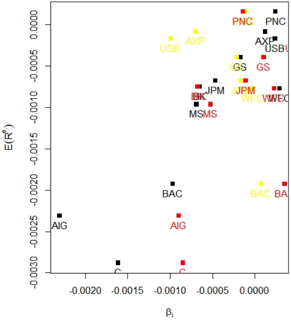
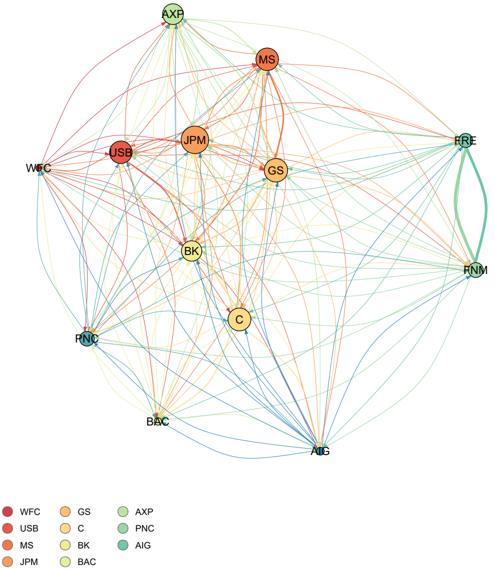


Figure 2: Asset pricing model, step 1, 3 factors. Time series regression with 3 frequency connectedness risk factors: $ret = const + shortfreq.factor^{*}\beta_1 + mediumfreq.factor^{*}\beta_2 + longfreq.factor^{*}\beta_3$. Short-term betas in black, medium-term betas in yellow and long-term betas in red color. Correlation of frequency measures shows upward direction in line with expectations.

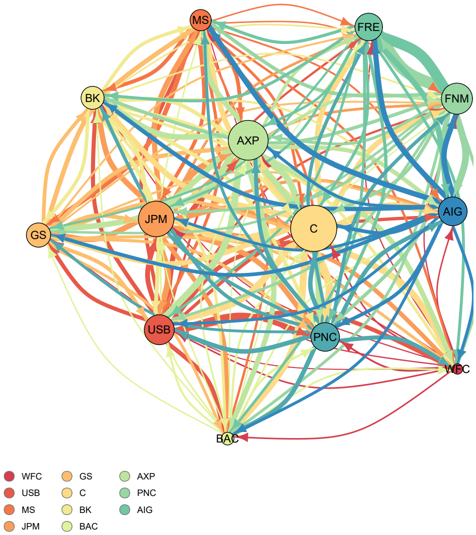
Connectedness linkages factors price the risk premium statistically significantly in the short and long-frequencies, the short frequency risk-pricing factor estimate is negative and the long frequency estimate shows positive relation to excess returns.
This is in line with the expectation and network-model representation of results of long-term frequency having a profound impact on higher risk transmission and stronger linkages between financial institutions and their stock prices.

Network model figures: The size of node depicts total TO connectedness (obtained shocks), the width of edge presents pairwise spillover. The edge color corresponds to its vertex origin.

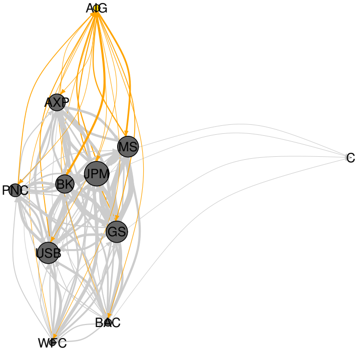
Connectedness Network Model: short-term frequency



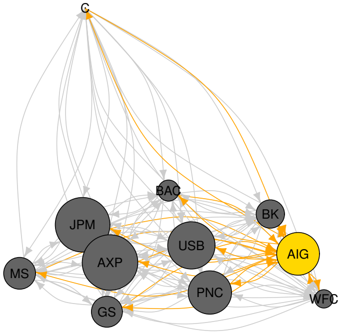
Connectedness Network Model: long-term frequency



Connectedness Network Model: Pairwise connectedness



(a) Short-term frequency.



(b) Long-term frequency.

Figure 5: Connectedness network model, main U.S. financial institutions, 2000 - 2016: directional connectedness of American International Group in yellow color.

Time-dynamics of connectedness in the system

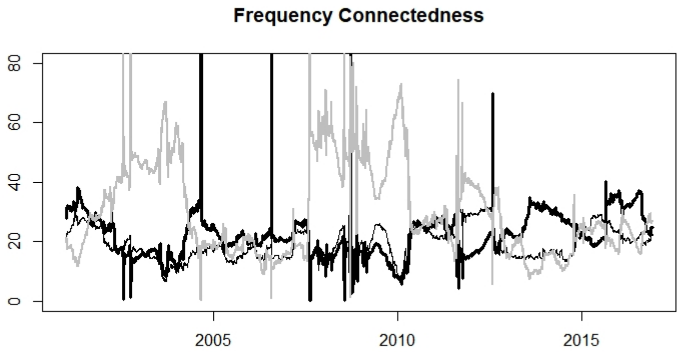


Figure 6: System-wide connectedness: main 11 U.S. financial institutions, 2000-2016.
Dynamic analysis shows rich time-dynamics of connectedness at bands $d_1 \in [1, 5]$ days in black bold, $d_2 \in (5, 20]$ days in black and $d_3 \in (20, 250]$ days in gray.
Our representation of connectedness in networks rigorously illustrates, that high aggregated connectedness is driven mainly by low-frequency components.

Thank you for your attention.

Connectedness Table: short-term frequency

Table 2: Connectedness table: short-term frequency decomposition, $d \in [1, 5]$ days.

	WFC	USB	MS	JPM	GS	C	BK	BAC	AXP	PNC	AIG	$FROM_{ABS}$	$FROM_{WTH}$
WFC	16.77	1.11	0.59	1.35	0.74	0.01	0.69	0.52	0.66	0.79	0.20	0.61	2.98
USB	0.33	4.09	0.76	1.25	0.83	0.00	1.15	0.30	0.88	0.83	0.15	0.59	2.90
MS	0.18	0.82	4.83	1.29	1.95	0.01	1.06	0.32	1.04	0.32	0.69	0.70	3.43
JPM	0.43	1.32	1.26	4.21	1.38	0.01	1.02	0.45	1.11	0.63	0.20	0.71	3.49
GS	0.29	1.05	2.28	1.67	5.11	0.01	1.42	0.40	1.18	0.45	0.34	0.83	4.06
C	0.03	0.03	0.06	0.17	0.08	77.45	0.03	0.05	0.03	0.02	0.02	0.05	0.23
BK	0.32	1.75	1.56	1.47	1.70	0.00	7.12	0.36	1.18	1.14	0.85	0.94	4.62
BAC	0.46	0.94	0.90	1.31	0.94	0.01	0.71	14.67	0.65	0.79	0.24	0.63	3.11
AXP	0.21	0.94	0.98	1.12	0.99	0.00	0.83	0.22	4.22	0.42	0.10	0.53	2.60
PNC	0.36	1.21	0.47	0.90	0.53	0.00	1.03	0.38	0.59	6.20	0.20	0.52	2.54
AIG	0.13	0.35	0.46	0.46	0.40	0.01	0.22	0.19	0.18	0.33	9.32	0.25	1.22
TO_{ABS}	0.25	0.87	0.85	1.00	0.87	0.01	0.74	0.29	0.68	0.52	0.27	6.34	/
TO_{WTH}	1.23	4.26	4.16	4.91	4.27	0.03	3.65	1.43	3.36	2.56	1.34	/	31.17

Connectedness Table: long-term frequency

Table 3: Connectedness table: long-term frequency decomposition, $d \in (22, 250]$ days.

	WFC	USB	MS	JPM	GS	C	BK	BAC	AXP	PNC	AIG	$FROM_{ABS}$	$FROM_{WTH}$
WFC	6.60	7.82	4.14	8.07	4.39	0.07	4.05	4.01	8.62	8.04	7.00	5.11	7.91
USB	3.52	12.93	5.21	10.92	5.89	0.07	5.84	3.99	11.42	8.82	6.39	5.64	8.73
MS	2.48	6.63	9.59	9.64	7.47	0.08	5.11	3.11	9.05	5.75	10.49	5.44	8.41
JPM	2.89	9.03	6.67	13.90	6.54	0.07	5.50	3.33	11.78	6.92	6.04	5.34	8.27
GS	2.28	7.13	8.36	9.59	10.95	0.08	5.07	2.62	9.24	5.18	6.63	5.11	7.90
C	0.17	0.31	0.28	0.52	0.21	4.94	0.16	0.27	0.44	0.38	0.40	0.29	0.44
BK	2.60	7.73	6.41	9.66	5.71	0.05	7.02	2.95	9.42	6.50	8.30	5.39	8.34
BAC	3.57	7.70	4.33	8.21	4.41	0.08	3.83	8.09	8.07	8.38	6.61	5.02	7.76
AXP	3.11	9.98	6.51	11.71	6.54	0.05	5.77	3.39	15.05	7.94	6.57	5.60	8.66
PNC	4.15	9.98	4.55	9.78	4.57	0.07	5.21	4.72	10.71	12.61	8.27	5.64	8.72
AIG	3.82	7.43	3.19	7.04	2.63	0.08	3.68	4.49	7.84	9.70	25.22	4.54	7.02
TO_{ABS}	2.60	6.70	4.51	7.74	4.40	0.06	4.02	2.99	7.87	6.15	6.06	53.11	/
TO_{WTH}	4.02	10.37	6.98	11.97	6.80	0.10	6.22	4.63	12.18	9.51	9.38	/	82.15

References i

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