Syndication, Interconnectedness, and Systemic Risk

Jian Cai (WashU)
Anthony Saunders (NYU Stern)
Sascha Steffen (ESMT)

Global Financial Interconnectedness
Basel, 1-2 Oct 2015

This paper addresses the question how to quantify interconnectedness between banks

- Major forms of contagion
  - Contractual contagion or domino contagion
  - Information contagion
  - Fire-sale externalities
  - Price complexity contagion
  - Common Exposures

- How can we quantify interconnectedness between banks?

- Implications for stress testing (micro vs. macro-prudential stress tests)

Several market-based measures of systemic risk exist…but what are they measuring?

- Systemic risk measures using market data
  - SRISK
  - CoVaR
  - …
  - And several other measures
- Shortfall estimates (similar to stress tests)
- Questions:
  - What risks are banks exposed to?
  - What about privately-held banks?

Systemic risk of largest European financial institutions

Rank	Name	Country	SRISK [bill. €]	Market cap. [bill. €]
1	Deutsche Bank AG	Germany	74.402	34.79
2	BNP Paribas SA	France	73.284	60.52
3	Barclays PLC	United Kingdom	66.092	46.87
4	Societe Generale SA	France	59.387	29.46
5	Credit Agricole Group	France	56.073	54.18
6	Royal Bank of Scotland Group PLC	United Kingdom	38.522	51.98
7	ING Groep NV	Netherlands	35.127	42.6
8	London Stock Exchange Group PLC	United Kingdom	31.486	8.01
9	UniCredit SpA	Italy	26.032	34.06
10	Commerzbank AG	Germany	25.619	12.19
11	BPCE Group	France	23.597	58.19
12	AXA SA	France	20.921	44.29

As of 14 Oct 2014

Several market-based measures of systemic risk exist…but what are they measuring?

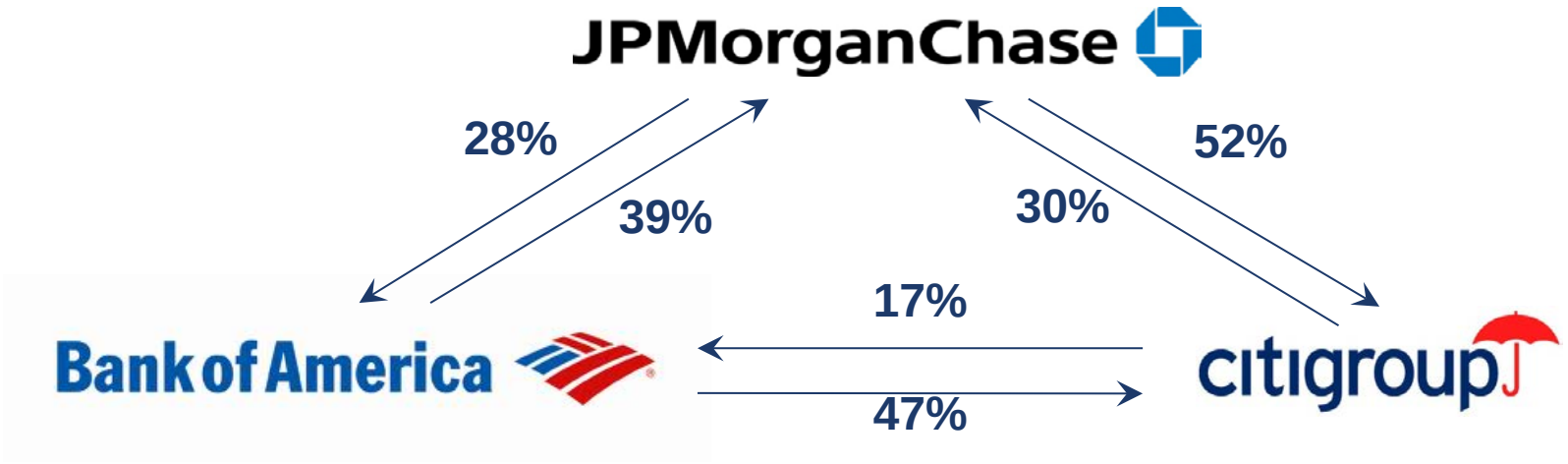
- Systemic risk measures using market data
  - SRISK
  - CoVaR
  - …
  - And several other measures…
- Shortfall estimates (similar to stress tests)
- Questions:
  - What risks are banks exposed to?
  - What about privately-held banks?

This paper…

- How can we measure interconnectedness of banks?
- What are key drivers of interconnectedness?
- How does interconnectedness relate to (market-based) measures of systemic risk?

We measure interconnectedness as overlaps of large corporate loans

The U.S. Syndicated Loan Market 2004-2006



- 71% of US syndicated loans are reciprocal (Cai, 2010).

Data source

- Syndicated loans from LPC Dealscan
  - US originated loans 1988 – 2011 period
  - Info: Top 100 lead arrangers, loan amount, borrower industry and location
- Systemic risk data
  - SRISK, CoVaR, DIP, CATFIN
- Compustat/CRSP
  - Borrower specific information
- Call Report and SNL
  - Bank characteristics (total assets, market equity)
- NBER recession dates

Methodology: Measuring interconnectedness

- "Distance" between two banks [Euclidean Distance]
  - Borrower industry, geographic location

Industry specialization *j*

$$\text{Distance}_{m,n,t} = \sqrt{\sum_{j=1}^{J} \left(w_{m,j,t} - w_{n,j,t} \right)^2}$$

Banks *m, n* at time *t*

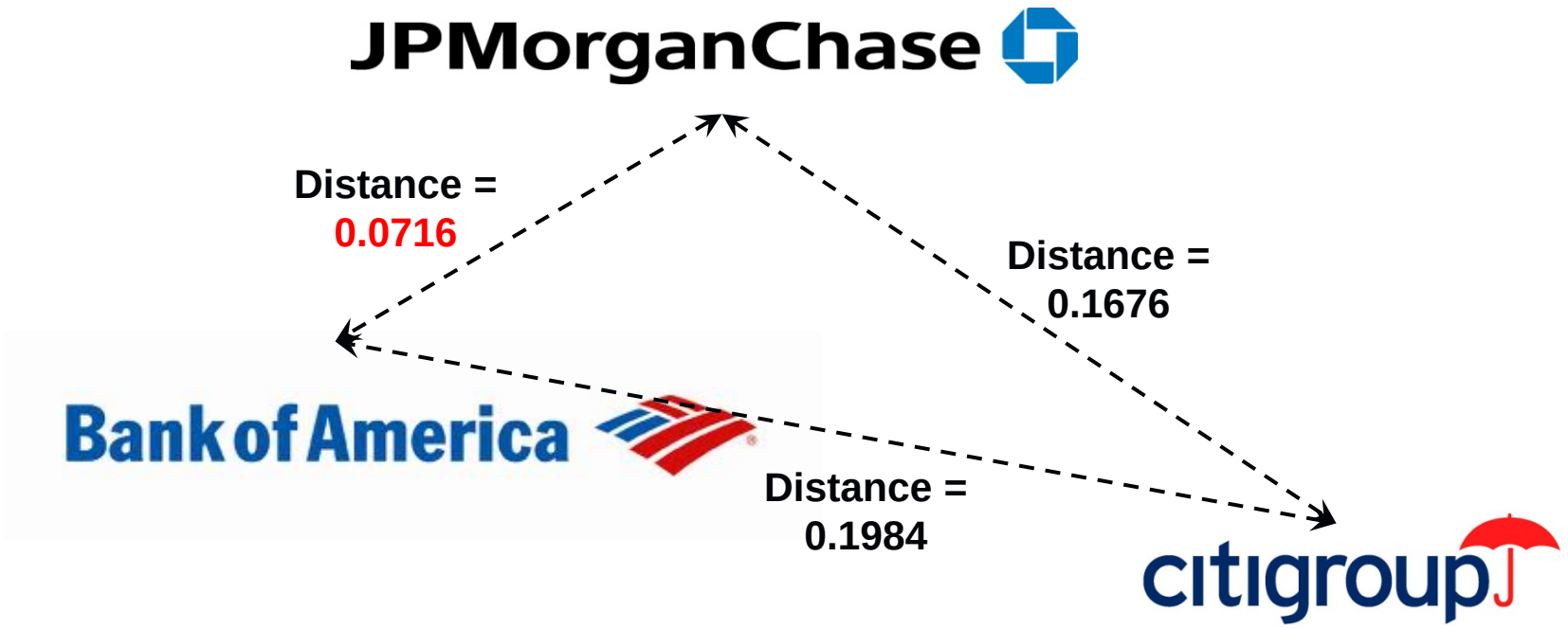
Portfolio weight *w*

Top 3 lead arranger in 2006

SIC Industry Division (2-digit SIC Industries)	JPM (1st)	BAC (2nd)	C (3rd)
Agriculture, Forestry & Fishing (01-09)	0.0288%	0.1695%	0.0000%
Mining (10-14)	5.0995%	3.7503%	4.7749%
Construction (15-17)	2.3374%	6.3482%	0.3057%
Manufacturing (20-39)	28.6855%	23.3487%	35.3001%
Transportation, Communications, Electric, Gas & Sanitary Services (40-49)	12.2990%	12.0246%	20.1229%
Wholesale Trade (50-51)	2.4575%	3.8202%	0.9026%
Retail Trade (52-59)	6.8148%	7.3637%	2.8273%
Finance, Insurance & Real Estate (60-67)	29.1845%	30.7133%	18.4803%
Services (70-89)	13.0931%	12.4389%	17.1766%
Public Administration (91-97)	0.0000%	0.0226%	0.1096%
Total	100%	100%	100%

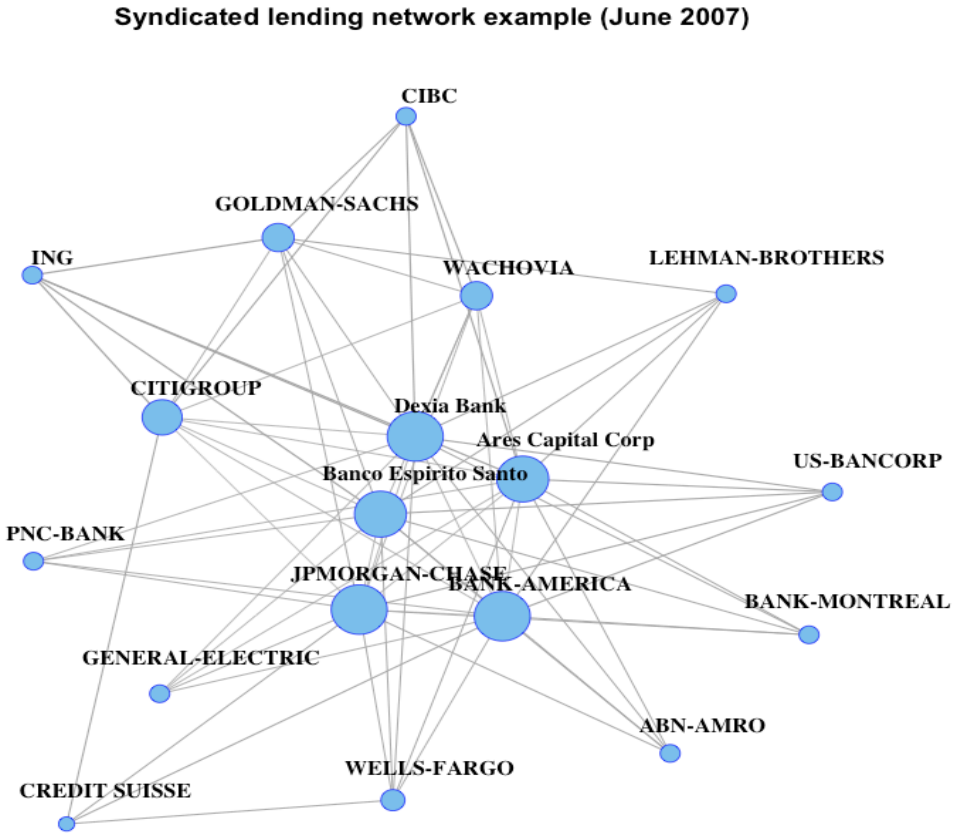
JPMorgan and Bank of America have more similar loan portfolios w.r.t. manufacturing.

In 2006, BoA and JP Morgan were more interconnected



- Largest portfolio overlap in 2006 between BoA and JP Morgan
  - "Smallest distance" or "more interconnected"

Globally active banks are interconnected in the US syndicated loan market



- Interconnectedness is not (only) determined by size
  - Dexia and Banco Espirito Santo are smaller compared to US banks (and both eventually failed)

Measuring interconnectedness

$$\text{Interconnectedness}_{i,t} = \left(1 - \frac{\sum_{i \neq k} x_{i,k,t} \cdot \text{Distance}_{i,k,t}}{\sqrt{2}}\right) \times 100$$

Weight *x*

- Distances are weighted using
  - Equal weights
  - Relationship weights
- Interconnectedness is normalized on a scale of 0-100.

Arranging banks are more likely to select banks that are more interconnected

Syndicate member indicator	(I) SIC Division	(II) 2-digit SIC	(III) 3-digit SIC	(IV) 4-digit SIC
Distance from lead arranger	-0.036***	-0.042***	-0.040***	-0.040***
	(.001)	(.001)	(.001)	(.001)
Previous relationship with lead	0.022***	0.020***	0.020***	0.020***
	(.001)	(.001)	(.001)	(.001)
Previous relationship with borrower	0.534***	0.533***	0.533***	0.533***
	(.004)	(.004)	(.004)	(.004)
Market share as a lead	0.422***	0.403***	0.405***	0.406***
	(.017)	(.017)	(.017)	(.017)
Loan facility fixed effects	Yes	Yes	Yes	Yes
N =	10,916,818	10,916,818	10,916,818	10,916,818
Adjusted R^2	0.3226	0.3229	0.3228	0.3228

- Interconnectedness even increases, i.e. banks become more similar.

Lack of diversity increases risks to the financial system

Bank-level Interconnectedness	Equal-weighted				Relationship-weighted			
	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC
Total Assets	0.001***	0.002***	0.002***	0.002***	0.001***	0.001***	0.001***	0.002***
	(.0002)	(.0001)	(.0002)	(.0002)	(.0002)	(.0001)	(.0002)	(.0002)
Diversification	0.272***	0.347***	0.366***	0.370***	0.361***	0.442***	0.475***	0.482***
	(.0039)	(.0011)	(.0012)	(.0013)	(.0102)	(.0062)	(.0056)	(.0055)
# of Specializations	0.622***	0.164***	0.063***	0.043***	2.039***	0.387***	0.138***	0.092***
	(.0407)	(.0065)	(.0025)	(.0016)	(.0948)	(.0133)	(.0042)	(.0028)
Lead Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N =	19,569	19,569	19,569	19,569	19,569	19,569	19,569	19,569
Adjusted R^2	0.8268	0.9726	0.9771	0.9773	0.737	0.8299	0.8515	0.852

- Larger and more diversified banks are more interconnected.
- Diversity versus diversification (Wagner (2010))

Can we use interconnectedness as monitoring tool in banking supervision?

- Federal Reserve Chairman Ben Bernanke, Conference on Bank Structure and Competition, Chicago, May 2010:
  - *"We have initiated new efforts to better measure large institutions' counter-party credit risk and **interconnectedness**, sensitivity to market risk, and funding and liquidity exposures. These efforts will help us focus not only on risks to individual firms, but also on concentrations of risk that may arise through common exposures or sensitivity to common shocks. For example, we are now collecting additional data in a manner that will allow for the more timely and consistent **measurement of individual bank and systemic exposures to syndicated corporate loans**."*

- Our approach: Does interconnectedness help predict differences in systemic risk? I.e. how do our measures relate to market-based measures of systemic risk?

Market-based measures of systemic risk

- SRISK
  - Acharya et al. (2010); Brownlees and Engle (2013)
  - Assumes a 40% global stock market decline and a regulatory capital threshold
- Distressed Insurance Premium (“DIP”)
  - Huang et al. (2010)
  - Insurance premium if losses exceed a certain threshold of total banks’ liabilities
  - “Bailout measure”
- CATFIN
  - Allen et al. (2012)
  - Aggregate VaR measure of systemic risk in the financial system

More interconnected banks have higher SRISK during recessions

SRISK	Equal-weighted				Relationship-weighted			
	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC
Interconnectedness	-0.189***	-0.139***	-0.139***	-0.141***	-0.085***	-0.070***	-0.069***	-0.068***
	(.037)	(.033)	(.033)	(.033)	(.015)	(.014)	(.014)	(.014)
Recession	-15.581***	-12.047***	-13.048***	-12.766***	-9.822***	-8.331***	-9.373***	-9.195***
	(1.681)	(1.225)	(1.251)	(1.254)	(1.077)	(1.012)	(1.019)	(1.014)
Interconnectedness x Recession	0.566***	0.538***	0.557***	0.549***	0.314***	0.301***	0.316***	0.312***
	(.055)	(.043)	(.044)	(.044)	(.027)	(.026)	(.28)	(.027)
Total Assets	0.074***	0.074***	0.074***	0.074***	0.074***	0.074***	0.074***	0.074***
	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)	(.001)
Market Share	0.328	0.333	0.334	0.334	0.28	0.283	0.289	0.288
	(.278)	(.276)	(.277)	(.277)	(.278)	(.277)	(.277)	(.277)
Lead Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N =	5,738	5,738	5,738	5,738	5,738	5,738	5,738	5,738
Adjusted R^2	0.9013	0.9018	0.9021	0.9021	0.9011	0.901	0.9013	0.9013

- Larger banks have higher systemic risk.
- If interconnectedness is large enough, it increases systemic risk.

More interconnected banks have higher DIP during recessions

	Equal-weighted				Relationship-weighted			
DIP	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC
Interconnectedness	-0.131*	-0.058	-0.058	-0.053	-0.071**	-0.037	-0.034	-0.032
	(.068)	(.062)	(.065)	(.066)	(.031)	(.037)	(.041)	(.042)
Recession	-11.516***	-7.434***	-7.893***	-7.573***	-6.445***	-6.012***	-7.320***	-7.164***
	(4.045)	(2.212)	(2.427)	(2.436)	(2.24)	(1.974)	(2.309)	(2.338)
Interconnectedness x Recession	0.447***	0.409***	0.413***	0.405***	0.243***	0.252***	0.275***	0.272***
	(.134)	(.103)	(.106)	(.106)	(.067)	(.066)	(.072)	(.072)
Total Assets	0.016***	0.016***	0.016***	0.016***	0.016***	0.016***	0.016***	0.016***
	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)	(.002)
Market Share	5.862***	6.058***	5.954***	5.950***	5.760***	5.957***	5.967***	5.962***
	(1.083)	(1.086)	(1.091)	(1.09)	(1.093)	(1.096)	(1.093)	(1.092)
Lead Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N =	1,414	1,414	1,414	1,414	1,414	1,414	1,414	1,414
Adjusted R^2	0.6678	0.6704	0.6706	0.6704	0.6659	0.668	0.6695	0.6694

CATFIN is a market-wide systemic risk measures

- Allen et al. (2012) develop a systemic risk measure for the financial system.
- Unweighted average of three VaR measures.
- Idea: Capture effects of financial sector risk taking on the macro economy
- Market-wide interconnectedness measure (“Index”):

$$\text{Interconnectedness Index}_t = \sum_i y_{i,t} \cdot \text{Interconnectedness}_{i,t}$$

…and more interconnected banks have higher CATFIN during recessions

CATFIN	Equal-weighted				Relationship-weighted			
	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC	SIC Division	2-digit SIC	3-digit SIC	4-digit SIC
Interconnectedness Index	-0.518*	-0.37	-0.276	-0.266	-0.07	-0.167	-0.164	-0.163
	(.295)	(.281)	(.274)	(.279)	(.221)	(.252)	(.252)	(.252)
Recession	-45.413*	-13.444	-12.836	-11.817	-31.010***	-29.738**	-27.696**	-27.664**
	(24.52)	(12.89)	(12.002)	(11.87)	(11.272)	(11.929)	(11.847)	(11.911)
Interconnectedness Index x Recession	1.772**	1.086**	1.075***	1.039***	1.170***	1.238***	1.189***	1.186***
	(.689)	(.44)	(.407)	(.402)	(.272)	(.306)	(.302)	(.303)
Market Size	-0.009***	-0.008***	-0.009***	-0.009***	-0.010***	-0.010***	-0.010***	-0.010***
	(.002)	(.003)	(.003)	(.003)	(.002)	(.003)	(.003)	(.003)
Herfindahl Index	-0.156	-0.114	-0.074	-0.068	0.133	0	-0.014	-0.006
	(.341)	(.339)	(.34)	(.34)	(.414)	(.409)	(.416)	(.413)
N =	252	252	252	252	252	252	252	252
R^2	0.3685	0.3676	0.3722	0.3708	0.4045	0.4041	0.4036	0.4032

Implications

- Interconnectedness between banks can help regulators to monitor build-up of risks in the financial system.
  - Identify G-SIFI's (interconnectedness as a new factor)
  - FSOC has the task to monitor and address systemic risk in the financial system.

- Regulators can use more detailed data to extend our analysis
  - Monitor specific industry overlap, common exposures to leveraged loans, exchange rate risks

- Implications for stress-testing and capital requirements
  - Incorporate tests for 2nd round effects due to interconnectedness (-> qualitative part?)
  - Reflect elevated systemic importance enforcing larger capital buffers

Backup Slides

Summary statistics

	N =	Mean	*SD*	10^{th}	50^{th}	90^{th}
All borrowers:						
Sales at closing ($mm)	59,877	2,800	12,400	52	411	5,580
# of previous syndicated loans	91,715	2.38	4.24	0	1	6
Private firm indicator	72,633	0.37	0.48	0	0	1
Public, unrated firm indicator	72,633	0.28	0.45	0	0	1
Public, rated firm indicator	72,633	0.34	0.47	0	0	1
Borrowers with *Compustat* data:						
Total book assets ($mm)	40,414	11,000	68,875	89	893	14,381
Book leverage ratio	40,243	0.37	0.28	0.05	0.34	0.69
Earnings to asset ratio	38,211	0.06	0.26	-0.02	0.07	0.16
S&P debt rating indicator	42,009	0.49	0.50	0	0	1
S&P investment-grade indicator	20,417	0.55	0.50	0	1	1

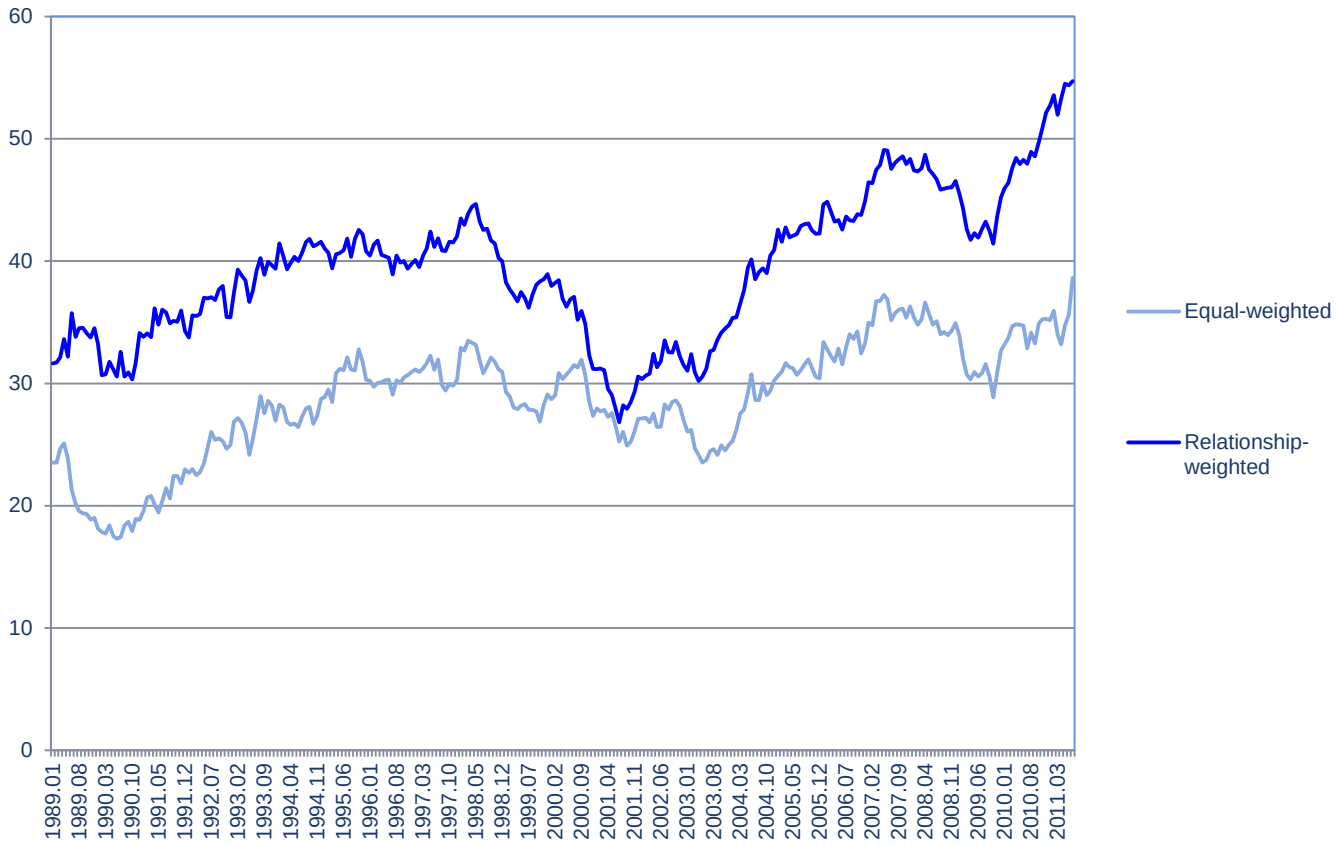
- XXX

Summary statistics (cont'd)

	N =	Mean	*SD*	10^{th}	50^{th}	90^{th}
Syndicated loan terms:						
Facility amount ($mm)	91,715	236	599	12.5	80	500
Maturity (months)	81,384	48	50	12	48	82
Spread on drawn funds (bps)	76,169	233	154	50	225	400
Term loan indicator	91,715	0.32	0.46	0	0	1
Syndicated structure:						
# of lenders in the syndicate	76,799	6.93	7.22	2	4	15
# of lead arrangers in the syndicate	91,715	1.24	0.63	1	1	2
% retained by lead arranger(s)	19,738	36.04	25.27	9.78	29.41	70.76
Purpose of loan indicators:						
Working capital/corporate	91,715	0.62	0.48	0	1	1
Refinancing	91,715	0.22	0.41	0	0	1
Acquisitions	91,715	0.23	0.42	0	0	1
Backup lines	91,715	0.07	0.25	0	0	0

- XXX

Graph….


60
50
40
30
20
10
0
1989.01
1989.08
1990.03
1990.10
1991.05
1991.12
1992.07
1993.02
1993.09
1994.04
1994.11
1995.06
1996.01
1996.08
1997.03
1997.10
1998.05
1998.12
1999.07
2000.02
2000.09
2001.04
2001.11
2002.06
2003.01
2003.08
2004.03
2004.10
2005.05
2005.12
2006.07
2007.02
2007.09
2008.04
2008.11
2009.06
2010.01
2010.08
2011.03
Equal-weighted
Relationship-weighted

- xxx