

Supplementary Materials

Early Warning of Systemic Risk In Global Banking: Eigen-Pair R Number for Financial Contagion and Market Price-based Methods

Appendix A. Steps for the Application of the Spectral SRI on BIS Data

A number of adjustments given in *Steps 1-3* are needed in order to arrive at the dynamical stability model in equation (8) for the cross border banking system-banking system network based on the BIS data.³¹

Step 1: BIS Reporting Countries Banking System-Banking System Data

This is needed for BIS reporting countries for which the banking sectoral break down has not been given. Note, b_i^R is a BIS reporting bank of country i . Foreign claims for each BIS reporting country banking system, i , on all sectors, S , of country j given by $\sum_{b^R} X_{S_j b_i^R}^F$ has to be adjusted to reflect only foreign claims on the banking sector, B_j of country j , viz. $\sum_{b^R} X_{B_j b_i^R}^F$. The ratio $\frac{\sum_i X_{B_j B_i}^F}{\sum_i X_{S_j B_i}^F}$ measures the total cross-border liabilities of banking system B_j over total cross-border liabilities of its sectors S_j and is used to scale down $\sum_{b^R} X_{S_j b_i^R}^F$.

Step 2: Adjustment for Tier 1 Capital for Cross Border Banking Sector Exposures

As both bank equity capital (given as Assets minus Liabilities) and Tier 1 capital which are reported, for instance in Bankscope, relate to consolidated balance sheets of banks, BIS consolidated banking data is appropriate. However, in order to relate the cross border assets and liabilities of the BIS reporting banks to the regulatory capital requirements, for each country i , we use Tier 1 capital. The sum of Tier 1 capital of cross border reporting banks in each BIS country i is adjusted by the ratio $\frac{\sum_{b^R} \sum_{j \neq i} X_{B_j b_i^R}^F}{\sum_{b^R} \sum_{j \neq i} X_{S_j b_i^R}^F}$ in order to identify what absolute losses of this can be sustained before a country's banking system is considered to be in distress from its cross border exposures to other banking systems.

Step 3: Absolute Tier 1 Capital Loss Thresholds derived from Bankscope data on Basel CAR/RWA

It is the role of the regulatory capital threshold to signal distress points, viz. the extent to which balance sheet losses can be accommodated before banks in the system are considered to be under stress. As shown in equation (36) the empirical data for the cross border banks of reporting countries Tier 1 capital held on the basis of the Basel CAR is converted to an absolute Tier 1 capital loss threshold for banking systems of the CGBSN. This facilitates easy comparisons between the permissible capital loss in banking systems and also satisfies the failure dynamics specified in equation (8) in terms of the tipping point conditions.

Appendix B. Tier 1 Capital For CGBS

Appendix B Table B.4 gives the Bankscope Tier1 capital for the cross border banks of the BIS reporting countries³². In Table B.5, this Tier 1 capital data is adjusted for the cross-border banking system-banking system exposure given in Step 2 of 3.1.

The last column, λ impact, of Table B.5 reports the loss of pro rata adjusted Tier1 capital in the worst case scenario, given by the Spectral SRI λ , as ratio of the total *unadjusted* Tier1 capital of Table B.4. In

³¹Note the full data set of matrices used for the Spectral SRIs are available from the authors upon request.

³²The list of banks is available from the authors upon request.

Table B.4: Time Series of Tier 1 Capital of Selected Cross Border Banks for each of the BIS reporting countries (in \$bn)

	Austria	Australia	Belgium	Switzerland	Germany	Spain	France	UK	Greece	Ireland	India	Italy	Japan	Netherlands	Portugal	Sweden	Turkey	US
2005Q4	10.73	19.46	14.03	54.87	35.73	81.88	113.00	169.85	9.80	25.52		50.65	228.53	94.45	16.09	39.12	16.91	479.37
2006Q1	12.34	28.20	14.96	57.99	58.36	87.36	121.83	203.16	10.24	28.51		57.32	231.75	88.98	17.20	41.81	18.51	501.26
2006Q2	13.96	36.93	15.89	61.10	80.99	92.84	130.67	236.47	10.69	31.49		63.99	234.97	83.51	18.30	44.49	20.11	523.14
2006Q3	15.58	45.67	16.82	64.22	103.62	98.32	139.50	269.78	11.13	34.48		70.67	238.20	78.05	19.40	47.18	21.71	545.03
2006Q4	17.19	54.41	17.75	67.34	126.25	103.80	148.33	303.09	11.58	37.47		77.34	241.42	72.58	20.50	49.86	23.31	566.92
2007Q1	23.52	58.02	21.03	67.05	154.81	111.23	164.50	329.17	13.01	40.08		95.85	256.96	77.28	21.36	51.41	26.40	583.49
2007Q2	29.84	61.64	24.31	66.76	183.38	118.65	180.67	355.24	14.45	42.70		114.36	272.50	81.98	22.22	52.97	29.49	600.06
2007Q3	36.16	65.25	27.58	66.47	211.94	126.08	196.84	381.32	15.89	45.32		132.87	288.04	86.69	23.09	54.52	32.59	616.62
2007Q4	42.48	68.86	30.86	66.18	240.50	133.51	213.01	407.39	17.33	47.93	30.48	151.37	303.58	91.39	23.95	56.07	35.68	633.19
2008Q1	42.74	69.20	36.23	67.57	245.08	141.61	231.36	390.34	17.64	47.63	31.59	149.72	298.69	87.35	24.67	56.84	37.26	709.33
2008Q2	43.00	69.54	41.59	68.97	249.66	149.70	249.71	373.29	17.95	47.32	32.70	148.07	293.80	83.31	25.39	57.61	38.84	785.46
2008Q3	43.26	69.89	46.96	70.37	254.25	157.80	268.05	356.24	18.26	47.01	33.82	146.42	288.91	79.28	26.12	58.38	40.42	861.59
2008Q4	43.52	70.23	52.32	71.77	258.83	165.89	286.40	339.19	18.58	46.71	34.93	144.77	284.02	75.24	26.84	59.15	42.00	937.73
2009Q1	46.50	76.47	60.52	74.81	291.82	174.89	312.45	367.26	21.99	46.13	37.63	150.54	331.77	78.18	28.64	63.13	44.42	966.37
2009Q2	49.48	82.72	68.72	77.85	324.82	183.90	338.51	395.34	25.41	45.56	40.33	156.32	379.52	81.12	30.45	67.10	46.83	995.01
2009Q3	52.47	88.97	76.92	80.89	357.82	192.90	364.56	423.42	28.83	44.99	43.03	162.10	427.27	84.06	32.25	71.08	49.25	1,023.65
2009Q4	55.45	95.22	85.12	83.93	390.82	201.90	390.61	451.50	32.25	44.41	45.74	167.87	475.02	87.00	34.06	75.06	51.66	1,052.29
2010Q1	55.86	99.65	84.88	87.61	387.27	209.85	391.44	466.42	31.87	40.78	47.99	167.14	492.02	80.86	33.68	76.02	54.05	1,089.18
2010Q2	56.27	104.09	84.64	91.28	383.73	217.80	392.28	481.35	31.50	37.16	50.25	166.41	509.02	74.71	33.30	76.98	56.44	1,126.07
2010Q3	56.67	108.52	84.40	94.96	380.19	225.75	393.11	496.27	31.12	33.53	52.51	165.67	526.02	68.56	32.93	77.93	58.83	1,162.95
2010Q4	57.08	112.95	84.16	98.64	376.64	233.69	393.94	511.19	30.74	29.90	54.76	164.94	543.02	62.41	32.55	78.89	61.21	1,199.84
2011Q1	56.97	116.80	78.94	99.74	378.62	236.34	396.48	509.72	23.24	34.20	55.46	167.91	543.02	62.94	32.64	79.57	60.36	1,213.29
2011Q2	56.86	120.65	73.72	100.84	380.60	238.99	399.03	508.25	15.74	38.50	56.16	170.87	543.02	63.47	32.73	80.24	59.50	1,226.74
2011Q3	56.75	124.51	68.51	101.94	382.58	241.65	401.57	506.78	8.24	42.79	56.86	173.83	543.02	63.99	32.83	80.92	58.64	1,240.19
2011Q4	56.65	128.36	63.29	103.04	384.56	244.30	404.12	505.31	0.74	47.09	57.55	176.79	543.02	64.52	32.92	81.59	57.78	1,253.64
2012Q1	58.05	131.60	64.32	106.73	402.50	239.62	409.69	513.91	1.92	41.73	59.09	178.32	543.02	63.91	34.58	83.05	61.58	1,272.45
2012Q2	59.46	134.83	65.36	110.41	420.44	239.62	415.26	522.51	3.10	36.37	60.63	179.84	543.02	63.30	36.24	84.51	65.37	1,291.27
2012Q3	60.87	138.07	66.39	114.09	438.38	230.26	420.84	531.11	4.29	31.01	62.17	181.36	543.02	62.70	37.90	85.96	69.17	1,310.09
2012Q4	62.28	141.31	67.43	117.77	456.32	225.58	426.41	539.71	5.47	25.65	63.70	182.88	543.02	62.09	39.56	87.42	72.97	1,328.91
2013Q1	62.28	141.41	67.08	119.71	484.56	234.43	432.27	539.81	10.31	25.08	65.14	181.19	528.84	76.40	39.48	88.49	72.39	1,356.10
2013Q2	62.27	141.51	66.72	121.64	512.81	243.29	438.12	539.90	15.14	24.50	66.57	179.50	520.47	90.70	39.41	89.55	71.81	1,383.28
2013Q3	62.27	141.61	66.37	123.58	541.05	252.14	443.97	539.99	19.98	23.93	68.01	177.80	512.09	105.01	39.34	90.62	71.24	1,410.47
2013Q4	62.27	141.71	66.02	125.51	569.30	260.99	448.83	540.08	24.81	23.36	69.44	176.11	503.72	113.31	39.26	91.68	70.66	1,437.66
2014Q1	58.60	143.36	62.13	124.09	531.02	251.71	441.41	526.89	22.49	23.19	67.93	172.27	497.13	114.46	34.97	89.45	72.80	1,461.90
2014Q2	54.94	145.00	58.24	122.67	492.75	242.42	433.00	513.69	20.16	23.02	66.41	168.43	490.53	109.61	30.68	87.22	74.94	1,486.14
2014Q3	51.27	146.65	54.35	121.24	454.47	233.13	424.59	500.49	17.84	22.85	64.90	164.60	483.93	104.76	26.39	84.98	77.08	1,510.39
2014Q4	47.61	148.29	50.46	119.82	416.19	223.85	416.18	487.29	15.51	22.68	63.38	160.76	477.34	99.91	22.10	82.75	79.23	1,534.63

Source: Bankscope. The list of banks is available from the authors upon request.

Table B.5: Time Series of Tier 1 Capital with pro rata rescaling using Step 2 Adjustment Factor from 3.1 for Banking System only foreign claims of Selected Cross Border Banks for each of the BIS reporting countries (in \$bn).

	Austria	Australia	Belgium	Switzerland	Germany	Spain	France	UK	Greece	Ireland	India	Italy	Japan	Netherlands	Portugal	Sweden	Turkey	US	λ impact
2005Q4	3.63	8.18	4.37	11.85	11.34	28.53	50.69	52.72	3.82			18.16	34.86	29.67	8.51	18.78	6.08	87.00	0.56
2006Q1	4.28	10.87	4.79	11.94	19.37	31.57	55.81	62.20	4.14	6.48		21.38	37.30	28.59	8.64	21.03	7.00	133.07	0.49
2006Q2	4.70	14.28	4.85	12.47	26.23	31.70	57.34	70.31	3.92	6.71		23.11	38.57	26.01	9.03	20.91	7.09	132.63	0.52
2006Q3	5.34	15.02	5.82	12.21	33.58	34.52	61.55	79.13	4.22	7.39		25.90	39.24	24.32	9.22	23.06	8.02	157.87	0.56
2006Q4	5.99	19.09	7.05	12.00	40.96	36.32	65.78	89.11	3.26	9.22		29.45	37.53	22.66	10.31	23.96	8.71	166.07	0.49
2007Q1	7.84	20.35	7.81	11.60	49.85	38.79	73.36	99.47	3.81	9.38		36.59	41.44	24.12	12.21	25.57	9.78	174.61	0.61
2007Q2	10.23	21.45	9.20	12.29	59.28	41.56	77.89	109.10	4.22	10.30		45.08	44.24	25.82	8.73	27.33	10.83	175.83	0.61
2007Q3	12.26	24.92	11.56	13.54	68.07	43.73	78.76	118.97	4.47	10.32		50.57	51.65	28.27	9.29	24.69	12.02	160.18	0.58
2007Q4	13.92	26.10	13.49	17.13	74.74	43.57	81.44	116.11	4.50	11.37	8.85	56.38	51.83	29.31	7.97	26.34	12.83	156.80	0.55
2008Q1	14.63	26.20	16.46	18.50	79.74	48.10	94.43	115.25	4.72	10.93	9.75	57.89	48.76	28.85	8.41	25.67	13.93	194.15	0.52
2008Q2	14.61	24.67	18.01	19.14	80.72	50.66	97.09	97.73	4.71	9.56	10.06	55.99	51.40	27.65	9.80	26.29	14.06	216.20	0.46
2008Q3	14.33	21.47	19.04	21.28	79.93	51.28	99.59	90.73	4.82	8.83	10.05	53.76	51.74	25.59	9.66	25.23	13.84	232.23	0.38
2008Q4	13.40	23.78	21.55	18.72	77.25	50.29	99.29	81.50	5.02	10.21	9.69	50.27	42.14	23.21	7.51	26.61	12.74	289.65	0.37
2009Q1	14.50	24.60	24.25	19.78	85.58	50.90	106.03	80.67	5.85	8.87	9.98	51.99	43.74	24.01	8.46	28.99	13.58	389.96	0.38
2009Q2	14.82	24.47	27.34	20.42	92.58	51.82	112.01	92.40	6.55	8.43	10.27	51.16	50.90	23.98	8.33	30.63	13.81	353.54	0.35
2009Q3	15.66	22.54	29.95	21.57	100.67	53.24	110.14	94.66	7.52	7.93	11.19	53.52	56.42	24.48	9.85	31.65	13.96	367.44	0.38
2009Q4	16.23	24.39	36.38	24.06	110.91	55.94	104.92	106.07	8.73	7.83	11.86	56.27	62.18	24.59	8.98	34.16	15.14	426.73	0.38
2010Q1	17.10	28.77	34.58	24.42	112.18	58.90	100.17	113.86	8.83	7.16	12.60	58.25	65.58	23.64	8.74	34.66	16.63	465.17	0.46
2010Q2	16.83	29.45	35.79	26.96	108.49	59.65	97.99	112.04	8.68	6.60	12.64	58.12	70.45	21.24	7.12	35.37	16.51	443.11	0.43
2010Q3	16.15	29.29	22.55	25.55	99.39	56.97	95.73	116.31	7.56	7.72	12.65	58.25	120.60	25.65	13.00	30.20	21.17	398.47	0.42
2010Q4	18.05	37.19	30.59	33.12	110.99	65.90	99.18	135.97	8.76	7.20	14.42	39.00	137.09	14.31	8.17	16.71	14.23	258.13	0.27
2011Q1	25.90	50.08	31.95	44.10	177.34	115.80	131.16	179.15	8.17	12.02	18.29	49.60	132.29	18.27	9.60	18.96	37.00	580.03	0.30
2011Q2	15.88	33.42	19.34	26.15	105.30	73.51	108.64	125.82	3.68	8.88	13.15	38.78	114.70	18.08	9.33	22.05	14.87	299.97	0.32
2011Q3	15.71	42.53	19.34	26.99	98.73	58.20	105.68	120.31	1.99	9.95	13.69	41.34	128.63	18.13	9.41	21.29	15.41	322.96	0.28
2011Q4	14.93	15.08	7.37	10.60	40.66	19.93	33.78	38.89	0.06	3.96	5.24	15.36	55.81	5.71	6.93	16.75	11.80	108.38	0.12
2012Q1	14.61	33.28	16.74	26.07	89.54	44.69	89.25	102.13	0.41	8.65	13.37	36.61	116.66	12.18	6.97	16.27	12.73	264.15	0.24
2012Q2	14.66	32.00	15.43	25.38	87.76	42.20	76.26	89.87	0.54	5.74	11.03	40.22	102.27	11.08	7.11	17.80	13.11	232.63	0.21
2012Q3	15.99	37.61	17.46	30.21	120.59	62.66	107.91	136.04	1.08	7.74	16.70	51.65	156.30	15.00	8.75	19.02	15.82	327.71	0.30
2012Q4	12.04	23.37	9.36	16.66	60.73	26.25	44.37	66.51	0.61	2.79	6.80	18.55	57.43	5.63	3.54	7.69	7.10	127.91	0.13
2013Q1	15.93	34.69	16.18	28.25	112.57	51.84	92.32	113.36	2.20	5.17	13.63	36.69	107.64	14.62	7.66	16.91	13.63	249.54	0.26
2013Q2	20.53	35.48	20.18	36.70	151.03	69.07	117.88	136.43	3.95	6.14	17.23	44.44	128.31	23.57	9.56	20.55	16.08	333.14	0.22
2013Q3	8.52	20.11	9.19	17.08	71.15	31.70	55.31	71.92	2.62	3.13	8.79	23.31	65.26	13.12	4.94	11.87	9.51	179.64	0.21
2013Q4	17.72	37.61	16.94	32.19	141.66	60.93	104.09	120.49	5.57	5.02	15.62	38.61	110.60	24.94	9.30	21.57	16.33	323.30	0.24
2014Q1	12.45	28.06	11.27	21.03	95.16	47.98	91.63	109.05	4.77	4.35	10.22	27.58	67.42	16.38	5.44	13.40	12.73	230.95	0.20
2014Q2	24.66	62.70	27.17	59.97	202.09	101.61	171.50	173.84	6.56	9.01	26.09	30.18	84.54	17.12	4.37	12.04	10.36	237.82	0.31
2014Q3	14.26	39.61	14.26	31.48	124.14	57.84	101.83	115.60	4.12	5.10	15.30	36.44	108.07	21.27	5.87	19.63	18.09	331.88	0.26
2014Q4	15.59	49.16	16.29	39.61	125.81	68.32	112.65	143.63	4.60	6.42	18.42	45.88	134.09	27.05	6.08	21.69	20.52	342.10	0.27

GFC. Note, this is equivalent to the Spectral SRI λ_{max} reported in Figure 3 which shows extreme losses of over 200% of the adjusted Tier 1 capital associated with the foreign claims of the BIS reporting banks.

Appendix C. Weighted Directed Clustering Coefficient

The unweighted clustering coefficient for node i , CC_i , is the number of pairs of neighbours of i that are connected, i.e. total numbers of triangles in which i participates, t_i , divided by the possible number of triangles, i.e. the total number of pairs of neighbors of i , $\frac{1}{2}k_i(k_i - 1)$ with k_i denoting the number of neighbours of i (Newman, 2010, Section 10.2). The formula for CC_i is as follows:

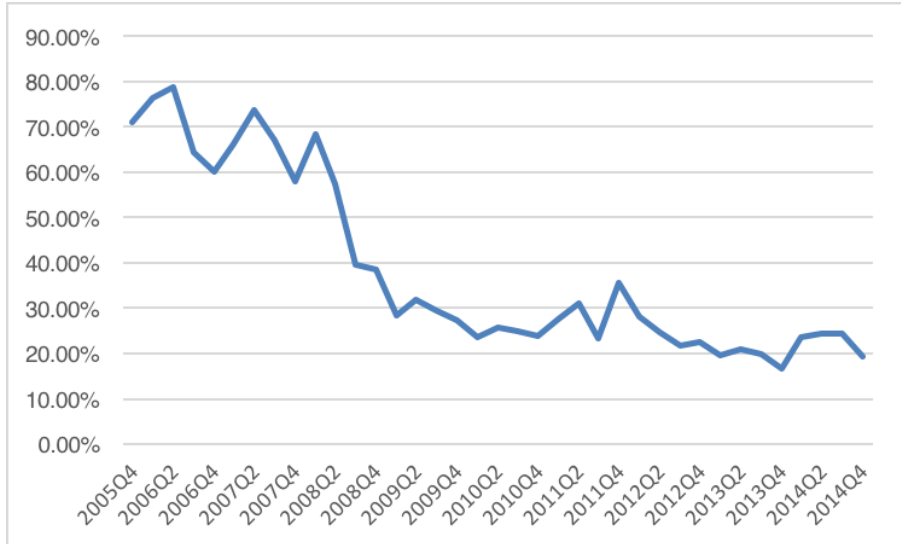
$$CC_i = \frac{2t_i}{k_i(k_i - 1)}. \quad (C.1)$$

In complete graphs like the core global banking system network the unweighted clustering coefficient is not informative as it is 1. Noting that the structure of the Θ matrix in equation (7) is such that the outdegree triplets apply (see Fagiolo, 2007): $\theta_{ij}\theta_{ih}\theta_{jh}$ or $\theta_{ij}\theta_{ih}\theta_{hj}$. This will yield an assessment of the average potential loss of capital from node i to a pair counterparties who between them also has a net debtor relationship.

$$\widehat{CC}_i = \frac{2}{k_i^{out}(k_i^{out} - 1)} \sum_{j,h} (\theta_{ij}\theta_{ih}\theta_{jh})^{1/3}. \quad (C.2)$$

We estimate the average weighted clustering coefficient given in eq. (C.2) for the 5 banking systems with the highest clustering coefficient in matrix Θ defined in equation (7). Table C.6 gives a good estimate of the risk, as a percentage of capital loss, that a participant poses as a net debtor to a pair of its counterparties when they have a similar relationship.

Figure C.10: **Weighted Directed Clustering Coefficient of Top 5 Banking Systems in CGBS**



Note: In the period 2005Q4-2009Q4, the top 5 banking systems with the highest clustering coefficients always included the US, UK at the top 2 positions, followed by Germany and France in the next two positions; Spain or Netherlands most frequently in 5th place and Japan, Italy and Ireland less so. (see Appendix C for full results).

Table C.6: Time Series average clustering coefficient of top five banking systems

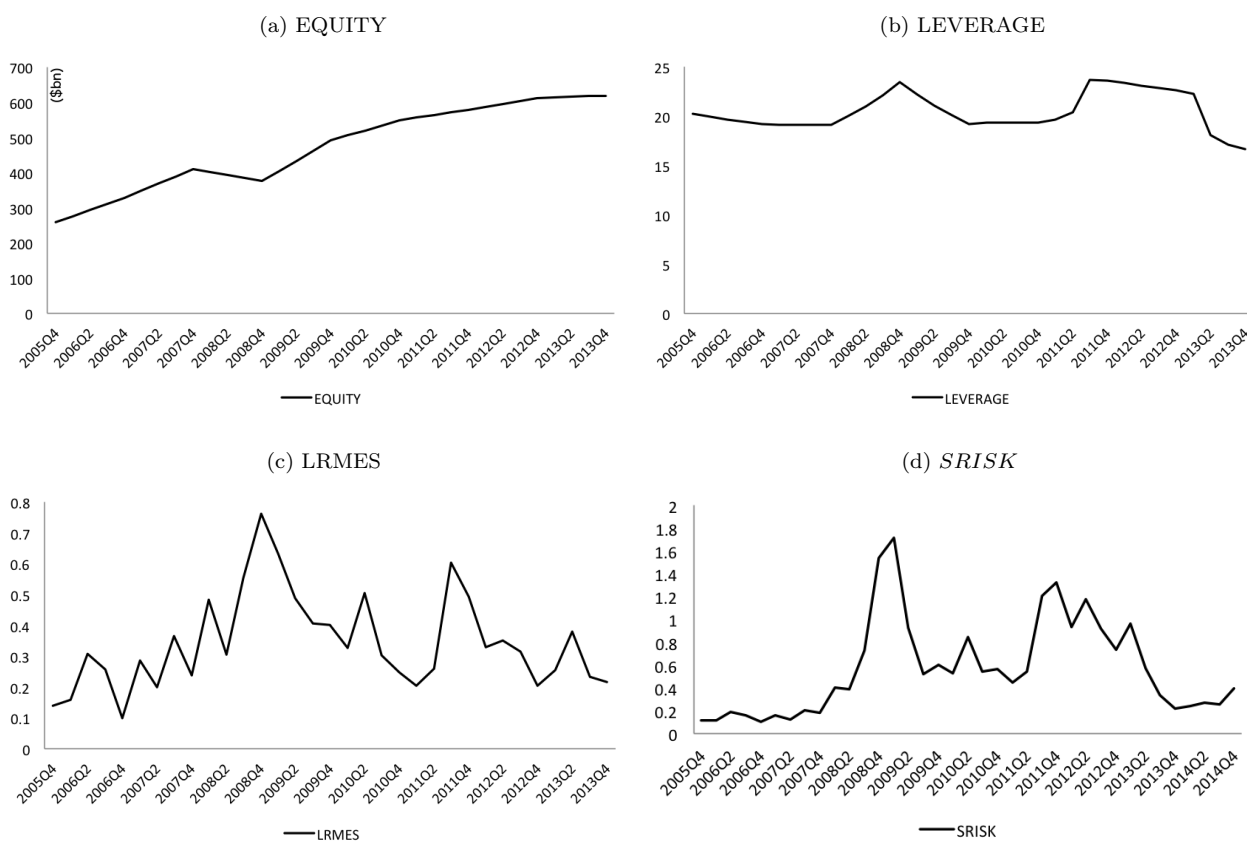
	Clustering of Top 5 Banking Systems					
	Avg	1st	2nd	3rd	4th	5th
2005Q4	70.95%	UK	US	DE	FR	IT
2006Q1	76.46%	UK	US	DE	FR	IT
2006Q2	78.63%	UK	US	DE	FR	ES
2006Q3	64.41%	UK	US	DE	FR	NL
2006Q4	59.98%	US	UK	NL	FR	DE
2007Q1	66.24%	UK	US	FR	DE	NL
2007Q2	73.76%	UK	US	FR	JP	NL
2007Q3	66.98%	UK	US	FR	DE	ES
2007Q4	57.86%	UK	US	DE	BE	ES
2008Q1	68.49%	UK	JP	US	DE	ES
2008Q2	57.58%	UK	US	DE	FR	IE
2008Q3	39.64%	US	UK	DE	BE	FR
2008Q4	38.65%	US	UK	BE	NL	ES
2009Q1	28.31%	UK	US	DE	ES	BE
2009Q2	31.96%	JP	US	UK	BE	ES
2009Q3	29.34%	UK	JP	US	DE	ES
2009Q4	27.32%	JP	UK	US	DE	ES
2010Q1	23.70%	DE	JP	UK	US	FR
2010Q2	25.67%	JP	US	UK	DE	FR
2010Q3	24.97%	JP	US	DE	UK	ES
2010Q4	23.88%	US	JP	UK	DE	FR
2011Q1	27.64%	US	JP	UK	DE	FR
2011Q2	31.05%	US	JP	UK	DE	FR
2011Q3	23.29%	JP	US	DE	UK	FR
2011Q4	35.70%	US	UK	FR	BE	JP
2012Q1	28.02%	US	UK	JP	DE	BE
2012Q2	24.61%	JP	UK	US	BE	DE
2012Q3	21.81%	JP	UK	FR	DE	BE
2012Q4	22.50%	UK	JP	US	FR	NL
2013Q1	19.58%	US	UK	JP	FR	DE
2013Q2	20.92%	US	NL	JP	UK	FR
2013Q3	19.81%	US	UK	NL	JP	DE
2013Q4	16.73%	UK	FR	US	DE	NL
2014Q1	23.58%	UK	US	DE	FR	ES
2014Q2	24.52%	US	UK	DE	FR	ES
2014Q3	24.37%	US	UK	DE	FR	ES
2014Q4	19.38%	US	UK	DE	FR	IT

Figure C.10 plots the average clustering coefficients for the 5 banking systems whose subgraphs based on the Θ matrix produced the largest clustering coefficients. As the clustering coefficients require non-zero triplets for each, where k_i are counterparties of banking system i for which it has a net debtor relationship relative to the capital of the exposed banking system (see Appendix C for the formula used), the inclusion of the top 5 such banking systems gives a good indication of how a failure of i can be further exacerbated by the second order relationship between a pair of i 's counterparties. As can be seen from Figure C.10, from 2005Q4 to 2008Q4 the average of these top 5 weighted clustering coefficients for the Θ matrix showed a high percentage of between 60% and 80% of the potential Tier 1 capital loss represented in the subgraphs associated with the 5 banking systems with the highest clustering coefficients. This falls off rapidly to under 20% by 2009. While the evidence of high weighted clustering in the run up to the GFC coincides with other studies on global banking networks, as will be seen, the Spectral SRI based on higher order interconnections than just second order neighbours, gives a more comprehensive measure of systemic risk than the weighted clustering coefficient.

Appendix D. Breakdown of the Components for the Core Global Banking System *SRISK*

As we can see from Figure D.11, leverage³³ was, on average, already high of the order of 20 for the 18 national banking systems during 2005Q4, peaking at 23 in 2008Q4. If we think of the minimum leverage ratio stipulated in Basel III of 3%³⁴, which is equivalent to a leverage of the order of 33. This would imply that these national banking systems, on average, exhibit lower leverage than the Basel III criterion. However, in our sample, there are countries such as Ireland that exhibit leverage well above 33, prior to the crisis, reaching a peak of 51, during 2008Q4. As they carry a very small weight in the overall equity, average leverage of the banking systems is moderate as seen in Figure D.11(b).

Figure D.11: Average Equity, Leverage, LRMES, and *SRISK*



In addition, the LRMES remains subdued at 25% right up to 2007Q1, peaking to 76% during 2008Q4. This offsets the weight of leverage in the *SRISK* formula, therefore, preventing this latter from picking up in the run up to the crisis.

³³Country level leverage data was collected from the Center of Risk Management, Lausanne, <http://www.crml.ch/index.php>.

³⁴Under Basel III, “leverage ratio” is defined as the ratio between Tier 1 capital and the bank’s average total consolidated assets (sum of the exposures of all assets and non-balance sheet items).

Appendix E. MSCI Indices

Country	Daily Returns MSCI Financials and World				<i>Leverage</i> = $\frac{Liabilities+Equity}{Equity}$			
	Mean	Std	Max	Min	Mean	Std	Max	Min
Australia	0.00%	1.39%	9.14%	-8.87%	17.65	0.93	18.82	16.01
Austria	-0.05%	2.60%	17.13%	-18.53%	16.50	1.19	19.87	14.73
Belgium	-0.06%	2.36%	16.70%	-34.30%	22.25	2.97	29.60	17.66
France	-0.01%	2.34%	17.05%	-11.80%	23.83	2.25	29.76	19.44
Germany	-0.01%	2.03%	16.08%	-12.50%	25.88	3.62	32.81	17.93
Greece	-0.16%	4.33%	25.74%	-34.97%	36.44	36.33	105.63	12.80
India	0.04%	2.18%	19.23%	-13.82%	14.56	0.6	16.14	13.82
Ireland	-0.17%	5.26%	38.53%	-56.65%	32.15	9.01	51.96	17.82
Italy	-0.04%	2.22%	15.60%	-10.49%	14.83	1.02	16.82	13.60
Japan	-0.02%	2.00%	14.49%	-12.40%	19.80	1.34	23.39	17.88
Netherlands	-0.02%	3.08%	21.46%	-20.31%	25.35	2.91	32.30	18.50
Portugal	-0.09%	2.44%	15.28%	-13.17%	21.35	1.71	24.60	18.46
Spain	-0.02%	2.17%	19.55%	-12.25%	18.34	1.24	21.84	15.92
Sweden	0.02%	1.98%	12.84%	-9.50%	23.01	1.77	26.53	18.57
Switzerland	-0.03%	2.11%	16.11%	-11.75%	21.22	1.78	24.82	17.94
Turkey	0.02%	2.35%	15.41%	-11.71%	9.26	1.54	16.00	8.27
United Kingdom	-0.02%	1.99%	17.61%	-13.43%	25.69	4.83	39.86	19.20
United States	-0.01%	2.34%	16.04%	-17.80%	13.43	1.32	15.60	11.64
MSCI World	0.01%	1.16%	8.90%	-7.37%	-	-	-	-

Table E.7: Source: Bloomberg for the MSCI and Bankscope for Leverage. Authors calculations

Country	Equity (in Billion USD)				RWA (in Billion USD)			
	Mean	Std	Max	Min	Mean	Std	Max	Min
Australia	165.34	66.01	247.48	32.34	1132.7	324.5	1506.3	261.0
Austria	131.19	23.06	154.06	63.54	726.5	181.1	1042.7	317.8
Belgium	145.89	17.63	194.46	110.41	811.9	215.1	1107.6	401.9
France	822.30	189.27	1141.83	401.32	3792.7	762.1	4660.4	2146.9
Germany	759.67	245.53	1161.15	247.19	3962.2	1197.2	5909.3	902.8
Greece	24.98	12.82	48.69	5.94	272.3	77.5	460.0	121.0
India	119.16	42.44	177.35	49.86	408.2	262.2	1158.5	7.7
Ireland	59.34	11.94	77.92	37.89	446.2	107.8	627.0	308.0
Italy	395.21	59.94	470.74	223.98	2473.9	515.9	2930.5	1180.4
Japan	1211.97	372.44	1674.03	673.06	4301.7	2996.4	8356.2	810.2
Netherlands	269.06	39.57	335.77	166.61	1242.9	135.1	1511.2	1034.2
Portugal	35.33	6.35	45.89	19.39	357.1	49.4	403.8	225.7
Spain	267.24	76.14	407.98	124.90	2192.8	492.7	2798.3	1108.4
Sweden	96.01	26.41	149.44	49.16	769.4	80.2	865.0	526.8
Switzerland	266.90	45.07	366.91	179.67	814.6	253.7	1485.9	428.3
Turkey	79.84	28.94	129.63	26.13	351.7	204.8	703.0	25.7
United Kingdom	1076.48	244.07	1441.59	637.18	5985.7	749.7	7014.2	3896.0
United States	2801.10	671.71	3765.27	1774.46	13779.2	3037.9	17590.3	7611.9

Table E.8: Equity and Risk Weighted Assets (RWA, in Billion USD) from Bankscope. Authors calculations based on the selected banks to represent the BIS reporting banks for the 18 countries. The list of banks is available from the authors upon request.

Country	Tier 1 Capital (in Billion USD)				Tier 1 Capital /RWA (%)			
	Mean	Std	Max	Min	Mean	Std	Max	Min
Australia	104.64	41.30	157.36	22.19	8.97%	1.28%	10.96%	7.15%
Austria	88.89	28.20	120.03	26.25	11.97%	1.64%	14.13%	8.26%
Belgium	89.96	30.10	127.12	34.36	11.25%	3.37%	15.72%	6.05%
France	461.74	182.22	677.44	119.30	11.6%	3.07%	15.81%	5.55%
Germany	436.17	211.98	848.40	67.92	10.42%	2.64%	14.49%	7.29%
Greece	17.71	9.59	34.08	1.60	6.43%	2.64%	11.20%	0.6%
India	61.60	33.92	120.61	10.58	28.7%	33.6%	136.7%	10.41%
Ireland	45.75	9.97	61.43	25.52	10.47%	2.16%	16.88%	8.07%
Italy	231.46	55.55	282.98	100.93	9.34%	1.18%	11.40%	7.86%
Japan	832.05	239.20	1153.12	444.09	31.40%	19.82%	67.74%	11.40%
Netherlands	152.02	24.84	222.37	113.06	12.37%	2.29%	15.24%	8.80%
Portugal	32.83	9.63	46.85	16.31	9.06%	1.92%	12.76%	6.69%
Spain	213.70	71.80	304.70	86.88	9.50%	1.52%	12.95%	7.65%
Sweden	82.37	22.64	114.84	41.81	10.63%	2.52%	14.22%	7.47%
Switzerland	146.84	51.73	269.24	74.74	17.93%	2.04%	20.11%	13.63%
Turkey	59.86	23.63	93.65	17.10	22.58%	12.47%	66.46%	12.77%
United Kingdom	820.21	239.23	1093.89	319.62	13.42%	2.70%	16.52%	8.20%
United States	1623.80	482.37	2316.40	874.23	11.61%	1.19%	13.17%	9.30%

Table E.9: Tier 1 Capital and Risk Weighted Assets (RWA, in Billion USD) from Bankscope. Authors calculations based on the selected banks to represent the BIS reporting banks for the 18 countries. The list of banks is available from the authors upon request.