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Macroprudential regulation and systemic capital requirements

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Macroprudential Regulation and Systemic Capital Requirements

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Motivation - System-wide risk

- Current regulation is focussing on risk at individual institutions
- Consensus about a system-wide approach to regulation that would focus on system-wide risks

Motivation - System-wide risk

- A model to measure systemic risk
- Ways to internalise it

Contribution

- We propose a model to measure systemic risk (in the spirit of RAMSI at the BoE)
- We propose to reallocate capital according to individual contributions to systemic risk
- Fixed-point: capital requirement equals contribution to system risk

Contributions on the data side:

- We use extended data on exposures between the big six Canadian banks
- We use non public information on the largest loan exposures of banks
- Expanding the set of exposures between banks and considering the granularity of the loan portfolio have significant impact

Main findings:

- Capital reallocation works: can decrease bank PDs as well as the probability of a crisis by around 25%
- Works for all 6 capital reallocation mechanisms

Main findings:

- Reallocated capital differs from current capital by up to 50%
- Reallocation is not trivially related to size or PD (at least in Canada)

Outline of the presentation

1. The related literature
2. A model of the banking system
3. Impact of contagion channels
4. Macroprudential capital requirements
5. Conclusion

1. The related literature

- Historical market data to exploit correlations and historical spillovers (Adrian and Brunnermeir [2008], Acharya et al. [2009])
- Network model and aggregate loss distribution conditional on stress-scenario (Aikman et al [2008], Elsinger et al [2006], Upper (2006))

2. A model of the banking system

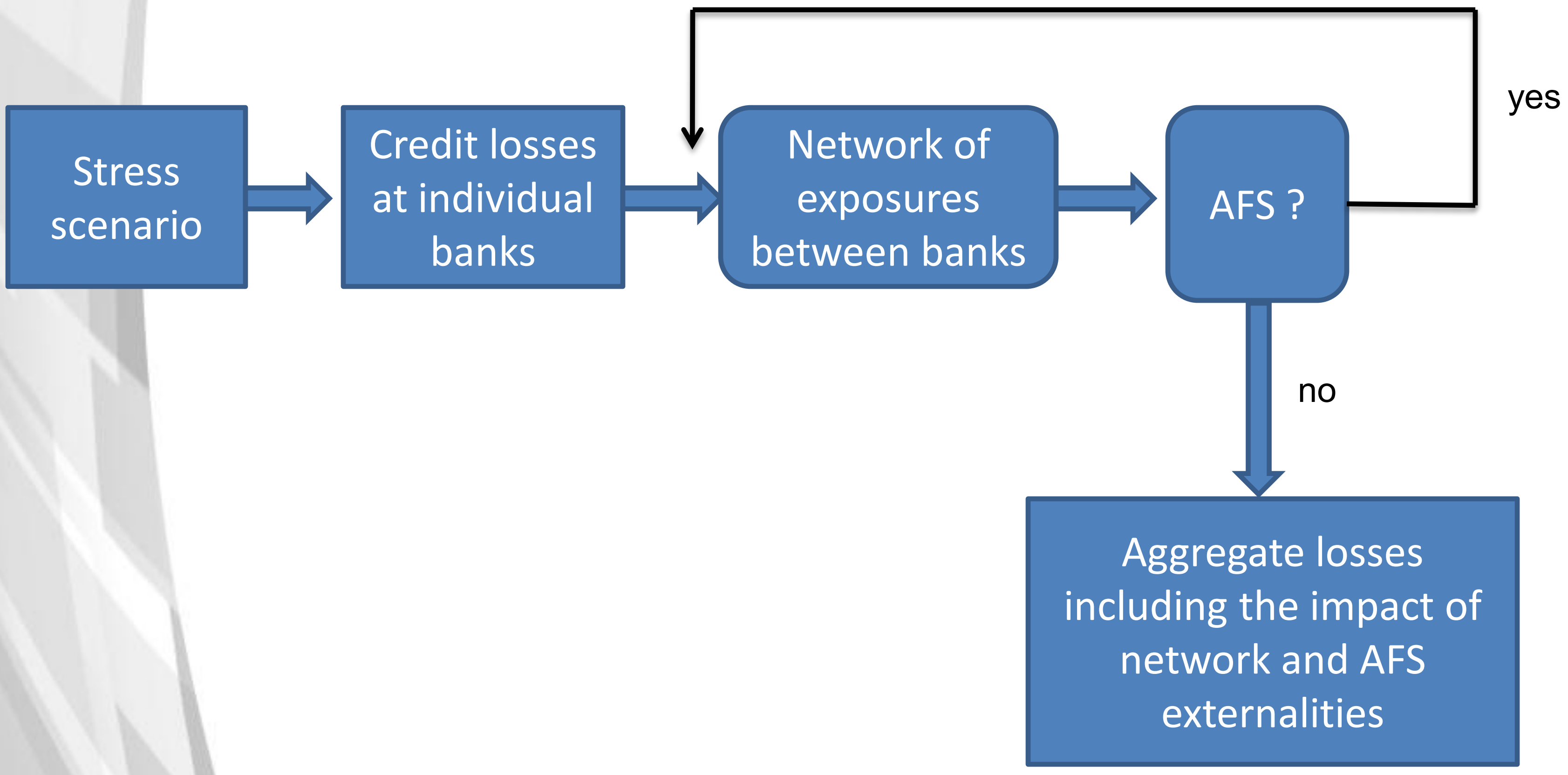
- The model used to generate the system loss distribution
- Integrate a credit risk model (Misina and Tessier [2006,2007]) to a network model of exposures between banks
- The network is a potential source of contagion

- Banks that fall short of regulatory requirements start selling assets to an illiquid market (Cifuentes, Shin and Ferrucci [2005])

- Spiral may occur because of mark-to-market accounting

- The aggregate loss distribution includes both network and asset fire sale externalities

2. A model of the banking system



2.1 The credit risk model

Two sources of uncertainty:

- Systematic factors which affects all loan portfolios simultaneously

- Idiosyncratic factors due to the composition of individual loan portfolios

2.2 The Network model

- Stylised balance-sheet (net worth)

$$p_i e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - d_i - L_i$$

- Clearing payment vector:

  Min between total amount due and whatever is left after outside debt holders are paid (fixed point, Eisenberg and Noe [2001])

2.3 The asset fire sale (AFS)

- Minimum capital requirement constraint:

$$\frac{p_i e_i + c_i + \sum_j x_i \pi_{ji} - x_i - L}{w_i p_i (e_i - s_i)} \geq r^*$$

- An equilibrium of the model is a combination of interbank payments, individual sales of illiquid assets, and their prices.

2.4 The different sources of defaults

Fundamental default:

- Credit losses decreases capital sufficiently for a bank to be unable to honour its interbank obligations even when others do honour theirs.
- Prices are not affected by AFS

AFS default:

- The bank is not in fundamental default...
- ...but cannot honour its interbank obligations at the equilibrium price of the illiquid assets...
- ...even when all other banks meet their interbank obligations

Contagious defaults:

- The bank is in default only because other banks are not able to keep their promises.

3. Impact of contagion channels

Bank	Fundamental PD (%)	Contagious PD (%)	AFS PD (%)	Contagious PD (AFS) (%)	Total PD (AFS) (%)
1	0.00	0.00	2.96	3.47	6.43
2	0.15	0.00	9.09	0.94	10.19
3	0.00	0.00	2.99	6.33	9.31
4	0.01	0.00	6.50	3.93	10.45
5	0.00	0.00	1.61	6.09	7.70
6	0.19	0.01	4.53	6.93	11.65

- The probability of a financial crisis

Number defaults	Probability (in %)	probability of involvement of bank 1	2	3	4	5	6
1	3.53	4.64	30.86	6.97	15.49	0.75	41.28
2	1.16	9.07	47.48	20.70	49.03	3.44	70.29
3	0.84	14.60	57.19	45.28	83.50	12.40	87.03
4	1.11	22.21	69.86	81.68	95.25	34.96	96.04
5	2.66	32.17	88.55	97.95	99.15	82.69	99.48
6	4.94	100.00	100.00	100.00	100.00	100.00	100.00

4. Macroprudential capital requirements

Component value-at-risk (beta):

- Allocates capital according to the relative marginal contributions of individual banks on the variance of the aggregate loss distribution

Incremental value-at-risk:

- Allocate capital according to the difference between the VaR of the aggregate loss distribution and the VaR of the aggregate loss without bank i.
- Measures the increase in risk by adding bank i to the system

Shapley values:

- Well known measure in game theory
- Allocate capital based on the average marginal value that the player's resources contribute to the total

CoVaR (Adrian and Brunnermeir):

- Allocate capital according to the difference in the VaR of bank i conditional on the whole banking system being at its VaR (CoVar) and the non-conditional VaR of bank i.

The reallocation mechanisms:

Bank	Component VaR	Incremental VaR	Shapley value		$\Delta CoVaR$
			Expected loss	VaR	
1	95.33	104.56	105.18	105.25	96.45
2	103.95	101.91	102.52	102.34	103.57
3	96.17	92.95	92.62	92.54	96.69
4	110.44	114.07	113.11	113.47	95.94
5	91.74	89.23	89.20	89.14	91.92
6	106.66	104.26	104.31	104.38	149.62

The impact on individual default probability:

Bank	Observed capital	Basel equal	Component VaR	Incremental VaR	Shapley value		$\Delta CoVaR$
					Expected loss	VaR	
1	6.43	9.05	6.60	3.91	3.75	3.73	7.53
2	10.19	9.97	7.68	8.15	7.91	7.97	8.93
3	9.31	8.91	8.34	8.82	8.87	8.91	10.57
4	10.45	9.04	6.72	5.77	5.91	5.85	11.97
5	7.70	7.73	7.55	7.76	7.73	7.74	9.47
6	11.65	10.53	8.28	8.49	8.44	8.43	2.42
Average	9.29	9.21	7.53	7.15	7.10	7.11	8.48

The impact on multiple defaults probabilities:

Number defaults	Observed capital	Basel equal	Component VaR	Incremental VaR	Shapley value Expected loss	Shapley value VaR	$\Delta CoVaR$
1	3.53	3.55	3.01	3.43	3.39	3.41	3.01
2	1.16	1.05	0.85	1.11	1.09	1.10	1.20
3	0.84	0.60	0.51	0.75	0.73	0.75	1.25
4	1.11	0.70	0.67	1.08	1.06	1.08	2.47
5	2.66	1.70	1.71	2.49	2.58	2.57	4.06
6	4.94	6.09	4.62	3.04	2.95	2.93	1.93
≥ 5	7.60	7.78	6.33	5.53	5.53	5.50	5.98
≥ 4	8.70	8.48	7.00	6.60	6.59	6.59	8.46

5. Conclusion

- Macroprudential capital allocation mechanisms reduce individual default and the prob. of systemic crisis by as much as 25%
- First step in measuring systemic risk and macroprudential capital requirement

5. Conclusion

2.2 The Network model

- Stylised balance-sheet

$$p_i e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - d_i - L_i$$

- Price of illiquid assets function of riskiness of BS

$$p_i = \min(1, p + (\overline{w} - w_i)\kappa)$$

- Changing the elasticity of the demand curve

Bank	AFS PD	Contagious PD (AFS)	Total PD
	(All data, P_{min}=0.97, in %)		
1	33.58	24.84	58.42
2	57.64	3.92	61.74
3	29.05	34.23	63.29
4	55.06	8.63	63.71
5	17.17	44.67	61.84
6	26.88	36.86	63.94

	Systematic and idiosyncratic factors		Systematic factors	
Panel A: Descriptive statistics of aggregate loss distributions				
	$Billion	%of Tier1 capital	$Billion	%of Tier1capital
Mean	−55.7	58.2	−45.7	47.7
Standard Deviation	−11.4	11.9	−7.9	8.3
Quantiles:				
99%	−21.9	22.9	−27.3	28.5
10%	−77.3	80.8	−35.5	37.1
1%	−97.5	101.9	−63.7	66.6
Panel B: Frequencies of bank defaults (%)				
Minimum	0.004		0.0	
Average	0.06		0.0	
Maximum	0.18		0.0	

Advantages of scenario analysis:

- Compute the potential losses based on current positions rather than using past losses

- Does not induce pro-cyclical risk-taking

2.1 The credit risk model

Severe recession scenario mapped into default rates for 7 sectors

	Minimum	Average	Maximum	Historic Peaks
Accommodation	3.0	11.7	21.0	7.6
Agriculture	1.0	1.7	2.0	0.8
Construction	2.0	6.4	10.0	3.3
Manufacturing	5.0	12.2	20.0	8.3
Retail	0.0	4.3	8.0	5.3
Wholesale	2.0	7.0	12.0	4.6
Mortgage	0.0	0.6	1.0	0.6

- Which banks are most often involved in multiple defaults?

Bank	PD (in %)	Cond. probability of multiple defaults 1	2	3	4	5	6
1	6.43	2.55	1.64	1.91	3.82	13.28	76.80
2	10.19	10.70	5.41	4.72	7.60	23.08	48.50
3	9.31	2.64	2.58	4.09	9.71	27.93	53.05
4	10.45	5.24	5.45	6.72	10.10	25.21	47.30
5	7.69	0.35	0.52	1.35	5.03	28.54	64.21
6	11.65	12.51	7.00	6.28	9.13	22.68	42.41

2.4 The different sources of defaults

- Fundamental default

$$e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - L_i < d_i$$

- AFS default

$$e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - L_i > d_i \qquad \text{and}$$

$$p_i^* e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - L_i < d_i$$

- Contagious defaults

$$p_i^* e_i + c_i + \sum_{j=1}^{N} \pi_{ji} d_j - L_i > d_i \qquad \text{but}$$

$$p_i^* e_i + c_i + \sum_{j=1}^{N} \pi_{ji} x_j^* - L_i < d_i$$