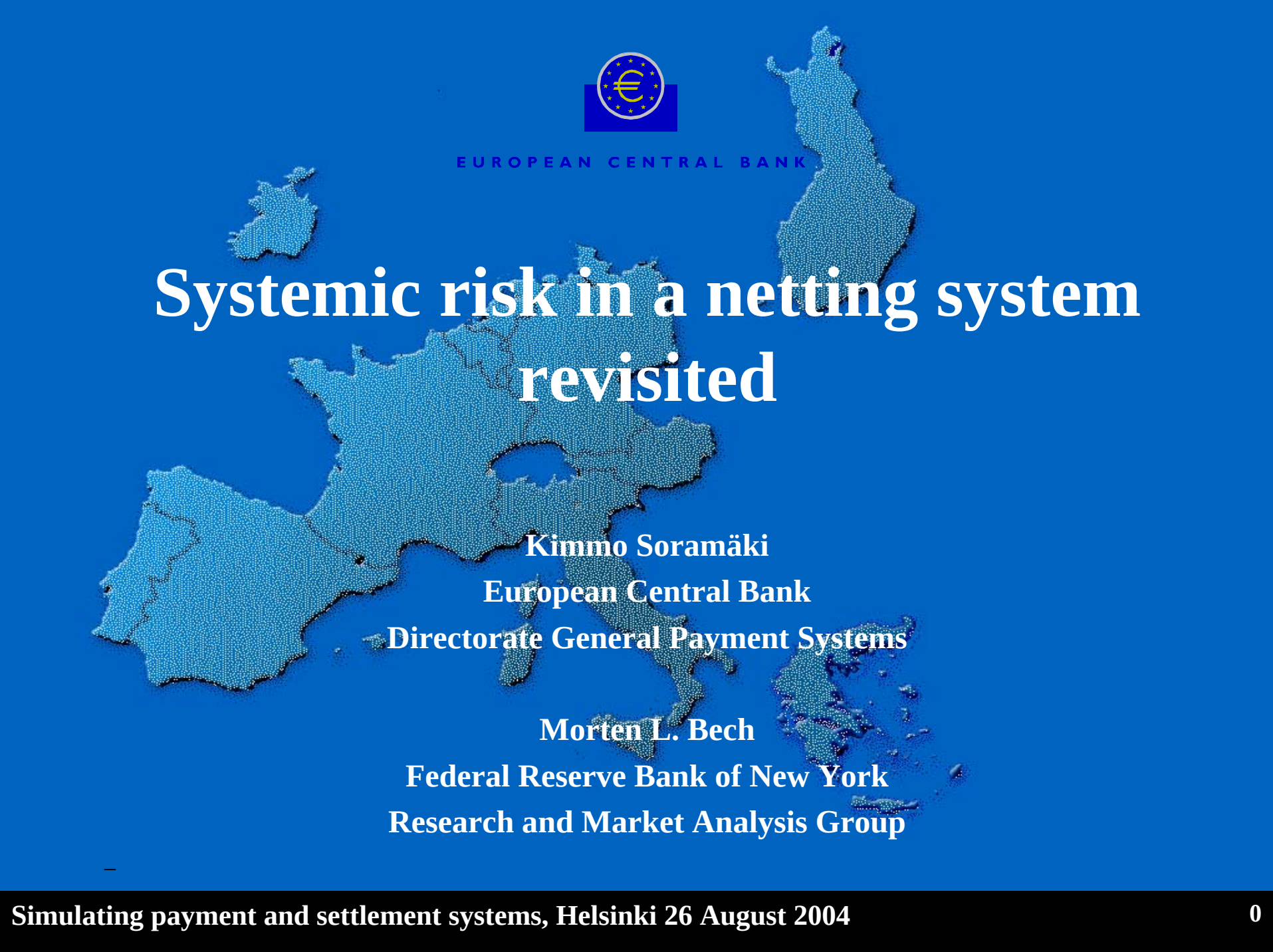


EUROPEAN CENTRAL BANK

Systemic risk in a netting system revisited

Kimmo Soramäki
European Central Bank
Directorate General Payment Systems

Morten L. Bech
Federal Reserve Bank of New York
Research and Market Analysis Group

Agenda

I. Introduction
II. Methodology
III. Computing
IV. Results

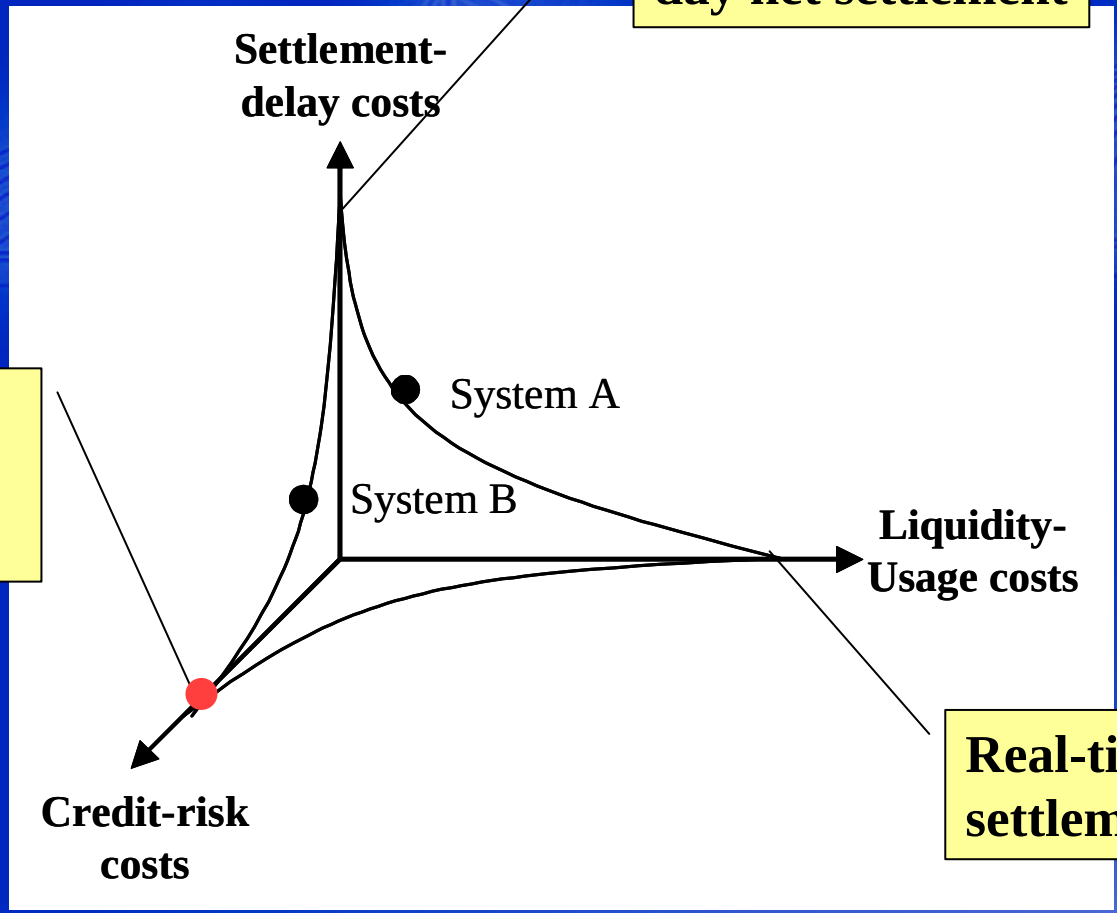
Systemic risk

- i.e. the impact a failure by a participant in the system may have on other system participants.
- ... may become contagious and may eventually impede the effective functioning of the payment system or the financial system at large.

- Our questions:
  - How much systemic risk can there be?
  - Is the largest bank the worst?
  - How about multiple failures?

We base our results on simulations where one or more banks are set into insolvency at the end of the day and the impact of the failure is propagated through the system.

Positioning the study



from Leinonen-Soramäki 1999/2003

Methodology

Initial shock:

A sudden and unexpected failure of a participant. The participant is removed from settlement all the payments to and from the participant are unwound. Only participants with a net debit position are considered.

Propagation:

1. the remaining participants' multilateral net positions are recalculated
2. all banks with a deterioration in the multilateral position exceeding a threshold value and a new net debit position are removed from settlement
   a) If banks were removed then all payments to and from these banks are unwound and the process starts over from 1
   b) If no banks were removed, the contagion process ends

Parameters

Previous research:

Author	# of failures	selection criteria	failure threshold
Humphrey (1986)	1	single largest net creditor	capital
Angelini et al (1996)	1	all	capital
Bech et al (2002)	1	single largest net debtor	25, .5, .75, 1 * capital

We simulate

1. for single failure scenario all banks in a net debit position
2. for the simultaneous failure of 2 and 4 banks all combinations of 10 largest banks with a net debit position

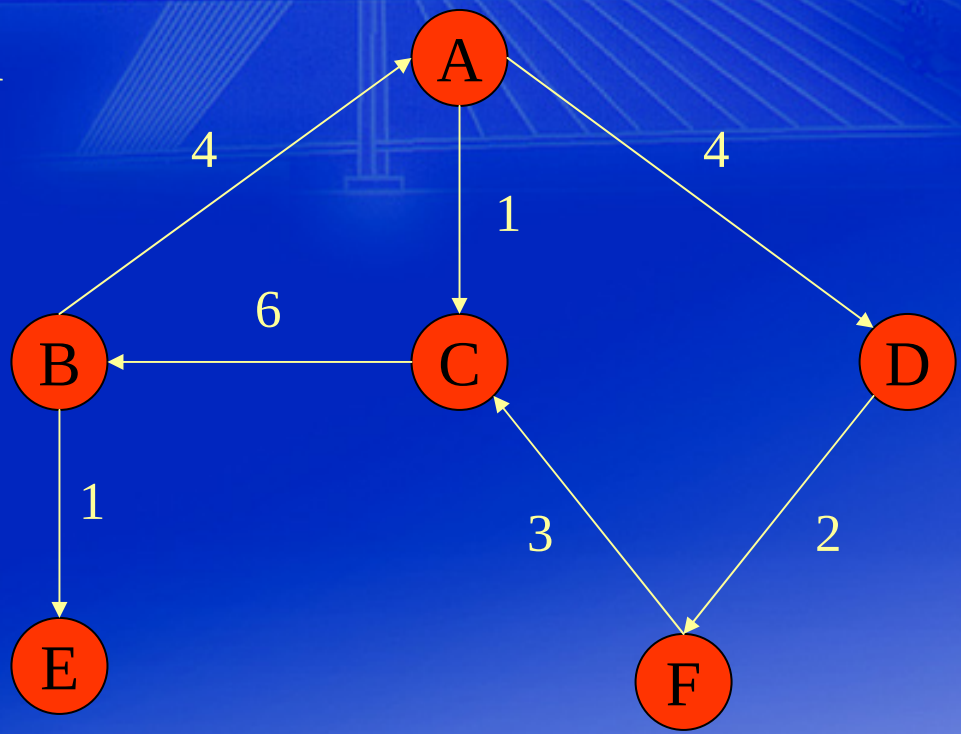
with 6 failure thresholds (.05,.01, .25, .5, .75, 1) relative to the Tier 1 capital of the banks.

Methodology: Example - slide 1/6

The system consists of six participants that have exchanged payments during the day. The threshold values for triggering failures are in the example the following:

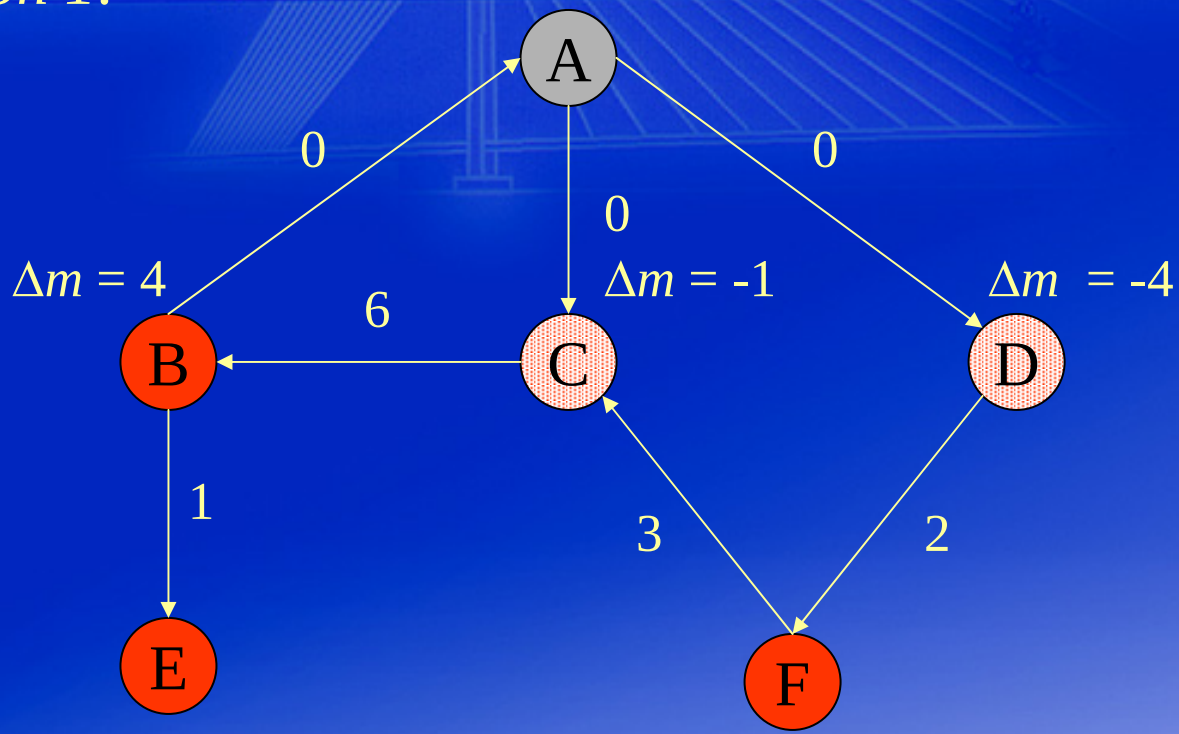
banks B=C=D=3

banks E=F=1



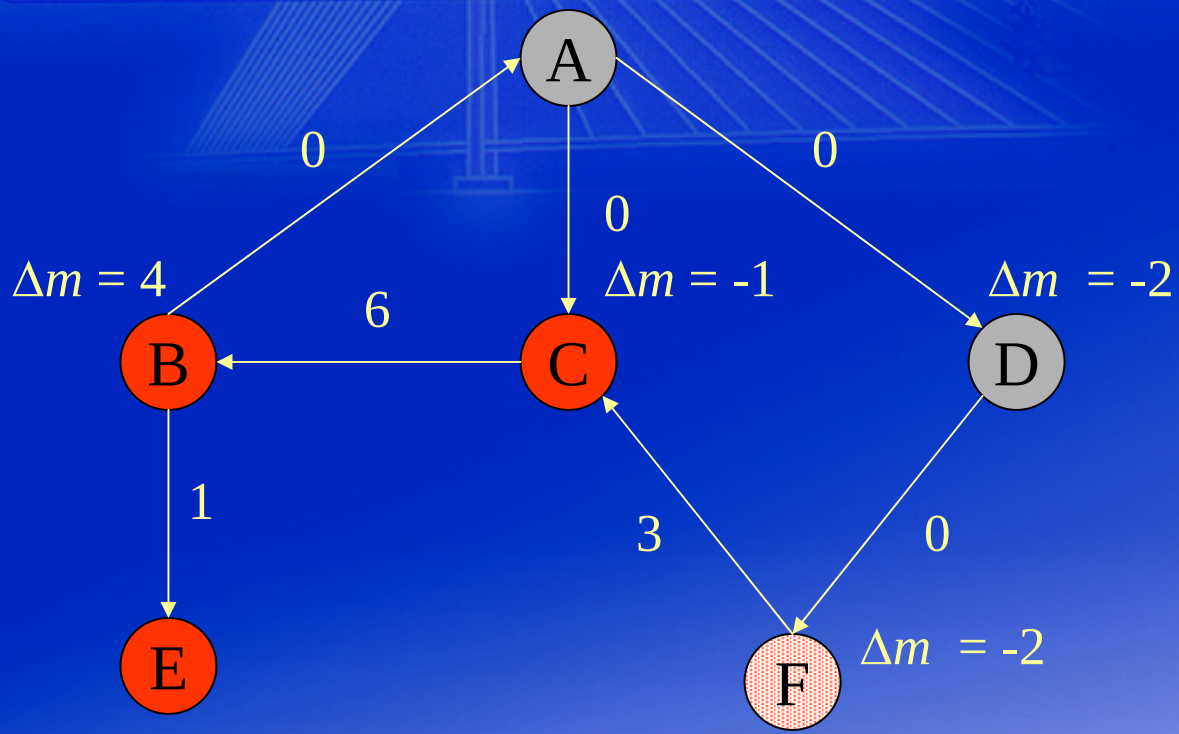
Methodology: Example - slide 2/6

We let bank A fail and calculate the changes in multilateral net positions when payments from and to bank A are removed from settlement (unwound). Bank A is the *primary failure*. As this is the first step in the process of contagion, we call this round *generation 1*.



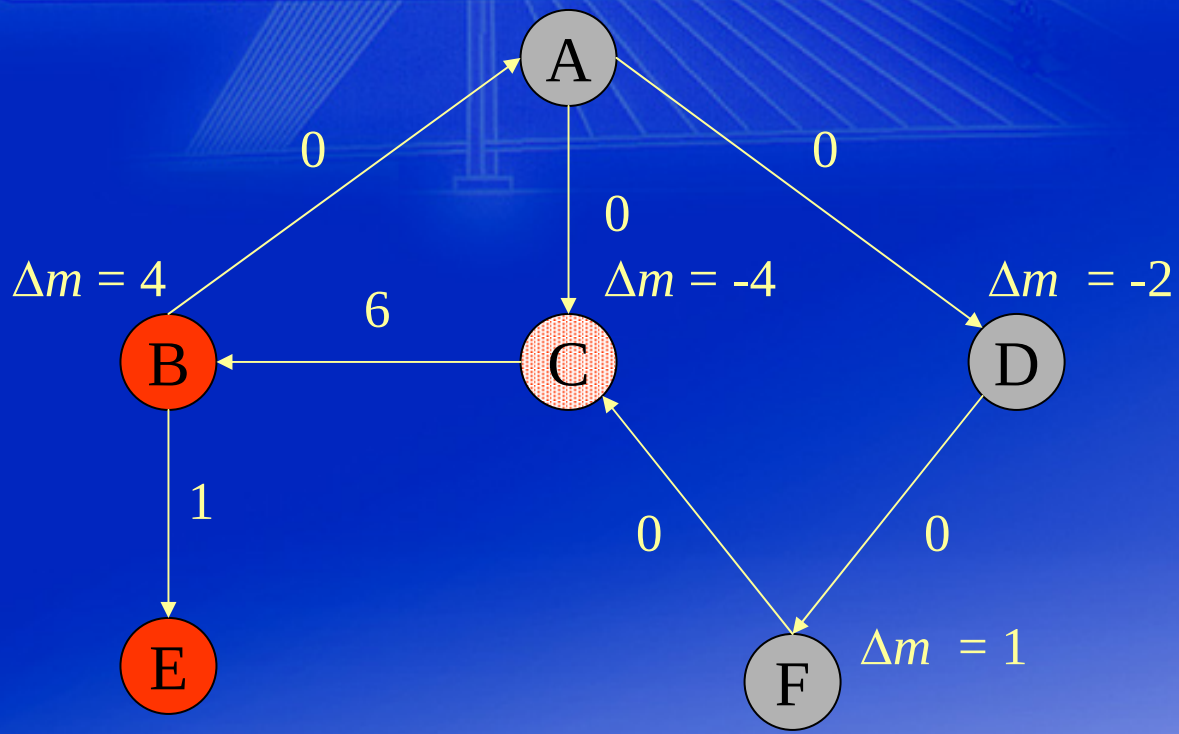
Methodology: Example - slide 3/6

As a consequence, Bank D is removed from the system and the multilateral net positions are recalculated. The recalculation of the positions moves the contagion process to the second generation. Bank D is the only *direct secondary failure*..



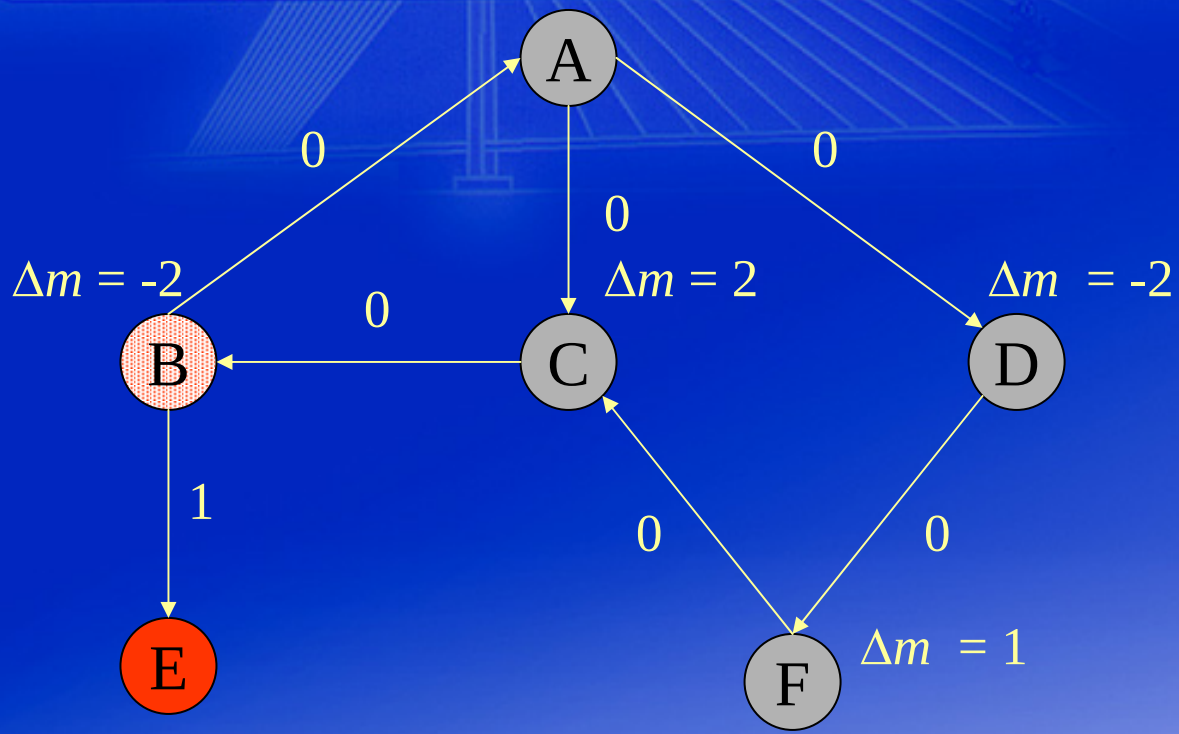
Methodology: Example - slide 4/6

Bank F fails, as its loss is higher than its threshold value for failure (2>1). Bank F is the first *indirect secondary failure* and the only failure in the third generation.



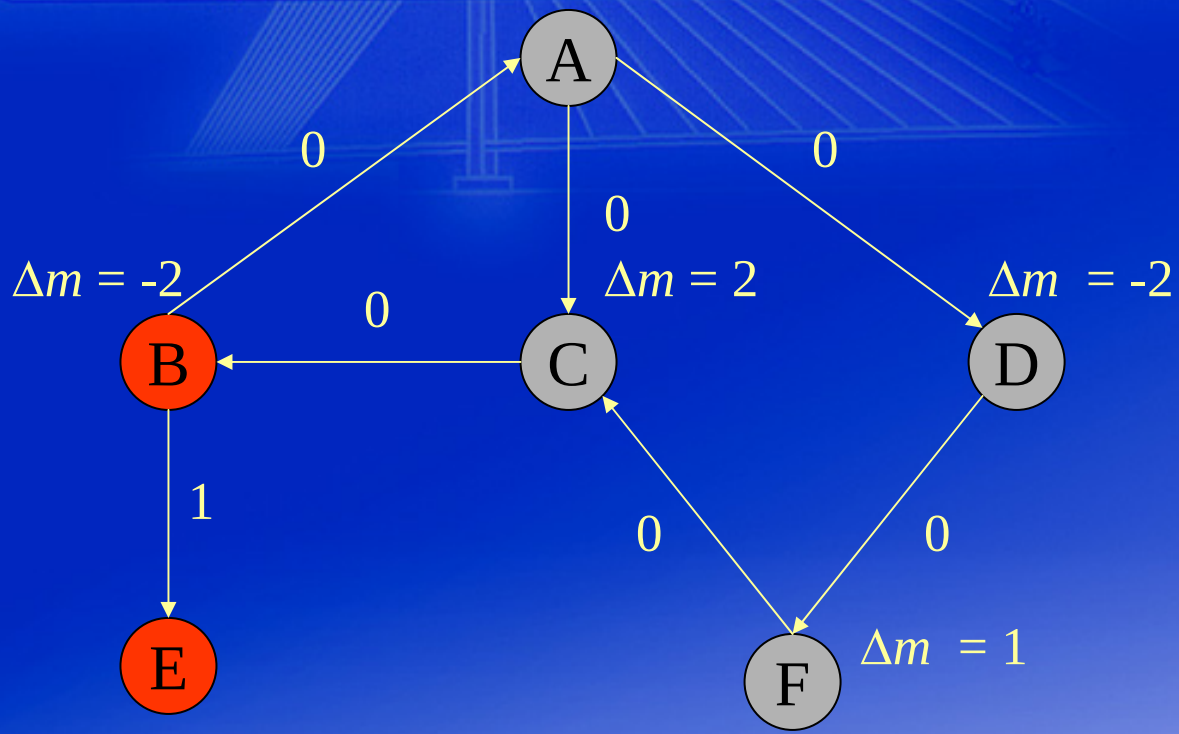
Methodology: Example - slide 5/6

The failure propagates in the system. Bank C is removed and the positions recalculated for the fourth time. The combined deterioration caused by the failure of banks A and C on bank B's positions is two - less than its capital.



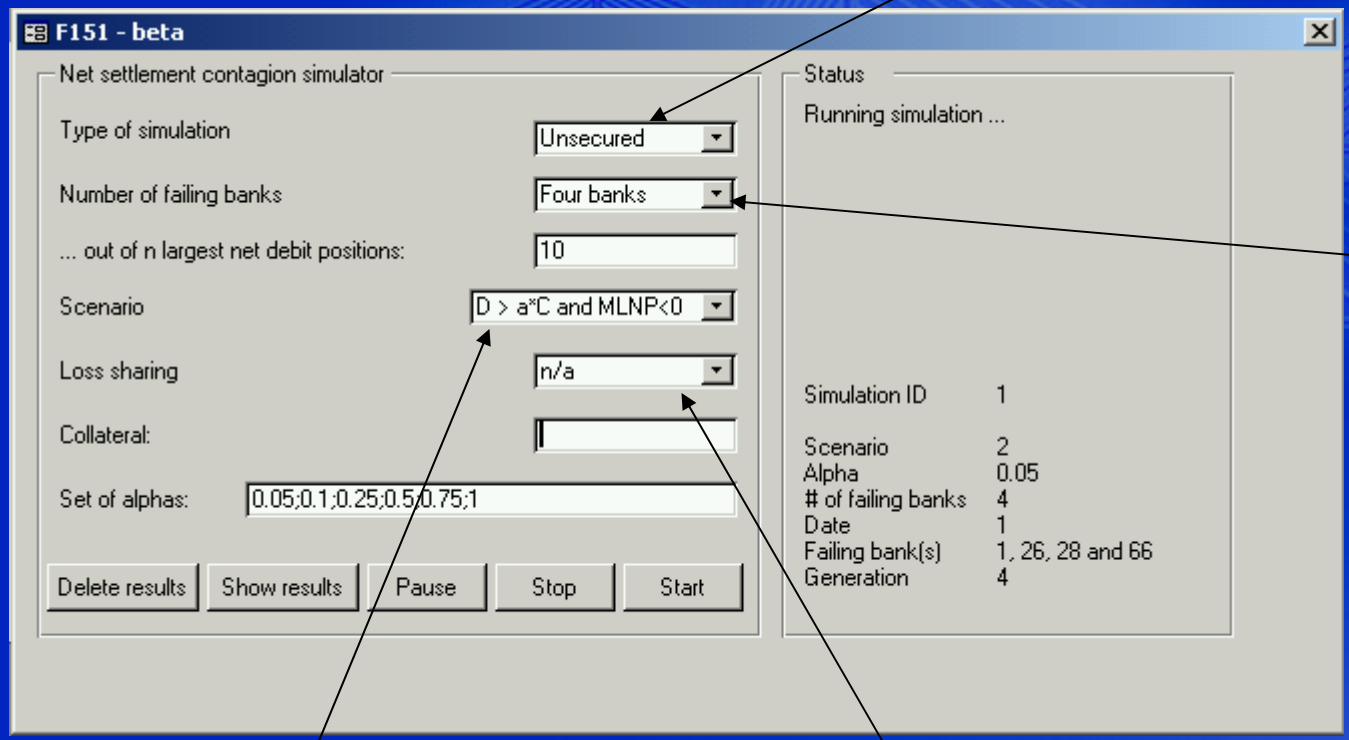
Methodology: Example - slide 6/6

The contagion ends at generation five as no new failures take place.



Computing - program

Small Access program



Unsecured	1
Secured	2

- Single bank
- Two banks
- Three banks
- Four banks
- Scenarios 1 to 2
- Scenarios 1 to 3
- Scenarios 1 to 4

- D > a*C
- D > a*C and MLNP<0
- D > a*C and -MLNP>C
- All of the above

- equal
- euro1
- n/a

Computing - Input and output

INPUT - bilateral positions

Day	Sender	Receiver	Balance	ValueSent
1	285	807	-127580.7	195057
1	436	815	-4285.3	184196.94
1	214	807	-3000	3000
1	218	807	-648714.21	649786.9
1	41			
1	220			
1	34			
1	29			
1	230			
1	245			
1	28			
1	257			
1	258			
1	27			
1	297	805	35000	0
1	19	814	-177684.18	177684.18
1	819	807	-650	1400

INPUT - participant data

ID	Legal name of participant	Equity	Assets
11000028	STATE STREET B&TC	4,657,252,000	82198318000
11000536	FHLB BOSTON	843,332,000	11980517
11001234	MELLON TR OF NEW ENGLAND NA	372,985,000	6287843000
11001276	ONE UNITED BK	29,892,000	442855000
11001438	INVESTORS B&TC	508,415,000	10099212000
11002343	BOSTON PRIVATE B&TC	117,056,000	1676877000
11002550	WAINWRIGHT B&TC	50,980,000	642584000
11002628	CAPITAL CROSSING BK	130,987,000	959120000
11002877	ASIAN AMER B&TC	17,671,000	120189000

OUTPUT

InitialFail	Date	Alpha	IniIDFailed	IniNetDebitPosFailed	NumberFailed	DeltaFailed	NetDebitPosFailed	CapitalFailed	ValueUnsettled
1	2	0.05	627	-1729571.62	0	0	0	0	0
1	2	0.05	629	-710736110.32	10	-179130494.91	-72757421.22	1325404000	761628819.24
1	2	0.05	633	-12309936.83	0	0	0	0	0
1	2	0.05	636	-7152912.18	0	0	0	0	0
1	2	0.05	637	-1083576.6	0	0	0	0	0
1	2	0.05	638	-755014.61	0	0	0	0	0
1	2	0.05	639	-1583169538.18	227	-52370198318.79	-37464507568.99	2.573837E+11	1.1030349075E+12
1	2	0.05	645	-91666715.27	19	-765970848.61	-6197252966.84	9457124090	28414161523.77
1	2	0.05	647	-78489925.61	28	-949966023.89	-6391310919.01	10552966090	29538718650.98
1	2	0.05	648	-12736137.74	20	-772797760.21	-6295746593.71	9482110090	28999953227.52
1	2	0.05	649	-5842597.11	0	0	0	0	0

Data

We base our results on the simulation of 21 days of US Fedwire data from January 2003.

	Turnover	Bilateral Net Position	Daily Multilateral Net Position	Bilateral Netting Effect	Multilateral Netting Effect	Per bank Capital	Per bank Daily Links
		$billions				$billions	
Mean	1,286.1	305.9	56.0	76%	96%	0.6	63
Median	1,259.9	290.5	56.4	76%	96%	0.1	32
Minimum	1,188.9	274.6	41.0	75%	94%	0.001	1
Maximum	1,509.8	366.5	81.3	78%	97%	56.2	893
St. Deviation	91.7	30.1	11.8	1%	1%	3.2	102

Source: Own Calculations

Magnitude of systemic risk

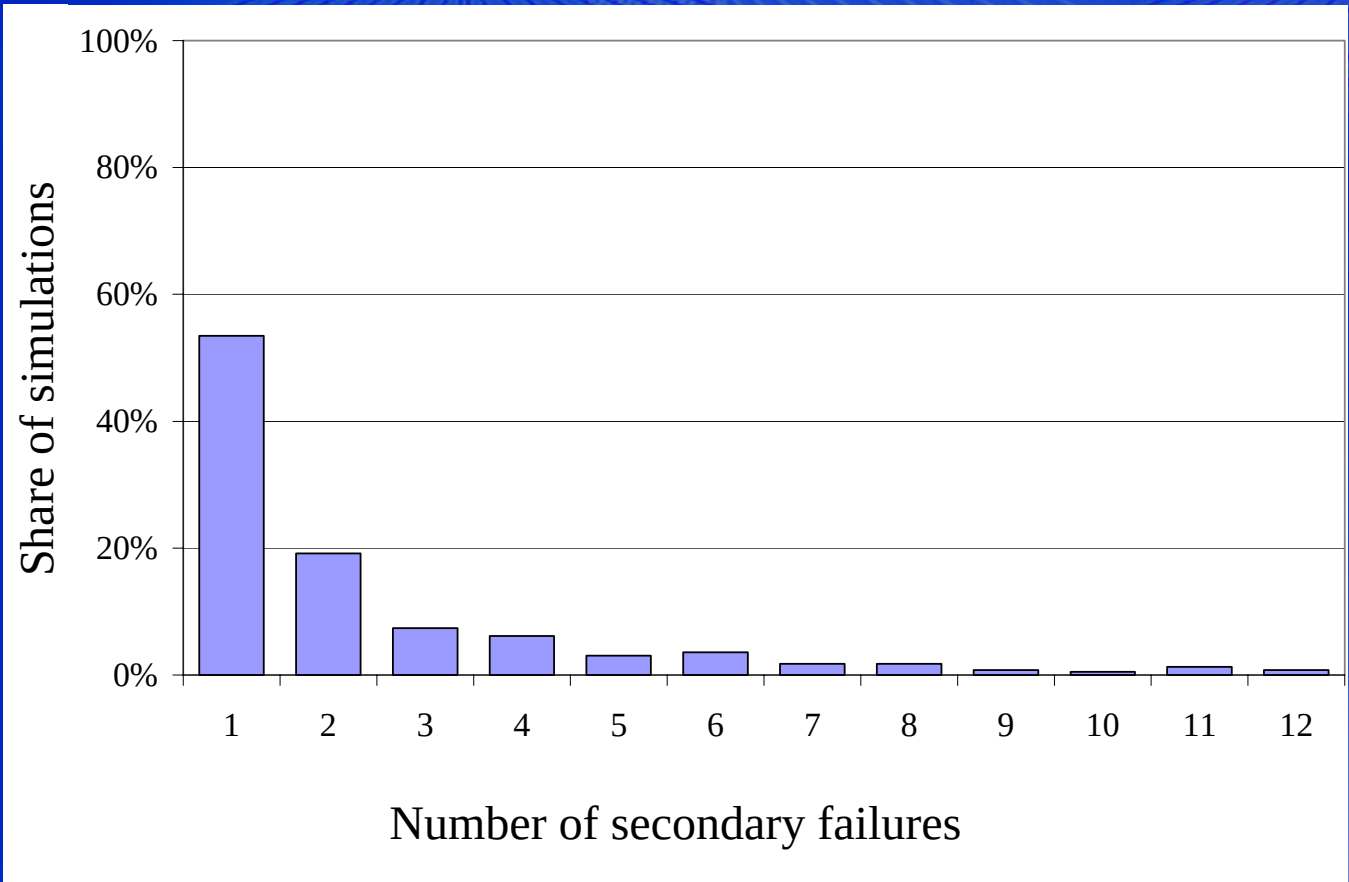
Previous research:

Author	Period	Data	Systemic risk
Humphrey (1986)	2 days	US (CHIPS)	significant
Angelini et al. (1996)	21 days	Italy (BI-REL)	relatively low
Kuussaari (1996)		Finland	relatively low
Bech et al (2002)	2 months	Denmark (PBS)	low
Northcott (2002)	231 days	Canada (ACSS)	limited, if any

The samples are getting bigger and the effects smaller.

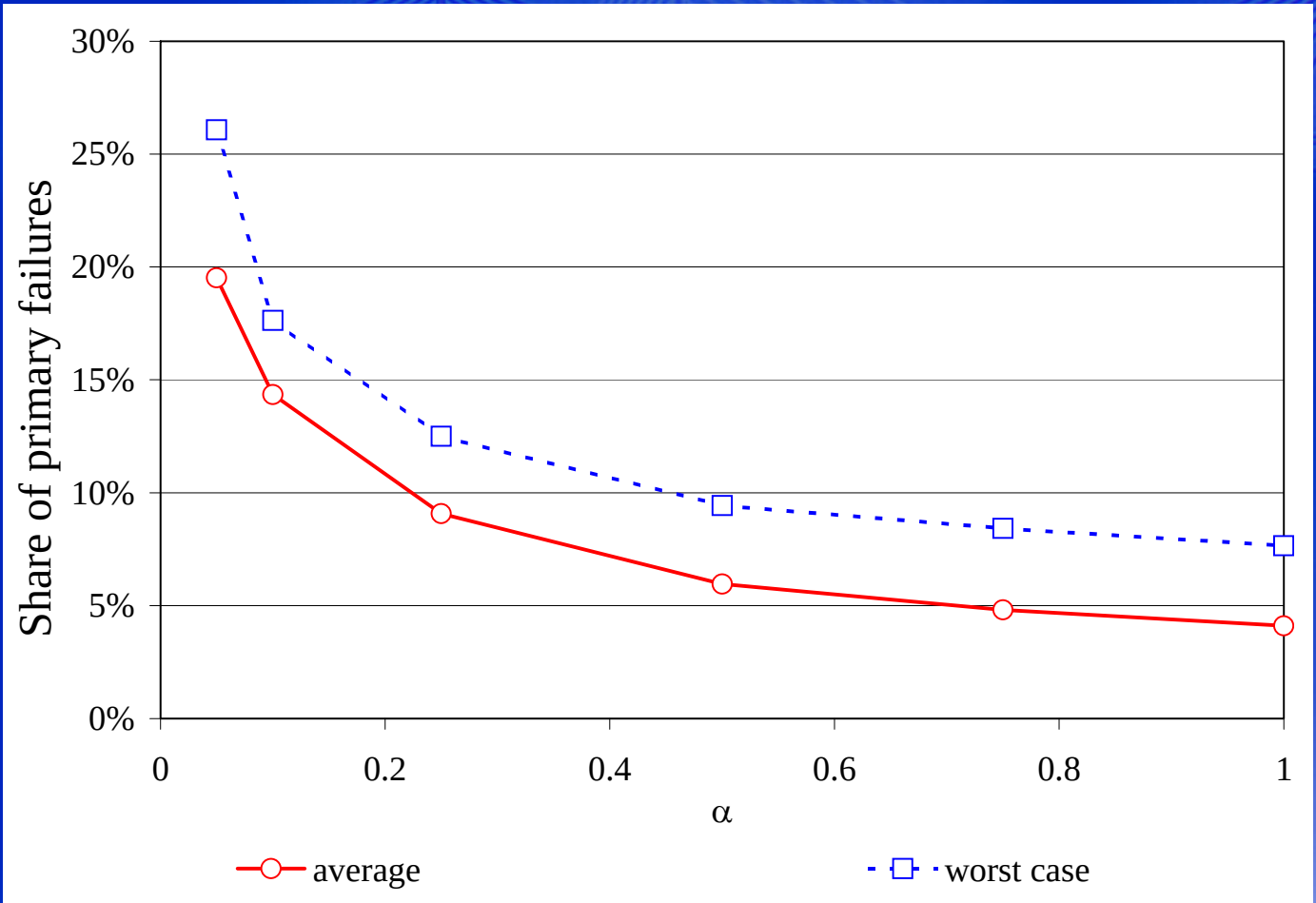
Systemic risk generally low

The vast majority of bank failures did not cause any systemic consequences in the simulations (only 15 - 30 banks per day). Also the systemic consequences were modest when present:



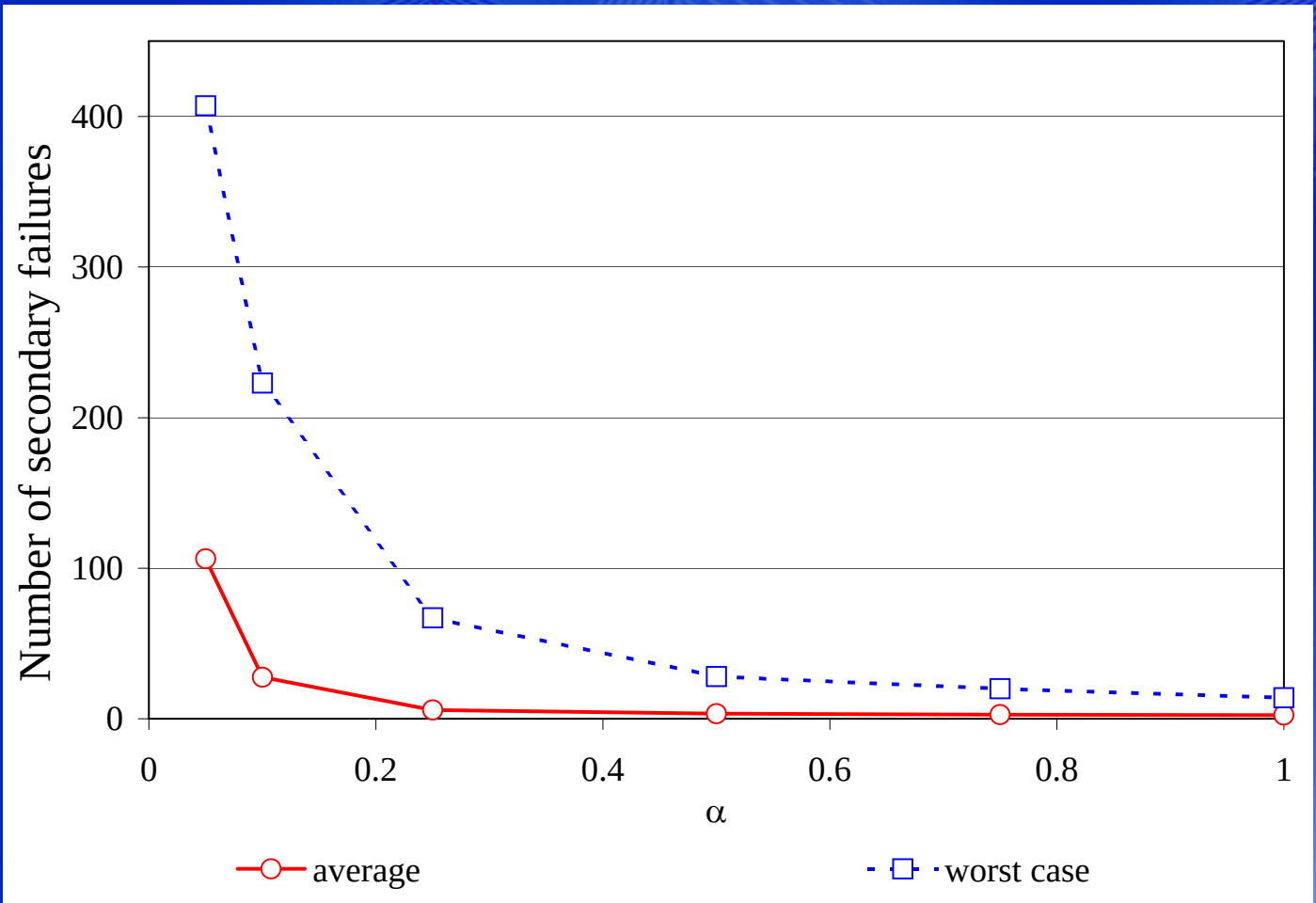
… but chances increase as α gets lower

Relationship between the failure threshold and the share of primary failures causing systemic consequences



… and so does the impact

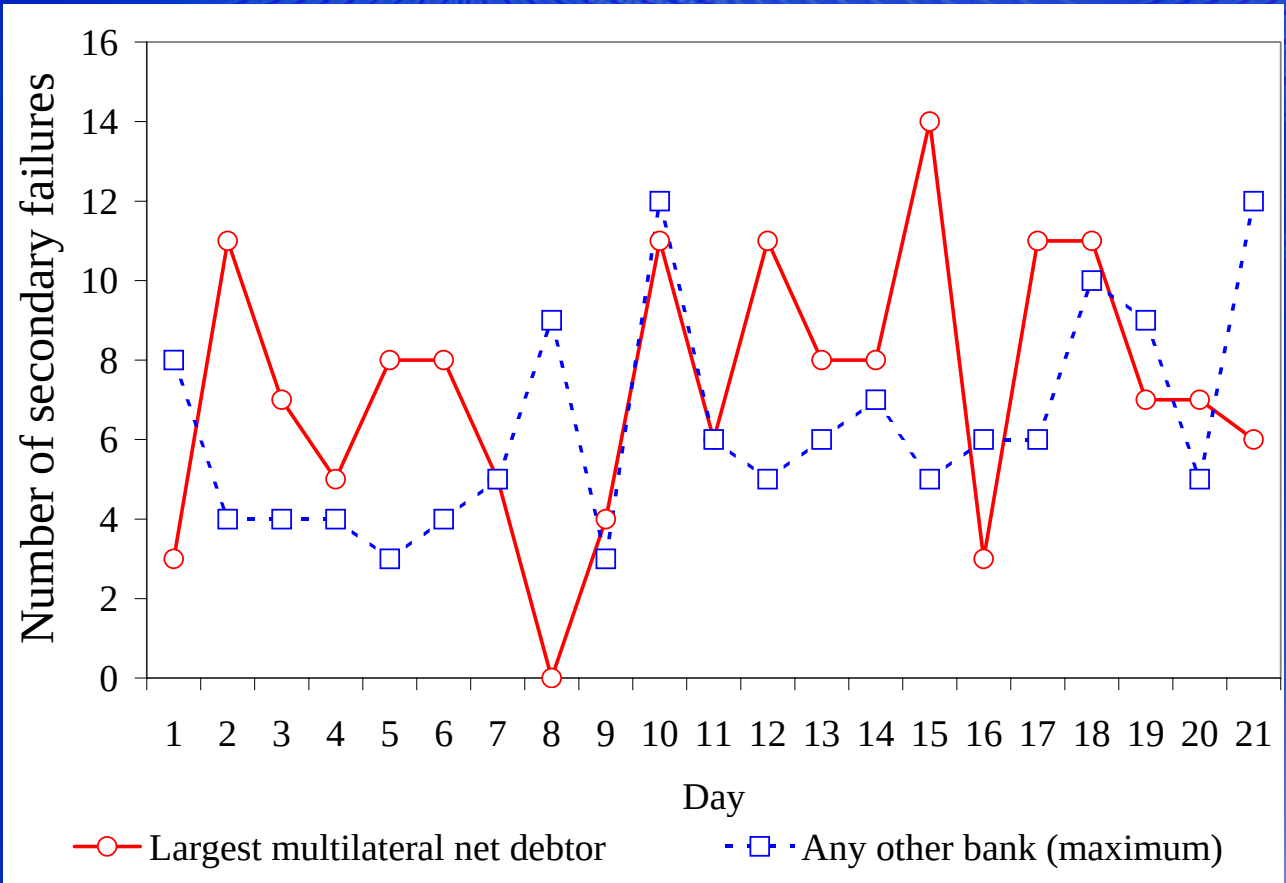
Relationship between the failure threshold and the number of secondary failures caused by a primary failure



Not always the usual suspect

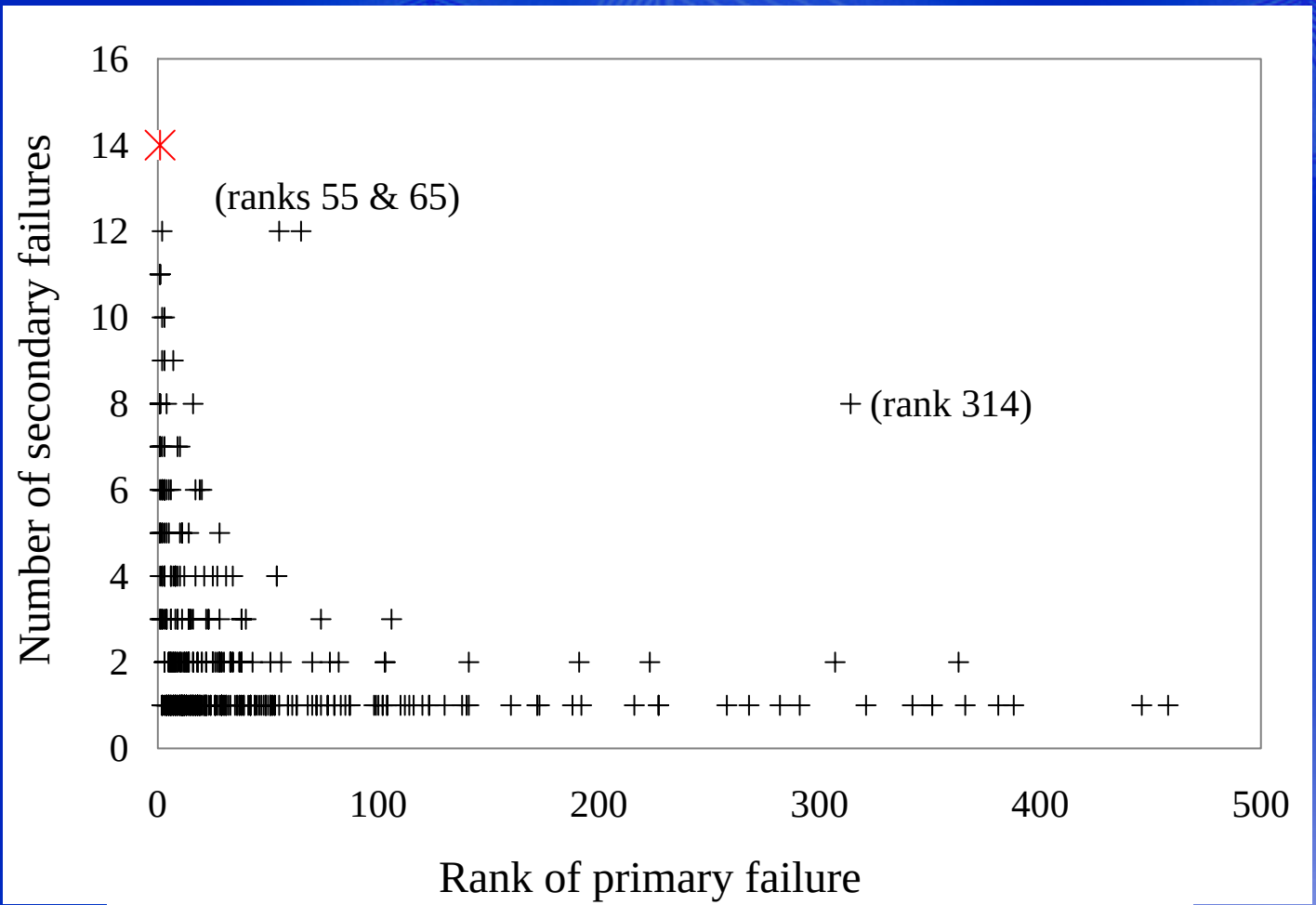
Comparing the the number of secondary failures caused

- by the single largest net debtor, and
- any other bank with a net debit position



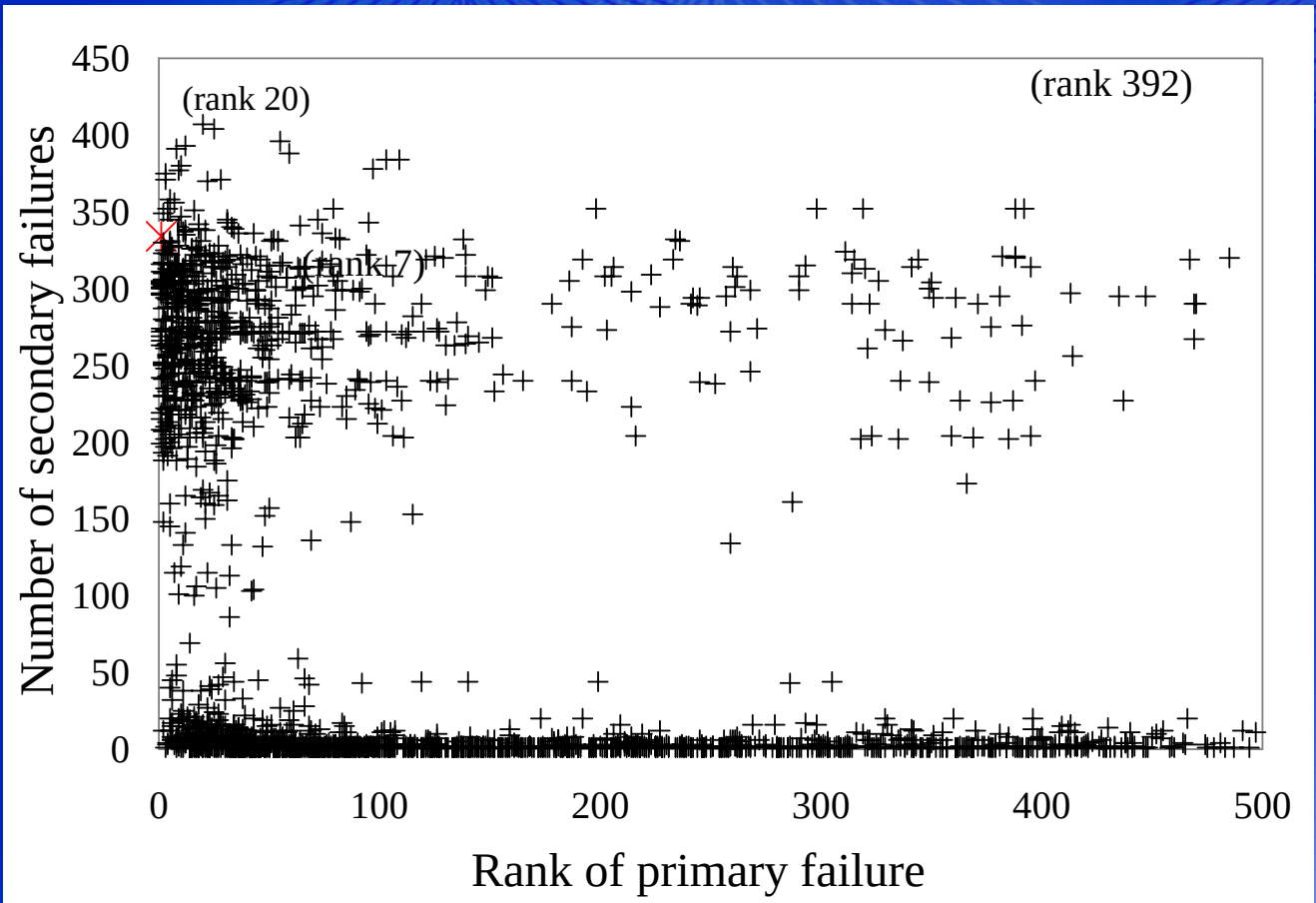
Virtually any bank? No.

For α=1. Banks with lower multilateral net debit positions are less likely to produce higher systemic consequences



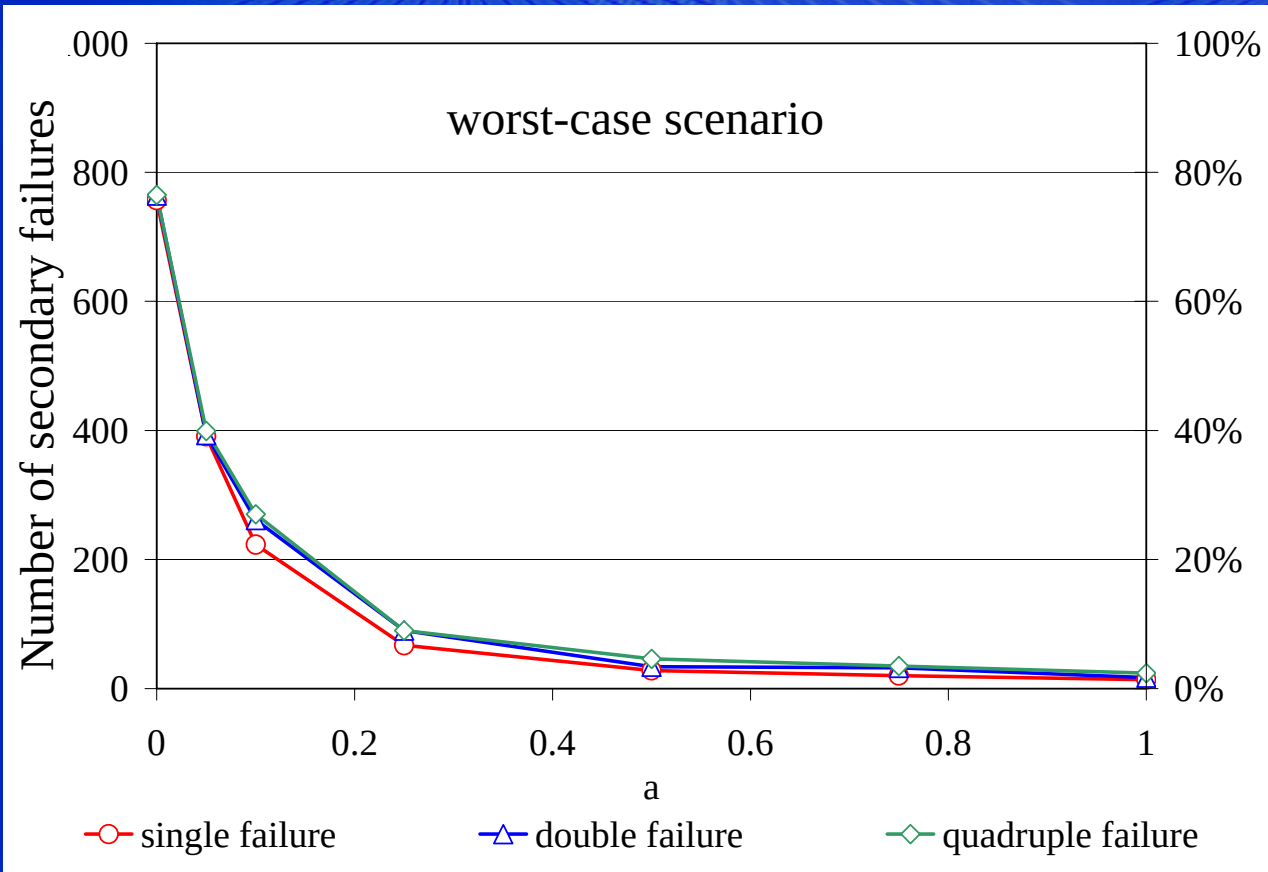
Virtually any bank? Yes.

For α=0.05. Virtually the failure of any bank, irrespective of its multilateral net debit position, could cause severe systemic consequences.



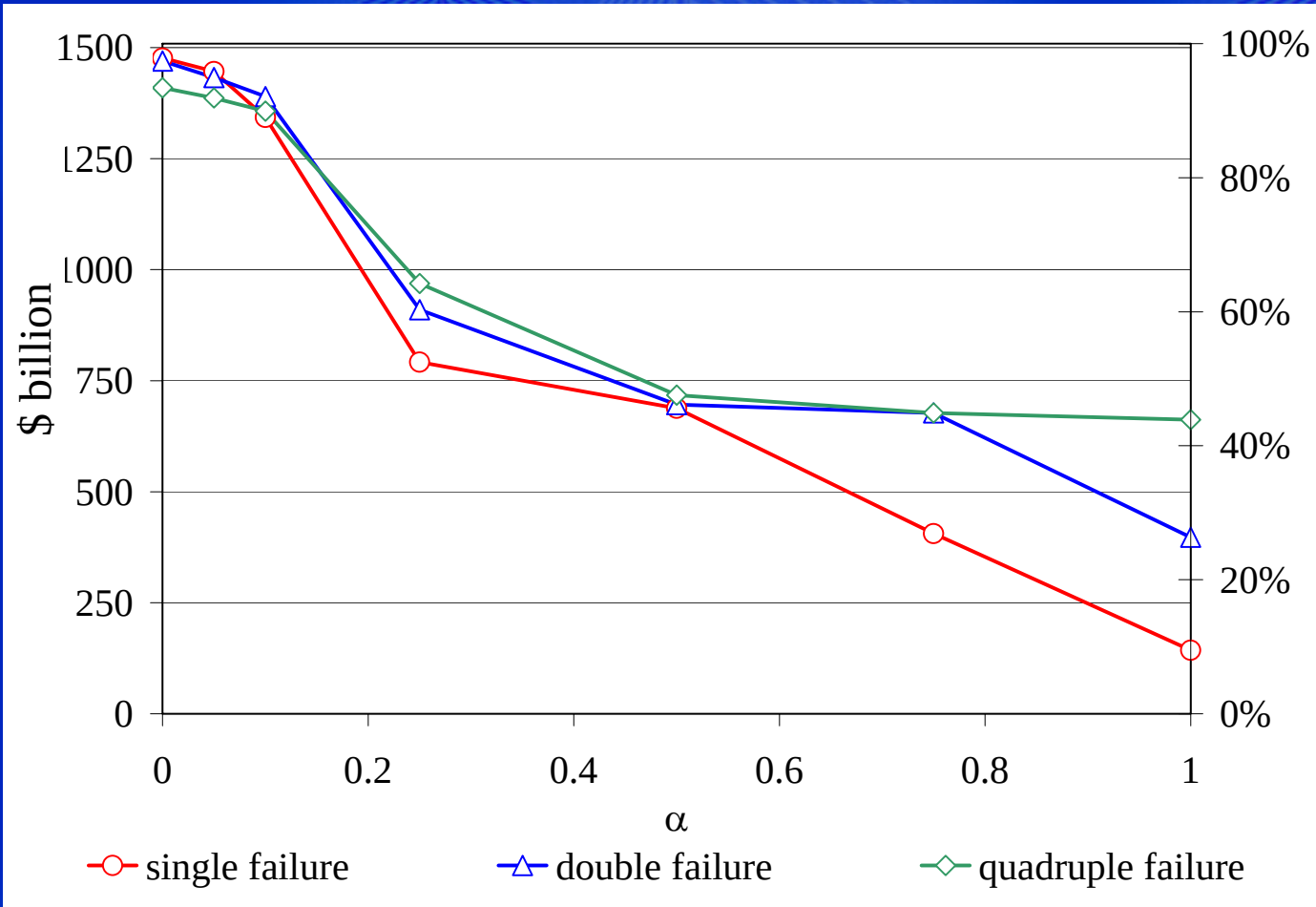
How about multiple primary failures?

The differences are surprisingly small. Seems to be a less decisive factor for systemic consequences than the failure threshold used.



Multiple primary failures 2

The value of unsettled payments, does, however increase substantially.



Conclusions

Results:

- We find the intrinsic systemic risk to be low
- Careful not to study only single largest net debtors, especially for liquidity effects
- Multiple primary failures surprisingly benign

Interesting further directions:

- what has happened since Humphrey (1986)?
- what are the drivers of systemic risk? (network topology, statistical properties)
- what about more secured forms of settlement?
- ...

Simulating payment and settlement systems, Helsinki 26 August 2004