Analysing the impact of operational incidents in LVPS: a simulation approach

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Roadmap

1. Background
2. A framework: simulating operational risk
3. An application—Feb 2004 CHAPS
4. Conclusion and further work

Background

Definition

- The Bank of England (2000) defines operational risk as ‘the risk that hardware or software problems, or human error, or malicious attack will cause a system to break down or malfunction giving rise to financial exposures and possible losses’

Why Simulate?

- We can try different what-if scenarios
  - Would not go down well if we did this in CHAPS!
- Useful in payment system policy
  - Analysing effects of various policy changes
- Useful in payment system research
  - Analysing settlement, credit, liquidity and node risk

Past Research

- BoF-PSS1 developed in 1997 and used to assess:
  - Liquidity effects of introduction of TARGET in Finland (Koponen & Soramaki, 1998)
  - Alternative queuing/liquidity concepts (Johnson, McAndrews and Soramaki, 2003)
  - Gridlock resolution by (Bech and Soramaki, 2001)

A framework: simulating operational risk

1. Identifying the worst-case scenarios
2. Assessing the impact of risk scenarios
3. Uncovering empirical distribution of impact

Types of operational failure

- Three types of disruption:
  - Inability of one settlement bank to send payments
  - Similar problems involving multiple settlement banks simultaneously
  - Unavailability of the central payment system
- CHAPS has controls in place to deal with such eventualities, e.g.,
  - By-pass mode

Worst-case scenario

- Definition: times at which operational events would have maximum impact.
- Single bank failure: find the time at which a bank is sitting on largest amount of liquidity, i.e. largest positive balance; early in the day;
- Multiple-bank failure: similar
- LVPS system failure: depends on the contingent plan

Impact of risk scenarios (1)

- Absolute measure: value/volume unsettled
- Time-adjusted delay: Bech and Soramaki (2001)

$$Delay = \frac{\sum_i \left(t_{2,i} - t_{1,i}\right) a_i}{\sum_i \left(t_{end} - t_{1,i}\right) a_i}$$

Impact of risk scenarios (2)

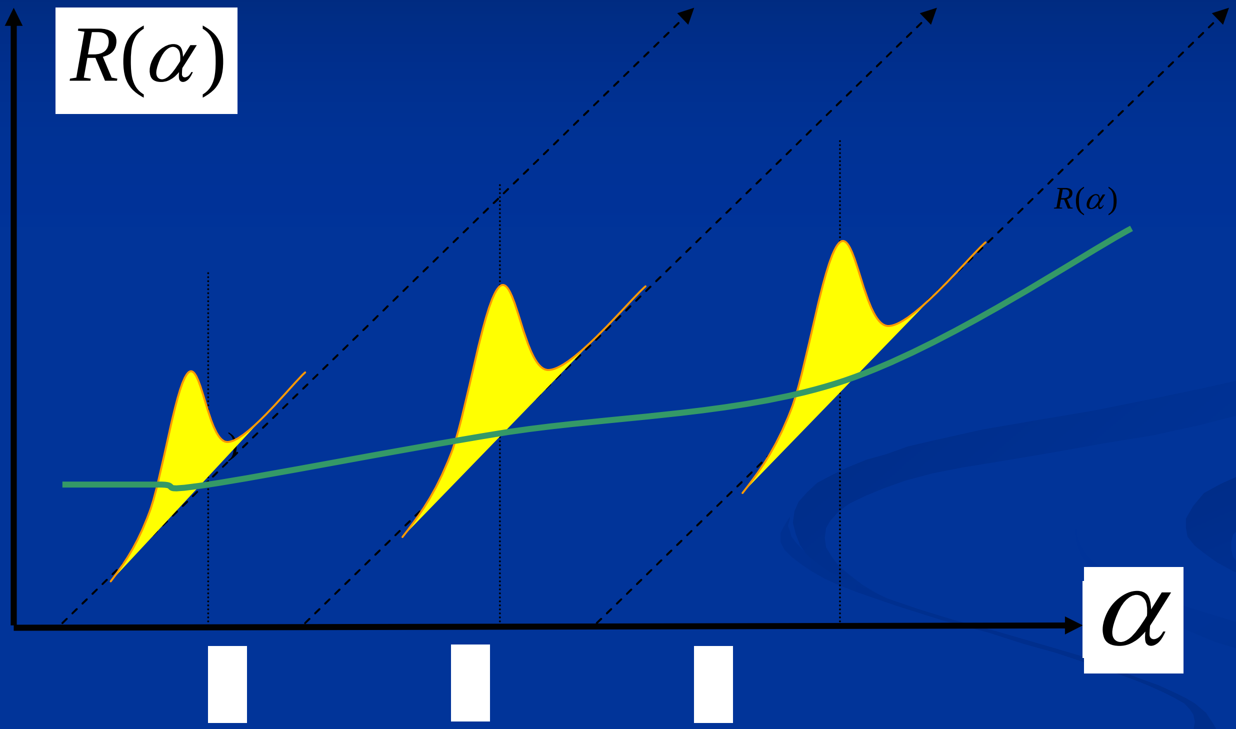
- Liquidity level: lower bound and upper bound

  Liquidity level = $UB - \alpha(UB - LB)$
- Establishing a benchmark delay for each liquidity level, i.e. normal scenario without incidents
- The impact of an operational incident is measured as relative the delay in a benchmark case

Uncovering empirical distribution of delay measures

- Find the time for the worst-case failure in a certain interval, e.g. one month;
- Assume that a bank's system goes down at that time for the rest of the day;
- Simulate and record the delay performance
- Repeat the steps for many intervals and for various level of liquidity

Empirical distribution of impact of operational incidents

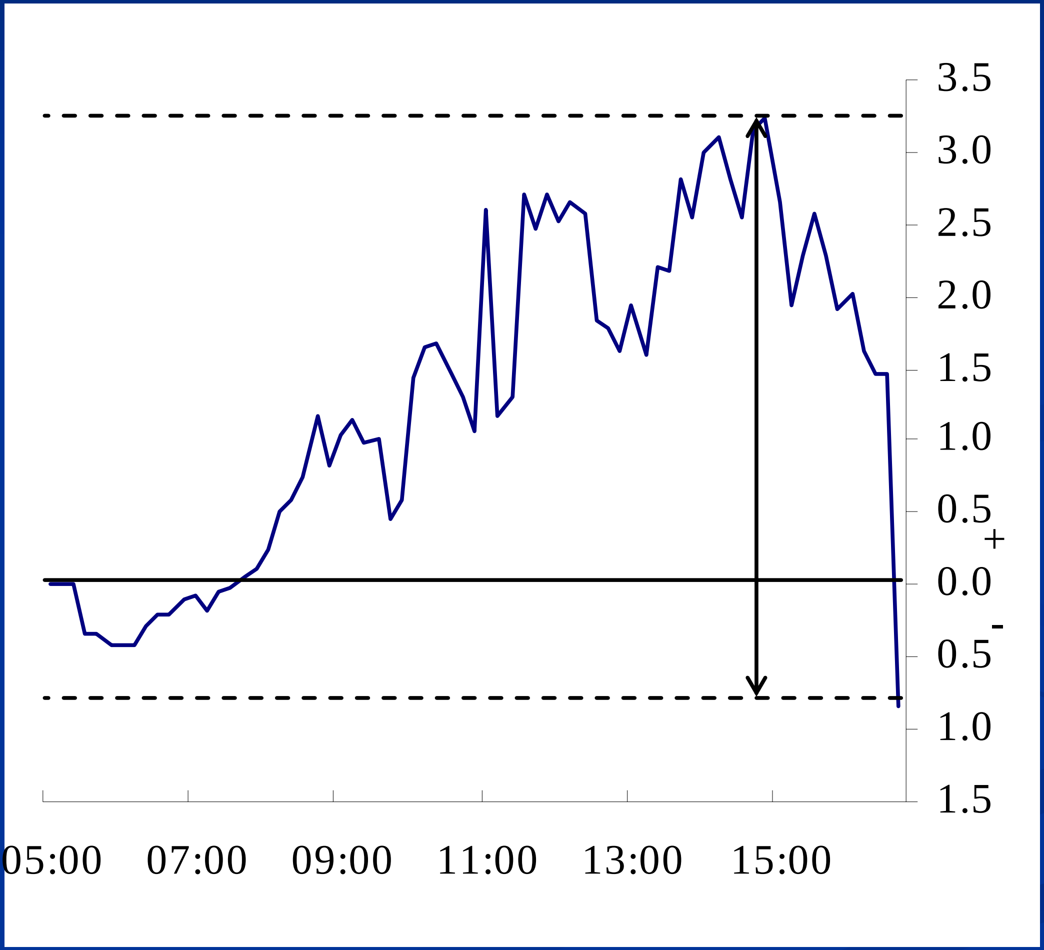


An Application: CHAPS Feb 2004

Data

- Use CHAPS transactions for February 2004
- Calculate ‘upper’ and ‘lower’ bounds
- Examine effects of events in high/low liquidity systems
- Try to gauge times at which operational events would have maximum impact

Settlement account balance



Individual settlement bank can't make payments

- Assume that a bank's system goes down so it can't make payments
- Worst case: Bank is sitting on lots of liquidity; early in the day
- Over the remainder of the day 46,389 payments with a total value of £45.71 billion could not be settled

Individual settlement bank can't make payments

Liquidity in system	Value of unsettled payments (£bn)	Volume of unsettled payments
Upper Bound (UB)	0.00	0
UB-0.25*(UB-LB)	0.00	0
UB-0.5*(UB-LB)	0.01	7
UB-0.75*(UB-LB)	0.35	66
Lower Bound (LB)	4.03	4086

Individual settlement bank can't make payments

Liquidity in system	Maximum queue value (£bn)	Average queue value (£bn)	Delay Indicator
UB	2.52	0.01	0.00
UB-0.25*(UB-LB)	2.85	0.03	0.01
UB-0.5*(UB-LB)	2.89	0.07	0.01
UB-0.75*(UB-LB)	3.62	0.15	0.04
LB	6.32	0.23	0.06

Three settlement banks can't make payments

- Assume that three banks' systems go down so they can't make payments
- Worst case: Banks are sitting on lots of liquidity; early in the day
- Over the remainder of the day 50,809 payments with a total value of £143.37 billion could not be settled

Three settlement banks can't make payments

Liquidity in system	Value of unsettled payments (£ billion)	Volume of unsettled payments
UB	0.00	0
UB-0.25*(UB-LB)	0.68	24
UB-0.5*(UB-LB)	2.84	1078
UB-0.75*(UB-LB)	7.58	3225
LB	13.08	6299

Three settlement banks can't make payments

Liquidity in system	Average queue value (£billion)	Delay Indicator
UB	0.02	0.03
UB-0.25*(UB-LB)	0.05	0.05
UB-0.5*(UB-LB)	0.66	0.06
UB-0.75*(UB-LB)	1.34	0.20
LB	0.25	0.25

CHAPS goes down – Bypass mode not invoked

- All payments sent after cut off time processed manually
- 48,570 payments would need to be sorted out!

CHAPS is run in ‘bypass’ mode

- All payments sent after the system failed multilaterally netted at the end of the day
- But the £1 billion sender caps meant that 23 payments with a total value of £3.78 billion were left unsettled
- In practice, bank would have borrowed to ensure that it could make payments
  - This leads to credit risk

Conclusion and further research

Conclusion and further research

- CHAPS is well placed to withstand variety of plausible operational incidents;
- Potential liquidity risk still present
- Immediate task: run the simulation for many intervals to uncover the whole picture of the empirical distribution