Stress testing Securities clearing and settlement systems (SCSS)

Payment and settlement simulator seminar - 2005

Matti Hellqvist, Bank of Finland

Overview

1. Introduction
2. Specialties of SCSS
3. Caveats
4. How did/do we do it?
5. Conclusions

Stress testing infrastructure

1. Introduction

Introduction

Stress testing (in this context) is about

- Quantifying the impacts of a default or a operative failure* in a system
- **How and why should we stregthen our infra?**

*** Operational risk is defined as ”the risk that deficiencies in information systems or internal controls, human errors or management failures will result in unexpected losses”. (BIS 2001)**

Introduction

Ways of conducting stress tests on SCSS

- Theoretical (see eg Iori 2004, Devriese – Mitchell 2005)
- Empirical (see eg the BoF Financial Stability 2004, Hellqvist – Koskinen 2005)

What is the best way?

Introduction – why simulate?

- Real and massive data sets can be used
- Incorporation of relationships that are complex and close to reality
- Models based on enumeration rather than calculus
- Various and multiple risk scenarios can be simulated
- Results generally reliable when behavioral effects can be controlled or anticipated

Introduction – creating stress tests

- Focus of disturbance – which participant(s) or part(s) of the infrastructure?
- Duration of disturbance
- Scope of the simulation

Scenarios are described as changes in data sets or processing rules

Stress testing SCSS

2. Specialties of SCSS

Payment systems vs. SCSS

- Delivery versus Payment (DVP)
  - Two (or more) debited and credited accounts in all transactions

  ⇒Processing and algorithms more complicated
- Assets = book entry currencies
  - Huge number of simulated accounts possible

  ⇒Preparing the data more complicated

Differencies continued…

- Direct holding vs. nominee accounts.
- Emissions, maturings, IPO:s, splits, mergers, etc. special events more common.

- Number of studies dealing with the issue close to 0

Stress testing SCSS

3. Caveats

Caveats

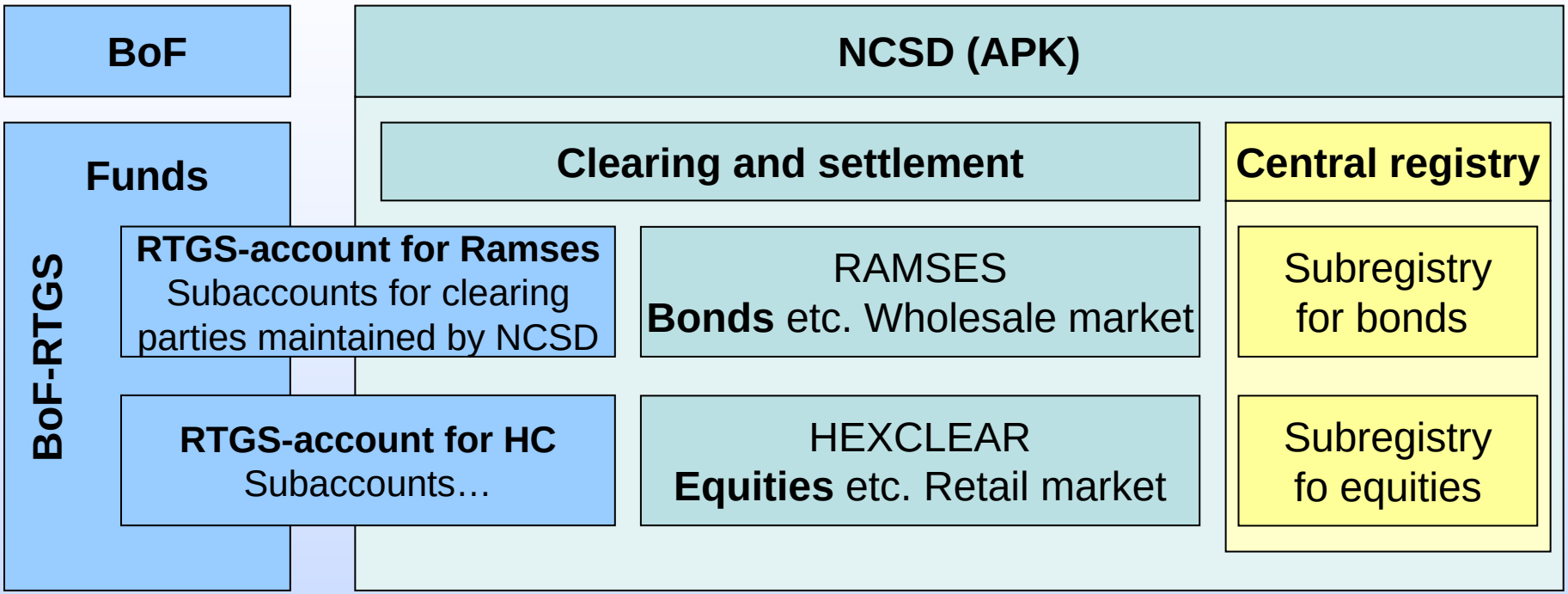
- Settlement algorithm of a real system not available
  - → Results need to be adjusted respectively, a close alternative should always be used
- Data not available…
  - → Structure of the system is written implicitly into the data, complete set of data from real systems is required
- … as time series
  - → Model based on enumeration needs long period of data for reliable results
- … Many assumptions are made concerning the changes in the system participants' behaviour
  - → Easiest solution: Keep the actions of participants as they were in the real historical data. Results will show the scale of losses participants would be facing and also how quickly they have to react to prevent these losses

Hypotheses should be constructed with practitioners before undertaking any large scale simulations

Stress testing SCSS

4. How did/do we do it?

How did/do we do it- The Finnish infra



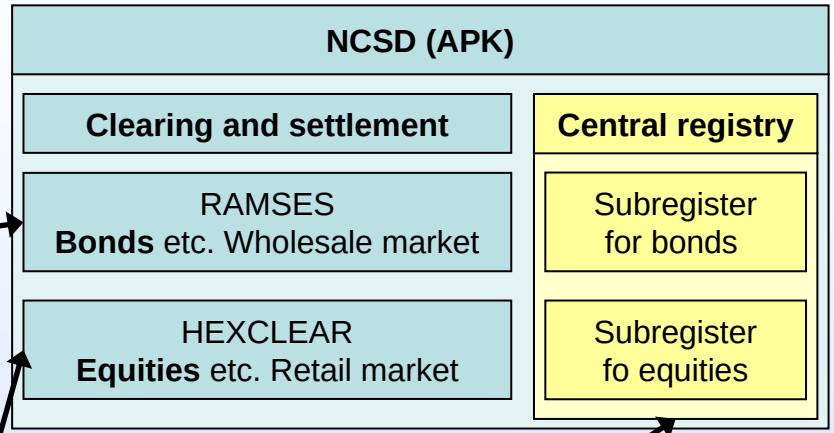
CSD = **C**entral **S**ecurities **D**epository
having functions
Clearing, **S**ettlement and **D**epository

* Links exist to other CSD:s from both subregistry

How did/do we do it- The Finnish infra

Bonds, certificates of deposit
15 clearing parties ~1500 trades, total ~ 15 b€ / Month
-RTGS with some gridlock resolution
-Mainly T+2, T+3 (T+0…T+n possible)
- OTC market

Equities:
- 23 clear. part. ~500 000 trades, total ~40 b€ /month
-Optimization batches + RTGS on the background
-Mainly T+3 (T+0…T+n possible)
-Exchange & OTC trades



Registry:

Registred owners	857 960
Book-entry accounts	1 169 183
Nominal value of bonds	68 b€
equities	179 b€

How did/do we do it?

Developed scenarios

- Last year (stress tests on the **bond** clearing and settlement system):
  - Each clearing bank at a time subject to an operative disturbance => 260 scenarios => distribution for impacts
  - Default of a participant in a situation (worst case) where the participant has reached its maximum payment obligation of the month
- This year (stress tests on the **equities** clearing and settlement system):
  - Technical default of the largest participant in the market
  - Most commonly used settlement algorithm fails and – where appropriate, another algorithm must replace it
  - Single but important asset (ISIN) is not available, at the same time volumes are high in the system

How did/do we do it – the ingredients

We have:

- the precise participant and account structure;
- the account balances of all book entries from the beginning of the reference period (incl. fund accounts);
- all events affecting the account balances (time and value of transaction, flow through the accounts, information on transaction type) for the whole period
- the precise logic of clearing and settlement

How did/do we do it?

Main questions that we aimed/aim to tackle are the following:

- Can the Simulator be used? (Yes)
- Dynamics of settlement failures (direct and contagion), liquidity effects on the participants?
- Is the system as a whole adequately designed and able to withstand shocks?
- How about such participants that are not entitled to intraday credit?

How do we do it – Implementation

- Results by comparing undisturbed benchmark and stress scenarios
- Currently new user modules for DVP-linking groups of transactions and PNS for DVP data
- Some hints:
  - Combine multiple non overlapping scenarios in a single simulation
  - Results as empirical distributions highly recommended in stead of point tests
  - Transactions between systems can not be in DVP
  - New version 2.0.0 of Bof-PSS can be even 95% faster when accounts are numerous.

How did we do it – results

Results can be analysed from two viewpoints:

- the system level – eg the total number or value of unsettled, cancelled or delayed transactions

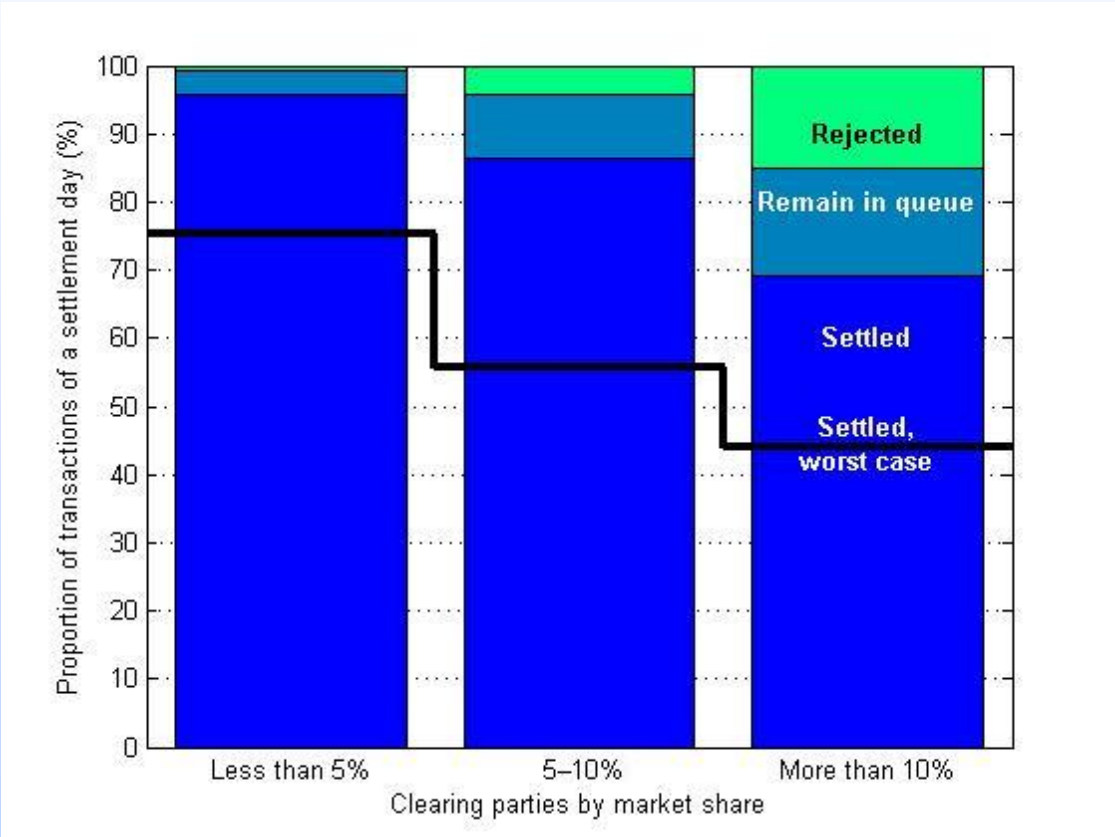
- the participant level – eg adequacy of participants' liquidity reserves in a disturbance

How did we do it – results

- High level of concentration
  - in terms of nominal values, four largest parties involved in 73 % of the trades
  - in terms of number of transactions, the corresponding figure was 66 %

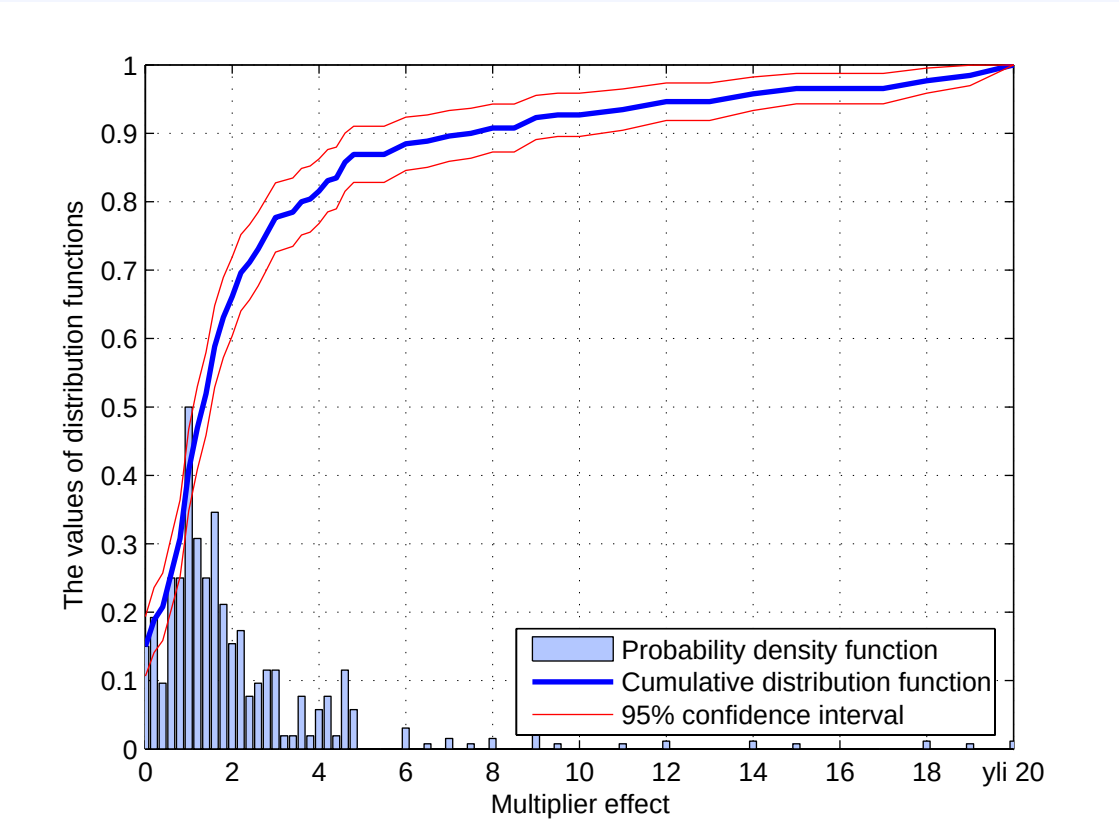
How did we do it – results

Average share of affected transactions on system level after operational failure of participants with different market share



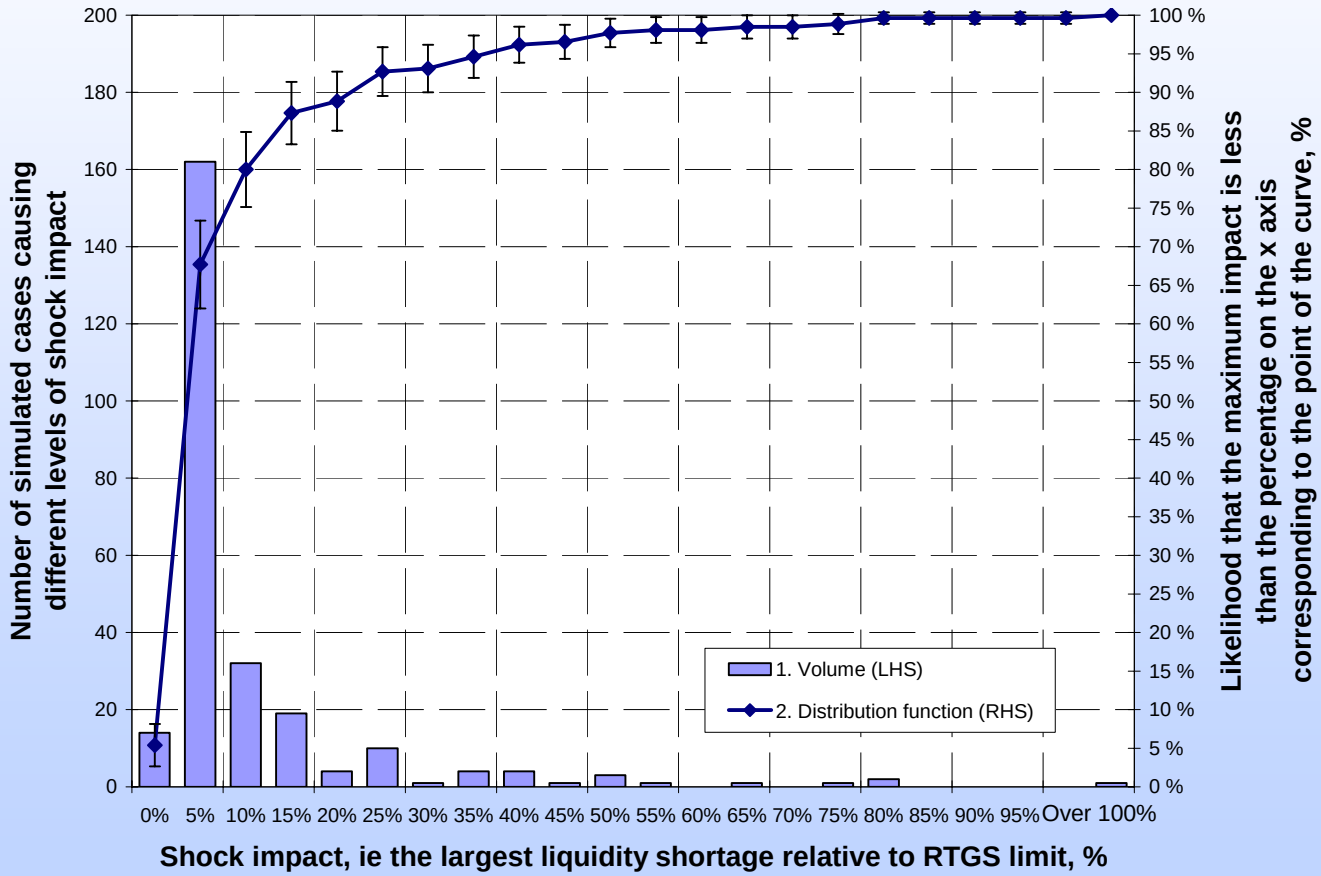
How did we do it – results

Empirical distribution for nonsettled on system level vs. settlement obligations of the failing participant i.e. Measuring the ”Chain reaction”



How did we do it – results

Empirical distribution for liquidity impacts of operational failure on counterparties of monetary policy



How do we do it – lessons learned

- **Preparation** of data sets very time consuming
- It was ok to clarify the simulation plan during the journey
- One should begin by **validating** the model and results – important to evaluate the assumptions made
- Constructing the model and examining the data gives **better understanding on how the system is used**

Stress testing SCSS

5. Conclusions

Conclusions

Stress tests and simulation can be used

- to assess risks associated with operative or other disturbances
- to define the extent of the assumed disturbances within systems and strength of their impact on the other financial market systems

SCSS for bonds is not a significant source of systemic or liquidity risk in Finnish financial market

Conclusions

Key areas for improvement:

- More realistic algorithms for DVP transactions
- improved modelling of the **parties' overall liquidity position** may be required
- modelling of **parties' reactions** in a disturbance required (a big challenge)

References

Iori, G. (2004): An analysis of systemic risk in alternative securities settlement architectures. ECB working paper No. 404

Devriese, J. – Mitchell, J. (2005): Liquidity risk in securities settlement, NBB Working paper, forthcoming

Bank of Finland (2004) **Financial stability**. Bank of Finland Bulletin, special issue 2004. p. 81, 84-85

Hellqvist – Koskinen (2005): Ch.12 in Bank of Finland Studies E:31

BIS (2001): Recommendations for securities settlement systems. CPSS Publications No. 42