MAGYAR NEMZETI BANK

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Operational Disruption and the Hungarian Real Time Gross Settlement System (VIBER)

*Views are those of the individual authors and do not necessarily reflect official positions of the Magyar Nemzeti Bank..

Presentation outline

Motivation

- Scope of the research
- Operational incidents in the past

Data and methodology

- Indicators describing the functioning of VIBER
- Endangered participants
- Assumptions

Simulation results

- 6 scenarios (3 entire day for the 6 systematically most important participants, 3 part-time incidents with optimalisation)
- Gross and net liquidity deficit

Conclusions

Motivation

- Large-value transfer systems: key market infrastructure
- Identification of systemically important and endangered participants
- Quantitative assessment of the ability of the system to withstand certain types of operational shocks
- Simulating the technical default of one or two systemically important participants
- Calculating the additional liquidity required to settle desired transactions

Scope of the research

OPERATIONAL INCIDENTS

a) Historical

b) Hypothetical

PROBABILITY

a) Estimated from an incident database

b) Estimated from a theoretical distirbution

IMPACT (the possible effects of operational distruptions)

a) First round effects (directly observed in the payment system)

aa) Ex post analysis: historical payment system data

ab) Forward looking analysis: simulated payment system data

b) Second round effects (can not be directy observed in the payment system)

c) Cost estimations of first and second round effects

EXPECTED COSTS OF OPERATIONAL INCIDENTS IN PAYMENTS SYSTEMS FOR THE ENTIRE ECONOMY

EVALUATION OF BACK-UP FACILITIES:

Efficiency and sufficiency of currently used back-up facilities, further possible investment decisions on back-up facilities

EXPECTED COSTS AND BENEFITS OF ADDITIONAL INVESTMENTS IN BACK-UP FACILITIES

COST AND BENEFIT ANALYSIS OF INVESTMENTS IN THE PAYMENT SYSTEM

Data and methodology

- Simulator developed by the Bank of Finland (BoF-PSS)
- Actual data: December 2006 – January 2007 (41 days)
- Simulations:
  - Benchmark case: replicating the actual functioning of VIBER
  - Distressed periods
- Parameterization: institutional features of VIBER
  - FIFO – queue release algorithm
  - Gridlock resolution: 30 minutes – multilateral partial offsetting

Indicators of the operation of VIBER

Non-submitted payments
Rejected payments
} Unsettled payments

Hypothetical liquidity levels:

- Lower bound of liquidity
- Upper bound of liquidity
- Potential liquidity (based on balance sheet data and evaluation policy of the central bank)

Liquidity usage indicator

Queue and delay statistics:

- Number and total value of queued transactions
- Maximum queue value
- Average queue length
- Delay indicator

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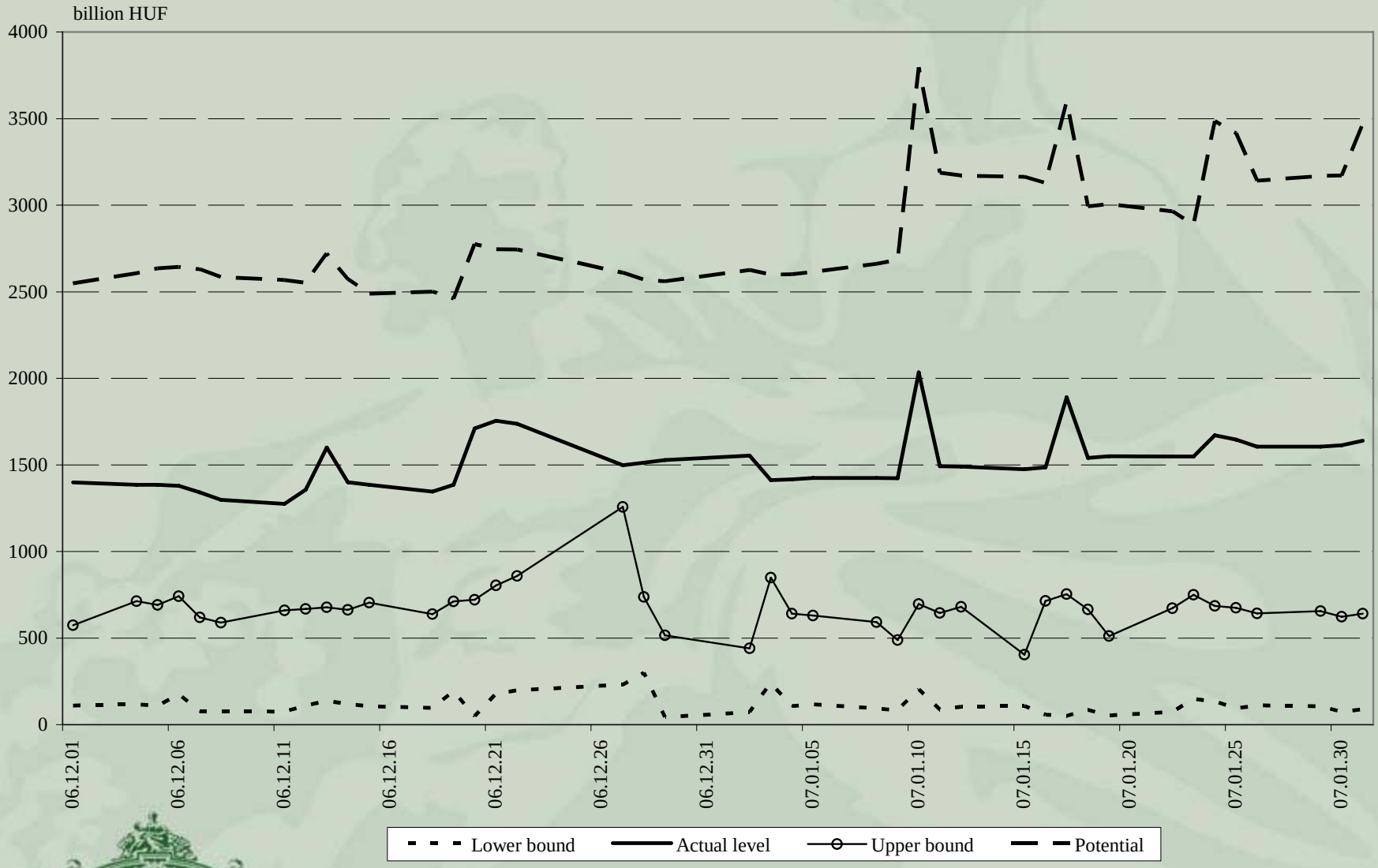
Normal functioning of VIBER

- Comparison of the stress scenarios with the benchmark case
- Identification of critical periods of the business day
- Discovering critical participants:
  - Systemically important participants
  - Endangered participants

} Overlap?

	Minimum	Average	Maximum
Number settled	2,098	3,429	4,963
Number unsettled	-	-	-
Value settled (million HUF)	1,422,990	3,496,231	5,387,416
Value unsettled	-	-	-

Liquidity levels - system



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Queue and delay statistics

	Minimum	Average	Maximum
Value of payments initially not submitted	-	-	-
Value of unsettled payments	-	-	-
Total value of queued transactions (in % of value settled)	2.62%	16.41%	33.02%
Maximum queue value (in % of value settled)	1.35%	4.29%	11.08%
Average queue length (hh:mm:ss)	0:08:34	0:41:24	2:08:44
Settlement delay	0.01	0.07	0.16

Clustering of participants

Systemically important participants:

- Concentration indicators of the debited banks
- Network criteria (weighted outdegree & out-proximity centrality)

Endangered participants:

- Assessing liquidity risk under normal conditions (clustering)
- Proxies for liquidity risk (volume and value of unsettled payments, relation of various liquidity levels, queue indicators, liquidity usage indicators, delay indicator, queue length indicator)
- Assessing liqudity risk under stress with a simple sensitivity analysis (”predicting” simulation results)

The clusters

The actual level of liquidity was less then the upper bound of liquidity (%, out of 41 days)			*Other criteria applied for grouping direct VIBER participants*		Number of participants	Share in debit turnover	Types of institutions in the group	Groups
Low boundary	<...<	*Upper boundary*						
0%	<...<	10%	Liquidity usage is greater than 50% on at least half of the days		5	13,51%	banks (sometimes with special profile)	A
			Liquidity usage is less than 50% on at least half of the days	Ratio of intraday credit line to available liquidity is high	4	21,14%	specialized credit institutions	
				Ratio of intraday credit line to available liquidity is middle-sized	8		banks (sometimes with special profile)	
				Ratio of intraday credit line to available liquidity is low	8		universal and specialized banks, Hungarian State Treasury	
10%	<...<	50%	Balance sheet seems to contain enough liquidity buffer		3	0,25%	banks (often with special profile)	B
			Rarely there can be days when balance sheet does not contain enough liquidity buffer		3	3,74%	banks (sometimes with special profile)	C
50%	<...<	100%	Balance sheet seems to contain liquidity buffer, but there can be days when balance sheet does not contain enough liquidity buffer	Delay indicator is relatively high	0	55,43%	foreign owned banks highly exposed to FX settleemnt risk	D
				Delay indicator is middle-sized	3			
				Delay indicator is relatively low	0			
			It can easily happen that balance sheet does not contain enough liquidity buffer	Delay indicator is relatively high	1			E
				Delay indicator is middle-sized	1			
				Delay indicator is relatively low				
Sum					36	94,07%		

Graphs on liqudity levels according to clusters

Group A Group C Group D Group E

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Assumptions

- Behavioural reactions of technically non-defaulted participants
  - No reaction
  - Stop sending payment in two hours
- Timing and length of the operational incidents
  - Worst-case scenario: entire day incident
  - Part-time incident
- Number and list of technically defaulted participants
  - One or two banks
  - Chosen from the six systemically most important institutions
- Application of existing back-up procedures

Simulated scenarios

	Entire day incident			Part-time incidents		
Scenario	**1**	**2**	**3**	**4**	**5**	**6**
Number of technically defaulted participants	1	1	1	1	1	2
Duration of the incident (hours)	9	9	9	4	6	4
Contingency procedures: Back-up facilities	-	+	-	-	-	-
Behavioral reaction of technically non-defaulted participants	-	-	+	-	-	-

Scenario 1: Entire day incident

- Operational incidents at the most active player lead to serious disturbances in many cases
- Technical problems of 3 banks require special attention
- Strong influence of the daily payment pattern
- Mitigating the shock:
  - Back-up facilities (Scenario 2)
  - Banks' adoption to the situation (simple reaction: stop sending, Scenario 3):
    - Adjustment of intra-day trading (trading activity after the incident)
    - Adjustment of settlement behaviour (changing settlement behaviour for already agreed trades and new trades after the incident)

Overestimation

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Scenario 2: Back-up facilities

- Lower disturbance in the functioning of the payment system
- Significant improvement in the case of 3 banks
- Dependence on the selection procedure of manually processed payments

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Scenario 3: Behavioural reactions without back-up facilities

- Results should be considered as indicative
- Stop sending rule without filtering out the intra-day financial transactions – misleading
- Stop sending: doubtful behaviour
  - Fulfilment of obligations
  - Transactions management
    - Place transactions at the end of the queues (lower priority)
    - Submit transactions at the end of the business day
    - Important from the point of view of loss-reallocation

Gross and net liquidity deficits (Sc1 & Sc2)

- Additional liquidity that would be required to settle all rejected transactions
- Source of additional liquidity:
  - Counterparties on the money market (trading patterns)
  - Central bank: Monetary policy framework (eligible collateral)
  - Central bank: Lender-of-last resort role (if considered to be needed)
- Gross liquidity deficit:

$$GLD_i = \max\left\{\left[\left(\sum_{j=1}^{n} p_{ij}^{out} - \sum_{k=1}^{n} p_{ik}^{in}\right) - \left((IDCL_i^{end} + b_i^{end}\right)\right]; 0\right\}$$

- Net liquidity deficit:

$$NLD_i = \max\left\{\left[GLD_i - \left(POT_i^{end} - IDCL_i^{end}\right)\right]; 0\right\}$$

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Net liquidity deficits

- High variation across banks suffering from the incident
- Range of NLD: 0.1 – 316 billion HUF
- Results are in line with the clustering

- Liquidity deficit is significantly lower in Scenario 2 than in Scenario 1

Part-time incident scenarios (Sc4-Sc6)

- Optimization procedure: incidents lasting for 4 & 6 hours
- Value of transactions not submitted on time (million HUF)

	Mimimum	Average	Maximum
Scenario 4	75 040	466 334	650 003
Scenario 5	98 459	540 828	773 256
Scenario 6	124 417	806 287	1 186 135

- Timing of the incidents

	Mimimum	Average	Maximum
Scenario 4	8:52:16	9:54:56	12:36:05
Scenario 5	8:01:22	9:25:48	10:16:16
Scenario 6	8:23:46	9:47:25	11:12:05

Conclusions I

- First step to evaluate the ability of VIBER participants to withstand certain types of operational shocks
- Hypothetical scenarios, several assumptions
  - Participants do not raise intraday credit lines with the central bank (liquidity buffer in the balance sheets)
  - Unchanged trading pattern (same value and volume of transactions with the same counterparties)
  - Unchanged settlement behaviour (transactions management)
- Limited knowledge on the behaviour of participants in shock situations
  - Modifications in intraday trade (trading altogether less, trading with operationally viable participants)
  - Changes in the payment pattern (blocking payments, modifying time stamps, re-prioritizing payments)

Conclusions II

- Technical default of the systemically most important participants: serious disturbance with the given assumptions
- Back-up options: can be very efficient
  - Dependence on the selection procedure (priority vs. value)
- Impact of stop sending rule: more unsettled payments
- Part-time incidents: more queues and longer delays
- 'What if types of questions':
  - keep the simulation as simple as possible
  - avoid more speculative assumptions until we do not know more about the participants' reactions (settlement and trading behavior)

Research: to be continued…

Thanks for your attention!

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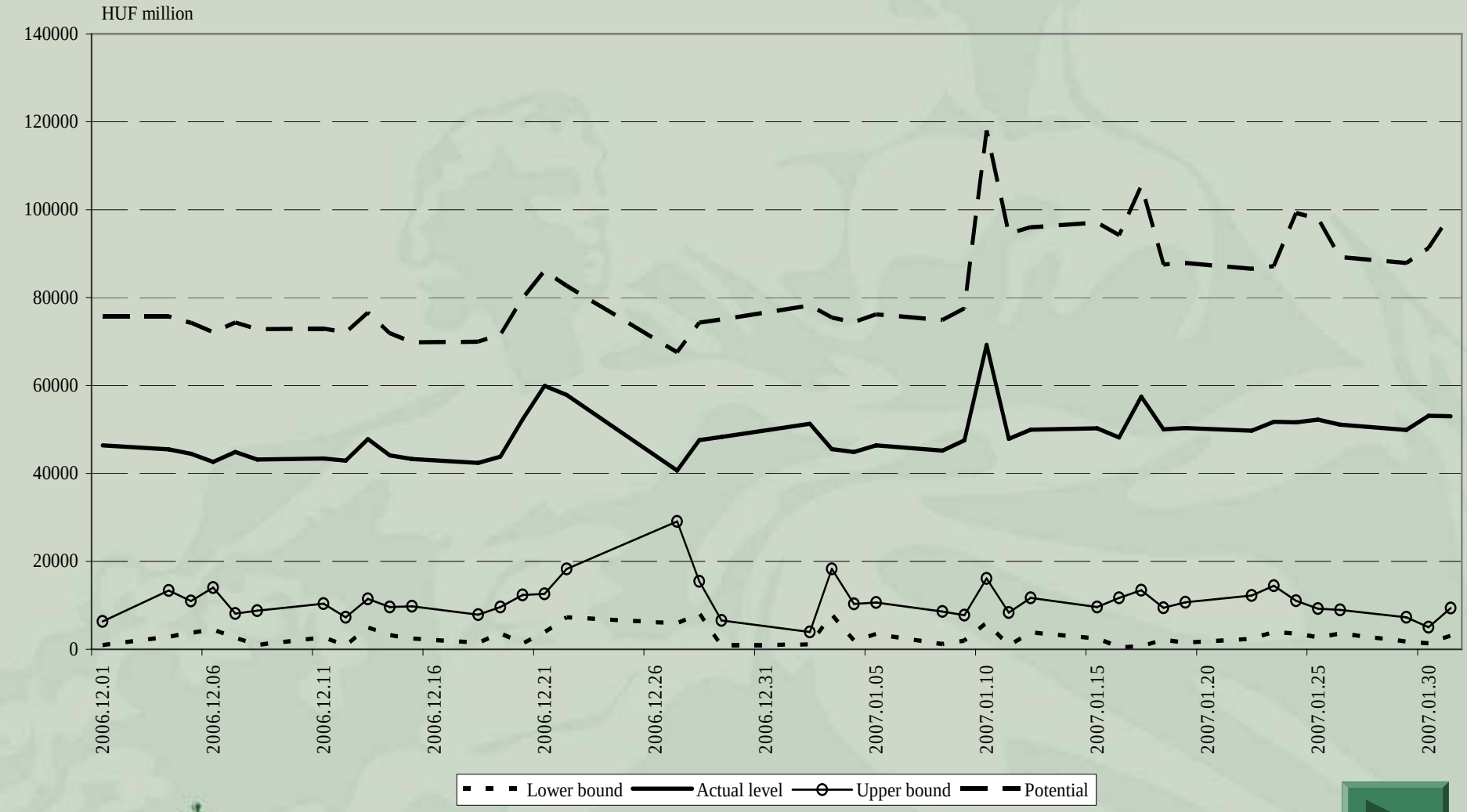
Liquidity levels: Group A



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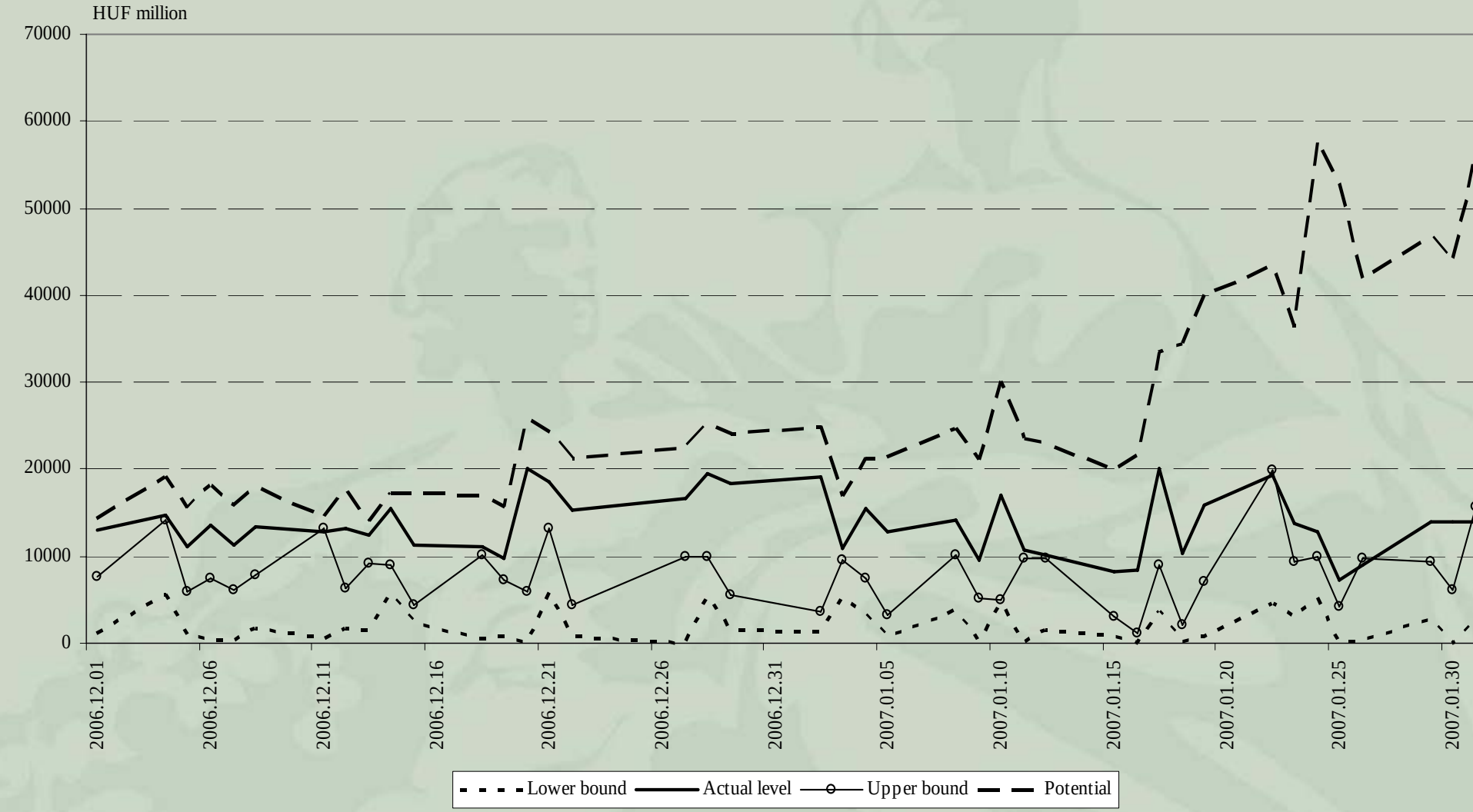
Liquidity levels: Group C



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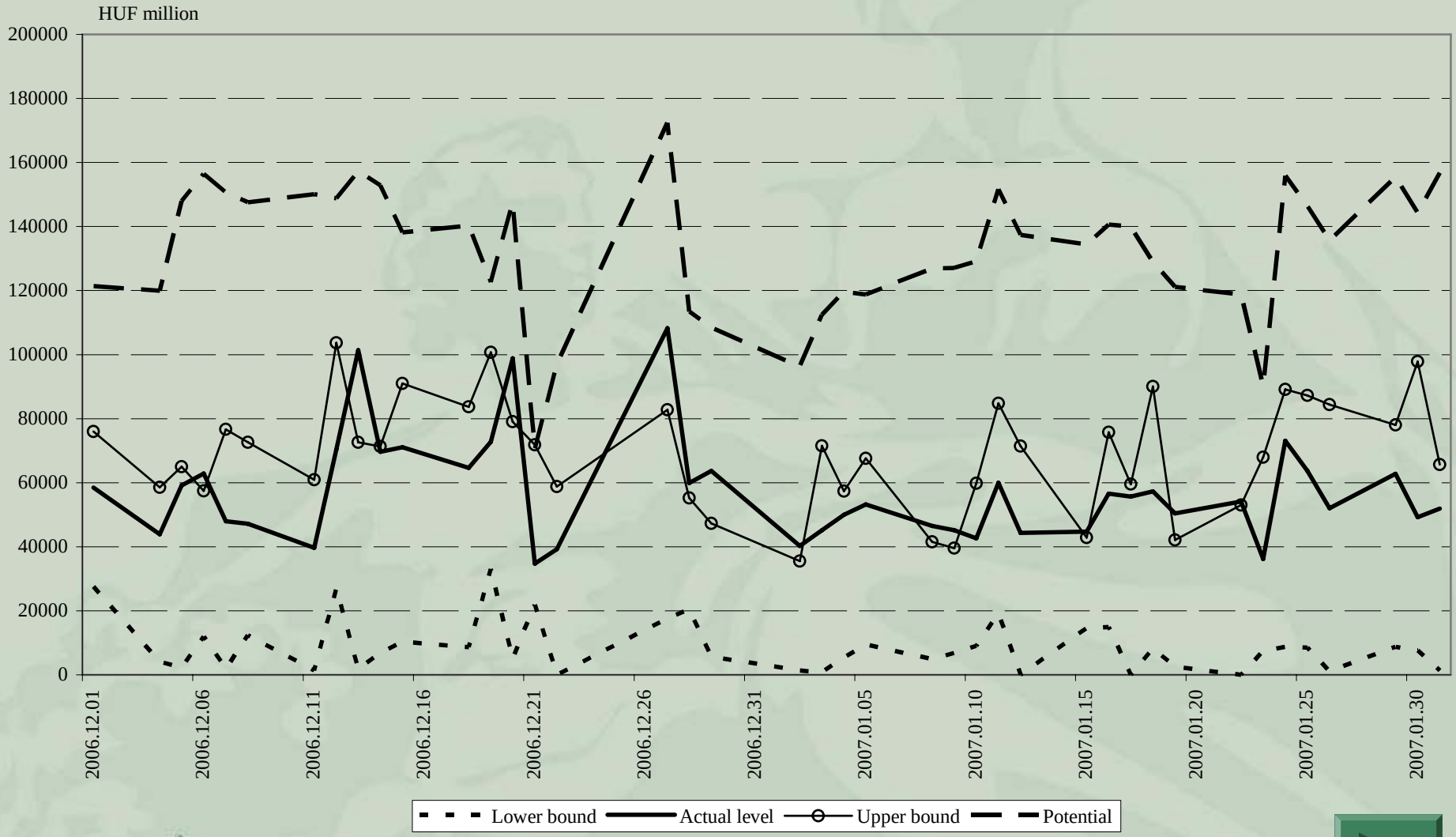
Liquidity levels: Group D



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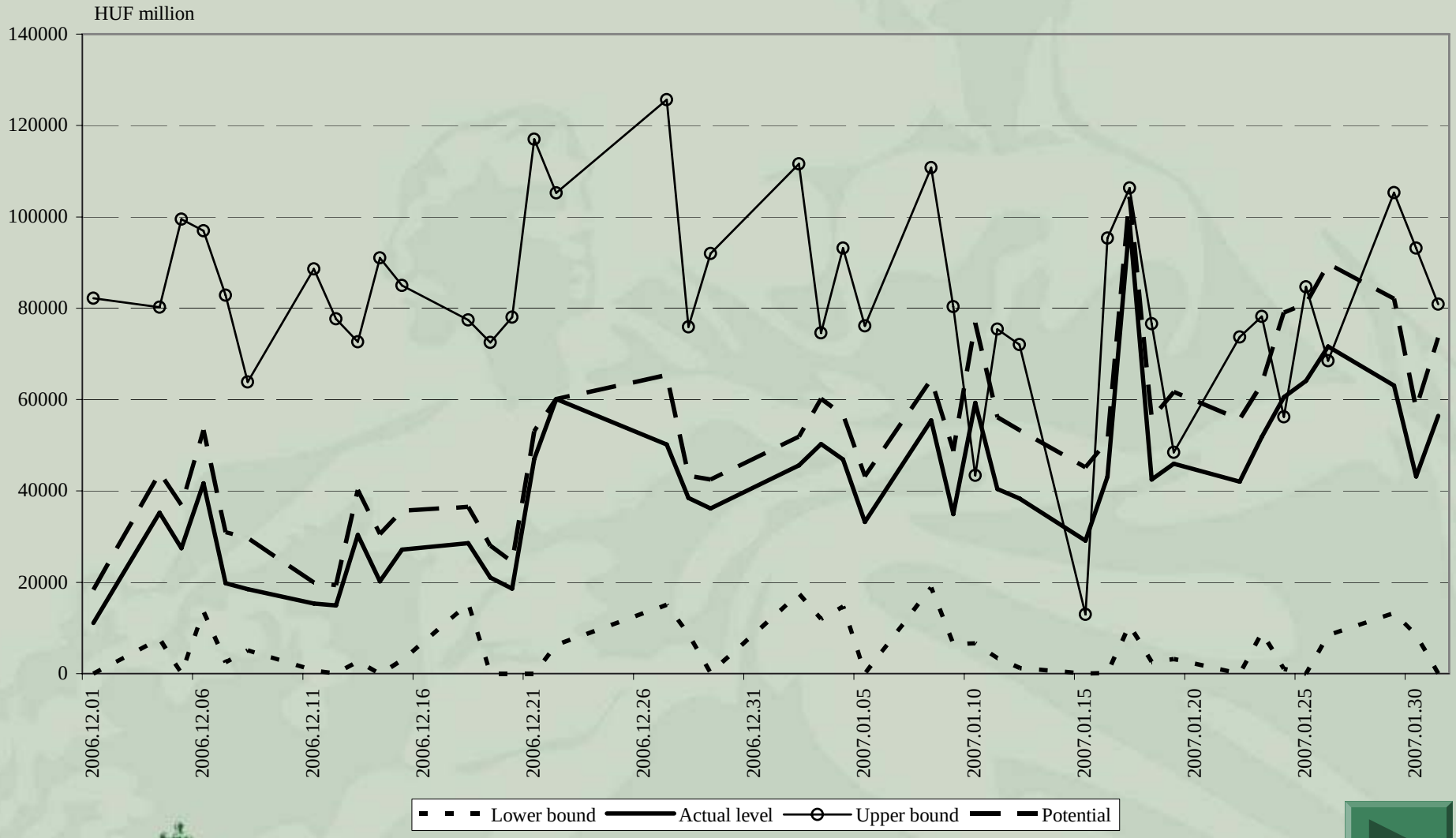
Liquidity levels: Group E



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Scenario 1: Entire day incident

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Value of payments initially not submitted (in % of the benchmark scenario)	16.30%	13.68%	10.27%	6.58%	5.84%	4.49%
Value of rejected payments (in % of submitted payments)	16.21%	13.77%	6.95%	3.09%	2.67%	0.49%
Value of unsettled payments (in % of the benchmark scenario)	30.99%	26.67%	17.18%	9.91%	8.62%	5.13%
Total value of queued transactions (in % of submitted payments)	38.37%	39.40%	34.17%	30.54%	25.41%	22.75%
Maximum queue value (in % of submitted payments)	19.42%	17.79%	13.08%	9.43%	7.64%	6.11%
Average queue length (hh:mm:ss)	01:49:41	02:07:23	01:27:39	01:07:35	00:59:17	00:43:51
Settlement delay	0.29	0.27	0.20	0.12	0.10	0.08

Disturbance in the system: Scenario 2

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Value of payments initially not submitted (in % of the benchmark scenario)	2.96%	8.16%	4.99%	3.08%	0.23%	0.10%
Value of rejected payments (in % of submitted payments)	0.08%	5.77%	2.25%	0.96%	0.00%	0.00%
Value of unsettled payments (in % of the benchmark scenario)	3.26%	14.54%	7.45%	4.40%	0.25%	0.11%
Total value of queued transactions (in % of submitted payments)	32.10%	36.66%	31.94%	29.54%	22.99%	21.64%
Maximum queue value (in % of submitted payments)	16.43%	16.49%	12.33%	9.07%	7.01%	5.84%
Average queue length (hh:mm:ss)	1:20:28	1:08:39	1:14:33	1:14:33	0:52:42	0:42:28
Settlement delay	0.24	0.18	0.18	0.11	0.09	0.08

Disturbance in the system: Scenario 3

	Bank 1	Bank 2	Bank 3	Bank 4	Bank 5	Bank 6
Value of payments initially not submitted (in % of the benchmark scenario)	29.62%	25.47%	18.36%	12.11%	10.91%	7.99%
Value of rejected payments (in % of submitted payments)	2.55%	1.99%	1.59%	0.69%	0.45%	0.24%
Value of unsettled payments (in % of the benchmark scenario)	32.54%	28.16%	20.43%	13.30%	11.77%	8.48%
Total value of queued transactions (in % of submitted payments)	19.49%	23.53%	22.78%	20.80%	17.12%	18.04%
Maximum queue value (in % of submitted payments)	7.06%	7.75%	7.46%	5.87%	4.79%	4.93%
Average queue length (hh:mm:ss)	0:51:35	1:13:18	1:17:31	0:46:01	0:47:18	0:45:23
Settlement delay	0.11	0.13	0.11	0.08	0.07	0.07

Liquidity deficits

Scenario1: GLD/Rejected	*Bank 1*	*Bank 2*	*Bank 3*	*Bank 4*	*Bank 5*	*Bank 6*
Minimum	0.00%	24.57%	12.67%	0.00%	0.00%	0.00%
Average	46.42%	52.4%	49.08%	55.19%	48.49%	36.83%
Maximum	75.89%	88.53%	99.88%	96.29%	100.00%	97.4%
Percentile (25%)	39.8%	41.83%	32.87%	39.57%	17.64%	0.00%

Scenario1: GLD/Not submitted	*Bank 1*	*Bank 2*	*Bank 3*	*Bank 4*	*Bank 5*	*Bank 6*
Minimum	0.00%	1.24%	1.08%	0.00%	0.00%	0.00%
Average	36.19%	38.86%	23.02%	15.36%	15.54%	5.32%
Maximum	67.31%	68.94%	57.58%	44.88%	44.6%	38.24%
Percentile (25%)	27.55%	30.47%	10.46%	4.3%	0.77%	0.00%

Scenario1: NLD/Benchmark turnover	*Bank 1*	*Bank 2*	*Bank 3*	*Bank 4*	*Bank 5*	*Bank 6*
Minimum	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Average	2.09%	3.64%	1.66%	0.55%	0.64%	0.14%
Maximum	5.9%	7.94%	6.25%	2.91%	2.88%	2.28%
Percentile (25%)	0.87%	1.46%	0.01%	0.00%	0.00%	0.00%

Simulation results: part-time incidents

	Scenario 4			Scenario 5			Scenario 6		
	Mimimum	Average	Maximum	Mimimum	Average	Maximum	Mimimum	Average	Maximum
Total value of queued transactions (in % of submitted payments)	2.43%	24.48%	37.92%	0.84%	28.73%	40.8%	2.96%	23.54%	37.71%
Maximum queue value (in % of submitted payments)	1.98%	11.41%	24.77%	0.44%	14.39%	31.11%	1.98%	12.22%	24.68%
Average queue length (hh:mm:ss)	0:23:48	0:52:58	1:21:04	0:46:16	1:07:56	1:59:37	0:16:52	1:01:57	1:27:19
Settlement delay	0.05	0.12	0.23	0.07	0.2	0.35	0.03	0.12	0.21