Using FMI transaction data in simulations: less is more?

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De Nederlandsche Bank

Bank of Finland PSS Seminar

Helsinki, August 2014

Outline

- Time span used in simulations
- How can we gain?
- Research question
- Used methodology
- Results
- Conclusions
- Future work

Time span in simulation (1)
Nr days used in past simulations

Author	Year	Title	Focus of analysis	Country	System	Nr. of days	Nr. of transactions (* 1,000)
Andersen, K.S. & Madsen, I.	2009	A quantitative assessment of international best practice for business continuity arrangements in payment systems	System design, Participants behaviour, Shocks	Denmark	Kronos	22	64
Arciero, L.	2010	Evaluating the impact of shocks to the supply of overnight unsecured money market funds on the TARGET2-Banca d'Italia functioning: a simulation study	Participants behaviour, Shocks, Network theory	Italy	TARGET2-IT	28	3,605
Arculus, R.; Hancock, J. & Moran, G.	2010	The impact of payment system design on tiering incentives	System design, Participants behaviour, Network theory	Australia	RITS	21	624
Arjani, N. M.	2007	Examining the tradeoff between settlement delay and intraday liquidity in Canada's LVTS: a simulation approach	System design	Canada	LVTS	64	1,050
Bech, M. & Soramäki, K.	2005	Systemic Risk in a Netting System Revisited	System design, Participants behaviour, Shocks, Network theory	United States	Fedwire	21	10,314
Bech, M. & Soramäki, K.	2005	Gridlock Resoluation and Bank Failures in Interbank Payment Systems	System design, Participants behaviour, Shocks	Denmark	KRONOS	64	59
Bedford, P.; Millard, S. & Yang, J.	2005	Analysing the Impact of Operational Incidents in Large-Value Payment Systems: A Simulation Approach	System design, Shocks	United Kingdom	CHAPS	21	2,100
Clarke, A. & Hancock, J.	2010	Participant operational disruptions: the impact of system design	System design, Participants behaviour, Shocks	Australia	RITS	10	310
Denbee, E.; Garratt, R. & Zimmerman, P.	2010	Methods for evaluating liquidity provision in real-time gross settlement payment systems	System design, Participants behaviour	United Kingdom	CHAPS	102	12,750
Glaser, M. & Haene, P.	2009	Liquidity effects of a participant-level operational disruption in the Swiss Interbank Clearing System	Participants behaviour, Shocks	Switserland	SIC	18	2,950
Heijmans, R.	2009	Simulations in the Dutch interbank payment system: A sensitivity analysis	Participants behaviour, Shocks	Netherlands	TOP	22	405
Heikqvist, M. & Koskinen, J.	2005	Stress testing securities clearing and settlement systems using simulations	System design, Participants behaviour, Shocks	Finland	RM	22	2
Heikqvist, M. & Snellman, H.	2007	Simulation of operational failures in equities settlement	Participants behaviour, Shocks	Finland	HEXClear	19	906
Imakubo, K. & McAndrews, J. J.	2007	Funding levels for the new accounts in the BOJ-NET	System design, Shocks	Japan	BOJ-NET	10	1,200
Johnson, K.; McAndrews, J.J. & Soramäki, K.	2005	Economising liquidity with deferred settlement mechanisms	System design	US	Fedwire	10	4,031
Koponen, R. & Soramäki, K.	2005	Intraday Liquidity Needs in a Modern Interbank Payment System: A Simulation Approach.	System design, Participants behaviour, Shocks	Finland	PMJ, POPS	4	2,500
Lasaosa, A. & Tudela, M.	2007	Risks and efficiency gains of a tiered structure in large-value payments: a simulation approach	System design, Participants behaviour, Network theory	United Kingdom	CHAPS	21	2,500

All publications on simulations using BoF simlator and FMI transactions data:
average period used: 22 days

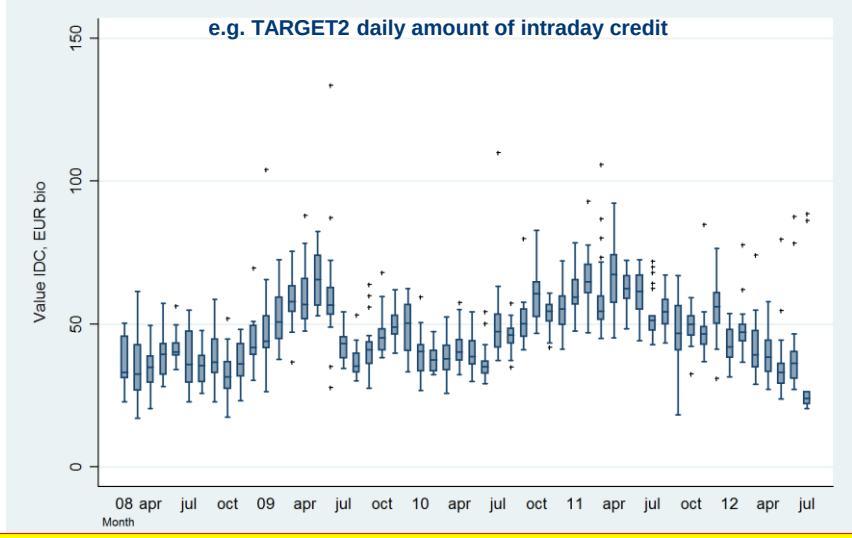
Time span in simulation (2)
Focus of research and desired time span

- System design — days
- Participants behaviour — weeks-months
- Shocks — weeks-months
- Network theory — months-years

- Future (e.g. EWI) — years

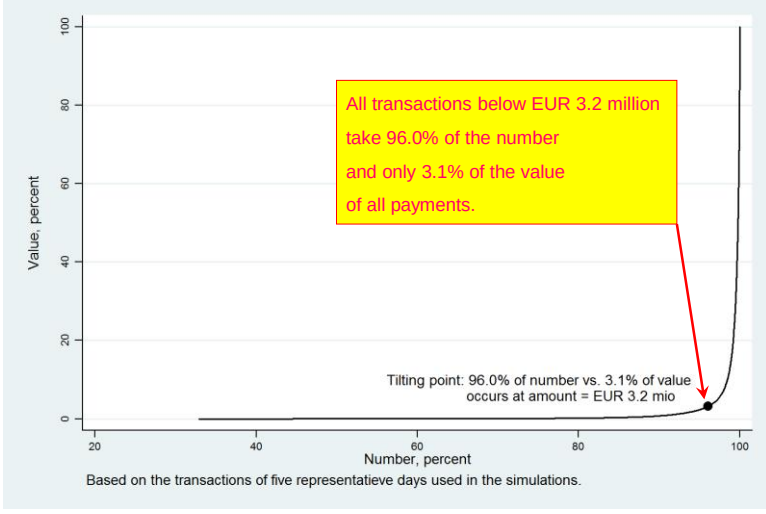
See also: Introduction chapter in BoF Seminar proceedings 2005, 2007, 2009, 2012 for mapping of research focus.

Time span in simulation (3)
Data representation / coverage



Each month presented does not cover all possible liquidity scenarios.
Therefore: the desire to increase the time span to 6 months or longer.

Can we gain ?
Typical distribution of payments by size – TARGET2NL



Is it possible to decrease the number of transactions,
by aggregating the small value payments, without disturbing the simulation outcome ?

Can we gain ?
Research question

- Can we aggregate lower value transactions

  between participants

  beneath EUR 3.6 mio

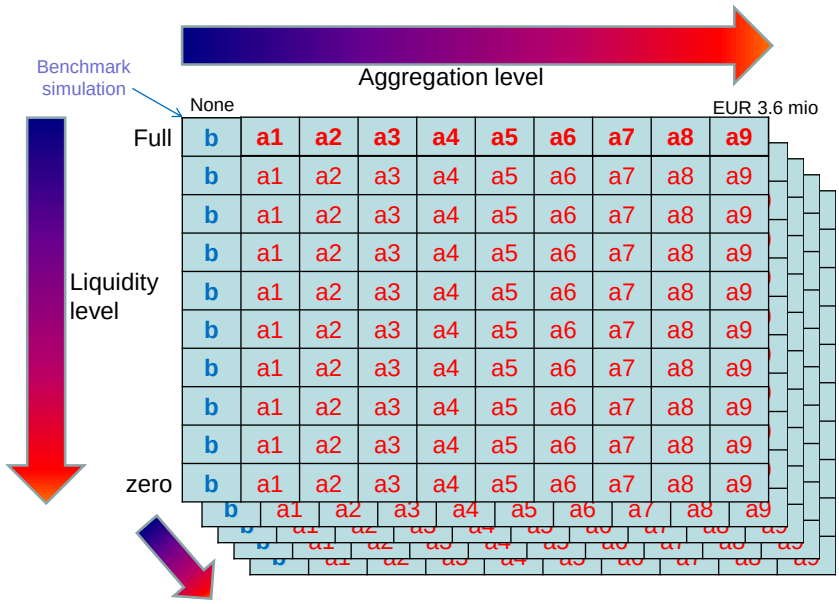
  without largely disturbing the outcome of simulations?

- What would be the gain in simulation speed?

Used methodology (1)

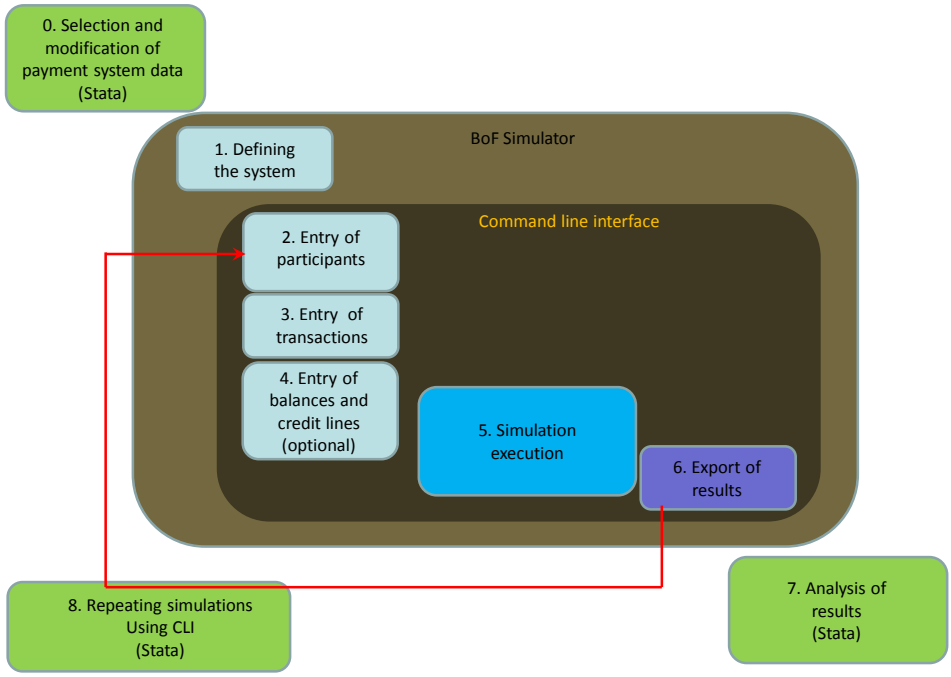
- Generate one benchmark simulation, in which all participants possess sufficient liquidity at startup
- Using the same transaction data, generate nine simulations containing aggregation at increasing level:
  - all transactions between two participants
  - within the day
  - beneath the aggregation ceiling
  - are totalized
  - assigning the value weighted timestamp
- Use 4 statistics to compare the outcome to the benchmark (%settled, lower bound, balance drop, avg. queue value)
- Repeat this for nine other levels of decreasing liquidity, up till zero therefore leading to 100 simulations
- Use five representative days w.r.t. number of transactions therefore leading to 500 simulations

Used methodology (2)



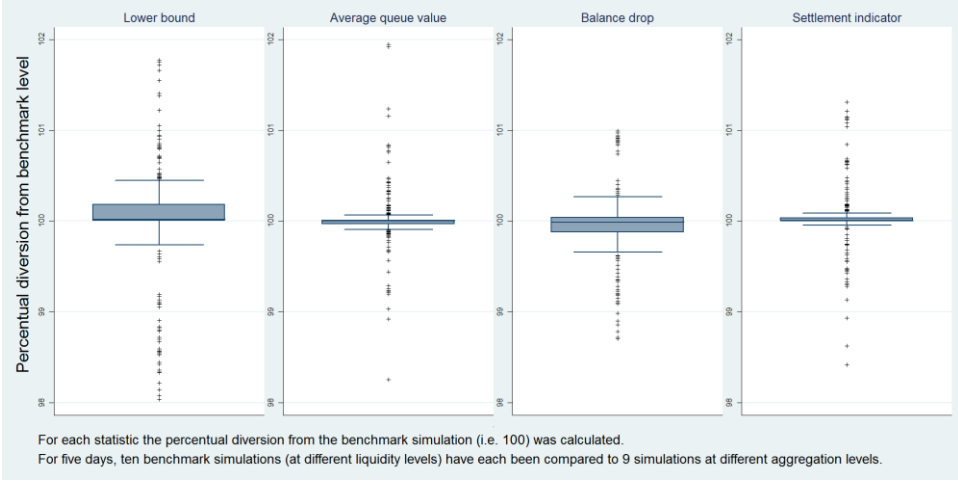
10 aggr. * 10 liq. * 5 days = 500 simulations

(How to) Actions and Simulator components when performing simulations



Results (1)

Comparison of simulations containing aggregations to the benchmark values



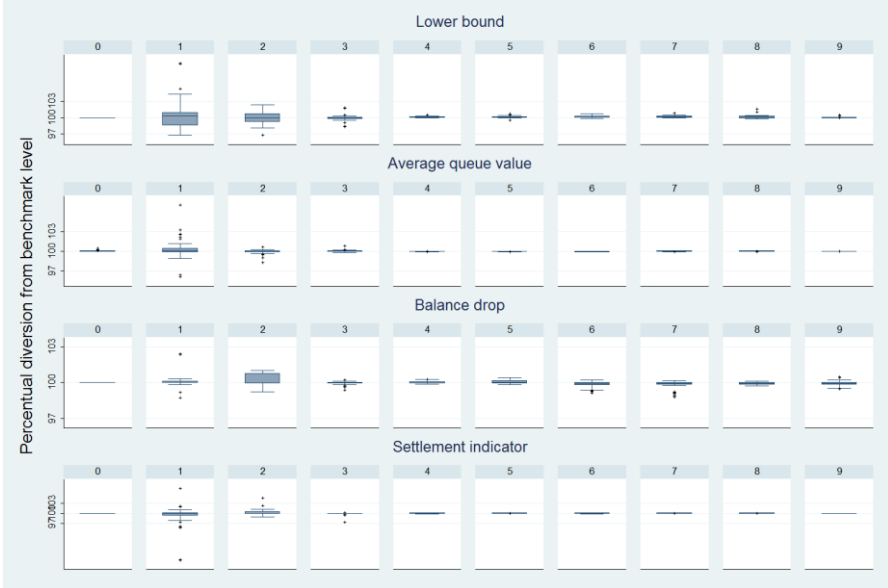
For each statistic the percentual diversion from the benchmark simulation (i.e. 100) was calculated.
For five days, ten benchmark simulations (at different liquidity levels) have each been compared to 9 simulations at different aggregation levels.

The majority of diversions from the benchmarks values lie well within 99-101 range

Note: Area between whiskers (iqr + 1.5 iqr + 1.5 iqr) stands for 99.7% of population.

Results (2)

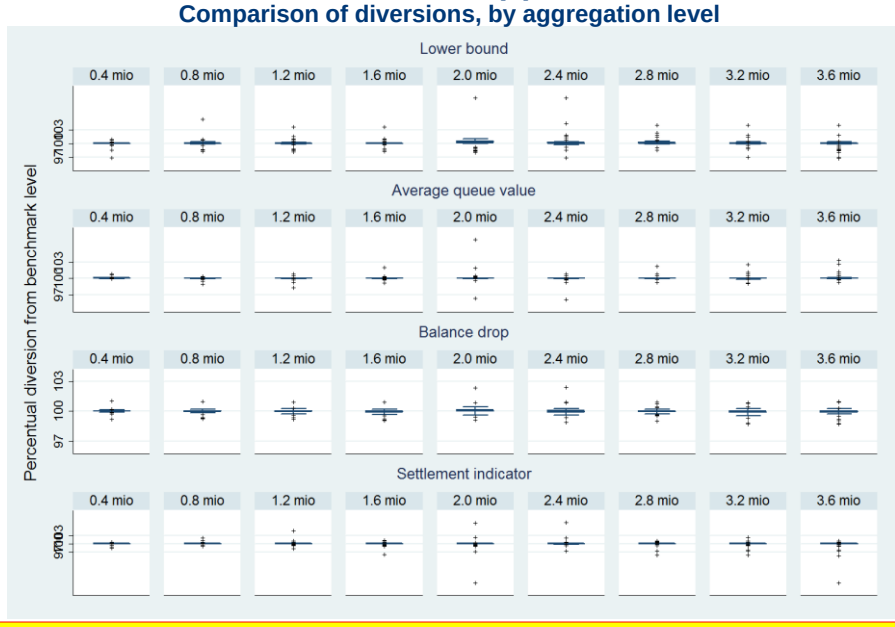
Comparison of diversions, by liquidity level



Diversions at each level lie well within 97-109 range,
with the exception of liquidity level 1 (almost no liquidity for all participants).

Results (3)

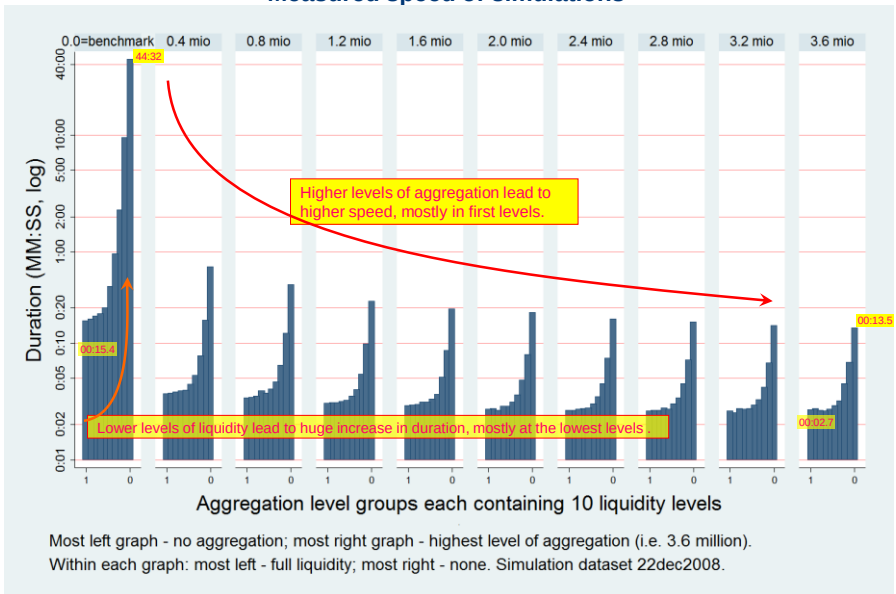
Comparison of diversions, by aggregation level



Extreme diversions seem to be independent of aggregation level (mostly at level 2.0 , 2.4 and 3.6).

Results (4)

Measured speed of simulations

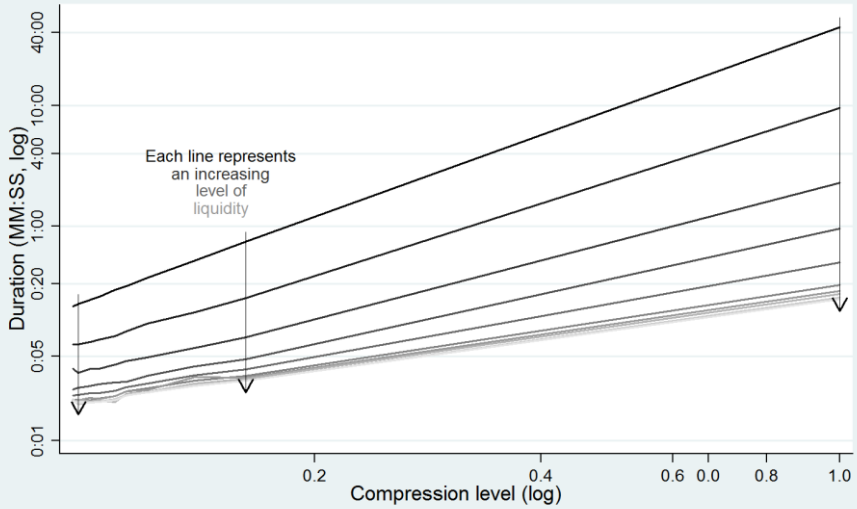


Most left graph - no aggregation; most right graph - highest level of aggregation (i.e. 3.6 million).
Within each graph: most left - full liquidity; most right - none. Simulation dataset 22dec2008.

Gain in speed through aggregation:	44:32 to 00:13.5 = 99.49%,	00:15.4 to 00:02.7 = 82.5%.
Loss of speed through liquidity drain:	00:15.4 to 44:32 = 99.42%,	00:02.7 to 00:13.5 = 80.0%.

Results (5)

How does the level of compression influence speed?

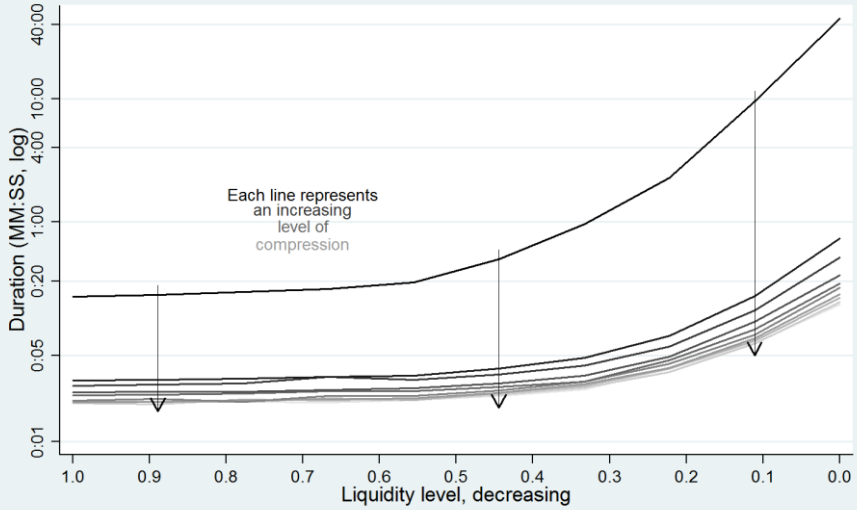


For each observed level of liquidity one line is drawn, showing the relation between compression and duration of simulation runs. Simulation dataset containing date 22dec2008.

There is a linear relation between the number of transactions and the speed of simulations.

Results (6)

How does the level of liquidity influence speed?



For each observed level of compression one line is drawn, showing the relation between liquidity and duration of simulation runs. Simulation dataset containing date 22dec2008.

There is a (stronger than) logarithmic relation between liquidity and speed of simulations.

Conclusions

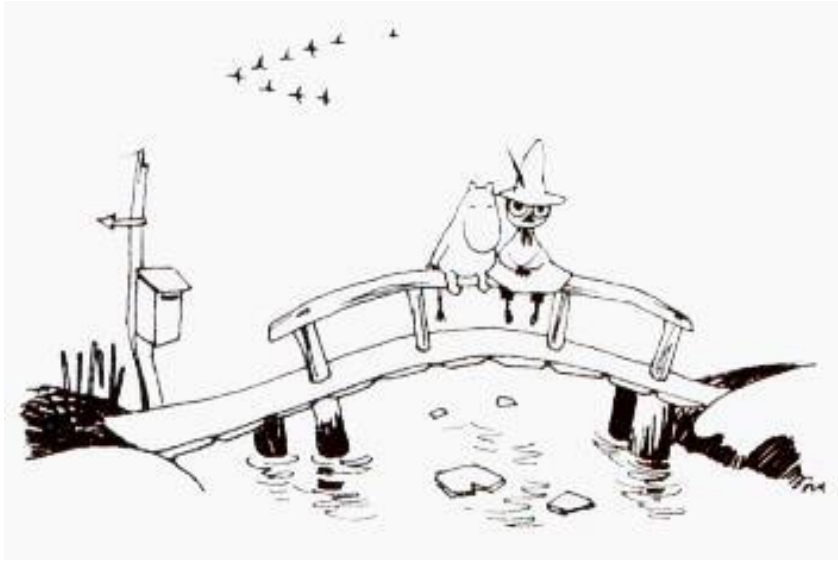
- Aggregation of transactions works well
- The realized level of data compression depends on the type of transactions data
- Strongest gain in compression is already achieved at the first levels of aggregation (i.e. lowest value)
- Extreme liquidity scenarios can cause larger diversions

- BoF Simulator Command Line Interface is essential !

Future work

- Exploring reasons for diversions
  (which accounts, events, chains)
- Exploring ideal height of aggregation ceiling
- Refining method (e.g. per hour, per participant, …)
- Document method and discuss amongst colleagues

… when there is time to spare, there is time to talk to friends



Kiitos huomiostanne
(Thanks for your attention)