Don't be stressed overseer: we have stress indicators

Work in progress

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Outline

Motivation of analysis

- FMI transaction level data (often) available or can become available.
  - At least to central banks.
- Currently, little quantitative information available for overseers/operators.
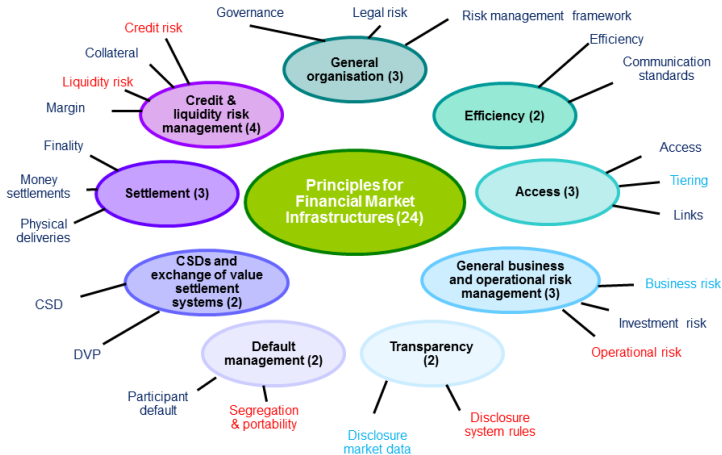- Data provides crucial information to overseers/operators.

- How to derive stress indicators from the Principle for Financial Market Infrastructures by using FMI transaction level data?

- In other words:
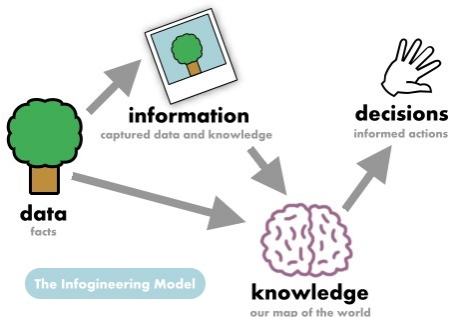
Principles for Financial Market Infrastructures (24)

Legend: completely new raising the bar basically unchanged

Principles for Financial Market Infrastructures (24)

PFMI nr	Description	relevant for quantitative oversight
1	Legal basis	-
2	Governance	-
3	Framework for the comprehensive management of risks	★
4	Credit risk	★
5	Collateral	★
6	Margin	★
7	Liquidity risk	★
8	Settlement finality	-
9	Money settlements	★
10	Physical deliveries	★
11	CSD's securities safekeeping	-
12	Settlement of two linked obligations	-
13	Participants-default rules and procedures	★
14	Segregation and portability	-
15	General business risk	★
16	Custody and investment risks	★
17	Operational risk	★
18	Access and participation requirements	-
19	Tiered participation arrangements	★
20	FMI links	★
21	Efficiency and effectiveness	-
22	Communication procedures and standards	-
23	Disclosure of rules - key procedures - and market data	-
24	Disclosure of market data by trade repositories	-

- We focus in this paper on 1) operational, 2) liquidity and 3) FMI Links.

Data

- As a proof of concept we use TARGET2 transaction level data.
- Data ranging from June 2008 until May 2016.

Basic concept

- Stress indicators should be easy to understand by a none-scientist (e.g. overseer, operator or manager)
- We propose a traffic light approach:
  - green: no stress.
  - yellow: increased stress.
  - red: high stress.

Be aware of this creature:

Is not equal to a:

What is true?

A Kiwi:

1. can run faster than Usain Bolt.
2. can fly.
3. lays the largest eggs of all birds relative to its body size.
4. has the shortest beak of all birds.
5. has good vision.

How to proceed?

- Develop time series from which indicators can be derived.
- Potentially combine several time series to make one indicator.
- Check for seasonality, other repetitive cycles and trends.
- Check with end users (e.g. an overseer) for usability.

- Watch out for the Kiwi. Confusion of tongues not unlikely!

Which quantitative measure(s) to use?

1. Legislation/supervision quantitative measure.
2. Quantitative (external) guideline.
3. Based on its own history (absolute/relative change).

The third measure can be a bit tricky (think of the Kiwi).

Service level agreement (legal)

- Provider of TARGET2 guarantees a certain nr of transactions X_{max} per day and hour.
    - A red light should e.g. be given when:

$$X_{settled} >= X_{max} \tag{1}$$

    - And a yellow light when:

$$X_{settled} >= X_{max} - thresshold \tag{2}$$
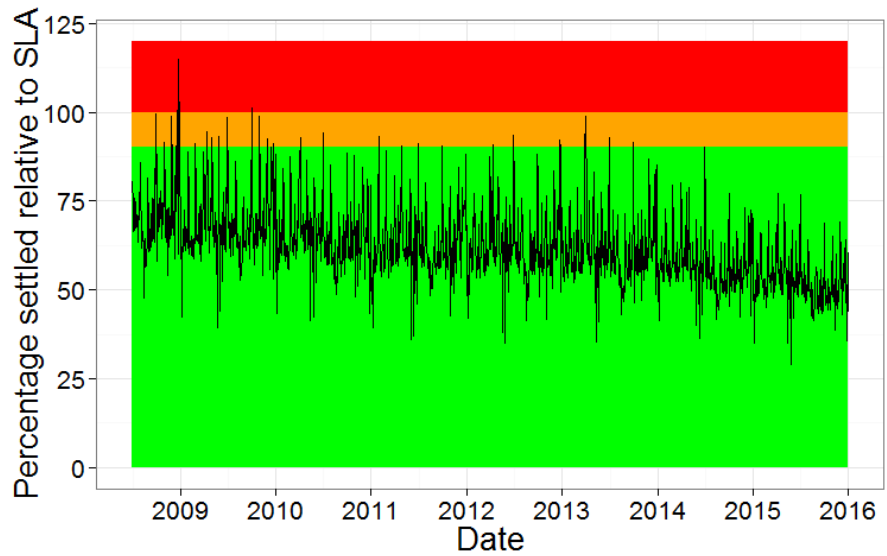
- The overseer will initially only see the traffic light for a given month (or the last couple of months):

	June 2009	December 2012	October 2015
Above 100%	3	0	0
Above 100% - σ	4	2	0
Traffic light	Red	Yellow	Green

Throughput guidelines (external guideline)

- A certain percentage of transactions (value) has to be settle before a certain time (UK LVPS CHAPS, see e.g. Ball et al. (2011)).

$$Transferred \quad value \quad before \quad 14.30 \quad hours <= 75\% \qquad (3)$$

$$Transferred \quad value \quad before \quad 12.00 \quad hours <= 50\% \qquad (4)$$
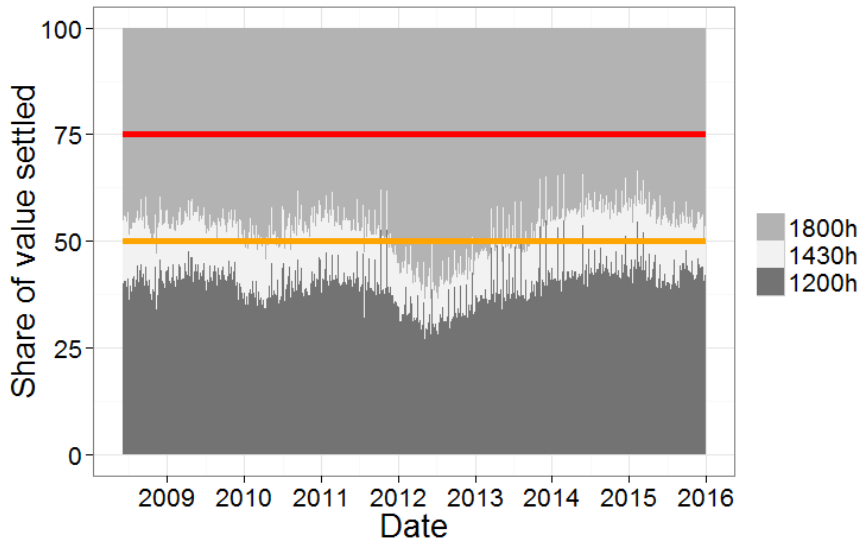
Under investigation

- Network indicators:
  - ▶ basic properties: such as degree, connectivity
  - ▶ advanced properties: such as Hub/authority centrality (see e.g. thesis Carlos Leon).
  - ▶ combined properties: combine (similar) network properties to one overall indicator.
  - ▶ for different payment types (interbank, customer, etc).
- Links to other payment systems (FMI-links or interdependencies).
- Look for cyclical patterns you may have to correct for (based on Van Ark, Heijmans and Heuver in progress).

- What else? What are your ideas?

Preliminary conclusions

- First results look very promising, but we are not there yet.
- Interpretation is a challenge when there is no clear/external bench mark for stress.
- General warning: Don't be KIWI-ed!

- Data handling and processing speed essential in development of indicators: well functioning data warehouse is a prerequisite.

Oversight Stress Indicators

Data warehouse implementation
of TARGET2 payment system data
using a dimensional model approach

Data warehouse definition

A data warehouse is a copy of transaction data specifically structured for query and analysis

(Ralph Kimball)

Different purpose...

Transaction Processing	Analysis
• One transaction at a time e.g. - storage of one settlement • Limiting history in order to keep high performance e.g. - max of 5 day online, older days in archive	• A large data-range at a time e.g. - daily number of settlements within the whole month • History is important e.g. - compare current years to pre-crisis situation in 2007

Current TARGET2 data

- Is stored as an archive

- Contains detailed data on each transaction

- Has many character key fields
  (account, payment type, date)

- Huge storage size

- Not suited for analytics

- Desire to integrate:
  - Furfine output (money market transactions)
  - BIC condolidation
  - MFI integration

Purpose of the TARGET2 data warehouse

- Researchers

  that aim to perform analysis

  spanning multiple years

  and yet desire granularity

- Some examples:
  - Stress indicators
  - Network analysis
  - Multiple year simulations using BoF Simulator

You win some - you lose some...

- Win:

  - Performance

  - Flexibility

  - Integration of other data sources

- Lose:

  - some columns (e.g. priority)

  - some granularity (e.g. quarter of the hour)

What is a dimensional approach

- First define the core facts

  - Value of payments
  - Number of payments
  - Account balance, Credit Limit

- Then define the key dimensions

  - Sending Participant, receiving Participant
  - Time, day, month
  - Payment Type

Dimensional Model - Star Schema

Sending Bank

Receiving Bank

Dimensions

Value of Payments

Facts

Time, date, month, year

Transaction Type
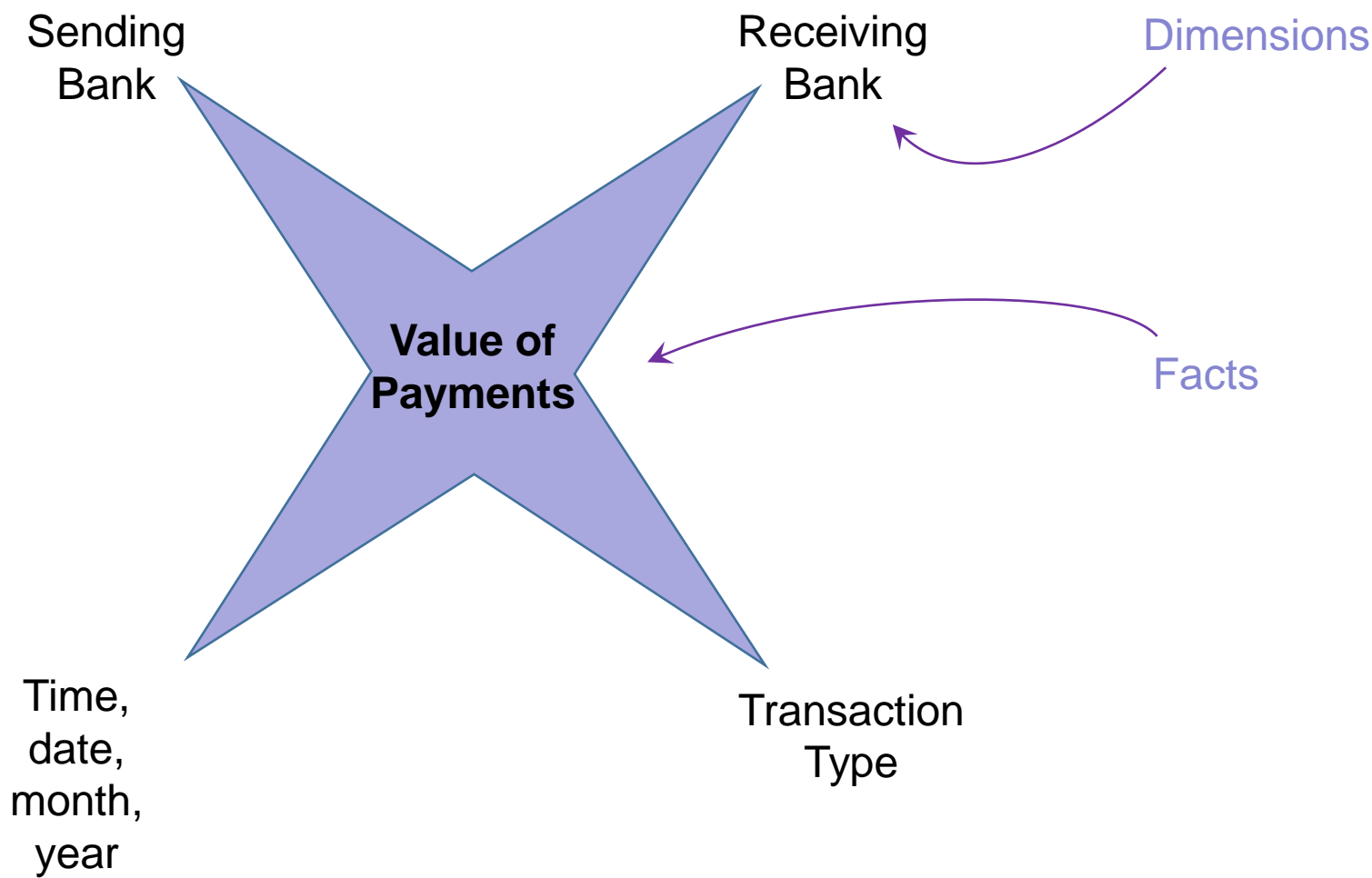
How to achieve DWH performance

- Fact tables are "lean and mean", containing

  - key facts

  - keys pointers to dimensions (integers)

- Dimension tables

  - are accessible through key pointers

  - contain character fields / details

Stylized example:
- Archive of payment transactions

Day ch 10	BIC db ch 11	BIC cr ch 11	Transaction Type ch 18	Amount nd 8
2016-01-01	ABNANL2AXXX	RABONL2UXXX	Bank payment	100.000,25
2016-01-01	INGBNL2AXXX	GILLNL2AXXX	Client payment	12.807.342,31
2016-01-01	ABNANL2UXXX	FLORNL2ACUR	CB-deposit	1.250,17
2016-01-02	KABANL2AXXX	ABNANL2UXXX	Client payment	2.187.024,37
2016-01-02	ABNANL2UXXX	INNDNL2UDDE	Settlement Equens	200.000,00
2016-01-02	RABONL2UXXX	ABNANL2UXXX	Bank payment	507,17
2016-01-02	INGBNL2AXXX	RABONL2UXXX	Bank payment	204.057.018,33

Line width is: 10+11+11+18+8 = 58 bytes.
Table is large and contains redundance.

Table contains many character columns
 --> not suited for a computer.

Stylized example - Data Warehouse implementation

Fact table

Day ni 4	Bank db ni 2	Bank cr ni 2	Ttype.nr ni 1	Amount ni 6
20160101	1	2	1	100.000
20160101	7	3	2	12.807.342
20160101	1	5	3	1.250
20160102	4	1	2	2.187.024
20160102	1	6	4	200.000
20160102	2	1	1	507
20160102	7	2	1	204.057.018

Dimension table "Bank"

Banknr ni 2	Bank name ch 11
1	ABNANL2AXXX
2	RABONL2UXXX
3	GILLNL2AXXX
4	KABANL2AXXX
5	FLORNL2ACUR
6	INNDNL2UDDE
7	INGBNL2AXXX

Dimension table "Transaction Type"

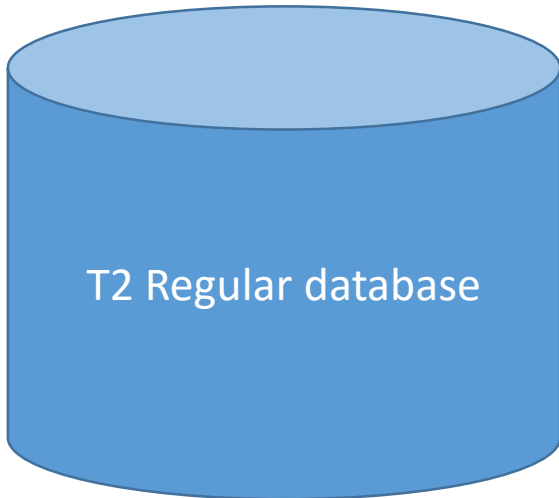| Ttype.nr ni 1	Transactie Type ch 18
1	Bankbetaling
2	Clientbetaling
3	CB-deposito
4	Verevening Equens

Line Width is: 4+2+2+1+6 = 15 bytes.
This is a 75% decrease.

Fact table contains numbers only.
--> much better suited for a computer.

First implementation in TARGET2

Time ==Dimension==

qoh	date_pk	month

Transaction type ==Dimension==

tran_type_sk	tran_class	tran_type

Money Market Transactions

date_pk	time	part_db	part_cr	tran_type_sk	value	maturity	rate	value_iqt_pk

Trans aggr day

date_pk	qoh_pk	[bank_db]	[bank_cr]	tran_type_sk	tran_nr	nr_iqt_pk	tran_value	value_iqt_pk

Acct Bal

date_pk	[bank_db]	[bank_cr]	tran_type_sk	tran_nr	nr_idt_pk	tran_value	value_idt_pk

date_pk	[bank]	sod_bal	sod_iccl	==Fact tables==

Bank aggregation

==Dimension==

MFI head

mfi_head_sk	mfi_head_code	...	...	...

MFI

mfi_sk	mfi_c

BIC consolidated

part_head_sk	bic

Participant

part_sk	part_bic

Account

acct_sk	acct_id

First impression on performance

T2 Regular database — DWH — **Improvement**

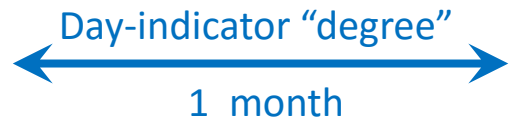|		
715 Mio	Nr of records → 90 Mio	8 x
220 Gb	database size → 9 Gb opslag	25 x
16.5 sec	Query 1 day → 1.7 sec	10 x
Not possible	Day-indicator "degree" 1 month → 60 sec	∞ x

Future work

- Indexes

- Final tests

- Documentation

  - Paper

  - Technical documentation

  - User manual