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Size, time and delay: melting payment system indicators in a single index

The opinions expressed are those of author and do not commit the Bank of Italy

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Introduction

Over the last years a large set of payment indicators has been developed both to evaluate the system overall and participants performances

Quite surprisingly, none has dealt with the issue of building a synthetic index able to summarize the available payment system indicators in a single index.

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The Methodology (1)

The methodology is illustrated in the OECD Handbook on Constructing Composite Indicators (OECD, 2008)

The approach involves three steps

(i) normalization of variables;

(ii) computation of the variable weights by means of a factorial analysis;

(iii) aggregation of variables into sub-indices and final index.

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The Methodology (2)

The actual variables are normalized between 0 and 1, using the min-max procedure to ease aggregation over variables expressed in different measurement units:

$$Ind_x = \frac{x - x_{min}}{x_{max} - x_{min}}$$

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The Methodology (3)

Computation of the variable weights by means of a factorial analysis

The summary indices are then obtained by means of factor analysis, in which each initial indicator is weighted according to its contribution to the overall variance in the data.

Two steps:

- Latent factor extraction through a Principal Component Analysis (PCA).

- Rotation of latent factors.

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Elementary indicators

a) The total value of payments sent within TARGET2-Banca d'Italia (**pay**);

a) the available liquidity at the central bank (**liqui**);

a) The total value of time-specific obligations (**anci**);

a) the daily maximum intraday liquidity (**lcno**);

a) Average time of settlement (**settime**);

a) Settlement delay indicator (**settdelay**);

Data comes from TARGET2-BdI participants from 2010-01 to 2015-06

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Choosing the factors

The number of factors to be retained are usually chosen including those explaining a significant share of the variance which corresponds to the eigenvalue of the correlation matrix (here 3 factors)

Eigenvalues of the Correlation Matrix	Eigenvalue	Difference	Proportion
1	3.01	1.94	0.50
2	1.07	0.12	0.18
3	0.95	0.43	0.16
4	0.52	0.19	0.09
5	0.33	0.22	0.06
6	0.12		0.02

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Associating variables to factors

Then, we associate each variable to the factors according the significance of each factor loading (i.e. the variance of each variable explained by each factor)

Factor Pattern	Factor1	Factor2	Factor3
setdelay	3	68	74
settime	2	77	-62
anci	85	6	-9
pay	94	4	-4
liqui	85	7	-1
lcno	82	-9	12
Values are multiplied by 100 and rounded to the nearest integer. Values greater than 0.35 are flagged in red			

Here: Factor 1 has high positive loading factors with pay (0.94), anci (0.85) and liqui (0.85) and lcno (0.82); Factor 2 and 3 are both associated with setdelay and settime.

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Rotating factors

The rotation performed to maximize the loadings of individual indicators on individual factors so to have factors 2 and 3 turn dominated by settime and setdelay, respectively

Rotated Factor Pattern (Varimax procedure)	Factor1	Factor2	Factor3
setdelay	1	3	100
settime	1	99	3
anci	85	12	-1
pay	94	7	2
liqui	85	4	2
lcno	82	-13	5

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Computing the sub indices

The original variables pay, anci, liqui, settime, lcno, setdelay are grouped into the three sub-indices using the square of factor loadings - which represent the proportion of the total unit variance – from the matrix of factor loadings after rotation as

```
size=anci*(.85)**2+pay*(.94)**2+liqui*(.85)**2+lcno*(82)**2;
time=settime*(.99)**2;
delay=setdelay;
```

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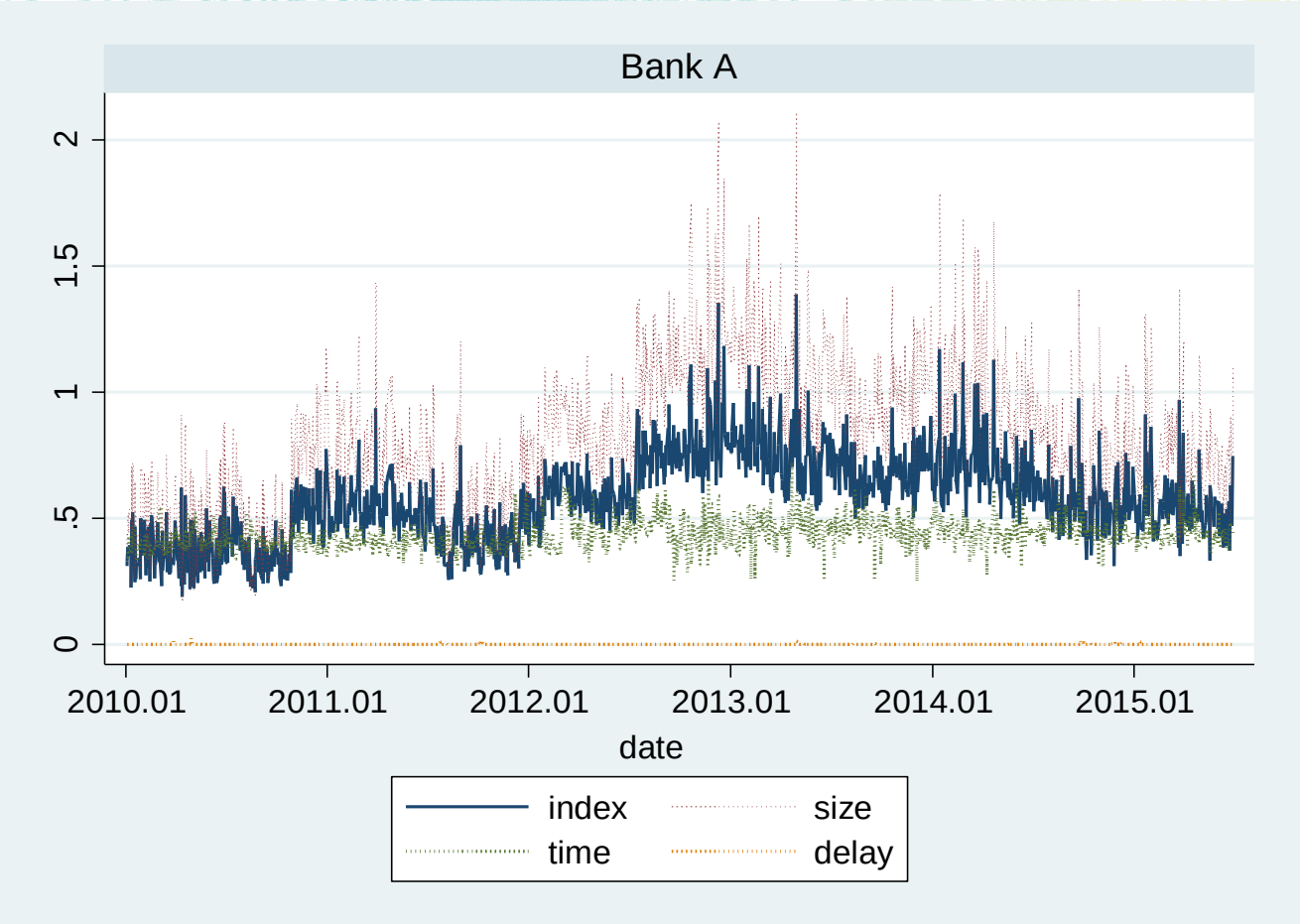
Computing the final index

The final step involves the aggregation of the four sub-indices in the final index weighting each one of them according to the proportion of the explained variance in the data set.

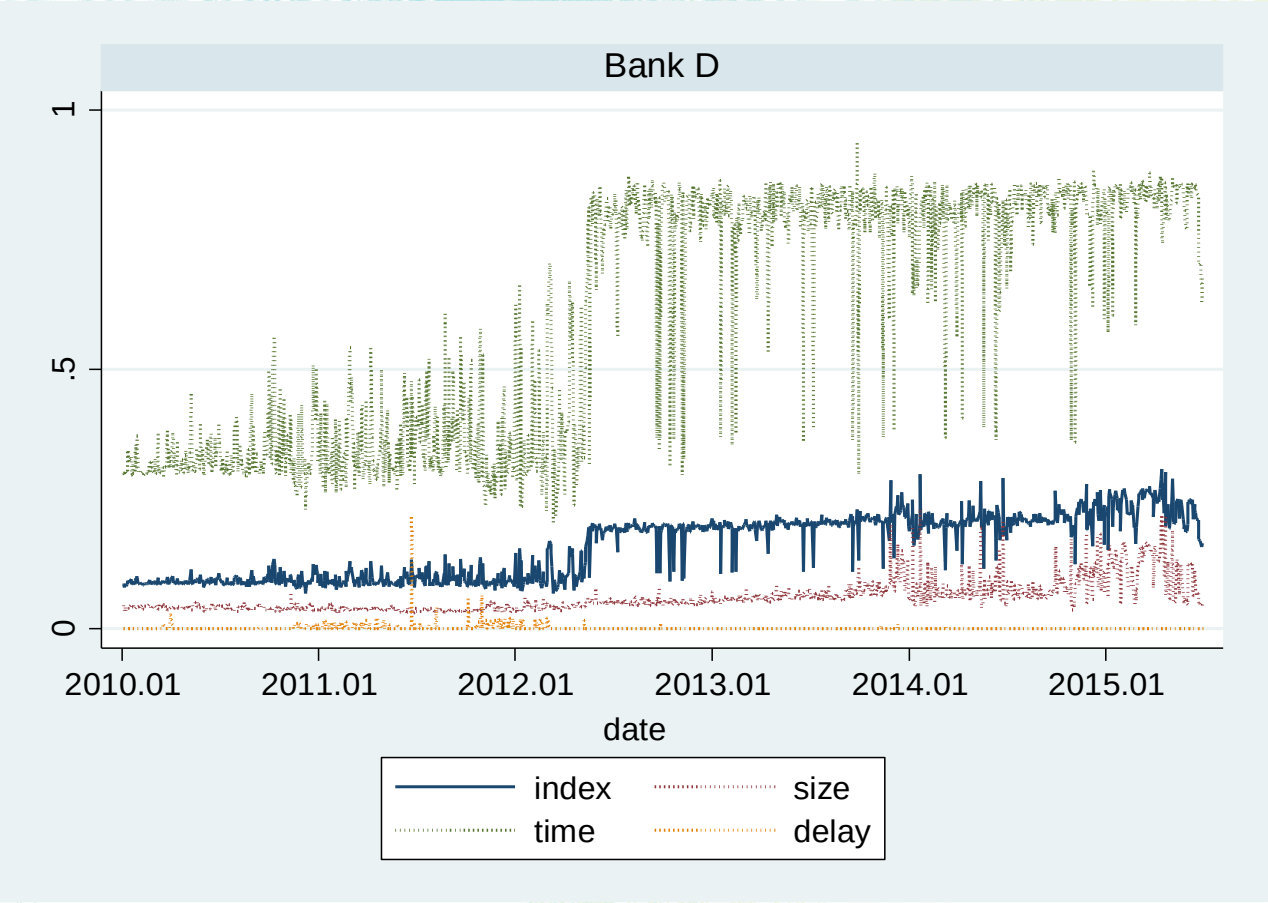
Index=0.598*size+0.203*time+0.199*delay.

The final index over the period

A few cases: a big bank



A few cases: a small bank



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Next steps

- Augmenting the number and types of variables (e.g. adding network and/or money market indicators)
- Mapping significant events on the index
- Exploring dynamic PCA methodologies