

Stable, Changing or Fragile?

Assessing the stability of Payment Profiles

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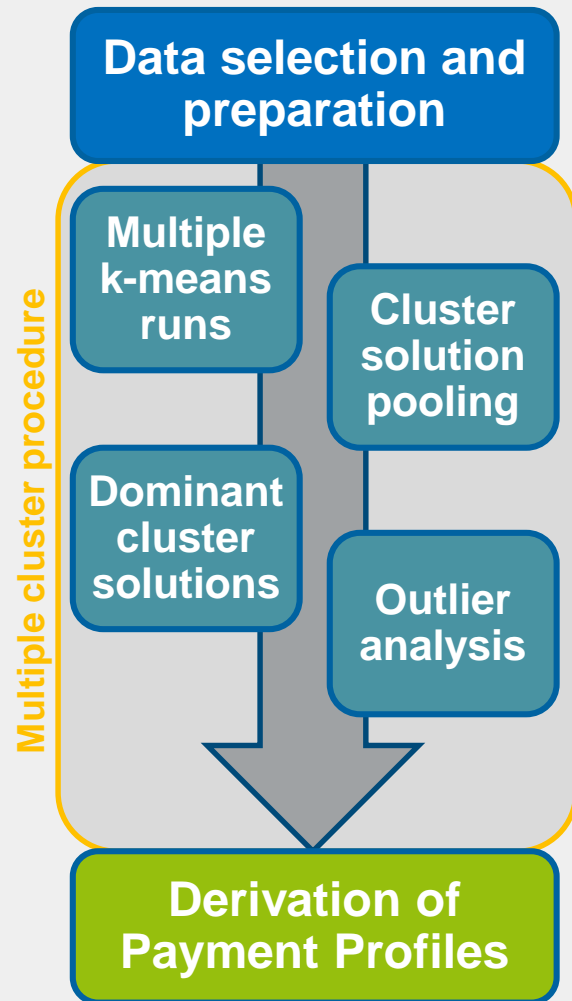
Stable, Changing or Fragile? - Assessing the stability of Payment Profiles

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The authors of this paper are member/alternate of one of the user groups with access to TARGET2 data in accordance with Article 1(2) of Decision ECB/2010/9 of 29 July 2010 on access to and use of certain TARGET2 data. The Bundesbank, the MIB and the MIPC have checked the paper against the rules for guaranteeing the confidentiality of transaction-level data imposed by the PSSC pursuant to Article 1(4) of the above mentioned issue. The views expressed in the paper are solely those of the authors and do not necessarily represent the views of the Eurosystem.

Introduction

Recall profiling of banks (1) - Overview



Results

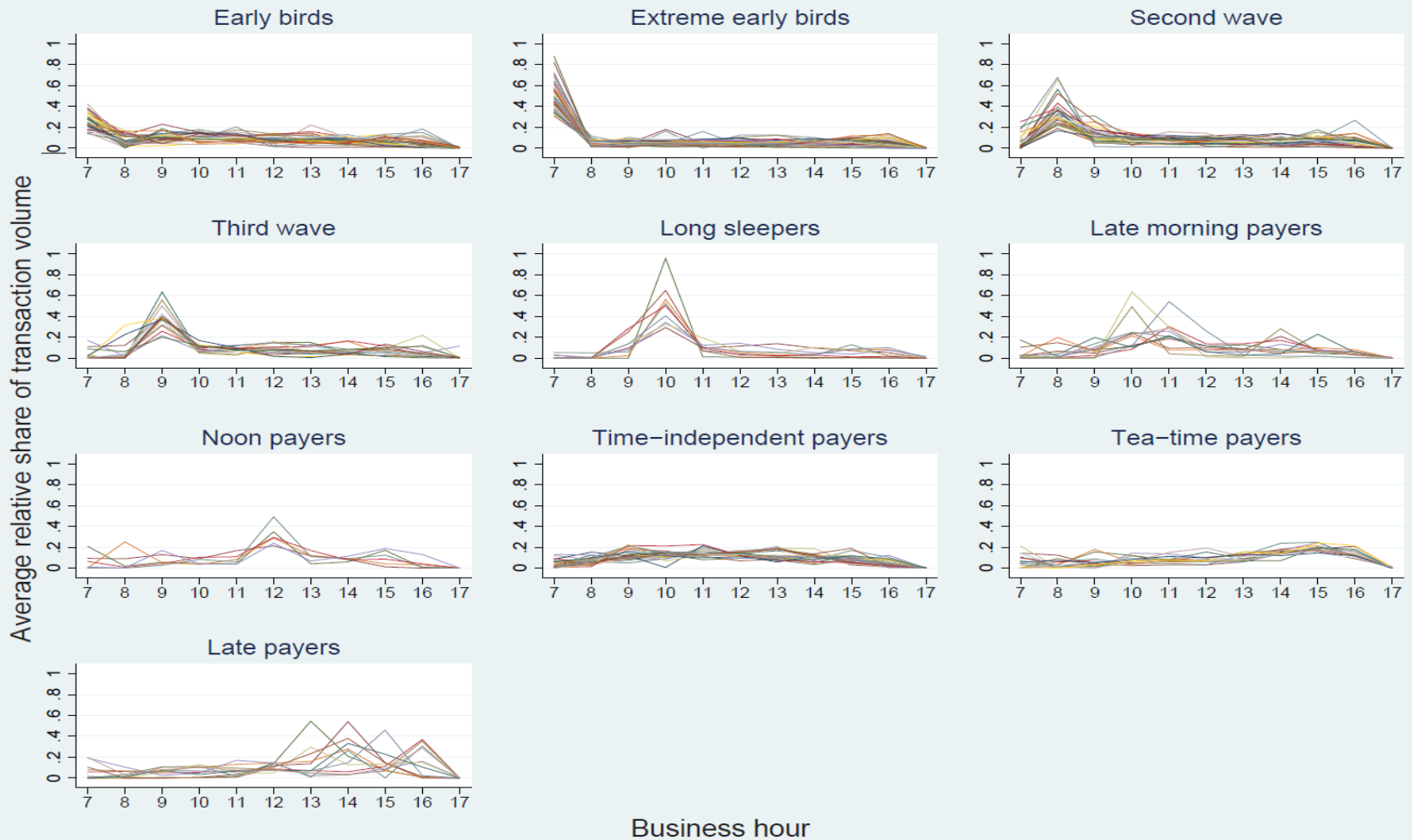
- Develop a cluster procedure for payments data
 - Independent from seed setting
 - Combine different similarity measures
- Identify different meaningful Payment Profiles

Open Issues

- Analyse the effects of different data sets on the multiple clustering procedure and Payment Profiles
- Investigate the stability of Payment Profiles
- Use Payment Profiles for further analysis

Introduction

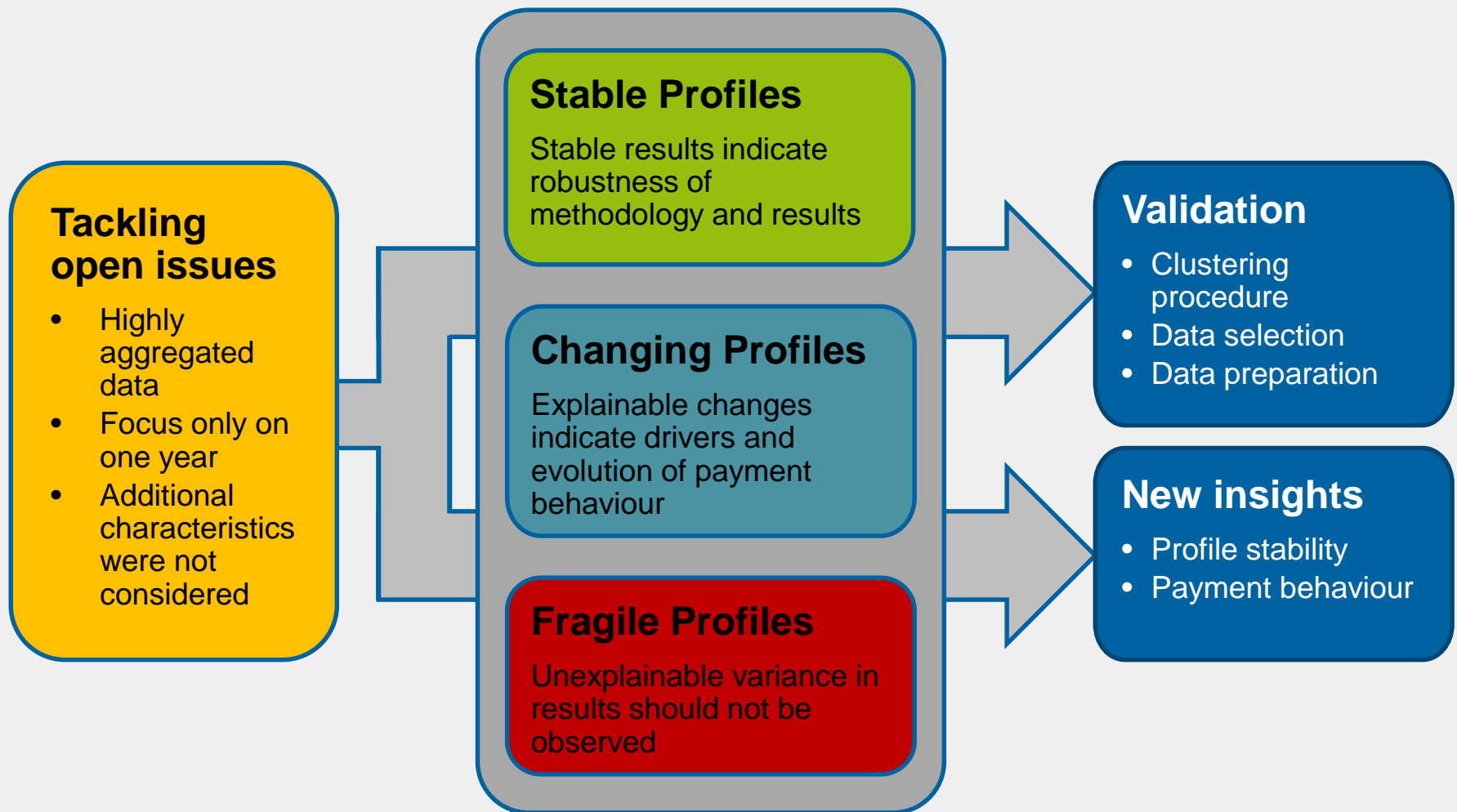
Recall profiling of banks (2) – Clustering results



Introduction

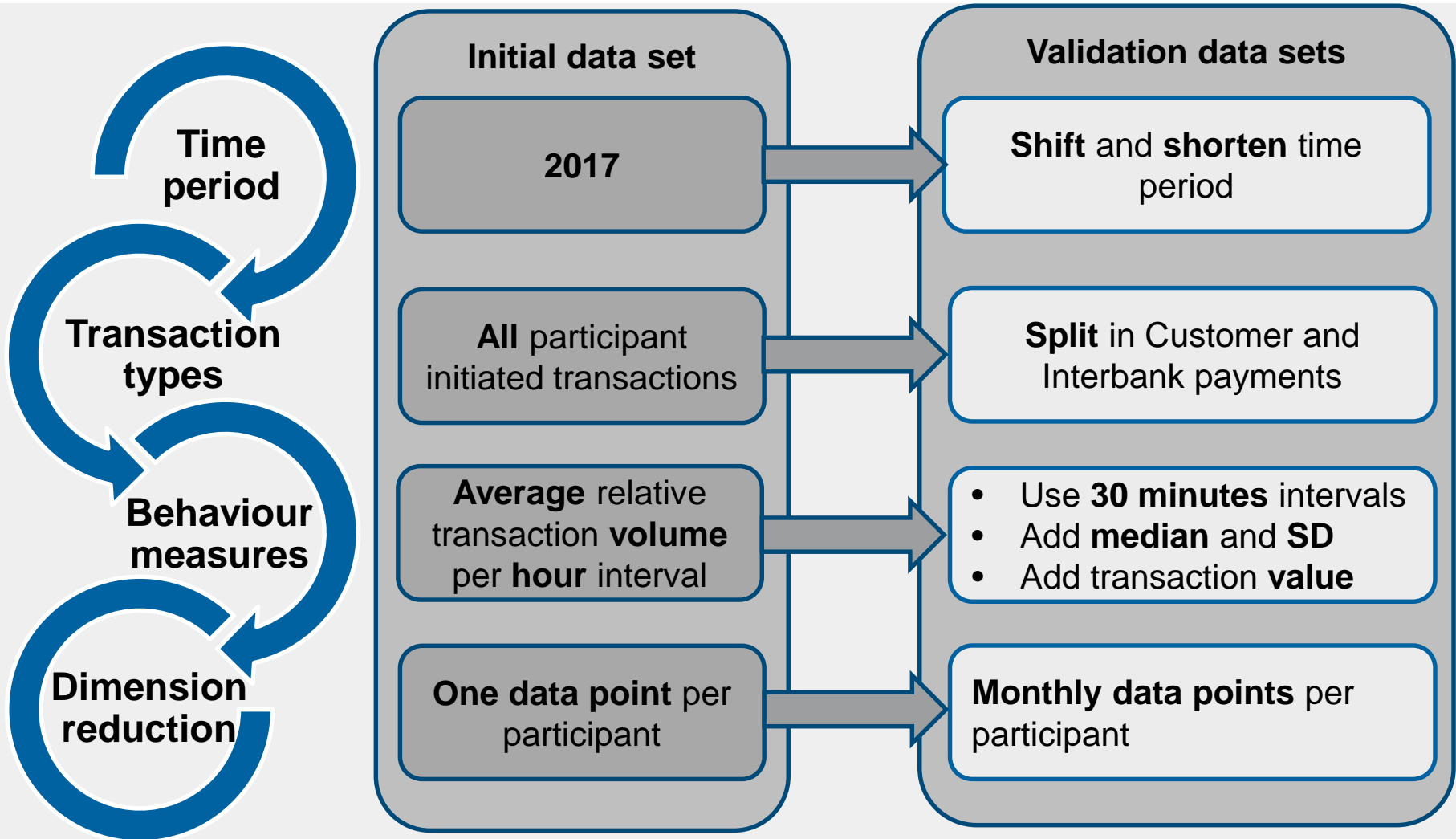
Recall profiling of banks (3) – Payment Profiles

Payment Profiles	Main characteristics
Early Birds	Between 20% and 40% of the daily transactions are introduced in the first business hour . In addition, this is the maximum for the day .
Extreme Early Birds	The maximum of the day and more than 40% of the daily transactions are introduced in the first business hour .
Second Wave	More than 20% of the daily transactions are introduced between 8:00h and 9:00h . This is also the maximum for the day .
Third Wave	More than 20% of the daily transactions are introduced in the third business hour and, in addition, this is also the maximum for the day .
Long Sleepers	The maximum for the day and more than 20% of the daily transactions are introduced between 10:00h and 11:00h .
Late morning Payers	More than 20% of the daily transactions are introduced in the fifth business hour . In addition, this is also the maximum for the day .
Noon Payers	More than 20% of the daily transactions are introduced between 12:00h and 13:00h and, in addition, this is also the maximum for the day .
Time-independent Payers	The participants with these profiles distributed their payment activity evenly over the day with fewer transactions in the morning or evening. No one-hour interval exceeds 20% of the transaction share.
Tea-time payers	The transaction volume share increases over the day and reaches a maximum between 15:00h and 17:00h . In addition, the transaction volume share remains usually below 20% over the day.
Late Payers	The maximum and more than 20% of the daily transactions are introduced in the afternoon between 13:00h and 17:00h .



Stability Testing

Scenario overview



Stability Testing

Scenario: Varying time periods

Legend

✓ = High chance for deviation of Profile

— = Deviation of Profile is not clear

✗ = Low chance for deviation of Profile

**Assessment of
profile deviation**

① = Cluster solution shows well separated behaviours

① = Cluster solution includes diverse behaviours

**Assessment of initial
clustering quality**

⊙ = Good match with initial cluster solution (extreme Values)

⊙ = Poor match with initial cluster solution

⊙ = Clear assignment to one profile is not possible

⊙ = Well separated outlier cluster that establish a profile

**Assessment of outlier
clustering quality**

Stability Testing

Scenario: Varying time periods

Payment Profile	2011		2017		2018		2017/2018	
Early Birds	—	①	✓	①	✓	① ②	✓	① ②
Extreme Early Birds	—	②	✓	① ②	✓	①	✓	①
Second Wave	✓	①	✓	① ②	✓	① ②	✓	① ②
Third Wave	✓	①	✓	① ②	✓	① ② ③	✓	① ②
Long Sleepers	✓	①	✓	① ②	✓	① ②	✓	① ②
Late morning Payers	✓	④	✓	③	✓	②	✓	④
Noon Payers	✓	① ③	—	③	✓	②	—	① ③
Time-independent Payers	✓	①	✓	①	✓	①	✓	①
Tea-time payers	—	① ③	✓	①	✗	①	✗	① ①
Late Payers	✓	① ① ② ② ②	—	④ ④ ③ ②	✓	② ② ② ② ②	✓	① ① ② ② ② ③

Stability Testing

Scenario: Varying time periods

Payment Profile		Jan 2017		Jun 2017		Nov 2017
Early Birds	—	1	—	1	✓	1
Extreme Early Birds	—		—		✓	1
Second Wave	✓	1	✓	1	✓	1
Third Wave	✓	1	✓	1	✓	1
Long Sleepers	✓	1	✓	1	✓	1
Late morning Payers	✓	1	✓		✓	
Noon Payers	✓		✓		✓	
Time-independent Payers	✓	1	✓	1	✓	1
Tea-time payers	✗		✗		✗	
Late Payers	✓	1	—		✓	1

Stability Testing

Scenario: Varying time periods - Conclusion

Initial cluster solutions are relatively stable

Monthly data does not lead to the identification of new profiles

Differentiation of tea-time payers is not unconditionally possible

Late Payers combines several clusters (often single participants)

Real outliers exist

(All) Payment Profiles could be derived in each scenario

Outlier clusters are not as stable as initial cluster solutions

Outlier clustering leads to valuable solutions for profiling

Peaks allow for clear differentiation

Payment behaviour of some participants changes over time

Differentiation of Early and Extreme Early birds is not clear for every time period

Stability Testing

Scenario: Transaction types

Split in Customer and Interbank payments

Main findings

Customer payment profiles

Profiles for customer payments are very similar to overall profiles (expected)

Interbank payment profiles

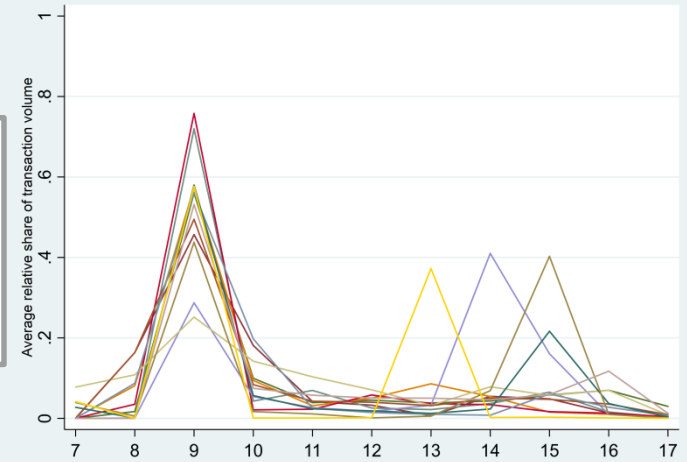
- Less marked-off peaks
- Twin peaks and consecutive peaks

Conclusion

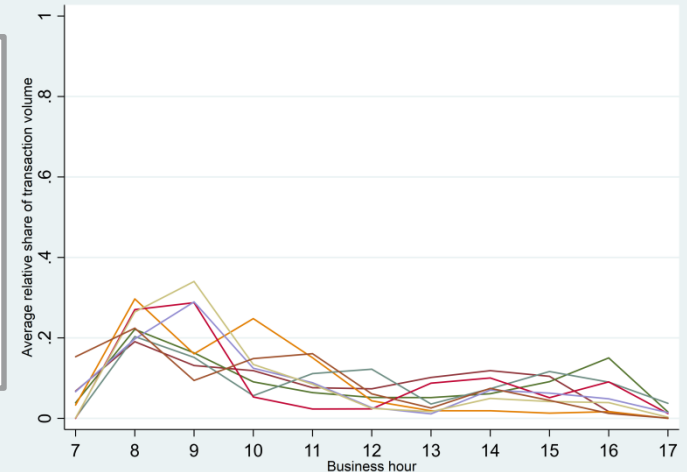
- Independent derivation of interbank payment profiles would be challenging
- However, interbank payment cluster results can fit into overall profiles

Interbank Payments

Twin Peaks



Consecutive Peaks



Stability Testing

Scenario: 30 minutes interval

Use **30 minutes**
intervals

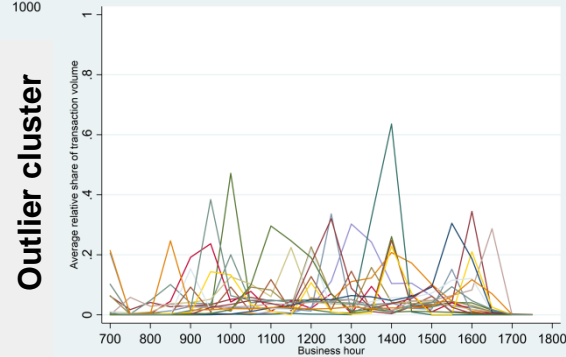
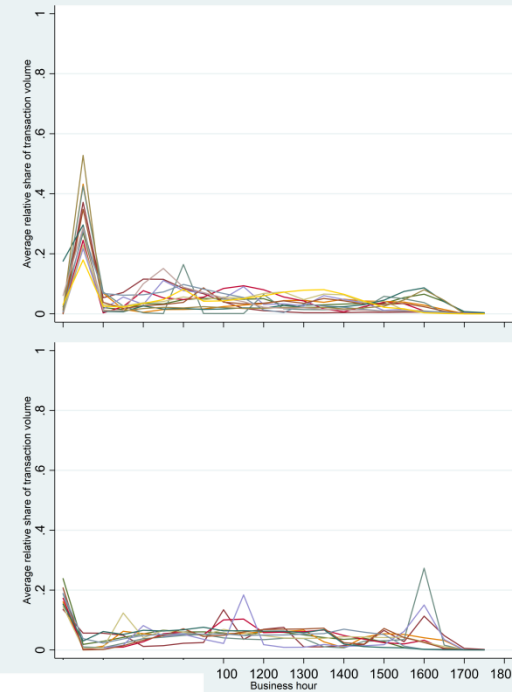
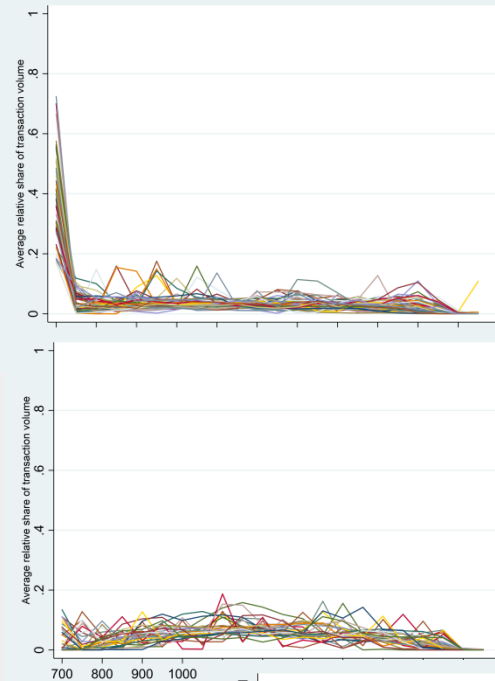
Main findings

- Main profiles were clustered but in some cases separated into two or more clusters
- Differences in the area below a transaction volume share of 20 % are more often used for separation of cluster
- Exceeding 20 % transaction volume share leads to grouping of (new) *outlier* clusters

Conclusion

- Smaller intervals make the clustering of similar participants' payment behaviour and the derivation of profiles more difficult
- Using smaller intervals does not lead to new profiles

Separation of Early-
Independent Payers
Birds



Stability Testing

Scenario: Extension of statistical measures

Add median
and SD

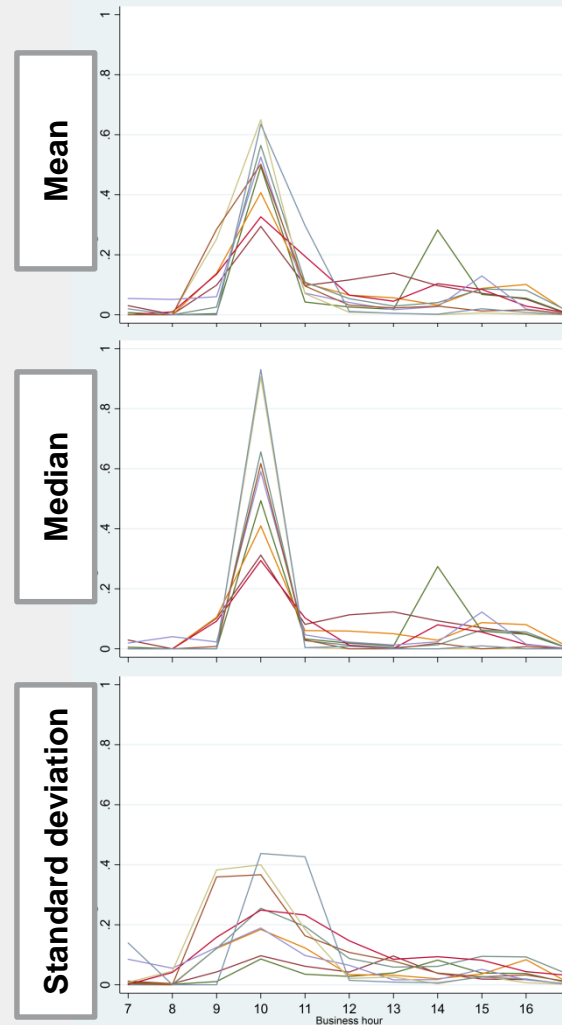
Main findings

- Main profiles were clustered
- No split of initial profiles into „high SD“ and „low SD“ versions
- Peaks similar for all measures, except early payers having low SD
- New „late payer with high SD“ profile

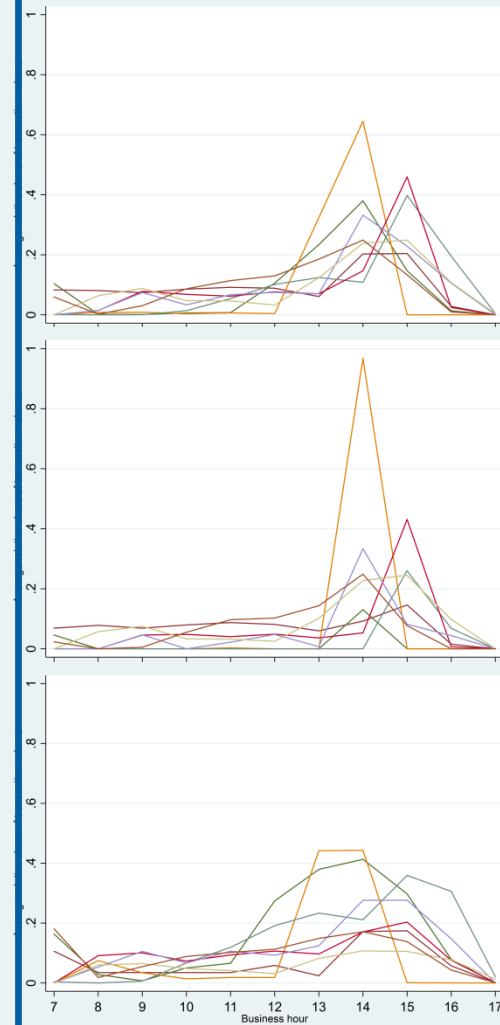
Conclusion

- Fragility hypothesis can be rejected
- Better understanding of peaks
- Additional measures can provide insights, if calculated, but are not necessarily needed in cluster procedure

Long Sleepers



Late Payers



Stability Testing

Scenario: Transaction value and volume

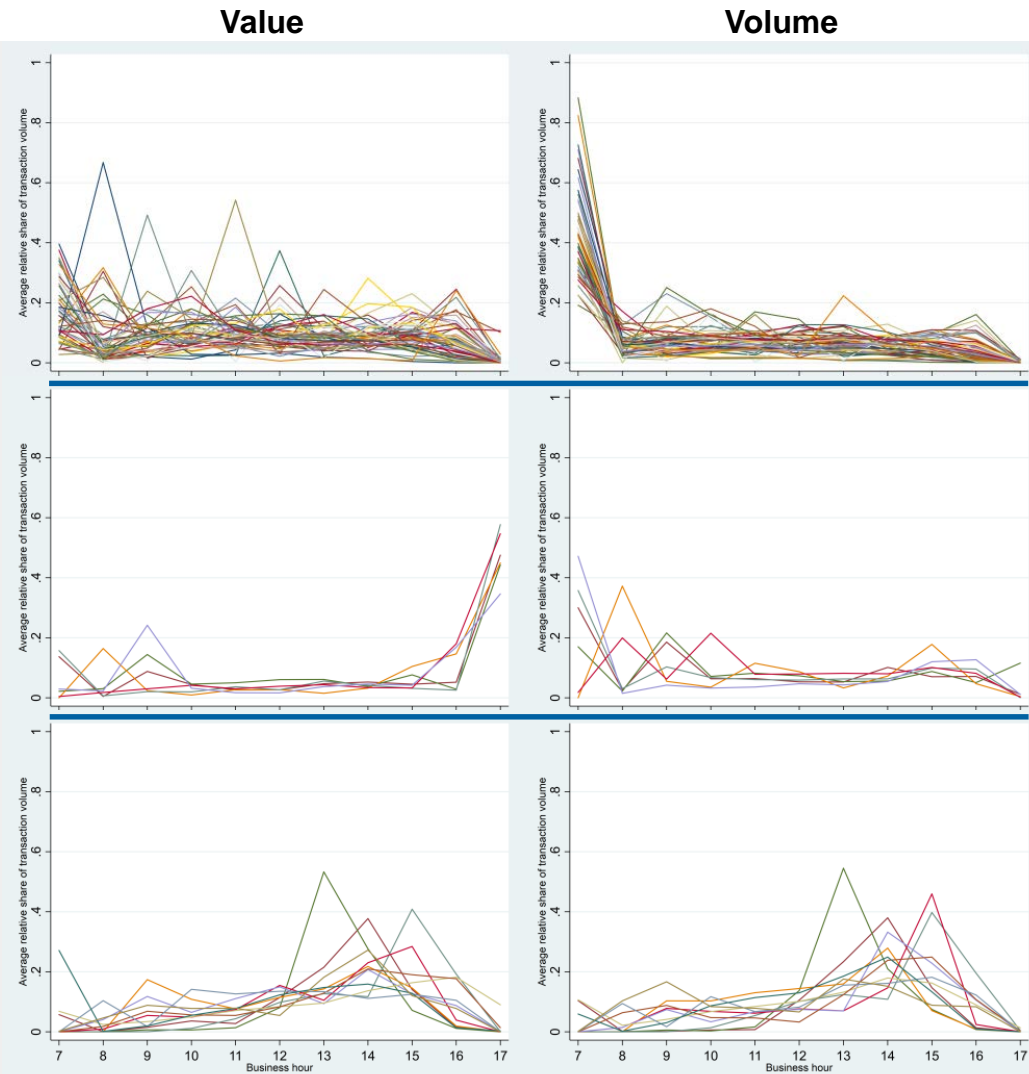
Add transaction
value

Main findings

- Main profiles were clustered
- Often volume and value profiles are correlated
- Nevertheless, profiles are more or less clearly driven by one or the other measure

Conclusion

- Number of less meaningful results increases as expected
- Fragility hypothesis can still be rejected
- Depending on the use case, value and volume profiles should be derived separately



Stability Testing

Scenario: Monthly data points

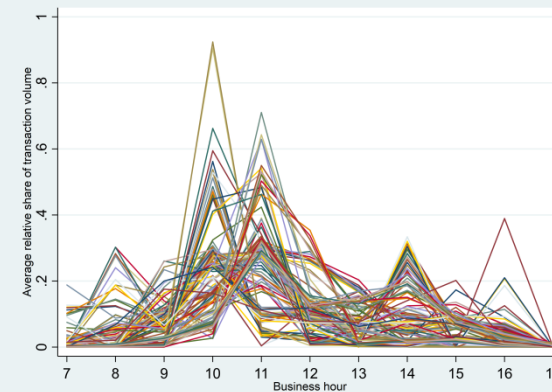
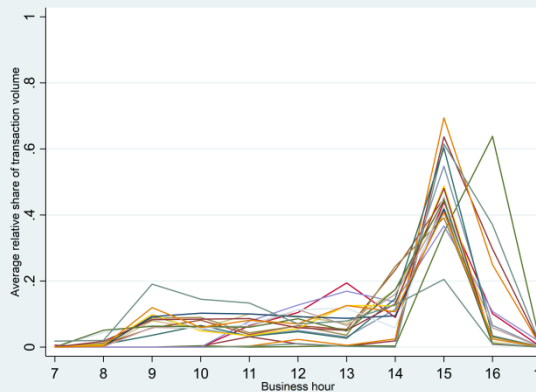
Monthly data
points per
participant

Main findings

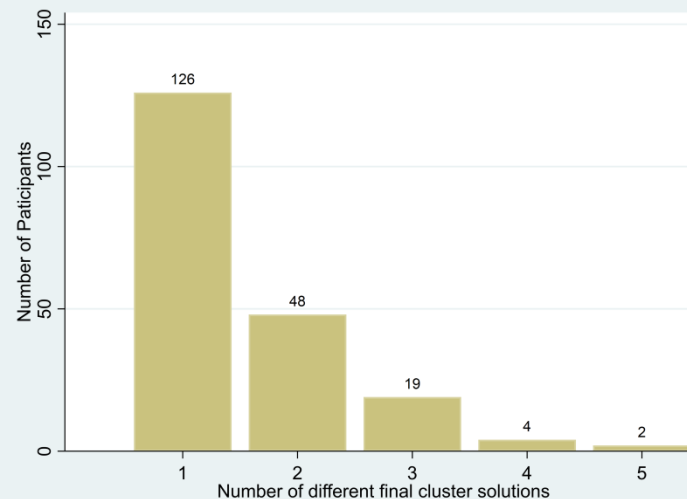
- Main profiles were clustered
- Higher probability of *meaningful* (smaller) cluster
- Majority is clustered in the same profile each month
- Payment behaviour changes during the year lead to *real* outlier clusters but no new profiles
- With more data points smaller (dis-) similarities are neglected

Conclusion

- Profile assignment is stable but some changes exist
- Using monthly data points does not lead to new profiles
- Yearly average smooths monthly extreme values and facilitates profiling



Profiles assignments by participant



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Lessons learned and way forward

Achieved Goals

- ✓ Derivation of payment profiles by using the multiple cluster procedure was validated as general method
- ✓ Results turn out to be sufficiently stable over time, the interpretation of remaining changes allows gaining additional insights

Methodological Adjustments

- Using median instead of average
- Merge time-independent-payer and tea-time-payer into one profile

Way Forward

- Track changes of participants
- Scenario extension: Daily data

Insights to be considered for further interpretation

- Human interpretation of results is still a crucial factor
- Check for changes of payment behaviours over time
- Additional statistics improve interpretation
- Adjust data selection and preparation to research question