

# **Participant Behavior in TARGET2**

## Stability and Anomalies

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# Participant Behavior in TARGET2 - Stability and Anomalies

## Co-Authors and Disclaimer

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Authors of this paper are members 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 Deutsche Bundesbank 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. Co-authors not being a member of one of the user groups with access to the above mentioned data were not involved in the transaction-level data analysis. The views expressed in the paper are solely those of the authors and do not necessarily represent the views of the Eurosystem.

# Participant Behavior in TARGET2 - Stability and Anomalies

## Introduction

### Payment behavior

- Describe how participants introduce their transactions intraday
- Behavior matters for liquidity needs and potential gridlocks in an RTGS
- Relevant for a number of FMI analyses (Liquidity distribution, risk identification, fraud detection etc.)

### Stability and Anomalies

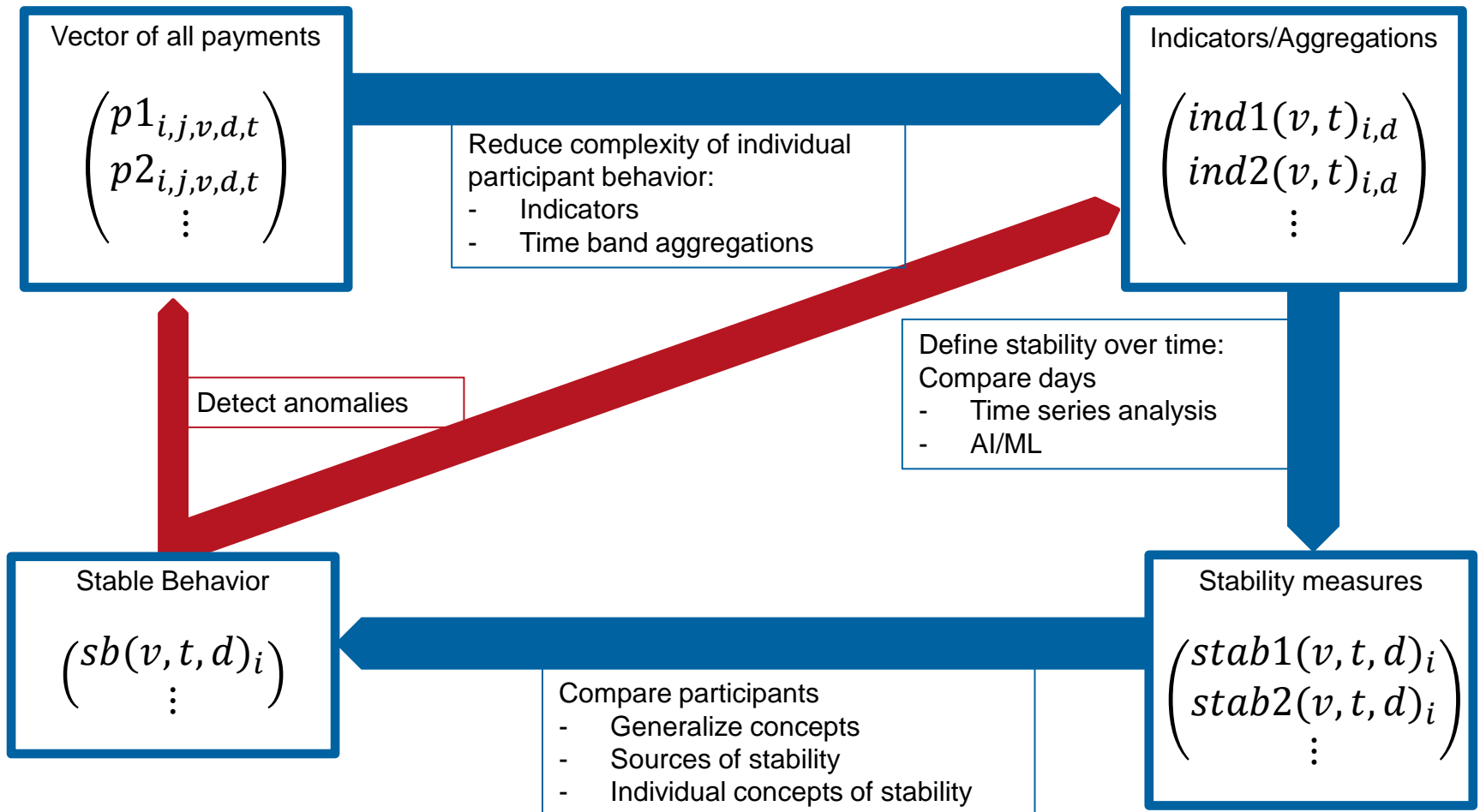
- Deviations from regular payment behavior (“anomalies”) could indicate a risk event
- Regular payment behavior requires stability: If there is no normal, there is no anomaly
- Stable behavior improves classification of behavior

### Methodological Challenges

- Behavior has various dimensions (eg counterparties, values, timing)
- Several possibilities to define and measure stability
- Backtesting as an issue: Also anomalies need to be defined

# Participant Behavior in TARGET2 - Stability and Anomalies

## How to measure stability of participant behavior?



*p: payment*  
*i: participant*  
*j: counterparty*  
*v: value*  
*d: date*  
*t: time*

# Participant Behavior in TARGET2 - Stability and Anomalies Datasets

**Data Basis:**  
TARGET2  
transaction data

**Data Selection:**

- Large participants (at least 0.05 % transaction volume on TARGET2)
- Participant-entered transactions
- Day-time settlement cycle transactions
- Transactions settled in 2017

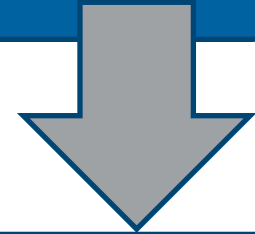
**Data Preparation:**  
Separate  
Methods

# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators - Methodology

### Data Preparation:

- Main Idea: „Condense“ the daily payment behavior in one single figure
- Several indicators have been developed to measure timing and the payment behavior
- Calculation of Value Weighted Average Introduction Time, Median Value Introduction Time, Average Introduction Time, Median Introduction Time

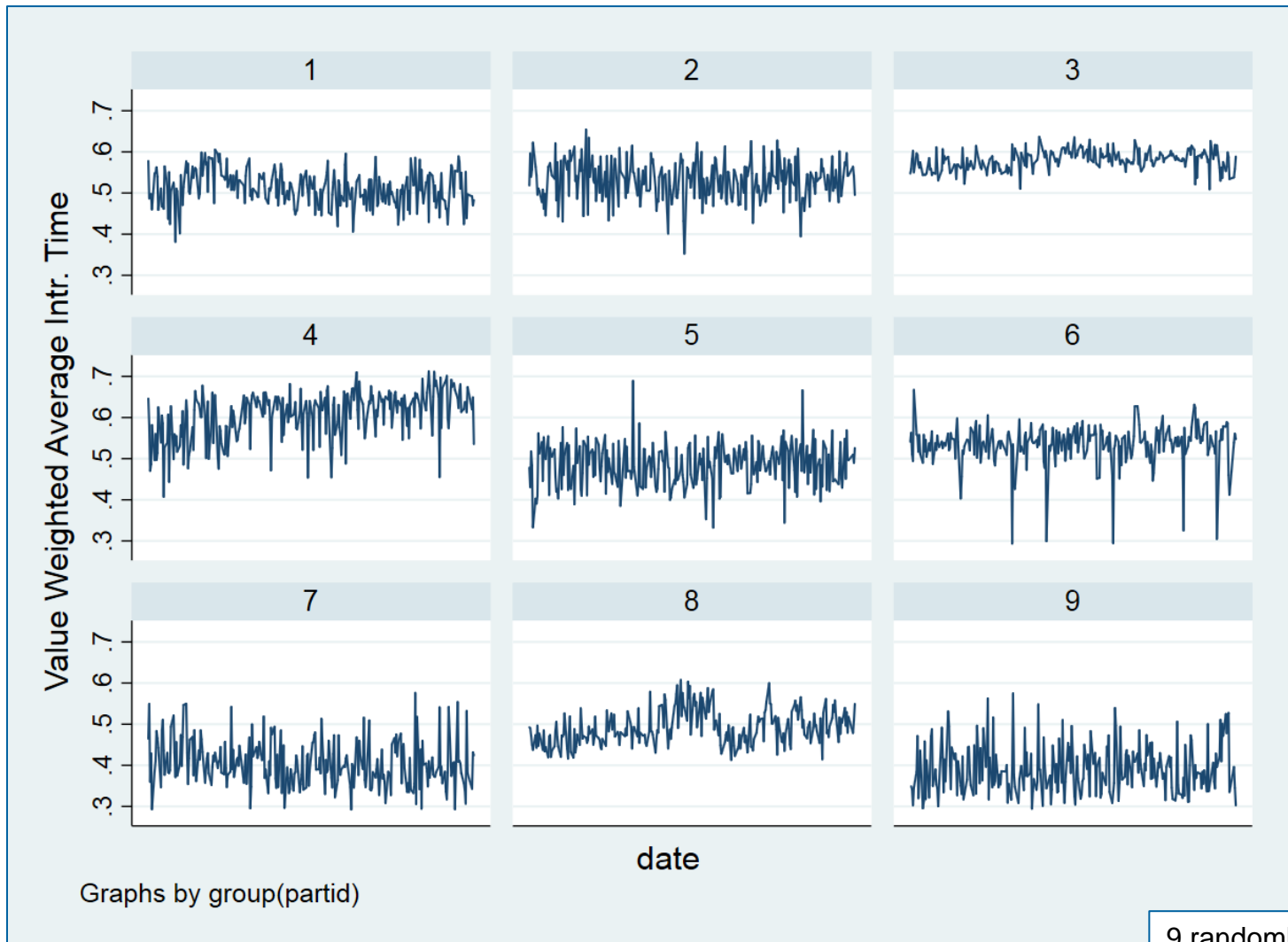


### Analysis

Dataset to be analyzed: Daily time series of each indicator for each participant

### What is stability?

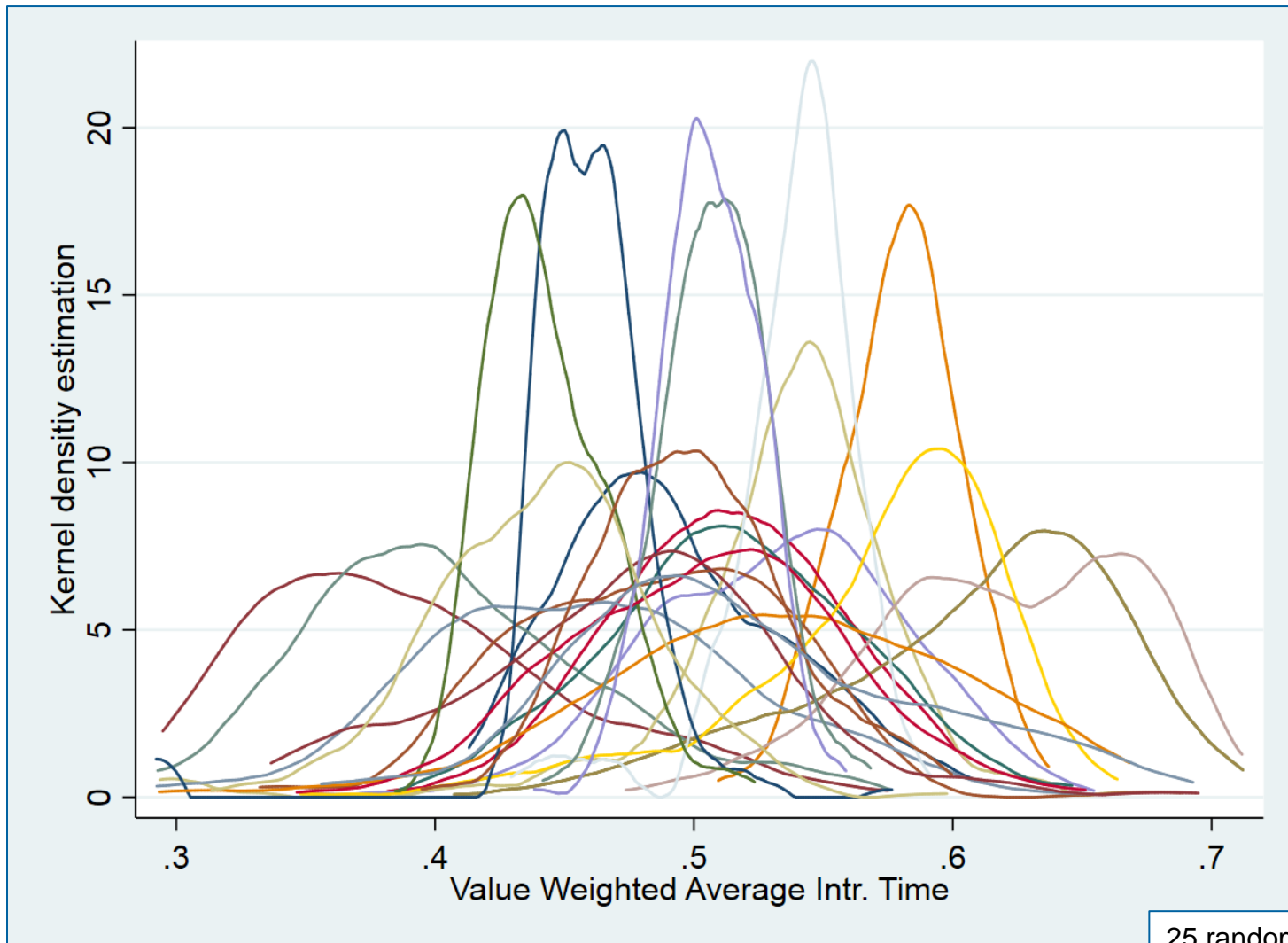
# Participant Behavior in TARGET2 - Stability and Anomalies Indicators – Time Series



9 randomly selected participants

# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – Distribution of Indicator Values

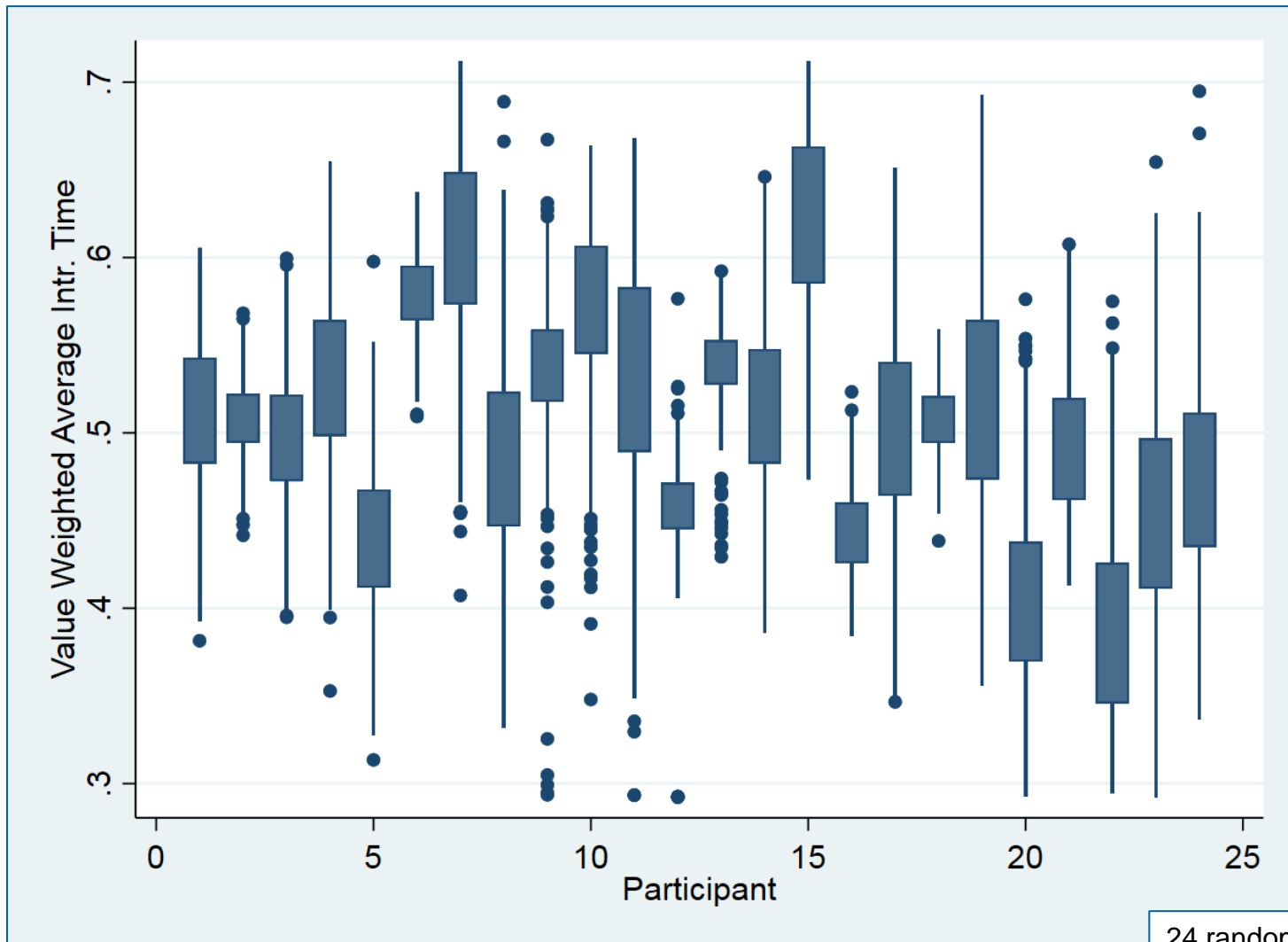


25 randomly selected  
participants



# Participant Behavior in TARGET2 - Stability and Anomalies

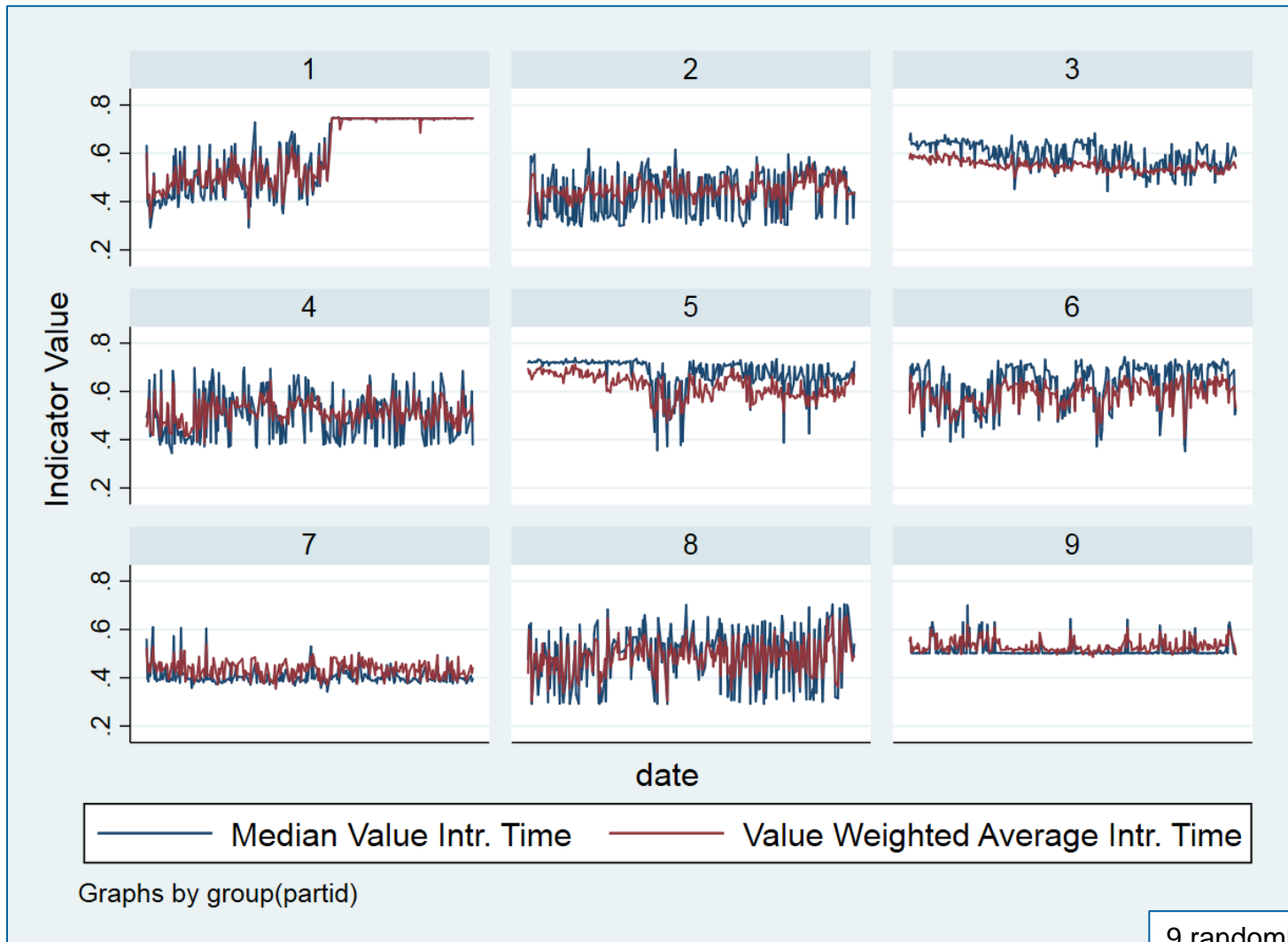
## Indicators – Distribution of Indicator Values



24 randomly  
selected participants

# Participant Behavior in TARGET2 - Stability and Anomalies

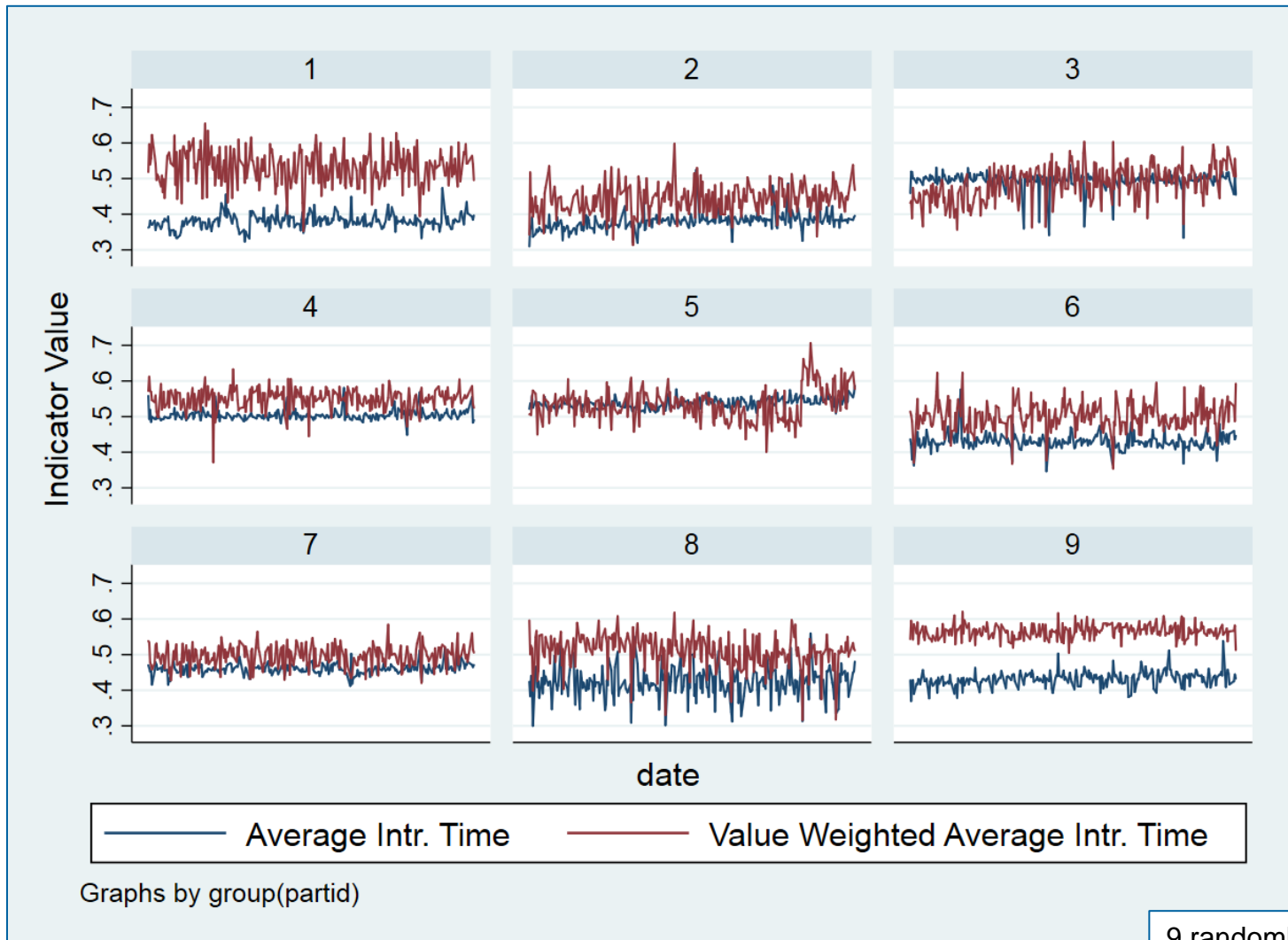
## Indicators – A different Indicator: Average or Median?



9 randomly selected participants

# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – The Impact of Value Weights



9 randomly selected participants

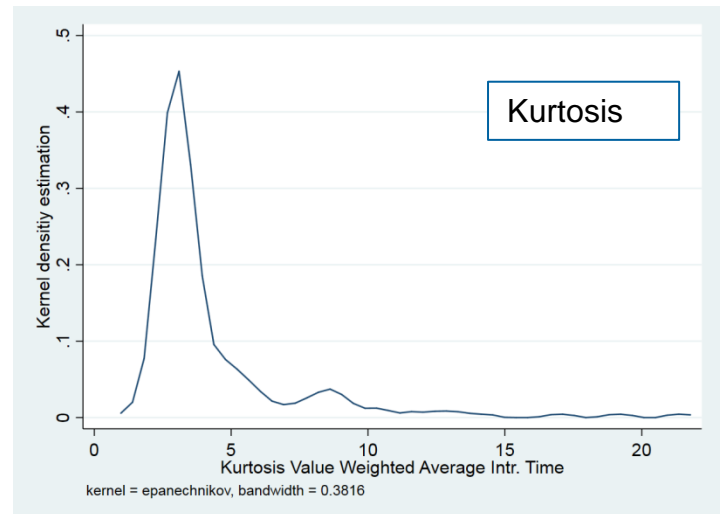
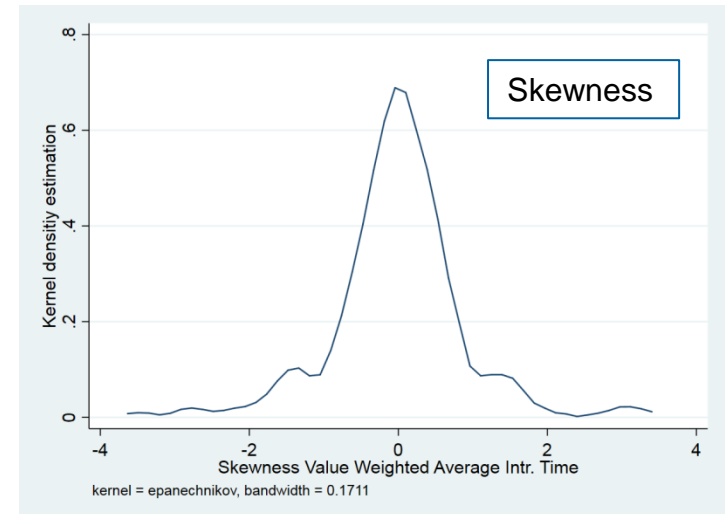
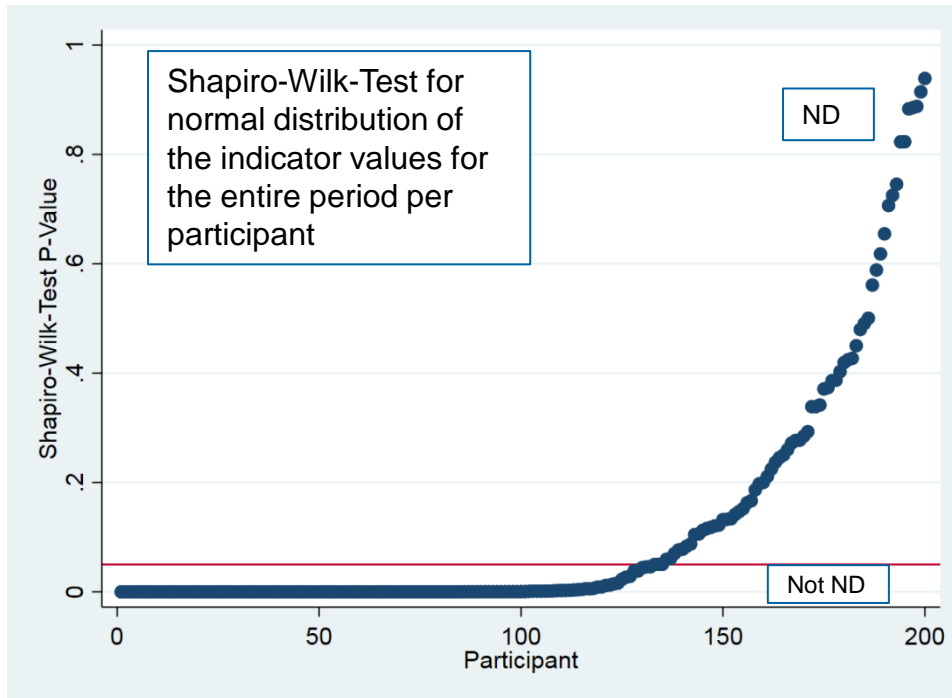
# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – What is Stability?

- Set of measures to assess the „stability“ of the indicator:
  - Standard descriptors of a distribution: Standard Deviation, Skewness, Kurtosis
  - Deviations from confidence intervals
    - Test if the share of days where the value is above the threshold implied by a normal distribution is higher than implied by the confidence interval
  - Number of outliers as defined for standard box plots (25/75 percentile +  $1,5 * IQR$ )
  - Deviations from mean in absolute terms
    - Share of days when indicator deviates from mean by 1/2/3 hours
- Make participants comparable by normalizing the measures to range between 0 and 1
- High diversity of the results

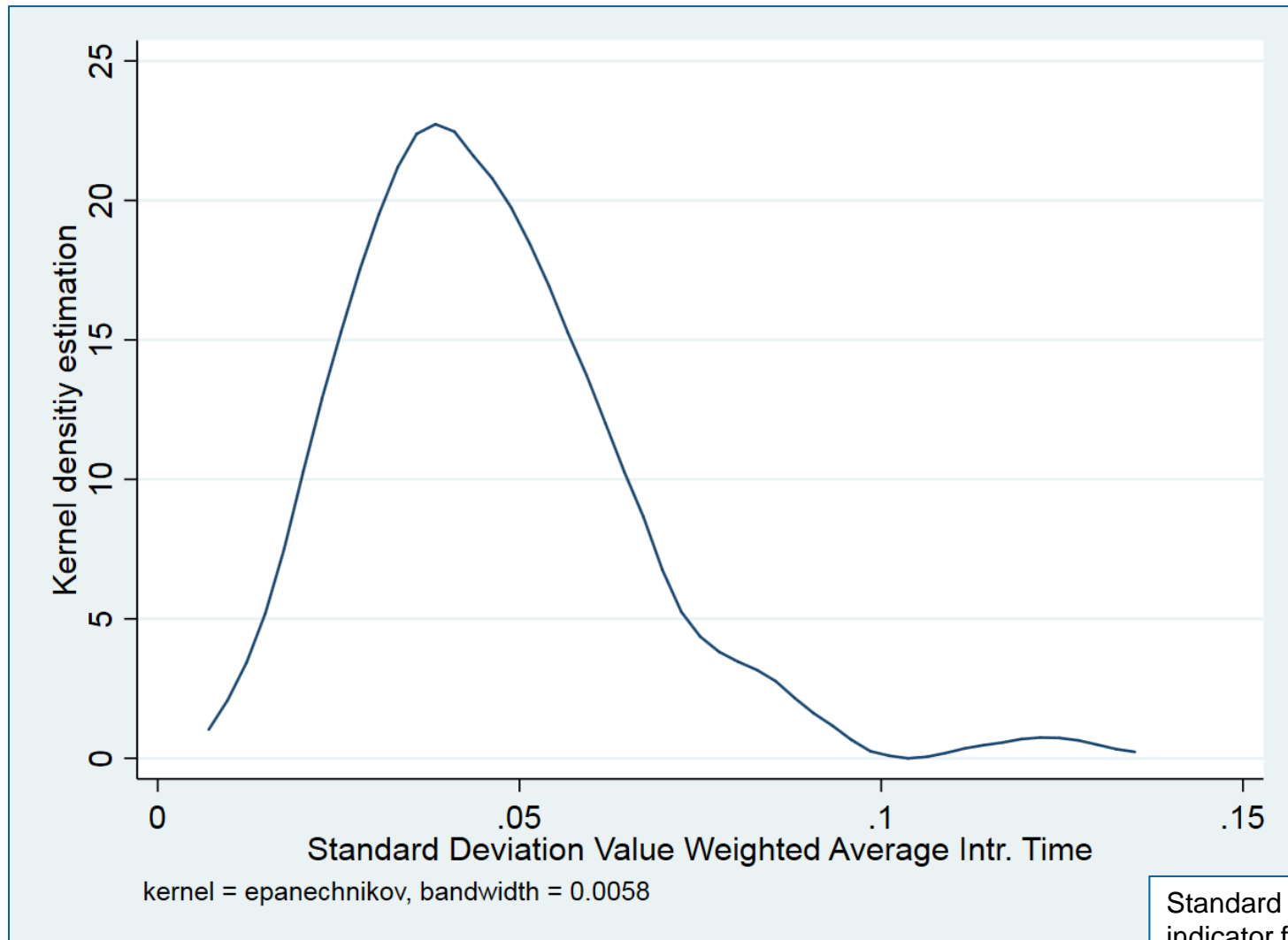
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## Indicators – Normal Distribution of Indicator Values?



# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – Stability: Standard Deviation over all participants



Standard deviation of indicator for each participant over time

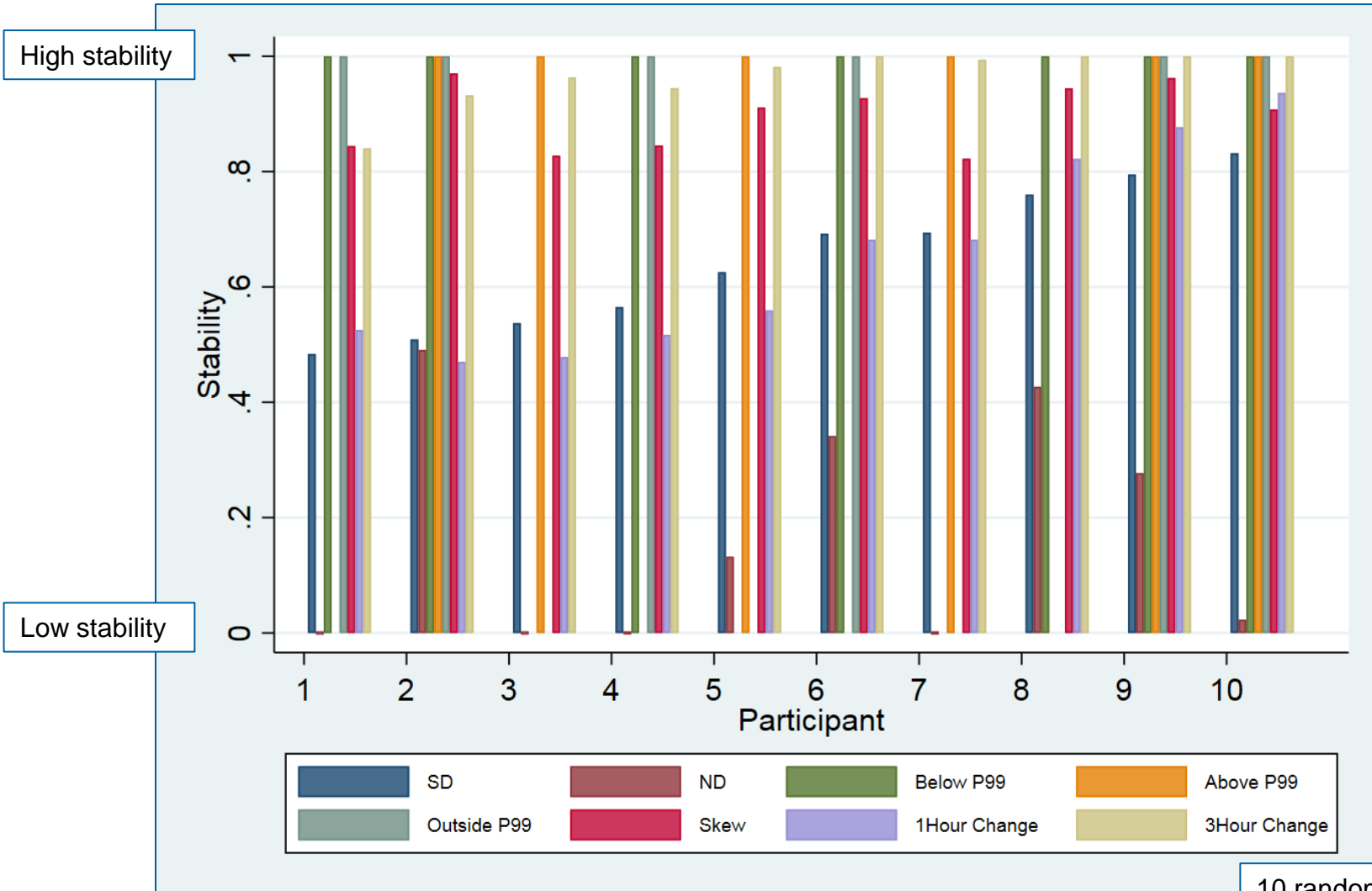
# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – Time Series Analysis

- Use Augmented Dickey Fuller Test to assess the stability of the time series:
  - Stability is confirmed for almost all participants
  - Obvious structural break in the case the ADF leads to rejection of stability assumption
  - However, test for structural breaks leads to a different results and signals much more structural breaks in the time series
- Persistence of Time Series is generally rather low
- Low Auto-Regressive Behavior of the time series, i.e. deviations from average are temporary
- Seasonality: No clear evidence for obvious seasonal effects on participant level

# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – Different Concepts of Stability



10 randomly selected participants



# Participant Behavior in TARGET2 - Stability and Anomalies

## Indicators – How is stability determined?

$$SD(Value\ weighted\ average\ intr.\ time)_i = c + total\ value_i + \varepsilon$$

Standard deviation	Coef.	Std. Err.	t	P>t
<b>Value</b>	-4.10e-15	7.18e-16	-5.71	0.000
<b>_cons</b>	.0483524	.0013345	36.23	0.000

n = 200

R<sup>2</sup> = 0.1415

$$SD(Value\ weighted\ average\ intr.\ time)_i = c + total\ volume_i + \varepsilon$$

Standard deviation	Coef.	Std. Err.	t	P>t
<b>Volume</b>	-1.08e-08	1.91e-09	-5.66	0.000
<b>_cons</b>	.0490385	.0013863	35.37	0.000

n = 200

R<sup>2</sup> = 0.1394

# Participant Behavior in TARGET2 - Stability and Anomalies

## Cluster analysis - Methodology

### Data Preparation:

- Aggregation transaction volume to one-hour intervals
- Creating data points without transactions in case of missing payment activity

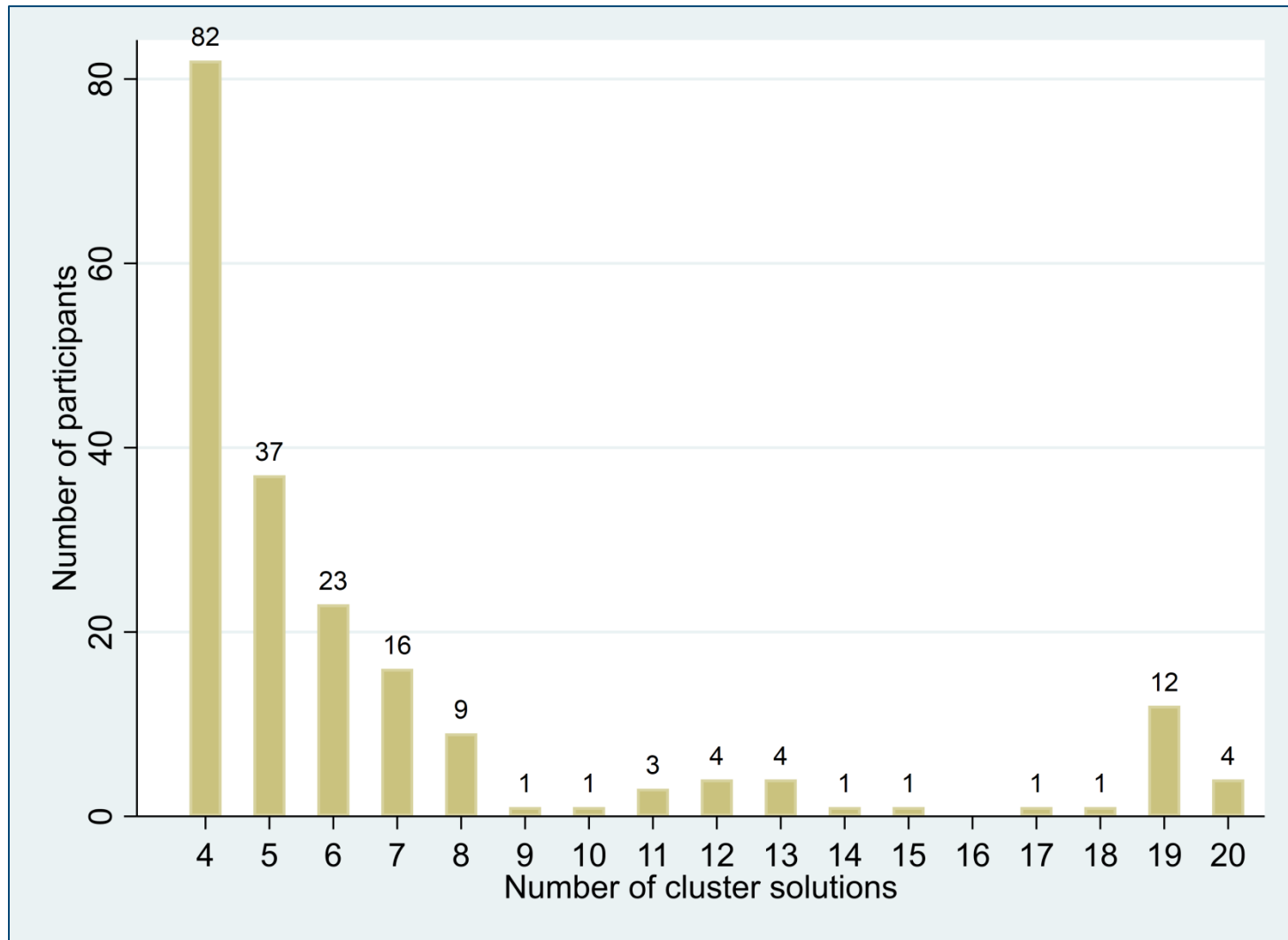


### Cluster Analysis

- Split data set for each participant
- Calculate Calinski-Harabasz Pseudo-F Index for cluster solutions between 4 and 20 number of clusters
- Choose cluster number with highest Pseudo-F Index
- Run k-means cluster analysis with previously chosen cluster number (Similarity measure: Euclidian distance; Start option: Random)

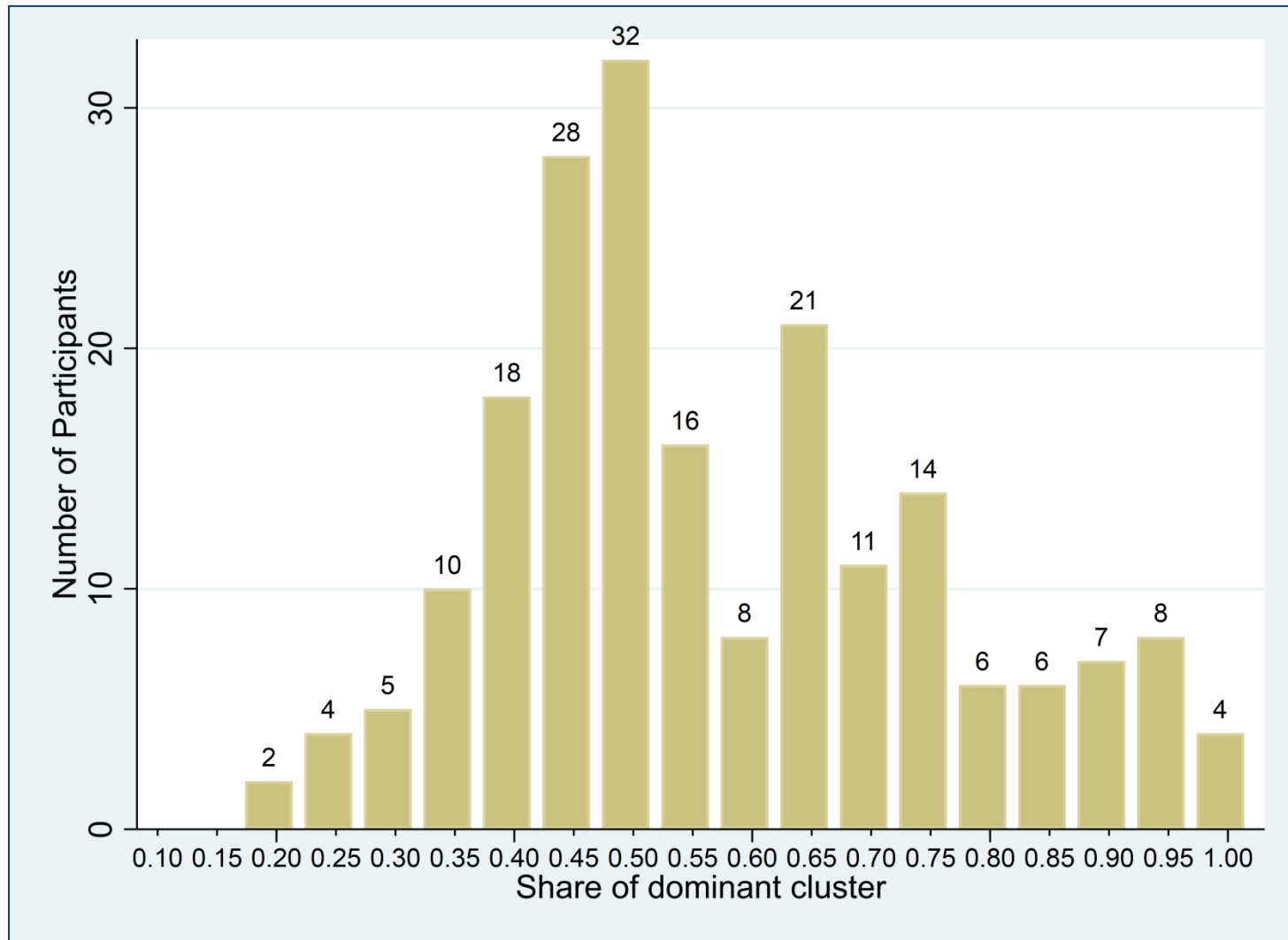
# Participant Behavior in TARGET2 - Stability and Anomalies

## Cluster analysis – Number of cluster solutions



# Participant Behavior in TARGET2 - Stability and Anomalies

## Cluster analysis – Share of dominant cluster



# Participant Behavior in TARGET2 - Stability and Anomalies

## Conclusion and way forward



- Large set of indicators and stability measures
- Partial evidence for stability
- Interesting insights using ad-hoc analysis of individual participants



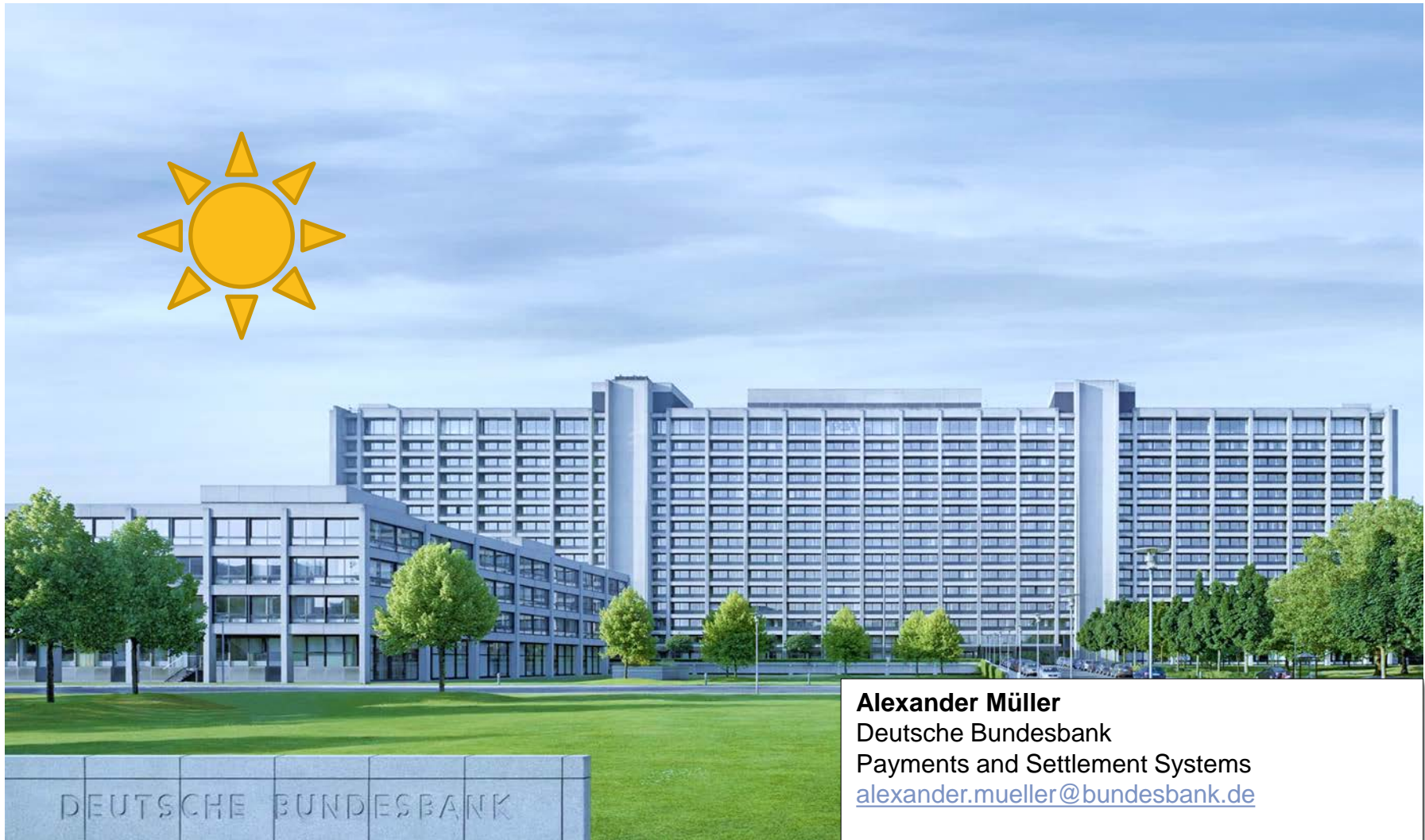
- Work in progress and preliminary results
- Data inherent definition of stability and anomalies
- Generalization of methods/insights still an issue

### Way Forward:

- More complex corrections for seasonality and external event information to be integrated
- Additional methods
- Combination of the results of different methods – for stability on participant level and for identification of anomalies for single days

# Participant Behavior in TARGET2 - Stability and Anomalies

## Thank you for your attention!



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