EUROPEAN CENTRAL BANK
EUROSYSTEM

# TESTING FRAMEWORK FOR EARLY WARNING INDICATORS

Joint project by:

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## CONTENTS

1. Motivation
2. Purpose of the project
3. Background
4. Signaling analysis
5. Data
6. Indicator testing

## MOTIVATION

- Payment systems are essential for the smooth functioning of the financial markets
- Monitoring bank's payment behaviour gives information about its liquidity position
- Distress can (for example) be highlighted as delays in incoming and outgoing payments

➡ Motivation to build payment indicators set to detect these problems



## PURPOSE OF THE PROJECT

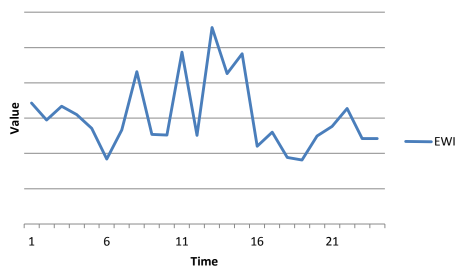
- The purpose of the project is to set up a TESTING FRAMEWORK for Early Warning Indicators (EWI)
- Testing framework should provide answers to following questions:
  - How good (strong) is the signal provided by each EWI?
  - How early can this signal be detected?
- Payments data is granular but rich –are there crisis signals visible?
  - For example, there's some evidence that banks want to hide their problems by changing their payment behaviour to actually pay as soon as possible

    → Do indicators work?

      → Need to test

## BACKGROUND

- Consider a time series of EWI observations

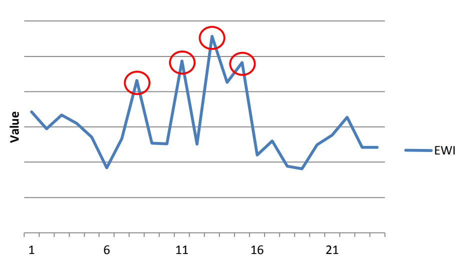






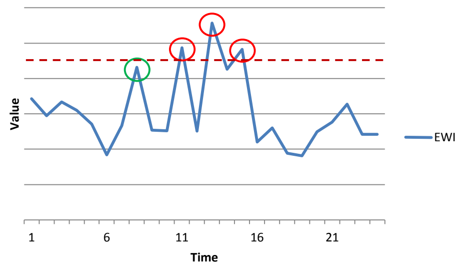

## BACKGROUND

- Does every peak or decline in the series signal an upcoming crisis?



## BACKGROUND

- Not necessarily - need to select a threshold which separates when movements are considered as signal of a crisis and when they are not

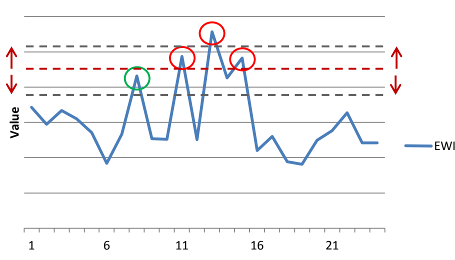






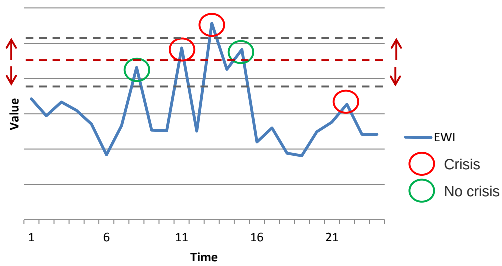

## BACKGROUND

- But what is an appropriate threshold?



## BACKGROUND

- Choosing the optimal threshold involves a trade-off between missed crises and false alarms

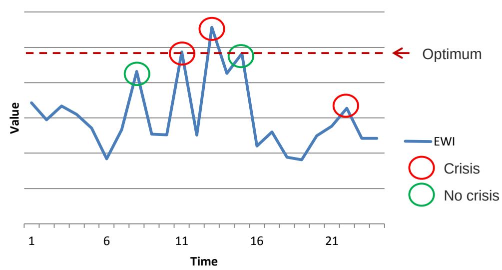







## BACKGROUND

- Signaling analysis to select the optimal threshold



## SIGNALING ANALYSIS

- Signaling analysis approach: because of the importance of taking policy makers preferences into account with respect to Type I (missed crises) and Type II (false alarms) errors (Alessi & Detken, 2011)
- Each observation of the EWI time series falls into one of the following quadrants of the matrix:

| | Crisis occurred | No crisis occurred |
|---|---|---|
| Signal issued | A | B |
| No signal issued | C | D |



## SIGNALING ANALYSIS

| | Crisis occurred | No crisis occurred |
|---|---|---|
| Signal issued | A | B |
| No signal issued | C | D |

In the matrix:

**A** – signal issued, correct;

**B** – signal issued, incorrect (no crisis followed);

**C** – no signal issued, incorrect;

**D** – no signal issued, correct (no crisis followed).

The quadrants of the matrix are then computed, i.e. aggregated in order to calculate the loss function (Alessi & Detken, 2011):

(1) $$L = \theta \frac{C}{A+C} + (1-\theta)\frac{B}{B+D}$$

## SIGNALING ANALYSIS

Where, $\frac{C}{A+C}$ = ratio of missed cases error (the crisis occured);

$\frac{B}{B+D}$ = ratio of false alarm error (the crisis has not occurred);

$\theta$ = preference parameter which shows the relative importance of missed cases errors with respect to false alarm error

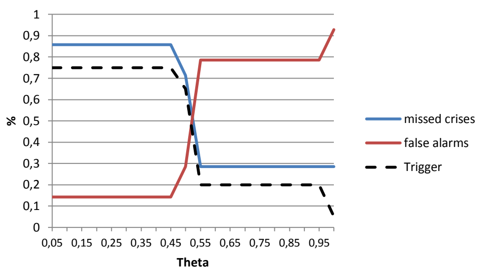


## SIGNALING ANALYSIS

- If $\theta$ = 0.5 there is an equal preference weight between false alarms (type II) and missed cases (type I)
  - If $\theta < 0.5$, preference is to avoid false alarms, optimal trigger value of EWI is high
  - If $\theta > 0.5$, preference is to avoid missed cases, the trigger is low
- Taking into account the granular nature of payments data and that the crises are (luckily) relatively rare, it would be justified for policy maker to have preference for avoiding missed cases (high $\theta$)

## SIGNALING ANALYSIS

- Policy makers' trade off between false alarms and missed crises




When policy maker has a low preference for false alarms (low *θ*), the optimal trigger value is high, as is the share of missed crises. Increasing the preference towards capturing all the possible crises lowers the trigger value and increases the share of false alarms (high *θ)*



## SIGNALING ANALYSIS

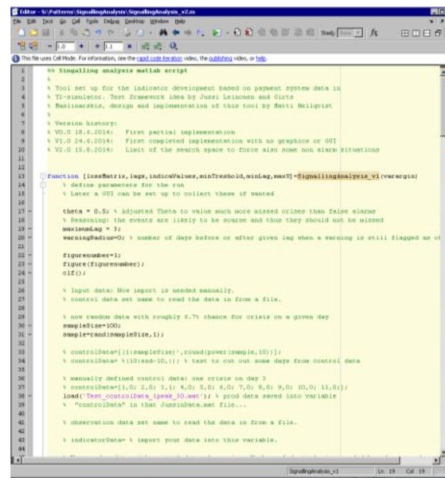
- Usefulness achieves its maximum when the loss function (L) minimized (Alessi & Detken, 2011):

(2) $$U_a = min[\theta; 1-\theta] - L$$

- If the usefulness is positive, the indicator in question is useful. If it is negative, the indicator is not useful.
- The trigger value with the highest usefulness ratio is used in the assessment

## IMPLEMENTATION EXAMPLE

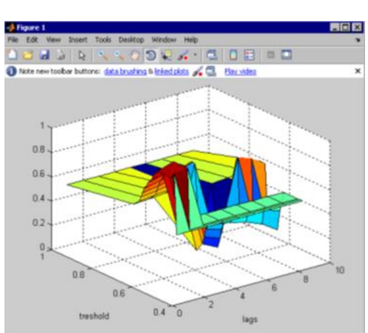
- Variables to be imported:
  - Indicator data
    - A time series of EWI values
  - Control data
    - To represent the difference between crisis and a normal period
    - Time series, binary variable (0=normal times, 1=crisis)
    - Can be system wide, countrywide or bank specific, depending on the focus of attention





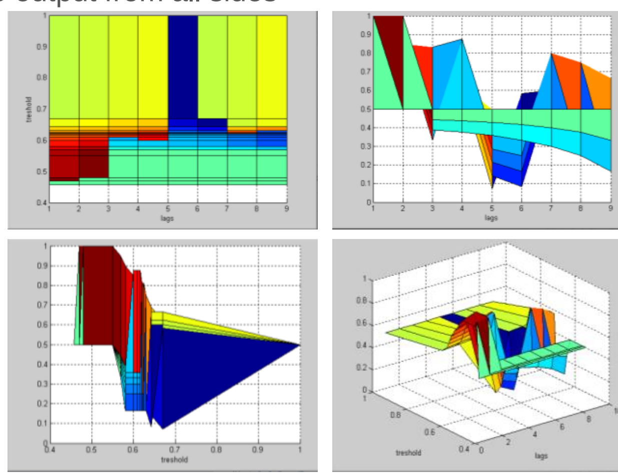
## RESULT EXAMPLE

- Artificial EWI time series
- 20 observations
- Output in 3D format

## RESULT EXAMPLE

- Closer look at the output from all sides
- Results:
  - U = 0.4286
  - Trigger = 0.67
  - Lag = 5
  - Trigger P-value = 0.0002





## TO PUT THE TOOL INTO PRACTICE

- Need to construct a control dataset consisting of real crises
  - Examples:
    - System wide: days surrounding the downgrade of Greek debt to junk bond status
    - Country wide: days surrounding the collapses of Dexia in Belgium and Fortis in NL
  - Control data is there also for to be developed and amended with the help of market data (e.g. CDS-data to recognize the crisis periods)
- Graphical user interface around the script
- Challenges faced
  - To ensure the robustness of theta and the threshold (trigger)
  - Build a reliable control dataset to capture the correct crisis starting point

# Thank you for your attention!