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# Combining liquidity usage and interest rates on overnight loans: an oversight indicator



EUROJÄRJESTELMÄ  
EUROSYSTEMET

Bank of Finland Research  
Discussion Papers  
23 • 2011

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The views expressed in this paper are those of the authors and do not necessarily reflect the views of the Bank of Finland.

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We are especially grateful to Päivi Heikkinen, Karlo Kauko, Kari Kemppainen, Harry Leinonen, Marianne Palva and participants at the 9th BoF Simulator Seminar for their helpful comments and discussions.

<http://www.suomenpankki.fi/en>

ISBN 978-952-462-782-5  
ISSN 1456-6184  
(online)

Helsinki 2011

# Combining liquidity usage and interest rates on overnight loans: an oversight indicator

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## Abstract

This study utilises payment system data to analyse market participants' liquidity usage and to trace interest rates paid on overnight loans. Our aim is to examine how liquidity usage has changed during the years 2006–2/2011 and to combine this information with data on overnight lending rates between market participants. It turns out that the Furfine algorithm used in the analysis produces overnight interest rates that correlate very closely with the EONIA curve. Based on Finnish payment system data, we identify four separate time periods: normal, start of turmoil, acute crisis and stabilizing period. The results show that, during the acute crisis period, TARGET2 participants holding an account with the Bank of Finland paid, on average, lower overnight interest rates than other banks in the euro area. However, the results reveal there has been some lack of confidence between Finnish participants since the onset of the financial crisis. A new indicator – the Grid – which we present here shows this very clearly. We suggest that this new indicator could be a highly useful tool for overseers in supporting financial stability analysis.

Keywords: liquidity, interest rates, overnight loans, payment systems, indicators

JEL classification numbers: C81, E42, E43, E58

# Indikaattori likviditeetinkäytön ja yön yli -lainauksen seurantaan

## Suomen Pankin keskustelualoitteita 23/2011

Tatu Laine – Tuomas Nummelin – Heli Snellman  
Rahapolitiikka- ja tutkimusosasto

### Tiivistelmä

Tässä selvityksessä analysoidaan markkinaosapuolten likviditeetinhallintaa ja vakuudettomien yön yli -lainojen hinnoittelua maksujärjestelmädatan avulla. Tavoitteenamme on selvittää muutoksia osapuolten likviditeetinkäytössä vuodesta 2006 helmikuun 2011 loppuun sekä yhdistää tämä tieto osapuolten toisilleen maksamiin yön yli -lainojen korkoihin. Analyysissa käytetty Furfine-algoritmi näyttäisi jäljittävän yön yli -lainoista maksetut korot maksutapahtuma-aineistosta, sillä algoritmin avulla saatu korkokuvaaja korreloi hyvin eoniakoron kuvaajan kanssa. Suomen maksujärjestelmädatan perusteella tarkastelujakso voidaan jakaa neljään osaan: normaaliaika, kriisiä edeltävä aika, kriisin aika ja tasaantumisen aika. Tulosten mukaan Suomen Pankin kautta TARGET2-järjestelmään osallistuvat pankit maksoivat kriisin aikana alhaisempaa korkoa yön yli -lainoista kuin euroalueen pankit keskimäärin. Tässä työssä esiteltävä indikaattori kuitenkin paljastaa, että myös suomalaisten osapuolten kesken näyttäisi olleen luottamuspulaa kriisin alettua. Indikaattori voisi olla hyödyllinen lisätyökalu yleisvalvojille rahoitusmarkkinoiden vakausanalyysia tukevassa työssä.

Avainsanat: likviditeetti, korot, yön yli -lainat, maksujärjestelmät, indikaattorit

JEL-luokittelu: C81, E42, E43, E58

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# 1 Introduction

The payment system data include a wealth of information on market participants' behavior. The financial crisis has highlighted the need to better utilise also the data of payment systems in support of financial stability analysis. TARGET2 – the RTGS system owned and operated by the Eurosystem – provides real-time processing and settlement in central bank money. The data on payment transactions in TARGET2 could be used more effectively for oversight purposes, for instance to reveal potential problems of counterparties.

The purpose of this paper is to analyze the usage of liquidity by TARGET2 participants holding an account with the Bank of Finland. In addition, we analyze the interest rates paid by one financial institution to another for overnight credit. The aim is to combine these two pieces of information in building an indicator. Ideally, this indicator would be used in everyday oversight work, in order to immediately observe changes in a participant's behavior. Such an indicator would provide information from two independent sources, namely the central bank and individual participants in the interbank money market. The central bank can observe participants' accounts and liquidity usage in TARGET2, which information is otherwise known only to each participant. Participants see changes in other participants' behavior, if payment transactions are not received on time. However, banks make real time assumptions about each others' financial situation, as the interbank money market is highly integrated. If a participant assumes that another participant is running into trouble, the former is first supposed to raise the interest rate on overnight credit. If risks are assumed to be excessive, the participant is supposed to end its lending to the problem participant.

As stated above, this paper aims to combine earlier ideas into a single easy-to-use tool for everyday oversight work.<sup>1</sup> A further motivation is that interest rates on overnight loans have previously been studied using eg US and Dutch data but not Finnish data.

The results of our study indicate that the overnight loan interest rates combined with liquidity usage by market participants provides an indicator that could reveal whether a market participant is potentially in trouble. The crucial points here are that the data are

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<sup>1</sup> The basic idea was presented in the Bank of Finland Bulletin: Financial Stability 2010 (Bank of Finland, 2010).

analyzed on a daily basis and that the indicator is calibrated based on historical payment data. These are the next steps that should be taken.

## 2 Analysis

The analysis Section is divided into three parts. A brief literature review is given in 2.1. Part 2.2 describes how market participants' daily liquidity usage can be used to build the Forest Fire diagram. Part 2.3 describes how interest rates on overnight loans can be used to study the confidence of the market participants in each other.

### 2.1 Literature review

Liquidity usage has been illustrated by Forest Fire diagram in this paper. This idea was inspired by Capel et al. (2009) who presented the idea in the Bank of Finland Simulator Seminar in 2009. Furthermore, Heijmans and Heuver (2011) illustrated collateral use for intraday credit by using a similar diagram.

The other part of the indicator, namely interest rates paid on overnight credits, has been discussed in the literature of the last decade. Furfine (1999) developed an algorithm to trace transactions related to overnight loans and Demiralp et al. (2004) further developed the algorithm for selecting candidate loan transactions. Recently, Heijmans et al. (2010) improved the algorithm for identifying loans of maturities up to one year, in addition to overnight loans. Heijmans et al. (2010) show how spreads and volatility of interest rates on interbank loans increased during the financial crisis. Furthermore, Akram and Christophersen (2010) discussed overnight interest rates based on Norwegian data. They concluded that interest rates on overnight loans vary across banks and over time. In contrast, Eklund (2009) concluded that in Sweden the majority of overnight loans are made without a risk premium.

## 2.2 Liquidity usage

Liquidity management differs across participants in the TARGET2-Suomen Pankki system<sup>2</sup>. In this paper, liquidity refers to money in a participant's central bank account and to the collateralized overdraft facility of the account, which can be used immediately as intraday credit, when needed. The difference between the start-of-day balance and the minimum balance for the day is divided by the sum of the start-of-day balance and the available intraday credit, as shown below:

$$\text{Liquidity usage [\%]} = \frac{(\text{Start of Day Balance} - \text{Minimum Balance})}{(\text{Start of Day Balance} + \text{Intraday Credit})}$$

This results in maximum usage of liquidity by the participant<sup>3</sup>. Some of the participants may actively manage their liquidity and extensively use intraday central bank credit. Some others may hold large deposits on their central bank accounts, in order to assure the smooth execution of payments and to avoid credit. High usage of liquidity, as opposed to active liquidity management, may also indicate problems for the participant in meeting its obligations.

Figure 1 illustrates liquidity usage of participants. The green area indicates participants using up to 30% of their liquidity and the black area indicates usage in excess of 90%. We see that in year 2006, ie before the financial crisis, more than one half of the participants used at most 30% of the liquidity. The green area shrunk after the start of 2007 and was at its smallest in 2009. The share of participants in the black area has been fairly stable, and less than 10% of participants have used over 90% of their liquidity. However, this share was slightly higher during 2007.

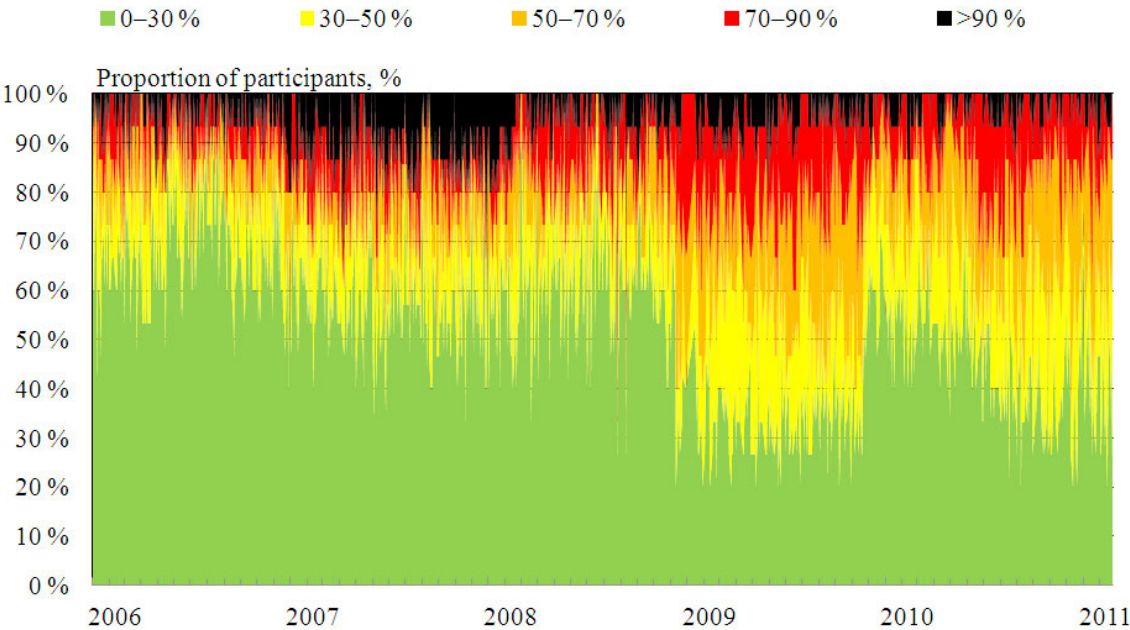
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<sup>2</sup> TARGET2-Suomen Pankki system was launched on 18 February 2008, and it is part of TARGET2. We have used for the analysis the data of TARGET2-Suomen Pankki system and the data of its predecessor BoF-RTGS system.

<sup>3</sup> The information on the value of additional eligible collateral pledged with the Bank of Finland could be added to the comparison, but these data were not available for this study.

Problems in the US housing loan market escalated in August 2007 (at the start of turmoil period<sup>4</sup>). In September 2008, US mortgage banks Fannie Mae and Freddie Mac were taken over by the federal government and Lehman Brothers went bankrupt (eg Bank of Finland, 2008). In this paper, this was defined as the start of the acute crisis period. As Figure 1 shows, the red, orange and yellow areas expanded after 2008Q3, which indicates that a bigger share of participants then used over 30% of their liquidity. Towards the end of 2009, the diagram shows that the liquidity usage is at the same level as during the start of turmoil period. However, since end-2010 the share of participants using less than 30% of their liquidity has been decreasing. This could indicate the forthcoming second turbulent period. Figure 1 shows the aggregate liquidity usage by participants, but for oversight purposes the liquidity usage of each participant could also be analyzed.

**Figure 1.** Liquidity usage by TARGET2-Suomen Pankki participants.



<sup>4</sup> In this paper, we have divided the five years into four periods: A) the normal period before the financial crisis (1.1.2006–30.6.2007), B) the start of turmoil period (1.7.2007–14.9.2008), C) the acute crisis period (15.9.2008–30.6.2009) and D) the stabilizing period (1.7.2009–28.2.2011).

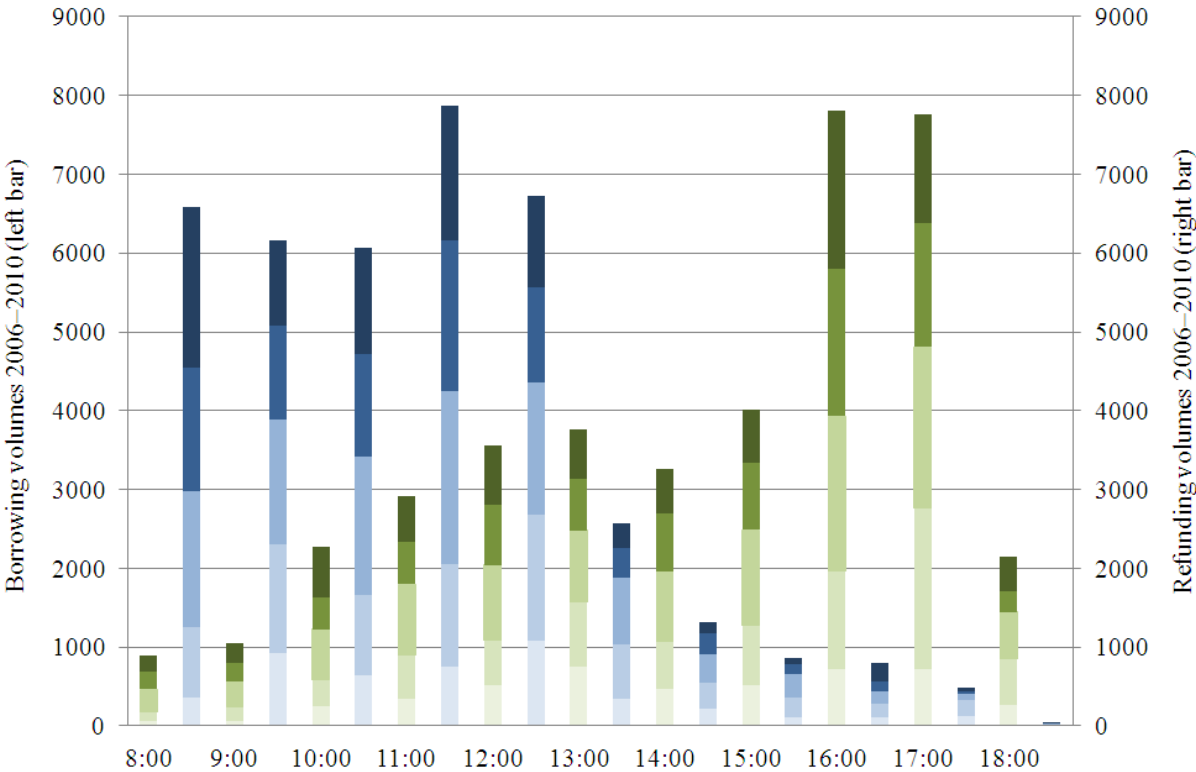
## 2.3 Interest rates on overnight loans

Normally, banks even out their liquidity fluctuations in the interbank money markets. If a bank pays a higher interest rate on overnight loans than others, this could indicate some lack of confidence. Furthermore, if there are notable changes in the level of interest rates paid by a bank compared to its own history, this could be an important signal, if interest rates paid by other counterparties remain steady. Information on interest rates on overnight credit is not readily available. However, interest rates can be estimated from payment systems data. We assume that loans and refunds take place in the same system.

In this study, we concentrate on overnight loans and do not analyze longer maturities. According to the results of Heijmans et al. (2010), over 80% of the value of interbank loan transactions was for overnight loans. Also in bilateral discussions with Finnish financial institutions, the participants have indicated that they mainly lend and borrow money from interbank markets on an overnight basis. Longer-term loans have remarkably decreased during the financial crisis. In this analysis, we concentrate on borrower-participants.

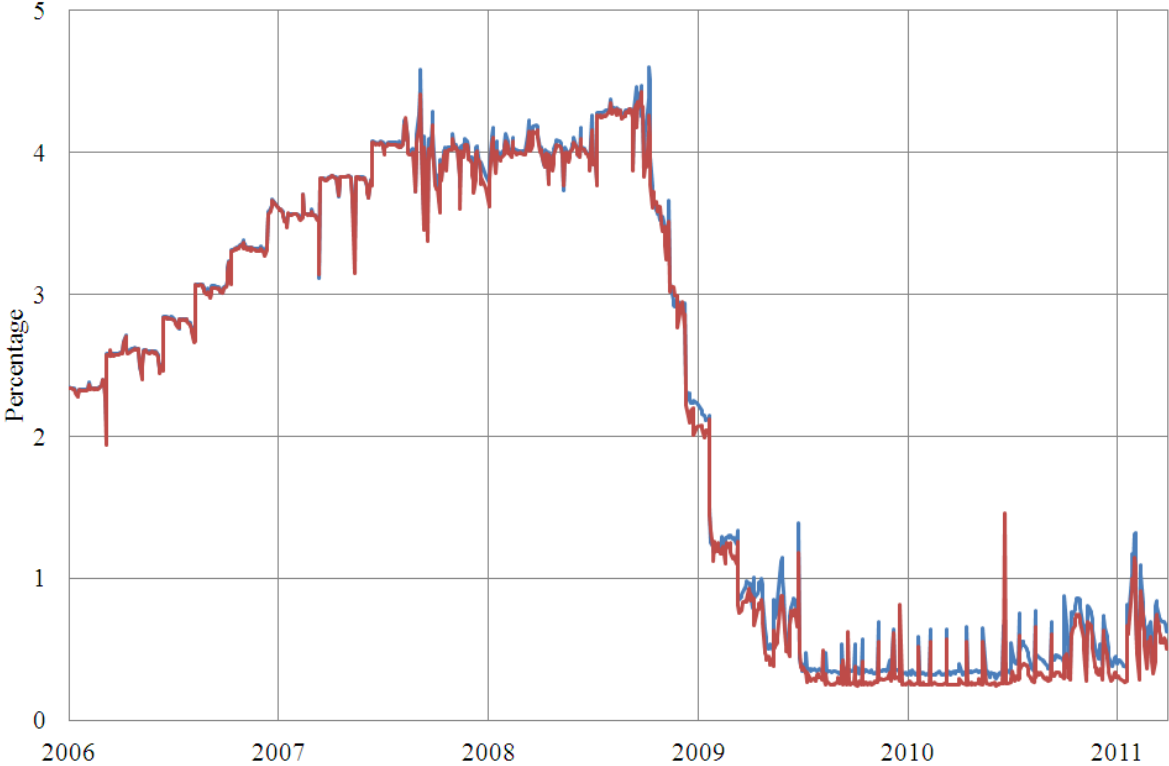
In bilateral discussions with financial institutions we have also found out the procedure for granting overnight loans (see Figure 2). Generally, the participants make deals before lunch time, after which the transactions are handled in the back-office and then executed in the payment system. Overnight loans of the previous day have to be paid back before granting new credit. The participants have a common understanding on the procedures of overnight loans. If a participant does not follow the unwritten rules, this may increase mistrust among other participants.

**Figure 2.** Borrowing (left bars, green) and refunding (right bars, blue) numbers of overnight loans have different distributions over the business day. The light color (bottom of bar) indicates year 2006 and the dark color (top of bar) 2010.



Following Furfine (1999), we search for transactions paid eg on Monday by bank A to bank B and refunded on Tuesday by bank B to bank A at interest rate  $r$ . The analysis is based on the actual data on TARGET2-Suomen Pankki transactions. Furfine (1999) used only payments larger than \$1 million ending in five zeros whereas we included all transactions over EUR 10 000 ending in four zeros. Based on the discussions with market participants, the refund typically includes both principal and interest. Therefore, we assumed that loans are refunded on the next day and that these transactions include the original principal and the interest. In case of many matches, the first possible transaction pair was identified as the loan and refund (see eg Heijmans et al. (2010)). The weighted average interest rate (FEONIA) was calculated from these found principal-interest rate pairs. Comparing FEONIA with EONIA indicates that these two interest rates follow each other very closely (Figure 3). In other words, the interest rate found on the basis of the Furfine (1999) method seems to work well. Quality of fitting can be described eg by the  $R^2$  statistic, which is close to 1.

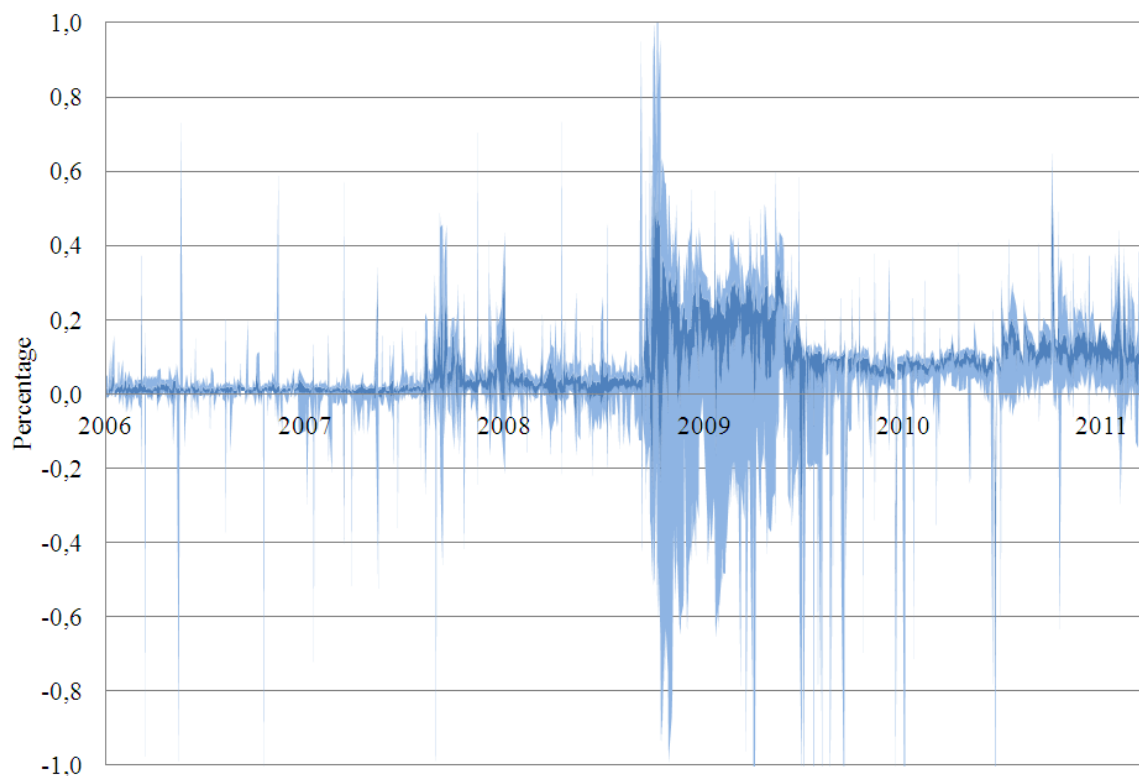
**Figure 3.** FEONIA (Finnish EONIA; red line) and EONIA (Euro OverNight Index Average; blue line).



During normal times, interest rates paid by counterparties seem to be highly concentrated and equal. Figure 4 is based on the daily data where interest rate paid by each participant was subtracted from EONIA. The spread between minimum and maximum values is shown, and from Figure 4 we can see that the interest rates paid by counterparties vary much more during the acute crisis period. This indicates that some counterparties have to pay higher interest rates because other counterparties have judged that the risks relating to those particular banks have increased. Figure 4 includes the data of participants in TARGET2-Suomen Pankki as well as the data on their transactions with other TARGET2 counterparties. If the RTGS accounts of foreign participants are excluded, the data describing the pure Finnish market are concentrated in the dark area. This means that banks participating in TARGET2-Suomen Pankki could have had overnight loans from the home market with lower interest rates than from abroad during the financial crisis. This indicates that domestic market participants had more confidence in each other than in foreign banks. It seems that TARGET2-Suomen Pankki

participants pay lower interest rates on average than other TARGET2 counterparties after the acute crisis period.

**Figure 4.** Spread between minimum and maximum of the difference curve (EONIA - interest rate paid by each participant for overnight credit). 50% of observations are concentrated in the dark area.



Single peaks were not smoothed out from the raw data of Figure 4. Most of the single peaks are false principle-interest findings<sup>5</sup> from the raw data, but if all of them are mechanically smoothed out, also the important change might not be observed. Here, particular days and participants were not reported, for the sake of anonymity. For oversight purposes, potentially stressed participants could be identified and monitored.

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<sup>5</sup> Type 1 errors, ie some transactions are classified as overnight interbank loans even if they are not such transactions. See eg Heijmans et al. (2010).



## 3 Indicator

In this Section, we first present the general idea of the indicator. In part 3.2, we choose the two most interesting participants and conduct further analysis by including the time dimension. Further steps are discussed in part 3.3.

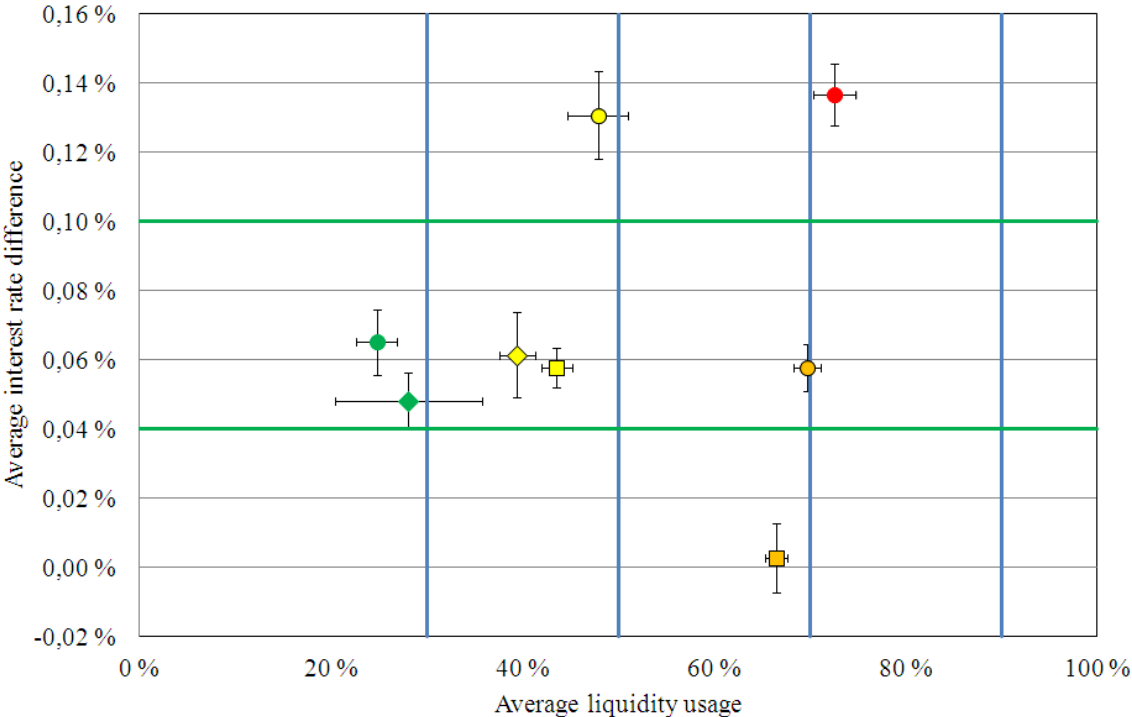
### 3.1 General indicator

The next step is to combine the information on liquidity usage and on interest rates on overnight credit. In more concrete terms, these two parts of the indicator can be included in the same plot; see Figure 5. In Figure 5, the average interest rate difference (EONIA - interest rate paid by each participant for overnight credit) calculated over about five calendar years (2006–2/2011) is shown as a function of the average liquidity usage for the eight biggest participants in TARGET2-Suomen Pankki system. From the figure we observe that the average liquidity usage varies from 25% to 73% and the average interest rate difference from 0.0028% to 0.1366%. The higher average interest rate difference indicates that the bank pays less for overnight credit.<sup>6</sup> From Figure 5 we see that the red dot (bank A) best manages its position. Bank A does not keep too much excess liquidity in the payment system and, on the other hand, it can get overnight loans at lower interest rate than the others. The orange square (bank B) has almost the same average liquidity usage level as Bank A, but it pays higher interest for overnight loans. Bank B could well deserve closer examination. The yellow dot (bank C) can also get cheap overnight loans, but its liquidity usage is not as efficient as for Bank A. The other banks stay in the neutral central zone. Their average liquidity usage varies from 25% to 67% and average interest rate difference from 0.0482% to 0.0651%.

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<sup>6</sup> Generally, the Finnish overnight loan interest rates are lower than EONIA.

**Figure 5.** A proposed indicator; the average interest rate difference is shown as a function of average liquidity usage. Now the total area is divided into fifteen blocks. A high interest rate difference combined with high liquidity usage indicates that a participant has a good and healthy position. A low interest rate difference combined with high liquidity usage indicates that a participant may be more stressed. Error bars indicate the area containing two-thirds of data points.



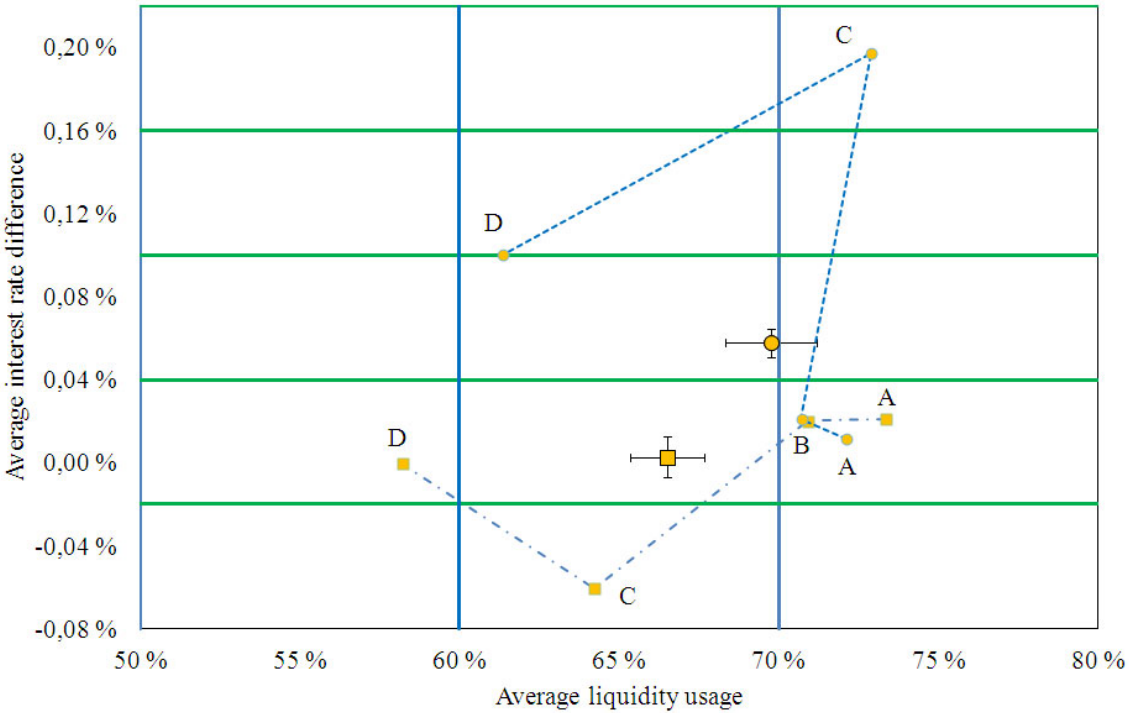
In the Finnish case, Figure 5 could be the baseline for the indicator. By defining the blue and green lines, we can divide the total area into subareas. In this example, blue lines define five liquidity slices (0–30%, 30–50%, 50–70%, 70–90%, 90–100%) and green lines three average interest rate difference slices (-0.02–0.04%, 0.04–0.10%, 0.10–0.16%). Altogether we have a grid of fifteen panels containing the participants. Since we do not have had any major bank defaulting in Finland, the large negative average interest rate difference values are missing. If a participant were in trouble, it would pay high interest on overnight loans and it would end up in the below -0.02% level in Figure 5. Also this same defaulting participant would have high average liquidity usage, probably above the 90% level.

## 3.2 Time behavior

When building the general indicator in part 3.1 we found out that two participants should be further analyzed. We decided to divide the five years into four periods, as Heijmans et al. (2010) suggested in their work.

Figure 6 shows how the proposed indicator develops over time. The four points refer to time periods as follows: A) the normal period before the financial crisis (1.1.2006–30.6.2007), B) the start of turmoil period (1.7.2007–14.9.2008), C) the acute crisis period (15.9.2008–30.6.2009) and the D) the stabilizing period (1.7.2009–28.2.2011). From Figure 6 we see that two participants (dot and square) are very close to each other during the normal (A) and start of turmoil (B) periods. The participants move in opposite directions when the start of turmoil mode (B) turns to the acute crisis mode (C). Finally, the participants end up in different stabilizing period states (D). This means that the other money market participants have re-evaluated the creditability of these two participants. The dot participant is in a better position than the square participant after the turbulent period. The next step would be to monitor these two participants on a daily basis to see whether the disparity vanishes or continues to grow over time.

**Figure 6.** An example of how the proposed indicator drifts over time. The indicator is shown for two participants (dot and square) who move in opposite directions when the start of turmoil mode (B) turns to the acute crisis mode (C). The money market participants have greater confidence in participant dot than in participant square. (D) describes the stabilizing period state; the disparity of the two participants is clearly visible from the graph.



### 3.3 Further steps

To summarize, if the participant has to pay a high interest rate on overnight credit and, at the same time, has used almost all of its liquidity, this participant may be running into problems. Such observable change in behavior could guide an overseer or supervisory authority to take a closer look at the participant's behavior.

The crucial points are the calibrations of the indicator ie the Grid. In practice, this would mean studying in greater detail the historical payment data from 2006 to the present. The key question is which of the peaks in Figure 4 are true alarms and which are not. Part of the calibration procedure is how to choose time windows (eg daily, monthly, yearly average) for the data point in the Grid. The next step would be to bring the data processing more into real

time. Each day, we should be able to calculate the indicator value on the basis of the previous day's data.

## 4 Conclusions

This work was inspired by the idea that information on TARGET2-Suomen Pankki payment system participants' liquidity usage could be combined with information on interest rates paid on their overnight loans. This Finnish example shows that there are observable differences between the ways in which participants manage their liquidity positions and how much they pay for overnight credit. Since there have been no major participant defaults in Finland, the results only indicate that some market participants do better than others, but that no one is in a serious trouble.

The next step could be to broaden the scope of this same exercise, eg to the 15–20 largest banks in the euro area. First, we should define the baseline period and block sizes for the Grid based on the historical data, which is not necessarily straightforward during abnormal times. The second step would be to detect and analyze the movements of participants within the Grid. The challenge here is to be able to calibrate the Grid smartly and to filter the single peaks, the false alarms, out of the raw data. If the filtering is too intensive, then there is a risk that also some significant sudden changes will be excluded. Obviously, Eurosystem non-standard monetary policy measures, like fixed-rate full-allotment procedures, have effect on the calibration of the Grid. In such a situation, participants may borrow more money from central banks, instead of interbank market.

Using the indicator also poses a challenge for the data management process, as data should be available on a close-to-real-time basis. In the best case, the today's indicator value would be calculated on the basis of yesterday's data.

In sum, we find this indicator to be a potentially highly useful tool for overseers to support the financial stability analysis. The more data from various sources are combined, the more knowledge we can obtain. Stock prices and collateral volumes could be next in line for adding to the indicator presented here.

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