

Timing characteristics of overnight unsecured interbank transactions in VIBER*

László Bodnár – Miklós Luspay – Cecília Pintér

The article examines the timing, duration and underlying factors affecting the properties of overnight loans settled in the Hungarian large-value payment system (VIBER¹) operated by the MNB (Magyar Nemzeti Bank), from a payments perspective. The authors primarily focus on questions such as what sort of patterns or trends exist in regard to the settlement times of unsecured overnight loans completed in VIBER, what factors affect these times and what does the maturity of an O/N transaction depend on, in general. The paper finds that in the case of money market shocks, system participants tend to react similarly in relation to the timing of their O/N transactions. The maturity of overnight transactions is more affected by the timing of O/N loan repayments rather than the borrowing times.

Journal of Economic Literature (JEL) Classification: E42, E44, G21.

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1. Introduction

This study examines the settlement practices of money and capital market transactions performed in VIBER, specifically focusing on the timing patterns of lending and repayment of overnight (O/N) unsecured money market loans. This paper is the first part of a series that will go on to analyse other interbank transactions completed in the payment systems.

In our analysis, we linked Hungarian O/N unsecured interbank transactions with the VIBER database and then examined the timing of transactions' settlement, the underlying reasons for diverging timing behaviours, and also the adjustment of the banking sector as a whole to the events that occurred during the period under review.

* The views expressed in this paper are those of the author(s) and do not necessarily reflect the official view of the Magyar Nemzeti Bank.

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¹ Domestic, large-value time critical payments, including interbank money market transactions are settled in VIBER (Hungarian acronym for the real-time gross settlement system) operated by the MNB.

For a stable banking system, smoothly functioning money and capital markets are required in which the optimisation of sector-level liquidity takes place. For the money market as a whole, we can distinguish two submarkets. In the case of the secured money market, banks are obliged to pledge adequate collateral to ensure guaranteed completion of the transaction, i.e. counterparty risk is hedged. This includes the *repo market*, where the underlying collateral is a security, and the *FX swap market*, where currency swaps take place, i.e. “the receivable arising in one currency serves as collateral for the liability outstanding in the other currency” (Páles et al. 2010). The other segment of the money market is called the *unsecured (depo) market*, where no collateral is required to complete a transaction, and therefore no guarantees are included at all if the other credit institution in the same transaction defaults. In this case, the counterparty limits set by the individual business partners against one another restrict lending and borrowing. Transactions can be concluded for various maturities, but longer maturities are less relevant in terms of payment transactions, so this paper primarily focuses on overnight unsecured transactions. Market players with temporary liquidity shortages or surpluses may – alongside other market and central bank options – lend to one another with overnight maturity, which implies a repayment obligation on the following business day. These short-maturity transactions constitute a key tool of bank liquidity management. Credit institutions also have the option of concluding their transactions with the central bank (by placing deposits at the central bank in the event of a liquidity surplus, or by borrowing from it in the event of a liquidity shortage), but in an optimal scenario, banking system participants complete such transactions among each other rather than with the central bank, a behaviour which is also stimulated by the central bank’s pricing (width of the interest rate corridor). The objective is for credit institutions to place their excess liquidity on the interbank market and to meet their liquidity needs from this same interbank market. Depending on what is written in the contract by the parties, O/N unsecured interbank transactions can be regarded as both lending and the placement of a deposit, they are henceforth referred to as O/N interbank lending and repayment.

An O/N unsecured interbank transaction is concluded directly between two counterparties on the transaction date (hereinafter day T) under market terms, and its fulfilment involves a movement of cash (movement of principal), that is, a payment between the participants in the transaction. On day T, the lender of the O/N loan (Bank A) transfers the principal amount to the borrower (Bank B). On the following business day (hereinafter day T+1), the borrower of the loan repays the principal amount and the interest payable based on the interest rate defined for the transaction to Bank A.

The cash movement linked to O/N transactions can be carried out in two different manners, depending on where the two participants keep their payment accounts. If the lender does not have a payment account for the borrowing bank, then two

direct VIBER participants transact with each other, meaning that the settlement of the O/N loan takes place in the large-value payment system VIBER. However, the O/N unsecured interbank transaction is not necessarily carried out as a VIBER transaction if one of the credit institutions holds a payment account for the other. In this case, the transaction may be settled through this account, without using the payment system (these are referred to as “on-us” transactions²). If a credit institution holds a payment account for the other party, but obtains the required funds for the O/N loan from the money market, then a VIBER transaction is associated, although not directly, since this latter settled in the payment system is separate from the on-us O/N transaction. Last but not least, we must also mention the case where both the creditor and borrower hold their accounts at the same third party credit institution. In this latter case, the transaction is settled by means of a simple book transfer between these two accounts, hence not generating any turnover in the RTGS.

In this analysis, we observed the timing of interbank O/N transactions based on data available in the RTGS. We analysed how the different properties of the participating institutions affected the timing of O/N transactions, and also how the various changes taking place on the money market in the period under review (such as central bank liquidity measures, money market uncertainty) affected this. The majority of studies focusing on the O/N money market concentrate primarily on the general features of O/N interbank markets, but tend to focus less on the settlement practices of transactions, timing patterns and changes therein (especially during times of money market shocks). This paper attempts to identify the features of the unsecured O/N market from the perspective of payments, in particular timing patterns and how these features have changed on the whole since 2008. Developments in the timing of transactions may allow us to draw certain conclusions on trends and behavioural patterns. When writing this study, aside from analysing data, we also talked to treasury and back office experts to identify behavioural patterns.

This paper is divided into five chapters. After the introduction in Chapter 1, Chapter 2 presents the analysis environment, in particular the period under review, as well as the role of the domestic RTGS. Chapter 3 highlights the methodology applied in the analysis. In this section we also elaborate the success rates of linking the two databases, detailing the result ratios (how many transactions we could successfully identify in both databases) and the possible reasons for failed identifications. Chapter 4 details our findings and addresses the unique characteristics of the borrowing and repayment legs (first and second leg) of O/N transactions, as well as developments in the timing of both of these legs during the period under review. We explore the role of various sized transactions in liquidity management and

² see Subchapter 3.2 for more.

identify the possible reasons driving the movements in the quarterly and year-end timing of O/N items. Finally, we summarise the length of O/N transactions. Chapter 5 provides a summary of our experiences and sums up our conclusions.

2. Analysis environment

2.1. Horizon

This study examines O/N unsecured forint interbank transactions settled between 2 January 2008 and 31 July 2014 among all of the interbank money and capital market transactions. On the basis of VIBER value dates, we observed the settlement time stamps (not the time when the contract itself was concluded) of both legs of unsecured O/N loans. Timing behaviour is significantly influenced by the characteristics of the interbank market, and thus we have broken down the entire period into phases based on the key economic events that shaped the market. The five periods reviewed are:

- (1) Pre-Lehman period: 2 January 2008 – 20 October 2008.* A “period of calm” for the O/N unsecured interbank market. O/N transactions were carried out smoothly, without considerable adjustments and with similar volumes as in earlier periods. No significant change characterised timing behaviour.
- (2) The Lehman shock – the period when the US subprime mortgage market crisis filtered through to Hungary: 21 October 2008 – 16 December 2008.* The impact of Lehman’s collapse in September filtered through to Hungary in October 2008, causing substantial changes on the O/N unsecured interbank market in terms of value, volume and also timing patterns. In general, mistrust among market participants occurred, counterparty limits set against each other decreased, drying up the money markets. Credit institutions channelled their excess forint liquidity into MNB deposit instruments (primarily overnight deposits), considered to be the safest at that time.
- (3) Post-Lehman period: 17 December 2008 – 31 December 2009.* Credit institutions adapted to the changed circumstances on the interbank market. This was an initial period of market consolidation which is clearly reflected in the reduction of O/N central bank deposits and in the partial reversal of counterparty limits. The liquidity measures introduced by the MNB, along with the improvements in market confidence, caused a slow pick-up in activity on the O/N unsecured interbank market.
- (4) Market adjustment, stable period: 1 January 2010 – 30 June 2012.* Thanks to cooperation of the major central banks, international investor sentiment and risk appetite improved considerably. The positive impact of this phenomenon was progressively felt on the Hungarian market as well. Activity on the overnight

interbank market, the timing of transactions and counterparty limits stabilised at pre-October 2008 levels.

(5) *The period following the introduction of the Interbank Clearing System (ICS): 1 July 2012 – 31 July 2014.* The ICS impacted the timing of intraday clearing in several respects.

2.2. Payment system under review

Our analysis only concentrates on the settlement of O/N unsecured interbank transactions identified in VIBER. VIBER is the real-time large-value gross settlement system operated by the Magyar Nemzeti Bank (MNB). VIBER is primarily used for the settlement of large-value time critical payments infrastructures. Money market (or the so-called interbank) transactions constitute a considerable share of turnover generated in VIBER. Unsecured O/N loans can also be classified in the money market cluster (with the exception of “on-us” items settled on loro accounts).

In our analysis, we separately analysed the periods that are relevant from the aspect of VIBER’s operation. This was necessary primarily due to the changes taking place in intraday timing patterns. Until 1 January 2012, VIBER closed one hour earlier compared to the current settings, operating between 8:00 and 17:00. Since 1 January 2012, the RTGS is available for system participants between 8:00 and 18:00.³ Within these business hours, credit institutions may fulfil their customer orders between 8:00 and 17:00, their own interbank and securities transactions until the closing of VIBER at 18:00.

3. Methodology

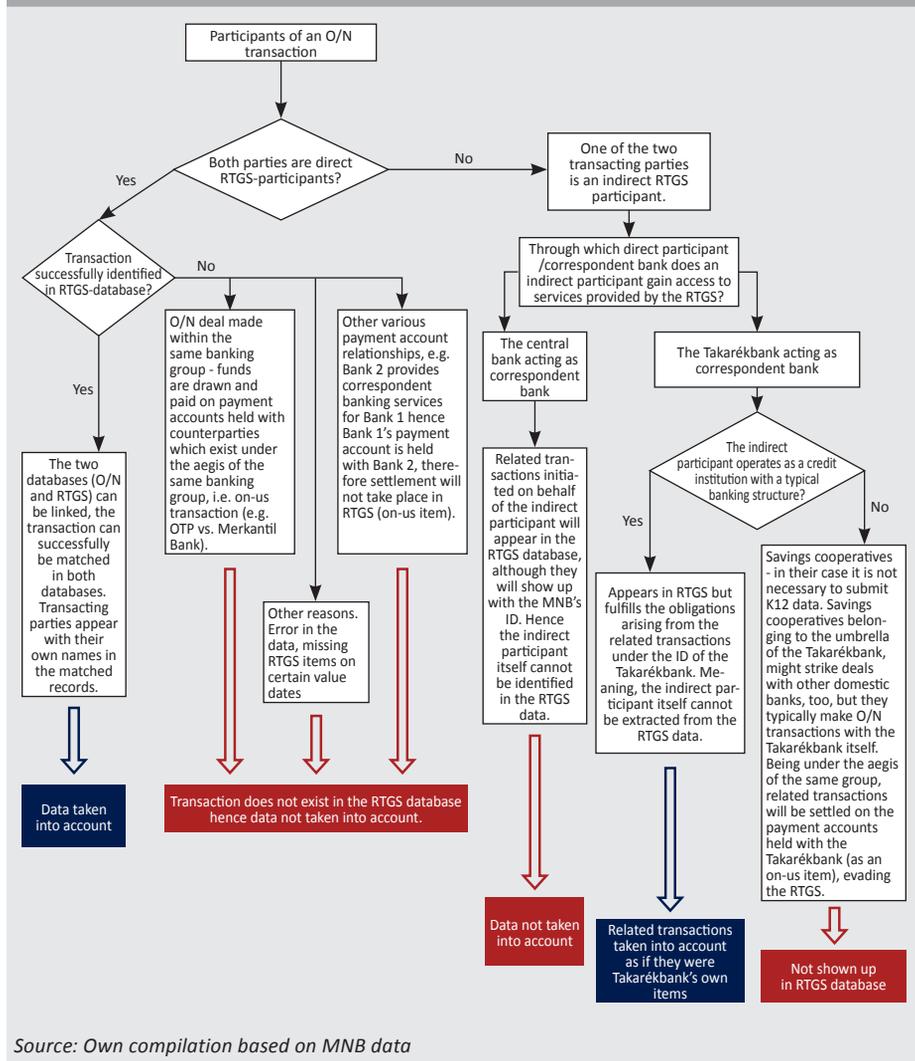
3.1. Basic data and databases

For the transaction-based identification of O/N loans and for matching both its legs in the RTGS database, we used RTGS payment data and the mandatory K12 data reporting entitled “Daily report on interbank overnight forint loan and forint deposit interest rates”. The MNB, in its capacity as VIBER’s system operator, continuously records key data on the system’s operation and attributes, and in this context, it also records the VIBER turnover on settlement dates. Thanks to this, a significant portion of the data necessary for the study became available, including the identifier (SWIFT BIC code) of both the sending and recipient VIBER participant, the transaction amount, the date and *time (timestamp)* of settlement. The K12 data report contains data for unsecured interbank O/N transactions concluded between credit institutions on the transaction day. In every case,

³ VIBER’s opening hours changed as of 3 August 2015. From this date onward, the RTGS opens at 7:00 and closes at 18:00.

both involved parties are obliged to report the transaction, but we naturally took each transaction into account only once. The report also specifies the maturity, amount and interest rate for each transaction. Our primary objective in linking the two databases was to identify the greatest number (possibly all) O/N unsecured interbank transactions within VIBER. We proceeded based on the iteration logic presented in Figure 1.

Figure 1.
Steps in linking the K12 and RTGS databases



By linking the two databases according to the primary keys, we finally obtained the dataset used for our analysis. For the first leg (borrowing) of an O/N unsecured loan, the date of the transaction, the contractual amount involved and the participating counterparties needed to be identified to link it to the associated transfer in RTGS. On the following day, the amount plus interest (second leg) is repaid, so the search must be performed accordingly. Another aspect was whether the principal and interest are repaid separately or bundled into a single transaction. Based on our experiences we can say that in most cases, the contractual amount and interest were repaid together, in one single RTGS transaction. There were some situations, however (1 per cent of all successfully identified records) where the contractual amount and interest due were settled in two separate transactions in the RTGS; in these cases, we only took into account the RTGS transactions containing the net contractual principal amount without interest.

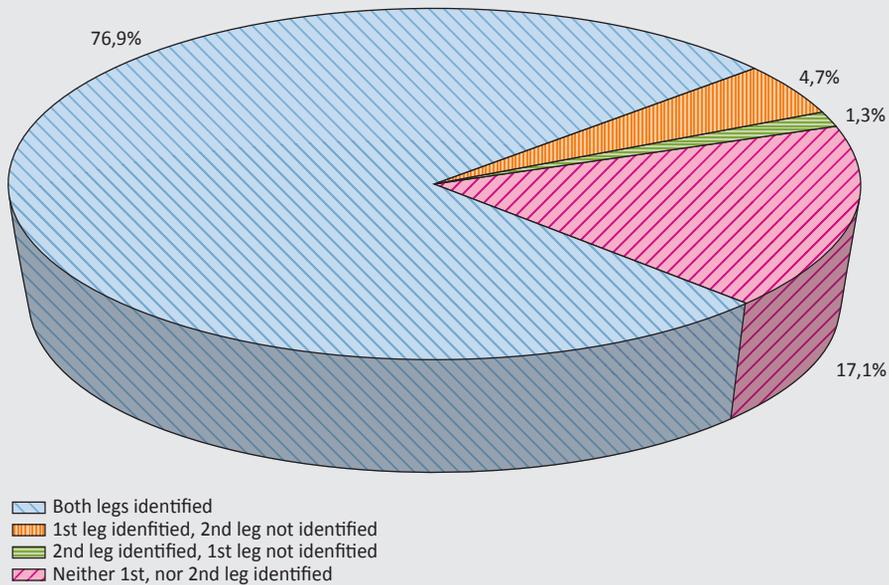
3.2. Outcome of linking the databases

We managed to identify approximately 80 per cent of transactions by linking the K12 database and VIBER payment data. In the period between 2 January 2008 and 31 July 2014, money market participants concluded a total of 54,788 unsecured transactions, and we managed to identify nearly 80 per cent of these in VIBER (Figure 2). The reasons for the failed identification of the remaining approximately 13,000 transactions (20 per cent) varied:

1. *The transaction was executed outside the payment systems (“on-us” items).* “On-us” items are the ones when either one of the transacting participants (either the creditor or the debtor) holds a payment account for the other party and thus the transaction is executed without coming into contact with payment systems, via a simple book transfer within the bank. We can distinguish two groups within this category: (1) credit institutions which are part of the same banking group, and (2) a bank providing correspondent bank services for various reasons. If banks with such mutual payment account management relationships conclude an O/N unsecured interbank transaction, it does not generate any turnover in VIBER, as the transactions are completed via internal settlement (i.e. book transfer). “On-us” items have a relatively smaller significance based on the entire data series, accounting for merely 11 per cent of total O/N transactions.
2. *Items not identifiable for other reasons.* When pairing the data of the two databases, sometimes it is not the payment flows associated with an O/N unsecured interbank transaction that are identified. Counterparties concluding the transaction may also conclude other types of (non-overnight) interbank transactions in the same amount on the same value date. These items cannot be filtered out, and therefore their distorting impact might influence, although only at a small-scale, the results obtained.

3. *Partial or full roll-over.* The principal amount of an O/N transaction may be rolled over on day T+1 to the following day (or the amount itself might be changed), in which case only the interest (or the difference resulting from the amended principal amount) is settled. This could partially be the reason for why we found a large proportion of transactions where the 1st leg was successfully identified in the RTGS, but the 2nd leg was not. We could only identify the first leg of transactions in 5 per cent of the cases, while transactions for which we could only identify the second leg only accounted for 1.3 per cent. As these items may significantly distort our calculations, we ignored them in our analysis.
4. *The MNB's databases do not contain the data (related to the indirect submitter) necessary for pairing.* If one of the transacting parties is an indirect system participant (meaning it uses the RTGS through a direct participant) and is not concluding the transaction with this correspondent bank, then settlement of the transaction will generate turnover in the RTGS. So the indirect participant can only fulfil its payment obligation in VIBER through a direct VIBER participant (its correspondent bank). This means that the transacting parties and the RTGS direct participants which effectively initiate and send the items will differ. Therefore, these items are recorded as transactions initiated by the correspondent bank.

Figure 2.
Identification ratio of O/N unsecured interbank transactions in the RTGS



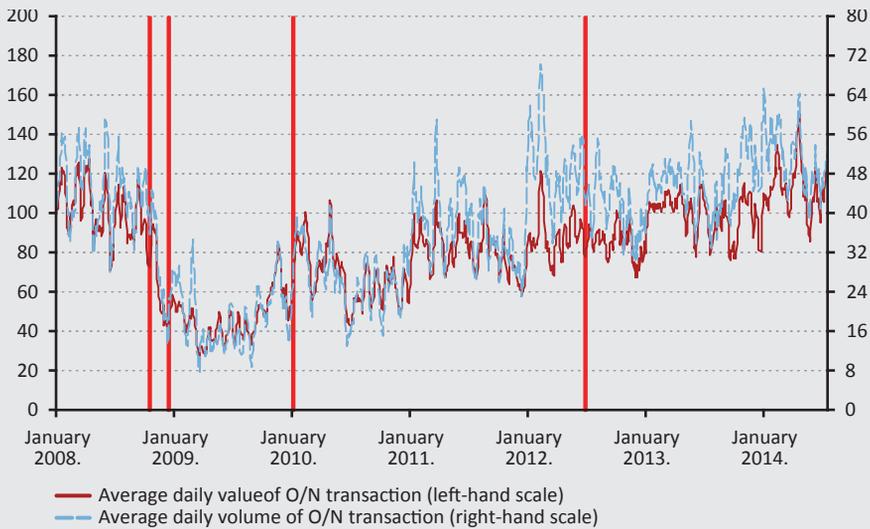
Source: Own compilation based on MNB data

4. Results

4.1. Size and characteristics of the market

During the entire period under review, market participants concluded O/N unsecured interbank transactions in a daily amount of HUF 93.3 billion on average, accounting for 2–4 per cent of total VIBER turnover. In terms of turnover generated by O/N transactions in VIBER, the first leg (borrowing) accounted for 2-4 per cent of VIBER turnover (Figure 3). If we add *repayments* on day T (associated with borrowings taking place on day T-1) to the borrowings on day T then this previously mentioned ratio rises to 4-8 per cent. Considering that the average daily VIBER turnover is HUF 4,781 billion⁴ – amounting to 41 times the annual Hungarian GDP on average – we can state that the turnover of O/N transactions settled in VIBER is significant. We obtain a similar result in terms of volume, with the number of transactions linked to O/N borrowing relative to the total number

Figure 3.
Volume and value of O/N unsecured interbank transactions
(2008 – July 2014)



Note: Ten-day moving average

Source: Own compilation based on MNB data

⁴ Based on RTGS data covering period 2 January 2008 – 31 July 2014.

of VIBER transactions ranging between 0.5 and 1 per cent. If we also factor in intraday repayments, this range roughly doubles, to 1–2 per cent.⁵

Developments in the value and volume of O/N interbank transactions in the observation period clearly reflect the events that unfolded on the interbank market. Following the collapse of Lehman Brothers, turnover dwindled on the entire interbank market, prompting the central bank to introduce a number of measures that allowed banks' liquidity position to stabilise over time. The MNB helped banks managing their liquidity by expanding the scope of eligible collateral, decreasing the minimum reserve ratio and running VIBER's automated gridlock resolution algorithm⁶ more frequently. Due to these measures, banks – in line with international experiences – were able to increase their liquidity available for payments, which was reflected mainly in the rise in intraday credit lines (Figure 4), and turnover in the unsecured interbank market also increased simultaneously.

Credit institutions' market position underwent a significant change in the period under review. The number of participants shrank significantly at the end of 2008, and the market saw concentration in terms of both the creditors and borrowers. All of this had a tangible impact on the O/N unsecured interbank market, which started contracting from October 2008 onwards in terms of both value and volume. After the crisis, the interbank market gradually returned to its earlier dynamics. Thanks to the cooperation of key central banks and monetary easing, international risk appetite improved. Also, as a consequence of the measures initiated by the MNB, an increasing number of money market participants returned to the O/N unsecured interbank market.

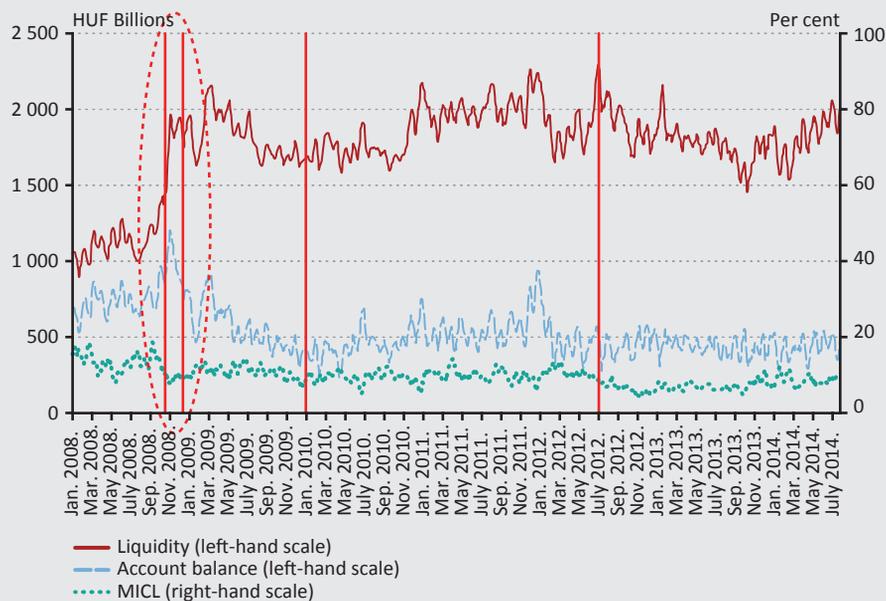
Scrutinising the liquidity of the entire interbank market is essential for analysing O/N unsecured interbank transactions in terms of payments. The payment liquidity of VIBER participants consists of two elements: the account balance and the central bank overdraft facility backed by collateral. During the day, the current account balance changes continuously as credits and debits occur, but the possible level is effectively determined by the reserve requirement regime. The intraday credit

⁵ It is worthwhile to compare these values with international statistics. Advances of overnight unsecured interbank loans accounted for 11 per cent of the daily average value (roughly GBP 200 billion) of the United Kingdom's large-value payment system (CHAPS Sterling). If we also include repayments linked to the borrowing of the preceding day, the figure rises to 22 per cent of total CHAPS Sterling flows (Millard *et al.* 2004) Craig H. Furfine obtained similar results in his study. According to his estimate, overnight unsecured transactions account for approximately 24 per cent of the volume generated within the US's Fedwire payment system (Furfine 1999). These ratios are somewhat lower on Canada's Large Value Transfer System (LVTS), with overnight interbank transactions accounting for only 3 to 4 per cent of the total turnover generated within the system (Hendry *et al.* 2007).

⁶ If a VIBER participant is unable to fulfil its outgoing items due to a liquidity shortage, the items are queued and are not settled until the credit institution finds sufficient liquidity. During the crisis, queuing emerged at several banks due to the lower counterparty limits set between credit institutions, thereby jeopardising the sound and efficient operation of the financial system. In the interest of more effective queuing, the MNB ran its gridlock resolution algorithm more frequently (every 10 minutes), which multilaterally resolves opposing debts.

line is basically affected by the list of eligible collateral (mainly securities) accepted by the central bank. Once a system participant executes its payments using its intraday credit line, it must "top up" the resulting negative account balance to zero by the end of the day at the latest. Therefore, VIBER participants strive to close the credit line used up during the day, as the credit line used intraday is free of charge, its sole price being essentially the opportunity cost of the pledged collateral, but if the intraday credit remains open at the close of the day for the central bank, it is automatically converted into overnight collateralised credit (on which interest is payable). The optimal case is when an adequate amount of incoming items is received by the credit institution by the end of the day, the financing impact of which is sufficient for the bank to close the credit line used during the day. If a VIBER participant does not expect a sufficient volume of incoming items, it may take out an O/N unsecured loan on the interbank market to meet its payment obligations. If the credit institution is still unable to find funding on the market in time, it receives the central bank's automatic overnight secured loan. On the other

Figure 4.
Account balance, liquidity (sum of account balance and intraday credit line), and the maximum utilisation of intraday credit line (MICL) of VIBER participants
 (2008 – November 2014)



Note: We excluded the MNB's transactions in our calculations. Data calculated using a ten-day moving average.

Source: Own compilation based on MNB data

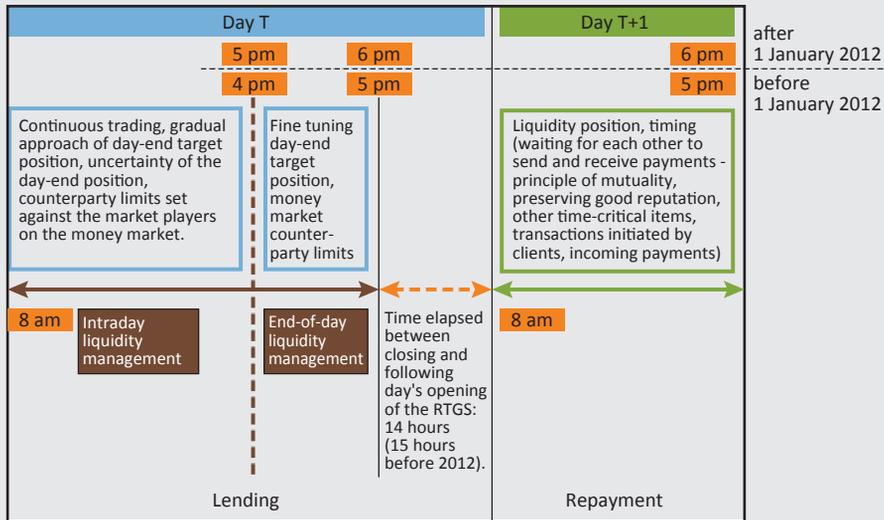
hand, if a credit institution's intraday liquidity increases, its need for the liquidity-providing (financing) role of O/N unsecured interbank transactions decreases. Overall, forint liquidity has changed significantly during the period under review for the banks participating in the Hungarian payment systems, but remained ample.

Uncertainty and turbulence on the interbank market affects the O/N unsecured market significantly as the settlement of transactions is not guaranteed by the counterparties with collateral. In the case of O/N loans, the creditor's counterparty risk is that the other party involved in the same transaction fails to repay its obligation on the following day, causing a loss for the creditor. One of the tools for mitigating this counterparty risk is the use of counterparty limits, which involves limiting a position against the other credit institution. At the end of 2008, due to news emerged about banks with good credit ratings having financial difficulties or even going bankrupt, credit institutions became uncertain as to whether they were properly able to assess their trading partners' creditworthiness and hence market participants significantly decreased their counterparty limits against each other. Participants of the Hungarian interbank market primarily responded to market uncertainties with quantity adjustments, i.e. a sharp decrease in the number of transactions (*Figure 3*). Banks concluded fewer and smaller value transactions due to the modified counterparty limits, and also it was much easier for banks to find counterparties for such smaller transactions on the market. Meanwhile, interbank interest rates increased, making funding more expensive, which further decreased unsecured interbank turnover. Later, with market consolidation, turnover gradually returned to its pre-crisis level. It should be noted, however, that banks' counterparty limits are not the only obstacle to trade. It is often the case that a credit institution's willingness to take risks, internal rules of procedure or other self-imposed restrictions (such as the size of the available liquid portfolio that may be advanced as credit) function as limits that may significantly impact its liquidity management.

4.2. Timing practices of advancing and repaying O/N unsecured interbank market transactions

Timing practices of O/N unsecured interbank transactions – in terms of both borrowing and repayment – are shaped by liquidity considerations, risk management expectations, reputational risk considerations (protecting one's good reputation) and yield expectations. The drivers behind the borrowing and repayment of an O/N loan may vary, substantially influencing the lending and repayment habits and the timing of items (*Figure 5*).

Figure 5.
Factors shaping the timing of the 1st leg (borrowing) and 2nd leg (repayment) of O/N loans



Source: Own compilation based on MNB data

The motives behind borrowing (first leg) vary based on whether the transaction takes place during the day or at day-end. Banks' liquidity position is uncertain until 17:00 – this is the cut-off time for customer payments in VIBER. Participants attempt to gradually approach their expected end-of-day target position by means of continuous trading. Obviously, intraday liquidity management is not solely defined by the approach of planned end-of-day positions, other factors matter as well, e.g. the volume of repayments of interbank transactions falling due that day and obligations stemming from the fulfilment of newly concluded bank-to-bank and customer transactions.⁷ During this period, the relative availability of a system participant on the market is also a key factor. Intraday market behaviour is also shaped by parent bank expectations, which are particularly significant in terms of setting counterparty limits. The intraday trend in interbank interest rates may also be a key factor in the timing of transactions. Interest rates typically change at around 14:00-16:00, which can significantly affect intraday liquidity management. During VIBER's last business hour (17:00-18:00), only the settlement of interbank

⁷ Banks signed a voluntary interbank agreement to fulfil payment orders submitted by their clients within two hours (the two-hour rule). This is also a motive in terms of reputation.

transactions, securities transactions and the last cycle of ICS intraday clearing⁸ can be carried out. This final hour time-window is usually referred to as end-of-day interbank liquidity management when the most accurate adjustment of the closing account balance position is given priority, as both reserve deficiency and reserve surplus⁹ comes at a price. At the end of the day, the balance of the VIBER participant's current account (held with the MNB) gradually approaches the target closing value, but during this process other factors may come into play, such as resolving liquidity surplus / shortages, adjusting liquidity management behaviours to comply with the averaging mechanism of the reserve requirement system, implementation of liquidity strategy, and also implementation of the closing balance target due to reporting obligations to the parent bank.

There are also several factors playing a role in the timing of the repayment (second leg), based on which the bank decides to either bring forward or postpone repayment. The basic motivation is the payment obligation existing between the parties as the loan taken out earlier must be repaid. Banks can repay the loan in two ways:

1) They may initiate repayment during the day on the payment due date (T+1)

The main factors that may entail either early or delayed repayment include: (i) the available liquidity, (ii) the intraday liquidity position (e.g. is there any queuing), (iii) the expected volume of incoming items (their financing impact), (iv) the expected timing of client transactions to be executed the same day, (v) other time critical items.

Timing may also be influenced by the counterparty limit conditions set within the framework of the O/N loan contract. That is, does the part used by the transaction

⁸ ICS is the domestic small-value gross payment system operated by GIRO Zrt. Introduced in July 2012, the intraday clearing system offers five cycles during the day for clearing transactions instead of the earlier overnight clearing. Cycles and post-cycle clearing periods: First cycle: 06:30-08:30 (08:30-09:40), second cycle: 08:30-10:30 (10:30-11:40), third cycle: 10:30-12:30 (12:30-13:40), fourth cycle: 12:30-14:40 (14:40-15:50), fifth cycle: 14:40-16:30 (16:30-17:55) (Luspay et. al., 2014). This changed as of 7 September 2015, clearing now takes place in ten cycles instead of the earlier five.

⁹ The reserve requirement is derived from the product of the required reserve ratio — which may be set freely between 2 and 5 per cent every half year — and the credit institution's reserve base. This is the minimum amount that must be held by the specific credit institution on its account held at the central bank (the rule changes from 1 December 2015 onwards when each system participant will have to use a fixed, 2 per cent reserve ratio). Credit institutions must meet this mandatory minimum level as a monthly average, i.e. they must ensure that the average of their end-of-day closing balances reaches this statutory minimum in the given month. Hence this mechanism provides banks with a certain flexibility in the sense that they have more freedom in determining their account balances and therefore the liquidity available for their payment transactions over the course of a given month. Some banks, for example, hold a higher account balance than their selected reserve ratio (i.e. run a reserve surplus) at the beginning of the month, and adjust this surplus in the second half of the month (run a reserve deficit). It is important to note however that running a reserve surplus or deficit has (the same) cost. The MNB does not pay any interest for the balances held above the reserve requirement (i.e. running a surplus incurs losses for the system participant), whereas running a deficit means penalty rates are imposed which equal the base rate. As a result, banks strive to keep an account balance equal to their obligations on average over the course of a month (Bodnár-Luspay-Madarász, 2014).

become available only after receipt of the repayment or already on the morning of the repayment's due date. In addition to the above, the expectations of the creditor may also be determining from the perspective of the "debtor" if the creditor is not willing to conclude another interbank transaction until the debtor has repaid its debt. In such a case, the obligor bank may accordingly bring the repayment forward. But the other side may also be true, i.e. if it is waiting for an incoming item from its counterparty in relation to another transaction then they may have to wait for each other due to their payment obligations, so the principle of mutuality may entail the postponing of the time of settlement. Using the PvP module of VIBER may help in such cases. If two banks initiate a bank transfer to one another then the module allows the settlement of these transactions only if both parties have provided the necessary amount of collateral¹⁰.

2) Repayment is already initiated in VIBER on the day of borrowing (day T)

Transactions may be submitted already value-dated to VIBER. Value-dated repayment refers to cases when the bank submits a payment item for a future value date, i.e. the day the transaction is initiated differs from the day the transaction is fulfilled. Value-dated transactions submitted on day T account for a large portion of items settled before 08:30 day T+1. These transactions are immediately settled after VIBER opens on day T+1 (provided sufficient funds are available), meaning that in the case of O/N loan repayment, the bank repaying the loan can no longer use the amount for its T+1 day payments, while the creditor bank can use the amount immediately after VIBER opens for the day. Bank concentration is significant in the case of value-dated transactions, as more than 70 per cent of these items were associated with two banks until 2013. After 2013, only one of them followed this practice. The proportion of value-dated items compared to all second leg transactions stands at around 20–25 per cent per period. On average, 4–12 transactions were fulfilled value-dated on a daily basis, or HUF 15–65 billion on average.

4.3. Impact of money market events on the timing of the first leg of O/N unsecured interbank transactions

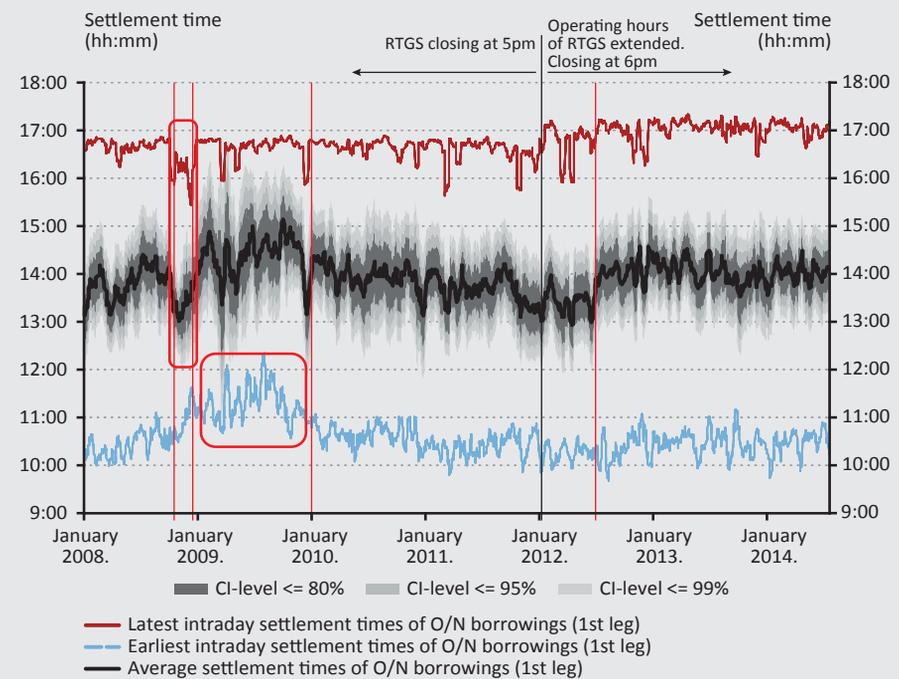
The timing of the first leg of O/N unsecured interbank transactions reflects money market events and turmoil, and different periods are characterised by different timing behaviours (Figure 6). At the end of 2008 (during the second period) due to contraction of the unsecured O/N market, reduced counterparty limits and mistrust, banks brought the timing of the first leg forward within the day (the average time stamps shifted from 13:50 to 13:20 (Table 1). Banks did not wait

¹⁰ In other words: bank A owes money to bank B and vice versa, whereas they want to initiate a transaction to one another. Thanks to the PvP module, one transaction will be settled only if the other one is also settled, i.e., the module "holds" the two transactions until sufficient funds are available on behalf of both banks for completing the transfers. Thanks to this, the settlement risk between the parties is eliminated.

with O/N interbank borrowing “until the last moment” – that is VIBER’s closing time. Instead they acted on as soon as they had the chance or it was necessary for them to borrow or place funds, much earlier compared to prior practices. Due to the uncertainty entailed by the crisis, credit institutions were worried that as approaching day-end closing, the number of banks being able to provide them with liquidity would decrease (as these might finish trading sooner) meaning there would be no bank left to grant them a loan. Due to the mistrust on the market, banks were reluctant to conclude transactions with one another. As a consequence of the low interbank counterparty limits, the pool of liquidity available shrank, which was another reason that made borrowing urgent for the banks so that they could access at least a part of this limited liquidity. In order to address the situation, the MNB narrowed the interest rate corridor and as a result, credit institutions primarily concluded their transactions with the MNB to “fine tune” their liquidity position instead of obtaining funds from or placing their surplus liquidity on the

Figure 6.
Timing of the 1st leg of unsecured interbank transactions (daily averages) with the earliest and latest intraday settlement times and the 80%, 95% and 99% confidence intervals

(2008 – July 2014)



Note: with a ten-day moving average

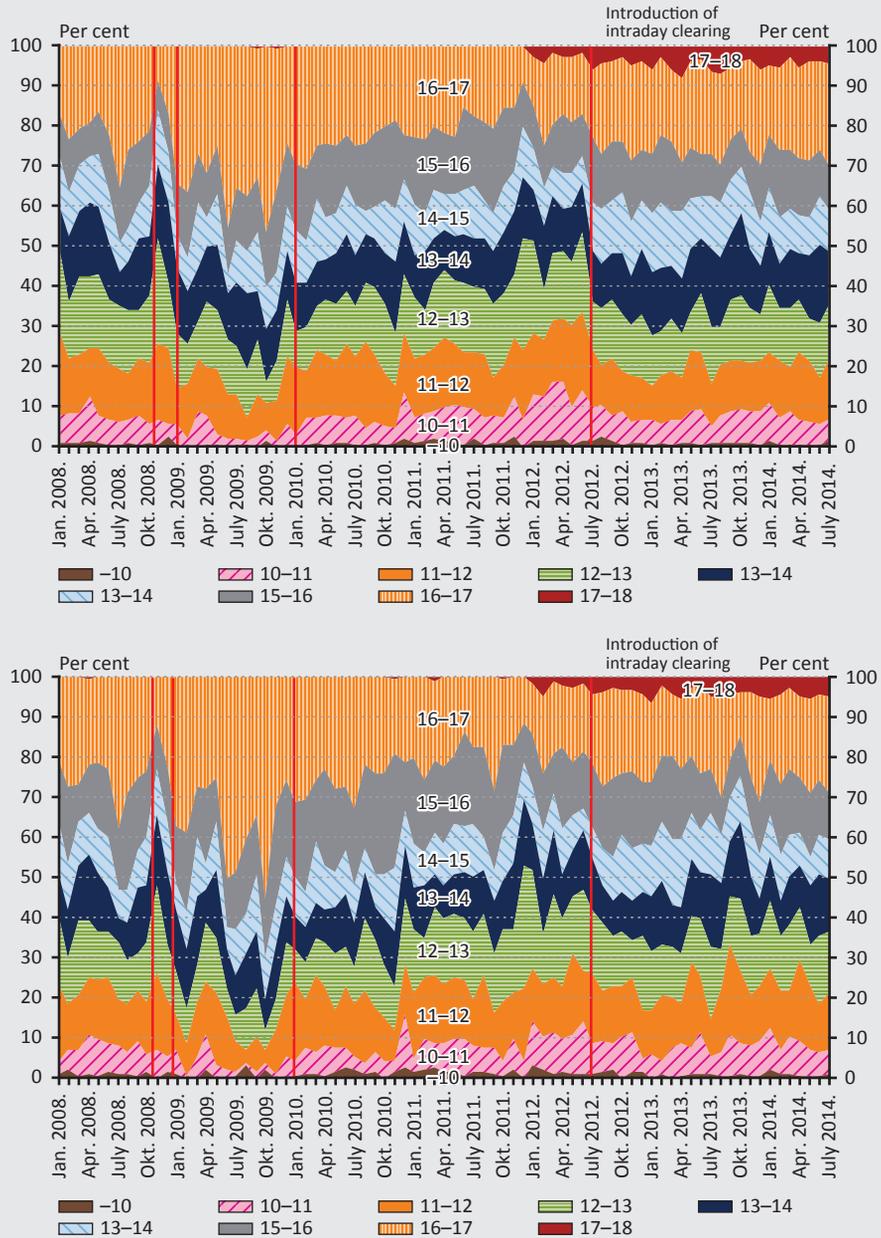
Source: Own compilation based on MNB data

interbank market. The few transactions that system participants concluded on the market were settled as early as possible during the day to allow them to find a counterparty in time for their open transactions. This is the reason why (based on historic data) the scope of both the banks willing to lend and those wanting to borrow substantially decreased between the 16:00 and 17:00 time frame (which is critical for the end-of-day liquidity management) meaning that the market became more concentrated. The timing of O/N transactions settled *last* within a day was also brought forward substantially. Early exit of creditors forced the remaining market participants to close their positions sooner, so system participants also had to adjust their closing balance targets earlier. However, from the beginning of 2009, when confidence returned and counterparty limits started to reverse, banks' borrowing times gradually adjusted back to the pre-October 2008 level, while the confidence interval broadened significantly, which means that at that time it was not possible to accurately determine when the specific transactions will be settled even at a 99 per cent certainty. Essentially, O/N borrowing could take place with the same chance at any time between 11:00 and 17:00. Simultaneously, until approximately September 2009, the intraday period between the *earliest* and the *latest* settlement times, during which banks concluded O/N interbank unsecured transactions, had "narrowed" substantially. Compared to other periods, banks were willing to conclude transactions only in a more limited time window. Postponing the earliest O/N transactions' settlement times could have played a key role here; we assume that banks started to transact later in the morning because they were waiting for market news about their counterparties. To sum up, the intraday time window for payments has shortened as a result of the crisis, while at the same time the settlement of transactions completed within this time window became more random, indicating the uncertainty of the market.

The bulk of the first leg of O/N unsecured interbank transactions were fulfilled in VIBER between 15:00 and 17:00 both before and after the crisis (Figure 7 and Table 2). Under normal circumstances, banks calculate their liquidity needs in advance, trying to assess the volume of incoming and outgoing payments on a given business day. If necessary, they access the O/N unsecured interbank market and either lend or borrow the difference between their estimated and actual turnover at the end of the day. In such cases, banks generally prefer to conclude transactions late in the afternoon, but they do not wait until the very last moment to submit their transactions. Under less stable circumstances – mainly as a result of shaken interbank confidence – it is more difficult to plan ahead during the day, so whenever the opportunity arises, banks immediately lend or borrow, that is, they conclude transactions much sooner during the day. As a result of the crisis, the settlement of the first leg of O/N unsecured interbank transactions has become concentrated in the early afternoon (between 12:00 and 15:00), i.e. credit institutions' timing behaviour has changed. Previously, items typically timed later within a given day were brought forward shortly after the Lehman

Table 1 Statistics of settlement times related to O/N borrowing (hour : minute : second format)*					
Period	(1) Pre-Lehman period	(2) The Lehman shock	(3) Post-Lehman period	(4) Market adjustment, stable period	(5) The period following the introduction of the ICS
Time interval	2 January 2008 – 20 October 2008	21 October 2008 – 16 December 2008	17 December 2008 – 31 December 2009	1 January 2010 – 30 June 2012	1 July 2012 – 31 July 2014
Average settlement times of O/N borrowings (1st leg)	13:51:07	13:20:01	14:27:09	13:48:58	14:05:59
Settlement time of the earliest O/N transaction in the period.	8:23:38	9:46:13	8:56:09	8:21:18	8:29:29
Average settlement time of the earliest daily O/N transactions in the period.	10:29:52	10:49:19	11:20:29	10:31:52	10:31:59
Settlement time of the latest O/N transaction in the period.	17:03:02	16:59:04	17:19:10	17:40:34	18:08:33
Average settlement time of the latest daily O/N transactions in the period.	16:40:06	16:13:13	16:38:47	16:39:24	17:02:18
Standard error	2:01:03	1:46:40	1:57:23	2:03:00	2:03:56
Variance	0:10:11	0:07:54	0:09:34	0:10:30	0:10:40
Statistical indicators	* The items identified in the large-value payment system included 31 transactions which were settled early in the morning. Specifically, we found 29 items fulfilled between 07:50 and 08:00, one item settled at 08:00 and one more item at 08:07. They may have been other (non-O/N) transactions, therefore, we did not take them into account among the statistics. Source: Own compilation based on MNB data				

Figure 7.
Monthly distribution of settlement times of O/N transactions (1st leg) in an hourly breakdown based on volume (left panel) and value (right panel)
 (2008 – July 2014)



Source: Own compilation based on MNB data

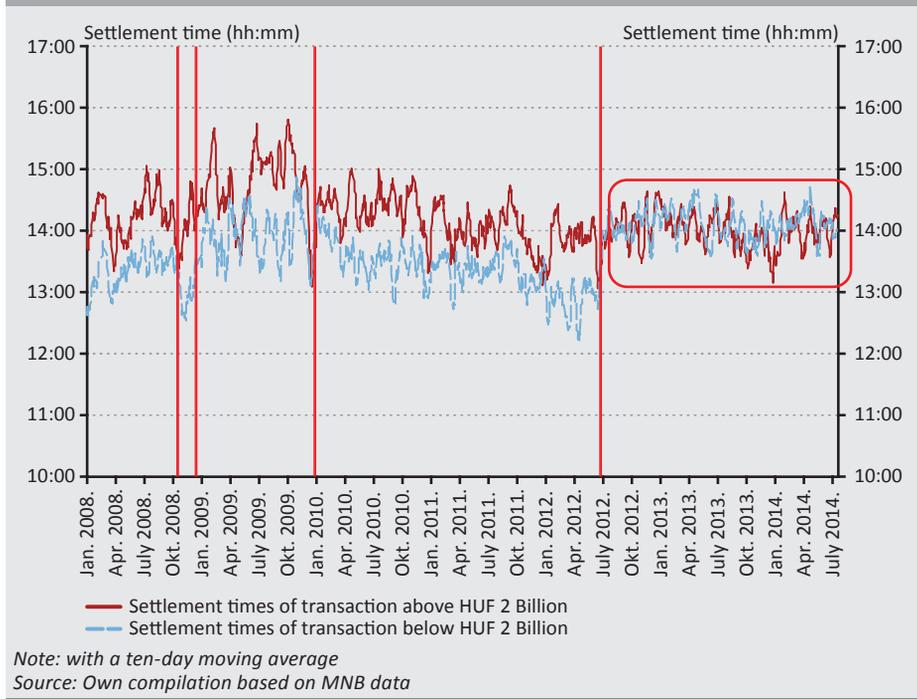
Table 2. Distribution of settlement times linked to O/N borrowing in the different periods, by intraday time bands (per cent, January 2008 – July 2014)												
Period	Time interval	Time band (per cent)										Total
		-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18		
based on volume												
(1) Pre-Lehman period	2 January 2008 – 20 October 2008	0,83%	7,02%	14,68%	16,66%	14,69%	10,94%	12,66%	22,46%	0,07%	100,00%	
(2) The Lehman shock	21 October 2008 – 16 December 2008	1,04%	5,58%	19,84%	21,53%	18,81%	13,62%	8,17%	11,41%	0,00%	100,00%	
(3) Post-Lehman period	17 December 2008 – 31 December 2009	0,42%	3,52%	11,41%	12,00%	14,01%	10,57%	14,17%	33,82%	0,08%	100,00%	
(4) Market adjustment, stable period	1 January 2010 – 30 June 2012	1,05%	8,03%	15,41%	15,69%	12,66%	10,47%	15,76%	20,16%	0,76%	100,00%	
(5) The period following the introduction of the ICS	1 July 2012 – 31 July 2014	0,85%	6,86%	12,55%	13,24%	14,64%	12,66%	13,21%	21,30%	4,70%	100,00%	
based on volume												
Period	Time interval	Time band (per cent)										Total
		-10	10-11	11-12	12-13	13-14	14-15	15-16	16-17	17-18		
(1) Pre-Lehman period	2 January 2008 – 20 October 2008	0,89%	6,59%	13,81%	13,66%	12,36%	11,08%	15,88%	25,70%	0,03%	100,00%	
(2) The Lehman shock	21 October 2008 – 16 December 2008	1,17%	6,76%	17,58%	17,85%	17,37%	11,00%	11,85%	16,41%	0,00%	100,00%	
(3) Post-Lehman period	17 December 2008 – 31 December 2009	0,77%	3,10%	10,46%	9,81%	12,93%	10,18%	16,70%	36,02%	0,03%	100,00%	
(4) Market adjustment, stable period	1 January 2010 – 30 June 2012	1,39%	7,25%	14,31%	15,64%	11,68%	10,14%	18,24%	20,52%	0,83%	100,00%	
(5) The period following the introduction of the ICS	1 July 2012 – 31 July 2014	0,82%	7,52%	14,55%	14,25%	12,57%	11,64%	14,63%	19,89%	4,13%	100,00%	

Source: Own compilation based on MNB data

collapse. However, as the result of the adjustment which ensued, the behavioural pattern seen before the end of 2008 emerged once again in terms of timing. With the gradual increase of counterparty limits and the widening of interest rate corridors, the MNB sent a signal to the market that system participants can feel free to conclude O/N unsecured transactions with one another and should thus try to resolve their liquidity problems on the market. Simultaneously with the rise in market liquidity and the improvement in interbank confidence, adjustment in timing gradually materialised and by early 2010, it reached the level seen prior to the Lehman collapse.

The timing of unsecured interbank market items is largely shaped by value, a significant difference can thus be pinpointed between smaller transactions (under HUF 2 billion) and large-value transactions (over HUF 2 billion). Smaller value transactions are typically used to acquire additional intraday liquidity (in other words, to resolve ad-hoc liquidity shortages), while larger value items carry significance in terms of closing out positions at the end of the day or complying with the reserve requirement. During the period under review, until July 2012

Figure 8.
Timing of the 1st leg by transaction value
 (2008 – July 2014)



transactions of under HUF 2 billion were typically settled earlier on during the day, while items of over HUF 2 billion were typically settled later¹¹ (Figure 8). The effect of the Lehman shock can be observed here in this area, too, as borrowers attempted to obtain the necessary liquidity and close their positions as early as possible during the second (risk averse) period, and therefore the timing of their transactions related to both intraday and end-of-day liquidity shifted to earlier times (Table 3). The divergence in the settlement times of small and large-value items was significant until 2012 H2, after which their “timing profile” became nearly identical. All of this may be linked to the introduction of intraday clearing within ICS on 1 July 2012, which prompted credit institutions to adjust their liquidity management. Until this date, the ICS only featured overnight clearing which did not require liquidity during the day for settlement. However the introduction of five intraday settlement cycles meant that the need for additional liquidity during the day increased substantially compared to the previous period, spreading out this continuous liquidity demand within the day due to these cycles. In addition, the daytime turnover of the ICS – which consists of items initiated by bank clients – cannot be forecasted by VIBER participants, so a bank may need to access extra liquidity at any time during the day.

Table 3.
Settlement time statistics linked to the O/N borrowing broken down by value size for each period

(following the format of hour : minute : second)

		(1) Pre-Lehman period	(2) The Lehman shock	(3) Post-Lehman period	(4) Market adjustment, stable period	(5) The period following the introduction of the ICS
		2 Jan. 2008 – 20 Oct. 2008	21 Oct. 2008 – 16 Dec. 2008	17 Dec. 2008 – 31 Dec. 2009	1 Jan. 2010 – 30 June 2012	1 July 2012 – 31 July 2014
Statistics related to transactions below HUF 2bn	Average	13:24:10	12:54:43	14:00:39	13:25:03	14:07:54
	Standard deviation	1:55:47	1:32:04	2:01:41	2:00:11	2:05:17
Statistics related to transactions above HUF 2bn	Average	14:15:13	13:56:50	14:46:11	14:08:55	14:04:34
	Standard deviation	2:00:36	1:55:22	1:50:20	2:01:45	2:02:54

Source: Own compilation based on MNB data

The first legs of overnight unsecured transactions exhibit a shift in their settlement times to earlier parts during the day (irrespective of transaction value) towards the end of the calendar year, and also towards the end of quarters (Figure 6).

¹¹ Due to the relatively high level of standard deviation, this difference cannot be considered to be statistically significant.

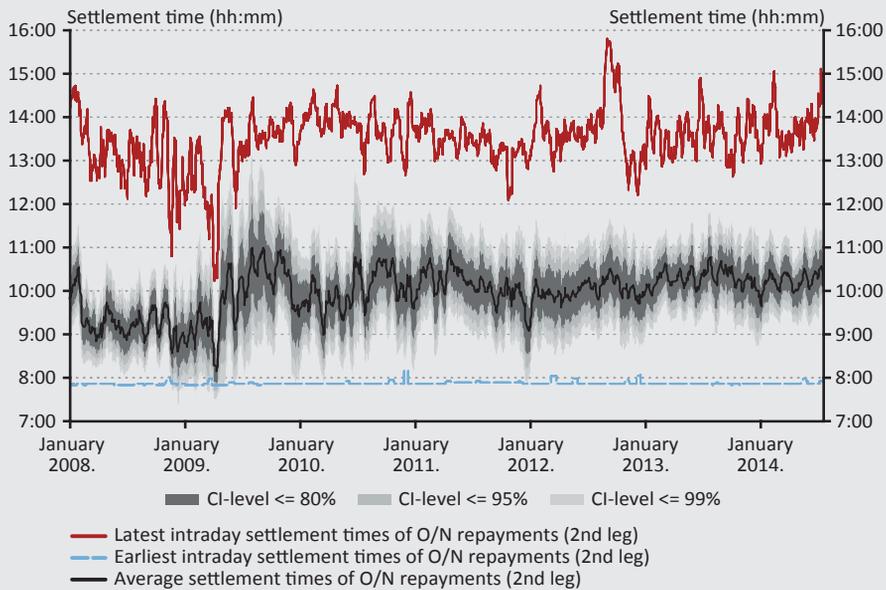
This phenomenon may stem from several reasons. At the end of the year, before holidays spanning several days, credit institutions strive to fulfil the transactions as soon as possible within the day. In addition, households' cash holdings, which spike before the end of the year holidays and then wane after the holidays, significantly shapes the banking system's liquidity on an aggregate level, which may indirectly impact the timing of interbank transactions (Komáromi 2008). In addition, many credit institutions performed balance sheet adjustments linked to the year-end closing of positions in the form of currency swaps. The forint liquidity within the system may temporarily change due to this, and – for security considerations – banks may thus initiate transactions earlier on (MNB 2013). Earlier intraday settlement times was observed in late 2011 and early 2012, which may possibly be linked to the money market turmoil felt in Hungary at the time. Interestingly, credit institutions did not make any material change to the number of concluded O/N items (with the average values concluded daily even increasing in early 2012 based on the available data, see Figure 3), however they presumably tried to mitigate the emerging market tension by bringing the settlement of their items earlier within the day (this adjustment in terms of timing is quite similar to banks' response to the collapse of Lehman described before). A similar pattern emerges when we look at quarters, particularly Q1, where the impact of multinational corporations may also come into play alongside the above specified seasonal effects (holidays spanning several days). Hungary is characterised by a strong presence of non-resident (particularly US and British) corporations, most of which follow a financial year different from the calendar year (ending, for instance, on 31 March). Activities linked to closing the financial year may impact, albeit indirectly, interbank liquidity and timing of transactions within the day. At the same time, since the introduction of ICS intraday clearing, this impact seems to have faded. Financial transfers linked to the real economy may be more evenly spread out over the day, explaining this phenomenon.

4.4. Impact of money market events on the timing of the 2nd leg of O/N unsecured interbank transactions

The timing of the repayment of O/N interbank transactions within the day shifted to earlier parts of the day six months before the collapse of Lehman, a phenomenon that persisted until June 2009 (Figures 9–10, and Table 4). The temporary shift of second leg's average settlement times to earlier parts of a day in late 2008 and early 2009 partly stemmed from the significantly lowered counterparty and settlement limits. As a result, the earliest possible repayment of loans from the previous day was necessary to ensure the safety of payments. Due to the drastic cuts to counterparty limits in the wake of the Lehman collapse, the risk of a bank being unable to conclude another interbank transaction with the specific

counterparty until it has repaid its O/N unsecured interbank loan contracted earlier increased, as the bank was using its counterparty limit until completion of the transaction. Another explanation is that the earlier times for loan repayments may have been an indication to the counterparty that the borrower was reliable and thus carried a low risk of insolvency. The change in timing was also impacted by the central bank liquidity measures in response to the crisis, which increased banks' liquidity. This reduced the banks' need for interbank O/N loans to carry out payments during the day, and they were able to repay a smaller amount of loans at the beginning of the date without the need to wait for the financing effect of subsequently incoming items. It is interesting to note that due to the money market turmoil in late 2011 and early 2012, the timing of the second leg of O/N transactions shifted to earlier in the day (similarly to the first leg). Based on this, it seems that banks react to uncertain, turbulent market situations by shifting the repayment leg of O/N transactions to earlier in the day.

Figure 9.
Timing of the 2nd leg of unsecured interbank transactions (daily averages) with the earliest and latest intraday settlement times and the 80%, 95% and 99% confidence intervals
 (2008 – July 2014)



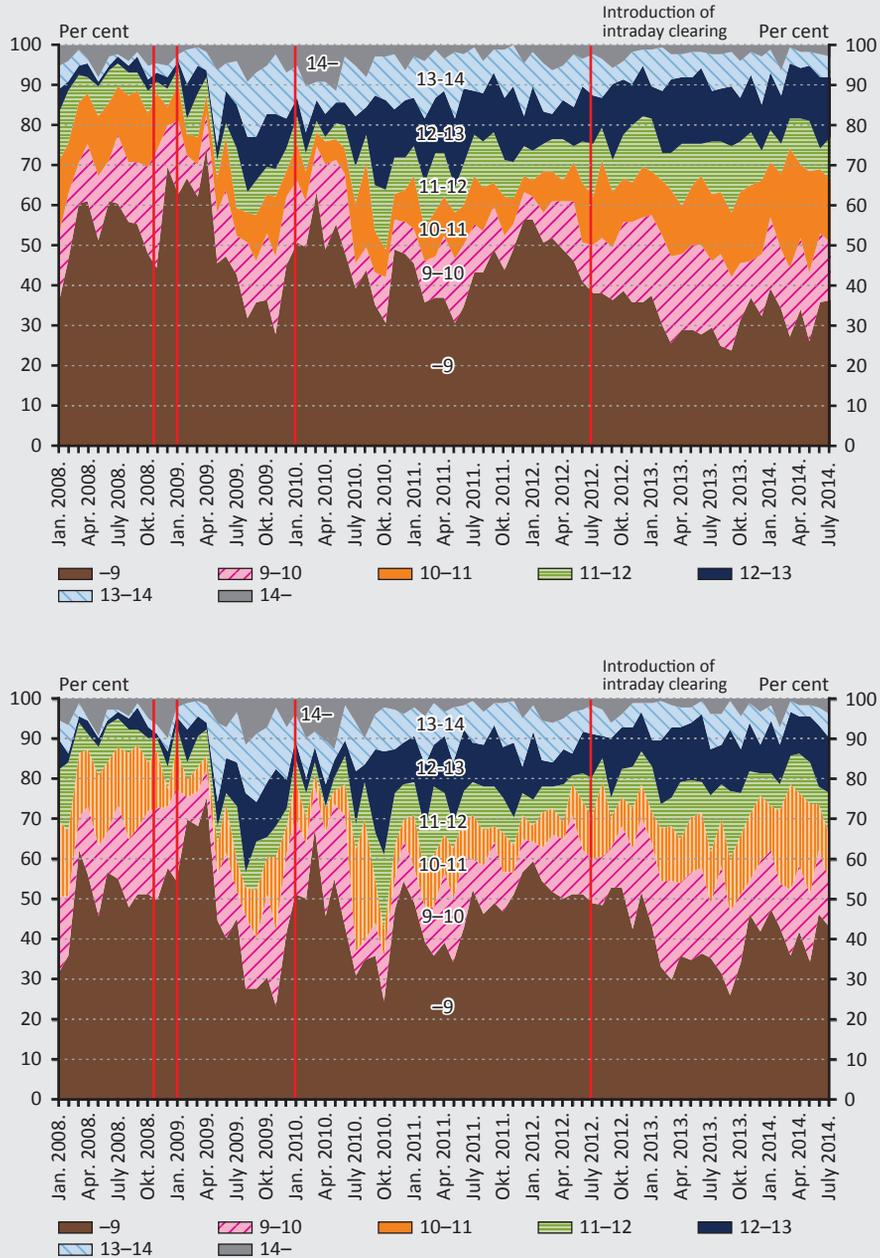
Note: with a ten-day moving average
 Source: Own compilation based on MNB data

Table 4.
Statistics of settlement times related to the repayment of O/N loans
(hour : minute : second format)

Period	(1) Pre-Lehman period	(2) The Lehman shock	(3) Post-Lehman period	(4) Market adjustment, stable period	(5) The period following the introduction of the ICS
Time interval	2 Jan. 2008 – 20 Oct. 2008	21 Oct. 2008 – 16 Dec. 2008	17 Dec. 2008 – 31 Dec. 2009	1 Jan. 2010 – 30 June 2012	1 July 2012 – 31 July 2014
Average settlement times of O/N repayments (2nd leg)	9:23:03	9:23:25	9:53:03	10:02:57	10:13:23
Settlement time of the earliest O/N transaction in the period.	7:50:15	7:50:20	7:50:12	7:50:21	7:50:20
Average settlement time of the earliest daily O/N transactions in the period.	7:50:53	7:53:12	7:51:23	7:52:49	7:51:50
Settlement time of the latest O/N transaction in the period.	16:28:18	16:16:22	16:40:41	17:16:50	17:01:23
Average settlement time of the latest daily O/N transactions in the period.	13:19:31	12:52:49	13:04:54	13:36:12	13:43:10
Standard error	1:50:01	1:54:50	2:13:04	2:13:45	1:58:14
Variance	0:08:24	0:09:09	0:12:18	0:12:25	0:09:42

Source: Own compilation based on MNB data

Figure 10.
Monthly distribution of settlement times of O/N transactions (2nd leg) in an hourly breakdown based on volume (left panel) and value (right panel)
 (2008 – July 2014)



Source: Own compilation based on MNB data

Starting from June 2009, the timing of the second leg shifted continuously to later in the day, in line with market consolidation (Figures 9–10, Table 5). The gradual reversal of counterparty limits from summer 2009 (the rise in previously lowered limits) meant that the timing of the repayment of interbank O/N loans represented an increasingly smaller restriction on trade, allowing the settlement

Table 5. Distribution of settlement times linked to O/N repayment in the different periods, by intraday time bands (per cent, January 2008 – July 2014)												
Period	Time interval	Time band (per cent)							Total			
		–9	9–10	10–11	11–12	12–13	13–14	14–				
based on volume												
(1) Pre-Lehman period	2 January 2008 – 20 October 2008	53,51%	15,15%	14,84%	7,32%	2,82%	2,61%	3,76%	100,00%			
(2) The Lehman shock	21 October 2008 – 16 December 2008	50,45%	24,12%	11,15%	3,89%	2,46%	2,33%	5,58%	100,00%			
(3) Post-Lehman period	17 December 2008 – 31 December 2009	47,38%	13,76%	9,04%	6,72%	8,51%	10,32%	4,27%	100,00%			
(4) Market adjustment, stable period	1 January 2010 – 30 June 2012	45,30%	11,25%	8,93%	8,39%	11,91%	9,96%	4,25%	100,00%			
(5) The period following the introduction of the ICS	1 July 2012 – 31 July 2014	32,46%	17,50%	16,21%	10,75%	13,81%	6,82%	2,45%	100,00%			
based on volume												
Period	Time interval	–9	9–10	10–11	11–12	12–13	13–14	14–	Total			
(1) Pre-Lehman period	2 January 2008 – 20 October 2008	49,40%	16,04%	16,94%	8,01%	3,09%	2,38%	4,13%	100,00%			
(2) The Lehman shock	21 October 2008 – 16 December 2008	51,81%	21,04%	10,12%	4,71%	2,64%	2,22%	7,47%	100,00%			
(3) Post-Lehman period	17 December 2008 – 31 December 2009	45,35%	14,92%	9,25%	6,70%	8,81%	10,43%	4,54%	100,00%			
(4) Market adjustment, stable period	1 January 2010 – 30 June 2012	47,53%	12,31%	9,03%	7,85%	10,72%	8,63%	3,92%	100,00%			
(5) The period following the introduction of the ICS	1 July 2012 – 31 July 2014	40,89%	16,67%	13,62%	9,09%	11,88%	5,49%	2,36%	100,00%			

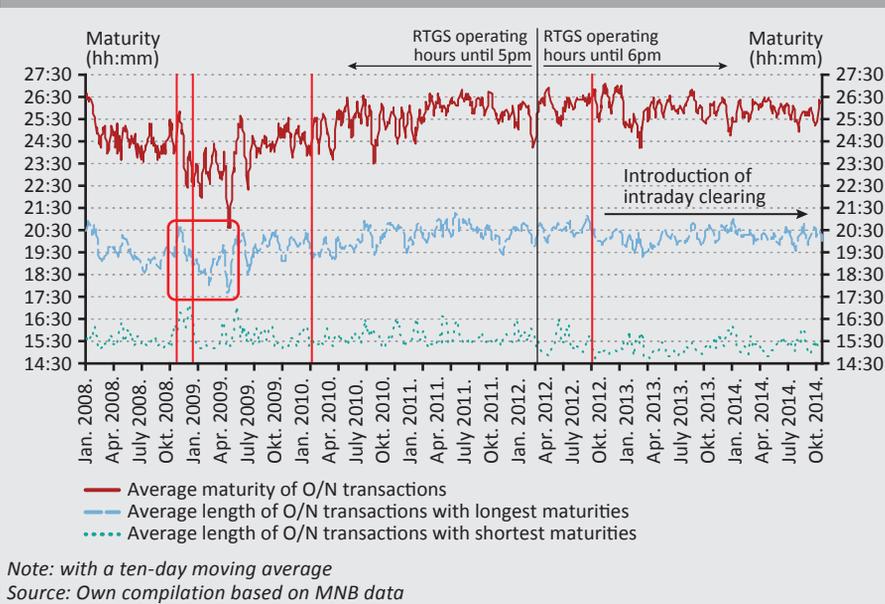
Source: Own compilation based on MNB data

of the second leg to shift to later times in the day. This adjustment process began long before the one-hour extension of VIBER's opening hours from 1 January 2012 onwards, suggesting that the change in the timing of the second leg was not driven by the change in business hours. Following the Lehman collapse, the banking system needed this much time for the situation to normalise in terms of intraday liquidity management. As the interbank market regained stability, credit institutions presumably no longer prioritised the repayment of loans on day T+1 in the early morning hours and thus once again began relying more on the financing role of incoming items, and accordingly the repayment of O/N loans shifted to later in the day.

4.5. Developments in the maturity of O/N unsecured interbank market transactions

To answer the question of how long an O/N unsecured interbank transaction actually lasts, we need to look at the time elapsed between the settlement of the first and second leg. Due to VIBER's business hours, the minimum time that elapsed between closing and opening on the following day – unless business hours were extended for that day – was 15 hours until 2012, which decreased to 14 hours following the extension of VIBER's business hours from 2012. Transactions cannot be settled using central bank liquidity during this period. The average maturity of O/N interbank unsecured transactions ranged between 17 hours 40 minutes and 20 hours 40 minutes (*Figure 11*). After the collapse of Lehman Brothers, banks timed their borrowing earlier in the day and also repaid the borrowed amounts earlier on the following day, which reduced the average maturity of unsecured O/N transactions in late 2008 and early 2009. In his paper, Craig Furfine also examines the average maturity of overnight interbank transactions settled in the US funds transfer system. In his analysis, Furfine found that the average duration of an O/N transaction was 21 hours and 27 minutes (*Furfine 1999*). This is longer than the result of our study. In addition to the largely different market conventions, the discrepancy may stem from a number of other methodological reasons, including the fact that Furfine only looked at data for three months in his study (1998 Q1); in other words his results are based on data for a very different period. The difference may also stem from the very different business hours of the Federal Reserve's funds transfer system compared to VIBER: at the time of Furfine's study, the Fedwire operated between 00:30 and 18:30. Besides business hours, the deviation in the maturity of overnight transactions also diverges: in Furfine's paper, the shortest overnight transaction was 7 hours and 7 minutes long, while the longest one was 40 hours and 39 minutes long, whereas the dataset used for our paper featured a shortest maturity of 13 hours 55 minutes and a longest maturity of 30 hours 32 minutes.

Figure 11.
Developments in the maturity of O/N unsecured interbank market transactions
 (2008 – July 2014)



The maturity of O/N unsecured interbank transactions mainly increased due to the shift of the settlement times of the second leg to later in the day in the period following April 2009. This prompts the question of which of the two determines overnight maturity: the timing of the first leg (borrowing) or of the second leg (repayment)? Our data reveal that it is primarily the repayment of the second leg that defines maturity. This is in line with our preliminary assumption, as banks do have an entire day for settling the second leg, as opposed to the second half of the day generally available for settling the first leg, assuming that it is used primarily for liquidity management. Banks made relatively smaller changes to the timing of borrowing in the period following the collapse of Lehman Brothers, and the timing essentially returned to its original pre-crisis path by 2010. By contrast, the crisis resulted in lasting changes in the domain of repayments, and credit institutions adjusted their timing patterns more markedly.

5. Summary

This study focused on examining the timing of unsecured interbank transactions within the large-value payment system (VIBER) from the perspective of payments. Overnight transactions play a key role in intraday liquidity management, and their settlement at specific times may have strategic relevance in daily practice. For a specific O/N transaction, the creditor advances the principal amount to the

borrowing bank on day T. Counterparties initiate transactions among each other individually, and thus for a given day, they do not bundle payments linked to multiple interbank transactions into one single VIBER transaction. VIBER participants do not apply netting, meaning they do not mutually offset their outstanding receivables against each other, and thus transfer the total principal amount on day T and the principal amount plus interest due on day T+1 - settlement of the principal amount and the interest as two separate items is rare.

In the event of money market shocks, credit institutions showed similar reactions in terms of the timing of their overnight items: they initiate borrowing earlier in the day, as well as repayment the following day. This was the experience over the 2008 crisis, when overnight market turnover dipped significantly in the wake of money market uncertainty and lower interbank counterparty limits, as system participants were increasingly less willing to lend to each other. Worried about finding themselves unable to secure sufficient liquidity from the interbank market at the end of the day, banks scheduled their borrowing earlier during the day. Furthermore, the time window for trading during which transactions were concluded narrowed significantly, coupled with the rise in the randomness of transaction settlement times within this timeframe, which also suggests uncertainty. The overnight unsecured market essentially came to a halt, and the central bank temporarily narrowed the interest rate corridor to allow market participants to access sufficient liquidity in an effort to dissipate the tension. In addition, in the case of foreign-owned banks in Hungary, parent banks began exerting greater control, thus intervening more in their liquidity management. Later on, foreign borrowing, cooperation among the key central banks and the MNB's liquidity measures increased systemic liquidity, and confidence began returning to the interbank market, while state interventions on a global scale calmed market participants. From summer 2009, limits began returning to their earlier levels, albeit selectively and on a mutual basis. The MNB broadened the interest rate corridor, signalling to credit institutions that they should strive to resolve their liquidity issues among each other on the market. The parent banks of foreign-owned credit institutions in Hungary continued to exercise strict oversight, actively shaping their subsidiaries' market behaviour. We observed that the responses in the wake of the money market turmoil that prevailed in Hungary in late 2011 were being similar to the reactions in 2008; in other words it seems that credit institutions react similarly in terms of the timing of their overnight items in response to money market shocks. Regarding the *long-term* impacts of the 2008 economic crisis on the timing and maturity of interbank transactions, credit institutions tend to adjust primarily through the timing of repayments (second leg) rather than the timing of borrowing (first leg), as the timing of the former stabilised at a later part of the day following the crisis. It is therefore repayments (second leg) rather than borrowing (first leg) that mainly impact maturity.

The average time of settlement of O/N loan borrowing is also greatly influenced by value size. Small value items primarily play an important role in resolving intraday ad hoc liquidity management issues, while large-value items are relevant for closing positions at the end of the day and meeting reserve requirements.

Based on our study, the average maturity of O/N interbank unsecured transactions ranged between 17 hours and 40 minutes and 20 hours and 40 minutes, and maturities increased after the crisis mainly due to the adjustment of the second leg.

References

- Bodnár, L. – Luspay, M. – Madarász, A. (2014): The effect on payments of the conversion of MNB bills into deposits. MNB Bulletin, 2014.
- Furfine, C.H. (1999): The Microstructure of the Federal Funds Market. Financial Markets, Institutions & Instruments, V. 8, N. 5, November 1999. 1999 New York University Salomon Center. Published by Blackwell Publishers, 350 Main Street, Malden, MA 02148, USA, and 108 Cowley Road, Oxford, OX4 1JF, UK.
- Komáromi, A. (2008): The role of monetary aggregates in the monetary policy. MNB Occasional Papers 71, 2008. Downloaded: 6 January 2015 http://www.mnb.hu/Root/Dokumentumtar/MNB/Kiadvanyok/mnbhu_mnbtanulmanyok/mnbhu_mt_71/mt_71.pdf
- Hendry, S. – Kamhi, N. (2007): Uncollateralized Overnight Loans Settled in LVTS. Working paper, November 2007. <http://www.bankofcanada.ca/wp-content/uploads/2010/03/wp07-11.pdf>. Downloaded: 6 January 2015
- Luspay, M. – Madarász, A. (2014): The effects of the introduction of intraday clearing on turnover in Hungarian payment systems. MNB Bulletin, 2014.
- Millard, S. – Polenghi, M. (2004): The relationship between the overnight interbank unsecured loan market and the CHAPS Sterling system. <http://www.bankofengland.co.uk/publications/Documents/quarterlybulletin/qb040103.pdf>, Downloaded: 2 January 2015
- MNB (2013): Annual Report. http://www.mnb.hu/Root/Dokumentumtar/MNB/Kiadvanyok/mnbhu_evesjel/MNB_EvesJelentes_2013_HUN_vegleges.pdf, Downloaded: 6 January 2015
- Páles, J. – Kuti, Zs. –Csávás, Cs. (2010): The role of currency swaps in the domestic banking system and the functioning of the swap market during the crisis. MNB Occasional Papers (90). http://www.mnb.hu/Root/Dokumentumtar/MNB/Kiadvanyok/mnbhu_mnbtanulmanyok/MT_90.pdf, Downloaded: 6 January 2015