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Abstract

This study examines overnight (O/N) interest rates which constitute the short end of the yield curve and the factors which have an impact on such rates. The MNB, unlike several other central banks, does not have a direct overnight interest rate target; it does, however, limit the divergence of O/N interest rates from its policy rate with the settings of its operational framework. First, the MNB's regulations on compulsory reserves allow banks to apply averaging in the reserve maintenance period, which reduces overnight interest rate volatility. Second, the interest rate corridor – determined by MNB's collateralised loan and deposit – limits the maximum fluctuation band of overnight interbank interest rates.

The study finds that the role of reserve averaging to reduce yield fluctuations is imperfect, as a clear seasonal pattern is observed in the intra-maintenance period evolution of overnight rates. The frequency of cumulative front-loading and excess reserves is significantly higher than the frequency of reserve deficit. Therefore, the level of overnight interest rates tends to remain below the policy rate and drop towards the interest rates of overnight central bank deposits at the end of the maintenance period. Moreover, statistical analysis finds evidence that the impact of liquidity withdrawing shocks are typically greater – approximately twice as much – as of those injecting liquidity. This phenomenon could be explained by the volatility of autonomous liquidity factors, especially that of the government accounts, which is particularly high on VAT payment days. Institutional settings (credit limits, limitation of maximum deviation from reserve requirements, high interbank concentration) curtail the potential of the interbank market to efficiently distribute liquidity over the entire system, which may also explain the asymmetric liquidity management characteristics of Hungarian banks.

Introduction

The overnight (O/N) rate, which is the very starting point of the yield curve, plays an important role in monetary policy. Developments in O/N interest rates have a tendency to influence short-term interest rates, which are the operating target of monetary policy in many countries. Consequently, it is essential for the central bank to have an accurate picture of the factors with an impact on O/N interest rates, so as to implement monetary policy and develop applied monetary policy instruments. Naturally, the more reliable the central bank's model of O/N interest rates, the greater its ability to set interest rates for the purposes of monetary transmission.

Chapter One of the analysis contains a brief overview of the instruments applied by the MNB to conduct monetary policy, in order to facilitate understanding of the empirical examinations. The MNB does not have a direct O/N interest rate target; it does, however, limit the divergence of O/N interest rates from its policy rate with the settings of its operational framework, to preclude any unfavourable influence that such divergence may have on its monetary policy.

Following the description of the operational framework, we demonstrate the theoretical relationships which are essential for the analysis of overnight rates, and the practical limitations of these considerations. The MNB's regulation on minimum reserve requirements allows credit institutions to use averaging to fulfil reserve requirements. As a result, the horizon of banks' liquidity management is defined by a one-month maintenance period, which helps to reduce yield fluctuations triggered by changes in liquidity conditions. However, there are several factors which cause difficulties in the widespread use of the averaging method in Hungary. First, it is difficult to forecast autonomous liquidity factors, especially the evolution of governments accounts within the reserve period, which tends to have an enormous influence on the level of O/N interest rates. Second, the potential of the interbank market to efficiently distribute liquidity over the entire system is limited.

Chapter Two presents the empirical analysis of O/N rates. Following an overview of the descriptive statistics, it examines whether the Hungarian banking system takes advantage of the averaging method to its full potential. Finally, our model for O/N rates is presented, and the results of model estimation are interpreted.

Chapter Three attempts to outline future trends: it contains an overview of expected changes in the environment behind the fluctuations of O/N rates. Finally, Chapter Four summarises the conclusions of this study.

1. Driving factors behind overnight interest rates

The central bank can influence overnight (O/N) rates, and the volatility of short-term interest rates, with the setting of its monetary policy instruments. Due to the fact that the operational framework laid down by the central bank, and the role of O/N rates in the central bank's monetary policy has a substantial influence on the development of O/N interest rates, we shall provide a brief overview of the MNB's instruments for conducting monetary policy, and the reasons behind the use of various instruments. Following this, we illustrate the theoretical relationships to facilitate an understanding of the empirical analysis of O/N rates under the conditions set by the operational framework of the MNB. Finally, we point out the practical limitations of theoretical relationships.

1. 1 Instruments of the MNB

Among the overall objectives of the MNB's monetary policy, 3-month money market yields represent the operating target. The central bank indirectly influences this point of the yield curve with its monetary policy instruments, in order to achieve its inflation goals.

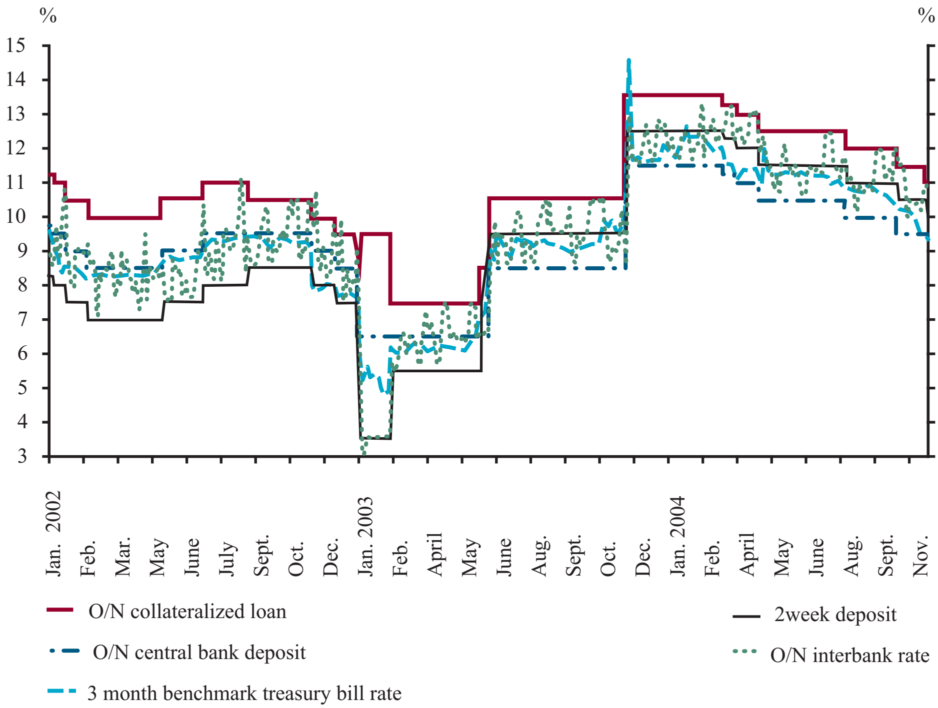
The MNB does not have an O/N interest rate target, and the maturity of the operating target is far longer than one day. Nevertheless, permanent deviation of O/N rates from the prevailing key policy rate and excessive volatility may increase the degree of fluctuation of longer-term yields as well, which would in turn reduce the efficiency of monetary transmission. Hence, the MNB applies monetary policy instruments which limit fluctuations in the level of overnight interest rates to a certain degree.

The principle market for banks' liquidity management is the O/N forint market. Movements in O/N interbank rates are driven first and foremost by quantities, such as the demand and supply of reserves.[1] Amongst other aims, in formulating the operational framework the MNB endeavoured to reduce the fluctuation of short-term rates

[1] The factors of demand and supply of reserves and monetary policy operations are described in detail in Borio [1997], Antal-Barabás-Czeti-Major [2001], Monetary policy in Hungary [2002].

Chart 1

The MNB's operating target and central bank interest rates



resulting from liquidity imbalances. The easiest way to explain the liquidity management of the MNB and its monetary instruments is the demonstration of the central bank's balance sheet structure (Table 1).

Those factors of reserve supply over which the central bank is unable to assert any influence in the short run (net foreign assets, currency in circulation, government accounts, etc.) are referred to as *autonomous factors.* First, owing to economic openness, the foreign exchange rate of the Hungarian forint plays a crucial role in economic policy. As a result, the supply of central bank money is influenced in part by the development of *net foreign assets,* more specifically the size of foreign exchange reserves. The level of foreign exchange reserves are, in principle, influenced by the MNB's operations on the FX-market, and also by the denomination of

Table 1

Simplified balance sheet of the MNB*

Assets	Liabilities
E./I. Net foreign assets	*F./I. Currency in curculation*
	F./II. Government accounts
	F./III.Reserves (settlement accounts)
	F./IV. 2 week deposit
E./2. O/N collateralized loan	F./V. O/N deposits
E./3. Net other items	

** Autonomous liquidity factors are indicated with italic font type.*

public debt. The volume of *currency in circulation* is also included in the group of autonomous factors that reduces the availability of reserves in the long run depending on economic growth and the velocity of circulation of money. *Government accounts*[2] are in the balance sheet of the MNB, which means that the transactions conducted by government institutions in relation to the primary balance and the financing of public debt also have an influence on the supply of reserves.[3]

The reserve demand of banks is mainly governed by the regulations on reserve requirements. The MNB was aiming to achieve several different goals when the features of the obligatory reserve system were set. First, it was important to establish an effective reserve requirement system in which the *level of reserve requirements* exceed banks' working balance targets stemming from their settlement needs. The MNB allows banks to satisfy their reserve requirements in average, hence banks can cover any temporary fluctuation in the supply of reserves from the reserve account (buffer function). The reserve maintenance period is one calendar month, which also determines the horizon for the banks' decisions relating to liquidity management.

[2] Single Treasury account (KESZ), Hungarian Privatisation and State Holding Co. (ÁPV Rt.) account, Hungarian State Treasury account.

[3] Naturally, transactions between government accounts and the MNB do not affect the liquidity of the banking system.

The structural liquidity position of the banking system is determined by the summation of autonomous factors and reserves (reserve requirements + excess reserves). As the autonomous liquidity supply in Hungary exceeds the level of reserve requirements, the key policy instrument of the MNB is a deposit-type instrument intended to drain liquidity (two-week deposit). Banks are allowed to place two-week deposits once a week, every Tuesday (with settlement on Wednesdays). As the MNB does not limit the volume of two-week deposits allocated to its counterparties, this arrangement allows banks to offset the effects of changes in the supply of reserves between reserve maintenance periods by changing the volume of two-week deposits.

In order to reduce uncertainties in short-term rates the MNB employs an *interest rate corridor.* The borders of the interest corridor are determined by the interest rate of O/N standing facilities *(collateralised loan, deposit),* and its centre by the key policy rate. Central bank O/N collateralised loan and deposit are continuously available to counterparties, which means that the interest rate corridor has the capacity to limit the maximum deviation of overnight rates from the key policy rate. The MNB has gradually narrowed the width of the interest rate corridor – with a view to reduce fluctuations in short-term rates – to ±1 percentage point, where it stands today.

In order to reduce the risks of higher yield fluctuations arising in consequence of liquidity imbalances stemming from autonomous factors, the MNB may apply *quick tenders.* This, however, is very rare, as more active intervention by the central bank is likely to diminish the efficiency of the interbank market. Moreover, if the central bank automatically offsets imbalances in liquidity, it may apparently bring about the risk that speculative aspects will have a stronger influence on banks' liquidity management.

All in all, in spite of the fact that the MNB does not have an O/N interest rate objective, it endeavours to mitigate the divergence of overnight rates from the key policy rate stemming from fluctuations in liquidity. Nonetheless, it should be noted that active liquidity management by the central bank may prevent developments in the interbank market and the effective redistribution of liquidity under market conditions; therefore, the MNB operates a passive liquidity management system.

1.2 Theoretical relationships

The principle objective of the minimum reserve system of the MNB is to reduce the spread between the O/N rates and the key policy rate. Reserve averaging provisions provides banks with a facility to manage liquidity by offsetting daily reserve deficiencies with surpluses over a given maintenance period. As a result, daily changes in the supply of reserves will not necessarily bring about changes in the level of O/N rates. Assuming that the interbank market functions perfectly and the interest rate elasticity of demand for reserves is flexible,[4] then the O/N rate (r_t) should be equal to the O/N rate expected by the interbank market participants for the days remaining from the reserve period ($E_t[r_{t+1}]$,…, $E_t[r_{t+n}]$,…,$E_t[r_T]$), on each day of the maintenance period, in other words, the development of O/N interest rates could be treated as a martingale process,[5] in formal terms:[6]

$$r_t = E_t[r_{t+1}] = \ldots = E_t[r_{t+n}] = \ldots = E_t[r_T] \tag{1}$$

Contrary to this case, an arbitrage opportunity could exist for interbank market participants simply from reserve averaging.[7] In other words, market participants would hold reserves on t. day only if the alternative cost, that is the overnight interest rate expected for the remaining days of the reserve period, is equal to current rates. Let us assume, for example, that on t. day of the reserve period the interest rate expected for t+n. day is lower than the level of interest rates on t. day $(r_t > E_t[r_{t+n}])$. If this were to happen, market players who took advantage of the difference would achieve arbitrage by lending from their reserve account on t. day and borrowing the same volume on t+n. day, without having any effect on their monthly average reserves. And this is not likely to happen in a market that operates effectively.

As the alternative cost of short-term interbank market transactions is consistent with the key policy rate in a neutral reserve market, the O/N rate follows the interest rate which the MNB pays for two-week deposits. The main driving force behind reserve demand is

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[4] In practical terms, the validity of these presumptions is limited, as is pointed out in subsequent chapters.

[5] In the literature this phenomena concerning the development of O/N interest rates is commonly referred to as martingale hypothesis.

[6] Henceforward, the days of the reserve period are marked t, t+1, …,T, and the reserve period itself is marked, τ, τ+1,…, τ+n.

[7] See Hamilton [1996], Prati-Bartolini-Bertola [2001], Bindseil [2001].

the central bank reserve requirements. Therefore, the level of O/N interest rates deviates from the centre of the interest rate corridor only if the supply of reserves fails to satisfy the level necessary to meet reserve requirements throughout the entire reserve period. Commercial banks are able to offset fluctuations in the supply of reserves during the maintenance period by using the averaging method, and by varying their two-week deposit portfolio in between reserve periods. If these instruments are insufficient to restore stability in the reserve market, banks must resort to O/N central bank instruments (collateralised loan or deposit). In this case, the alternative cost of O/N interbank placements is the interest rate of standing facilities, therefore the O/N rate adjusts to the central bank O/N collateralised loan rate (r_l), or O/N deposits rate (r_d), whichever is consistent with the reserve position. Consequently, the interbank interest rate for t. day of the reserve period is determined by the likelihood of cumulated excess reserves (P_d) and cumulated reserve deficit (P_l) the banks expect for the end of the month, formally:[8]

$$r_t = P_d \cdot r_T^d + P_l \cdot r_T^l, \quad where \quad P_d + P_l = 1 \tag{2}$$

In the event of neutral liquidity expectations, if the likelihood of cumulated excess reserves and reserve deficit at the end of the reserve period is equal (P_l=P_d=0,5), the O/N interbank interest rate will be defined as the arithmetical average of interest rates of central bank standing facilities. In view of the symmetrical interest rate corridor of the MNB, this means a value identical to the key policy rate. If the interest rate of central bank's standing facilities is defined as a stochastic variable rather than a constant, apart from the probabilities stemming from expectations relating to liquidity position, the actual O/N rate is also influenced by expectations relating to the central bank's interest rate policy, namely the interest rates on two-week deposits and O/N central bank instruments. Changes in the base rate or in the interest rate corridor within a maintenance period do have an influence on the alternative costs of reserve requirements for subsequent days. Thus, short-term interest rates tend to adapt to the new conditions following any movement in these rates. Hence, interest rate expectations are reflected in the actual level of O/N rates and if there are strong expectations for changes in interest rates, the O/N rates may depart from the centre of the interest corridor even if not otherwise warranted by liquidity conditions.

[8] For further details refer to Bindseil-Seitz [2001] study.

The degree of impact of interest rate expectations on O/N interest rates depends mostly on expectations relating to the timing and/or extent of interest rate changes. These collectively lay down how much rates could potentially change by the end of the reserve period. The intensity of expectations also have a strong influence on the pass-through of expectations into actual rates, notably, the conditional probability of interest rate movement expected by interbank market players in light of the known objectives of the central bank. Consequently, the interbank interest rates are determined by expectations concerning reserve positions, and the central bank's interest rate policy.

$$r_t = P_d \cdot E_t[r_T^d] + P_l \cdot E_t[r_T^l], \quad where \quad P_d + P_l = 1 \tag{3}$$

O/N interest rates tend to follow the level of interest rates expected by the end of the reserve period, meaning that in case of prompt changes in central bank rates the O/N rates may depart from the centre of the interest corridor as far as the expected magnitude of interest rate change. Moreover, central bank rate movements that occur after the end of the maintenance period will obviously have no effect on current O/N rates.[9]

1.3 Limitations in banks' liquidity management, frictions in the interbank market

The theoretical underpinnings of O/N rates were made under the assumption that the interbank market functions perfectly and the demand of reserves is elastic to interest rates. However, these presumptions are true only to some extent with regards to the limitations in the liquidity management of Hungarian banks.

The main force blocking the efficient redistribution of liquidity over the entire system in Hungary is the considerable volatility in liquidity supply resulting from autonomous factors. In itself, the high degree of volatility is not a problem if it can be forecasted for the commercial banks and the level of reserve requirements exceed the demand for

[9] The European Central Bank (ECB) has decided, with a view to the unfavourable effects of interest rate expectations on O/N interest rates, to set the timeframe of maintenance periods adjusted to the governing council meetings, and to eliminate any overlap in its *main re-financing operations* between reserve periods. Due to these changes interest rate decisions will become effective only from the following reserve period; therefore, according to ECB expectations, interest rate expectations are less likely to influence the decisions of banks relating to liquidity management, and that in turn is likely to reduce fluctuations in the level of O/N interest rates over the long run.

working balances. Yet, making a prognosis of autonomous factors is profoundly difficult and necessitates rapid processing of large quantities of uncertain information. To some extent, transactions made in connection with public debt management operations are easier to anticipate, as well as items showing predominantly seasonal characteristics (e.g. currency in circulations, tax payments).

Taking into account that the single most important tool of banks' liquidity management is the settlement account, the impact that autonomous factors have on day-to-day liquidity in comparison to reserve requirements demonstrates the limitations of banks in terms of liquidity management (Table 2). The greatest sources of volatility in liquidity are the government accounts in the balance sheet of the MNB. The standard deviation of changes in liquidity generated by these government accounts in 2004 reached almost 12 per cent of the settlement accounts. Relative indices were also calculated on basis of Hungarian data compared to those of the Eurosystem. The level of day-to-day volatility generated by autonomous factors in Hungary is 3.7-4.1 times higher than the euro zone level. This could also explain, to some extent, the higher volatility of O/N interbank interest rates in Hungary.

Since central banks, in general, have access to more reliable and concentrated information for forecasting of autonomous factors, numerous central banks publish their prognosis regarding autonomous factors in an effort to assist banks in their liquidity management.[10] Furthermore, having access to an accurate prognosis reduces the risks of incorrect decisions; hence these publications may even have a mitigating effect on O/N yield fluctuations. The publication of autonomous factors is hindered by several factors in the case of the MNB. One is that the MNB's ability to forecast government accounts, which are responsible for the bulk of volatility in liquidity, carries a significant error. This is due partly to the fact that the central bank has limited access to information concerning the transactions made by the numerous varying budgetary institutions on government accounts, and particularly about the timing of these transactions. On the other hand, publication of the full prognosis would provide implicit information on the central bank's foreign exchange reserves that would impose con-

[10] Central banks, unlike commercial banks, have access to aggregated data concerning factors that have an influence on the liquidity conditions, whereas commercial banks only have at their disposal individual data or indirect information on the overall picture. Bindseil [2001] argues for the publication of central bank forecasts.

Table 2

Day-to-day effect of autonomous factors on liquidity and the volatility of O/N rates in Hungary and in the euro area (January – October 2004)

	2004		
	Average absolute change	Maximum absolute change	Standard deviation
Liquidity shock in % of the reserve requirements			
1. Hungary			
a. Net foreign assets	0.1	1.7	0.2
b) Currency in circulation	1.4	6.0	1.9
c) Government accounts	7.8	52.8	11.8
d) Net (a.+b.+c.)	8.2	52.4	12.1
2. Eurosystem			
a) Net foreign assets	..	..	..
b) Currency in circulation circulation	0.6	2.5	0.8
c) Government accounts	1.9	11.1	3.2
d) Net (a.+b.+c.)	2.1	12.8	3.3
Hungary/ Eurosystem (1.d./2.d.)	3.9	4.1	3.7
O/N rate spread (in basis points)			
3.a EONIA	2.0	49.0	8.6
3.b O/N DEPO (HUF)	8.6	90.5	51.9
Hungary/ Eurosystem (3.b/3.a)	4.2	1.8	6.0

Source: ECB, MNB.

siderable limitations on the central bank's leeway, especially in times of speculation in the foreign-exchange market. Nevertheless, the MNB publishes its aggregate data on the reserve requirements and day-to-day reserves holdings of commercial banks in an effort to assist the liquidity management of banks.[11] All in all, this helps counterparties to use averaging more effectively, while it provides extra information for the pricing of interbank transactions, which in turn may have a mitigating effect on interbank interest rate volatility.

The proper use of averaging is further obstructed by the fact that there are considerable differences in the banking system as regards the settlement turnover and the level of reserve holdings to execute these transactions. Since the reserve requirements are determined in principle by the volume of short-term liabilities, in case of smaller banks, which are less active in collecting deposits, yet are engaged in handling massive volumes of payment transactions, the demand for working balances may limit the use of averaging, which in turn may reduce interest rate elasticity of reserve demand. The MNB's intraday credit, made available to banks free of charge against collateral, pledged for the central bank, may eliminate this limitation.[12] For banks in short collateral position the intraday credit is unlikely to be of any assistance in the conduct of payment transactions. For this reason, the demand for working balances of certain banks may be higher, which may reduce their averaging capability, which also reduces the elasticity of interest rates.

In addition to substantial volatility in liquidity and deviations in the demand for working balances of commercial banks, the limited effectiveness of the interbank market presents a further obstacle to taking better advantage of averaging. One reason is that the costs of interbank transactions are indirectly influenced by the transaction costs in relation to technical achievements and regulatory practice.[13] Moreover, internal regulations governing the operations of interbank market players may also impede the effective functioning of the market. The internal regulations of banks, for example, often contain provisions

[11] Updated daily at Reuters NBHL site.

[12] The availability of intraday credit is restricted by the central bank limit calculated from the volume of pledged securities. Outstanding intraday credit at the end of day is automatically converted into an O/N collateralised loan.

[13] See for example Hamilton's [1996] analysis of the American interbank market.

for partner limits, that is to say they restrict the size of maximum position vis-à-vis interbank market players, which may be of great importance particularly in respect of unsecured transactions. Due to the strong concentration[14] in the Hungarian interbank market, this may have a particularly unfavourable impact on the effective redistribution of reserves.

[14] The Herfindahl index of the liquidity surplus is typically around 1300-1500, and approximately 30-40 percent of the liquidity surplus is controlled by one bank. Consequently, interbank lending is also characterized by strong concentration (See the *Report on Financial Stability,* December 2004).

2. Empirical analyses of Hungarian data

Our analysis of O/N interbank rates covers a time series of 1182 days in 59 reserve periods between January 4, 2000 and November 30, 2004. The period between January 14 and March 3, 2003 was omitted from the sample, because during that particular period the MNB took extraordinary measures in the operational framework of monetary policy to cope with a speculative attack against the national currency, and in consequence the O/N interbank interest rate adjusted to the bottom of the interest rate corridor.[15]

The O/N rate data was obtained from the interbank interest rate statistics of the MNB based on its K12 Reports. We conducted the analysis on the weighted average interest rate of unsecured transactions, which make up for a significant portion of the interbank market.[16]

In the sample period, the key policy rate varied in a very wide spectrum, due to several cycles of interest rate increases and decreases. For this reason we concentrated our empirical surveys on the relative position of overnight rates inside the interest corridor $s_t = \frac{r_t - r_t^p}{r_t^p - r_t^b}$, instead of on the level of these rates.[17]

2.1 Descriptive statistics of the overnight rate

One of the most obvious characteristic of the histogram of O/N rates is that the mode is situated in the middle of the distribution (Chart 2). O/N interbank rates stayed within a ±25 basis point band around the key policy rate (*centre of interest corridor)* for about 60 per cent of the sample period. This attribute proves that the key policy rate is an effective tool to anchor the short end of the yield curve.[18]

The O/N interbank interest rate remained below the centre by 9 basis points on aver-

[15] Commercial banks were able to place the extra liquidity obtained during the speculative attack exclusively in O/N interbank deposits. See Barabás [2003].

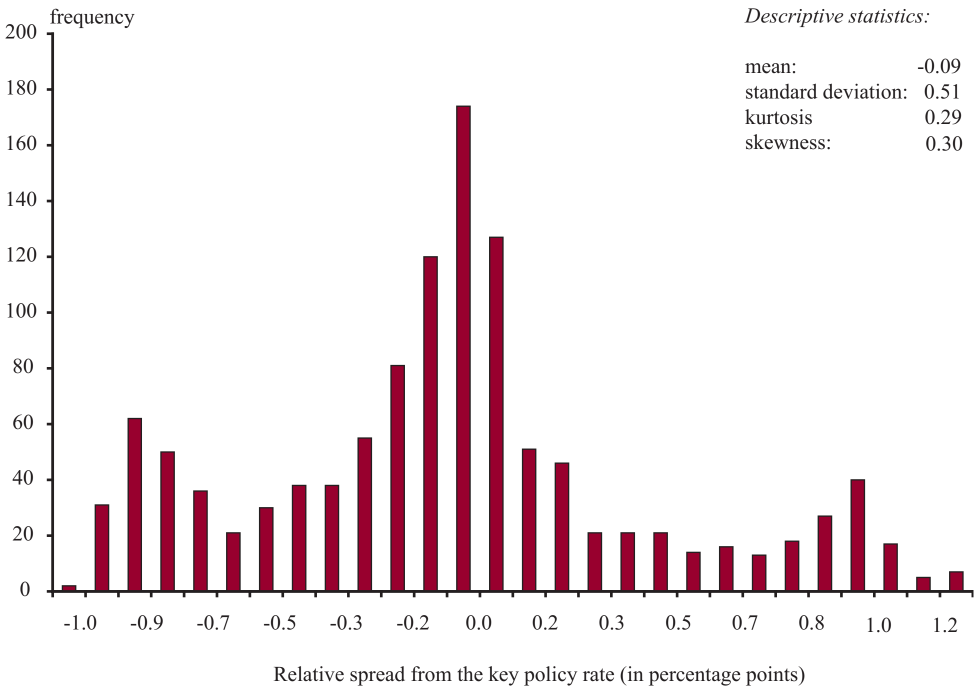
[16] According to the Balogh-Gábriel [2003] analysis of the Hungarian money markets, the ratio of O/N maturity in interbank transactions is close to 30%, while it exceeds 80% in case of unsecured transactions.

[17] In the following sections of this analysis, the term O/N rate, or spread shall mean the position of the interest rate within the interest corridor. Any derogation from this rule is expressly indicated.

[18] At the same time, as regards international comparison, the volatility of O/N rates is significantly higher in Hungary. For more details refer to Table 2 and the comparative table in Annex 4.

Chart 2

Histogram of the relative position of O/N rates within the interest corridor



age during the period under review.[19] The fact that the spread was negative, and that the distribution is asymmetric (skewed to the left) may be due to the variables contained in equation (3).

First, Hungarian commercial banks are inclined to exercise caution in their reserve management, which results in strong front loading. This increase the likelihood of recource to the central bank deposit facility and the likelihood of O/N rates below the centre of the corridor. As a result, the central bank O/N deposit instrument is used decidedly more often than the O/N collateralised loan. From the 59 reserve periods under review, in 43 cases the O/N deposit facility had to be used to offset cumulative reserve surplus on the last day of the reserve period, whereas commercial banks had

[19] This may be due in part to the fact that the effective annual yield that may be achieved by rolling over the O/N instruments could be 1-2 basis points higher than the key policy rate.

to resort to collateralised loans in only 16 reserve maintenance periods (Table 3).[20] If inertia stemming from adaptive expectations plays any role in the pricing of interbank transactions, it will also have an effect to increase the likelihood of interest rates below the centre also before the end of the reserve period.

Second, the path of key policy rates, showing a descending pattern parallel with the disinflation process in Hungary, could have also contributed to O/N rates below the centre of the corridor. The interest rate expectations pointed toward a decreasing path of interest rates – with the possible exception of the third quarter of 2002 and the end of 2003. Nevertheless, it should be also noted that in certain cases, interest rate expectations may indirectly generate an adverse effect. In view of the fact that the MNB does not limit volume in the allocation of its key policy instrument, and therefore, beside liquidity conditions, interest rate expectations also have an important effect on the decision of banks in terms of the volume of placement in two-week deposit. Bringing forward or postponing the placement of two-week deposits in a reserve maintenance period may result in higher interest rate earnings, if the interest rate movement takes place within that reserve period. The adverse effect results from the fact that the two-week deposits, that is not optimal from the standpoint of liquidity, has a negative impact on the liquidity management freedom of banks. For example, if there is a speculation anticipating interest rate cuts, increasing the volume of two-week deposits intensifies the possibility of reserve deficits that in turn may reduce the direct effect of expectations for interest rate cuts on the level of O/N rates. In extreme situations, where the expected change in the key policy rate exceeds one-half of the width of the interest rate corridor and the key policy rate is changed on the day of placement, speculation on interest rate movement may be profitable even if the standing facilities should be used to finance the speculation.[21]

The spread can not be described with a pure normal distribution. Rates are positioned more on the edges of the interest corridor than in the intervals between the centre and the edge of the corridor. And this is by no accident. Due to the high volatility of autonomous factors the chance for recourse to standing facilities and for reserve defi-

[20] Several smaller banks exercise extreme caution and less effective measures in their liquidity management, which is also reflected in their inactivity in the interbank market and that they tend to roll over their liquidity surplus in O/N deposits.

[21] A cost-profit analysis of interest rate speculation is available in Gereben [1999] study on the Hungarian interbank forint market (pages 26-28).

ciencies shows a growing pattern already in the second half of the maintenance period. Any positions outside the interest corridor occurred almost exclusively above the interest corridor, which may be explained by the design of the operational framework. The MNB introduced a limit for each bank in connection with overnight lending up to April 2001, in an effort to decrease the risk of speculation against the exchange rate band. A credit line for borrowing above the limit was available through a supplementary repo under significantly worse conditions. Although the central bank provision has long since not been in effect, internal bank regulations imposing provisions to restrict the development of liquidity deficiencies may have been maintained, and their impact could have passed through into later periods as well. The MNB provides overnight funding only against collateral in subsequent periods as well, meaning that banks without sufficient collateral were able to obtain funds from the central bank only by borrowing collateral in the interbank market or through banks with excess collateral.[22] In this light, the cost of O/N collateralised loans, due to its secured nature may be higher for commercial banks than the costs of O/N central bank deposits, which are available without collateral. The collateralised nature of O/N loans could well be a reason why O/N interest rates were above the interest corridor if there was substantial extra demand for O/N central bank funds. However, collateralisation of overnight lending is typical for other central banks as well, since unsecured lending could run great risks (default risk, financial stability risk, etc.).

The design of the minimum reserve system may also strengthen commercial banks' asymmetric reserve management aptitude (Table 3). The MNB does not remunerate excess reserves, however, in the case of a reserve deficit twice the difference between the reserve requirements and the average of actual reserve holdings must be placed on a non-interest-bearing account for one month. Therefore, the cost of a reserve deficit is twice as much as the cost of excess reserves. During 59 periods in our sample, only 4 cases of aggregated reserve deficit occurred, and the size of the deficit was extremely low in almost all cases. Obviously, this coincides with the objective of the MNB's regulations on compulsory reserve, namely that requirement of reserves shall create stable demand for central bank money.

[22] According to the answers provided in the questionnaires used for the Balogh-Gábriel [2003] interbank market analysis, 30 per cent of all banks experienced difficulties in obtaining funds in 2002.

Table 3

Frequency of using central bank instruments and the aggregated reserve compliance on the last day of the reserve period (January 2000 – November 2004)

Recourse to O/N standing facilities (bn HUF)	O/N deposit	O/N collateralized loan
< 20	5	6
20 - 40	8	1
40 - 60	3	2
60 - 80	5	3
80 - 100	7	4
100 <	15	0
Total	43	16
Difference from reserve requirements (bn HUF)	Aggragated deficit	Aggregated excess reserves
< 0.5	0	1
0.5 - 1	6	1
1 - 1.5	16	0
1.5 - 2	13	1
2 - 2.5	6	1
2.5 <	14	0
Total	55	4

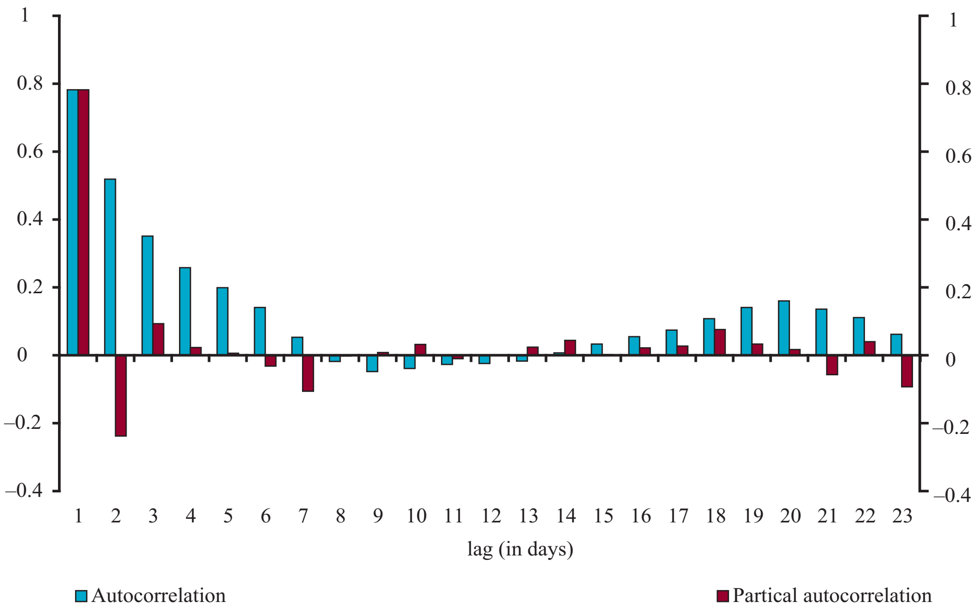
Besides the design of the operational framework, the natural risk aversion behaviour of banks also plays an important role in their cautious liquidity management. In terms of liquidity management, the main principle is that commitments to clients must be discharged at all times. Liquidity deficiency tends to increase the default risk, which may lead to loss of reputation especially under critical circumstances, in times of money market turbulence. This could have an extremely adverse impact on long-term success, and therefore Hungarian banks seem to place less emphasis on losses of efficiency and profit resulting from cautious conduct of liquidity management.

2.2 Intra-maintenance period development of overnight rates

The correlogram of O/N rates (Chart 3) shows strong positive partial autocorrelation ($\rho 1 \sim 0.8$). The reason for this is that it usually takes several days for any change to materialize in the expectations of commercial banks. Autonomous liquidity shocks do not necessarily lead to changes in these expectations, as long as they remain manageable with the current accounts and with the two-week deposits. Sudden, massive changes in expectations are more likely to occur in the second half of the reserve period, when banks' liquidity management freedom gradually decreases.

Chart 3

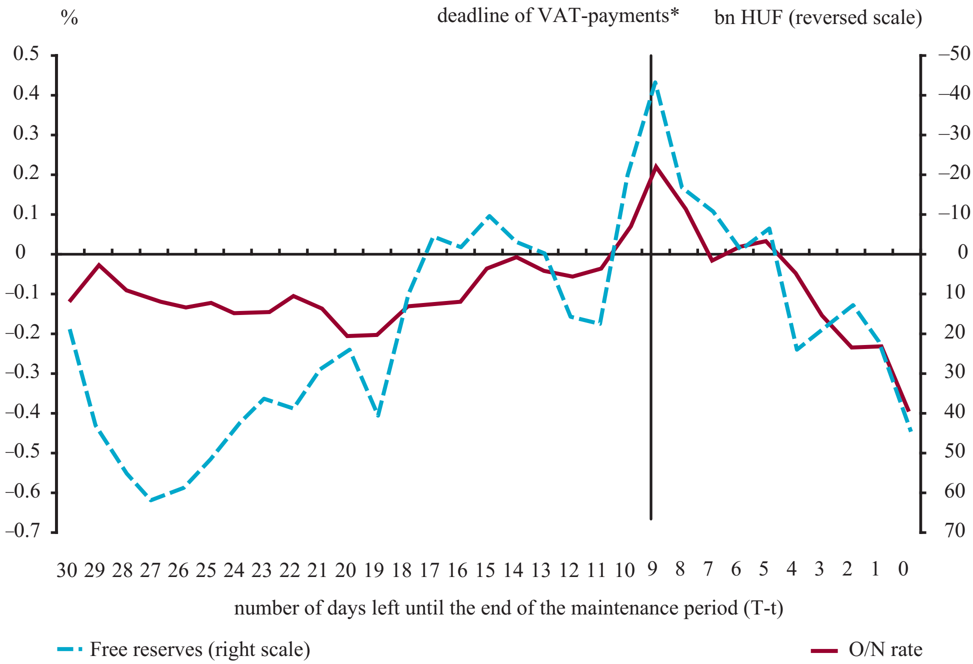
Correlogram of O/N interbank interest rates



The overnight rate follows a clear intra-maintenance period pattern which contradicts the martingale hypothesis. As a result of excess reserves at the end of the reserve period the overnight rate usually drops to the lower segments of the interest corridor by the end of the month. Commercial banks avoid end-of-the-month reserve surplus by using O/N deposit facility and increasing the volume of two-week deposits at the occasion of last placements in the reserve period, hence creating an actual reserve deficit position.

Chart 4

Average free reserves (FRS)[23] and O/N rate position within the interest corridor on the days of the maintenance period



** On average VAT payments were due in the sample 9 days before the end of the maintenance period.*

Due to the impact of excess reserves at the end of the month and to the maturity of O/N deposits, commercial banks commonly begin the first days of the next reserve period in a neutral reserve position. Consequently, at the beginning of the reserve period the level of O/N interest rates generally rises to the centre position. Until mid-month the overnight rate remains slightly below the centre, in parallel with increasing free reserves, whereas the correlation between the two variables remains limited. The reason for this is that the liquidity management leeway of commercial banks is considerably broader at the beginning of the month, which also means that the demand for reserves may be more interest rate elastic. Subsequently, the rate temporarily rises above the centre by 15-25 basis points 9 days before the end of the reserve period.

[23] See Annex 1 for the formal definition of free reserves and other reserve indicators.

This rise in the level of interest rates is attributable to the Hungarian taxation system, as the deadline for VAT payments falls in this period.[24] These payments of taxes result in substantial withdrawing of liquidity, that in some cases reach as high as 50% of overall reserve requirements of commercial banks. The substantial decline in liquidity – even if it is only temporary – induces a spike in interest rates. This empirical observation, which contradicts the martingale hypothesis, may be due to the fact that under tight liquidity conditions the current accounts of some banks may drop below their working balance needs. It is also possible that even though the available reserves in aggregated terms exceed the demand for working balances, interbank borrowing of banks in short position is impeded by credit limits.

In order to test the martingale hypothesis we analysed whether there are any calendar variables which can aid the forecasting of overnight rate (s_t)[25] apart from the previous day's level. For this analysis a linear regression was estimated where among the explanatory variables, in addition to the lagged value of dependent variable, dummy variables of weekly (ω_t) and monthly (γ_t) periodicity were included, where θ_1, θ_2 representing the row vector of the variables' parameters. On the first days of reserve periods, the previous day's level of interest rates do not influence the spread; therefore, we inserted another variable for handling the change of reserve periods, that equals the value of the previous day's level of interest rates on the first day of the month ($s_{t-1} \cdot$ dum_firstday) and zero otherwise.

$$s_t = \alpha_0 \cdot s_{t-1} + \alpha_1 \cdot s_{t-1} \cdot dum\_firstday + \theta_1 \cdot \omega_t + \theta_2 \cdot \gamma_t + u_t \tag{4}$$

We examined whether s_{t-1} reflects all available information, that is formally:

$$H_0 : \theta_1 = \theta_2 = 0$$

Of the monthly variables, we included in the equation only the dummy variables of the beginning of the reserve period, of the period following the last placement of two-week deposits, and of the VAT payments, since the O/N rate shows variability on these days of the maintenance period only.

[24] In general, VAT has to be paid by the 20th day of each month, or by the next working day if the 20th day falls on a holiday. However, the actual decline in liquidity typically occurs on the working day that follows the deadline for VAT payments.

[25] Before the test, we checked whether s_t is stationary. The hypothesis of a unit root is rejected by both the Dickey-Fuller and Phillips-Perron tests (Annex 5).

Table 4

Estimated regression statistics[26]

	coefficient	standard error	t-statistic	P value
Weekly variables (ω_t)				
dum_mon	-0.02	0.01	-1.09	0.28
dum_tue	0.00	0.01	-0.11	0.91
dum_thu	0.00	0.02	-0.13	0.90
dum_fri	0.03	0.02	1.79	0.07
Monthly variables (γ_t)				
dum_last_day	-0.14	0.06	-2.41	0.02
dum_lastday $_{t+1}$	-0.18	0.05	-3.60	0.00
dum_lastday $_{t+2}$	-0.22	0.05	-3.93	0.00
dum_lastday $_{t+3}$	-0.09	0.04	-2.10	0.04
dumvat	0.11	0.05	2.32	0.02
s_{t-1}	0.79	0.02	31.54	0.00
s_{t-1}·dum_firstday	-0.73	0.05	-15.40	0.00
u_{t-1}	0.34	0.05	6.82	0.00
R^2	0.73	Durbin-Watson statistic		1.95
Adjusted R^2	0.73	Sample size		1178

Based on the estimated results, although for the most part the actual O/N rate determines the next day' rate, certain calendar variables also carry explanatory power, meaning that the martingale hypothesis cannot be perfectly accepted. The explanatory variables – except for the lagged dependent variable – contained only dummy variables, allowing for comparison of the absolute values of their parameters. In accordance with our expectations, the seasonality of O/N rates is strongest around the last day of the reserve maintenance period, i.e. the end-of-the-month dummy variables were significant. In parallel with the rise in free reserves, on the last three days, the

[26] In view of the error autocorrelation we included the lagged value (u_{t-1}) of the error term in the final form of the estimated equation. The ultimate ARMA(1,1) model satisfies the condition that the error term is not serially correlated under standard statistical tests (Annex 5.c).

level of interest rates drops by approximately 14-22 basis points. Moreover, on the first day of the reserve period the previous day's spread is adjusted by 73 percent. The sign of dummy variables of VAT payments is positive, as expected. The spread increases by 11 basis points on the day of VAT payment, causing a substantial decline in liquidity.

Of the weekly variables none had any explanatory power at higher confidence levels. At a somewhat lower confidence level (90 per cent) the Friday dummy variable appeared significant. On Fridays, the O/N rate goes up by 3 basis points from Thursdays. One possible explanation for this phenomena is the cautious conduct of banks in reserve management. First, the reserve period covers weekends, and therefore, the last day of the week carries more weight in terms of compliance with reserve requirements. Second, on Fridays the supply of reserves is lower due to weekly seasonality of currency in circulation.

All in all, we concluded that Hungarian commercial banks take advantage of the averaging provided by the reserve system in a limited manner, which diminishes the buffer function of the compulsory reserve regulation intended to cushion fluctuations in O/N rates. In addition to extensive variations in liquidity generated by autonomous factors, this is due to the fact that the internal regulations of most banks impose restrictions on the maximum daily and cumulated deficit within the reserve period.[27] Further limitations may be presented by the fact that the liquidity position of banks is influenced by the summation of the transactions of several banks divisions (customer departments, foreign-exchange market departments, etc.); netting the transactions, however, often takes place at the end of the day, when the interbank market no longer provides any option for closing the position.

[27] Magyar-Vincze [2002].

2.3 Modelling the overnight rate

The volatility of overnight rates is limited – apart from exceptional cases – by the interest rate corridor: hence, the assumption of a linear relationship between the O/N interest rate and potential explanatory variables would lead to incorrect conclusions. The linear effect of explanatory variables on O/N interest rates is gradually decreasing from the centre level toward the edges of the interest rate corridor (Chart 5). If, for example, commercial banks anticipate ample liquidity conditions and reserve surplus to the end of the reserve period with a probability of P_d=1, it will trigger the O/N interbank interest rate to adjust to r_d however high the volume of excess reserves is. Accordingly, the model we devised is similar to the EONIA[28] model of Würz [2003]:

$$f(x_t, \alpha, \beta_t) = \alpha\left(\frac{2}{1+e^{-2\beta_t' x_t}} - 1\right) \tag{5}$$

and

$$s_t = f(x_t, \alpha, \beta_t) + \varepsilon_t \quad , \tag{6}$$

where x_t is a vector of explanatory variables, β is the parameter vector, α is the variable indicating the width of the interest corridor, and ε_t is the error term with zero mean and normal distribution.

This form of the equation appears favourable also because it is able to handle non-normal distribution of O/N rates, that is the "kurtosis" at the tails of the distribution (Chart 2). The range of the estimated equation is the [$-\alpha$,$+\alpha$] interval. In light of the fact that the interest corridor limits fluctuation of rates in most cases, the value of α scalar could be around 1.

As for the variance of error term (σ^2_t), it was assumed that it is not independent from the variance of previous periods. Therefore, we augmented the model with a GARCH[29] equation for the conditional variance of the error term. In the equation for the condi-

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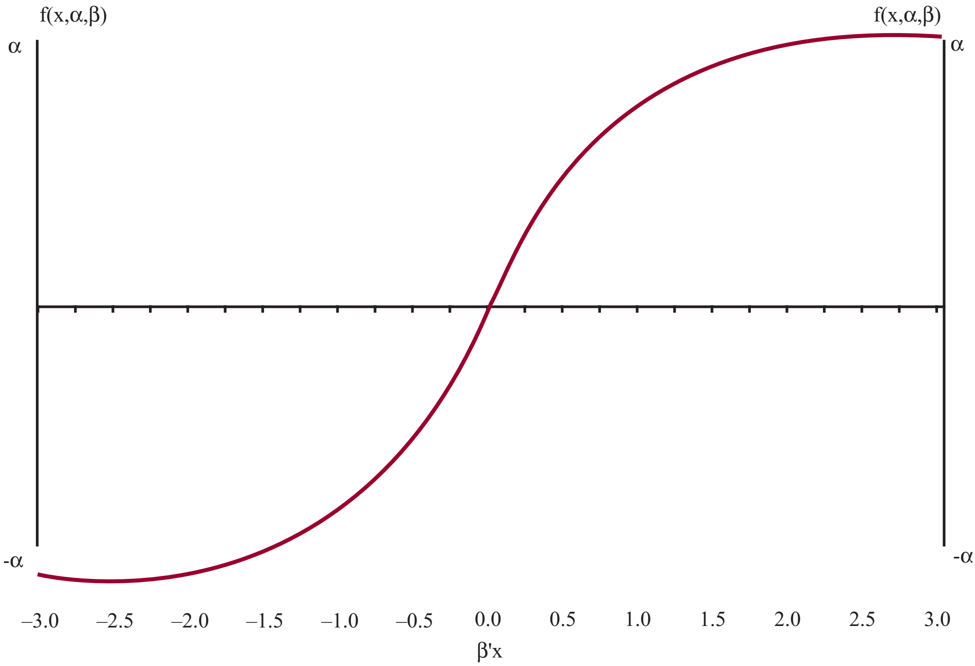
[28] EONIA (Euro Overnight Index Average), a reference yield of euro markets. EONIA is the weighted average interest rate of O/N unsecured lending transactions of 52 panel banks in the Eurosystem, which is calculated and published by the European Central Bank.

[29] GARCH (generalized autoregressive conditional heteroskedasticity) models are commonly used for the analysis of high frequency financial data (yields, exchange rates). In principle, it is helpful in modelling volatility where a relatively stable volatility under tranquil circumstances rises as induced by exogenous factors, then gradually reverts to its normal level.

Chart 5

Relationship between the explanatory variables and the level of O/N rates



tional variance we included, in addition to the previous period's squared error, ε^2_{t-1} and conditional variance, σ^2_{t-1}, certain explanatory variables of the equation for O/N interbank interest rates, along with other variables in the z_t vector.

$$\sigma_t^2 = c + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 \sigma_{t-1}^2 + \lambda' z_t$$

Augmenting the model, apart from the fact that it resolves the unfavourable effects stemming from the heteroskedasticity of the error term (thus improving the accuracy of parameter estimation), also enlarges the scope of final conclusions to be drawn from the model, since it helps to identify the factors which have an influence on the volatility of O/N rates.

We grouped the explanatory variables of the regression – excluding the lagged dependent variables – into four main groups (Table 5). With a view to theoretical relationships the first group includes the proxy variables relating to the liquidity conditions

Table 5

Grouping of explanatory variables[30]

DESCRIPTION	DEFINITION
Liquidity condition expectation	
x_1 – RSDEF	Actual reserve position: difference between reserve holding and reserve requirements on t. day.
x_2 –ACCRS	Cumulative reserve position: difference between the average reserve holdings and monthly reserve requirements up to t. day.
x_3 –FRS	Free reserves: difference between the actual reserve position and the reserve requirements for the period remaining from the month on t. day.
x_4 – NETON	Difference between recourse to O/N deposit and O/N loan facilities.
x_5 –DUMNETON+	dumNETON+ = 1, if x4 > 0 and dumNETON+ = 0, if x4 < 0
x_6 –DUMNETON-	dumNETON- = 1, if x4 < 0 and dumNETON- = 0, if x4 > 0
x_7 – DUMFRS+	dumFRS+ = 1, if x3 > 0 and dumFRS+ = 0, if x3 < 0
x_8 – DUMFRS-	dumFRS- = 1, if x3 < 0 and dumFRS- = 0, if x3 > 0
Interest rate expectations	
X_9– BUBEXP	Interest rate cut expectations implied in the 3-month BUBOR in percentage points.
x_{10} – DUMRATECHANGE	DUMRATECHANGE =1 on the day of changing the key policy rate, otherwise zero.
Calendar variables	
x_{11} – DUM_firstday	DUM_firstday = 1 on the first day of the month, otherwise zero.
Lagged dependent variables	
X_{12} –s_{t-1} X_{13} – s_{t-2}	Lagged values of the dependent variables.

of the banking sector, and the second group gauge interest rate expectations along with a dummy variable measuring the effects of key interest rate changes. The third group of dummies, measuring calendar effects, contains only one dummy for the beginning of the month in the final basic model equation, as the information contained in the other dummies relating to seasonality are also measured by other regressors (liquidity variables, cf. Chart 4). Leaving out the dummy from the beginning of the

[30] See Annex 1 for a more detailed description of certain variables.

month would have distorted the model estimation due to the model's autoregressive nature and to the reserve periods changes. Finally, the fourth group contains the lagged values of dependent variables in consequence of strong autocorrelation characteristic of the dependent variable.

2. 4 Estimation results

The review of estimated results begins with an analysis of the signs of estimated coefficients and, where possible, comparison of the extent of the coefficients. The interpretation of the effect of explanatory variables (x_{it}) on the spread in numerical terms is somewhat difficult due to the non-linear definition of the model. For the sake of simplicity, the linear effect of x_{it} will be interpreted as the partial derivative of the estimation function according to x_{it}, presuming that the total effect of all interpretative variables is zero:.

$$\partial f(x_{t,}\alpha, \beta_t)/\partial x_{i_t}\Big|_{\forall x_t:\beta_t' x_t = 0} = \alpha\beta_{i_t} \quad .$$

This does not constitute an unrealistic condition, since in most cases the level of O/N interest rates remained close to the centre of the interest rate corridor; in other words the full effect of explanatory variables was close to zero.

The value of the constant (α) reflecting the width of the interest rate corridor is close to 1, as we expected a priori, which means that the interest rate corridor is an effective tool to limit the movements of short-term interest rates.

Liquidity condition variables

The coefficients of liquidity proxy variables have negative signs in line with our expectations. The cumulated reserve surplus/deficit and an increase in recourse to central bank O/N deposits/loans results in the decrease/increase in O/N rates. The indicator of actual reserve position *(RSDEF),* and the retrospective liquidity ratio *(ACCRS)* did not have explanatory force, hence they were omitted from the final version of the estimated equation. The insignificance of these variables is an indication that commercial banks are able to cushion temporary shocks in liquidity with the help of their settle-

Table 6

Regression statistics of the estimated model[31]

Overnight rate spread (s_t)			
	cofficient	standard error	p-value
α	0.987	0.031	0.00
Liqudity conditions			
FRS^+	-0.001	7.97E-05	0.00
FRS	-0.002	1.67E-04	0.00
$NETON^+$	-0.011	7.53E-04	0.00
$NETON^-$	-0.023	2.46E-03	0.00
Interested rate expectation			
BUBEXP	0.000	0.000	0.14
Lagged dependent variables			
DUM_firstday s_{t-1}	0.628	0.031	0.000
s_{t-1}	0.787	0.037	0.000
s_{t-2}	0.073	0.016	0.000
Conditional variance			
c	0.004	0.000	0.00
Garch variables			
ε^2_{t-1}	0.122	0.013	0.00
σ^2_{t-1}	0.668	0.009	0.00
Calendar variables			
DUM_lastday	0.039	0.012	0.00
DUM_lastday$_{t-1}$	0.022	0.006	0.00
DUMVAT	0.052	0.005	0.00
Operational dummies			
DUMRATECHANGE	0.043	0.009	0.00
R^2	0.859	Durbin-Watson statistics	1.67
Adjusted R^2	0.857	Sample size	1179

[31] Further statistics of the model are available in Annex 5.b. We also cross-checked the model without the GARCH augmentation, using the least squares method (OLS) (Annex 2). In order to avoid the distorting effect of heteroskedasticity we used the Newey-West heteroskedasticity and autocorrelation consistent estimation method. The conclusions drawn from OLS estimation coincide with our results which reflect that our conclusions stem from proper model specification.

ment accounts and with their two-week deposits. The free reserves (FRS) index, similar to the ACCRS index, is basically a retrospective indicator; however, it reacts to any decline in liquidity management freedom much more sensitively as the end of the reserve period is approaching. For this reason, it may also reflect future expectations to some extent, since banks tend to evaluate their reserve position taking into consideration the expected liquidity conditions for the remainder of the month, with due consideration of seasonal factors. The importance of the information this indicator carries is confirmed by the significance of parameters.

The estimated results obtained through the separation of tight and loose liquidity situations[32] support an earlier postulation that banks approach these two situations asymmetrically. On the basis of free reserves (FRS), the coefficient of reserve deficits is twice as high as the coefficient of reserve surpluses. A 10-billion forint increase in liquidity surplus generates a 1 basis point fall in O/N rates, and the overnight rate rises by 2 basis points in reaction to reserve deficits of the same degree.

Similar conclusions can be drawn with regards to the effect that recourse to O/N central bank instruments has on the spread. Recourse to an overnight collateralised loan of 1 billion forints triggers a +2 basis points spike in the rate, while the reaction of the spread is -1 basis point if the same amount has been placed in O/N deposits.

Interest rate expectations

As we explained in the previous sections, the impact of interest rate expectations on overnight rates is twofold. First, under the martingale hypothesis, ceteris paribus the expectation of cuts or rises in the interest rates decreases or increases the spread. Second, interest rate expectations also have an effect on the magnitude of placements of banks in two-week central bank deposits, and indirectly on liquidity condition variables, meaning that interest rate expectations may generate an adverse effect as well. Based on the estimated results, these two effects may be similar, as the BUBEXP variable has turned out to be insignificant. In view of the operational framework of the MNB, it is not impossible that the interest rates on two-week deposits may prevent the

[32] FRS+, FRS- indices are calculated from FRS and DUMFRS+/- variables.

spill-over of interest rate expectations into the spread before the interest rate change occurs, as the two-week deposit of the MNB provides an alternative to interbank lending to some extent. Although, concerning the interest rate hike expectations, such limit does not exist, in light of the dominance of interest rate cut expectations during the period under review, the insignificance of the BUBEXP variable seems acceptable. Taking this into consideration along with the indirect effect through liquidity variables, the direct although latent effect of interest rate expectations could well be positive. In this respect, the almost standing facility nature of two-week deposit of the MNB (no limitation on the volume) may alleviate the effect of interest rate expectations on O/N rates to some extent.

Expressing the effect of interest rate expectations on O/N rates numerically could be difficult because strong interest rate expectations typically occur in times of turbulences in the foreign-exchange market or at times of intense movements in foreign exchange rates. In such cases commercial banks are inclined to take a more speculative approach toward liquidity management. Moreover, any intervention by the central bank in the foreign-exchange markets may have a substantial impact on liquidity position variables. Separating the effect of pure interest rate forecasts is further impeded by the fact that the proxy variable of interest rate expectations we used pertains only to longer-term interest rate expectations. Derivative instruments (e.g. short-term interest rate swaps) which have the potential to supply more accurate information on short-term, more precisely intra-maintenance period interest rate expectations are less popular in the Hungarian money market.

As regards our interest rate expectation proxy variable we attempted to take into account the scheduled dates of pre-announced meetings of the decisions-making bodies of monetary policy[33] (council meetings). We presumed that following the last pre-announced council meeting of the reserve period interest rate expectations will have a less strong effect on the spread, as the probability of extraordinary decisions relating to interest rates is substantially lower. However, separating the interest rate expectations within the reserve period using this method was not successful, as the

[33] The supreme decision-making body at the MNB in terms of monetary policy was the Monetary Council after July of 2001, preceded by the Central Bank Council (JT). As during the era of the JT interest rate movements did not follow any regular pattern, we opted to address the period following July 2001.

effect of interest rate expectations on the spread was not significantly different from zero before the last council meeting in the maintenance period.

Variance equation

The estimation results show that volatility is determined mainly by the GARCH(1,1) components. Essentially, the variance rises significantly at about the end of the reserve period, showing similar results as in the empirical works of Prati-Bartolini-Bertola [2001] and Würz [2003] using euro area data.

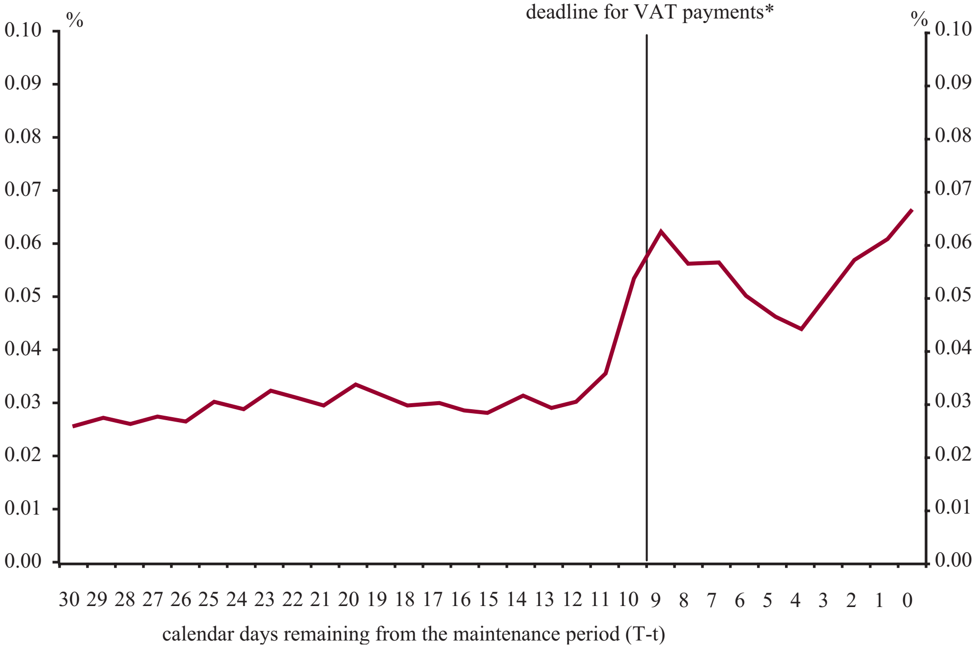
The rise of volatility at the end of the month may be due to the fact that the liquidity management freedom of banks gradually decreases as the end of the reserve period approaches. The buffer function of averaging disappears at the end of the month, as the reserve requirement becomes effective, and the only resource left for banks to balance their reserve position following the last placement in two-week deposits is overnight central bank instruments.

The variance indicates a sudden rise for the first time at the time of VAT payments. On the deadline for VAT payments this increase is close to 5 basis points, after which volatility declines once again up to the fourth day before the end of the reserve period. This may be due, in part, to the fact that banks at this time may still invest in two-week deposits in reaction to movements in the liquidity position attributed to autonomous factors. The last placement of two-week deposits is generally made 3.5 days before the last day of the reserve period, as redemption is always on Wednesdays, whereas the end of the reserve period could be any day of the week.

In the conditional variance equation, the variable of interest rate changes was also significant. The volatility increases by 4 basis points on the days of interest rate changes that may be attributable to natural uncertainty relating to the magnitude and timing of official interest rate movements.

Chart 6

Intra-maintenance period conditional variance according to the estimated equation



**See comment on Chart 4.*

3. Potential trends in the future

The analyses demonstrated in the previous chapters aimed to help detecting and understanding the factors behind O/N rate movements. In the following, working from these results, we attempt to outline future trends. Our main support in this effort is a presentation of the prospective path of the factors influencing of O/N rates, and the evolution of institutional surroundings.

3.1 Liquidity-related trends

As far as liquidity conditions are concerned, the most important change is that fluctuations in the government accounts in the central bank balance sheet are expected to lessen. The government body vested with power to manage public finances and the public sector accounts (ÁKK Rt. – Government Debt Management Agency) introduced new measures in the first quarter of 2004 intended to improve the transparency of liquidity conditions and the security of public debt management. The ÁKK plans to decrease fluctuations in liquidity – that could be of substantial volume as generated by the debt management, yet it can be relatively well projected – by way of a more flexible strategy for issuing treasury notes, by issuing special instruments with less than 3-month maturity (adjusted to longer-term redemptions), by more efficiently synchronizing public financing operations, and by way of a more intense programme for bond buy-back transactions. ÁKK plans to compensate the effect of transactions relating to the primary balance and those which are increasingly difficult to predict, if the balance of public sector accounts deviates from a pre-determined zone. If the balance deviates from the target zone due to daily transactions, the ÁKK will attempt to push it back to the target zone by the performance of repo and reverse repo operations with government papers. In reality, there were several blocking factors existing during 2004 in smoothing out the KESZ-balance. Firstly, the Treasury had to draw up the legal framework for repo contracts (master agreements) beforehand, since they were non-existent in the Hungarian market. Furthermore, it was difficult to determine the magnitude and timing of smoothing operations due to the complex nature of prognosis of the KESZ-balance.

After all, the volume of Treasury repo operations gradually rose during 2004, and the expected improvement in the outcome of smoothing operations may make it considerably easier for banks to plan liquidity within the reserve period. This also could allow for greater accuracy in forecasting liquidity conditions. Furthermore, it may reduce the risks stemming from erroneous decisions of commercial banks in connection with liquidity management in the future, as well as the magnitude of deviation of O/N interest rates from the key policy rate.

3.2 Interbank market trends

The ratio of unsecured transactions among all interbank transactions has been gradually decreasing since deregulation of the foreign exchange market, even though the turnover of unsecured transactions did not decline.[34] In interbank transactions the greatest increase took place in FX-swap transactions. The turnover of repo-type transactions also increased due, amongst other reasons, to the fact that the MNB excluded this particular instrument from the reserve required liabilities as of the autumn of 2002. The widening spectrum of instruments available for liquidity management and further improvements in the liquidity of the interbank market may help reduce fluctuations in O/N interbank rates. The best advantage that secured transactions offer is that these transactions are substantially less burdensome on the banks' credit limits compared to unsecured transactions, hence they can help to improve the effectiveness of the interbank market.

The development of the interbank market would receive a great boost if interest-rate swaps were to gain more popularity. This instrument provides facilities to cover the interest risks of long-term unsecured transactions, thereby helping to broaden the spectrum of liquidity management instruments whose term is longer than overnight.[35]

[34] See Balogh-Gábriel [2003].

[35] According to the MNB's information, most Hungarian banks deal in interest-rate swaps with foreign banks and this particular instrument is not commonly known to be used to hedge transaction in the interbank market *(Report on Financial Stability,* December 2004).

Furthermore, the development of an interest-rate swap market, similar to the EONIA-swap market, may also present a speculative tool for interest rate movements that in turn may increase market liquidity, and may provide information with regard to interest rate expectations.

4. Conclusions

Based on the analysis of Hungarian time series, the principle driving force behind the movement of O/N rates are the expectations of liquidity conditions. Yet, Hungarian banks fail to take advantage of reserve averaging to its full potential, which is reflected in the fact that clear seasonal patterns can be observed in the evolution of O/N interbank rates. Overnight interest rates tend to rise at times of VAT payments, and drop in the last third of the reserve period. One possible explanation for this phenomena is the cautious conduct of liquidity management by commercial banks and imperfections in the interbank market. Possible reasons for caution in liquidity management are the substantial volatility in liquidity conditions generated by autonomous factors, and the internal regulations of banks imposing limitations on liquidity managers' freedom. Consequently, Hungarian commercial banks use an asymmetric approach to the risks stemming from reserve surplus and reserve deficit, which is also the reason why they endeavour to front-load and maintain a cumulative reserve surplus position before the end of the reserve period. This asymmetric approach to reserve management may be affected by the difference in the costs of central bank O/N instruments and the different cost of excess reserves and non-compliance with reserve requirement. As a result, interbank interest rates generally fluctuate below the centre of the interest corridor and drop to the bottom edge of the corridor by the end of the reserve period. The effect of interest rate expectations on overnight interest rates may be the same or may be adverse of the direction of interest rate expectations. Based on the estimated results, on account of the standing facility feature of two-week deposits and the speculative approach of banks toward liquidity management, the opposite effect may appease the direct effect of interest rate cut expectations.

The volatility of O/N rates increases at the time of VAT payments, and also at the end of the reserve maintenance period, which is an indication of decreasing freedom of banks' liquidity management. Fluctuations in the level of O/N rates are expected to be lower in the coming years. This will be enhanced by the diminishing impact of autonomous factors on liquidity, and further development of the interbank market.

Annexes

Annex 1. Formal definition of some explanatory variables

Cumulated reserves: $ACCRS_t = \dfrac{\sum_{i=1}^{t} RS_i - t \cdot RR_\tau}{t}$ where RR_τ stands for the volume of reserve requirements in the τ. reserve period, and RS_t is the volume of reserves held on t. day.

Actual reserve deficit: $RSDEF_t = RS_t - RR_\tau$, consistent with the conventions used for cumulative reserves.

Free reserves: $FRS_t = RS_t - \dfrac{T \cdot RR\tau - \sum_{i=1}^{t} RS_i}{T - t}$.

Interest rate cut expectations:

$BUBEXP = \left\{ \left[(1 + r_{bubor}^{3M} \cdot 0{,}25)^4 \right]^{14/365} - 1 \right\} \cdot \dfrac{360}{14} - r_p$ where is r_{bubor}^{3M} the 3-month BUBOR and r_p and the MNB's prevailing interest rate for two-week deposits in %. The indicator captures the immediate change in the policy rate required to achieve the same yield to the 3-month interest rates by rolling the key policy instrument.

Annex 2. OLS-estimation of the model for O/N rates*

	O/N rate spread		
	coefficient	standard error	p-value
α	1.003	0.026	0.00
Liquidity conditions			
FRS+	-0.001	1.46E-04	0.00
FRS-	-0.003	2.02E-04	0.00
NETON+	-0.010	8.57E-04	0.00
NETON-	-0.026	4.01E-03	0.00
Interest rate expectations			
BUBEXP	0.000	0.000	0.13
Lagged dependent variables			
DUM_firstday $\cdot$ s_{t-1}	-0.605	0.057	0.00
s_{t-1}	0.640	0.034	0.00
s_{t-2}	0.301	0.048	0.00

R^2	0.867	Durbin-Watson statistic	1.88
Adjusted R^2	0.866	Sample size	1179

* *Newey-West heteroscedasticity and autocorrelation consistent estimation method for standard errors.*

Annex 3. An example for liquidity management strategy to utilize averaging

The development of O/N rates, based on past observations, show a clear intra-maintenance period pattern in Hungary. Taking advantage of reserve averaging, it may therefore by profitable to make investments in the interbank market on the days when O/N interest rates are clearly above the centre of the interest rate corridor, and finance the positions with borrowing on days when the level of interest rates is below the centre. The requirement of this strategy is that the average amount of lending and borrowing weighted by the number of days of lending and borrowing is equal. Under this strategy, the lending made on the day of VAT payments or on the following two days is financed by a triple loan borrowed on the last day of the period (Chart 7).[36]

The pay-off function shows a cascaded pattern as the lending and borrowing, and the corresponding interest payments fell on different days of the reserve period. Although in the months when the entire banking system was in a position of cumulative reserve deficit before the end of the reserve period, and thus the level of O/N interest rates rose to the interest rates for overnight collateralised central bank loan, the monthly profit would (in some cases) have been negative. However, for the entire period under review we would have achieved a positive yield, disregarding the re-investment of profits. The annual yield is around 0.7 per cent, that may be reduced even further by transaction costs. To shed light on the cost of interbank transactions, the bid-ask spread stands around 0.2-0.25 percentage point in the overnight interbank market. The volume of gain does not appear high, nevertheless, let us not overlook the fact that this particular investment strategy does not require extra funds, and it can be financed from the settlement account. Moreover, the level of risk can also be minimized by increasing the number of partners.

The ease in the slope of the pay-off function after the end of 2001 may be due, among other reasons, to the narrowing of the interest corridor, as the maximum difference between the yield of lending and borrowing dropped from 4 percentage points to 2 percentage point by September of 2002.

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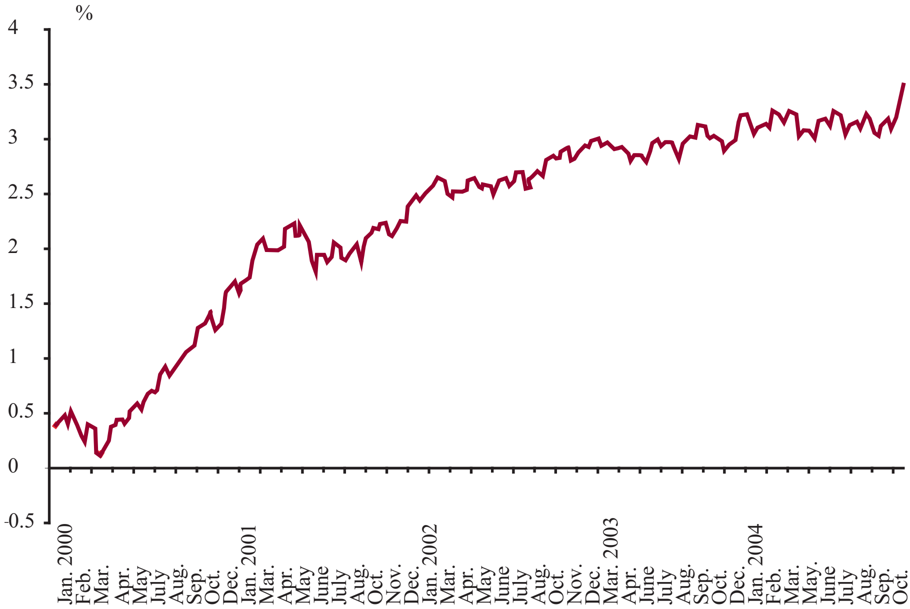
[36] On days when the maturity of investments and loans falls on a day other than a working day, investment or borrowing was proportionally lower.

Chart 7

Pay-off function of a liquidity management strategy supported by averaging

(annualised yield per placement, 20-day moving average)



Annex 4. Volatility of money market rates in several countries (2000-2004)

	Average absolute deviation from the prevailing key policy rate	
	O/N	3 -month
AUS	1	20
CAN	1	17
CH*	28	9
CZK	6	9
DK*	17	15
Eurosystem	11	13
HU	62	33
NOR*	33	32
NZ	0	25
SE*	10	3
UK	40	15
US	5	19

** Instead of O/N interest rates T/N interest rate.*

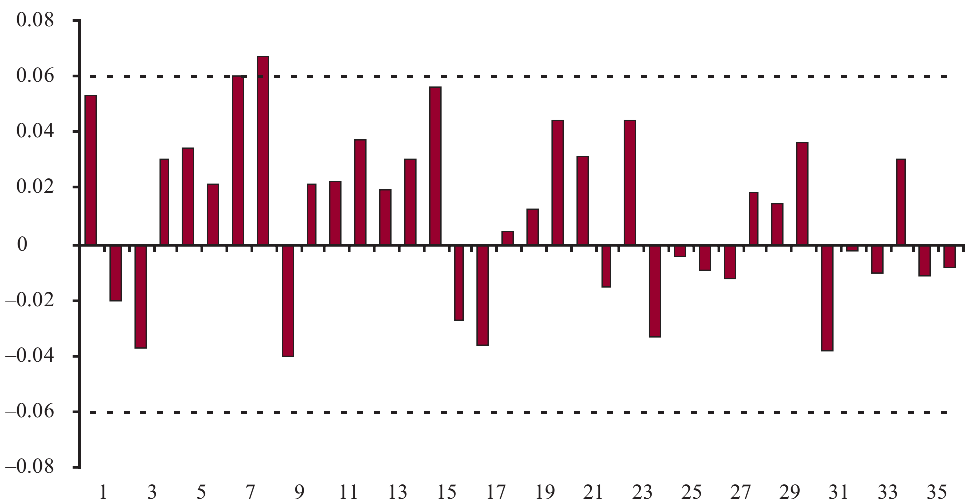
Annex 5. Statistical surveys

a) Unit root test on the spread (s_t)

Null Hypothesis: ONRELPOZ has a unit root.		
		t-statistic
Augmented DF test statistic (lag = 2)		-12.215
Phillips-Perron test statistic		-12.5456
Critical values:	1%	-2.566925
	5%	-1.941092
	10%	-1.616519

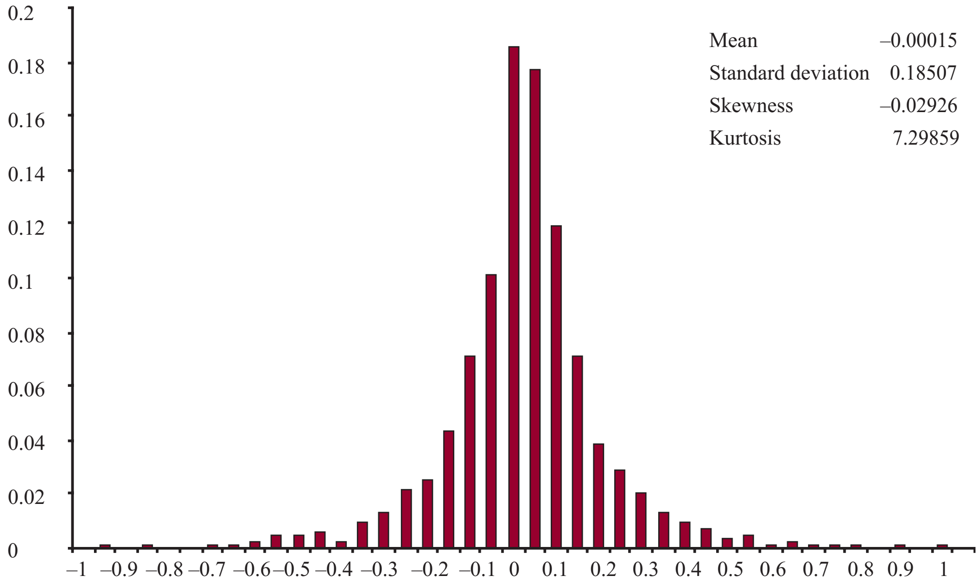
b) Residual statistics of the GARCH model defined for overnight interest rates*

Correlogram of the residuals



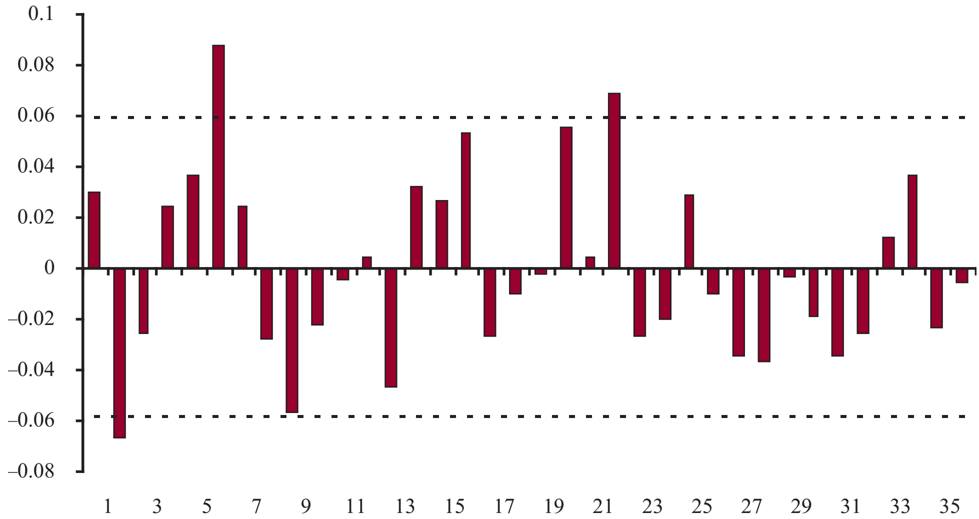
**Dashed lines indicate the 95%s confidence interval of the hypothesis of zero correlation.*

Histogram and descriptive statistics of the residuals



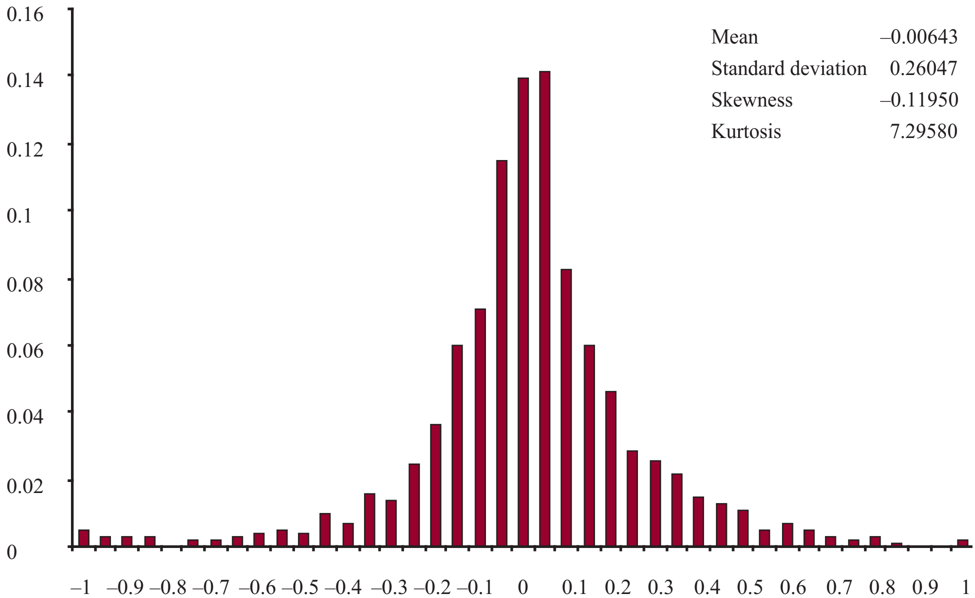
c) Residual statistics of the equation defined for calendar variables*

Correlogram of the residuals



*Dashed lines indicate the 95%s confidence interval of the hypothesis of zero correlation.

Histogram and descriptive statistics of the residuals



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