György Pulai and Zoltán Reppa: The design and implementation of the MNB's euro sale programme introduced in relation to early repayments*

As a result of the early repayment programme launched in the autumn of 2011, buying demand for several billions of euros arose on the side of domestic banks. The purchase of such amounts in the foreign exchange market would have alone contributed to a substantial weakening of the forint; moreover, it could have led to a speculative attack, further aggravating the depreciation of the currency. The objective of the MNB's euro sale programme was to use the Bank's foreign exchange reserves in a prudent manner, under clearly defined terms, to prevent depreciation of the national currency without increasing the country's vulnerability. Both the situation of domestic banks and the development of the instrument were made difficult to a great extent by the fact that the volume of loans to be repaid and hence the quantity of foreign currency necessary for hedging were uncertain. The Bank therefore needed to define the parameters of the instrument so as to enable credit institutions to continuously buy foreign currency from the Bank, but without encouraging overhedging and to ensure that the price of the instrument is not cheaper than the market rate, but not so high as to discourage banks from using it. The MNB held a total of 22 tenders; it paid out approximately EUR 2.6 billion of the foreign currency sold at the tenders, equalling 60 per cent of the total volume of the early repaid loans.

INTRODUCTION

In connection with the early repayment of foreign currency loans (allowed by Act CXXX of 2011) a substantial, albeit uncertain demand for foreign currency arose on the side of banks. Satisfying such demand in the interbank foreign exchange market could have contributed to a significant rise in the EUR/HUF exchange rate and an increase in its volatility. As these trends would have adversely affected both the outlook for inflation and financial stability, the Monetary Council decided that the Bank should satisfy the euro demand arising as a result of early repayments using its foreign exchange reserves, as a means of preventing an excessive depreciation of the forint. To this end, on 3 October 2011 the MNB introduced a new instrument. Under the facility, the Bank sold euros in exchange for forints to its counterparty credit institutions. In the following, we describe the structure of the euro sale programme, the motivation behind its introduction, the considerations relating to the determination of particular parameters and the use of the instrument. With respect to the effects of the instrument, we only discuss the anticipated effects, i.e. those that were foreseeable at the time the instrument was designed. We have not undertaken a subsequent analysis of the actual effects, as these are difficult to distinguish from the impact of other events.

CONSEQUENCES OF THE EARLY REPAYMENT PROGRAMME: WHY WAS THE CENTRAL BANK INSTRUMENT NECESSARY?

Repayment of a foreign currency loan requires foreign currency. This also holds true in relation to foreign currency-denominated loans, although in this case, the foreign currency is necessary for the closing of the lending bank's hedging transaction and not for the repayment of the loan.[1] In the case of the latter, the loan is disbursed – and repaid by the customer – in forints, but the bank records the foreign currency amount determined on the date of disbursement as a receivable from the customer on its balance sheet, irrespective of subsequent changes in the

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

[1] Páles, Judit, Zsolt Kuti and Csaba Csávás (2010), 'Role of currency swaps in the domestic banking system and analysis of the swap market during the crisis', *MNB Occasional Papers*, 90.

exchange rate. Thus, the bank is owed foreign currency by its customer. However, the bank does not have a foreign currency liability at this point, which results in a foreign currency exposure (a unit shift in the CHF/HUF exchange rate results in an exchange rate gain or loss for the bank). Banks typically try to cover their market risks resulting from traditional business with hedging transactions (with the exception of intentional open positions taken for speculation purposes). To this end, they need to create a foreign currency liability concurrently with the disbursement of the loan. The bank may do so in two ways, depending on its ability to acquire foreign currency funds: 1) it (mainly) borrows foreign currency through FX-swap transactions, which leads to a forward foreign exchange liability,[2] 2) it obtains foreign currency funds (e.g. from its foreign parent bank), and in both cases, it sells the foreign currency received in the foreign exchange market. Upon the repayment of the loan by the customer, as is the case with early repayments, however, the reverse occurs: the credit institution needs to buy foreign currency either for the closing of the FX-swap transaction or the repayment of foreign currency funds.

Following the enactment of Bill No. T/4144 on the amendment of certain acts relating to home protection,[3] i.e. the fixing of the exchange rates for early repayments, a special situation evolved, where the foreign currency position of credit institutions basically opened up before the launch of the early repayment scheme. This resulted in an unintentional exchange rate exposure, albeit its degree was uncertain in terms of volume. On the asset side of the banks' balance sheet, the forint value of loan receivables to be repaid was fixed by the bill,[4] but there was no change on the liabilities side of their balance sheet or in their off-balance sheet items (i.e. including the aforementioned hedging transactions). Thus, they needed to buy foreign currency to eliminate their exposure. Its amount, however, could not yet be estimated at the time, as it depended on the volume of the actual loan stock of customers effecting early repayment, which only became known later.

The foreign currency exposure of the portion of household foreign currency loans participating in the early repayment programme could be eliminated if it was taken over by other economic agents, depending on where the banks obtained foreign currency for hedging from:

1. In relation to the portion for which the banks purchased foreign exchange from the MNB under the instrument, the MNB, and indirectly the state assumed the foreign currency position, as the foreign exchange reserves of the MNB fell by the same amount (the forint exposure of non-residents did not change);

2. In relation to the portion for which the banks purchased foreign exchange on the interbank market, the foreign currency position of the affected households was assumed by the sectors below:

   a) foreign currency purchased from non-resident market participants in exchange for forints increased the forint exposure of non-residents,

   b) foreign currency purchased from the domestic corporate sector in exchange for forints changed the position of the corporate sector,[5]

   c) it was assumed by other households within the household sector, which sold foreign exchange in this period.

It should be noted that these sectors are not homogeneous in this regard, and therefore it is difficult to distinguish the effect of early repayments from other factors in relation to changes in their position. As shown under point 2.c), the household sector is not homogeneous either, as some participants – benefiting from a higher EUR/HUF exchange rate – sold foreign currency. Furthermore, some non-resident market participants sold foreign currency to domestic banks, thereby increasing their forint exposure [see point 2.a)], while others – anticipating depreciation of the forint – sold forint, thereby reducing their forint exposure (in retrospect, it seems that the latter group was dominant, as non-residents sold a substantial amount of forint in the foreign exchange market between the summer and end of 2011).

[2] In the FX-swap transaction, the parties exchange foreign exchange for a specific period: one party buys foreign exchange from the other party (in exchange for another currency; in this case, forints), and the parties also agree on the future repurchase, the date and exchange rate of which is determined when the transaction is concluded. Thus, in the swap transaction, the party buying foreign exchange at the initial leg will have a future foreign exchange payment liability (which is commonly recorded as an off-balance sheet item).

[3] Subsequent Act CXXX of 2011 on the amendment to Act CXII of 1996 on Credit Institutions and Financial Enterprises in relation to the expansion of home protection measures.

[4] Fixed at a 180 forints/francs exchange rate for loans denominated in Swiss francs, at a 250 forints/euro exchange rate for loans denominated in the euro, and at a 2 forints/yen exchange rate for loans denominated in the Japanese yen.

[5] Experience suggests that with a higher euro/forint exchange rate (weaker forint), the domestic corporate sector sells a larger volume of foreign exchange (this is how exporting companies try to increase the forint value of their future foreign exchange revenues).

Had credit institutions wanted to purchase the foreign currency necessary for early repayments (against forint) simultaneously and in a large volume in the foreign exchange market (see above point 2), this would have caused immediate depreciation of the forint as a result of the sudden forint supply and foreign currency demand arising in the market. Moreover, market reception of the early repayment programme was less favourable from the outset, as it imposed a significant extra burden on the financial intermediary system, which, according to market expectations, negatively affected its future lending capacity and propensity. Thus, the early repayment programme in itself increased the country risk, in addition to the effect on the above mentioned supply and demand impact in the foreign exchange market, thereby contributing to weakening of the forint.

Moreover, two additional factors could have aggravated the depreciation pressure on the forint:

1. With expectations of forint depreciation, banks would have presumably aimed at buying foreign currency in the necessary quantity as early as possible, to minimise its price, which would have reduced the horizon of high foreign currency demand to an even shorter period;

2. Speculative forint sales of market participants (who were even not involved in early repayments, but only wished to realise an exchange rate gain speculating on forint depreciation) would have presumably strengthened.

Historical data show that the speculative positions of major non-resident participants (banks, investment funds, hedge funds, etc.) taken in favour of a weaker forint usually go hand in hand with a significant weakening of the forint.[6]

ALTERNATIVES AVAILABLE TO THE BANK

A marked depreciation of the forint is unfavourable for several reasons. First, it raises inflation, and, second, it would have led to a further deterioration of the banks' loan portfolio through an increase in instalments of the remaining foreign currency loans (presumably associated with financially troubled debtors, who were unable to effect early repayment), and to an increase in their funding costs through the banks' worsening capital position.

Prior to the introduction of the programme, the MNB needed to consider whether:

1. To remain passive, and possibly face a weakening of the forint at a rate that is clearly harmful in terms of inflation and financial stability;

2. Not to intervene in an organised form, but only attempt to dampen the possible weakening of the forint, if necessary, with ad-hoc exchange rate crisis management instruments; in this case, however, the above mentioned speculative demand for foreign currency would have had to be satisfied from the foreign exchange reserves, in addition to foreign currency related to early repayments;

3. To make available foreign currency necessary for the programme from the reserves in an organised manner, and thereby avoid any forint weakening possibly requiring more foreign currency.

The Bank chose the third option. First, with an organised tool, it ensured that banks would be able obtain foreign currency from the Bank necessary for hedging; therefore they were not forced to obtain it from the foreign exchange market within a short period of time, with concerns about possible weakening of the forint. Second, it helped to disperse expectations geared toward a weakening of the forint, thereby reducing speculation in this direction. In other words, the availability of the instrument alone produced a stabilising effect, even if the quantity of foreign currency purchased under the instrument was not disclosed at the time. Moreover, the Bank not only aimed at preventing the weakening of the forint, but also the rising volatility of the its exchange rate, which is also unfavourable in terms of predictability.

The decrease in the foreign exchange reserves, however, is harmful in terms of the country's external vulnerability.[7] Market participants and analysts take into account numerous indicators to measure a country's foreign exchange reserves. One of these is the so-called Guidotti–Greenspan rule. According to this rule, foreign exchange reserves should provide cover for the given country's short-term debt, i.e. they should provide sufficient liquid assets in the event that the country is unable to renew its maturing external debt for a period of one year. To ensure that the decline in foreign exchange reserves does not significantly hamper

[6] Kiss, M. Norbert and Zoltán Molnár (2012), 'How do FX market participants affect the forint exchange rate?', *MNB Bulletin,* February.
[7] Antal, Judit and Áron Gereben (2011), 'Foreign reserve strategies for emerging economies – before and after the crisis', *MNB Bulletin,* April.

compliance with the indicator, the MNB required participating credit institutions to initially reduce their short-term liabilities (i.e. within one year) if they repay external funds using the received foreign currency. As a result, not only did the foreign exchange reserves decrease, the short-term external debt of the country also declined, which also reduces the need for reserves based on this indicator.

The MNB needed to estimate the amount by which such a programme reduces foreign exchange reserves. The MNB's experts estimated the volume of early repayments (including those funded by taking loans in forint) to be equal to 20 per cent of the foreign currency-denominated mortgage loan stock, as a part of debtors did not have sufficient savings, on the one hand, and banks' propensity to lend is rather low in certain customer segments, on the other; it was also necessary to take into account that the initial instalments on forint loans would not be lower than those on foreign currency-denominated loans. The MNB expected the early repayment of loans to be approximately EUR 3.3 billion out of the total EUR 16.7 billion in foreign currency loans within the banking system. This ratio, however, showed significant variations at the level of individual banks, and it was not clear, either, as to which banks will apply for the instrument of the MNB and in what proportion to their loans. It is important to note that although this is a substantial amount, it did not even reach 10 per cent of total foreign exchange reserves,[8] that is, there was no threat of a significant decline in the level of reserves as an effect of the programme.

We should also explain why the MNB decided to provide euros, when most of the foreign currency loans were denominated in Swiss francs, and, consequently, Swiss francs were required for the closing of the underlying hedging transactions. The Bank decided in favour of euro sales not only because euro reserves were available in a large amount, significantly facilitating the sales, but also because the aim was to prevent forint sales in the market (irrespective of the purchased currency). Thereafter, credit institutions were able to convert the euros purchased from the Bank to Swiss francs in the foreign exchange market, without any resulting effect on the forint exchange rate. Moreover, the EUR/CHF market is sufficiently large and liquid to ensure that this conversion demand of the banks does not move the exchange rate in a negative direction for them.

EXPECTED EFFECTS OF THE INSTRUMENT ON OTHER MARKETS AND THE LIQUIDITY OF THE BANKING SYSTEM

Upon the introduction of the programme, the MNB also needed to consider other factors and effects on other markets.

The MNB programme was expected to reduce surplus central bank liquidity in the banking system. When the Bank sells foreign currency to banks in exchange for forints (forints purchased by the Bank are no longer part of liquidity within the system), it reduces the amount of MNB bonds and overnight central bank deposits on a systemic level, where surplus liquidity appears in the system.[9]

The decline in forint liquidity may be considerably asymmetrical among the banks, depending on whether foreign currency lending in the past was financed with foreign currency or forint funds:

1. Forint liquidity declines and the balance sheet total also decreases at banks where foreign currency loans (or the foreign currency sales for hedging at the start of the loan) were financed with foreign currency funds from abroad. These banks receive foreign currency liquidity from the Bank in exchange for their forint liquidity, which they spend on the repayment of foreign funds. This does not affect the stock of their net outstanding swaps, which thus remains unchanged.

2. The stock of MNB bills, forint liquidity and the balance sheet total do not decrease at banks where foreign currency loans (or the foreign currency sales for hedging at the start of the loan) were financed with forint funds and FX-swaps (i.e. the replacement of forints with foreign currency). The stock of their outstanding swaps, however, declines, as the received foreign currency is used for the closing of swap transactions.

In an extreme case, the different changes in the forint liquidity of banks could have resulted in liquidity shortages for some banks, with the concentration of the dominant share of surplus liquidity at a few banks. The significantly asymmetrical distribution of forint liquidity may limit the forint lending capacity of some banks, potentially affecting the size of early repayments as well.

[8] According to the official statistics, international reserves equalled 37,554 million euro in August 2011.

[9] For details on the liquidity of the banking system and the function of the central bank instruments see the publication of the Magyar Nemzeti Bank (2009) entitled *Monetary policy instruments of the Magyar Nemzeti Bank*.

In relation to the second case, it was also necessary to take into account that non-residents kept the forint that they had acquired (in the form of swap transactions) in forint instruments (e.g. MNB bills, government securities). When reducing the stock of outstanding swaps, however, non-residents have to sell these forint instruments to be able to repay forints (in exchange for foreign currency) to domestic credit institutions. If the domestic bank(ing system) assumes these positions (buys these instruments), this may moderate the negative effects on the government securities market resulting from the sale by non-residents.

As a favourable consequence of the second case above, the foreign currency liquidity requirement of the banking system decreases; and it needs to renew less swaps to maintain foreign currency coverage. Therefore, in such a case, banks' balance sheet would not decline, but the net foreign currency raising swap stock would fall sharply, possibly resulting in a decline in swap market premia (it reflects the difficulty of acquiring foreign currency in the swap market; sometimes also referred to as 'implied basis') and the rise in swap market liquidity (the quantity of foreign currency available on the swap market rises, as domestic banks need to borrow increasingly less foreign currency with swap transactions). This also contributes to the improved effectiveness of the MNB base rate, i.e. the interest rate desired by the MNB more effectively passes through to the economy via the interbank market.[10]

STRUCTURE OF THE PROGRAMME, CONDITIONS FOR ACCESSING FOREIGN CURRENCY

Following the announcement of the sale of euros necessary for early repayments, the MNB informed the credit institutions concerned of the programme details. Coordination was necessary to clarify the method of implementation for the credit institutions. The particular details were then finalised and published.

The Bank announced the tenders regularly, on a weekly basis, between early October 2011 and end-February 2012. Banks could submit bids every Monday. In the tenders, credit institutions could receive foreign currency in an amount that did not exceed the value of their mortgage loans and home equity loans provided to the household sector, outstanding in foreign currency on 31 August 2011. Upon announcement of the tenders, the MNB did not determine the quantity to be allocated. All accepted bids were accepted at the submitted exchange rate (multiple rate tender). Results were announced on tender days at 12 noon; at this time, the MNB published the lowest acceptable EUR/HUF exchange rate.

The credit institutions received the foreign currency allocated to them only after effecting early repayments; until then, the MNB rolled it over in overnight EUR/HUF FX-swaps (spot/next – starting on the second day after the concluded transaction and maturing on the business day thereafter). Thus, although the counterparties purchased the foreign currency in the tenders, every day they technically 'lent' it to the Bank for one day in a swap transaction, until they became entitled to the use of the foreign currency through the effected early repayments. This was also favourable to the extent that the foreign exchange reserves of the MNB did not diminish until the actual use of the amounts. For the purpose of monitoring early repayments, credit institutions were required to provide data relating to the early repayment applications submitted to them and the amount of effected early repayments, which was a condition for participating in the programme. In addition, credit institutions were required to provide data on forint loans provided for the repayment of foreign currency loans, as well as external funds repaid as a result of the effected early repayments. The Bank published the quantity of allocated and actually paid amounts in the middle of the month following the reference month (together with the statistical balance sheet).[11]

Data provision on changes in foreign funds was necessary because credit institutions participating in the tender were also required to first repay their short-term (i.e. less than one year) external funds. The counterparties met this requirement on the basis of provided data. Between the launch of the programme and 23 March 2012, the long-term external funds of the Bank's counterparties – excluding mortgage banks[12] – increased by a total of HUF 635 billion, while short-term external funds decreased by HUF 2,071 billion[13] (these two amounts correspond to approximately EUR 2.1 billion and EUR 6.9 billion, respectively). In both cases, the change was chiefly attributable to foreign currency funds, while the change in forint funds played a much smaller role.

[10] For details on the pass-through of the base rate into economic trends, see the publication of the Magyar Nemzeti Bank (2012) on so-called interest rate transmission entitled *Monetary policy in Hungary*.

[11] The final actual payments, drawing out into March, were published on April 12.

[12] Mortgage banks report the issue and repurchase of mortgage bonds denominated in foreign currency, hence issued abroad, as a change in external funds. This, however, is misleading, as the owner may in fact be the domestic parent bank, therefore we ignored these items.

[13] Funds with maturity that shortens to within one year are not recorded either as items reducing long-term funds, or items increasing short-term funds; the above figures only show changes resulting from maturities and transactions.

Upon termination of the programme on 8 March 2012, the credit institutions were obliged to convert unused foreign currency to forints at the MNB. Amounts were converted at the exchange rate at which they purchased the euros from the MNB to ensure that in the event of overhedging, they do not assume the risk of movements in the EUR/HUF exchange rate until it is reconverted, in relation to the already purchased foreign currency. When determining the exchange rate of the unused and reconverted foreign currency, the MNB applied the FIFO (first in, first out) principle: the foreign currency was used in the order of purchases, thus the Bank determined the reconversion exchange rate on the basis of the exchange rate of the counterparty's last purchases.

FACTORS CONFINING PRICING, DETERMINATION OF PARAMETERS

The foreign exchange offered by the MNB as a product does not fully correspond to foreign exchange purchased by a bank in the market, as other rights and obligations are associated with it (it needs to be kept with the MNB in a specific form, it may only be used for a specific purpose, etc.). Thus, the comparability of the price established in the tenders and the market price is somewhat limited from the outset.

Furthermore, the pricing of the product was made more difficult by the uncertainty of the volume of loans to be repaid. The MNB deemed it important for banks to be able to continuously satisfy their foreign currency demand – significantly varying on a bank-by-bank basis – with the instrument, to the maximum extent possible, adjusted to their received applications, but without encouraging overhedging due to the limitation of the use of reserves to the necessary level. To this end, pricing needed to be determined with respect to the following principles:

1. To not discourage banks from applying for the central bank instrument, i.e. so that it is not too expensive;

2. To charge, however, a cost for expected overhedging, i.e. so that overhedging is not too affordable;

3. So that the exchange rate bids submitted and accepted in the tenders are more easily comparable to the EUR/HUF exchange rate observed in the market, to ensure transparency.

A major difference between purchasing foreign currency in the market and in the framework of the MNB's instrument is that in the case of overhedging, the MNB repurchases unused foreign currency at the original buying rate. The MNB thereby offered to banks a product that was unavailable elsewhere in the market, which provided cover for risks arising from the uncertainty regarding the volume of early repayments. Thus, the 'product' offered by the MNB is essentially a forward foreign exchange position, which automatically becomes void if it is not needed. In this sense, it has properties similar to those of options.

Thus, credit institutions did not assume a risk arising from possible overhedging, although certain risks needed to be taken into account in this regard on a macro level: in case of substantially higher overhedging, analysts could have anticipated a larger decline in reserves, and on the basis of higher demand for the instrument, analysts could have concluded a larger volume of early repayments, and thus higher losses for banks. For this reason, the MNB did not want to encourage banks to purchase much more foreign currency than their expected demand. To this end, the MNB decided that unused amounts should be reconverted at an exchange rate that exactly corresponds to the buying rate. Thus, the counterparty lost the interest rate spread for the period of holding (the forint interest rate was approximately 6 per cent higher than the euro rate, which would have justified reconversion at a higher EUR/HUF exchange rate), resulting in a weaker motivation for overhedging.

The MNB also had the possibility of affecting the appeal of the instrument and the temporal spread of its use with the pricing of the FX-swaps. The amount of loss incurred by a credit institution may also be affected by the interest rate it receives on the euros lent and the interest rate it pays on the forints borrowed, if the foreign currency it buys is in excess of its needs in the early tenders (which it rolls over in swap transactions until used). The MNB eventually decided to price the swap transaction on the basis of the average market interest rate (HUFONIA and EONIA) of overnight lending/deposit transactions for the previous day, that is, it did not move the price of the swap transactions in a direction that was favourable to it.[14] This price, however, was still moderately higher than the market price, particularly on days when access to foreign currency on the FX-swap market became significantly more expensive as a result of higher demand for borrowing in foreign currency. In such periods, banks could have also allocated their euros

[14] For example, had it demanded the base rate for lent forints instead of the HUFONIA rate, this would have been a larger penalty for the counterparty, motivating counterparties to renew smaller amounts.

to other banks at interest rates that were higher than the reference interest rate.

It was necessary to quantify all of these effects to determine the pricing parameters of the instrument, i.e. to evaluate the bids submitted in the tenders and to determine the price of FX-swaps. In this regard, the largest problem was that the final position of banks participating in the programme, i.e. the payout function of the product, depends on the percentage of foreign currency loans repaid by households. This risk factor cannot be hedged in the market (i.e. the market is incomplete), and therefore the 'equilibrium price' cannot be deduced the principle of no arbitrage.

In such cases, it is necessary to make pricing assumptions relating to the preferences of market participants. For the calculations, we assumed that the banks are ready to pay a constant return in exchange for a unit of reduced risk, that is, their preferences are linear in risk-return space. In other words, this assumption means that banks choose between two risky instruments on the basis of the Sharpe ratio.[15] Finally, we also assumed that the market alternative to the MNB's instrument is hedging with forward transactions.[16] Thus, the 'equilibrium tender rate' will be the exchange rate to which banks are indifferent in terms of choosing between the instrument and market forward transactions.

It was necessary to calibrate the parameters to produce specific numbers. The key parameter is the slope of the indifference curve in risk-return space; we used the Sharpe ratio – observed in stock markets – as a basis for determining this, which we modified to the extent that banks presumably have higher risk aversion than stock market investors.

According to results based on simulations and sensitivity tests, in most cases the equilibrium tender rate approximated the actual market rate. Major differences arose if we assumed that banks had already hedged most of the expected early repayment ratio (in earlier tenders or with forward transactions concluded in the market); in this case, banks would have been willing to hedge an additional one per cent in the framework of a tender only at a EUR/HUF exchange rate that was lower than the prevailing market rate, and hence more favourable for them. In other words, only banks with very high risk aversion would have been willing to take up a position at a market rate, which would have very likely resulted in overhedging (see appendix for detailed model calculations).

USE OF THE INSTRUMENT – TENDERS, ALLOCATION, PAYMENTS

The MNB conducted a total of 22 tenders between early October 2011 and end of February 2012. The vast majority of submitted bids approximated the market EUR/HUF exchange rate. In each case, the MNB determined the minimum accepted exchange rate close to the prevailing market EUR/HUF rate (average rate during the 15-minute tender), that is, the Bank did not in any case sell foreign currency at an exchange rate that was more favourable than market rates. The average exchange rate of all allocations equalled EUR/HUF 302.23.

In the course of the tenders, the MNB accepted bids from eight counterparties in the total value of EUR 2,679 million. However, not all of this amount was actually paid out, based on the effected early repayments reported to the MNB (see below). Of the ten banks with a foreign currency loan portfolio of over EUR 100 million, only two counterparties did not participate in the tenders of the MNB, and another bank obtained only one-third of foreign currency related to its early repayments through the MNB's instrument. None of the credit institutions with a portfolio of less than EUR 100 million used the central bank instrument. These credit institutions presumably purchased euros necessary for closing their foreign currency position from the market or their parent banks.

The counterparties of the MNB reported effected early repayments in the total value of EUR 4,353 million. On the basis of the above, a total of EUR 2,586 million was actually paid out of the currency allocated through the tenders, i.e. the MNB's instrument covered approximately 60 per cent of total foreign currency demand. The remaining 40 per cent was purchased by credit institutions from their parent banks or in the foreign exchange market; the related forint sales may have contributed to the considerable weakening of the national currency observed in the autumn of 2011. The average exchange rate of total actual payments was EUR/HUF 302.05.

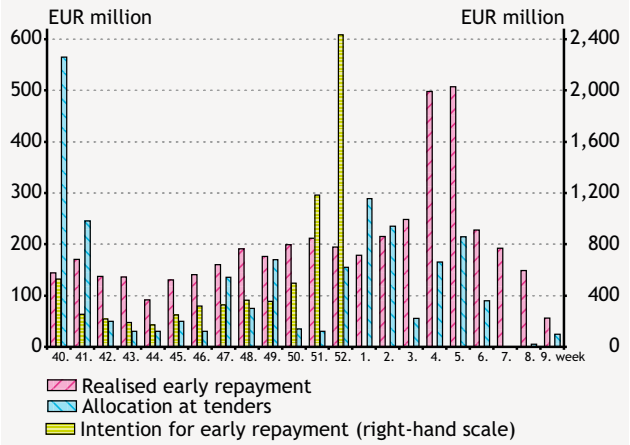
[15] The Sharpe ratio indicates the extra yield on the unit risk (yield fluctuation) of a financial instrument. The higher this ratio, the more attractive the instrument, as the higher the yield realised on it relative to its risk.

[16] A forward transaction is defined as an OTC forward transaction. In the aforementioned transaction, serving as an alternative, the bank buys foreign exchange related to a future value date, but sets the parameters of the transaction (price, quantity) in the present.

Table 1
Lowest market and lowest accepted EUR/HUF exchange rates during the tenders, and amounts allocated through the tenders

Date	Lowest market EURHUF exchange rate (HUF/EUR)	Lowest accepted EURHUF exchange rate (HUF/EUR)	Allocated amount (EUR million)
3 Oct. 11	294.35	294.45	565
10 Oct. 11	293.00	293.30	245
17 Oct. 11	290.85	291.25	50
24 Oct. 11	297.25	297.35	30
2 Nov. 11	306.45	306.85	30
7 Nov. 11	306.70	306.95	50
14 Nov. 11	314.30	314.65	30
21 Nov. 11	305.30	305.50	135
28 Nov. 11	308.10	308.25	75
5 Dec. 11	301.05	301.30	170
12 Dec. 11	303.90	304.20	35
19 Dec. 11	303.52	303.75	30
27 Dec. 11	306.55	306.90	155
2 Jan. 12	314.90	315.20	289
9 Jan. 12	313.60	313.85	235
16 Jan. 12	309.90	310.40	55
23 Jan. 12	302.90	303.30	165
30 Jan. 12	295.51	295.80	215
6 Feb. 12	292.60	293.05	90
13 Feb. 12	292.60	–	0
20 Feb. 12	288.00	288.35	5
27 Feb. 12	291.90	292.30	25

Chart 1
Amount allocated through the tenders and amount of reported and effected early repayments in a weekly breakdown



At the end of the programme, a total allocated amount of EUR 93 million remained with three counterparties, which they were unable to use, as the amount of early repayments by their customers was lower than the amount of foreign currency purchased through the tenders. The MNB repurchased this amount – in accordance with terms announced in advance – at the EUR/HUF exchange rate at which the counterparties had purchased the foreign currency in the last tender(s), in accordance with the FIFO principle.

As regards the direct effects of the programme on the accounting profit, and hence the budget of the MNB (beyond the macroeconomic and vulnerability criteria discussed above), we should make separate mention of the effect that is directly affected by the selection of parameters, and the parameter independent effect that depends on the buying rate of the foreign currency sold:

1. A loss could not be directly incurred as a result of the above described parameters (tender exchange rate, pricing of FX-swaps, reconversion exchange rate, etc.); pricing that was moderately less favourable than in the market – for banks – was to result in a moderate profit for the MNB.

2. A substantial exchange rate gain was realised on the foreign currency sold through the programme, as its buying rate was significantly lower than the selling rate.

Table 2
Amount of bids accepted in the tenders and actually paid amounts in a monthly breakdown

	Amount of accepted bids on the euro selling tender		Amount of actual foreign currency payments related to the realized final repayment	
	EUR millions	HUF billions	EUR millions	HUF billions
October 2011	890	262	235	69
November 2011	320	98	291	86
December 2011	390	119	336	101
January 2012	744	232	707	216
February 2012	335	99	921	279
March 2012	0	0	97	29
Sum	**2,679**	**810**	**2,586**	**781**

Source: Press release on the preliminary statistical balance sheet of the MNB for March.

This, however, is independent of the programme's function, nor did it play a role in the introduction of the programme, and it is not suitable for evaluating its success.

Overall, the programme was favourably received and positively assessed by market participants. In view of the programme's success, in May 2012 the MNB launched a new foreign currency sale programme for the purpose of supplying foreign currency necessary for hedging related to the conversion of foreign currency loans delinquent for more than 90 days. The volume of these loans, and thereby the potential effect of the programme on foreign exchange reserves, is significantly smaller than is the case with the programme related to early repayments, as discussed above.

APPENDIX

In the following, we describe the key elements of model calculations carried out for developing the instrument.

Terms of the MNB transaction (simplified):

- in earlier tenders, the bank hedged d_0 per cent of its total foreign currency loan portfolio with the MNB, at an average S_* exchange rate and with an r_* interest rate spread;
- in $t = 0$, the bank wishes to hedge an additional d per cent at an S exchange rate;
- it immediately swaps this with the MNB, with an r interest rate spread;
- in $t = 1$, X per cent of total foreign currency loans to be fully repaid is received for repayment;
- in $t = 1$ the bank receives the foreign currency from the MNB;
- if this is too much $(d_0+d>X)$, the surplus amount is reconverted with the MNB at the original exchange rate, according to the FIFO principle;
- if it is too little $(d_0+d<X)$, the bank supplements the missing amount on the spot market at the S_1 exchange rate.

Under the terms of the tender, the MNB determines the interest rate differentials, while the banks submit bids in the tenders for pairs of exchange rate prices and quantities. Obviously, the actual transaction is more complex, as tenders may be held at different times and repayments are made on a continuous basis. Nevertheless, the simplified model also effectively expresses the essence of the transaction.

The formula below expresses the cash flow performed in $t = 1$ (bank expenditure is a positive value):

$$\Phi = d_0 S_*(1 + r_*) + dS(1 + r) + \Phi_X,$$

where Φ_x is the portion of the cash flow that depends on X:

$$\Phi_X = \begin{cases} (X - d_0)S_* - dS, \text{ if } X < d_0, \\ (X - d_0 - d)S, \text{ if } d_0 < X < d, \\ (X - d_0 - d)S_1, \text{ if } d_0 + d < X. \end{cases}$$

The first two terms of Φ designate interest expenditure on swaps held with the MNB; this may also be interpreted as the bank concluding a forward transaction with the MNB, but the forward price is determined not by the market rate and interest rate, but by S and r. Explanation of Φ_x:

- In the first case, d_0 would have already resulted in overhedging. In this case, surplus d_0-X and d quantities are reconverted at the S_* and S exchange rates, which arises as revenue for the bank, i.e. the cash flow is $-(d_0-X)\ S_*-dS$.

- In the second case, overall there is overhedging, but the initial d_0 quantity alone would have been insufficient. Then, the surplus quantity is d_0+d-X, which is reconverted at the S exchange rate, based on the FIFO principle, thus the cash flow is $-(d_0+d-X)S$.

- In the last case, the total tied-up quantity is insufficient, and the bank supplements the missing amount on the spot market (expenditure), at the S_1 exchange rate.

Since payment depends on the value of X, and hedging is unavailable for this uncertainty in the market due to incompleteness, the price of the product cannot be deduced on the basis of no arbitrage criteria. In such cases, pricing is only possible if we apply assumptions to the degree of banks' risk aversion, i.e. to their risk-yield preferences. This is easiest to carry out in the following manner:

- We calculate the difference between the standard deviation of the product and the standard deviation of a market alternative;

- We determine the difference in expected returns required by the market to compensate for a unit difference in standard deviations, i.e. the market price of risk;

- We set a parameter of the product such that ratio of the difference of returns and the difference of standard deviations if equal to the market price of risk.

In our case, the alternative possibility is obviously hedging with market forward transactions, the cost function of which differs from the one above for two reasons. First, the forward rate is different, as it depends not on the (S, r) exchange rate and interest rate applied to the MNB transaction, but on the appropriate (S_0, r_0) market values. Second, in the terms depending on X, S_1 must be used instead of S, since now the bank hedged the d quantity in the market and not with the MNB, i.e. closing must also be made at the market exchange rate. If the cash flow of hedging with market forward transactions is Φ_P, then

$$\Phi_P = d_0 S_*(1+r_*) + dS_0(1+r_0) + \Phi_X,$$

and Φ_X is now

$$\Phi_X = \begin{cases} (X-d_0)S_* - dS_1, \text{ if } X < d_0, \\ (X-d_0-d)S_1, \text{ if } d_0 < X < d, \\ (X-d_0-d)S_1, \text{ if } d_0 + d < X. \end{cases}$$

The Sharpe ratio indicates the price of one unit reduced risk expressed in expected value. Since the spread of the MNB product is smaller, the expected value must be greater (as this is cost). If ρ designates the Sharpe ratio, it follows that the equation below must be valid:

$$\rho(D\Phi_P - D\Phi) = E\Phi - E\Phi_P,$$

where D designates the spread, and E marks the expected value. The equilibrium tender exchange rate is the solution of this equation in S.[17]

[17] This is a quadratic equation that has a unique positive solution with not too extreme parameter values.