Dániel Holló: Risk developments on the retail mortgage loan market*

In this study, using three commercial banks' retail mortgage loan portfolios (consisting of approximately 200,000 clients with housing and home equity loans), we analyse the risk characteristics of the portfolio, identify customer-specific and product-specific factors, and market and macroeconomic factors that influence portfolio quality, and finally calculate the loan loss on the retail mortgage portfolio of the banking sector in an extreme macro-risk scenario (10 per cent decline in GDP; exchange rate of EUR/HUF 340). Our findings suggest that the loans' denomination structure, the initial loan-to-value (LTV) ratio and the debtor's level of education can be considered as the main customer-specific and product-specific drivers of default risk, while the unemployment rate, domestic and foreign interest rates as well as the exchange rate constitute the major macro-risk factors impacting defaults. Based on our calculations, in the macro-risk scenario the total loss on the retail mortgage loan portfolio of the banking sector would amount to HUF 372 billion, which is approximately 6 per cent of the end-2008 mortgage loan portfolio.

INTRODUCTION

Continuous monitoring and measurement of credit risk in mortgage portfolios is of particular importance, as demonstrated by the financial crises that began in August 2007. The underpricing of risk and the spread of complex financial instruments have contributed significantly to financial strains and tightening credit conditions, which are now exacerbating the world-wide recession.

As in many countries, mortgage loans play a dominant role in retail lending in Hungary. At the end of 2008, 31 per cent of banks' interest income was related to these products, and these loans accounted for approximately two thirds of the total household loan portfolio (HUF 5,800 billion, of which HUF 4,300 billion was foreign currency-denominated debt at end-2008).

Although there have been no signs of substantial deterioration in the creditworthiness of Hungarian mortgage borrowers on the scale of the developments in the USA so far, a continuous increase in the default risk of these loans has been seen. The default probability (the probability of falling into payment arrears in the coming year) of retail mortgage loans advanced to 3.8 per cent in 2008, from 2.4 per cent in 2005.[1]

Although mortgage-type loans usually bear moderate default and recovery risks for financial institutions compared to other retail products, the build-up of real estate market concentration may make the banking sector sensitive to housing price fluctuations. In addition, due to FX lending, a substantial, permanent exchange rate depreciation may add not only to default risk, but – through the change in the forint value of outstanding debts- also to recovery risk. This, in turn, might jeopardise the financial stance of credit institutions, ultimately affecting the stability of the Hungarian economy. Therefore, it is very important to develop a stress testing framework for analysing the mortgage portfolio's risk sensitivity to adverse macro shocks.

In this study, using three commercial banks' retail mortgage loan portfolios (monthly data from January 2003 to June 2008 on 200,000 debtors with housing and home equity loans), the risk characteristics of these loans is analysed. We then describe the methodology developed for investigating the portfolio's macro shock sensitivity (stress testing framework). Finally, in an illustrative manner, we present the use of these models for stress testing purposes in an extreme macro-risk scenario (10 per cent decline in GDP; exchange rate of EUR/HUF 340, in line with the stress path of the April 2009 *Report on Financial Stability)*.

RISK CHARACTERISTICS OF THE RETAIL MORTGAGE LOAN PORTFOLIO

Mortgage portfolio quality is fundamentally determined by two interdependent factors: the share of loans granted in different years within the outstanding loan stock (vintage effect), and the 'ageing' of the portfolio.

Taking into account the 'ageing' effect in determining the portfolio's riskiness is important, as empirical evidence indicates that the closer the loan is to the date of expiry, 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] Values computed on the basis of the retail banking database.

Table 1

Changes in lending standards between 2004 and 2007

	2004	2005	2006	2007
Average housing loan amount taken (CHF-based)	5,900,000 HUF	6,300,000 HUF	6,800,000 HUF	7,600,000 HUF
Average starting maturity of housing loans (Year)	16	18	20	21
Average starting LTV of housing loans (Per cent)	47%	54%	58%	61%
Average yearly APR of CHF-based housing loans	5.94%	5.96%	5.82%	6.04%
Starting loan installment of an average CHF-based housing loan	47,683 HUF	47,637 HUF	47,994 HUF	53,302 HUF

Note: The table shows Swiss franc loans, as this was the key currency in the period under review. Initial loan instalments were quantified using the credit conditions presented in the table (amount of loan, maturity, APR), assuming annuity type constructions.

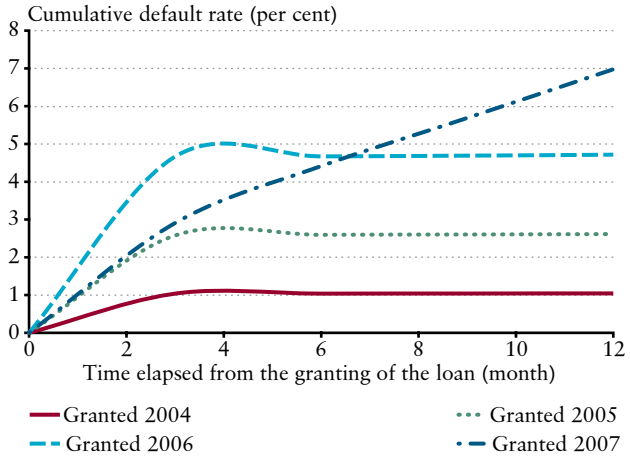
lower the default risk is. International empirical evidence suggests that defaults mostly occur within four years after loan origination (see, for example, Gross and Souleles, 2001), but then the ratio of problem loans decreases progressively as a function of loan age.

In addition to the 'ageing' effect, the other factor that determines portfolio quality is the 'vintage effect'. The 'vintage effect' captures the impact of the time period (year) of loan origination on portfolio quality. Due to the different macroeconomic and market circumstances, the life cycle of loans may differ depending on the year they were granted. For instance, if banks grant credit with eased conditions in a certain year (i.e. higher starting LTV ratios, longer maturity, etc.) then due to easing liquidity constraints borrowers with a tight financial stance may gain access to the credit market. As a result, financial institutions can grant more credit, but banks can also expect that as a proportion more clients may encounter payment problems compared to years in which lending standards were tighter.[2] This can have a significant influence on the portfolio's riskiness, especially if a large share of the portfolio is comprised of 'cohorts' with an unfavourable risk profile.

Between 2004 and 2007, the lending standards of retail mortgage loans eased considerably (the average initial LTV and maturity of housing loans increased by 30 per cent during this period), resulting in 29 per cent nominal growth in the average loan amount and a 12 per cent increase in the initial loan instalment (Table 1).

Chart 1

Vintage curves of mortgage loans granted between 2004 and 2007



Note: As the number of loans granted before 2004 is relatively small in the sample, the vintage curve for 2004 contains loans granted in and before 2004. The chart does not show the vintage curve of loans granted in 2008, as observations for 2008 as a whole were not available.

The easing of lending standards resulted in a 'dilution' of the portfolio, as shown by the differences in mortgage vintage curves between 2004 and 2007 depicted in Chart 1. The chart demonstrates the less favourable life cycle (risk profile) of credits which were originated later. For example, while approximately 1 per cent of mortgage loans granted in 2004 became non-performing one year after origination,[3] for loans granted in 2007 this ratio was already close to 7 per cent.

[2] However, if the banking behaviour is prudent (i.e. pricing of credit risk and reserve accumulation is adequate) this lending policy does not necessarily threaten the capital position of banks. Higher credit risk is validated in the loan price, which on the one hand increases default risk, on the other hand banks can realise significant "loss-compensated" revenues on clients who are willing to and are able to pay the higher cost of credit.

[3] We define those borrowers to be in default who are past due more than 90 days on any credit obligation, or those that can be considered highly unlikely to be able to pay their credit obligations (BCBS, 2006). In the database, on the basis of the aforementioned definition, the three banks identified the defaulting debtors with the help of a binary variable (0, 1) We denote the ratio of the number of vintage *k* loans experiencing a default at age *s* over the number of vintage k loans with no default for age<s by P_s^k. We compute the cumulative default rate (CDR) for vintage k at age t as the fraction of loans experiencing a default at or before age *t*:

$$CDR_t^k = 1 - \prod_{s=1}^{t}\left(1 - P_s^k\right)$$

It is important to note that changes in lending standards and macroeconomic developments are not independent of one another. On the one hand, looser lending standards may result in a 'dilution' of the portfolio, which may appear in the growing number of defaults and increasing portfolio sensitivity to macroeconomic shocks. On the other hand, the growth surplus caused by the additional lending may improve the macro fundamentals over the short run, and might reduce the 'default increase' due to macroeconomic shocks. However, over the long run, the build-up of a riskier portfolio and a standstill in economic growth may result in significant losses.[4]

STRESS TESTING FRAMEWORK FOR THE RETAIL MORTGAGE LOAN PORTFOLIO[5]

In this section, we outline the methodology developed for investigating the retail mortgage loan portfolio's sensitivity to macro shocks. The models and assumptions are presented, through which macroeconomic factors can be linked to the risk parameters influencing the developments in banks' losses: the probability of default (PD), loss given default and exposure.

Probability of default

In order to explore the extent and direction of the relations between the developments in defaults and the factors influencing solvency, regression analysis is performed. The applied method (survival analysis) allows us to simultaneously consider the vintage and portfolio ageing effects, customer-specific and product-specific factors as well as market and macro-risk factors on defaults.

In estimating the PD model, the first step is to define the default event. The definition of defaulted loans is similar to that established in Basel II. Namely, obligors that are past due more than 90 days on any credit obligation, or those that can be considered highly unlikely to be able to pay their credit obligations are considered to be in default (BCBS, 2006). The next step is to obtain the determinants of default from a large group of possible covariates. The scope of explanatory variables, in turn, was selected on the basis of their explanatory power. Accordingly, the denomination structure of loans (FX/HUF), the type of loan (housing/home equity), the initial loan-to-value (LTV) ratio, the borrower's level of education, the unemployment rate, the 3-month Bubor and Euribor rates as well as the percentage deviation between the CHF/HUF exchange rate level at which the individual loan was granted from the actual CHF/HUF exchange rates proved to be the variables with significant explanatory power. The general form of the model is as follows:

$$DR=f(LD, LT, LTV, E, U, EXCHR, IR), \qquad (1)$$

where DR is the default risk, LD is the loan denomination, LT is the type of loan, LTV is the initial loan-to-value ratio, E denotes the borrower's educational level, U is the

Table 2

Marginal effects of model variables on default risks

	Marginal effect of the variable on default risk (decrease ↓, increase ↑)
Loan denomination	
Domestic	↓
Foreign	↑
Loan type	
Housing	↓
Home equity	↑
Education	
Lower	↑
Higher	↓
LTV at the time of loan origination	↑
Unemployment rate	↑
Percentage deviation between the exchange rate level at which the individual loan was granted from the actual exchange rates	↑
Interest rates	↑

[4] In the case of small, open economies such as Hungary, the aforementioned mechanism is far from perfect; as the economic cycle and thus portfolio quality may be more strongly influenced by the change in external demand than by internal lending amplified domestic demand.

[5] For a detailed description of the models presented in this chapter see the English-language study by Dániel Holló (2009) entitled 'Modelling loan losses on the Hungarian retail mortgage portfolio' (manuscript).

unemployment rate, EXCHR represents the percentage deviation of the CHF/HUF exchange rate level at which the individual loan was granted from the 'actual' CHF/HUF exchange rates, and finally, IR denotes the domestic and foreign interest rates. The estimation was prepared on the basis of data for the period from January 2003 to June 2008. The main findings are summarised in Table 2.

The results suggest that forint-denominated loans are less risky than FX loans.[6] This, on the one hand, can be explained with the smaller fluctuations in the instalments of forint-denominated loans compared to FX loans (there is no change in debt servicing costs due to exchange rate depreciation, the repricing period is longer and most forint-denominated housing loans are interest-rate subsidised). On the other hand, the period when a large portion of forint mortgages[7] were granted (i.e. between 2000 and 2004) was characterised by tight lending standards, hence it was mostly high quality borrowers that had access to these products.

The results also show that housing loans are less risky compared to home equity products. This is indeed surprising, as the two credit types are basically the same (loan granted against real estate as collateral), but it is an empirical fact that the quality of the home equity mortgage portfolio is worse than that of the portfolio of housing loans. One of the possible underlying explanations is that most housing loans are intended for purchasing the 'first home', and therefore the willingness to pay these loans is strong. By contrast, home equity mortgages are mainly for consumption purposes, and the collateral of the loan is not necessarily the residential property of the debtor, but maybe some other real estate, which may also affect the debtor's payment attitude.

The qualification variable attempts to capture the effect that the income position and employment opportunities of those with lower educational levels are usually worse, and they are more exposed to income shocks caused by economic fluctuations (e.g. unemployment), which adds to the default risk of these clients.

The loan-to-value ratio at the time of loan origination has also proven to be a significant risk factor. The higher the loan-to-value ratio at which the loan is granted, the lower the downpayment required by the bank, and the more customers in tight financial and income positions have the opportunity to borrow. This may affect both the debtor's willingness to pay (if the value of the property declines, it is not worth repaying the loan) and the customer's ability to pay. The impact of the latter appears through the higher instalments related to the higher amount of the loan (assuming unchanged maturity and interest conditions), and through the relevant income-proportionate repayment burden. Therefore, the default risk of loans extended at high loan-to-value ratios may be higher than that of loans disbursed with more conservative LTV ratios.

Finally, the macro indicators (interest rates, unemployment rate, exchange rate) capture the effects of macro-risk factors affecting default risks. Macro-risk factors have an impact on each customer's solvency, albeit to different degrees. For example, exchange rate depreciation affects the solvency of all debtors with FX loans, but its magnitude depends on the initial exchange rate at which the client became indebted.[8] The underlying reason is that the weaker the exchange rate was at the time of borrowing, the lower the probability that repayment problems will arise directly as a result of permanent, substantial exchange rate depreciation.

Using the estimated parameters of the macro factors of model (1), the effects of various macro-risk scenarios on the default probabilities can be determined, that is the so-called 'stress' default probabilities can be computed.

Loss given default

Loss given default is the non-recoverable part of a non-performing loan increased by the amount of costs arising during the debt collection process. Its value is affected by factors such as the outstanding loan amount at the time of default, the length of the collection period, costs arising during collection and the size of the interest rate used for discounting money flows arising in various periods. Considering that – in respect of the factors determining loss given default – we only have information on the developments in exposures, the way we approached loss given default is as follows:

1. If the loan-to-value (LTV) ratio of a loan is below 100 per cent at a given point in time, the bank would not realise any loss on the given transaction in the event of customer default, that is the recovery is 100 per cent (the size of the outstanding exposure is smaller than the value of the collateral).

[6] Making an exact decision regarding this issue is rather difficult considering the fact, that FX loans constituted 80-90 per cent of new loans in recent years, i.e. FX loans dominated the portfolio both in terms of loans outstanding and the number of contracts. In the absence of a basis for comparison (the marginal share of households' forint-denominated mortgage loans within the portfolio), it is not possible to make a precise comparison of mortgage loans of different denominations in terms of credit risk.

[7] Forint denominated home equity loans were not granted practically.

[8] In the database, the average exchange rates at the time of loan origination were EUR/HUF 255 and CHF/HUF 162.

2. In the event that the value of the ratio at a given point in time is above 100 per cent, the size of the bank's potential loss (i.e. the loss given default) is the portion above 100 per cent of the LTV (the size of the outstanding exposure exceeds the value of the collateral).

The loan-to-value ratio may exceed 100 per cent for several reasons. For example, due to exchange rate depreciation, the forint value of FX exposures changes; in addition, housing prices may also vary. When determining the LTV of non-performing customers we took into account the effect of both factors. In calculating the value of the home we took into account housing price developments between the date of borrowing and the default.

It must be mentioned that there may be a close relationship between the number of defaults and changes in the value of collaterals. For example, as a result of permanent, substantial exchange rate deprecation many FX debtors may become non-performers, that is numerous properties may become subject to foreclosure, which may lead to a fall in housing prices and significant increase in banks' losses.

Exposure

Under exposure we denote the outstanding loans of customers at a given point in time. The size of the exposure is determined by the remaining maturity of the loan, the interest rate condition (fixed, variable) and the currency of the loan (FX/HUF).

ILLUSTRATIVE EXAMPLE: LOSS CALCULATION IN AN EXTREME MACRO-RISK SCENARIO

Calculation of the total loan loss requires the determination of the loss distribution. We determined loss distribution both in the case without macro shock (baseline) and in an extreme macro-risk path (the stress scenario in the April 2009 *Report on Financial Stability* [10 per cent fall in GDP; EUR/HUF 340]). The procedure was as follows:

1. Default probabilities for each borrower were computed by using model (1).[9] In the baseline case, the values of the macro variables in the estimation period were used (exchange rate, unemployment rate, domestic and foreign interest rates), while in the stress scenario their shocked values were employed (assuming unchanged customer and loan characteristics).[10]

2. We take the outstanding mortgage portfolio in June 2008 (the end of the sample period), and generate uniformly distributed pseudorandom numbers on the interval [0,1) for each borrower. If the default probability of the borrower exceeded the random number (separately in the baseline and in the macro shock case), then the exposure was considered to be in default.

3. The bank incurs a loss on a non-performing debtor if the customer's loan-to-value (LTV) ratio exceeds 100 per cent. In the baseline, in determining the LTV we took into account housing price changes between the date of borrowing and the date of the default. LTV calculation along the macro-risk scenario was different from the above to the extent that in the case of FX exposures we also took into account the effects of exchange rate deprecation (the forint value of the existing exposure changes) and a 20 per cent decline in housing prices.

4. Loss on the debtor level is the product of the outstanding exposure and the above-100 per cent part of the LTV. By summing up the individual losses, the portfolio share of total retail mortgage loan loss is computed. This procedure ensures that default depends on its own PD, and also considers to some extent the PD-LGD correlation, as LTV is included both in the PD scorecard and the model for the loss rate.

5. Repeating points 2-4, 10,000 times results in the loss distributions shown in Chart 2. We assumed a one-year risk horizon in the calculations.

Knowing the loss distribution (which shows the distribution of the 10,000 portfolio-proportionate loss realisations), allows us to calculate the total retail mortgage loan loss of the banking sector, which only requires to determine the 99.9th percentile of the distribution,[11] and then multiplying the resulting figure with the end-2008 retail mortgage loan

[9] As the model of the probability of default was estimated on the basis of a period that was not characterised by significant macroeconomic turbulences, the model parameters of macro variables presumably underestimate the effect of macro shocks on default risks.

[10] In the model, the effect of GDP does not appear directly, but through the change in unemployment.

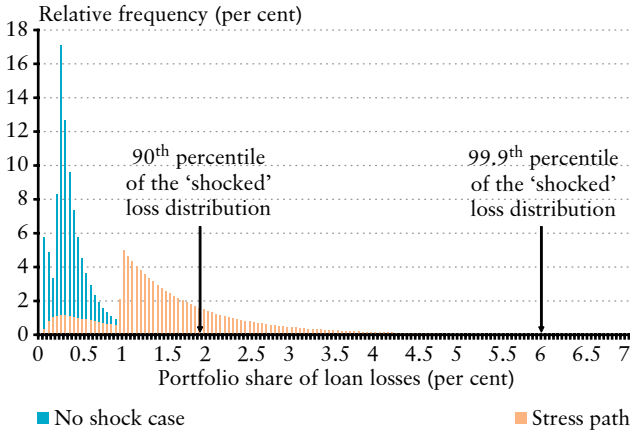
[11] The given percentile of the loss distribution gives the extent of loss coverage. For example, at a confidence level of 99.9 per cent, the capital and the reserve will not be sufficient to cover the loss in only 1 case out of 1,000. Of course, the lower we 'set' the confidence level, the more cases ('state of nature') there will be when the capital and the reserve will not cover the losses. Therefore, the deviation of the selected confidence level from 100 per cent can also be interpreted as the probability of a bank's insolvency. The 99.9th percentile used in the calculations is widely used in domestic and international bank practices in determining the economic capital needs.

portfolio stock (in an implicit manner we assume that the retail mortgage loan portfolio of the three banks is representative from the aspect of the banking sector).

According to our results, on the basis of the 'baseline loss distribution' (the distribution marked in blue in Chart 2) the total loss on retail mortgage loans would amount to HUF 118 billion (approx. 2 per cent of the end-2008 retail mortgage loan portfolio), which would increase to HUF 372 billion (approx. 6 per cent of the end-2008 retail mortgage loan portfolio of the banking sector) in the stress scenario.

Chart 2

Simulated loss distributions of the retail mortgage loan portfolio before and after the stress



SUMMARY

Using the retail mortgage loan portfolio of three commercial banks, this article analysed the portfolio's risk characteristics, identified the main customer-specific and product-specific factors, as well as market and macroeconomic factors influencing portfolio quality, and computed banking sector losses on retail mortgage loans in an extreme macro-stress scenario (10 per cent decline in GDP, and EUR/HUF 340).

Our results suggest that the riskiness of loans granted in different years differs substantially. The lifecycle of credits granted later (e.g. in 2007) is less favourable compared to earlier ones (e.g. loans granted in 2004). In the case of subsequently granted mortgages, the share of non-performing loans within total loans granted in a given year is higher, as a function of time elapsed from loan origination. Based on our estimation results, the denomination structure of loans, the initial loan-to-value (LTV) ratio and the customer's education level can be considered as the main customer-specific and product-specific factors affecting developments in defaults, while the unemployment rate, domestic and foreign interest rates as well as the exchange rate constitute the major macro risk factors that have an impact on defaults.

According to our calculations, the loss on the retail mortgage loan portfolio increases considerably in the macro-stress scenario. Along the stress path, the total loan loss of the banking sector would increase from the baseline level of HUF 118 billion to HUF 372 billion, which is approximately 6 per cent of the banking sector's end-2008 retail mortgage loan portfolio.

In evaluating the results one must keep some further issues in mind. Namely, in the calculations we neglect to measure how the shock propagation affects other sectors in the economy, and how asset prices are affected, which may generate additional, even substantial losses through the deterioration of other banking portfolios and through the decline in collateral values.

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