CREDIT RISK AND STRESS TESTING OF THE BANKING SECTOR IN THE CZECH REPUBLIC

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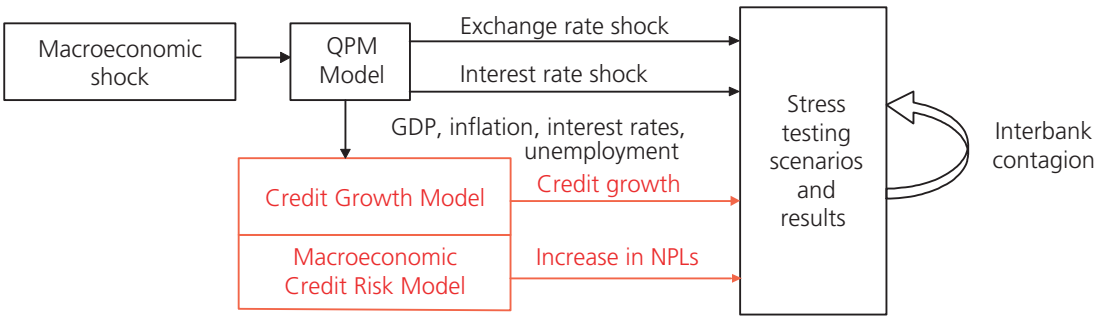
This article presents the results of stress tests of the Czech banking sector conducted using models of credit risk and credit growth broken down by sector. The use of these models enables the stress tests to be linked to the CNB's official quarterly macroeconomic forecast. In addition, the article updates the stress scenarios, including simple sensitivity analyses of credit risk for individual sectors. Based on the analysis, an answer is sought to the question of whether the observed growth in credit to the corporate sector and households poses any threat to the stability of the banking sector. The analyses conclude that the banking sector as a whole seems to be resilient to the macroeconomic shocks under consideration.

1. INTRODUCTION

The creation of model scenarios and the stress testing methodology in this article follows up on the previous method applied in the 2004 and 2005 Financial Stability Reports.[95] In these reports, the basic stress tests with historical scenarios[96] were complemented by an interbank contagion test. These tests were followed by model scenarios with in-built estimated macroeconomic factors from the CNB's quarterly forecast and estimated growth in non-performing loans (NPLs) from the macroeconomic credit risk model.[97]

The dynamic growth in the household credit market and the renewed growth in loans to non-financial corporations requires that the previous tests of aggregate credit portfolios be supplemented with credit growth models. The different growth rates of loans in these sectors are also leading to change in the structure of banks' loan portfolios. The different sensitivities of corporations and households to the macroeconomic environment, along with the changing structure of the loan portfolio, calls for an extension of the credit risk model to include separate estimates for individual sectors. The estimated models of sectoral credit risk and credit growth serve for revision of the stress tests both for the aggregate loan portfolio and for the separate portfolios of the household and non-financial corporation sectors. The predictions obtained from the estimated models are used in simple tests of loan portfolios and in a stress test linked to the CNB's quarterly macroeconomic forecast. The incorporation of the newly developed credit growth and credit risk models into the stress testing methodology is described in Chart 1.[98]

Chart 1 – Architecture of incorporation of stress tests with consistent model scenarios



Note: Red parts of the scheme are newly included or have been updated.
QPM (Quarterly Prediction Model) stands for the CNB official macroeconomic forecast.

The article looks first at credit growth modelling (section 2) and the extension of the credit risk model (section 3). In section 4, these models are used to calculate the effects of shocks in a stress testing exercise. Sections 4.1 and 4.2 update the basic historical scenarios from the past, including simple sensitivity tests of credit risk broken down

95 The stress testing methodology is explained in CNB (2006).

96 The historical scenarios (described as Scenarios I and II) are based on extreme values from the past. These tests reflect the specific development of the Czech economy in 1997–1999.

97 The macroeconomic credit risk model is described in Jakubík (2006).

98 For a more detailed account of the stress testing methods, see Čihák, Heřmánek and Hlaváček (2007).

by sector. In section 4.3, the models of credit growth and credit risk are used to abstract from other types of risks (interest rate risk, exchange rate risk, interbank contagion). Section 4.4 presents a complete set of stress tests, while maintaining the link to the CNB's quarterly macroeconomic forecast. This section considers credit risk in relation to other commonly analysed risks. The last section sums up the results and assesses the potential risks for the banking sector.

2. CREDIT GROWTH MODELLING

The strong credit growth observed in recent years calls for the inclusion of a credit growth model, given the one-year horizon of the stress tests. This extension of the stress tests affords a more realistic view of banks' loan portfolios.

The models used most frequently for the loan portfolio growth rate, which are based on panel regressions, were applied to the countries of Central and Eastern Europe.[99] The vector error correction (VEC) model[100] is generally used for estimates for individual countries. It captures the long-term and short-term relationships between the observed variables. The model does not explicitly address the causality of the observed variables. It is estimated as a system of equations, where each variable is both explanatory and dependent. Where the motivation is to obtain a direct estimate of one of the variables, a single-equation version of the model is used.

In many studies the volume of loans in the economy is expressed as a ratio of loans to the private sector to GDP and is often estimated on the basis of a set of macroeconomic variables. Other studies try to model directly the rate of growth of the absolute volume of loans in the economy, which is considered an important indicator for the assessment of financial stability.[101]

As regards the long-term credit growth model, the variables used most frequently in the literature are GDP growth, interest rates and the inflation rate. Variables such as the property price index and the trade balance are also often considered, as are a number of qualitative variables such as the maturity of the banking sector, characteristics of the legal environment, the quality of accounting standards, etc. The estimate of the long-term relationship is used to find the equilibrium level of credit growth. Under the standard methodology this long-term relationship is estimated by cointegration analysis.[102] If the current value is higher, "error correction" occurs, i.e. the value should decline in the future period, and vice versa. In this article we seek the equilibrium level of real credit growth in the economy, taking into account both the demand and supply sides of the credit market. Indicators on the demand side include, for instance, GDP growth and the current level and expected evolution of interest rates. The banks' loan supply depends on variables such as loan portfolio quality, as measured by the default rate or the distance to default,[103] the interest rate margin or the cost-revenue ratio.

2.1 The credit growth model estimated

The vector error correction (VEC) model was used to estimate real growth in bank loans granted to residents.[104] Quarterly time series of loans and other macroeconomic variables from 1997 Q1 to 2006 Q3 were used to estimate the VEC model.

A number of macroeconomic variables were taken into account in the estimate for the Czech Republic.[105] A long-term relationship could not be proved for some of them. In some cases, the signs of the estimated variables were

99 Credit growth for Central and Eastern Europe based on panel regressions is examined, for example, by Cottarelli, Dell'Ariccia, Vladkova-Hollar (2003) and Duenwald, Gueorguiev, Schaechter (2005).

100 VECs are used both for estimates for individual countries and for aggregate data for several countries – e.g. Hofmann (2001) and Schadler, Murgasova, Elkan (2005).

101 Growth in the absolute volume of loans for the countries of Central and Eastern Europe is modelled, for instance, by Fabrizio, Igan, Mody, Tamirisa (2006).

102 The cointegration relationship in the VEC model can be tested, for example, using the Johansen cointegration test.

103 The distance to default expresses the likelihood of the value of the assets being lower that that of the debt.

104 In the calculation of real credit growth, nominal credit growth was deflated by the consumer price index (CPI).

105 Variables such as the output gap, the interest rate gap, the unemployment rate, the share of non-performing loans in the total loan portfolio, real interest rates, the real output growth rate, the inflation rate, growth in real investment and consumption, the exchange rate, the differential between long-term and short-term interest rates, the level of privatisation of the banking sector, etc. were considered when searching for the long-term relationship.

not in line with the economic theory, probably due to the transformation changes that occurred in the Czech economy or to quite specific events on the credit market. In the end, the long-term real credit growth rate was explained by means of the real GDP growth rate and the default rate of the aggregate credit portfolio of banks.[106] As the current default rate affects a bank's future decisions, we worked with the time series of the default rate lagged by two quarters. The cointegration relationship between the credit growth rate, the real output growth rate and the default rate was significant at the 1% significance level.[107] Based on the results achieved, we considered the credit growth rate as a positive function of real GDP and a negative function of the default rate in the economy.

In addition, when choosing the explanatory variables we took into account their possible use for the forecast and hence also the link to the CNB's quarterly macroeconomic forecast. As the model was to be incorporated into the stress testing of the banking sector, an appropriate response of the model to adverse economic developments was also highly desirable. The following model was chosen with regard to these objectives and econometric properties:[108]

$$\Delta loanstr_t = \delta(\alpha + loanstr_{t-1} + \beta_1\, rgdpr_{t-1} + \beta_2\, dft_{t-3}) + \gamma_1 \Delta rnewgap_{t-3} + \gamma_2 \Delta rgdpr_{t-1} + \gamma_3 dum, \qquad (1)$$

where $loanstr$ is real credit growth, $rgdpr$ the annual real GDP growth rate, df the aggregate default rate in the economy, $rnewgap$ the interest rate gap on new loans[109] and dum a dummy variable taking the value of 1 for the period of massive clean-up of banks' loan portfolios. A lag of two quarters was applied to the interest rate gap time series, as it usually takes some time before a change in rates in the economy passes through to the credit demand and supply sides. Forecasts for all the variables used, excluding the default rate, can be obtained from the CNB's quarterly macroeconomic forecast. The macroeconomic credit risk model for the aggregate economy expressed by equation (2) can be used for the default rate.[110]

$$df_t = \psi(-2.0731 - 4.9947\, gdp_t + 2.7839 R_{t-4} - 2.4364\, \pi_{t-2}) \qquad (2)$$

The default rate is expressed as a distribution function of a linear combination of GDP, nominal interest rates and inflation. This implies a negative dependence of the default rate on GDP and a positive one on real interest rates.

Equations (1) and (2) can be used to obtain a forecast for the loan portfolio growth rate. Incorporating this forecast into the stress testing can reduce its stationarity. Tables 1 and 2 show the results of the estimated model (1). The coefficient of determination of the error correction model (1) was 78%, while the adjusted coefficient of determination was 76%.[111]

Table 1 – Error correction model for credit growth

Variable	Coefficient	Standard error	t-statistic	Pr<|t|
Cointegration long-term				
relationship (δ)	-0.268	0.053	-5.047	<0.0001
Difference in interest rate gap of				
new loans (γ_1) - $\Delta rnewgap_{t-3}$	-1.381	0.317	-4.353	0.0001
Difference in real GDP				
growth (γ_2) - $\Delta rgdpr_{t-1}$	2.618	0.817	3.205	0.0031
Dummy (γ_3) - dum	0.029	0.009	-3.381	0.0020

Table 2 – Estimate of cointegration relationship

Variable	Standardised coefficient	Standard error
Real credit growth – $loanstr_t$	1.000	
Real GDP growth (β_1) - $rgdpr_t$	-3.639	0.609
Aggregate default rate		
(β_2) - df_{t-2}	3.647	1.327
Constant	0.047	

106 The literature also uses the distance to default as one of the determinants of credit growth. See, for example, Fabrizio, Igan, Mody and Tamirisa (2006).

107 Stationarity of time series was also tested. All the series under consideration were I (1). Although the cointegration relationship was highly significant, a change in the time series length changed the significance. The instability of this relationship over time corresponds to a number of specific features of the Czech transforming economy.

108 Only variables whose coefficients were statistically significant in the estimate are included in equation (1).

109 The interest rate gap is defined as the difference between real and equilibrium interest rates. The interest rate gap forms part of the CNB's quarterly macroeconomic forecast – see CNB (2003).

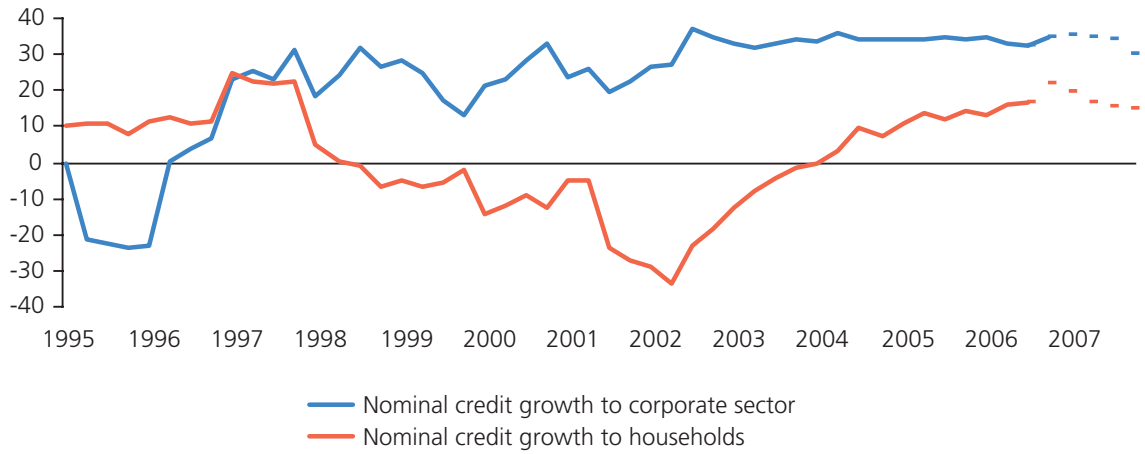
110 A full description of the macroeconomic credit risk model used for the purposes of stress testing in the CNB, estimated last year, can be found in Jakubík (2006) and Jakubík (2007).

111 The good statistical properties of the model are confirmed by the Durbin-Watson statistic, which was 1.98.

2.2 The use of the credit growth model for the forecast

Equation (2) implies that we must have forecasts of the nominal interest rate and inflation in order to be able to estimate the model. Forecasts for loans to corporations and households were derived from the forecast for aggregate credit growth. The share of loans to households in the total portfolio was modelled using a simple linear regression equation estimated for the time series in 2003–2006. This was used to obtain a forecast for the nominal volume of loans to households.[112] The volume of loans to corporations was then estimated as a residual. Chart 7 shows the evolution of nominal annual credit growth, including a forecast for 2007 obtained using equation (1).

Chart 2 – Nominal annual credit growth
(%)



Source: CNB
Note: 2007 data denote prediction.

Based on the estimate of the future evolution of macroeconomic variables and equations (1) and (2), the second half of 2007 should see some easing in real credit growth owing to a falling GDP growth rate and a widening positive interest rate gap. When interpreting the results, one should keep in mind that there is some uncertainty surrounding not only the estimate of the model (1), but also the forecasts of the key macroeconomic variables. The considerable instability of long-term relationships over time and the numerous specific features of a transforming economy are a general problem of credit growth modelling in the Czech Republic.

3. CREDIT RISK MODELS

In a stress testing exercise, it is necessary to assess the change in the credit risk of a loan portfolio in relation to change in the macroeconomic environment. To this end, a macroeconomic credit risk model for the aggregate loan portfolio (see equation (2)) was developed in the CNB in 2006.

One disadvantage of model (2) is that it cannot capture the different sensitivities of corporations and households to change in the macroeconomic environment. The structure of the loan portfolio has changed considerably over the past five years. The share of loans to households in banks' total loan portfolio increased from 10% in 2001 to almost 40% at the end of 2006. It is thus apparent that the household sector is becoming increasingly significant in the total loan portfolio. For this reason, it would be appropriate to estimate the macroeconomic credit risk model separately for the corporate and household sectors. The main obstacle to the estimation of such models is the non-availability of data on the dependent variable.

112 Throughout this article, the term "households" refers to private individuals excluding trades.

The aggregate risk model was estimated on quarterly data on the inflow of non-performing loans (NPLs).[113] However, such data is only available on an aggregate basis and cannot be obtained separately for the household and corporate sectors. The sectoral breakdown shows NPL stocks, not flows. To obtain flows, one has to estimate the outflow of NPLs as a result of write-offs, sales or enforcement of such classified liabilities of banks. The following relationship applies to the stock of NPLs, the default rate and the rate of outflow.

$$NPL_2 = NPL_1 - u\,NPL_1 + df\,(Loans_1 - NPL_1), \tag{3}$$

where NPL is the stock of NPLs in the relevant period, u the rate of outflow, df the default rate and $Loans_1$ loans at the beginning of the period under review. This enables us to derive the following relationship (4) for the default rate.

$$df = \frac{\Delta NPL + u\,NPL_1}{Loans_1 - NPL_1} \tag{4}$$

Depending on the frequencies monitored, equation (4) can be used to compute the quarterly or annual default rate. Except for the rate of outflow, all the variables in relationship (4) are usually known. Volumes of total loans and NPLs are available for the Czech economy broken down by sector. The rate of outflow was only available for aggregate loans. This figure is highly volatile, mainly due to non-recurring massive write-offs at the end of the 1990s and at the beginning of the new millennium as a result of clean-ups of large banks' balance sheets. It can be assumed that most of the problem loans related to corporations rather than households and that the rate of decrease for the household sector is relatively stable over time. The period of write-off, sale or enforcement of NPLs to households was chosen to be two years as an expert estimate. If we work with the annual default rate, the corresponding rate of decrease is 0.5.[114] Based on this assumption, the default rate of households in the economy was derived using relationship (4). If we assume that the aggregate default rate is a weighted average of the default rates for corporations and households, the default rate for corporations can then be derived.

3.1 The macroeconomic credit risk model for the household sector

To model the credit risk for the household sector the same methodology was used as for estimating the aggregate model expressed by equation (2).[115] The resulting model was estimated for the annual default rate time series from 1996 Q3 to 2006 Q3.[116]

A whole range of macroeconomic indicators were considered for the estimate. The model chosen as the statistically best model, in line with the economic theory, was one containing the unemployment rate and the real interest rate.[117] The unemployment rate was lagged by four periods, which corresponds to the lagged impact on payment discipline in the event of loss of employment.[118] The statistically best results were achieved with a lag in the real interest rate of three quarters. This result expresses the lagged impact of an interest rate change on debtors resulting from interest rate fixation. The resulting estimated model corresponds to equation (5). The estimate of the coefficients is shown in Table 3.

$$df_t = \psi(c + \beta_1 u_{t-4} + \beta_2 r_{t-3}) \tag{5}$$

113 NPLs are loans with a classification of 3 or higher, i.e. substandard, loss and doubtful.

114 Parameter u in the equation (4) may not in fact be constant over time. Nonetheless, we believe that the level of 0.5 is relatively realistic and consistent with anecdotal evidence.

115 The estimate is based on a single-factor latent model. This methodology can be found, for instance, in Jakubík (2006) and Jakubík (2007).

116 The quarterly time series of the annual default rate was generated from the monthly series of the annual default rate calculated using relationship (4) by averaging the three monthly figures corresponding to the relevant quarter. Although the default rate obtained using equation (4) was available from 1994, the time series on which the model was estimated had to be shortened as a result of some lags in the model and due to the shorter series of the other macroeconomic indicators included in the model.

117 The real interest rate was calculated by deflating the annual PRIBOR by the CPI. Also considered for the estimation of the model were nominal interest rates, inflation, the interest rate gap, the real GDP growth rate, the output gap, the ratio of interest paid to income or disposable income, etc. Disposable income was modelled using average wages and household consumption, while interest paid was modelled as the product of the credit volume and the annual PRIBOR increased by a certain interest rate spread.

118 The loan is initially repaid from savings or the redundancy payment; payment discipline is affected only after that.

Table 3 – Default rate model for the household sector

Description of variable corresponding to estimated coefficient	Notation	Estimate	Standard error	Pr>|t|
Constant	c	-2.142	0.048	<0.0001
Unemployment (β_1)	u_{t-4}	2.956	0.563	<0.0001
Real interest rate (β_2)	r_{t-3}	1.204	0.522	0.0262

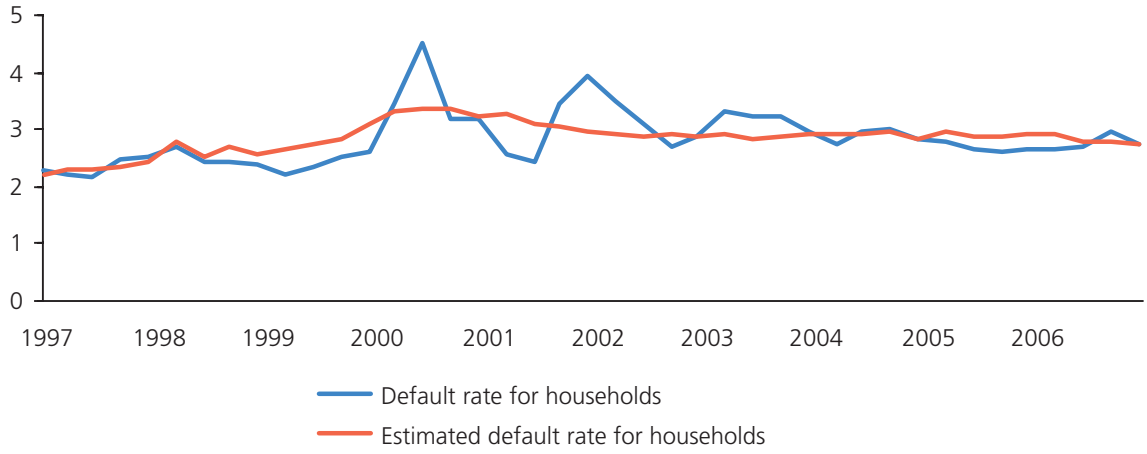
3.2 The model for the corporate sector

The estimate of the macroeconomic model for the corporate sector is not yet available. Unlike in the household sector, the outflow of non-performing loans from banks' balance sheets is not easy to estimate. A historical time series of the default rate is lacking for the estimate of the model. This could be resolved in the future by the Central Register of Credits run by the Czech National Bank, which has been in operation since October 2002. The register contains data on legal entities and individual entrepreneurs and can be used to obtain information on the payment discipline of banks' clients. However, this data is currently of no use for credit modelling due to short time series. In the end, the default rate for the corporate sector was estimated as a weighted difference between the default rates for the aggregate economy and the household sector.[119]

3.3. The forecast for credit risk of households

The CNB's quarterly macroeconomic forecast for the unemployment rate, the 12-month PRIBOR and the CPI can be used to predict credit risk in the household sector.

Chart 3 – Default rate for the household sector
(%)



Source: CNB

119 The aggregate default rate was considered as a weighted average of the default rates for corporations and households. The weights were derived from the shares of the credit volume for the individual sectors in the total loan portfolio.

4. USE OF THE MODELS AND STRESS TESTING RESULTS

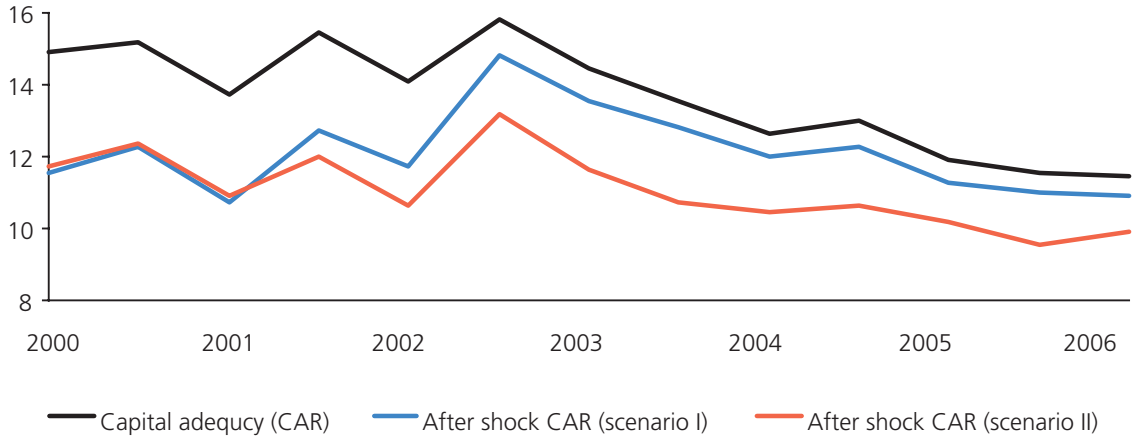
4.1. Basic stress tests with historical scenarios

In the stress testing exercise we first consider basic tests based on a methodology of two scenarios (Scenario I and Scenario II) representing two different types of stress in banks' portfolios. The values of the parameters in each scenario are identical to those used in previous Financial Stability Reports.[120] These scenarios take into account the prevailing international practice and the specific conditions of the Czech economy. The selected parameters reflect the historical experience from the currency crisis and subsequent recession in 1997–1999.

The tests demonstrate the evolution of capital adequacy and the resilience of banks' portfolios to extreme shocks in the long term. The test results are comparable over the period 2000–2006. The stress tests are based on the bottom-up methodology – they use financial data for individual banks and subsequently aggregate them for the banking sector as a whole.

The impacts of the two scenarios are assessed by comparing the capital adequacy ratio (CAR)[121] before the hypothetical shocks and after the impact of these shocks on the banks' portfolios (the post-test CAR, see Chart 4).

Chart 4 – Results of stress test scenarios for the Czech banking sector
(capital adequacy; %)



Source: CNB
Note: The scenarios differ due to the fact that they use different methodologies for the growth in non-performing loans (NPLs), hence the resulting CAR for each scenario develops differently over the monitored time horizon. The results exclude the effect of interbank contagion.

Capital adequacy declined by 3.5 percentage points in 2000–2006. This decline reflects the fact that some banks used their profits for the payment of dividends. In addition, risk-weighted assets recorded an increase. In the same period, the post-test CAR decreased by just 0.6 percentage point for Scenario I and 1.8 percentage points for Scenario II. The impacts of both shock scenarios are thus decreasing over time, which suggests a decrease in the exposure of the banking sector to basic types of risk. The post-shock CAR complied with the required 8% regulatory minimum for both scenarios. However, some banks could be below the required minimum and would need a capital injection to return to this threshold. For these banks, the effects of adverse changes would have a negative impact on the payment of dividends and bonuses. Overall, the banking sector proved resilient to the extreme stress of the shocks based on historical scenarios.

120 Scenario I consists in the combination of a hypothetical increase in interest rates of 1 percentage point, a depreciation of the exchange rate of 15% and an increase in the share of NPLs of 30% by reclassification of loans. Scenario II uses the combination of an increase in interest rates of 2 percentage points, a depreciation of 20% and an increase in the share of NPLs in total loans of 3 percentage points (a detailed description of these scenarios can be found in CNB (2006)).

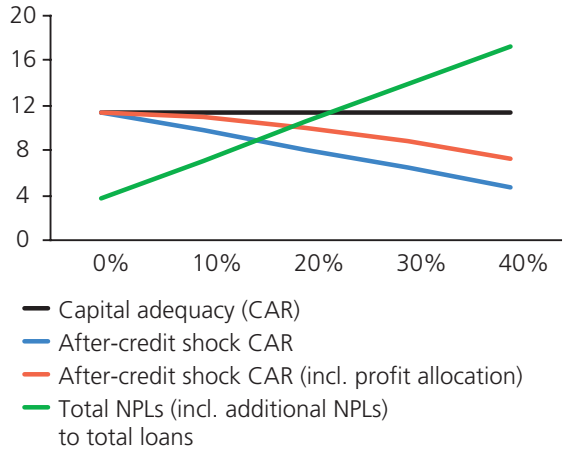
121 That is, the current CAR measured as the ratio of capital to risk-weighted assets of the banking sector.

4.2 Simple credit risk sensitivity tests

The modelling of credit growth and credit risk for the household and non-financial corporation sectors (section 4.3) was preceded by simple sensitivity tests on portfolios of loans granted by banks. These tests used credit shocks based on the hypothesis of conversion of a certain volume of consumer credit and housing loans into NPLs, which corresponds to an increase in credit risk vis-à-vis households (private individuals). The hypothesis of conversion of a certain volume of loans into NPLs was tested in the same way in the non-financial corporations sector (see Chart 5 and Chart 6).

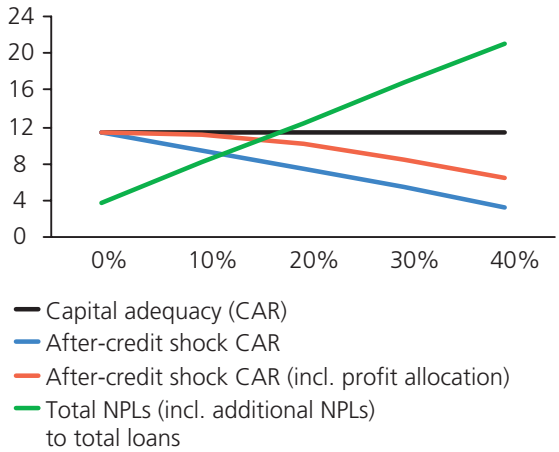
The simple sensitivity tests capture the effects of the one-off conversion of 10–40% of total loans in the given sector into NPLs. The tests analyse the tolerability of such shocks in banks' portfolios and in aggregated form for the banking sector as a whole. The shocks imply additional growth in NPLs, which generate an additional need for capital to cover the credit risk. The tests assume that the banks will create provisions equally for both existing and additional NPLs. The impact of the type and amount of collateral is not taken into account separately in the tests.

Chart 5 – Results of tests with credit risk scenarios for households, 2006
(capital adequacy; %)



Source: CNB
Note: Five scenarios of additional NPLs as 0–40% of consumer and housing loans becoming non-performing loans.

Chart 6 – Results of tests with credit risk scenarios for non-financial corporations, 2006
(capital adequacy; %)



Source: CNB
Note: Five scenarios of additional NPLs as 0–40% of non-financial corporation loans becoming non-performing loans.

Banks are able to withstand the simple credit shock which was tested for the individual sectors. In the case of an isolated shock to the household sector only, the banking sector was able to withstand[122] the conversion of up to 35% of existing loans into NPLs. The analogous figure for the corporate sector was 30%. The results correspond to the larger volume of loans and risk undertaken in the corporate sector. As for the total loan portfolio, banks would be able to withstand the risk of the conversion of around 16% of loans into NPLs. The expected further growth in loans to households and corporations presents a potential accumulated risk of subsequent loan defaults in the two sectors.

4.3 Credit risk tests using credit growth models

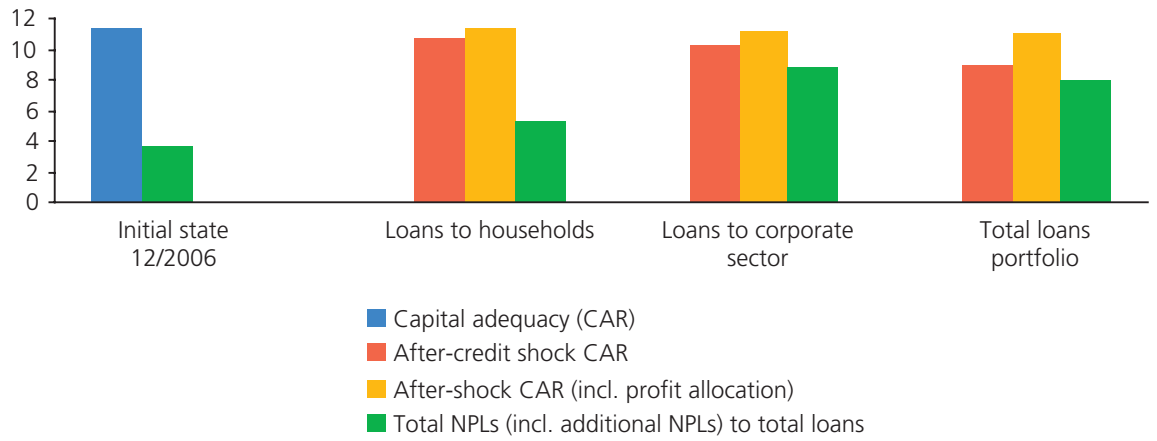
The following tests examine the effects of a credit shock separately for the household sector and the non-financial corporations sector. Other types of shocks (interest rate shock, exchange rate shock, interbank contagion) are not taken into account. The models of credit growth and credit risk as described in sections 2 and 3 are used for this purpose. The credit shock is based on the assumption that at the one-year horizon banks will hold a quantity of

122 That is, the post-test CAR was maintained above 8%.

NPLs dating from the previous period and that a proportion of the loans will be converted into NPLs at the same time. The new growth in NPLs was estimated from the credit risk model and the CNB's quarterly macroeconomic forecast for the following year. Estimated credit growth is also taken into account for the calculation. The tests assume that banks will create provisions equally for both existing and additional NPLs, and collateral is not taken into account.

The tests were based on the forecast of the annual credit growth rate for 2007, amounting to 30% for households, 15.5% for corporations and 16% for total loans for the banking sector. The scenarios (for loans to households and corporations, and total loans) tested the credit risk forecasts in the form of shocks for the 2007 horizon.

Chart 7 – Results of stress tests with incorporation of credit growth and credit risk models
(%)



Source: CNB
Note: The chart shows the results of the sole credit risk shock, firstly for loans to households, secondly for loans to the corporate sector and finally for the total loans portfolio. The other types of shocks are not considered. Scenarios of additional NPLs shocks and credit growth in 2007.

The effect of the credit shock on capital for the household sector was relatively small (see Chart 7). The impact on the corporate sector would be higher, but still tolerable (10.3% CAR). The credit shock considered for all loan portfolios of the banking sector would result in an 8% share of NPLs in total loans in the banking sector, while the CAR would probably be 11%.

4.4 Macro stress test with consistent model scenarios

This section follows up on the methodology of scenarios derived from macroeconomic models presented in the Financial Stability Report 2005. The macro stress tests are based on forecasts for macroeconomic variables obtained from the CNB's quarterly forecast, which are then used in macroeconomic models of credit growth and credit risk (see sections 2 and 3 hereof). Unlike in the Financial Stability Report 2005, credit risk is thus tested on separate portfolios for households and non-financial corporations, with credit growth forecasts also being newly added for the two sectors.

The baseline model scenario uses the CNB's quarterly macroeconomic forecast of April 2007, which estimates the developments in the Czech economy in 2007 and 2008. Besides the baseline model scenario, three alternative scenarios (A, B and C) were applied which reflect less probable shocks. The shocks in these scenarios take into consideration the history of real economic growth and its links to other macroeconomic variables. The parameters of these scenarios are identical to those in the scenarios included in the Financial Stability Report 2005 in order to preserve the comparability of the tests over time. The differences between the alternative scenarios and the baseline scenario reflect different hypotheses and shocks for the individual scenarios; the aforementioned period is relevant for the choice of the parameters tested (see Table 4).

Table 4 – Differences of alternative scenarios from baseline scenario

Type of scenario	period	Scenario A	Scenario B	Scenario C
Real GDP growth (% y-o-y)	2007 Q4	-1.0	-1.0	-3.1
Inflation rate - CPI (% y-o-y)	2007 Q4	0.4	-0.3	-0.7
Nominal growth of loans (%)	2007 Q4	-2.0	-3.3	-10.3
Interest rate (percentage points)	2007 Q2	0.8	-0.6	-0.7
Exchange rate (percentage points)	2007 Q2	3.2	-5.4	1.8

Baseline scenario

The baseline scenario is derived from the CNB's April 2007 forecast,[123] which expects real GDP growth of 5.7% in 2007 and 5.3% in 2008. The baseline scenario does not contain any risks that would pose an immediate threat to the stability of the banking sector. Inflation will be below 3.6% at the end of 2007 and decrease slightly to 3.3% in 2008. Consistent with the forecast is a gradual rise in interest rates. Relatively low interest rates, the positive outlook for investment activity and GDP growth will boost growth in lending to households and corporations. The low interest rate differential will prevent growth in debt in foreign currencies.

Alternative scenario A

Alternative scenario A analyses the potential response of the domestic economy to a significant global negative demand shock. Such a shock is not very likely, but it might hypothetically occur in a situation where global imbalances associated with a loss of confidence in the main economic zones suddenly correct and interest rates of the main world currencies, i.e. the dollar and the euro, start to rise. GDP growth rates in 2007 and 2008 would be about 1 percentage point lower than in the case of the baseline scenario, and interest rates would be higher.

Alternative scenario B

Alternative scenario B combines the effects of the development of the nominal exchange rate and the development of inflation. The scenario assumes a sudden appreciation of the exchange rate and a negative supply shock, which would, ceteris paribus, result in a rise in inflation. Overall, however, the stronger exchange rate would cause a fall in GDP growth and a slight decline in inflation compared to the baseline scenario. The monetary policy response would be to cut interest rates.

Alternative scenario C

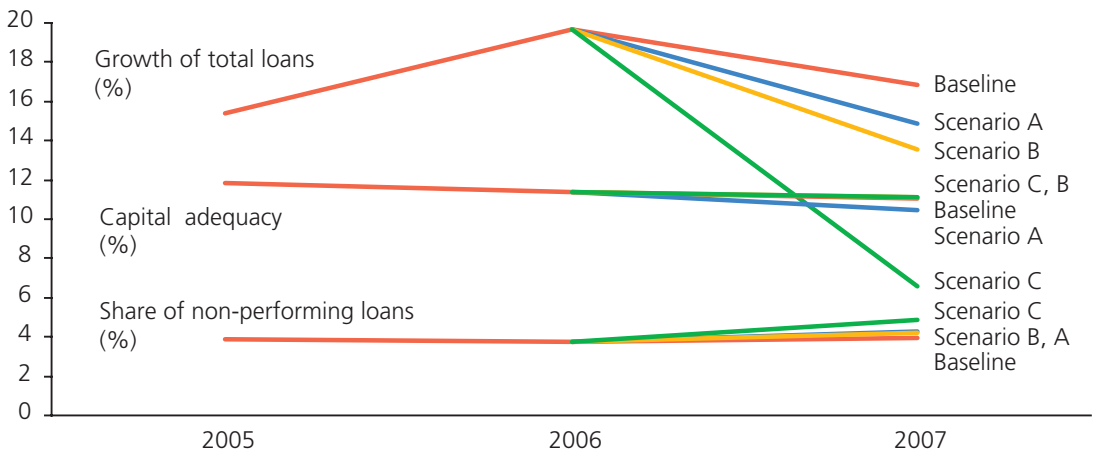
Alternative scenario C reflects the risks associated with a possible drop in domestic demand and assumes a gradual decline in GDP growth between 2007 Q2 and 2008 Q1. A negative shock to GDP growth would cause the output gap to widen and inflation to fall. Simultaneously, credit growth would be reduced compared to baseline scenario. The monetary policy response would be a significant easing, which would help to revive economic activity, in particular in 2008. The lower interest rates compared with other countries would also foster a slight depreciation of the exchange rate, which, in turn, would further ease the monetary conditions.

Test results for the model scenarios

The capital adequacy ratio in the baseline scenario would be 11.1% in 2007 (on the December 2006 banking sector data and the volume of loans modelled). The share of new NPLs in the volume of claims modelled would be 4%. The capital adequacy ratio would be 0.6 percentage points lower in Scenario A and at the same level in Scenario B and Scenario C compared to the baseline scenario for 2007. The new NPLs of the banking sector would be 4.3%, 4.2% and 4.9% in scenarios A, B and C respectively at the one-year horizon (see Chart 8).

123 A detailed description of the CNB macroeconomic forecast is given in CNB Inflation Report (2007), available from www.cnb.cz.

Chart 8 – Results of scenarios of macro stress testing
(%)



Source: CNB
Note: Growth in total loans is defined as the average annual rate of growth. The share of new non-performing loans (NPLs) is related to the estimation of the loan volume at the end of 2007.

The results for the model scenarios are contained in the joint summary of the stress test results for the banking sector together with the historical scenarios (see Table 5). The banking sector as a whole seems to be resilient to the effects of the macroeconomic tests under consideration, including the alternative credit risk tests. The banking sector displays an ability to withstand shocks corresponding to the two scenarios based on historical experience and the scenarios based on the macroeconomic model.

Table 5 – Summary of results of stress tests: Banking sector
(data in % unless stated otherwise)

Scenario type	Baseline		Scenario A	Scenario B	Scenario C	Scenario I		Scenario II	
	6/2006	2006	2006	2006	2006	6/2006	2006	6/2006	2006
Capital adequacy (CAR) [1]	11.5	11.4	11.4	11.4	11.4	11.5	11.4	11.5	11.4
Results for the chosen scenario type									
Overall impact of shocks (percentage points CAR)	-2.3	-2.4	-3.7	-1.9	-1.5	-2.3	-2.0	-5.2	-4.9
Interest rate shock	0.0	0.0	-1.2	0.9	1.0	-1.6	-1.5	-3.3	-3.0
Exchange rate shock	0.0	0.0	0.3	-0.4	0.1	1.1	1.2	1.5	1.7
Credit shock	-2.2	-2.1	-2.5	-2.2	-2.5	-1.6	-1.5	-3.0	-2.7
… households	-	-0.6	-0.6	-0.6	-0.5	-	-	-	-
… non-financial corporations	-	-1.5	-1.6	-1.6	-1.8	-	-	-	-
… indirect impact of exchange rate shock	0.0	0.0	-0.2	0.0	-0.1	-1.1	-1.0	-1.4	-1.3
Interbank contagion [2]	-0.1	-0.2	-0.3	-0.2	-0.2	-0.1	-0.2	-0.4	-0.8
Profit allocation (percentage points CAR) [3]	2.0	2.0	2.7	1.7	1.2	1.7	1.5	2.9	2.9
Post-test CAR	11.2	11.1	10.5	11.1	11.1	10.9	10.9	9.2	9.4
Capital injection (percentage of GDP) [4]	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.6	0.6
Share of banks with negative capital after shock [5]	0.0	0.0	0.2	0.0	0.0	1.2	1.3	5.1	11.3
Impact on dividends and bonuses [6]	-62.9	-74.3	-100.0	-60.8	-42.6	-68.6	-65.5	-100.0	-100.0

Notes:
[1] CAR means the capital adequacy ratio defined in accordance with the relevant CNB regulations (in particular those governing the capital adequacy of banks and other prudential business rules).
[2] Test integrated with interbank contagion for Method 1 (see Financial Stability Report 2005), expected level of loss given default (LGD) 100% and chosen probability of the banks' failure (default) on the basis of the CAR.
[3] The scenarios assume that in the absence of shocks each bank would generate profit (or loss) equal to the average for the previous five years and that it would use any profit as a first line of defence against a declining CAR.
[4] The capital needed to ensure that each bank has a post-shock CAR of at least 8%.
[5] Market share of banks with negative capital after the impact of the assumed shocks (as a percentage of total assets).
[6] As a percentage of dividends and bonuses of the previous calendar year.
Scenarios: baseline, A, B and C are based on the macroeconomic forecasting model of the Czech National Bank and the credit risk model.
Scenario I and Scenario II are based on the chosen hypothetical and historical shocks (see the methodology in the Financial Stability Report for 2004).
They differ from the results set out in Chart 4 since they include the impact of interbank contagion.

5. CONCLUSIONS

The stress tests confirmed that the current rapid rise in household indebtedness does not pose any significant risk of banking sector instability. However, the dynamic growth in loans to households should be viewed in the context of faster growth in lending to corporations, a preponderance of long-term loans and the prevailing low interest rate level. A combination of continuing credit growth and an unexpected increase in interest rates might lead to higher capital requirements and the need to cover a rise in credit risk. High household indebtedness could necessitate higher provisioning in the banking sector if banks misjudge the ability to repay debts and other risks. The expected development of the banking sector and the model-based stress tests signal a need to further increase banks' regulatory capital for more than one year into the future.

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