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EDITORIAL

This issue of the CNB Research Bulletin looks at advances in the area of financial stability. Financial stability issues have attracted the attention of central banks in the last 10 years, mainly due to the rapid development of financial systems, the emergence of new financial products and the increased integration of the financial system across borders. These issues are extremely important for the Czech financial sector as well. The Czech National Bank therefore addresses financial stability problems periodically in its Financial Stability Reports.

One of the most widely used analytical tools for evaluating the stability of the financial sector is stress testing. The first article – by Jaroslav Heřmánek, Petr Jakubík and Michal Hlaváček – describes progress in this area as compared to earlier versions of stress testing described, for example, in one of the previous issues of the Research Bulletin (the article by Martin Čihák in Research Bulletin No. 2, Vol. 3 of November 2005). Progress has been made primarily in the areas of modelling credit risk and linking the stress testing to the CNB's official macroeconomic forecast.

The second and third articles – by Adam Geršl and by Alexis Derviz and Jiří Podpiera – are devoted to the issue of cross border-contagion in the Czech Republic. This problem is of great importance for the Czech Republic due to the strong foreign ownership of the Czech banking sector and the increasing cross-border flows of capital. The article by Adam Geršl uses macroeconomic data from BIS and compares the threats of cross-border contagion from other CEECs using a common creditor index. The article by Alexis Derviz and Jiří Podpiera presents the results of a sophisticated microeconomic model of lending contagion within multinational banking groups together with an empirical model of lending contagion using individual bank data from Bankscope.

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IN THIS ISSUE

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Credit Risk, Credit Growth Models and Stress Testing

Jaroslav Heřmánek, Michal Hlaváček, Petr Jakubík[1]

The stress tests conducted in previous years have shown that credit risk is the major source of risk for the Czech banking sector (see, for example, Čihák and Heřmánek, 2005; Čihák, Heřmánek and Hlaváček, 2007; or the CNB's Financial Stability Reports – CNB, 2005–2007). We would therefore like to concentrate on our new approach to the modelling of credit risk related to the predictions of macroeconomic variables. The main contribution in comparison with our previous approaches (see, for example, Jakubík, 2007) is an extension of the credit risk model to include separate estimates of credit risk for the corporate and household parts of the credit portfolio of banks. This change is motivated mainly by the different sensitivities of corporations and households to the macroeconomic environment, along with the changing structure of the loan portfolio due to different growth rates of loans in these sectors (the share of loans to households increased from 10% in 2001 to almost 40% at the end of 2006).

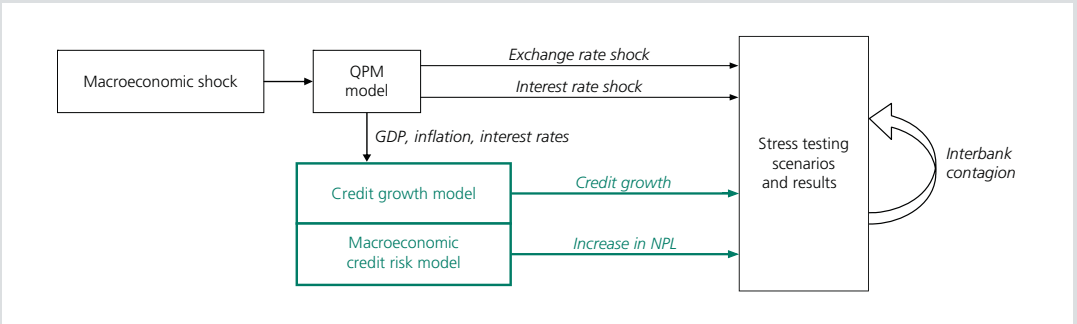
The dynamic growth in the household credit market and the renewed growth in loans to non-financial corporations mean that the level of credit risk would be underestimated under the traditional "static" approach to modelling credit risk. Therefore, our model of credit risk has been supplemented with credit growth models again linked to macroeconomic variables. The position of the credit risk and loan growth models within the macroeconomic stress test with model-consistent scenarios[2] is demonstrated in Chart 1. The macroeconomic shocks are generated within the CNB's quarterly macroeconomic forecast (QPM model). The impacts of the interest rate and exchange rate risks are then directly evaluated within individual banks' portfolios in the stress testing sheet. Some variables from the macroeconomic shock scenarios then enter the credit risk model and the credit growth model. Estimated additional non-performing loans (NPLs) are then subtracted from the capital of individual banks. At the end, series of interbank contagion tests are run to show the spread of the risk across the banking sector.[3] The results for individual banks are then aggregated for the banking sector as a whole and for major bank groups.

Credit Risk Models

The aggregate risk model used the default rate defined as the quarterly inflow of new NPLs. However, such data is only available on an aggregate basis and cannot be obtained separately for the household and corporate sectors, as the sectoral breakdown shows NPL stocks, not flows. To obtain

CHART. 1

Architecture of incorporation of stress tests with model-consistent scenarios



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

1 This short article is based on Jakubík and Heřmánek (2007).
2 Macroeconomic stress tests with model-consistent scenarios are the most advanced form of macroeconomic stress testing conducted in the CNB. In addition, basic stress tests with historical risk scenarios (including simple sensitivity analysis) have been calculated periodically since 2003 (data from 2000).
3 For the methodology of the interbank contagion test see Čihák and Heřmánek (2005), and for an application to the Czech banking sector see Čihák, Heřmánek and Hlaváček (2007).

flows, we used the following relationship between the stock of NPLs, the default rate and the rate of decrease of NPLs:

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

where NPL_1 is the stock of NPLs at the beginning of the period, u the rate of decrease, df the default rate and $Loans_1$ loans at the beginning of the period. The rate of decrease was only available for aggregate loans and is highly volatile. 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.

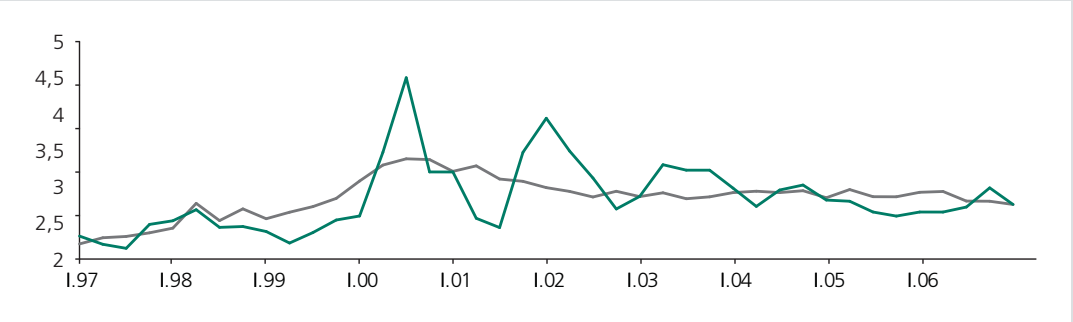
To model the credit risk for the household sector the same methodology was used as for estimating the aggregate model.[4] The resulting model was estimated for the annual default rate time series from 1996 Q3 to 2006 Q3. A whole range of macroeconomic indicators were considered for the estimate. Only those variables appearing in the CNB's quarterly macroeconomic forecast were taken into account, to enable us to link the credit risk model to this forecast.[5] The model chosen as the statistically best model was one containing the unemployment rate and the real interest rate.[6] The unemployment rate was lagged by four periods, which corresponds to the lagged impact on payment discipline in the event of loss of employment.[7] For the real interest rate the statistically best results were achieved with a lag 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 the equation below. The comparison of the model estimation with the real default rate is shown in Chart 2.

$$df_t = \psi\,(-2.1419 + 2.9564 \cdot u_{t-4} + 1.2044 \cdot r_{t-3})$$

As far as the model for the corporate sector is concerned, the exact estimate of the macroeconomic model for the corporate sector is not yet available. Unlike in the household sector, the rate of decrease seems to show considerable volatility historically and therefore it is more complicated to generate the time series of NPL inflows. 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.[8] The aggregate default rate was considered

CHART. 2

Default rate for the household sector (%)



Source: CNB — Default rate for households — Estimated default rate for households

4 The estimate is based on a Merton type single-factor latent model. This methodology can be found, for instance, in Jakubík (2007).
5 Therefore, some potentially relevant variables, for example house prices, could not be included.
6 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.
7 The loan is initially repaid from savings or the redundancy payment; payment discipline is affected only after that.
8 The default rate for the whole economy was estimated as (see Jakubík, (2007):
$df_t = \psi\,(-2.0731 - 4.9947 gdp_t + 2.7839 R_{t-4} - 2.4364 \pi_{t-2})$

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.

CREDIT GROWTH MODELLING

In our estimation for the loan portfolio growth rate we used the vector error correction (VEC) model.[9] This model 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.

In line with the existing literature a number of macroeconomic variables were taken into account in the estimate for the Czech Republic.[10] 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. The cointegration relationship between the credit growth rate, the real output growth rate and the default rate was significant at the 1% significance level.

The following model of the short term relationship was chosen with regard to these objectives and econometric properties:

$$\Delta loanstr_t = -0.27 \cdot (0.047 \cdot loanstr_{t-1} - 3.64 \cdot rgdpr_{t-1} + 3.65 \cdot dft_{t-3}) + \\ -1.38 \cdot \Delta rnewgap_{t-3} + 2.62 \cdot \Delta rgdpr_{t-1} + 0.29 \cdot dum$$

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 and *dum* a dummy variable taking the value of 1 for the period of massive clean-up of banks' loan portfolios. The first line describes the error correction model of credit growth and the second line the estimate of the cointegration relationship. All the variables were significant at the 1% significance level. The coefficient of determination of the model was 78%. Forecasts for all the variables used can be obtained from the CNB's quarterly macroeconomic forecast. The default rate was calculated using the aggregate credit risk model. Using the estimated model of credit growth together with the predictions of the relevant macroeconomic variables from the CNB's official forecast, 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.

USE OF THE CREDIT RISK AND CREDIT GROWTH MODEL IN MACRO STRESS TESTS WITH MODEL-CONSISTENT SCENARIOS

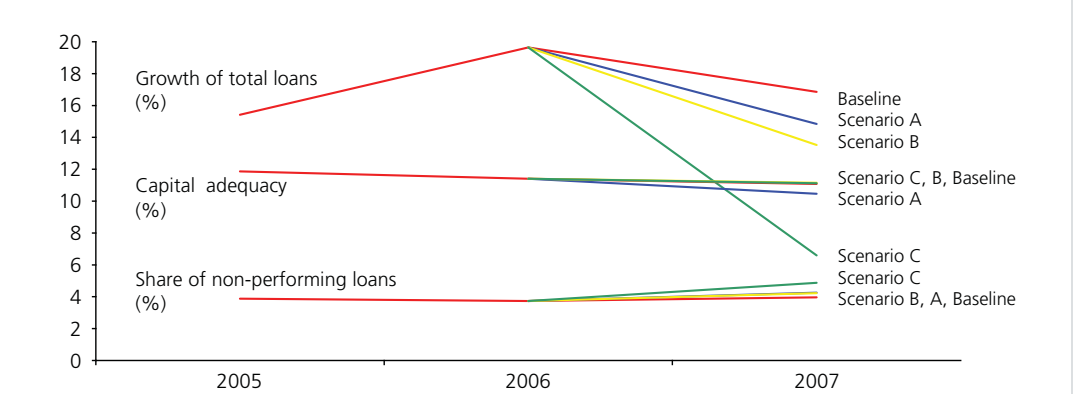
As already shown in Chart 1, the credit risk and credit growth models were used in macro stress tests with model-consistent scenarios linked to the CNB's official macroeconomic forecast. The baseline model scenario uses the CNB's quarterly macroeconomic forecast of April 2007, which estimates the developments 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. *Alternative scenario A* analyses the potential response of the domestic economy to a significant global negative demand shock. Such a shock 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 2008 and 2007 would be lower than in the baseline scenario, and interest rates would be higher. *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

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

10 Variables such as the output gap, the interest rate gap, the unemployment rate, the share of NPLs 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.

CHART. 3

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.

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 to a very low level. *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. 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.

As shown in Chart 3, all three alternative scenarios would have a significant impact on the share of new NPLs and on credit growth. The impact on capital adequacy would, however, be alleviated by the easing of monetary policy for scenarios B and C. In the case of the most stressful scenario A, the capital adequacy ratio would fall by approximately 1 percentage point. However, it would remain sufficiently above the 8% regulatory minimum. Therefore, the banking sector seems to be rather resilient to the estimated shocks.

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Cross-border Lending and the Risk of Contagion

Adam Geršl[1]

The strong inflow of capital in recent years has increased the integration of the Czech economy into international financial markets. Non-residents have significant shares in the financial and non-financial sector thanks to past foreign direct investment, and hold a range of other securities as portfolio investment. As a result, prices of assets on the domestic financial markets often change in line with global market sentiment. In addition, a number of domestic entities take credit abroad, either by issuing international debt securities or by taking loans from internationally active banks. A similar level of financial integration can be seen in other Central and Eastern European (CEE) countries.

The dominance of foreign players in domestic markets may generate concerns about whether the domestic financial and real sectors are becoming too dependent on foreign factors. One of the traditional problems discussed in analyses of financial stability for strongly financially integrated markets is the risk of cross-border contagion. A shock which affects one country can generate turbulence on financial markets and spill over to other countries. The issue of cross-border contagion has often been mentioned as one of the triggers of the Asian financial crisis in the latter half of the 1990s and has been empirically analysed since then in a number of studies (Peek and Rosengren, 1997; Van Rijckeghem and Weder, 2001; Claessens and Forbes, 2001; Kumar and Persaud, 2002). The Czech Republic experienced this phenomenon during the currency crisis in 1997 (Šmídková, 1998).

We explore the scope for cross-border contagion in the CEE countries via financial exposures. The analysis is based on the consolidated international banking statistics collected by the Bank for International Settlements (BIS). The data cover financial claims on other countries (so-called foreign claims) reported to BIS by internationally active banks, including the exposures of their foreign affiliates, and are collected on a worldwide consolidated basis with inter-office positions netted out.

Internationally active banks can provide credit to other countries via two main channels: directly, i.e. via cross-border (international) lending, or indirectly, via entering the domestic market of a host country in the form of a subsidiary or a branch and providing credit locally. The BIS statistics partly match this breakdown. Foreign claims consist of international claims and local claims of foreign affiliates. Unfortunately, the match is not fully accurate: international claims include BIS reporting banks' cross-border claims in all currencies plus the local claims of their foreign affiliates in foreign (non-local) currencies, while local claims include local claims of foreign banks' affiliates in local currency only. As a result, local claims understate the local activity of foreign banks' branches and subsidiaries.

Foreign claims as a percentage of GDP increased markedly between 1996 and 2005, mainly due to an increase in local claims. This was the combined result of bank acquisitions, usually via privatisation, green-field investments of foreign banks and the high credit growth that the CEE countries have been experiencing over the past couple of years. Of the countries analysed, the Czech Republic has the highest share of local claims. This is due to both the strong presence of local subsidiaries of foreign banks and the fact that most locally provided loans are denominated in domestic currency. Obviously, given the definition of local claims in the BIS data, the share of local lending in all foreign claims for a number of other CEE countries is underestimated given the high share of foreign-currency loans in those countries (Backe et al., 2006).

Table 1 also indicates the relative importance of foreign credit in comparison with domestic credit. In 2005, the combined local-currency lending by foreign affiliates and international claims exceeded total domestic credit (ratio higher than 100%) in almost all countries.

Indisputably, foreign banks' involvement in transition countries, especially through entering the local market, has brought significant benefits. However, the high involvement of foreign players may also increase the risk of cross-border contagion. If, for example, foreign claims are concentrated with one

1 This short article is based on Geršl (2007).

large creditor and that creditor is hit by a shock which forces it to liquidate its foreign investments, the impact on the debtor country will certainly be greater than if the domestic economy uses foreign capital from several countries. Table 2 shows that foreign claims are relatively concentrated in the case of the Czech Republic (the three most important creditor countries hold around 73% of all foreign reported claims) compared to other CEE countries. However, by far the most concentrated foreign claims can be found in the Baltic countries.

The risk of cross-border contagion is also co-determined by the degree of similarity of the creditor structures of individual debtor countries. For example, if a debtor country was hit by a large shock and all the creditors of that country were affected, it is possible that they would also withdraw their exposures from other countries where they have their claims. If the creditor structure of another country was completely identical to that of the country affected by the primary shock, this other country would also probably be hit by an investment outflow to the same extent.

To capture the degree of similarity of creditor structure, we calculated common creditor indices using the formula of Van Rijckeghem and Weder (2001). The index measures the similarity in patterns of creditors between any two countries and is bounded between 0 and 1 (1 indicates the same composition of creditors, while 0 indicates no common creditor).

Table 3 indicates that some CEE countries do indeed share common creditors to some extent. The Czech Republic's creditor structure is broadly similar to that of Slovenia, Slovakia, Hungary and Romania, but less similar to that of Poland and other CEE countries. This reflects the results of the expansion strategy of several (mainly EU-based) banking groups which have acquired significant shares in the domestic banking sectors in a number of CEE countries. The similarity of creditors with Slovenia is an interesting result given the low involvement of foreign banks in Slovenia as compared to the Czech

TABLE. 1

Composition of foreign claims

	Total foreign claims in % of GDP		Local claims by foreign banks in % of total foreign claims		Total foreign claims in % of total domestic credit	
	1996	2005	1996	2005	1996	2005
Czech Republic	22.2	75.8	29.1	69.6	32.8	178.1
Hungary	28.6	72.8	9.3	32.8	42.6	124.0
Poland	7.3	40.8	32.5	49.1	25.1	125.7
Slovakia	13.1	84.2	9.9	66.0	25.0	178.7
Slovenia	9.6	51.0	0.0	14.1	30.1	82.6
Estonia	3.9	138.9	0.0	16.7	19.1	214.6
Lithuania	3.0	58.1	0.0	16.0	25.9	144.3
Latvia	1.7	79.2	0.0	12.9	14.9	114.1
Bulgaria	24.8	46.8	0.6	26.5	62.2	113.4
Romania	8.8	32.5	2.4	30.9	39.3	179.8
Croatia	7.6	119.3	0.0	39.6	17.4	170.1

Source: BIS Consolidated International Banking Statistics, IMF International Financial Statistics.

TABLE. 2

Foreign bank claims by geographic origin
(end-2005; claims by banks from selected countries in % of total foreign claims)

	Austria	Belgium	Germany	Finland	France	Greece	Japan	Netherlands	Sweden	United States	Top-3
Czech Republic	28.4	26.2	6.7	0.0	18.6	0.0	0.5	3.4	0.0	2.7	73.2
Hungary	23.9	12.8	25.6	0.0	4.1	0.0	1.4	4.7	0.2	2.6	62.3
Poland	7.4	6.7	16.7	0.1	2.9	0.0	2.5	10.6	1.9	5.9	34.8
Slovakia	42.0	9.3	4.9	0.0	2.2	0.1	0.2	8.2	0.1	3.1	59.5
Slovenia	39.8	7.2	21.3	0.0	8.9	0.1	1.7	1.1	0.1	0.2	70.0
Estonia	1.5	0.6	5.3	12.0	0.1	0.0	0.1	0.1	78.2	0.2	95.5
Lithuania	2.4	0.4	9.5	14.2	0.4	0.0	0.0	0.0	56.7	0.4	80.4
Latvia	2.6	0.2	10.3	10.4	0.1	0.1	0.2	0.2	58.2	0.1	78.9
Bulgaria	16.0	0.8	7.3	0.0	4.4	18.7	0.4	2.1	0.0	2.5	42.1
Romania	19.6	0.2	5.5	0.0	16.4	11.5	0.5	12.1	0.2	3.5	48.1
Croatia	41.7	0.4	7.3	0.0	1.2	0.3	0.9	0.4	0.0	0.5	50.2

Source: BIS Consolidated International Banking Statistics.

TABLE. 3

Common Creditor Indices
(end-2005)

	Czech Republic	Hungary	Poland	Slovakia	Slovenia	Estonia	Lithuania	Latvia	Bulgaria	Romania	Croatia
Czech Republic	1.00										
Hungary	0.67	1.00									
Poland	0.44	0.67	1.00								
Slovakia	0.62	0.70	0.64	1.00							
Slovenia	0.64	0.78	0.56	0.76	1.00						
Estonia	0.12	0.14	0.15	0.10	0.10	1.00					
Lithuania	0.24	0.36	0.39	0.27	0.29	0.79	1.00				
Latvia	0.23	0.38	0.40	0.28	0.32	0.79	0.95	1.00			
Bulgaria	0.48	0.60	0.62	0.62	0.51	0.09	0.26	0.28	1.00		
Romania	0.61	0.61	0.56	0.62	0.54	0.10	0.26	0.28	0.71	1.00	
Croatia	0.47	0.56	0.55	0.80	0.71	0.11	0.31	0.33	0.67	0.53	1.00

Source: BIS Consolidated International Banking Statistics.
Note: Figures between 0.60 and 1.00 are flagged in red.

Republic. Interestingly, two main groups of countries linked with common creditors are emerging: central European and south-eastern European countries on the one hand, and Baltic countries on the other hand. This is mainly due to the different origins of foreign banks active in the two groups of countries, as in the Baltic countries Scandinavian banks are the main creditors (see Table 2).

However, for the common creditor effect to materialise and to present a risk to financial stability, two additional conditions would have to be fulfilled: first, the common creditor bank would have to be rather weak, and second, the adverse shock would have to be rather large. These conditions are rather hard to fulfil. Foreign banks active in the CEE countries are usually some of the largest banks from advanced EU countries and the relevance of CEE claims in their portfolios is rather limited. The vulnerability of the financial sector in many CEE countries is also limited by sufficiently sound macroeconomic policies. Thus, so far the risk of cross-border contagion seems to be contained.

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Lending Behaviour of Multinational Bank Affiliates

Alexis Derviz, Jiří Podpiera[1]

Motivation

The question of cross-border shock transmission in loan supply by an internationally active bank has become especially important in recent years. Regulators in the country of incorporation of the parent bank are often concerned about destabilising spillovers on it from foreign country units. These concerns are motivated by the fact that multinational banks (MNBs) usually belong to the leading institutions of the banking sector on the national level and are systemically important. The same argument often surfaces in the reasoning of rating agencies: it is known that an MNB sometimes suffers a downgrade when considered "overstretched" by foreign bank acquisitions. Conversely, policymakers in countries where MNBs play an important role may fear that a shock affecting the parent bank, although totally unrelated to the domestic economic or financial fundamentals, can distort lending decisions within their jurisdiction.

The present paper focuses on the latter aspect, in that it discusses the probable causes and empirical relevance of *lending contagion* from the parent bank itself, or economic conditions in its home country, to an affiliate in a different country. Contagion can be both positive and negative, meaning better/worse performance in the parent inducing more/less lending in the affiliate, respectively.

Although interdependence of investment decisions can be studied for any multinational financial institution, the case of banks has a number of important special features. Namely, units in different countries predominantly lend to local customers and are also managed locally. Under those conditions, why should the performance of one country unit (particularly the parent bank) be relevant for fund allocation in another? Whereas cross-border contagion in security markets is at least partially explainable by the global portfolio management motives of an investment company, the rationale for lending contagion in an MNB is not immediately available. So, at first glance, there should be less cross-border contagion in a bank than in a non-bank. On the contrary, our analysis was prompted by the well-documented observation of the existence of forces behind an MNB affiliate's lending decisions which cannot be explained by local driving factors.

The theoretical foundations of an MNB's operation in a concise form have so far been absent from the literature, but there exists some empirical work documenting MNB performance. Specifically, the significance of various macro- and micro-lending volume determinants in MNB affiliates is studied in a paper by de Haas and Lelyveld (2006). Our empirical analysis, based on the implications of a theoretical model, adds two important dimensions: the loan portfolio performance of the parent bank and the home-host country exchange rate volatility.

Modelling

We set up a model that is able to highlight the interplay of home country (where the parent bank is incorporated), host country (where the branch operates) and bank-specific ingredients in the optimal lending volume selection. We draw on two seminal contributions to the financial intermediation literature that offer suitable departing points for our own analysis. First, the theory of *bank-internal capital markets* (in which investment projects by different divisions compete for shareholders' funds), as developed by Froot and Stein (1998), can be specialised for the case of bank affiliates and their loan portfolios in different countries of MNB operation. Second, the idea of a bank as a site of two agency problems: between the borrower and the manager and between the manager and the shareholder, allow us to put the specific position of the affiliate manager in the forefront. The bank shareholder has to remunerate the latter based on his non-transferable skills in extracting returns from risky loans. We design a "reduced-form" synthetic version of the two named modelling paradigms. Two distinct features of a bank as opposed to other types of international investors are taken to be

1 Based on the authors' CNB Working Paper No. 9-2006 "Cross-Border Lending Contagion in Multinational Banks".

responsible for specific features of loan provision in an MNB branch: *liquidity-sensitivity* in the face of uncertain leverage provided by depositors and *delegation* to a local manager with non-transferable ability to earn interest on host country loans.

The shareholder can choose to operate the branch "at arm's length" without the manager, but the return on loans granted by the branch would then have a different distribution, and be, on average, lower than under delegated management. We call the choices made by the shareholder for the branch under this hypothetical arm's length operation *substitute*. The effective choices of MNB shareholders concerning the budget of the branch are based on the covariance structure of substitute returns and not the returns achieved under delegated management. On the other hand, the actual lending volume in the branch is based on the local manager's choices. We call lending contagion the outcome of the model in which the partial derivative of the branch loan volume with respect to the average return on loans in the parent bank is positive. The latter variable was selected as a summary statistic for the disturbances affecting the operation of the MNB in its home country. Quantitatively, as follows from our model, the affiliate loan volume sensitivity to the parent bank performance can be expressed by the formula

$$\frac{\partial x}{\partial Z} = DH + DP - X\pi\frac{z}{\gamma\sigma_l^2}$$

in which x is the loan volume in the affiliate, X is the loan volume in the parent bank, z (Z) is the mean return on loans in the affiliate (parent bank), γ is the risk aversion coefficient, σ_l^2 is the loan return variance in the affiliate and π is the precautionary behaviour multiplier. The term DH summarises the factors behind the hedging demand for x under delegation, whereas DP is the hedging demand for x under precautionary behaviour. Contagion occurs when the right-hand side of the above equation is positive, i.e. when cross-border hedging motives dominate over the direct incentive to expand the affiliate's lending proportionally to its average return on loans.

The model shows that both delegation and liquidity-sensitivity can give rise to lending contagion, depending on the interplay of the actual and substitute return statistics.

Under delegation, even if returns generated by the local manager are uncorrelated with the parent bank domicile variables, non-zero cross-country correlation of the shareholder's substitute returns is able to induce contagion. In short, although the branch manager has a local investment opportunity set, he cannot afford to ignore global factors that influence the parent bank. Given the rule determining his remuneration, a co-movement of earnings in all MNB divisions under the hypothetical arm's length management by the shareholder implies that the branch gets a higher/lower budget when the parent earns more/less, even though the manager himself is able to earn on loans independently of the parent bank.

In addition, due to **liquidity sensitivity**, there is an additional reason for contagion under certain return correlation structures. These can be best highlighted by comparing the MNB's actions with those of a fictitious non-leveraged (i.e. non-deposit-taking) international investor with the same loan portfolios in different country divisions. One needs to imagine an economy in which such an investor could trade in loans, including taking short positions, without frictions. Under many return covariance scenarios, this fictitious investor would have optimally chosen to go short on the host country loans. The bank cannot do this with actual loans, but the same covariance parameters will induce lending contagion.

In essence, our model demonstrates that, although MNB affiliate managers in individual countries are restricted to investing "locally", their incentives induce them to think "globally". This is why lending contagion in international banks can be present even in situations where cross-border portfolio contagion by other types of international investors is absent.

Empirical analysis

The given description of lending contagion is based mostly on non-observable variables. Therefore, one cannot empirically test the results of the model taken literally. Instead, we decided to formulate a reduced-form relationship between loan growth in an MNB affiliate and a number of variables which are likely to be relevant for both home and host country return on loans and the performance of the parent bank. If, in the estimation, the latter explanatory variable happens to have a positive effect on affiliate bank lending, we can claim the presence of contagion in the analysed bank group. To verify the formal implications of our model, we looked for evidence of cross-border lending contagion in a comprehensive sample of multinational banks worldwide. This is done by means of several fixed effect panel regressions. The dependent variable in all cases is the annual growth of loans in a host country affiliate. The home and host country macro fundamentals (GDP growth, inflation and long-term interest rates) are among the explanatory variables. The list of the latter is completed with a home-host country bilateral exchange rate volatility measure and a measure of credit risk management costs in the parent bank. Including the exchange rate volatility seems indispensable, given the contribution it makes to mutual correlations of the foreign affiliate balance sheet realisations from the parent bank viewpoint.

Two types of regression were employed. In the *parenthood* regression, we investigated the sign and significance of the relation between the credit risk cost in the parent bank and loan volume growth in the affiliate. In the *regional* regression, we grouped the parent banks according to the countries where they operate. In this way, we created four blocks of countries: Central and Eastern Europe (Czech Republic, Hungary, Poland and Slovakia), Old Industrial Countries (Canada, Ireland, Portugal, Switzerland, UK and US), New Industrial Countries (Mexico, Turkey and Korea), and Baltic Countries (Estonia, Latvia and Lithuania).

We find that the home country macroeconomic factors are not particularly important as determinants of lending, while, on the contrary, the host country ones are. This may indicate that lending contagion in liquidity-insensitive banks (i.e. those who act more or less like standard unconstrained portfolio optimisers), which should stay in a relation with asset return statistics co-driven by macro fundamentals, is of subordinate importance empirically. In all cases, the exchange rate volatility plays an important role.

We found a statistically significant relation between the credit risk costs of the parent bank and the credit growth in the affiliate. About two-thirds of the parent banks in our sample expand/restrict lending in affiliates in response to loan quality improvement/deterioration at home. The remaining roughly one-third of the banks behave inversely, i.e. as standard portfolio diversifiers (see Table 1 as well as the description of the estimation procedure in the original paper).

TABLE. 1

List of parent banks

1	*Allied Irish Banks*	17	**Crédit Lyonnais**
2	**American Express Company**	18	*Erste Bank*
3	*Banca Intesa*	19	**Foereningssparbanken - Swedbank**
4	**Banco Bilbao Vizcaya Argentaria**	20	**GE Capital International Financing Corp.**
5	*Banco Comercial Portugues*	21	*HSBC Holdings*
6	**Banco de Sabadell**	22	**ING Groep**
7	**Banco Santander Central**	23	*MBNA Corporation*
8	*Bank of America Corporation*	24	*Merrill Lynch & Co.*
9	**Bank of Ireland**	25	**Mitsubishi Tokyo Financial Group**
10	**Royal Bank of Scotland**	26	**Mizuho Corporate Bank**
11	*Barclays Bank*	27	*National Australia Bank*
12	*Bayerische Hypo und Vereinsbank*	28	*Raiffeisen-Holding Niederoesterreich-Wien*
13	*BNP Paribas*	29	*Skandinaviska Enskilda Banken*
14	*CERA (KBC)*	30	*Société Générale*
15	*Citigroup*	31	*Unicredito Italiano*
16	*Commerzbank*		

Note: Banks with names displayed in italics show signs of lending contagion, while the remainder (names in boldface) behave as conventional portfolio diversifiers

The regional regressions give evidence on the extent to which the results are driven by differences in the regions where affiliates operate. The results suggest that MNBs with affiliates in Central and Eastern Europe typically show signs of intra-bank lending contagion. This is not very surprising given the high degree of economic integration of this region with the euro area, from which most penetrating MNBs originate. On the contrary, parent banks that operate affiliates in the old industrialised, newly industrialised and Baltic countries show few signs of lending contagion. Looking at individual banks showing signs of lending contagion, we mostly find European banks with affiliates in other European countries. In those, sensitivity to liquidity is likely to be more pronounced (meaning that outside intervention due to an increasing probability of illiquidity is more likely to happen there than in other jurisdictions). For instance, the interventionist regulatory attitude of policymakers in Europe, even though often being more of a "rescue" than a penalty for the shareholders, should make most of these banks liquidity-sensitive. That is, we would often observe precautionary rebudgeting in response to credit risk cost shocks.

Altogether, even though we found both types of MNB lending behaviour, the contagion effect dominates. Also, the geographical location of the affiliate seems to play a role in this phenomenon. Looking in particular at the MNBs operating in the Czech Republic, we see that most of them are prone to lending contagion. The general lesson from our analysis for regulators would be to support a higher degree of informational transparency in commercial banks. In that way, the agency problems between the parent and the affiliate banks are less severe and the lending behaviour becomes more standard, i.e. less affected by bank-specific contagion impulses.

This Year's News from the CNB Research Department

The CNB Economic Research Department (ERD) this year published its evaluation report "CNB Economic Research: Focus on 2003–2004". This report gives an overview of our research activities and outcomes, together with a glimpse of how research is organised inside the CNB. It is available at http://www.cnb.cz/en/research.

When preparing the report, there was general agreement that the ERD should also draw the attention of Bulletin readers to the fact that the CNB's researchers publish extensively outside the CNB research publications. In each future issue we will therefore provide a list of selected publications in impact journals produced by CNB staff over the last few years.

In 2007, we are continuing to organise seminars jointly with the Czech Economic Society and CERGE-EI. L. Svensson, P. Portugal, C. Walsh and E. Bergloff will be our speakers. It is worth noting that the seminars are open to all members of the Czech Economic Society and to academia.

Finally, I would like to mention that this year, as every year, the ERD has seen several personnel changes. M. Cincibuch, J. Antal, M. Hlaváček and J. Frait are the current members of the team of advisers. They coordinate economic research in four areas (monetary policy, modelling, financial stability, the real economy and fiscal policy). Similarly, there have been changes in the composition of the CNB Research Advisory Committee. N. Battini, I. Begg, A. Blake, S. Cecchetti, C. Detken and L. Halpern are the current members. The Committee is chaired by R. Holman, a CNB Board Member.

Kateřina Šmídková
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CNB Economic Research Department

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