Dániel Holló: Identifying imbalances in the Hungarian banking system ('early warning' system)*

The new Hungarian Central Bank Act passed at the end of 2011 delegated macroprudential regulatory powers to the MNB. The essential elements of an effective macro-prudential policy are analytical tools which make it possible to quantify the effects arriving via different systemic risk channels and regulatory instruments which can help in the management of systemic risks. Among the four analytical tools tuned to identify and measure systemic risk ('early warning' system, stress tests, contagion models and a system-wide financial stress indicator) two are already in regular use at the MNB (stress tests and the system-wide financial stress indicator), a contagion model is currently under development and the 'early warning' system is about to be introduced. This article presents one of the four tools discussed above: the 'early warning' system. The 'early warning' system may help in the identification of periods characterised by excessive credit growth and the accumulation of critical imbalances on the banking sector's assets and liabilities side as a result of excessive bank lending (excessive credit growth channel of systemic risk), and may serve as a point of reference for the timing of the introduction of measures named in the new MNB Act to reduce systemic risk (e.g. anti-cyclical capital buffer and other regulatory instruments designed to prevent excessive credit growth). Our results show that excessive imbalances on the asset and liability sides of the Hungarian banking system started to emerge in 2005 Q4; the current problems facing Hungarian banks stem from the large imbalances on the assets and liabilities side (excessive credit growth and significant increase in the share of non-core or secondary liabilities within total liabilities), which characterised the period between 2005 Q4 and 2008 Q4.

INTRODUCTION

The new MNB Act, passed at the end of 2011, which also includes tasks related to the identification and management of systemic risks,[1] makes the MNB the institution primarily responsible for the conduct of macroprudential policy in Hungary. The essential elements of an efficient macroprudential policy are the analytical tools which can help in the quantification of potential effects arising via the various channels of systemic risk and regulatory instruments which allow for the efficient management of these risks.

Based on the findings in international literature, three main channels of systemic risk can be identified at present: (i) sustained and excessive credit growth associated with significant asset price growth,[2] (ii) external and internal shocks affecting financial system participants simultaneously, and (iii) interbank and financial market contagion. Quantifying the effects arising through these channels and the proper quantitative assessment of systemic risk require the simultaneous use of a number of analytical tools. The following tools constitute the backbone of the family of models and indices serving the measurement of systemic risks.

1. 'Early warning' systems, which may facilitate the identification of periods characterised by excessive credit growth and the accumulation of critical imbalances on the banking sector's assets and liabilities side as a result of excessive bank lending.

2. Stress tests (for liquidity, market and credit risks), which may help in quantifying the impact of various real economic and financial risks on financial institutions'

* 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] According to De Bandt and Hartmann (2000); De Bandt et al. (2009); ECB (2009) 'systemic risk can be defined as the risk that financial instability becomes so widespread that it impairs the functioning of a financial system to the point where economic growth and welfare suffer materially'.

[2] Alessi and Detken (2009).

solvency and liquidity position. Stress tests, however, can be used not only to measure the effects of distinct risk scenarios on banks’ solvency and liquidity, but also to produce risk scenarios (showing combinations of real economic and financial risks which might endanger financial system stability).

3. Contagion models, which may help in quantifying the effects arising via various contagion channels in the interbank and financial markets. Furthermore, contagion models may also support the identification of systemically important financial market participants.

4. Indicators of financial stress, which measure the current level of stress in the financial system, i.e. help to assess how the financial system’s risk level is changing as a result of the interaction of shocks and accumulated tensions and imbalances in the system. In addition, critical stress thresholds calibrated to the financial stress indices may help in deciding whether the level of risk observed in the financial system in a given period has reached an extent which would pose a threat to the entire system’s stability.

However, conducting macroprudential policy requires more than just the existence of analytical tools serving to measure the effects arising through the distinct systemic risk channels; it also requires regulatory instruments designed to mitigate systemic risks. The macroprudential instruments enumerated in the MNB Act primarily serve to mitigate risks arising from banks’ excessive lending (excessive credit growth channel of systemic risk), such as, for example, the anti-cyclical capital buffer and rules designed to prevent excessive credit growth (e.g. limits on the loan-to-value ratio). However, the Act also allows for the imposition of additional requirements to mitigate the default risk of systemically important financial institutions (SIFIs) in order to reduce contagion risks and to promote system-wide stability. Moreover, the new Central Bank Act makes it possible to prevent the build-up of systemic liquidity risks as well.

The ‘early warning’ system presented in this article serves two purposes. First, it may help to identify periods characterised by excessive growth in credit and to measure its impact on the banking sector’s assets and liabilities side, second, it may serve as a point of reference for timing the introduction of measures to mitigate systemic risk. Our results show that the excessive imbalances on the assets and liabilities side of the Hungarian banking system started to accumulate in 2005 Q4; the period between 2005 Q4 and 2008 Q4 was characterised by large imbalances on the assets and liabilities side (excessive credit growth and significant increase in the share of non-core or secondary liabilities within total liabilities), which are responsible for the current problems facing Hungarian banks. The article first outlines the set of criteria which may be worth considering in developing an ‘early warning’ system. It then presents the theoretical background of the Hungarian ‘early warning’ system and shows the results of the empirical analysis. Finally, the article gives a concluding summary.

CRITERIA SET FOR DEVELOPING AN ‘EARLY WARNING’ SYSTEM

The recent global financial and economic crisis has given new impetus to ‘early warning’ system-related research. At the same time, however, it has also resulted in a shift in respect of the research question. This is mainly attributable to the failure of the so-called first-generation approaches, which focused on crisis prediction. While the aim of the classical or first-generation ‘early warning’ systems was to predict a sort of financial crisis, the goal of the second-generation approaches was not crisis prediction, but rather the timely identification and measurement of critical financial imbalances causing systemic vulnerabilities.[3] According to the underlying philosophy, if an economy is not vulnerable (e.g. it is free from significant real and financial imbalances), then on the one hand there is a low risk that an ‘own’ financial crisis will emerge, and on the other hand the adverse financial and real effects of crises spilling over into the domestic economy will be less severe. The failures of the first-generation ‘early warning’ systems were mainly attributable to crisis definition problems (e.g. what is the precise definition of an exchange rate, a banking or a balance of payment crisis?), modelling difficulties (e.g. the relatively small number of crises, which may be an obstacle to developing a country-specific crisis prediction system) and coordination failures (e.g. the absence of harmonisation of signals generated by crisis prediction systems of various countries or regions and the lack of cross-border coordination of the related crisis prevention measures). Based on these, the following criteria may be worth considering in developing an ‘early warning’ system.

1. First, due to the problems with the first-generation ‘early warning’ systems, identifying and measuring the magnitude of financial imbalances potentially causing

[3] In an economic context, the concept of vulnerability expresses the multi-dimensional nature of crises, i.e. it denotes conditions created by real economic and financial developments which may easily lead to severe financial crises. Banking sector imbalances and fiscal and external imbalances also constitute part of this set of criteria. Consequently, vulnerability is a criteria set, while the various forms of imbalances are ‘elements’ of this criteria set.

systemic vulnerabilities (i.e. the second-generation approaches) might be more relevant than predicting a financial crisis.

2. Another argument in favour of the second-generation 'early warning' systems is that they may help to eliminate the main methodological weaknesses of the first-generation approaches, namely crisis definition problems and modelling difficulties arising from the relatively small number of crises.

3. Finally, in developing an 'early warning' system it may be useful to take into account regulatory aspects as well; in other words, focus should be placed primarily on those financial imbalances that can be managed with macroprudential regulation.

The Hungarian 'early warning' system has been developed in consideration of the above criteria, i.e. our objective is not crisis prediction, but rather the timely identification and measurement of the magnitude of critical imbalances on the assets and liabilities side of the Hungarian banking system. In developing the 'early warning' system, we primarily focus on the banking sector, because with macroprudential regulation banking system developments can be influenced directly, through which macroprudential policy may indirectly reduce imbalances in other segments of the economy and influence overall economic processes (e.g. imbalances in the real estate market, foreign trade deficit, short- and medium-term economic growth, inflationary developments, etc.). However, international experience suggest that – in terms of the direct and indirect costs – banking crises are the most severe as well as those crises, which do not originate from the banking sector, but in which the banking system is nevertheless significantly involved. The International Monetary Fund has estimated the direct costs of banking crises management in the year of the crisis and the subsequent five years to be 10–15 per cent of GDP on average;[4] but, according to Reinhardt and Rogoff (2008), these costs are dwarfed by the loss of tax revenues due to the banking crisis-related recession and the fiscal costs caused by the increase in social expenditure. As a result of these processes, the cumulative increase in government debt may be as much as 83 per cent on average three years following the crisis. **In other words, a stable, adequately capitalised banking system (i.e. capitalised consistently with its true risk level), which is free from substantial asset and liability side problems, may significantly improve the resilience of the entire financial system to shocks, as it is able to absorb, instead of amplify the effects of various adverse external and/or internal shocks, and can therefore also dampen business cycle fluctuations.** It is important to note, however, that imbalances potentially threatening the stability of the financial system may emerge not only in the banking sector, but also, for example, in respect of the external balance (current account) or fiscal positions. These imbalances, however, can only be partially and indirectly managed with macroprudential regulation (e.g. a foreign trade deficit might be reduced by restraining bank lending).

DEVELOPMENT OF IMBALANCES ON THE ASSETS AND LIABILITIES SIDE OF THE BANKING SYSTEM (THE THEORETICAL BACKGROUND OF THE HUNGARIAN 'EARLY WARNING' SYSTEM)

The traditional banking system channels the funds it raises from savers to borrowers. Deposits constitute the most important liabilities of banks. The increase in the stock of deposits depends on the ability of economic agents to accumulate financial wealth. In periods of economic boom, the amount of deposits is generally insufficient and may impede bank lending. Therefore, financial institutions have to rely on other sources of funding to finance the expansion of credit in periods of economic upswing. This, in turn means that banks' liability structure (the share of deposits considered stable and the share of other liabilities considered less stable within total liabilities) may vary considerably in different stages of the business cycle (Shin et al., 2011).

Similarly to the liabilities side, the structure of the banking sector's assets side is also constantly changing. This can be partly explained by the changing number of positive net present value investment projects as well as by changes in banks' risk preferences (e.g. in periods of economic downturn, financial institutions are less willing to finance risky investments). The relationships below may help the understanding of the build-up of banks' asset and liability side problems.[5] For the sake of simplicity, loans to the private sector are considered the only bank asset.[6]

[4] Sources: IMF banking crises database (http://www.luclaeven.com/Data.htm) and the related study (Laeven and Valencia, 2008).

[5] A detailed technical description of the approach can be found in the study by Shin et al. (2011).

[6] The stylised model presented provides an easily understandable, simple framework for the better understanding of developments and interactions on the asset and liability sides of banks' balance sheets. A possible future direction for extending the model could be the use of a more complex asset structure (e.g. taking into account liquid assets) and the inclusion of important off-balance sheet items (e.g. taking into account FX swaps, due to their importance in financing lending in Hungary).

Balance sheet identity

$$C = E + CL + NCLB + NCLFC, \quad (1)$$

where C denotes the stock of credit to the private sector, E denotes the amount of the banking system's capital stock, CL denotes deposits considered as the 'primary', or core liability of financial institutions, $NCLB$ and $NCLFC$ denote interbank and external liabilities respectively, which are the 'secondary' or non-core liability of banks.

Leverage I.

$$L = C \,/\, E, \quad (2)$$

where L denotes leverage.

Generally, financial institutions are willing to hold as much capital as they need to protect them against unexpected losses – in other words, the amount of economic capital required to cover unexpected losses must be just equal to the value-at-risk (VaR) of a given asset portfolio. If V denotes value-at-risk per unit of loan, then the amount of economic capital required as a buffer against unexpected losses is the following.

Economic capital

$$E = V \cdot C, \quad (3)$$

that is leverage can also be expressed using the following formula.

Leverage II.

$$L = C \,/\, E = 1/V. \quad (4)$$

Based on formula (4), leverage is procyclical – in other words, it is high due to the low value-at-risk of banks' asset portfolio in periods of economic upswing *(V,* i.e. value-at-risk, falls; and L, i.e. leverage, increases), while it is low due to the high value-at-risk of banks' asset portfolio in times of economic recessions (V, i.e. value-at-risk, increases; and L, i.e. leverage, falls).[7] Consequently, the 'balance sheet capacity' of financial institutions (the maximum size of their balance sheet) is determined by the amount of their available capital stock and the capital requirement per unit of loan.

During periods of economic upswing, the balance sheet capacity of financial institutions rises for two reasons. First, improving profitability increases the capital base and, second, the capital requirement per unit of loan falls, due to diminishing credit risks. These factors in turn contribute to an improvement in banks' ability and capacity to lend, i.e. to the increase in the supply of credit. If the rate of credit growth significantly exceeds the growth rate of deposits – that is the growth rate of core liabilities (the expansion of credit is not followed by an equal increase in deposits) – then banks' borrowing from external sources (non-core liabilities) increases. As a result the share of deposits within banks' total liabilities may fall significantly. This may be a problem primarily because deposits are more stable compared to non-core liabilities (interbank and foreign funds); they are a more predictable source of funding, less exposed to the adverse effects of changes in the economic cycle and investor sentiment. Consequently, the change in the liability structure of banks may provide useful information about the stickiness of funding, i.e. about the size of financial institutions' exposure to funding liquidity risk. It is also important to note that a change in the liability structure may not only increase banks' 'funding' liquidity risk, but may also raise contagion risks via the interbank market.

In contrast with economic upturns, financial institutions' 'balance sheet capacity' may fall for two reasons during periods of economic downturn. First, banks' capital stock may decline due to rising credit losses and, second, the capital requirement per unit of loan rises due to an increase in credit risks. As a consequence, banks may become capital constrained. In extreme situations, i.e. in times of very severe economic downturn, these developments may even lead to a credit crunch.

Consequently, an 'early warning' system, developed for the banking system, should be capable of capturing problems emerging simultaneously on the asset and liability sides of the banking sector. An explanation for this is that a deterioration in banks' loan portfolio quality, accumulated as a result of excessive lending, may result in an increase in financial institutions' 'funding' liquidity risk, the magnitude of which, however, depends primarily on their liability structure, i.e. the share of non-core, more volatile liabilities (interbank and foreign liabilities) within total liabilities. **The major risk is if financial institutions fully utilise their increasing lending capacity due to the expansion of their**

[7] The relationship can be easily realised with knowledge of the arguments of the Basel capital function. In periods of economic upswing, the value of the risk parameters expressing the credit risk of the portfolio (default probability, loss given default) are much lower than those observed in times of recession, i.e. with identical portfolio size, portfolio composition and confidence level, the value at risk of the portfolio during a period of upturn may be significantly lower than the value at risk of the portfolio in periods of economic downturn.

balance sheet capacity by significantly easing lending standards, which may entail a dilution of loan portfolio quality (the implicit accumulation of credit risks in periods of economic boom) and excessive lending is financed mainly from non-core liabilities (the implicit accumulation of 'funding' liquidity risks in periods of economic boom).

It is important to note that the default risk of individual financial institutions is not only influenced by the extent to which their credit losses and 'funding' liquidity risks increase due to various shocks, but also by the reaction of other banking sector participants to the shocks affecting the system. The strength of systemic effects depends on the number of banks reacting to the shocks, the similarities of their behaviour and the size of the reacting financial institutions. For example, banks may react to the deteriorating 'funding' liquidity position by shortening the maturities of their assets, lengthening the maturities of their liabilities, increasing the quantity of their liquid assets and reducing the quantity of their illiquid assets. Banks' reactions may primarily affect the markets of illiquid assets and stable funds; such reactions may lead to a fall in asset prices in the former and an increase in the price of stable funds in the latter. The decline in asset prices may entail further increases in losses and banks' default risk as well as a further deterioration in the 'funding' liquidity position. That may necessitate additional adjustments by banks on the asset and liability sides of their balance sheets. As a result, a credit and 'funding' liquidity risk spiral may ensue, which may lead to the collapse of market liquidity and, in an extreme case, the meltdown of the entire financial system.

EMPIRICAL ANALYSIS

In this section, we outline the econometric background of the Hungarian 'early warning' system. In the first step of the empirical analysis, by relying on the theoretical framework presented earlier the variables are chosen which may help to capture imbalances on the banking sector's asset and liability sides, asset price movements adversely affecting developments in the value of banks' assets, the current state of the business cycle and the product risk structure of the loan portfolio. The asset side imbalance was approximated with the deviation of bank loans to the private sector (exchange rate adjusted household and corporate loan stock) from its trend (loan stock/trend of loan stock), i.e. with the credit cycle. The greater the amplitude of the credit cycle, the greater the imbalance on the asset side of the banking sector's balance sheet (e.g. significant credit growth in good times due in part to an easing of lending standards, and a sharp curtailment of lending in times of recession due to materialising credit risks). The liability side imbalance was approximated with the deviation of the exchange rate adjusted loan-to-deposit ratio[8] from its trend [liquidity cycle=(loan-to-deposit ratio)/(loan-to-deposit ratio trend)]. The more the current loan-to-deposit ratio exceeds its equilibrium level, i.e. the quotient of the ratios exceeds 1 or 100 per cent, the more financial institutions finance lending by raising less stable, secondary funds, and the more the liability side imbalance of the banking sector (latent 'funding' liquidity risk) will increase. For example, if the equilibrium value of the loan-to-deposit ratio is 1.06 and its current level is 1.08, then the deviation of the loan-to-deposit ratio from its trend is approximately 2 per cent (1.08/1.06). The deviation of real GDP from its trend was taken as the proxy variable of the business cycle (real GDP/real GDP trend). In the empirical analysis, the deviation of the FHB house price index from its trend was taken as the asset price proxy (FHB house price index/FHB house price index trend). This variable captures movements in house prices more directly related to banks' lending activity.[9] Finally, the share of foreign currency private sector loans within total loans to the private sector was employed to approximate the 'product risk' structure of credit.[10] The relationship between imbalances emerging on the asset and liability sides of the banking system was modelled in a regime switching vector autoregressive model framework (Markov-switching VAR).[11] According to the underlying intuition, economic agents behave differently in distinct states of the world or regimes (e.g. in times of

[8] In performing the calculations, we decided to use the exchange rate adjusted loan-to-deposit ratio because the numerator of the loan-to-deposit ratio increases by more than its denominator as a result of exchange rate depreciation, due to the high ratio of foreign currency loans and the relatively low ratio of foreign currency deposits – in other words, the value of the 'unadjusted' indicator may increase sharply as an effect of an exchange rate depreciation, which may falsely suggest a change in the liability structure (increasing demand for secondary liabilities). It is important to note that in interpreting a change in the liability structure we focus exclusively on on-balance sheet items.

[9] Based on international experience, excessive credit growth is generally associated with rapid rise in residential property prices. In periods of recession, i.e. when credit risks materialise, banking losses are not only increased by the increase in the number of defaults, but also by the simultaneous decline in the value of properties used as collateral.

[10] In filtering a trend using the Hodrick–Prescott filter, we used the 400 000 lambda value for the credit variable by taking into account the recommendation of the Basel Committee and the 1600 lambda value for the liquidity and business cycles, (recommended value in the case of quarterly time series).

[11] The MS_Regress package, developed for MATLAB, was used to produce the estimate. It is downloadable at: http://www.mathworks.com/matlabcentral/fileexchange/15789.

Table 1
Descriptive statistics of model variables in regime 1 and regime 2

Estimation period	1998 Q2–2011 Q2		
Regime 1	**2005 Q4–2008 Q4**	**Regime 2**	**1998 Q2–2005 Q3; 2009 Q1–2011 Q2**
Regime 1 (credit cycle, mean)	112.6%	Regime 2 (credit cycle, mean)	98.4%
Regime 1 (credit cycle, standard deviation)	2.1%	Regime 2 (credit cycle, standard deviation)	7.9%
Regime 1 (liquidity cycle, mean)	102.2%	Regime 2 (liquidity cycle, mean)	97.1%
Regime 1 (liquidity cycle, standard deviation)	2.6%	Regime 2 (liquidity cycle, standard deviation)	4.0%
Regime 1 (growth rate of private sector loans to foreign currency private sector credit compared to the previous quarter, mean)	3.6%	Regime 2 (growth rate of private sector loans to foreign currency private sector credit compared to the previous quarter, mean)	0.7%
Regime 1 (growth rate of private sector loans to foreign currency private sector credit compared to the previous quarter, standard deviation)	2.6%	Regime 2 (growth rate of private sector loans to foreign currency private sector credit compared to the previous quarter, standard deviation)	2.8%
Regime 1 (asset price cycle, mean)	101.0%	Regime 2 (asset price cycle, mean)	98.0%
Regime 1 (asset price cycle, standard deviation)	1.3%	Regime 2 (asset price cycle, standard deviation)	4.7%

Note: The asset price cycle was approximated with the FHB house price index.

expansion and low growth) – in other words, the evolution of economic and financial developments is regime specific (e.g. periods of upswing are characterised by excessive credit growth, a shortening of funding maturities and a decline in the ratio of total liabilities to stable funds; periods of economic downturn are characterised by a sharp curtailment of lending, a lengthening of funding maturities and an increase in the ratio of total liabilities to stable funds). The econometric method can be used to quantify the probability of staying in different states of the world or regimes, where the regime probabilities can be considered as an 'early warning' indicator derived from the system. In the model, regime switching basically depends on two factors: the past behaviour of model variables and the so-called transition probabilities, i.e. a 'deterministic' and a stochastic factor. In the calculations, we assumed the existence of two regimes: an expansionary and a low growth regime.[12] The model itself does not identify the regimes, i.e. which is the low growth and which one is the expansionary period. The regimes can be identified based on the descriptive statistics of the model variables and on the basis of the estimated model parameters. The table below contains the mean and standard deviation of the model variables in regime 1 and regime 2.

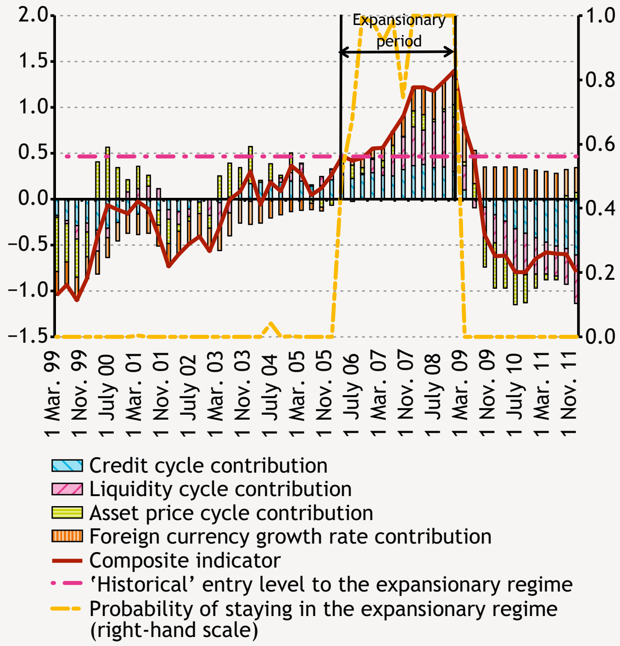
According to the results of the Table 1, the means of model variables in regime 1 exceed the average values in regime 2, and the means of the variables in regime 1 are above trend, while in regime 2 they are below trend. Furthermore, it can be seen that the standard deviation of the variables in regime 1 is lower than the standard deviation in regime 2 – in other words, regime 2 is characterised by a greater degree of uncertainty than regime 1, which can be generally observed in periods of economic downturn. A similar conclusion can be drawn by examining the constants and variances of the model. The values of regime-specific constants in regime 1 exceed those in regime 2; however, the direction is just the opposite in the case of the variances: regime 2 is characterised by higher volatility and regime 1 is characterised by lower volatility. Based on the behaviour of the model variables (above trend values and lower volatility in regime 1; below trend values and higher volatility in regime 2) and the regime-specific values of the model parameters, regime 1 is the expansionary regime and regime 2 is the low growth regime. This result partly coincides with the findings of a study examining periods of excessive credit growth in CEE countries written by MNB authors in 2006 (Kiss et al., 2006), i.e. with the finding that household credit growth in Hungary since 2004 was stronger

[12] Two regimes can be identified on the basis of the estimated Kernel density functions of the liquidity and credit cycles; the estimated empirical distribution of both variables is bimodal.

than justified by economic fundamentals, the deviation of which from the equilibrium path reached its maximum in 2009, exceeding its estimated equilibrium level by some 13 percentage points.

Our 'early warning' indicator, i.e. the probability of staying in the expansionary regime, derived from the model, is presented in the chart below. It shows that this probability clearly identifies the period of expansion – in other words, its values are close to 1 throughout the expansionary period. As mentioned earlier, regime switching depends on the past behaviour of the model variables (deterministic part) and the so-called transition probabilities. In order to better track the deterministic processes driving regime switching, a composite indicator was also built from the standardised model variables.[13] This index helps, on the one hand, to track the factors driving changes in the vulnerabilities of the banking sector (asset, liability side imbalances, and imbalances on the asset markets) and, on the other, to measure the extent to which the individual factors (credit cycle, liquidity cycle, asset price cycle, product risk structure of the loan portfolio) contribute to the vulnerabilities of the banking sector. High values of the composite indicator may signal a high level of banking system vulnerabilities, and an increase in the index may indicate a build-up of vulnerabilities, while low values may imply an absence or low level of vulnerability (pre-expansionary period), on the one hand, and a correction following a period of the build-up of vulnerabilities (post-expansionary period), on the other. The chart shows that the Hungarian banking sector entered the period of increasing vulnerability (persistent and positive trend deviations of credit and liquidity cycles, i.e. the development of asset and liability side imbalances) at the 0.47 value of the composite index and exited at its 1.37 value. At the time of entry into the expansionary period, the deterministic factor of the regime switch was driven primarily by positive trend deviations of the credit cycle, and, secondly and thirdly, by positive trend deviations of the asset price and liquidity cycles. In the correction phase, negative trend deviations of the liquidity, credit and asset price cycles were responsible for the fall in the composite index. It is important to note that the expansionary entry and exit levels of the composite index should not necessarily be considered critical levels remaining valid in the future, but as a kind of reference point. Furthermore, it is also important to note that an unambiguous increase in vulnerabilities in the banking sector requires a persistent, positive and simultaneous trend deviation of the model variables, as expressed by the steady and persistent rise in the composite index in the chart.

Chart 1
Probability of staying in the expansionary regime and the composite index built from the standardised model variables



SUMMARY AND CONCLUSION

The article presents a new tool developed for the identification of critical asset and liability side imbalances of the Hungarian banking sector. In developing the system, the focus was on banking sector developments, because, on the one hand international experience suggests that the direct (e.g. bank consolidation costs) and indirect costs (e.g. costs of a real economic downturn) of banking crises are the highest – in other words, timely identification and mitigation of asset and liability side problems of the banking sector may help avoiding serious banking system disruptions and, in the most severe case, banking crises. On the other hand, the banking sector can be considered stable and highly resilient to shocks if no significant imbalance evolves on either the asset or liability sides of banks' balance sheets. In that case, the banking sector absorbs rather than amplifies the adverse effects of the various financial and real economic shocks – in other words, its behaviour will be less procyclical.

In terms of the stability of the banking sector, persistent and significant credit growth and the simultaneous dilution

[13] Standardisation was performed by subtracting the sample mean from the 'raw' model variables and dividing this difference by the sample standard deviation.

of the portfolio quality (latent build-up of credit risks) can be considered the main risk factors, if these are associated with liability side problems, i.e. the increase in the ratio of total liabilities to stable funds (latent build-up of liquidity risks). If this occurs, the effect on banks' default risks of the interactions between asset and liability side strains in times of the materialisation of credit risks may intensify significantly.

According to our results, the significant asset and liability side imbalances (excessive credit growth, and sharp increase in the ratio of total liabilities to stable funds), responsible for the current problems of the Hungarian banking system, emerged in the period between 2005 Q4 and 2008 Q4.

The 'early warning' system presented may help decision-makers to identify excessive asset and liability side imbalances in the banking sector's balance sheet in a timely manner and may serve as a point of reference for the timing of the introduction of macroprudential regulatory instruments reducing such vulnerabilities.

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