LIQUIDITY RISK SENSITIVITY
OF CZECH COMMERCIAL BANKS

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Abstract

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The recent financial crisis has shown that a liquidity risk plays an important role in the current developed financial system. One of the efficient tools of liquidity risk management is stress testing which can show banks their potential vulnerability to liquidity shocks. The aim of this paper is therefore to measure the liquidity risk sensitivity of Czech commercial banks and to find out the most severe scenario and the most vulnerable bank. Our sample included significant part of the Czech banking sector; we used unconsolidated balance sheet data over the period from 2000 to 2011 which were obtained from annual reports of Czech banks. We have evaluated liquidity risk of each bank in the sample via six different liquidity ratios. Then we stressed these baseline values in three stress scenarios: run on a bank (simulated by a 20% withdrawal of deposits), confidence crisis on the interbank market (simulated by a withdrawal of 20% of interbank deposits) and use of committed loans by counterparties (simulated by a 5% increase of loans provided to nonbank clients). We measured the impact of all scenarios by relative change of liquidity ratios. The impact of modelled liquidity shocks differs among scenarios. The most serious liquidity problems would be caused by the first scenario – run on a bank. The negative influence of third scenario (use of committed loans) is less severe. The confidence crisis on the interbank market would not affect bank liquidity at all. The results also show that the severity of the impact of all scenarios worsens in periods of financial distress. We have also found that large and medium sized banks are most vulnerable to liquidity shocks, mainly to massive deposit withdrawals.

Keywords: liquidity risk, sensitivity analysis, Czech commercial banks

1 INTRODUCTION

Liquidity risk, e.g. the risk that a bank would not have enough liquidity, arises from the fundamental role of banks in the maturity transformation of short-term deposits into long-term loans. According to Nikolau (2009), the term liquidity risk includes central bank liquidity risk (which is highly unlikely as it is a risk that central bank would not be able to supply the liquidity needed to the financial system), funding liquidity risk (which captures the inability of a bank to service their liabilities as they come due) and market liquidity risk (which relates to the inability of trading at a fair price with immediacy). These types of liquidity risk are intensively interconnected. In normal times, these linkages promote a virtuous circle in financial system liquidity, guaranteeing the smooth functioning of the financial system. In turbulent times, the linkages can be distorted and there is a possibility of reverting from a virtuous to a vicious circle in the economy.

Banks can use three main mechanism to insure against liquidity crises: (i) to hold buffer of liquid assets on the asset side of the balance sheet; (ii) to rely on the interbank market where bank can borrow from other banks in case of liquidity need; (iii) or to rely on emergency liquidity assistance of a Lender of Last Resort (Aspachs *et al.*, 2005).

The recent financial crisis has shown that a liquidity risk plays an important role in the current developed financial system and has highlighted a pre-crisis lack of sound liquidity risk management

in banks. One of the efficient tool of liquidity risk management is stress testing. Stress tests can show banks their potential vulnerability to liquidity shocks. As it is evident how important stress testing is, this paper aims to measure the liquidity risk sensitivity of Czech commercial banks and to find out the most severe scenario and the most vulnerable bank.

2 METHODS AND DATA

2.1 Theoretical Background of Liquidity Ratios and Stress Testing

Liquidity ratios are used for liquidity risk measurement. They should identify main liquidity trends. Various authors provide various liquidity ratios. We will use following six liquidity ratios:

The ratio L1 is the share of liquid assets in total assets. Following the methodology of Czech National Bank (CNB, 2012, p. 68), liquid assets comprise the following items: cash, receivables from central banks, receivables from credit institutions payable on demand and bonds issued by central banks and general government (including securities put into repos). A large enough buffer of liquid assets reduce the probability that liquidity demands threaten the viability of the bank. The higher the share of liquid assets in total assets, the higher the capacity to absorb liquidity shock is, given that market liquidity is the same for all banks in the sample.

The ratio L2 is the share of liquid assets in deposits and short term borrowing. This ratio is focused on the bank's sensitivity to selected types of funding (deposits of households, enterprises, banks and other financial institutions and funds from debt securities issued by the bank) so it should therefore capture the bank's vulnerability related to these funding sources. The higher is the value of the ratio, the higher is the capacity to absorb liquidity shock.

The ratio L3 is the share of liquid assets in deposits. It measures the liquidity of a bank assuming that the bank cannot borrow from other banks in case of liquidity need. The bank is able to meet its obligations in terms of funding if the value of this ratio is 100% or more. Lower value indicates a bank's increased sensitivity related to deposit withdrawals.

The ratio L4, which is the share of loans in total assets, indicates what percentage of the assets of the bank is tied up in illiquid loans. Therefore the higher this ratio the less liquid the bank is.

The higher the ratio L5 (which is the share of loans in deposits) the less liquid the bank is. Lower values of this ratio also means that loans provide by the bank are financed by clients' deposits.

The last ratio L6 assesses activity of banks in interbank markets. It is the share of net interbank position (due from banks minus due to banks) in total assets. Positive values of this ratio signals that bank is a net lender; the value is negative for net borrowers.

Stress testing plays an important role in risk management practices of banks. BIS (2000) defines stress testing as a generic term describing various techniques used by financial institutions to gauge their potential vulnerability to exceptional, extreme or simply unexpected but plausible events. The concept of stress testing should answer the question of "What would happen if market conditions suddenly change?" Stress tests are usually divided into two categories: sensitivity tests and scenario analysis. Sensitivity tests address the impact of shocks to single risk factors in each test. In scenario analysis, multiple risk factors change in a fashion which is intended to be internally consistent within a defined broader, underlying scenario (Swinburne, 2007). A sensitivity analysis employs a scenario that is restricted to the change of a single factor, ignoring possible interactions with other risk factors. In general, scenario analyses do not use sophisticated modeling but establish a straightforward link between the scenario and its impact (Boss *et al.*, 2007).

Van den End (2008) introduced a stress-testing model for liquidity risk of banks which takes into account the first and second round effects of shocks, induced by reactions of heterogeneous banks, and reputation effects. Banks' liquidity positions are modeled in three stages: after the first round effect of a scenario (where the shocks to market and funding liquidity risk factors lead to decrease in liquidity buffer), after the mitigating actions of the banks (where banks try to improve their liquidity by operations in the market which results in the improved liquidity buffer) and after the second round effects (where the reactions of banks cause the second round effects of the scenario[1] which again decreases the liquidity buffer). Van den End (2008) applied his model on data of all Dutch banks in July 2007 and investigated impact of banking crisis scenario on bank liquidity. On average, the first round effect erased 8% of the initial liquidity buffer (however, some small banks would be faced even with a negative liquidity buffer after the first round of the scenario). Reactions of some banks mitigated the first round effect to around 7% on average. Smaller banks tended to react relatively more than large banks which signaled that an outflow of deposits would foremost bring small banks in a critical liquidity position. Due to the second round effects banks lost additionally

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1   The second round effect includes the idiosyncratic risk of the reacting bank (it faces a reputational risk since it may be perceived to be in financial distress) and the systemic risk (collective reactions of banks may lead to wider disturbing effects in the banking sector or on financial markets).

6% of their initial liquidity buffers on average. 30% of banks have a probability that would end up with a liquidity shortage. Mostly this was problem of small banks which confirmed that small banks are most vulnerable to a banking crisis scenario.

Komárková *et al.* (2011) described the model which is used by Czech National Bank (CNB) for stress testing of both market and funding liquidity risk. The model follows the methodology of Van den End (2008) but there are some differences. They applied the CNB's model on data provided by banks operating in the Czech Republic in 2011 by the supervisory liquidity report. The liquidity shortfall is determined by deposit withdrawals on average to 11% of total deposits; drawdown of committed credit lines amounting to 10%; growth in the nominal stock of credit, liquidity dries up in the money market, as 50% of interbank claims are unavailable, 20% of other claims are unavailable; government bonds and other securities suffer a 40% loss in value; any asset liquidated prematurely suffers a 50% loss in value; 20% of assets previously eligible for central bank rediscounting become ineligible; no net additional intra-group funding is available; and no additional intra-bank funding or securities issuance is available. The results showed that the Czech banking sector as a whole seems to be stable and liquid enough. As the Czech banks stand more or less on a conservative business model and are not very active in the capital or money market, the impact of the first round shock was more significant than the second round. Most Czech banks have a sufficient liquidity buffer to be able to withstand a potential liquidity shock; however, a few banks were not able to cover a further liquidity needs.

Negrila (2010) tested how Romanian banks would react on the stress scenario which is characterized by following aspects: sudden drawing of 20% from deposits of individuals, 10% from deposits of corporate clients and 30% from interbank deposits; a lack of liquidity on the interbank market which would result in additional costs of financing; the decrease of 35% of the value of shares in bank trading portfolio; very low volume of treasury bills in banks' portfolio and increase in minimum level of liquidity required by Central Bank. As a result of this scenario, liquidity ratio would decrease by more than 50%. In order to fulfill liquidity requirements, banks would have to face losses ensuring additional liquidity.

Other studies are less complex and focus on sensitivity analysis: they measure the impact of selected scenario (or several different scenarios) on bank liquidity. Boss *et al.* (2004) did liquidity risk stress tests for the whole Austrian banking sector, for the aggregated sectors (joint stock banks, savings banks, Raiffeisen cooperatives and others) and for the sample of systematically important banks (which included 15 largest banks). Liquidity ratios were shocked by four scenarios: market value of bonds decreased by 10%, market value of equities decreased by 20%, other banks withdraw 20% of interbank deposits and nonbank customers withdraw 20% of their deposits. Austrian banking system was well equipped with liquid assets in 2004.

Boss *et al.* (2007) continued in sensitivity analysis in 2007, when they conducted four scenarios (decrease of liquid bonds by 25%, decline in equity prices by 35%, withdrawal of 40% of all interbank short-term funding, and withdrawal of 50% of nonbank deposits) and investigated its impact on different liquidity ratios of the six largest Austrian banks. Although the impact on all ratios was substantial, all banks remained liquid which highlights their solid liquidity.

Jurča and Rychtárik (2006) investigated liquidity risk sensitivity for banks in Slovakia in 2005. They consider three scenarios: depreciation of government bonds by 10%, decline in client deposits by 20% and outflow of short-term capital from the banking sector for external reasons (this scenario simulated the situation where investors decide to reduce substantially their positions in Slovak banks which would result in decline of deposits of non-resident banks by 90%). They measured impact of these scenarios on different liquidity ratios. They came to conclusion that the first scenario – the depreciation of government bonds – did not have a significant effect on banks. The scenario for a withdrawal of 20% of client deposits had the biggest effect on large and medium sized banks. The last scenario influenced mostly some medium sized banks but also banks which are bound to their own financial groups.

Rychtárik (2009) measured the liquidity risk sensitivity of 32 banks active in Luxembourg banking sector. The study used four scenarios: run on a bank (simulated by a 20% withdrawal of clients' deposits), use of 50% loan commitments by counterparties, netting of the positions with the parent financial group and changes in conditions of refinancing operations with the Eurosystem (simulated by the 5% decline of government bonds and 15% decline of all other debt securities). The impact of all scenarios was measured by relative changes of liquidity ratios. Half of the banks in the sample proved to be negatively exposed to the risk of bank run. One third of the banks were not able to refund a potential use of 50% of the committed credit lines. The impact of netting of the position with the parent financial group depended on the character of the activity with the parent undertaking. Since most of the banks are net liquidity providers, the general impact of this scenario was positive. The last scenario had only minor impact.

2.2 Scenarios

The process of creating of the scenarios has been influenced mainly by the fact that, unlike the authors of previously cited studies, we can use only publicly available data obtained from the annual reports of individual banks. Therefore, we are not able to model for example a 50% loss

in value of any asset liquidated prematurely or to model that 20% of assets previously eligible for central bank rediscounting become ineligible (such as Komárková *et al*., 2011). For these reasons, we focus on three situations which may lead to significant outflow of liquidity from banks. These stress situations occurred in some cited studies and we are able to model their impact. This is a run on a bank, accompanied by withdrawal of clients' deposits, a confidence crisis on the interbank market, accompanied by withdrawal of interbank deposits, and the use of loan commitments, associated with higher lending activity of banks.

Firstly, we will evaluate liquidity risk of each bank in the sample via six different liquidity ratios (*L1–L6*) to obtain values for the baseline scenario. Then we will stress these ratios in three scenarios to calculate their stress value. All three scenarios will be applied on all banks in the sample.

Scenario 1: Run on a Bank

First scenario models a run on a bank, accompanied by the withdrawal of a certain volume of clients' deposits. It is entirely logical that we have to choose properly the threshold value of the deposit withdrawal. Looking at studies cited above, different authors used different thresholds. The lowest deposit withdrawal (11% of total deposits) was simulated by Komárková *et al*. (2011). On the other hand, Boss *et al*. (2007) applied the largest haircut 40% of short-term deposits. The majority of studies (such as Negrila, 2010; Boss *et al*., 2004 or Jurča and Rychtárik, 2006) simulated withdrawal of 20% of deposits of non-bank customers. We will simulate a 20% withdrawal of deposits; this haircut is applied on total deposits. Such threshold is in accordance with the approach of most studies. In our opinion, this haircut adequately reflects the impact of a possible bank run.

To calculate $L1_{SC1}$, i.e. the stressed value of liquidity ratio *L1*, we simply deduct the volume of withdrawn deposits, i.e. 20% of clients' deposits, from both the liquid assets (which banks have to use to be able to repay deposits) and the total assets (which will decrease as a result of this operation). Similar calculations are made to stress the values of ratios *L2* and *L3*. In case of liquidity ratios *L4* and *L5*, we do not change the numerator, as the value of loans is not directly affected by the deposits withdrawals. The only change is in the value of total assets (*L4*) or clients' deposits (*L5*). Both of them are lower by 20%. The liquidity ratio *L6* is not influenced by the run on a bank.

Scenario 2: Confidence Crisis on the Interbank Market

Second scenario models confidence crisis on the interbank market which is accompanied by a certain volume of interbank deposits. Also this scenario is often use in empirical studies cited above. Again, it is necessary to choose properly the haircut. Two studies applied very high threshold: Komárková *et al*. (2011) simulated that 50% of interbank claims become unavailable, Boss *et al*. (2007) assumed that 50% of non-bank deposits will be withdrawn. Three studies use much lower haircut: 20% (Negrila, 2010; Boss *et al*., 2004 and Rychtárik, 2009). In accordance with the three last studies, we will simulate a withdrawal of 20% of interbank deposits. This means both the decrease of dues from banks and dues to banks. Such threshold should adequately capture the effects of a possible crisis confidence on the interbank market, without being excessively and implausibly strict. The volume of liquid assets remains the same: dues from banks convert to cash or similar liquid assets. To calculate the stress value of liquidity ratios, we deduct 20% of dues to banks from total assets and also from short term financing which influence the denominator of *L1*, *L2* and *L4*. The liquidity ratios *L3* and *L5* are not influenced by crisis of confidence on the interbank market. In case of liquidity ratio *L6*, both numerator and denominator must be changed.

Scenario 3: Use of Committed Loans

The last scenario focus on the banks' capacity to provide the loans they have committed in a previous period. This scenario has been used only by two authors. Rychtárik (2009) simulated a use of 50% of loan commitments. Komárková *et al*. (2011) modeled a drawdown of committed credit lines amounting to only 10%, but together with growth in the nominal stock of credit. Therefore, we can expect a higher increase in bank lending activity. However, as we do not have data about loan commitments for all banks in the sample, we will simulate a 5% increase of loans provided to nonbank clients – we assume that this liquidity outflow is enough to cover use of loan commitments, larger bank overdrafts and greater use of credit cards by customers in case of any crisis period. Moreover, this 5% increase of loans corresponds to 50% of loan commitments for banks for which we have data about loan commitments.

To calculate the stressed values of liquidity ratios, we simply increase loans by 5% and decrease liquid assets by 5% (we assume that liquid assets are used for providing more loans). This will change the calculation of ratios *L1–L5*. The liquidity ratio *L6* is not influenced by use of loan commitments by nonbank clients.

Impact of Scenarios on Bank Liquidity

Stress values of ratios will be compared to the baseline values. We will identify the most severe scenario for the Czech banking sector and the most vulnerable banks under all scenarios via the magnitude of the relative changes between the baseline and the stressed value. Following the methodology of Rychtárik (2009), in order to find which scenario is the most severe and which banks are most sensitive in terms of liquidity risk

we will calculate the change of the baseline value of each bank across all ratios in all scenarios (1):

$$R_i = \frac{(R_S - R_B)}{R_B} \times 100 (\%),$$ (1)

where R_i is a bank/ratio/scenario specific figure, R_S is the stress value and R_B is the baseline value of all ratios, in all scenarios for all banks in the sample.

2.3 Data

We used unconsolidated balance sheet data over the period from 2000 to 2011 which were obtained from annual reports of Czech banks. The panel is unbalanced as some of the banks do not report over the whole period of time. Tab. I shows more details about the sample.

The sample includes significant part of Czech banking sector. Nevertheless, the number of banks in the sample may appear to be quite low. Partly it is a consequence of growing role of branches of foreign banks in recent years, partly it is because we do not include data from building societies, mortgage banks and from specialized banks like Českomoravská záruční a rozvojová banka or Česká exportní banka which focus on very special financial products and services.

3 RESULTS AND DISCUSSION

3.1 Values of Liquidity Ratios for Each Scenario

The average values of liquidity ratio $L1$, both for baseline scenario and for all three stress scenarios, are presented in Fig. 1. It is evident that liquidity of Czech banks declined in 2000–2009. The decline of liquid assets has been caused mainly by decrease of balances with central banks and other banks (ČNB, 2008). However, we can see a slightly improvement of liquidity in last two years so the average liquidity position of Czech banks is better. This is caused mainly by higher portion of government securities held by banks (ČNB, 2012).

Stressed values of the ratio $L1$ significantly differs among individual scenarios. In average, banks would be able to face run on the bank (Scenario 1), accompanied by 20% withdrawal of deposits for the whole analyzed period (this is proved by positive average value of $L1_{SC1}$). Of course, individual banks could have problems with such deposit withdrawals in some years (particularly Česká spořitelna in 2006–2008, ČSOB in 2006–2010, GE Money Bank in 2007–2009, Raiffeisenbank in 2010–2011 and UniCredit Bank in 2009). Other banks would have enough liquidity to fund the required deposit withdrawals, even in crisis period.

Although it would generate a liquidity outflow and it would result in lower value of ratio $L1$, an increase in lending activity by 5% would not be a problem for any bank during the whole analyzed period (Scenario 3). The Scenario 2 (confidence crisis on the interbank market, accompanied by withdrawal of 20% of interbank deposits) would have even slightly positive impact on liquidity of Czech banks. This result is logical because Czech banking sector is a net lender on the interbank market (more about net interbank position also in Fig. 6).

Although baseline values of ratio $L2$ (which is the share of liquid assets in deposits and short

I: *Data availability*

Indicator	00	01	02	03	04	05	06	07	08	09	10	11
Total number of banks	40	38	37	35	35	36	37	37	37	39	41	44
No. of banks in sample	14	15	16	16	16	15	13	13	12	12	13	12
% share of observed banks on total assets	75	77	76	76	74	71	74	74	68	70	70	77

Source: Author's processing
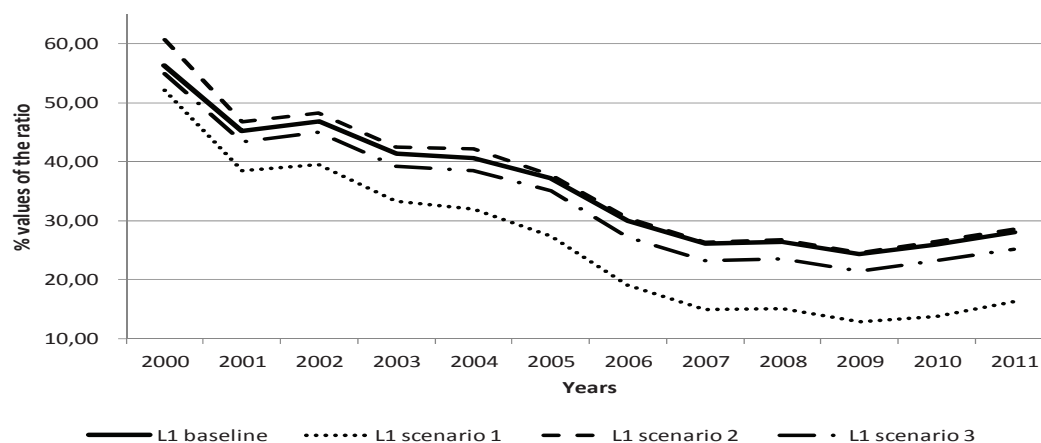
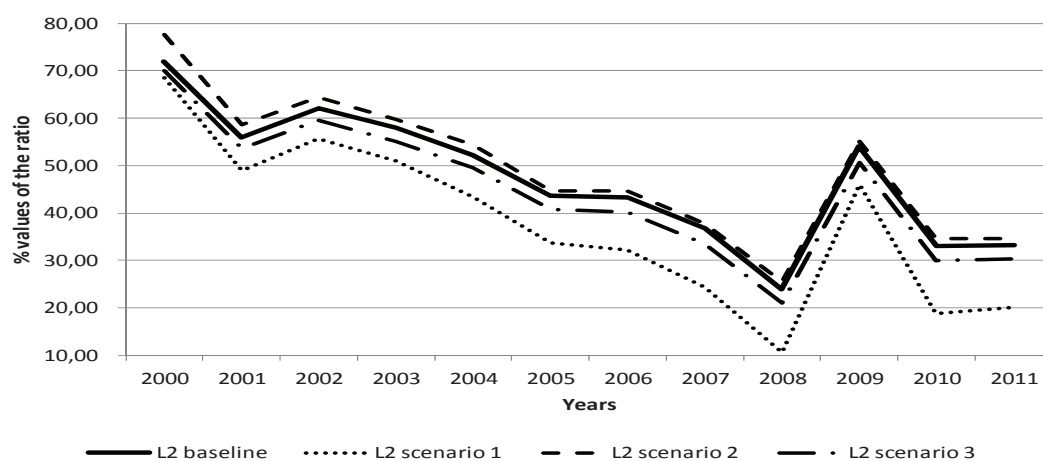1: *Liquidity ratio L1 under different scenarios*

term financing) differ significantly from baseline values of ratio *L1*, the trend is the same. Results confirm fall of liquidity of Czech banks and slightly improvement in last two analyzed years[2] (Fig. 2).

Also the impact of all stress scenarios is very similar: on average, depositors would be able to withdraw 20% of their deposits for the whole analyzed period (Scenario 1); banks would have enough liquidity to increase the volume of loans provided by 5% (Scenario 3) and the reduction of interbank transactions by 20% (both on asset and liability side) would slightly improve bank liquidity (Scenario 2).

As it was mentioned above, the liquidity ratio *L3* measures the liquidity of a bank assuming that the bank cannot borrow from other banks in case

of liquidity need. We can see that the trend of liquidity of Czech banks is similar to previous two indicators[3] (Fig. 3). The volume of liquid assets of the bank is high enough to cover volatile funding if the value of the ratio *L3* is higher than 100%. This was true only for some banks in some years[4]. These banks in other years and all other banks in the whole analyzed period are sensitive to potential massive deposit withdrawals (as we can see in all Figures in this section).

The impact of first stress scenario is very similar to impact on previous two ratios. Majority of banks would be able to pay to depositors 20% of their deposits (again with the exception of Česká spořitelna, ČSOB, GE Money Bank, Raiffeisenbank and UniCredit Bank in some years). Scenario 2 has

2: *Liquidity ratio L2 under different scenarios*
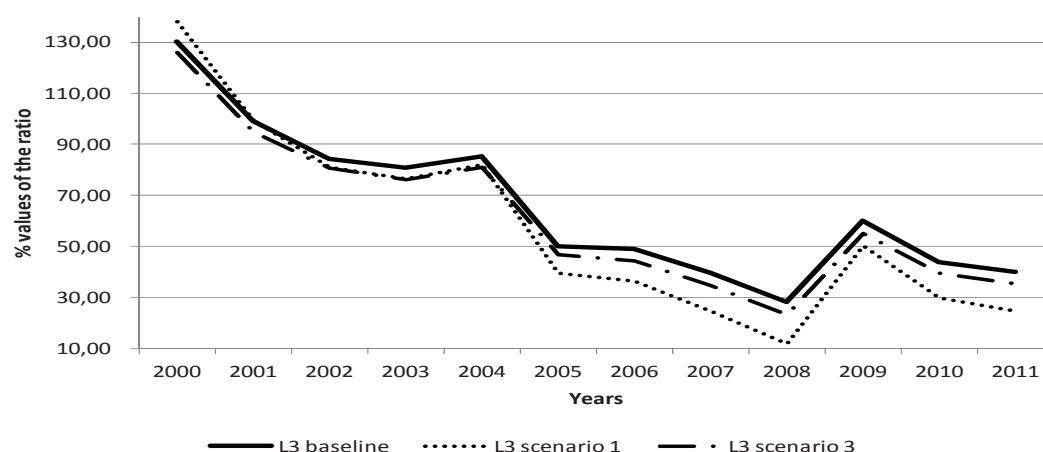
3: *Liquidity ratio L3 under different scenarios*

2   Very high value of this ratio in 2009, both for the baseline scenario and all stress scenarios, is caused by high value of liquid assets, accompanied by low value of deposits and short term financing of Evropsko-ruská banka, which resulted in extremely high value of this ratio in this year.
3   Value of the ratio in 2009 is again strongly influenced by the situation in Evropsko-ruská banka.
4   Calyon Bank Czech Republic in 2000–2004, Equa bank in 2002–2007, Dresdner bank in 2000–2001 and in 2004, eBanka in 2000–2002, Evropsko-ruská banka in 2009–2010, GE Money Bank in 2000–2001, J & T banka in 2000, LBBW BankCZ in 2000–2004, PPF banka in 2000–2001, Raiffeisenbank in 2000 and Živnostenská banka in 2000.

no impact on the value of the ratio *L3*. When it comes to Scenario 3, banks would be able to increase the volume of loans provided by 5% without any liquidity problems.

Values of liquidity ratio *L4* are presented in Fig. 4. As this ratio measures the share of illiquid loans in total assets, high value of this ratio means low liquidity. Increase in lending activity confirmed lower bank liquidity in 2000–2008. We can see that Czech banks were less willing to provide loans in 2010. The decline has been caused mainly by lower lending activity of large banks (ČNB, 2010); the increase in following years is mainly because of growing share of loans provided to households (ČNB, 2012).

Results for all three stress scenarios are homogenous: all of them would have negative impact on bank liquidity. The largest decline of bank liquidity would be again a result of run on banks (Scenario 1). Crisis confidence on interbank market (Scenario 3) would lower bank liquidity only slightly. In spite of liquidity outflow, banks would have no serious problem to refund a potential use of committed credit lines (Scenario 2).

Values of the liquidity ratio *L5* can be found in Fig. 5. Also in this case high value of this ratio means low liquidity. The huge fluctuation of values of this ratio is caused by development in a few banks (Calyon Bank Czech Republic, eBanka, Equa bank, Evropsko-ruská banka and LLBW Bank CZ). According to the median value of this ratio, the trend of development of bank liquidity is similar to previous indicators. Values of this loan-to-deposit ratio lower than 100% means that for the banking sector as a whole, lending activity is financed by clients' deposits. High value of *L5* (and thus high dependence on other sources of funding) reached mainly by LLBW Bank CZ, Raiffeisenbank and Volksbank which strongly rely on interbank market.

Scenario 2 has no impact on the value of the ratio *L5*. The largest decrease of bank liquidity would be again due to run on banks (Scenario 1) which would increase dependence of banks on other sources of financing (such as loans from other banks or funds from debt securities issuance). The impact of the use of committed loans (Scenario 3) would be very mild.
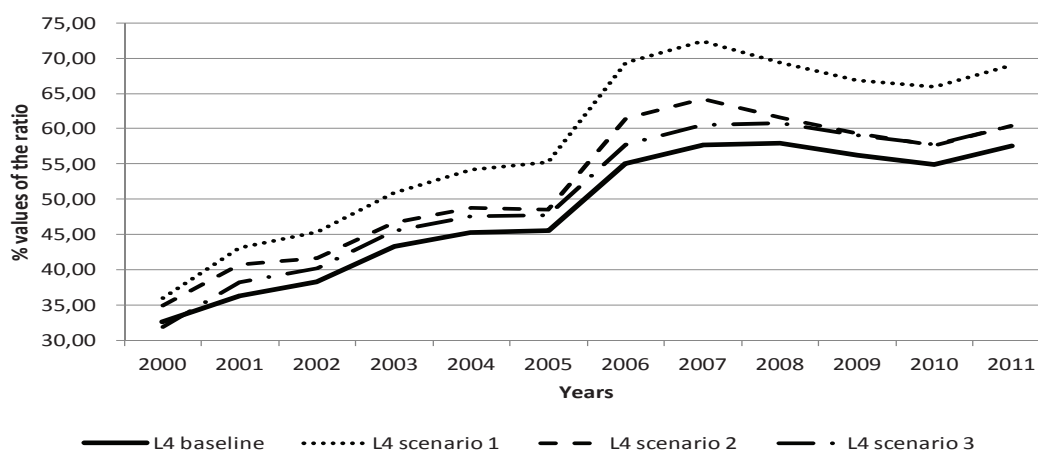
4: *Liquidity ratio L4 under different scenarios*
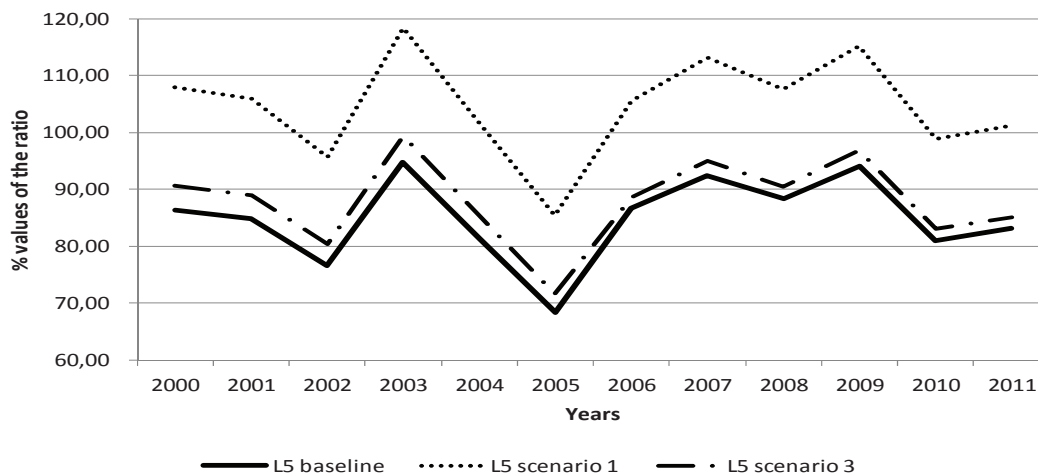
5: *Liquidity ratio L5 under different scenarios*
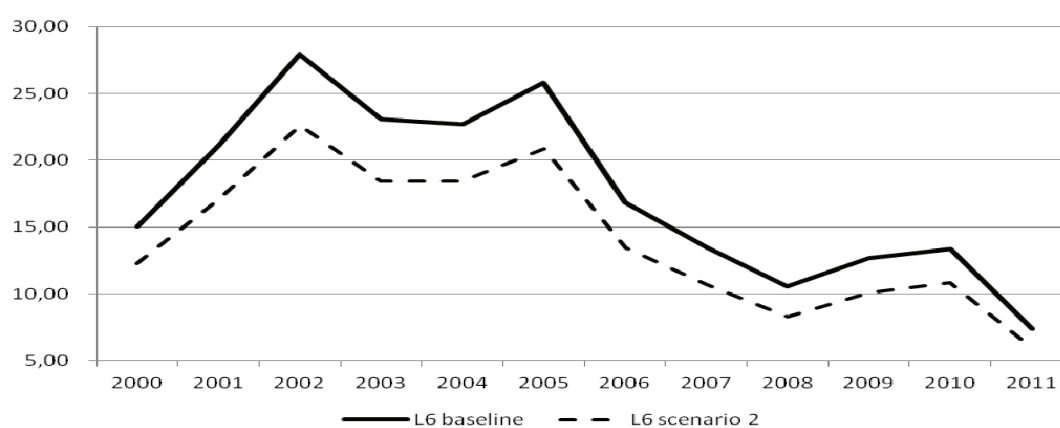
6: *Liquidity ratio L6 under different scenarios*

II: *Severity of scenarios (median values of R_i)*

	00	01	02	03	04	05	06	07	08	09	10	11
SC1	–6.2	–12	–16	–17	–18	–21	–25	–42	–57	–48	–49	–50
SC2	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	–0.1	0.01	0.02	0.02
SC3	–2.5	–5.3	–4.9	–5.3	–5.3	–7.7	–14	–22	–20	–15	–14	–11

III: *Descriptive statistics of percentage changes of ratios (R_i)*

	00	01	02	03	04	05	06	07	08	09	10	11
mean	–5.2	–7.0	–6.4	–8.8	–7.7	–11	–15	–21	–19	–16	–17	–15
median	–4.3	–6.2	–6.1	–5.6	–6.1	–11	–15	–22	–20	–15	–14	–14
minim.	–17	–17	–25	–46	–21	–28	–39	–51	–36	–36	–58	–36
maxim.	–0.4	–0.3	–0.5	–1.1	–2.4	–2.1	–1.4	–2.4	–0.2	–0.9	–3.4	–3.3
st.dev.	4.1	4.7	5.6	11	5.2	6.5	10	15	11	10	145	9.4

The last liquidity ratio *L6* is calculated as a share of net interbank position in total assets. It assesses activity of banks in interbank markets: the value is positive for net lenders and negative for net borrowers. As the average value of this ratio is positive for the whole analyzed period, it is evident that Czech banking sector as a whole is a net lender (Fig. 6). However, there are some banks which are net borrowers in the interbank market, such as LLBW Bank CZ, Raiffeisenbank and Volksbank.

The impact of Scenario 2 (confidence crisis on the interbank market) would slightly lower relative net position of the banking sector in the interbank market. This is logical as volume of dues from banks is greater than volume of dues to banks. However, the Czech banking sector would remain in the position of net lender. Two others scenarios have no direct impact on net interbank position.

3.2 Most Severe Scenario and Most Sensitive Banks

To assess the most severe scenario, we have calculated all R_i values. Then, in each scenario separately, we have calculated the median value of R_i for all ratios, for all banks. We can see the results

in Tab. II. Median values for individual banks in the sample can be found in Appendix.

It is evident that impact of each scenario differs. Scenario 1 (run on bank) would have the most serious impact. The negative influence of third scenario (use of committed loans) is less severe. The confidence crisis on the interbank market would not affect bank liquidity at all. The results also show that the severity of the impact of all scenarios worsens in periods of financial distress.

To identify the most sensitive banks, we have calculated the average R_i value for each bank across all ratios in all scenarios. The descriptive statistic of percentage changes of all ratios in all scenarios for each bank in the sample can be found in Tab. III. The negative values of the maximum indicate that as a result of stress scenarios, liquidity would decrease in all banks.

In case of Volksbank, UniCredit Bank and Raiffeisenbank, the impact of the liquidity shock lead to the average reduction of bank liquidity even up to 20% in 2011. The situation was similar for other large and medium sized banks. According to our findings, these two groups of banks are most vulnerable to liquidity shocks, mainly to massive deposit withdrawal. This is fully in line with conclusions of Jurča and Rychtárik (2006) for

Slovak banking sector in 2005. This finding also fully corresponds to the well known "too big to fail" hypothesis. If big banks are seeing themselves as "too big to fail", their motivation to hold liquid assets is limited. As we have found in our previous research (Vodová, 2012), liquidity of Czech banks decreases with size of the bank: small Czech banks hold buffer of liquid assets; on the contrary, large banks prefer strategies connected with the liability side of the balance sheet: they rely on the interbank market or on a liquidity assistance of the Lender of Last Resort. However, strategy of holding only minimum level of liquid assets could cause serious liquidity problems in periods of financial distress.

Appendix

Effects of stress scenarios on individual banks

Bank	00	01	02	03	04	05	06	07	08	09	10	11
Equa bank			–1.1	–1.1	–2.4	–2.1	–1.4	–2.7	–15	–14	–5.7	
Calyon Bank	–2.6	–4.1	–2.6	–4.2	–3.7							
Citibank	–4.7	–9.9	–6.1	–5.9	–4.8	–12	–8.4	–7.0				
Česká spořitelna	–1.9	–6.2	–6.0	–10	–12	–13	–18	–22	–20	–15	–11	–12
ČSOB	–2.4	–8.6	–4.4	–4.8	–6.1	–7.8	–15	–30	–22	–15	–21	–12
Dresdner Bank	–8.3	–8.7	–9.6	–7.1	–4.9							
eBanka	–0.4	–0.7	–0.5	–2.1	–6.0	–7.1	–5.7	–3.7				
Evropsko–ruská b.									0.0	–0.9	–3.4	–3.3
Fio banka											–4.8	–3.4
GE Money Bank	–1.1	–0.9	–3.5	–5.4	–9.1	–17	–24	–40	–36	–21	–16	–18
HVB Bank		–13	–11	–19	–21	–13						
J & T banka	–4.3	–12	–8.1	–3.8	–6.5	–15	–19	–21	–20	–10	–12	–9.7
Komerční banka	–2.8	–3.9	–2.8	–3.1	–3.2	–3.6	–5.2	–6.4	–10	–11	–14	–16
LBBW BankCZ	–7.2	–9.9	–7.1	–13	–5.5	–7.3	–11	–51	–21	–16	–19	–16
PPF banka	–7.1	–0.3	–1.9	–3.3	–3.5	–3.3	–3.6	–2.4	–1.7	–3.2	–4.1	–3.9
Raiffeisenbank	–8.1	–5.3	–6.9	–6.7	–7.4	–9.3	–17	–23	–20	–21	–58	–26
UniCredit Bank							–39	–35	–36	–36	–37	–36
Volksbank	–17	–17	–25	–46	–19	–28	–28	–31	–30	–33	–23	–21
Živnostenská banka	–4.2	–4.9	–6.2	–5.9	–8.5	–15						

Source: author's calculations

SUMMARY

The aim of this paper was to measure the liquidity risk sensitivity of Czech commercial banks and to find out the most severe scenario and the most vulnerable banks. We have evaluated liquidity positions of Czech banks via six different liquidity ratios in the period from 2000 to 2011. Liquidity of Czech banks declined in 2000–2009 (partly due to higher lending activity, partly due to the financial crisis) but it has improved in last two years. Most Czech banks finance their lending activity from clients' deposits. According to values of the share of liquid assets in deposits, almost all Czech banks are sensitive to potential massive deposit withdrawals (this fact has been proved also by application of stress scenario). Czech banking sector as a whole is a net lender on the interbank market during the whole analysed period.

Then we stressed these ratios in three different scenarios: run on a bank, confidence crisis on the interbank market, and use of committed loans by counterparties. The impact of modelled liquidity shocks differs among scenarios. The most serious liquidity problems would be caused by the first scenario – run on a bank. The negative influence of third scenario (use of committed loans) is less severe. The confidence crisis on the interbank market would not affect bank liquidity at all. The results also show that the severity of the impact of all scenarios worsens in periods of financial distress.

We have also found that large and medium sized banks are most vulnerable to liquidity shocks, mainly to massive deposit withdrawals. This fully corresponds to conclusions of Jurča and Rychtárik (2006) for Slovak banking sector in 2005 and also to "too big to fail" hypothesis. Strategy of holding only minimum level of liquid assets could cause serious liquidity problems in periods of financial distress.

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