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Systemic Liquidity Shocks and Banking Sector Liquidity Characteristics on the Eve of Liquidity Coverage Ratio Application - The Case of the Czech Republic[1]

Abstract: The paper contains an analysis of the economic and regulatory concept of bank liquidity in the context of systemic liquidity shock. A formal model analysis shows that the application of liquidity coverage ratio (LCR) based on Basel III will lead to a significant adaptation of banks liquidity management. LCR causes a change in bank´s liquidity allocation and funding to be less effective and more costly and restrictive for providing credits comparing with economic determinants. It is demonstrated that the application of LCR underestimates actual liquidity position of a bank and leads to allocation ineffectiveness. The empirical part contains simulation of impacts of systemic liquidity shock on the banking sector´s ability to withstand the unfavourable credit shock while solvency is maintained. The results confirm the robustness of the Czech banking system ensuing from the systemic surplus of liquidity, high volume of bank capital and its high profitability. The estimations of the VAR model show that the relations between liquidity characteristics of banks, sources of aggregate liquidity shock, interbank market illiquidity and the credit facilities of the Czech National Bank are relatively weak, supporting the conclusion that the banks face liquidity shocks of non-persistent character.

Keywords: LCR, Basel III, liquidity management

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1. Introduction

Taking into account the character of liquidity risk, its regulation is predetermined for the application of qualitative requirements. The formulated standards are historically based on respect to the best practices of banks and the application of regulation prefer the qualitative form of requirements that allows banks to use their unique risk profile. The global financial crisis resulted in an increase of refinancing risk and decrease of market liquidity that prevented the fast liquidation of positions and limited the access of banks to liquidity due to the realization of systemic liquidity shocks. It also indicated that a lot of banks were operating with a high leverage for a long time and financed their activities by resources that appeared unstable and relatively costly at critical moments (FRBNY, 2014; IMF, 2013). It has turned out at the same time that the realization of credit portfolio losses is closely related with bank liquidity in the long run. Subsequently, in the Basel III Accord, regulatory requirements were complemented by quantitative standards. As a part of this process, the liquidity coverage ratio (LCR) is being implemented as an indicator that measures resistance to a sudden stress situation in a 30-day horizon. Its general application should reduce both the risk of bank illiquidity and insolvency on a micro level and to strengthen financial stability on a macro level.

The present article contains an analysis of the economic and regulatory concept of bank liquidity management in the context of bank solvency in a situation of systemic liquidity shock realization. Liquidity shock may take the form of an individual shock affecting a specific bank, or a systemic shock resulting from the outflow of the banking system reserves with central bank (CB), i.e. a shock connected with the liquidity outflow of the whole banking system. The systemic liquidity shock can be understood as the range of depositors´ rush to currency in circulation (traditional bank run) or the outflow of home currency liquidity to a foreign currency evoking the strong domestic currency depreciation. An emphasis is laid on problems with LCR application while bank funding, liquidity allocation and response of banks to systemic liquidity outflow are accentuated. The empirical part comprises a simulation of the extent of capital losses of the Czech banking sector facing a systemic liquidity shock and an estimation of dynamic properties of liquidity characteristics of the banking system in response to systemic liquidity shock and shock in liquidity of the interbank market. The objective is to estimate the robustness level of the Czech banking system before the application of Basel III regulatory liquidity rules.

2. Unexpected shock in systemic liquidity of the banking system and variability in O/N interest rates

An unexpected shock in systemic liquidity of the banking system is caused by a difference between the level of demand for liquidity by the banking system as expected by CB and its actual level for a given trade day. The shock defined in this way assumes that the supply of CB's liquidity is fully adapted to the autonomous factors of demand for liquidity, i.e. the unexpected shock in the banking system liquidity corresponds to a difference between the expected and actual volume of autonomous factors. The liquidity supply (L_S) corresponds to the main items on the assets side of CB's balance sheet, i.e. foreign exchange reserves (FR), credit facilities (CF), securities held on outright ($SEC_{OUTRIGHT}$) and reverse repo ($SEC_{REVREPO}$) basis, securities held as collateral for lending facility (SEC_{LF}). Liquidity use (L_U) corresponds to the main items on the liability side of CB's balance sheet as minimum reserves (MR), excess reserves (ER), currency in circulation (CUR), government deposits (D_{GOV}), liquidity deposited with CB through outright operations with securities ($D_{OUTRIGHT}$), repo operations (D_{REPO}) and deposit facility (D_{DF}). Liquidity use involves demand of banks for liquidity (L_D) and liquidity sterilization. These basic relations hold good:

$$L_S = FR + CF + SEC_{OUTRIGHT} + SEC_{REVREPO} + SEC_{LF} \quad (1)$$

$$L_U = L_D + \text{liquidity sterilization} = MR + ER + CUR + D_{GOV} + D_{OUTRIGHT} + D_{REPO} + D_{DF}, \quad (2)$$

where $L_D = MR + ER + CUR + D_{GOV}$ and liquidity sterilization = $D_{OUTRIGHT} + D_{REPO} + D_{DF}$. As a lending facility is typically available automatically while volume is limited by disposable collateral only, net liquidity sterilization could be defined as:

$$\text{net liquidity sterilization} = D_{OUTRIGHT} + D_{REPO} + (D_{DF} - SEC_{LF}), \quad (3)$$

where $(D_{DF} - SEC_{LF})$ is net usage of automatic liquidity facilities.

Systemic liquidity shock affects both systemic liquidity positions of the banking sector and actual changes in the volume of sterilized liquidity. The systemic liquidity surplus (deficit) of the banking sector is defined as disequilibrium between the supply of CB liquidity on the basis of outright purchased instruments (FR and $SEC_{OUTRIGHT}$) and the banking sector demand for liquidity where long-term sources of CB liquidity are bigger (smaller) than demanded liquidity:

$$FR + SEC_{OUTRIGHT} >(<) MR + ER + CUR + D_{GOV}, \quad (4)$$

Unexpected shock in the banking system liquidity also causes a daily change in the short-term net liquidity position of the banking system vis-à-vis the CB that is reflected in a change in the net volume of sterilized liquidity:

$$\Delta \text{ net liquidity sterilization} = (\Delta FR + \Delta CF + \Delta SEC_{OUTRIGHT} + \Delta SEC_{REVREPO}) - (\Delta MR + \Delta ER + \Delta CUR + \Delta D_{GOV}) = \Delta D_{OUTRIGHT} + \Delta D_{REPO} + (\Delta D_{DF} - \Delta SEC_{LF}) \quad (5)$$

Equation (5) shows that systemic liquidity shock as a difference between new available liquidity on the basis of outright operations and CB´s liquidity facilities ($\Delta FR + \Delta SEC_{OUTRIGHT} + \Delta CF + \Delta SEC_{REVREPO}$) and banks liquidity demand is saturated through a lending facility and change in sterilized liquidity. Drawing on the CB liquidity facilities ($\Delta CF + \Delta SEC_{REVREPO} + \Delta SEC_{LF}$) is connected with either systemic liquidity deficit of banking system or uneven liquidity distribution among banks in case of money market freezes as the CB facilitates the liquidity flows among banks - it sterilizes the liquidity from banks with liquidity surplus and provides within the available collateral an unlimited supply of liquidity to banks with liquidity deficit.

Standard practice of day by day liquidity management in the banking system relies on the fact that liquidity supply by CB is partly endogenous and it is adapted to changes in autonomous demand of banks for liquidity (CUR + DGOV, in some cases excess reserves are added as it corresponds to rise in liquidity demand in time of financial stress). However, within a tender for liquidity supply/withdrawal the equilibrium cannot be expected automatically because CBs do not have an exact notion of the volume of liquidity demanded by banks within this tender and of the extent of subsequent autonomous changes in liquidity during the day. In general, banks liquidity demand may be larger or smaller than the actual minimum reserve and therefore their demand for excess reserves may be both positive and negative, depending on how costly is the CB liquidity financing for bank on a given day in comparison with funds available in the interbank market. On the other hand, the banking system liquidity is affected during the day by unexpected changes in autonomous factors such as changes in currency in circulation and changes in government deposits that influence the volume of available liquidity in the market in the meantime from the termination of a tender for liquidity supply/withdrawal (typically managed in morning times) to the moment when banks can use an automatic facility (typically after trading day is closed). Last but not least, it is to note that while the CB is ready to fully absorb expected movements of the volume of currency in circulation and government deposits, the flexibility vis-à-vis the bank demand for excess reserves may be significantly lower and/or can react only under specific circumstances of increased demand for liquidity (such as end of the holding period, freezing of the interbank market).

Based on these assumptions we define unexpected systemic shock in the banking system liquidity as the situation of an unexpected change in the volume of net sterilized liquidity caused on the one hand by CB's error in the estimation of the magnitude of a change in bank demand for liquidity (both within the tender for liquidity supply/withdrawal and further during the day) and on the other hand by the surprise of banks resulting from CB's imperfectly endogenous supply with respect to their demand for excess reserves. In the paper we consider macro sources of liquidity shocks as traditional banking run and flight of capital to foreign currency and liquidity shocks coming from micro level linked to individual bank´s customers demand for currency in circulation, individual bank strategies for minimum reserve requirements and impact of net flows of government expenditures on individual bank.

3. Model simulation of an economic and regulatory approach to bank liquidity facing a liquidity shocks

A methodical approach to the formulation of our model is based on Eisenbach, Keister, McAndrews & Yorulmazer (2014), where the conditionality of the relation between bank solvency and liquidity is solved. Their approach anticipates changes in bank liquidity regulation according to Basel III but the simulation of bank liquidity management at the application of new regulatory rules is not their primary concern. They focused on determining the rate of return on risky assets of a bank that will ensure the fulfilment of a solvency condition under different scenarios of liquidity conditions (liquidity outflow, leverage effect, structure of funding). Our model approach attempts to analyse factors influencing the conditionality of bank liquidity and solvency in both economic and new Basel III regulatory terms.

3.1. Economic view on liquidity shocks and sustainability of banking business

In our model we work with a simplified form of bank balance sheet (the balance is normalized as 1) – on the asset side there are liquid assets (*m*) with average rate of return r_m and nonliquid assets (y) with average rate of return r_y. A difference between liquid and nonliquid assets is in the costs of asset sale τ ($\tau \geq 1$) in case of liquidity outflow from the bank (τ_m and τ_y express the yield from liquid and nonliquid asset, respectively, whose yield is 1 when held to maturity, at the sale prior to maturity). Nonliquid assets are assets characterized by high τ, and therefore at liquidity outflow they are sold as the last (credits). It holds good that

$\tau_m < \tau_y$, while under normal conditions in the money market τ_m is close to one. On the liability side of the balance sheet there is bank capital (*e*), long-term resources (*l*) with average rate of return r_l and short-term resources (*s*) with average rate of return r_s. Bank assets and liabilities are reported in line with effective rules in market, nominal or otherwise determined value. The model enables to identify the impacts of repricing assets/liabilities at the realization of credit/market risk. The bank is considered as an economic agent without linkages typical of supranational holding structures and so a potential cross-border liquidity sharing within a bank group is not solved. The model does not include the ability of a bank to generate liquidity in the form of charges and commissions, which is in accordance with the concept of bank liquidity regulation according to Basel III.

A necessary but not sufficient condition of bank solvency is to meet the relations of returns on assets and liabilities and to cover the costs of liquidity outflow. It is assumed that the rate of return on nonliquid assets is higher than that on liquid assets ($r_y > r_m$), that the costs of funding with short-term funds are lower than with long-term funds ($r_s < r_l$), that the bank works with positive interest margin ($r_y + r_m > r_s + r_l$) and that the costs of the nonliquid asset sale are higher than the loss of the return on liquid and nonliquid assets at sale ($\tau > r_y$ and r_m, respectively).

From an economic aspect, the long-term bank liquidity is understood in the sense of bank solvency, hence like such a minimum rate of return on nonliquid assets $\overline{r_y}$ that will provide for the ongoing payment of bank liabilities at liquidity outflow of α for any *t*. Bank solvency and liquidity are mutually conditioned situations within which it is not defined whether the potential insolvency of a bank temporally precedes bank nonliquidity or vice versa (conditionality of credit and liquidity risk in relation to default probability see Imbierowicz & Rauch, 2014). The solvency of a bank for *t+1* is satisfied in the model if $e_{t+1} > 0$ and it holds good that (modification of Eisenbach, Keister, McAndrews & Yorulmazer, 2014):

$$r_y > \bar{r}_y = \frac{sr_s + lr_l - mr_m + \alpha s\,(\frac{r_m}{\tau_m} - r_s)}{y} \quad \text{for } s.\ \alpha \le m \tag{6}$$

$$r_y > \bar{r}_y = \frac{(1-\alpha)sr_s + lr_l - mr_m\,(1 - \frac{1}{\tau_m})}{y - \frac{s\alpha - m}{\tau_y}} \quad \text{for } s.\ \alpha > m \tag{7}$$

The rate of return on nonliquid assets according to condition (1) or (2) is an increasing function of the level of their risk, so from an economic aspect the liquidity of a bank is directly related with the credit and market risk of a bank (see Morris & Shin, 2009). The authors distinguish between conditioned solvency and solvency of a bank when conditioned solvency is such r_y that provides for the solvency of a bank for liquidity outflow α, but not necessarily for $\alpha \rightarrow 1$, while solvency is ensured at r_y for which the bank is solvent even at the complete outflow of liquidity ($\alpha = 1$). It holds good that r_y providing for conditioned solvency increases with the growth of liquidity shock because it brings about the costs of the sale of nonliquid assets and a decrease in bank returns. The value of r_y also increases when the banks prefer long-term financial resources at the cost of short-term resources, which decreases the refinancing risk, but because $r_l > r_s$, the costs of bank funding increase. Due to higher costs and decreasing yield from total assets the value of r_y also increases in case that the bank increases the volume of liquid assets at the cost of nonliquid assets. But this conclusion is valid only if it is ineffective to hold liquidity, i.e. when the bank works with a low capital volume and a high portion of more costly long-term resources. Otherwise, a higher volume of liquid assets diminishes the need of selling nonliquid assets at liquidity outflow at the lower costs of bank funding (the experience with liquidity management in the event of a shock; see ECB, 2009).

3.2. Liquidity shocks and regulation of liquidity in the form of liquidity coverage ratio according the Basel III

The Basel III regulatory approach (BCBS, 2013a; EC, 2013a; EC, 2013b) perceives both credit and liquidity risks as highly relevant. The attitude of regulators to liquidity risk followed the real experience of banks at liquidity management in the situation of massive liquidity shocks. In the pre-crisis period they accentuated solvency risk represented by capital adequacy, in response to the crisis they concentrated on liquidity rules and started being aware of the mutual relation of liquidity risk with credit and systemic risk (IMF, 2010). It has resulted in changes in the area of bank liquidity regulation connected with the application of *LCR*.

Setting a system of limits including total acceptable risk exposure and internally determined capital and liquidity reserves for risk limitation is a part of strategic decisions while these processes should be independent of the business activities as a consequence of which the bank is exposed to credit or market risk. Among strategic decisions there are requirements for the structure of assets, liabilities and off-balance sheet items. Principles of liquidity risk management including time horizons for its management, methods of liquidity management incl. stress tests, setting an acceptable risk exposure and rules for the case of liquidity crisis are also a part of strategy. The banks should introduce and observe the principles and procedures for the ongoing and prospective measurement and management of liquidity position and monitor it on a daily basis.

LCR is basically a stress test of liquidity that should be continually respected by banks. They should have at their disposal at least 100% coverage of net liquidity outflow for a 30-day period by means of high-quality, liquid and unpledged market-priced assets. It is based on a logic that short-term and uninsured deposits are attributed the highest rate of outflow while short-term receivables are attributed the lowest reduction of inflow. The net liquidity outflow also originates when the liquidity inflow can be included only to a maximum level of 75% of the outflow. The encumbrance can be decreased by preference of stable resources with longer maturity and receivables with shorter maturity. The creation of liquidity reserve in the form of unencumbered high-quality assets will help the bank to overcome discordance in net liquidity outflow. It could be expected that the existence of a group of such eligible assets will lead to an increase in demand for these assets, increase in secured transactions in the money market, by preferring operations with CB to operations in the unsecured interbank market. The reserve of eligible assets is divided into two levels (Level 1, Level 2A and Level 2B) when Level 1 comprises the highest-quality assets such as cash, reserves with CB, tradable securities, which represent receivables or claims secured by the government and CB, with no limit on volume. Level 2 assets of lower quality may account for 40% of the total eligible assets while Level 2B assets should not account for more than 15% of the total volume of eligible assets. The calibration of quantitative parameters of liquidity measurement is in the monitoring and fine-tuning phase (BCBS, 2013b). The fulfilment of LCR is to be phased, in 2015 the reserve of high-quality assets should cover 60% of the net liquidity outflow and the fulfilment of the final requirement is set to January 2019.

The application of *LCR* follows a regulatory framework of liquidity risk based on Basel II (BCBS, 2004) where scope and character of liquidity requirements were formulated in qualitative and not quantitative form. Banks had to divide their assets, liabilities and off-balance sheet liabilities according to currency and maturity date, in deposits they had to estimate their renewal and behaviour of sight deposits. They were also obliged to monitor the degree of asset liquidity to cover liquidity outflow, a possibility of their fast conversion to liquidity with the CB, fast marketability at a price proportional to their market price and a possibility of decreasing the value of assets simultaneously with a decrease in respective liabilities.

After the onset of the global financial crisis Basel II showed some shortcomings of requirements for the calculation of capital adequacy that had a negative impact on liquidity risk management. The capital adequacy arrangement motivated to undertake inadequate risky activities by setting up disproportionately low risk weights (typically for receivables of banks from governments or receivables secured by governments and for residential real estate in capital requirement for the credit risk of investment portfolio). The preference of assets with low risk weight allowed a significant use of leverage that increased the bank liquidity risk. The regulation was not aimed at the growth of total assets, but it was concentrated on the monitoring of risk-weighted assets, which led to a decrease in the capital share in the liabilities of banks with an overreach to the risk of bank insolvency. Compared to the Basel III proposal, the Basel II required a lower-quality and less transparent structure of regulatory capital. It resulted in the limited ability of banks to rapidly cover unexpected losses incurred and to face the liquidity outflow. No such a situation was solved when under the threat of liquidity risk materialization the bank did not need regulatory capital but liquidity that might be obtained by a rapid sale of liquid assets correctly evaluated from the aspect of credit risk.

The regulatory concept of bank liquidity expects the ability of a bank to comply with regulatory rules while this requirement is only loosely related with the economic concept of liquidity explained above, so different requirements of liquidity may be imposed on banks. According to Basel III, *LCR* is defined as the ratio of high-quality liquid assets (*HQLA*) and net liquidity outflow in a 30-day horizon that should be higher than 100% (BIS, 2013):

$$LCR = \frac{HQLA}{net\ \ cas\ \ outflow_{\ 30\,dní}} \geq 1 \tag{8}$$

With regard to equations (1) and (2), the regulator lays down the volume of necessary liquid assets m_R at the regulatorily specified net liquidity outflow α_R^{30}. Hence we can write:

$$LCR = \frac{m_R}{\propto_R^{30}} = \frac{\sum_{i=1}^{OST} m_{R,i}\,(1-H_i)}{\propto_R^{30}} \geq 1 \qquad \text{for } \propto_R > 0 \tag{9}$$

$$\propto_R^{30} = \sum_{k=1}^{K} s_k^{30} r_{s,k} RR_k - \left(\sum_{i=1}^{I} m_i^{30} r_{m,i} IR_i + \sum_{j=1}^{J} y_j^{30} r_{y,j} IR_j\right) \tag{10}$$

where H_i is the *haircut* which is applied to a liquid asset m_{i} of the *i*-th class evaluated in market value (H_1 = 0%, H_{2A} = 15%, H_{2B} = 25% or 50% and H_{OST} = 100%), IR_i and IR_j express the *inflow rate* of liquid and nonliquid assets of a bank with maturity within 30 days in which no default of the asset is assumed (*IR* = 0%, 15%, 25%, 50% and 100%), RR_k is the *run-off rate* of short-term resources s_k with maturity within 30 days (RR_k = 0-100% according to the type of *s*) and *L*, *J* and *K* represent type of liquid and nonliquid assets and short-term resources with 30-day maturity.

Restrictive conditions defining the structure of liquid assets of class 1, 2A and 2B should be satisfied [it holds good that $m_R = m_1 + m_{2A}(1\text{-}H_{2A}) + m_{2B}(1\text{-}H_{2B}) + m_{OST}(1\text{-}H_{OST})$]

$$\frac{m_{2A}(1-H_{2A})+m_{2B}(1-H_{2B})}{m_1 + m_{2A}(1-H_{2A})+m_{2B}(1-H_{2B})+m_{\text{ost}}\ (1-H_{\text{ost}})} \leq 0{,}4 \tag{11}$$

$$\frac{m_{2B}(1-H_{2B})}{m_1 + m_{2A}(1-H_{2A})+m_{2B}(1-H_{2B})+m_{\text{ost}}\ (1-H_{\text{ost}})} \leq 0{,}15 \tag{12}$$

as well as the coverage of liquidity outflow by liquidity inflow and highly liquid assets:

$$\frac{\sum_{i=1}^{I} m_i^{30} r_{m,i}\, IR_i + \sum_{j=1}^{J} y_j^{30} r_{y,j} IR_j}{\sum_{k=1}^{K} s_k^{30} r_{s,k} RR_k} \leq 0{,}75 \tag{13}$$

$$\frac{\sum_{i=1}^{OST} m_{R,i}(1-H_i)}{\sum_{k=1}^{K} s_k^{30} RR_k} \geq 0{,}25 \tag{14}$$

The continual sustainment of bank liquidity according to *LCR* is defined as the situation when the rate of return on nonliquid assets *t+30* days satisfies the condition:

$$r_y \geq \hat{r}_y = \frac{\sum_{k=1}^{K} s_k^{30} r_{s,k}\ RR_k - [\sum_{i=1}^{I} m_i^{30} r_{m,i}\, IR_i + \sum_{i=1}^{OST} m_{R,i}(1-H_i)]}{\sum_{j=1}^{J} y_j^{30} IR_j} \tag{15}$$

where $\overline{r_y}$ is the threshold rate of return for $\sum_{k=1}^{k} s_k^{30} r_{s,k}\ RR_k > (\sum_{i=1}^{I} m_i^{30} r_{m,i}\ IR_i + \sum_{j=1}^{J} y_j^{30} r_{y,j} IR_j)$ at simultaneous satisfaction of restrictive conditions (6) to (9).

3.3. Economic and regulatory liquidity requirements in case of realization of liquidity shock – are there any differences in marginal rate of technical substitutions?

A comparison of both approaches shows that the economic concept of bank liquidity maintains the intertemporal consistency of key stock and flow variables in the long run when liquidity flows are combined with undertaken credit and market risk and net asset value. The regulatory approach provides a view aimed only at actual regulatorily defined net liquidity flows and liquid assets while the relation with credit and market risk of a bank is evident only at the liquidity realization from bank's risky assets. Such approach does not take into account a potential future decrease in the volume of liquid assets at a lower market price due to fire sales, a decrease in liquidity inflow at credit portfolio impairment and an increase in liquidity outflow at more difficult refinancing of long-term funds. The *LCR* concept makes it possible to evaluate the bank at time *t* as liquid even in the situation of its factual insolvency and future illiquidity. In the economic concept the credit and market risk undertaken by the bank is purposefully managed through the portfolio of assets *m* and *y* and their rates of return r_m and r_y while in the regulatory liquidity concept the credit and market risk is an ex-post shock independent of the bank without a possibility of influencing the volume of collected liquidity from assets *m* and *y* in a 30-day period. It is to assume that the bank's *LCR* may largely fluctuate according to the actual regulatorily calculated net liquidity outflow and that the bank will have to adjust the portfolio of liquid assets m_R (at the given realized liquidity from m^{30} and y^{30}), which can initiate shocks in the money market at dynamic optimization of held liquidity.

There is an obvious difference in bank's flexibility at liquidity management. While in the economic concept the bank considers in a complex way liquidity sources and use, ratio of liquid and nonliquid assets and funding structure with regard to their availability, price and transaction costs, the *LCR* regulatory approach is restrictive in this aspect and causes changes in bank´s behaviour (for differences in the regulation on the basis of indicative rules and quantitative limits see Mandel & Tomšík, 2011). *LCR* factually underestimates the bank's liquidity situation, which forces the bank to hold higher liquidity within the expected extent of liquidity shock. The restriction is based on the strict regulatory definition of liquid asset m_R, liquidity sources m_i^{30}, liquidity use s_k^{30}, on the application of *haircuts*, *inflow rate* and *run-off rate* and restrictive conditions (6)-(9). Through a low *inflow rate* the bank underestimates liquidity inflow (i.e. $\sum_{i=1}^{I} m_i^{30} r_{m,i} IR_i + \sum_{j=1}^{J} y_j^{30} r_{y,j} IR_j < m^{30} r_m + y^{30} r_y$) because the regulatory rules allow the bank to include only liquidity inflow from unclassified credits, the bank should reckon with the credit portfolio growth corresponding to a significant portion of the liquidity obtained from credits payable; the negotiated credit facilities and CB facilities cannot be included in liquidity inflow, and to avoid the liquidity shock transmission it is reckoned with a high level of reinvestment of the bank's positions in the repo market. Due to the high *run-off rate* the bank has to work with overestimated liquidity outflow (i.e. $\sum_{k=1}^{K} s_k^{30} r_{s,k} RR_k > \alpha s^{30}$), when the regulator does not take into account the nonstationary character of deposits in the banking system, they can apply a relatively high outflow rate of (un)insured deposits, penalize the funding of a bank in the unsecured market and overestimate the outflow of resources secured by assets worse than Level 1. The resultant overestimation of net liquidity outflow is covered by regulatorily defined liquid assets, the volume of which is underestimated against their economic value due to the application of high haircut (i.e. $\sum_{i=1}^{OST} m_{R,i}(1-H_i) < m\frac{r_m}{\tau_m}$), which strongly underestimates the real volume of bank assets whose market does not reach the liquidity of assets like cash, reserves with CB and government bonds.

The application of *LCR* forces the bank to do economically suboptimum reallocation of asset portfolio and to change the funding structure in the sense of market, instrument type, term structure and credit risk. This factor is obvious when the bank faces liquidity outflow and has to acquire other financial resources. The marginal rate of technical substitution (*MRTS*) is introduced into our economic model, indicating the ratio of resource substitution at liquidity outflow *ds* while the credit risk of the nonliquid asset portfolio is maintained (i.e. for $\Delta \overline{r_y} = 0$):

$$MRTS = \frac{dl}{ds} = \frac{MR_{y,l}}{MR_{y,s}} = \frac{r_s + \alpha(\frac{r_m}{\tau_m} - r_s)}{r_l} \qquad \text{for } s.\ \alpha \leq m \tag{16}$$

$$MRTS = \frac{dl}{ds} = \frac{MR_{y,l}}{MR_{y,s}} = \frac{\frac{r_s(1-\alpha)}{\tau_y}(\tau_y y + m) + \frac{\alpha}{\tau_y}[l r_l - m r_m(1 - \frac{l}{\tau_m})]}{(y - \frac{s\alpha - m}{\tau_y})(r_l + \frac{m r_m}{\tau_m})} \quad \text{for } s.\ \alpha > m \tag{17}$$

where $MR_{y,l} = \frac{\delta \overline{r_y}}{\delta l}$ and $MR_{y,s} = \frac{\delta \overline{r_y}}{\delta s}$ is the marginal rate of return on nonliquid assets in relation to a change in the volume of long-term and short-term resources, respectively. Equation (11) indicates that the substitution of resources is a matter of their relative price, liquidity outflow extent, rate of return on liquid assets and transaction costs at their sale if the liquidity outflow does not exceed the volume of liquid assets. In case that the liquidity outflow is higher than the volume of liquid assets, the bank's decision according to (12) is also influenced by transaction costs of the sale of nonliquid assets (the relation between restriction on the side of resources and imbalanced assessment of assets see Brunnermeier & Pedersen, 2007).

A bank facing the regulatorily defined liquidity shock takes decisions with respect to the *LCR* in a different way than in a purely economic solution. Liquidity shock ds_i^{30} should be compensated in a regulatorily acceptable manner, i.e. either by the repayment of an obligation payable within 30 days or by strengthening the regulatory accepted liquid assets by means of resources with maturity longer than 30 days or resources with a lower *run-off rate*. In the case of combination of both possibilities the regulatory marginal rate of technical substitution ($MRTS_R$) is defined like this:

$$MRTS_R = \frac{ds_i^{30}}{d(s_j + l)} = \frac{MR_{y,s_j^{30}} + MR_{y,(s_j+l)}}{MR_{y,s_i^{30}}} = \frac{r_{s,j}\,RR_j + \dfrac{\delta \sum_{i=1}^{OST} m_{R,i}(1 - H_i)}{\delta(s_j + l)}}{r_{s,i}^{30}\,RR_i} \tag{18}$$

where $MR_{y,s_j} = \frac{\delta \overline{r_y}}{\delta s_j^{30}}$ and $MR_{y,s_i} = \frac{\delta \overline{r_y}}{\delta s_i^{30}}$ are marginal rates of return on nonliquid assets r_y in relation to the *i*-th and *j*-th financial resource with maturity within 30 days and $MR_{y,(s_j+l)} = \frac{\delta \sum_{i=1}^{OST} m_{R,i}(1 - H_i)}{\delta(s_j + l)}$ is the marginal rate of return on nonliquid assets in response to adjusting the regulatorily accepted volume of liquid assets to changes in the volume of short- and long-term liabilities. While the relative prices of financial resources remain an important criterion of resource substitution, the behaviour of banks is significantly influenced by the values of the *run-off rate* and by the structure of accepted liquid assets and magnitude of *haircuts* which have a limited relation to the actual level of transaction costs of liquid assets and to the liquidity outflow volume. Hence the bank regulatorily prefers funding through stable retail deposits and repo operations hedged by collateral from Level 1 assets at the allocation of acquired cash to liquid assets such as government securities or deposits with CB (impacts of the LCR application on bank funding through customer deposits see Balasubramanyan, & VanHoose, 2013; bank funding with regard to information asymmetry and seniority of funding see Huang & Ratnovski, 2010).

In an economic model the *MRTS* describes the demand side of bank funding and implicitly assumes that disequilibrium in the money/bond market is solved by adjustment of absolute and relative prices, i.e. by changes in the level and slope of the yield curve. Hence it does not work with systemic liquidity shock realization on the supply side in the form of autonomous liquidity factors, money/bond market freeze, it does not consider credit rationing or structural illiquidity when a part of economic agents gets beyond the reach of funding (e.g. small banks or banks outside financial groups). The same problems are not explicitly solved in the framework of regulatorily defined $MRTS_R$ when the *LCR* concept is understood as a tool of bank illiquidity prevention but it does not provide a solution at the exponential growth of transaction costs in financial markets, loss of refinancing in unsecured markets and liquidity outflow due to deposit conversion to cash or accumulation of government deposits with CB (the importance of systemic liquidity shock see Hong, Huang and Wu, 2014). It could be stated that the problem of negative systemic liquidity shock is less significant in the situation of systemic liquidity surplus because the banks hold receivables from CB in the form of sterilization instruments that are the regulatorily accepted liquid asset of Level 1 in the framework of *LCR*. Surplus liquidity sterilized by outright operations, repo operations or deposit facility represents Level 1 liquid assets beyond the scope of available liquidity of the banking system which is in the systemic deficit of liquidity.

4. Results of analysis of liquidity shocks in the banking sector of the Czech Republic in 2005-2013

4.1. Basic liquidity conditions of the domestic banking sector

Liquidity conditions of the CR banking system in 2005-2013 are analysed in an empirical part. The CR banking sector has had above-standard availability of liquidity connected with the systemic surplus of liquidity, which is a result of quantitatively significant interventions of the Czech National Bank (CNB) against the Czech crown appreciation. With regard to liquidity management, the CNB is present in the market on daily basis through repo operations, automated facilities, special facilities or fine-tuning operations. For liquidity redistribution in particular, an ultra-short segment of the unsecured interbank market was used, ca. 50% of the turnover were transactions with non-resident banks. In 2006, the CNB decreased the frequency of repo tenders to three operations a week, which led to a higher use of overnight (O/N) transactions, higher volatility of O/N interest rates, and an increased use of automated facilities. Liquidity problems in world financial markets in 2007 did not basically reflect on the CR banking sector. There was a moderate increase in credit risk premium, a decrease in market liquidity, and an increase in the use of intraday credit of CNB. A key feature of high balance sheet liquidity was a considerable volume of retail deposits. A dependence on other external resources, including foreign ones, was at minimum, similarly like the volume of liquidity distributed through the interbank and bond markets.

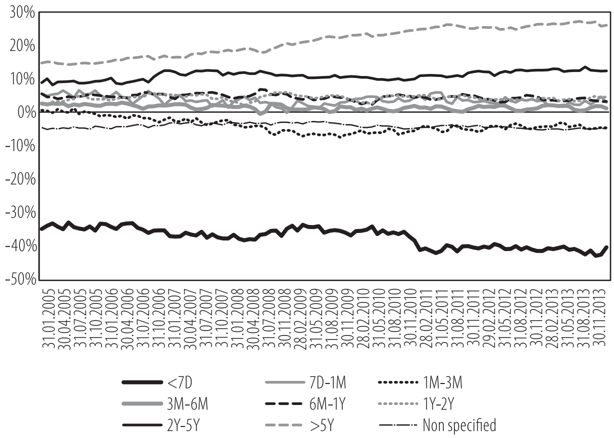
In September 2008, a period of great concerns with counterparty defaults started. The volume of transactions in the interbank market was decreasing, and their maturity was shortened with an emphasis on O/N operations. Liquidity demand increased for a short time, which led to an increase in currency in circulation and a decrease in deposits. The CNB cut the repo rate and for the event of structural illiquidity it introduced liquidity-supplying repo operations with acceptance of the collateral in the form of government bonds. The parameters of market liquidity substantially deteriorated, credit premium increased along with interbank interest rates despite a decrease in the CNB`s main policy rates. The Czech banking sector benefited from a favourable ratio of accepted deposits to granted credits, it had a positive net external position and sufficient capital endowment. Transactions with longer than O/N maturity were realized to a larger extent in the secured money market.

4.2. Simulation of potential liquidity outflow while maintaining the Czech`s banking system solvency

The analysis of economic characteristics of the CR banking system liquidity is done in line with model conditions of solvency maintenance. The banking sector works with a significant maturity gap which suggests a massive extent of refinancing risk and the potential of liquidity outflow (Graph 1). The potential of systemic liquidity shock can be understood as the range of depositors' rush to currency in circulation (traditional bank run) or the outflow of Czech crown liquidity to a foreign currency evoking the strong domestic currency depreciation. The high negative values of maturity gap with maturity within seven days (-35 to -45%) indicate the extent of funding the assets with longer maturity by ultrashort resources. Such disequilibrium is only partly compensated by a positive maturity gap for the maturity of seven days to one month (ca. 5%). Even though it is not possible to automatically deduce the regulatorily strong liquidity outflow in a 30-day horizon from the negative maturity gap with maturity within one month, the value and deepening of this gap indicate the need of holding a higher volume of liquid assets to meet the LCR requirement.

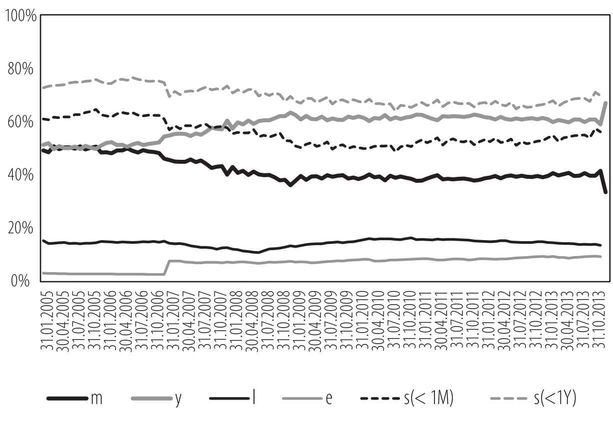
Graph 2 documents that the banking sector has an extensive volume of liquid assets (m = 35-50% of bank assets). Liquid assets consist of the net position toward the CNB, other debt securities, credits and other receivables, and other assets (in liquidity and interest rate risk with maturity within month). From the *LCR* aspect it is crucial that for the major part these are assets with low haircuts (especially receivables toward the CNB). But the banks maintain a stable relation of liquid assets to the volume of short-term liabilities of banks with maturity within one month ($s(<1\ M)$), whose share in the bank balance sheet is higher by ca. 10-15 percentage points. Potential systemic liquidity shock in one-month horizon is covered from ca. 70-80% by liquid assets, hence it does not require the activation of supplementary liquidity lines by the CNB or foreign parent banks. Payable liabilities of banks consist for the major part of customer deposits that show favourable relations of price, availability and stability unlike funding in the unsecured interbank market and have the low *run-off rate* from the regulatory aspect. The portfolio of non-liquid assets increases from the original values of 50% of the bal-

Graph 1: Maturity gap in the Czech banking sector



Source: CNB, our own calculations

Graph 2: Main assets and liabilities in solvency conditions



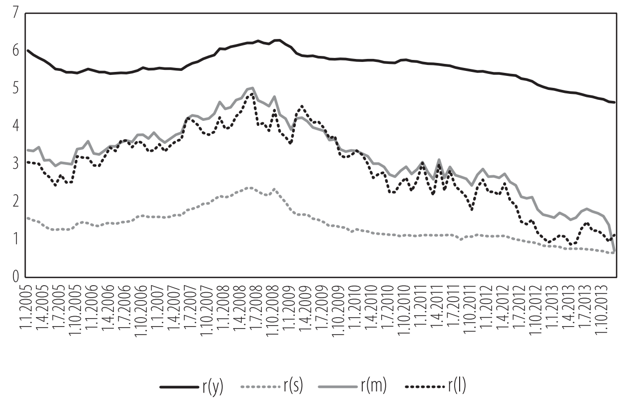
Source: CNB, our own calculations

ance sheet to stable 60%. Non-liquid assets are non-tradable debt securities, credits, and other receivables from customers and other credit institutions, and other assets except the items with maturity within one-month. In spite of refinancing risk, the portfolio of non-liquid assets is safely financed by customer deposits (the ratio of y and customer deposits is close to the 100% level for the most part of the period, even though this ratio has been increasing from the 80% level since 2006).

The weighted means of the rates of return on the particular assets and liabilities (Graph 3) indicate that the margin between non-liquid assets and short-term liabilities as the main source of bank funding is stable and reaches 4-5 percentage points, which brings the potential of sufficient net interest yields of banks. At the same time, the rate of return on long-term liabilities shows a high correlation with the rate of return on liquid assets.

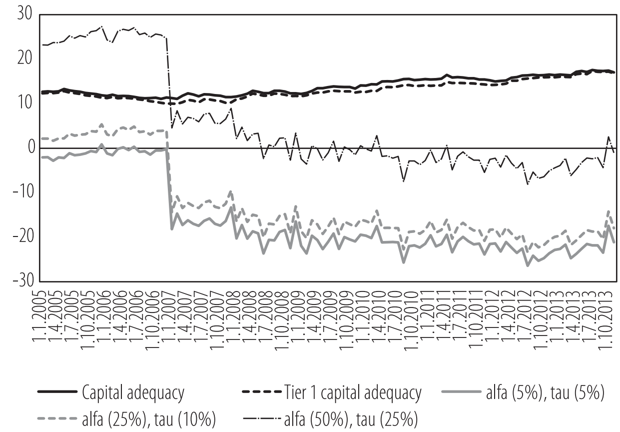
For the event of systemic liquidity shock of the magnitude α, the dynamics of the rate of return on non-liquid assets $\overline{r}_y$ was simulated while the condition of the banking sector solvency was observed. It is assumed that the shock does not exceed the ratio of liquid assets to liabilities payable within 1 month (it is usually above 70%), the sale of liquid assets is burdened with transaction costs τ_m and that solvency means the sustainment of the 8% ratio of capital adequacy. In such a case it is not necessary to realize the sale of non-liquid assets and to ask investors to increase bank´s capital. The simulation shows the banking sector ability to face not only systemic liquidity shock but also credit shock that will be reflected in the negative rate of return on the existing non-liquid assets.

Graph 3: Yields of main assets and liabilities in solvency conditions



Source: CNB, our own calculations

Graph 4: Capital adequacy measures and simulation of $\overline{r}_y$ for 8% capital adequacy and for different levels of α a τm (% p.a.)



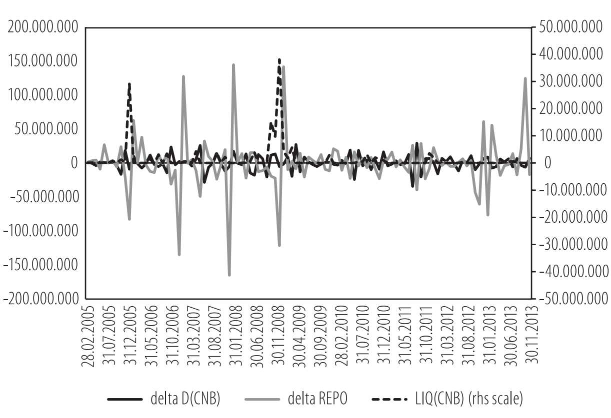
Source: CNB, our own calculations

Graph 4 confirms the high capital endowment of the banking sector when capital adequacy is safely above the 8% level and since 2008 it has risen to the value of 17%. The simulation of the rate of return on non-liquid assets shows that the meeting of 8% capital adequacy is conditioned (for a given extent of liquidity shock and transaction costs) by a maximum one year loss from non-liquid assets $\overline{r_y}$, which increases with the growth of liquidity shock and transaction costs (data before 2007 are biased by other methodology of reporting equity capital in the category of Other assets in liquidity and interest rate risk). It is evident that for low levels of both variables the capital cushion is sufficient to absorb the negative rate of return on non-liquid assets in the range of -10 to -25%. In an extreme case of 50% liquidity outflow and 25% transaction costs, this rate of return on non-liquid assets would move significantly close to the zero level, but always substantially lower than the actual rate of return on non-liquid assets (r_y in Graph 3). These results are caused by the existence of a sufficient liquidity cushion, relatively high return on the capital of domestic banks, and a rapid growth of bank capital after 2008.

4.3. Analysis of adjustment of banking system liquidity characteristics to aggregate liquidity shock and shock in the interbank market liquidity

An analysis of the dynamics of liquidity characteristics of the banking sector, sources of aggregate liquidity shock, market liquidity of the unsecured interbank market and drawing on the liquidity facilities of the CNB is presented. We assume that the ability of the CR banking sector to absorb liquidity shock in model (1) need not express the real liquidity conditions of banks facing the systemic liquidity shock in case of the interbank market illiquidity or in a situation when the CB does not flexibly react to the growing autonomous demand of banks for liquidity.

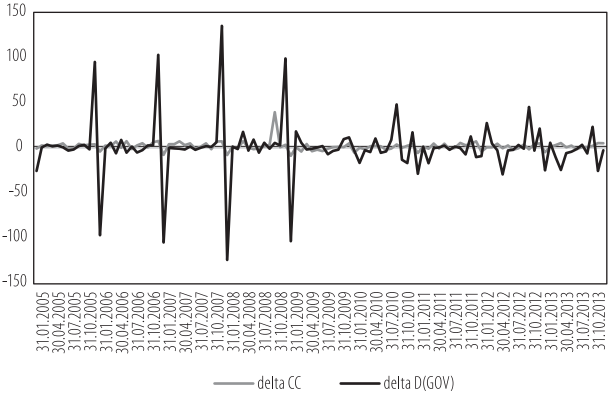
Graph 5: Changes in liquidity position of the banking sector with the CNB (thousands of CZK)



Source: CNB, our own calculations

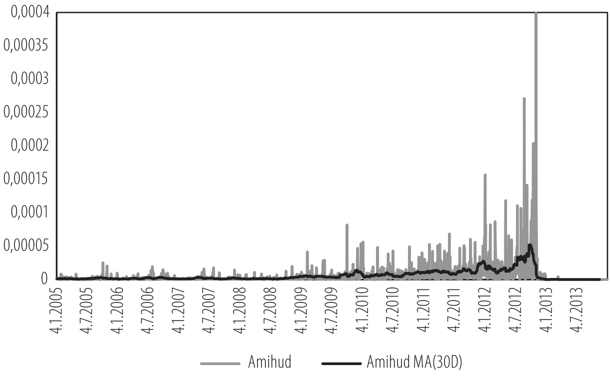
In a stationary form (stationarity tests are available by request), liquidity characteristics of banks are represented (monthly data for the 2005-2013 period are used, as to the end of the month) by the first differences of the ratio of liquid assets to liabilities with maturity within 1 month ($\Delta\frac{m}{s(<1M)}$), of the ratio of non-liquid assets to customer deposits ($\Delta\frac{y}{deposits}$), banks` balances in payment accounts with the CNB (ΔD_{CNB}) and balances on withdrawal repo deposits of banks with the CNB ($\Delta REPO$) (for changes in bank´s positions with the CNB; see Graph 5). Systemic liquidity shock is simulated as the first differences of government deposits with the CNB (ΔD_{GOV}) and the stock of issued currency in circulation (ΔCUR) (see Graph 6). The proxy variable for the interbank market illiquidity used here is the Amihud ratio (AMIHUD), according to Amihud (2002) (see Graph 7), where $AMIHUD_t = MA_d(\frac{|r_t|}{Volume})$, while MA_{30} is the 30-day moving average of the ratio of the absolute value of an interday change in reference O/N interest rate *CZEONIA* ($r_t = ln\frac{CZEONIA_t}{CZEONIA_{t-1}}$) to the volume of transactions in the interbank market with O/N maturity (*Volume*). Drawing on the liquidity facilities of CNB (LIQ_{CNB}) consists of data on the credit statements of banks accepted from CNB (see also Graph 5).

Graph 6: Changes in currency in circulation and government deposits with CNB (bil. CZK)



Source: CNB, our own calculations

Graph 7: Amihud indicator and MA30 Amihud indicator as a proxy for liquidity shock in interbank market



Source: CNB, our own calculations

Table 1 shows that it is possible to reveal a more significant linear relation between systemic liquidity shock in the form of a change in the government balances with the CNB, change in the volume of repo operations and a change in the ratio between liquid assets and short-term liabilities (corr. coeff. at the level -0.828665 and 0.503746). A decrease/increase in the banking system liquidity caused by the government's operations is neutralized at the cost/in favour of the volume of surplus liquidity that is sterilized through repo operations and does not require any significant drawing on liquidity through credit facilities of the CNB (corr. coeff. between ΔD_{GOV} and LIQ_{CNB} is at the level 0.380208). The reaction of $\Delta\frac{\mathrm{m}}{\mathrm{s(do1M)}}$ is also lower because a part of liquidity shock connected with the government's operations is accompanied by an opposite movement of customer deposits (budget incomes/expenditures based on tax payments and charges/purchases of goods and services by the government). In the event of systemic liquidity shock, there is a weaker relation shown as an increase/decrease in currency in circulation that is realized at the cost/in favour of the volume of withdrawn liquidity and/or that is connected with a decrease/increase in the ratio of liquid assets and short-term liabilities (corr. coeff. at the level -0.376870 and -0.379219, respectively) at limited drawing down the liquidity from the CNB (corr. coeff. between ΔCUR and LIQ_{CNB} is at the level 0.240553). Unlike the banking systems with systemic liquidity deficit, the additional liquidity need is not reflected in an increase in bank indebtedness in case of the realization of negative systemic liquidity shock but in a decrease in the high volume of liquid assets. It is to state that the systemic liquidity shock need not pose any substantial problems for meeting this regulatory requirement if in the application of a new regulation the liquidity surplus of the banking system is connected with the higher than regulatorily required *LCR*. A problem would arise if the liquidity surplus weakened the prudence of banks in obtaining the short-term funding and made them prefer resources from the unsecured market.

Table 1: Correlation coefficient of liquidity characteristics of the banking sector, aggregate liquidity shocks, illiquidity of interbank market and the CNB´s liquidity facilities drawing

	LIQ_{CNB}	AMIHUD	$\Delta\frac{m}{s(<1M)}$	Δ REPO	ΔD_{GOV}	ΔDCNB	$\Delta\frac{y}{deposits}$	ΔCUR
LIQ_{CNB}	1.000000	-0.088695	-0.157079	-0.314867	**0.380208**	-0.058191	0.006961	0.240553
AMIHUD	-0.088695	1.000000	0.022878	-0.016346	0.000375	0.034964	-0.103754	-0.080277
$\Delta\frac{m}{s(<1M)}$	-0.157079	0.022878	1.000000	**0.507634**	**-0.503746**	0.175628	-0.264922	**-0.379219**
ΔREPO	-0.314867	-0.016346	**0.507634**	1.000000	**-0.828665**	-0.154429	0.198098	**-0.376870**
ΔD_{GOV}	**0.380208**	0.000375	**-0.503746**	**-0.828665**	1.000000	-0.131754	-0.124815	**0.362638**
ΔD_{CNB}	-0.058191	0.034964	0.175628	-0.154429	-0.131754	1.000000	-0.287849	0.028961
$\Delta\frac{y}{deposits}$	0.006961	-0.103754	-0.264922	0.198098	-0.124815	-0.287849	1.000000	0.141391
ΔCUR	0.240553	-0.080277	**-0.379219**	**-0.376870**	**0.362638**	0.028961	0.141391	1.000000

Source: our own calculations

The relations between bank liquidity characteristics, sources of systemic liquidity shock, interbank market illiquidity, and drawing on the CNBş credit facilities are tested by the general *VAR* model of p-th order which provides estimations of parameters (matrix *C* and *A*) of the relationship between actual and lagged values of endogenous variables Y in the form $Y_t = C_t + \sum_{i=1}^{p} AY_{t-1} + V_t$. In the framework of the estimation we suppose that matrix Y is composed of the above described variables and that matrix *V* represents the errors of the estimation. The estimation was done using the EViews least-squares method. The final lag order was selected on the basis of statistical significance of the estimated parameters in combination with the values of coefficient of determination, Akaike and Schwarz criterion. The results of VAR(1) model are presented and confirm the economic character of bank liquidity management as a matter of bank adaptation to non-persistent shocks (Table 2). This conclusion is clearly evident from a number of partial characteristics of the estimation. First of all, the results in the majority of equations indicate the presence of autocorrelation maximally of the first order. It is also confirmed that the character of relations between the particular variables is strongly influenced by the inclusion of lagged endogenous variables when the magnitude and statistical properties of parameters indicate a decrease in the intensity and statistical significance of relations. The dynamics of repo deposits and of the ratio of liquid assets/short-term liabilities of banks does not show any more the relatively strong negative relation with lagged changes in the government deposits with the CNB.

Liquidity shock arising from the side of government deposits is connected with a negative influence of the lagged value of drawing on credit facilities and change in the stock of currency in circulation, which confirms that thanks to their construction, the liquidity facilities of the CNB are used only for instantaneous drawing on liquidity at the liquidity shock realization in the form of a change in currency in circulation and in a subsequent period they are refinanced by banks at the cost of the repo deposit volume. It confirms the finding that the change in currency in circulation lags a decrease in the liquidity volume withdrawn through repo deposits. At a lower significance level, the effect of an increase/decrease in currency in circulation on an increase/decrease in drawing on the CNB`s credit facilities is identified to act as a balancing factor under liquidity shock occurring on the day when no repo operations of the CNB are realized and that may reveal the structural illiquidity of some banks. The change in currency in circulation strongly positively influences the change in the volume of government deposits with the CNB, which is connected with the seasonal fluctuation of the consumption and tax yields of the government budget. The non-persistent character of the relation between liquidity shocks and the reaction of liquidity characteristics of banks shows that the application of one lag of endogenous variables makes it difficult to explain changes in the ratio of liquid assets/short-term assets (except for the statistically significant autocorrelations). It is also evident that the Amihud ratio is not in any relation with the analysed variables. It may be so because at a general surplus of the banking system liquidity the significance of the unsecured interbank market illiquidity is relatively limited.

Table 2: Estimation of parameters in VAR(1)

t-1 \ t	LIQ_{CNB}	AMIHUD	$\Delta\frac{m}{s(<1M)}$	Δ REPO	ΔD_{GOV}	ΔDCNB	$\Delta\frac{y}{deposits}$	ΔCUR
LIQ_{CNB}	**0.187075**	2.90E-14	7.31E-10	0.945986	**-1.30E-06**	0.243968	-7.58E-11	-1.93E-07
	(0.10507)	(7.9E-14)	(4.3E-10)	(0.82223)	**(6.1E-07)**	(0.20557)	(3.3E-10)	(1.1E-07)
	[1.78044]	[0.36679]	[1.68416]	[1.15052]	**[-2.11002]**	[1.18680]	[-0.22749]	[-1.78932]
AMIHUD	-5.25E+10	**0.872198**	213.0805	-1.90E+10	-255864.7	5.17E+10	-263.3732	-74090.54
	(6.7E+10)	**(0.05023)**	(276.194)	(5.2E+11)	(390919.)	(1.3E+11)	(211.853)	(68516.2)
	[-0.78620]	**[17.3634]**	[0.77149]	[-0.03630]	[-0.65452]	[0.39553]	[-1.24319]	[-1.08136]
$\Delta\frac{m}{s(<1M)}$	**48031968**	-9.90E-06	**-0.445357**	-1.52E+08	110.2142	-55715654	0.127017	-2.110073
	(2.8E+07)	(2.1E-05)	**(0.11752)**	(2.2E+08)	(166.331)	(5.6E+07)	(0.09014)	(29.1526)
	[1.68896]	[-0.46342]	**[-3.78975]**	[-0.68496]	[0.66262]	[-1.00139]	[1.40910]	[-0.07238]
ΔREPO	-0.031060	2.05E-14	8.11E-11	-0.231788	4.85E-08	-0.009605	**-1.48E-10**	5.39E-09
	(0.02432)	(1.8E-14)	(1.0E-10)	(0.19035)	(1.4E-07)	(0.04759)	**(7.7E-11)**	(2.5E-08)
	[-1.27687]	[1.12162]	[0.80667]	[-1.21769]	[0.34075]	[-0.20182]	**[-1.91359]**	[0.21603]
ΔD_{GOV}	-32091.83	2.35E-08	0.000138	316585.1	**-0.372714**	-56297.86	-4.89E-05	-0.029791
	(30824.9)	(2.3E-08)	(0.00013)	(241215.)	**(0.18029)**	(60306.8)	(9.8E-05)	(0.03160)
	[-1.04110]	[1.01551]	[1.08441]	[1.31246]	**[-2.06734]**	[-0.93352]	[-0.50004]	[-0.94280]
ΔD_{CNB}	0.015339	-2.23E-14	1.69E-10	0.380348	-5.35E-09	**-0.476137**	-1.45E-10	-6.43E-08
	(0.05251)	(3.9E-14)	(2.2E-10)	(0.41092)	(3.1E-07)	**(0.10274)**	(1.7E-10)	(5.4E-08)
	[0.29210]	[-0.56588]	[0.77745]	[0.92560]	[-0.01741]	**[-4.63458]**	[-0.87022]	[-1.19376]
$\Delta\frac{y}{deposits}$	8435159.	5.43E-06	0.018695	1.72E+08	-121.1689	68480074	**-0.346720**	-7.789074
	(3.2E+07)	(2.4E-05)	(0.13425)	(2.5E+08)	(190.016)	(6.4E+07)	**(0.10298)**	(33.3039)
	[0.25964]	[0.22228]	[0.13925]	[0.67851]	[-0.63768]	[1.07738]	**[-3.36698]**	[-0.23388]
ΔCUR	**151786.9**	-4.85E-08	-0.000215	**-1886467.**	**1.149004**	119503.8	0.000458	0.059423
	(106505.)	(8.0E-08)	(0.00044)	**(833436.)**	**(0.62292)**	(208369.)	(0.00034)	(0.10918)
	[1.42516]	[-0.60630]	[-0.48860]	**[-2.26348]**	**[1.84455]**	[0.57352]	[1.35625]	[0.54428]
C	**1185798.**	6.89E-07	-0.002721	1040247.	1.745834	-685900.2	0.003053	**2.281059**
	(640397.)	(4.8E-07)	(0.00265)	(5011319)	(3.74550)	(1252893)	(0.00203)	**(0.65647)**
	[1.85166]	[1.43228]	[-1.02839]	[0.20758]	[0.46611]	[-0.54745]	[1.50409]	**[3.47472]**
R-squared	0.113452	0.761440	0.257526	0.242691	0.275942	0.301882	0.248252	0.120134
Adj. R-squared	0.040334	0.741764	0.196291	0.180232	0.216226	0.244305	0.186253	0.047568
Sum sq. resids	2.28E+15	1.29E-09	0.038991	1.40E+17	78110.27	8.74E+15	0.022941	2399.495
S.E. equation	4851846.	3.65E-06	0.020049	37967331	28.37711	9492309.	0.015379	4.973637
F-statistic	1.551639	38.70069	4.205531	3.885637	4.620905	5.243127	4.004083	1.655504
Log likelihood	-1777.561	1181.603	268.7097	-1995.642	-500.3367	-1848.700	296.8217	-315.7449
Akaike AIC	33.70870	-22.12459	-4.900183	37.82343	9.610126	35.05095	-5.430597	6.127263
Schwarz SC	33.93484	-21.89845	-4.674041	38.04957	9.836267	35.27709	-5.204456	6.353404
Mean dependent	1412596.	5.26E-06	-0.000571	-313398.0	0.127358	194640.4	0.001616	1.687736
S.D. dependent	4952757.	7.18E-06	0.022364	41933847	32.05331	10919399	0.017048	5.096324
Determinant resid covariance (dof adj.)				7.14E+27	Determinant resid covariance			3.51E+27
Log likelihood				-4564.810	Akaike information criterion			87.48698
Schwarz criterion						89.29611		

St. errors in ( ) and t-statistics in [ ].
Source: our own calculations

5. Conclusions

The article presents an analysis of the economic and regulatory concept of bank liquidity management in the context of bank solvency in a situation of systemic liquidity shock realization. The model analysis shows that the application of *LCR* would lead to a significant adaptation of banks in the area of liquidity management. In case of a liquidity shock, due to the strict definition of *LCR*, bank is obliged to take into account not only economic factors, i.e. price, availability and flexibility of financial resources and liquidity allocation, but also regulatory restrictions such as *haircuts, inflow rate*, and *run-off rate* and structures of liquid assets and their relation with liquidity outflow. We have demonstrated that the application of LCR underestimates the actual liquidity position of a bank and leads to allocation ineffectiveness. The final effect of *LCR* introduction will be restructuring the balance sheets of banks, an increase in the costs of meeting the regulatory requirements, and a decrease in the volume of resources designed for granting credits.

The empirical part of this paper contains the simulation of impacts of systemic liquidity shock on the banking sector`s ability to withstand the unfavourable shock in the area of credit risk while solvency is maintained. In the framework of accepted assumptions of the model, the results confirm the robustness of the CR`s banking system ensuing from a high liquidity cushion due to the systemic surplus of liquidity, increasing volume of bank capital and its high profitability. It is evident that banks face a systemic liquidity shock by adjusting the volume of repo operations and only partly by means of CNB credit facilities. The estimations of the VAR model show that the relations between liquidity characteristics of banks, sources of aggregate liquidity shock, interbank market illiquidity, and drawing on the credit facilities of the CNB are relatively weak, supporting the conclusion that in their liquidity management, the banks face liquidity shocks of non-persistent character. It is to state that the Czech banking sector has at its disposal an above-standard large liquidity volume and that in spite of the restrictive character of *LCR*, domestic banks as a whole should be able to cope with the new liquidity regulation even at pessimistic stress scenarios.

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