# BANKS IN CURRENCY BOARD SYSTEMS AND LIMIT ON MINIMUM LIQUIDITY POSITION IN NATIONAL CURRENCY*

*Srečko Devjak***

Received: 6. 01. 2014
Accepted: 15. 04. 2014

Preliminary communication
UDC: 336.71

*Banks in countries with currency board arrangements are exposed to the risk of illiquidity in their national currency, which is driven by currency board stability. In line with liquidity risk appetite, banks need to restrict their own risk exposure with a limit on minimum liquidity position in the national currency. This paper presents mathematical derivations of a limit on minimum liquidity position in the national currency, which depends on the business environment and on the currency structure of the balance sheet. Algebraic calculation in this paper is of particular interest to banks, which do business in countries with currency board arrangements.*

## 1. INTRODUCTION

Recent business environment is demanding for corporations, due to the reduced aggregate demand and income. Decreased income and reduced creditworthiness of corporations is also reflected in reduced creditworthiness of the government. Sovereign risk in this case increases as reduced income of corporations reduces tax basis and, consequently, taxes, which are income of the state budget. If a country uses currency board arrangement, then increased sovereign risk endangers the stability of the currency board, as higher sovereign risk reduces opportunities for raising new governmental debt which increases the probability of reducing foreign exchange reserves (Ganevet al, 2012).

* The views expressed in this paper are those of the author and do not necessarily reflect the views of the Raiffeisen Bank International AG.

** Prof. Srečko Devjak, PhD, Raiffeisen Bank International AG, Am Stadtpark 9, 1030 Vienna, Austria, Phone: +43 1 71707-5698, Fax: +43 1 71707-765698, E-mail: srecko.devjak@rbinternational.com

Endangered stability of the currency board raises the liquidity risk in banks as clients prefer reserve currency to national currency. This, on the one hand, reduces stickiness and rollovers of deposits, and on the other shortens the expected maturity of deposits without contractual maturity. Both reasons deliver net outflows of deposits from a bank. A bank in a banking system with currency board should therefore monitor stability of the currency board and consequently build results of corresponding analysis in its liquidity risk management system.

The goal of this paper is to show how a bank can set a position limit and control its exposure to liquidity risk, which is driven by the stability of a currency board. The limit will be calculated with mathematical derivation from ratios for measurement of currency board stability. After showing the ratios for measurement of currency board stability, this paper explains the multicollinearity among them and calculates the limit on minimum liquidity position in the national currency. The limit on minimum liquidity position in the national currency will only be calculated algebraically. Calculating the absolute limit based on sample data is left to individual banks as the sample data of each bank is confidential and therefore not available to the public. A review of the existing literature shows that no paper explains the derivation of a non-regulatory liquidity limit. Unlike the existing literature, this paper explicitly explains how it is possible to calculate a limit on a minimum liquidity position in the national currency. This is what makes this paper original.

## 2. THEORETICAL BACKGROUND

Currently, there are two countries in Europe that have currency board arrangements. These are Bosnia and Herzegovina and Bulgaria. Estonia and Latvia had currency board arrangements in the past, but now both countries are a part of the Euro area. This is an expected consequence if we take into account that currency boards have been suggested as the proper exchange rate regime for potential European union (EU) and European Economic and Monetary Union (EMU) entry countries (de Haan et al., 2001). This was also confirmed by Minea and Rault (2011) research results on the currency board in Bulgaria. They concluded that adopting the currency board may have worked as a rather good device for integrating Bulgaria into the EMU.

The history of currency board systems since 1990 has shown that this special form of the exchange rate system can ease the consequences of financial shocks and can help to stabilize the economy after currency crises. The history has shown that the introducing a currency board system can deliver high credibility to the national currency and consequently reduce inflation rate,

which was experienced by some countries not having considerable experience in central banking like Estonia and Lithuania (Grimm, 2007). Based on the data from Bulgaria, Carlson and Valev (2001) showed that a currency board system in general reduces the expected inflation, but to various degrees for different agents. Differences exist as agents differently trust the disinflation rhetoric of the policymakers who are not equally familiar with the operation of the currency board.

A currency board can encourage fiscal discipline. If the fiscal authorities know that the budget deficit cannot be monetized, their incentives to have large deficits will be reduced (de Haan, et al., 2001).

The main disadvantage of currency board arrangements is the loss of independent monetary policy. Countries with currency board arrangements deal with loss of Central Bank functions which are especially important in case of problems with liquidity in the banking sector. They are not able to supply extra liquidity to the banking system or individual banks (Ganič, 2012).The loss of the lender of last resort function of the central bank can mean the loss of a safety net for the financial sector. The national authorities in this case should ensure that financial institutions have adequate capital and access to credit markets abroad. The absence of the lender of last resort function of the central bank reduces the moral hazard problem of banking management and/or supervision, because if banks are in difficulties, there is no one to save them. Automatic access to liquidity can be facilitated by using reserve requirements as introduced in a number of currency board arrangement countries (de Haan et al., 2001). To remain confident in the currency board, foreign exchange reserves should be sufficient to cover outstanding value of relevant liabilities at the chosen exchange rate. Where confidence is lacking, this proportion needs to be 100 percent (Bennett, 1993). Under the currency board system, unlike the practice when a country has a central bank, the commercial banks may be allowed or required to hold a significant part or all of their reserves denominated in the reserve currency (Peterson Institute for International Economics, 2013).

Nenovsky and Hristov (2002) explain the new generation of currency boards, which, to varying degrees, preserve the ability of the central bank to function as the lender of last resort and to intervene in case of a systemic risk. Such currency board existed in Argentina, Estonia and Lithuania, and still exists in Hong Kong and Bulgaria. The introduction of this second-generation currency board offers an opportunity to conduct monetary policy, which does not have its typical image.

Chobanov and Nenovsky (2004) claim that currency boards and golden standard as monetary regimes have a number of similarities. Besides credibility and confidence, there are two additional similarities. First, there is the automatic mechanism which links money demand and supply to the balance of payments and leads to a relatively quick adjustment of emerging imbalances in the economy. Automatism means that the balance is adjusted (restored) after a shock without the intervention of a central monetary authority. Automatic mechanism requires flexibility especially in the interbank money market. Second, both monetary regimes significantly constrain the domestic economic policies.

Frank (2004) describes several conditions that make a currency board sustainable. A country with a currency board has to abandon the independent monetary policy and has to duplicate the country's monetary policy with the anchor currency. The most important feature of the anchor currency is its stability, so the country should choose one of the major currencies for the anchor currency, which is also the national currency of their trade partner. Furthermore, countries need to implement a new regime in the national legislation as it is very important that the monetary authority and the government tie themselves to the currency board regime. Due to the absence of the lender of last resort function, adequate regulation of the financial sector should be ensured. With proper regulation, the need for the lender of last resort function will not appear. Another condition is labor market flexibility.

Frank (2004) states that, if the anchor currency appreciates, wages should fall, in order to keep foreign prices and competitiveness of the domestic industry unchanged. Gurtner (2004) states that a candidate country for a currency board should not be subject to massive and frequent terms of trade shocks (demand shock in trading partner should have limited effect on the domestic export industry). So,the country should have several trading partners and distribute its exports among them. In addition, low debt of the government is necessary to ensure the sustainability of the currency board. Frank (2004) states that, when default must be taken into consideration, interest rates soar and it becomes increasingly difficult to refinance the country's debt. Thus, a firm commitment to budget balance by the government is highly important.

If a country does not take into account all the conditions mentioned above, it is probable that the currency board will collapse. This happened in 2002 to Argentina, although it had had a successful currency board arrangement for more than ten years. The currency board in Argentina collapsed mainly due to fiscal policy and the devaluation of the national currency in Brazil. Frank

(2004) stated that fiscal policy in Argentina was one of the central issues leading to the breakdown of the currency board, especially the imperfect fiscal policy and difficult international financial environment. The financial environment changed when in the early 1999 Brazil, Argentina's main and most important trading partner, abandoned its peg to the USD and left BRL floating. There is a recommendation that a major part of the country's trade should be with the anchor economy. Argentina chose the USD as an anchor currency, mostly because of its stability. The devaluation of BRL made Argentinean goods much more expensive in Brazil, leading to the negative shock with Argentina's most important trading partner. Argentina could have responded with labor market reforms. Gurtner (2004) argues that the flexibility of the labor market is the key to the currency board sustainability. Mulino (2002) proves the same with a second generation model. A currency board system can become vulnerable to a currency crisis in case of unemployment persistence. However, labor markets in Argentina were highly inflexible during the currency board era. Depreciation of BRL against ARS became a growing problem and government was unable to enforce labor market reforms against the pressure of the unions.

## 3. LIQUIDITY RISK MANAGEMENT IN BANKS AND COLLAPSE OF A CURRENCY BOARD

Determinants of liquidity in the bank were investigated by several authors. Vodova (2011) identified determinants of liquidity in Czech commercial banks. The determinants of liquidity were identified using bank specific data and were empirically based on macroeconomic data over the period from 2001 to 2009. A multiple regression model shows liquidity of a bank is, on the one hand positively related to capital adequacy, interest rates on loans, share of non-performing loans and interest rate on interbank transaction, but on the other hand negatively related to inflation rate, business cycle and financial crisis. Relation between size of banks and their liquidity is ambiguous. The determinants of liquidity of Slovak commercial banks were explained in Vodova (2012). The determinants of liquidity of commercial banks in Romania were identified by Munteanu (2012).

A multivariate regression model shows the crisis brought about substantial changes in the structure of bank liquidity determinants. In times of crisis, the fraction of macroeconomic determinants increases and the fraction of bank specific determinants decreases. De Haan and van den End (2013) explain using empirical analysis that the banks usually hold more liquid assets against their stock of liquid liabilities as required by the regulation. Banks with stronger capital position hold less liquid assets against their stock of liquid liabilities,

which shows an interaction between capital and liquidity buffers. However, this interaction appears to be weaker during a crisis because of the impact of crisis on portfolio of the bank that consequently makes the capital of the bank questionable. This is confirmed by the experience of banks in Argentina.

During the crisis in 2001, the banks in Argentina had many liquidity issues. The banking sector functioned mainly in USD, so the banks had short term liabilities mainly in USD. At the same time, the stock of liquid assets in USD by banks and the stock of international reserves in USD were not enough to cover the financial liabilities of the consolidated financial system. And moreover, the lender of last resort was not available (Kiguel, 2011). People realized that there were not enough USD in the system to cover all the deposits and between July and November 2001 they withdrew around 15 billion USD from the banks. Three national banks (Banco de Galicia, Banco de la Nación and Banco de la Provincia de Buenos Aires) were particularly affected. To save them, the government set a cap of 1,000 USD on bank withdrawals per customer per month. This decision pushed the people of Argentina to the streets and resulted in the collapse of currency board regime (The Economist, 2002).

## 4. FORMAL CURRENCY BOARD ARRANGEMENT STABILITY CRITERIA

A set of formal currency board arrangement stability criteria is composed of eight ratios (Ganevet al, 2012):

1. **FX reserve coverage of the monetary base.** Within an orthodox currency board there should be notes and coins in circulation (monetary aggregate M0) covered by reserve currency. The bigger the difference between FX reserves and M0, the greater the stability of the currency board. Bulgaria decided that FX reserves in euros should not only cover M0, but also bank reserves at the Central Bank.

2. **FX reserve (less government deposit) coverage of the monetary base.** This ratio excludes the government deposits from the FX reserves and evaluates the stability of the currency board in case government keeps savings outside the Central Bank. The stability of the currency board is shown if value of this ratio equals at least 1. An additional buffer will increase the stability of the currency board.

3. **FX reserve coverage of the national currency denominated part of M2.** The stability of a currency board is also determined by FX reserve coverage of the national currency denominated part of M2. This indicator roughly measures the percentage of national currency denominated cash and deposits, which could be converted to reserve currency in case of a currency crisis. To a great degree, this should also be considered an extreme case, as in the event of a currency crisis and the following bank runs, the chance that the entire money supply (measured by M2) would be converted into reserve currency is very small.

4. **Ratio between money outside banks and the sum of deposits.** If the value of this ration increases, the probability of quick conversion of the national currency into reserve currency also increases. A value rise of this ratio shows an increasing propensity to raise cash holdings and decrease deposits in order to increase the ability of conversion to reserve the currency. Consequently, this ratio measures the trust in the banking system and in the governmental policy.

5. **Significant variation in demand for notes and coins.** Currency risk exists if we can see higher variability of demand for notes and coins in a period compared with variability of the same random variable in the preceding period (Ganevet al, 2012). Measures of variability are measures of uncertainty and, consequently, measures of risk. Assume financial investors are risk averse and assume they demand notes and coins in stress free environment on financial markets. Consequently, we can assume the probability distribution of daily demand for notes and coins is normal and variance can be used as a measure of risk. If $d$ is daily demand for notes and coins and if is $n$ the number of days in observation, then the variance of daily demand for notes and coins $s_d^2$ is defined as follows:

$$s_d^2 = \frac{1}{n-1} \cdot \sum_{i=1}^{n} \left(d_i - E(d)\right)^2 = \frac{1}{n-1} \cdot \left( \sum_{i=1}^{n} d_i - \frac{1}{n} \left( \sum_{i=1}^{n} d_i \right)^2 \right) \qquad (1).$$

6. **Abrupt changes in the currency structure of deposits.** Rapid replacement of deposits denominated from the national to reserve currency indicates fear of financial investors and presence of currency risk (Ganevet al, 2012). If a fraction of deposits in the national currency follows a monotonous upward trend in time, then we can conclude that

financial investors estimate the currency risk is reducing. If a fraction of deposits in the national currency remains unchanged in time, then we can conclude that financial investors estimate the currency risk as stable. Finally, if a fraction of deposits in the national currency follows a monotonous downward trend in time, then we can conclude that financial investors estimate currency risk is rising and the stability of currency board is reducing.

7. **Balance of payments dynamics.** Changes in the balance of payments are directly reflected in the changes of the FX reserves volume. The deficit in the balance of payments reduces the amount of the FX reserves and the surplus in the balance of payments increases the amount of the FX reserves. The tendency to deficit in balance of payments will in time result in the reduction of the FX reserves. If $x_i$ is the amount of deficit in year *i*, if $y_j$ is the amount of surplus in year *j* and if *Z* is the amount of FX reserves, then in subsequent $m+n$ years holds:

$$\sum_{i=1}^{n} x_i - \sum_{j=1}^{m} y_j = \Delta Z \qquad (2).$$

8. **Budget deficits unmatched by financing outside the fiscal reserve.** The inability to raise government debt forces a country to reduce FX reserves and to use government reserves for financing the budget deficit. The reduction of FX reserves increases currency risk and reduces the stability of the currency board (Ganevet al, 2012).

## 5. CALCULATION OF A LIMIT ON LIQUIDITY POSITION IN THE NATIONAL CURRENCY

Liquidity risk consists of several risk categories. One of the categories is the risk of currency board stability. To calculate the minimum liquidity position in the national currency, we will assume that the stability of a currency board is the only driver of liquidity risk. We will ignore all other categories of liquidity risk.

The stability of a currency board is also determined with FX reserve coverage of the national currency denominated part of M2. This ratio roughly measures the percentage of national currency denominated cash and deposits, which could be converted to reserve currency in case of a currency crisis. To a

great degree, this should also be considered an extreme case, as in the case of currency crisis and bank runs, the chance that the entire money supply (measured by M2) would be converted to reserve currency is very small (Ganevet al, 2012).

Assume this ratio is an ultimate measure of the currency board stability. Let M2 (LCY) be the national currency denominated part of M2 and let FXR (RCY) be the amount of FX reserves in reserve currency. Also assume, the value of FX reserve coverage of the national currency denominated part of M2 ratio is:

$$\frac{FXR(RCY)}{M2(LCY)} = a \qquad (3).$$

Before we calculate the limit on the national currency liquidity steering in a bank, we need to redefine macroeconomic ratio on a microeconomic level within a banking system. IMF (2013) defines foreign exchange reserve as assets of the central bank for covering its liabilities. Foreign exchange reserve can be denominated in currencies, which do not include the national currency as the central bank cannot have a claim to itself. If A (RCY) are assets of a commercial bank in reserve currency, then a commercial bank holds:

$$FXR(RCY) = A(RCY) \qquad (4).$$

. The proper level of foreign exchange reserves is explained in several papers, for example IMF (2001), IMF (2011), de Beaufort Wijnholds and Kapteyn (2001) and Roger (1993).

As explained by Mishkin and Eakins (1999), liabilities of the central bank are composed of currency in circulation and of bank reserves with the central bank. The currency in circulation is equivalent to current accounts in commercial banks as is currency in circulation immediate obligation of the central bank to the holder of the national currency. Bank reserves are the liability of the central bank, which is similar to term deposits in commercial banks as bank reserves are obligatory for banks.

Let D(LCY) be the deposits of a commercial bank in the national currency. Then for a commercial bank holds $M2(LCY) = D(LCY)$, and along with equation (4), also:

$$\frac{A(RCY)}{D(LCY)} = a \qquad (5).$$

If we mark total assets with *TA*, then it consequently holds:

$$\frac{TA - A(LCY)}{D(LCY)} = a \qquad (6),$$

$$\frac{TA}{D(LCY)} - \frac{A(LCY)}{D(LCY)} = a \qquad (7),$$

$$\frac{A(LCY)}{D(LCY)} = \frac{TA}{D(LCY)} - a \qquad (8),$$

$$A(LCY) = \left( \frac{TA}{D(LCY)} - a \right) \cdot D(LCY) \qquad (9),$$

$$A(LCY) = TA - a \cdot D(LCY) \qquad (10),$$

$$A(LCY) - D(LCY) = TA - a \cdot D(LCY) - D(LCY) \qquad (11),$$

$$A(LCY) - D(LCY) = TA - (1 + a) \cdot D(LCY) \qquad (12).$$

The last equation holds for all maturities on the balance sheet level. If $A_i(LCY)$ is an inflow on time interval *i* and if $D_i(LCY)$ is an outflow on time interval *i*, then on the total balance sheet level holds:

$$\sum_{i=1}^{n} (A_i(LCY) - D_i(LCY)) = TA - (1 + a) \cdot \sum_{i=1}^{n} D_i(LCY) \qquad (13).$$

Banks usually want to keep accumulated net cash flows *ceteris paribus* above the absolute limit up to and including time interval $N < n$. Therefore, it holds:

$$\sum_{i=1}^{N}\left(A_i(LCY)-D_i(LCY)\right)\geq TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY) \qquad (14).$$

Let $y$ be the stability of a currency board. If $x_1$ is FX reserve coverage of the monetary base, then $x_2$ is FX reserve less government deposit coverage of the monetary base, $x_3$ is FX reserve coverage of the national currency denominated part of M2, $x_4$ is the ratio of money outside banks to the sum of deposits, $x_5$ is significant variation in demand for notes and coins, $x_6$ are the abrupt changes in the currency structure of deposits, $x_7$ is the balance of payments dynamics, and $x_8$ are budget deficits unmatched by financing outside the fiscal reserve, then we can estimate $y$ with the following sample regression model (Gujarati, 1995):

$$y_i = a+\sum_{j=1}^{8}b_j x_{ij}+u_i \qquad (15).$$

Assume that multicollinearity exists, such that holds:

$$\lambda_1 x_1+\lambda_2 x_2+\lambda_3 x_3+\varphi_m=0 \qquad (16),$$

,

$$\sum_{k=4}^{8}\lambda_k x_k+\phi_n=0 \qquad (17).$$

In equations (16) and (17), $\varphi_m$ and $\phi_n$ are stochastic terms and $\lambda_1,\lambda_2,...,\lambda_8$ are constants. When calculating liquidity limit we have to use the largest volume of information about currency board stability possible. With this, we make sure $y$ as a coherent risk measure of currency board stability is reflected in the limit. The coherency of risk measure $y$ is proven with

coefficient of determination if independent variables in the regression model explain the majority of dependent variable variability.

Based on the assumption of multicollinearity among independent variables, FX reserve coverage of the national currency denominated part of M2 ratio has to be combined with any variable $x_k \forall k \in \{4, 5, 6, 7, 8\}$ at calculation of the liquidity limit. If partial correlation coefficient between any independent variable is $x_k \forall k \in \{4, 5, 6, 7, 8\}$ and $y$ is the highest for abrupt changes in the currency structure of deposits, then abrupt changes in the currency structure of deposits should be used along with FX reserve coverage of the national currency denominated part of M2 at calculation of the liquidity limit.

Currency board stability is defined with a situation in business environment of a bank, therefore, there should be a liquidity limit calculation in the bank linked to a situation in the business environment of the bank. The higher currency board stability, the higher can be the bank limit on liquidity position in the national currency. Similarly, the lower currency board stability, the lower may be limit on liquidity position in the national currency. As we can see the currency board stability and the limit on liquidity position in the national currency are in a linear relationship.

The deposits in a banking system are composed of deposits in the national currency and deposits in other currencies. The deposits in the national currency are labeled with *g* and those in other currencies with *h*. Then, the fraction of deposits in national currency is defined with $\frac{g}{g+h}$.

As it holds:

$$\sum_{i=1}^{N} \left(A_i(LCY) - D_i(LCY)\right) \geq TA - (1+a) \cdot \sum_{i=1}^{N} D_i(LCY) \qquad (18),$$

and as $TA - (1+a) \cdot \sum_{i=1}^{N} D_i(LCY)$ is a limit value in the case of full stability of the currency board, then the limit value in the case of partial stability of currency board equals:

$$\frac{g}{g+h}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right) \qquad (19).$$

If $g \to 0$ then:

$$\lim_{g\to 0}\left(\frac{g}{g+h}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right)\right)=\frac{0}{0+h}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right)=0 \qquad (20).$$

The derivation above confirms that the appropriate limit on minimum liquidity position in the national currency is zero in case there is no stability of currency board. If there is no stability of currency board, then financial investors hold no deposits with banks in the national currency. All deposits they hold with banks are deposits, denominated in the reserve currency.

And if $h \to 0$ then:

$$\lim_{h\to 0}\left(\frac{g}{g+h}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right)\right)=\frac{g}{g+0}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right) \qquad (21),$$

$$\lim_{h\to 0}\left(\frac{g}{g+h}\left(TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)\right)\right)=TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY) \qquad (22).$$

The last equation shows the appropriate limit on minimum liquidity position in the national currency in the case of a full stability of the currency board. This is $TA-(1+a)\cdot\sum_{i=1}^{N}D_i(LCY)$. If the full stability of currency board exists, then financial investors fully trust the national currency and all deposits they have with the banks are denominated in the national currency only. The amount of deposits in other currencies is therefore zero. The same is also clearly shown by the previous equation.

## 6. CONCLUSION

The stability of a currency board can be identified with a set of ratios. This paper shows that the measurement of currency board stability is possible with a risk measure, which is a dependent variable of a sample regression model with ratios for identifying currency board stability as independent variables. The coherency of such a risk measure is proven with the coefficient of determination

if independent variables in the regression model explain the majority of dependent variable variability.

A sample regression model should not include multicollinearity. Therefore, not all ratios for identification of currency board stability can be included into the sample regression model. Consequently, in the sample regression model ratios with insignificant additional information about currency board stability are not included.

Mathematical derivation shows it is possible for a bank to calculate a limit on minimum liquidity position in the national currency out of ratios for identifying currency board stability. When calculating liquidity limit, the largest possible volume of information about currency board stability should be used. This assures the risk measure for measurement of currency board stability is reflected in the limit. The result of algebraic calculation confirms a linear relationship between currency board stability and the limit on minimum liquidity position in the national currency. The higher currency board stability, the higher can be the bank limit on liquidity position in the national currency. Similarly, the lower currency board stability, the lower may be limit on liquidity position in the national currency.

## REFERENCES

1. Bennett, A. (1993). The operation of the Estonian currency board. *IMF Staff Papers* 40 (2), pp. 451-470.
2. Carlson, J. A. & Valev, N. T. (2001). Credibility of a new monetary regime: The currency board in Bulgaria. *Journal of Monetary Economics, 47* (3), pp. 581-594.
3. de Beaufort Wijnholds, J. O. and Kapteyn, A. (2001). Reserve Adequacy in Emerging Market Economies. *IMF Working Paper series* 01/143.
4. deHaan, J., Berger, H. & van Fraassen, E. (2001). How to reduce inflation: an independent Central Bank or a currency board? The experience of the Baltic countries. *Emerging markets review, 2* (3), pp. 18-243.
5. deHaan, L. & van den End, J. W. (2013). Bank liquidity, the maturity ladder, and regulation. *Journal of Banking & Finance, 37* (10), pp. 3930-3950.
6. Frank, D. (winter 2004-2005). *How Currency Boards Collapse - The Case of Argentina*. Institute for Foreign Trade and Payments and European Integration, Economics department, University of Basel, Switzerland.
7. Ganev K., Vidinova H. & Stelzeneder M. (2012). *Bulgaria: Currency board special*. Vienna: RaiffeisenResearch. Retrieved on 24th November

2013 from: http://www.rbinternational.com/eBusiness/01_template1/826124957350877869-826100030434411352_826101618230137223_8261020267889017 86-826102026788901786-NA-1-NA.html
8. Ganić, M. (2012). Perspectives of Application of Currency Board Arrangement with Special Emphasis on Bosnia and Herzegovina. *International Journal of Business and Social Science, 3* (4), pp. 74- 84.
9. Grimm, O. (2007). *Fiscal Discipline and Stability under Currency Board Systems.* Center of economics research at ETH working paper series 07/66, Center of economic research Zurich.
10. Gujarati, D. (1995). *Basic Econometrics*. Singapore: McGraw-Hill.
11. IMF (2001): *Issues in Reserves Adequacy and Management.* Retrieved on 24th November 2013 from: http://www.imf.org/external/np/pdr/resad/2001/101501.pdf
12. IMF (2011): *Assessing Reserve Adequacy*. Retrieved on 24th November 2013 from: http://www.imf.org/external/np/pp/eng/2011/021411b.pdf
13. IMF (2013): *Revised Guidelines for Foreign Exchange Reserve Management.* Retrieved on 24th November 2013 from: http://www.imf.org/external/np/pp/eng/2013/020113.pdf
14. Gurtner, Francois J. (2004).Why Did Argentina's Currency Board Collapse? *World economy*, 27 (5), pp. 679-697.
15. Kiguel, M. (2011). Argentina's 2001 Economic and Financial Crisis: Lesson for Europe. *Think Tank 20: Beyond Macroeconomic policy coordination discussions in the G-20*, pp. 7-9.
16. Minea, A. & Rault, C. (2011). External Monetary Shocks and Monetary Integration: Evidence from the Bulgarian Currency Board. *Economic Modelling, 28* (5), pp. 2271-2281.
17. Mishkin, F. S. & Eakins, S. G. (1999). *Financial markets and institutions*. *Thirdedition*. New York: Addison Wesley Longman, Inc.
18. Mulino, M. (2002). Currency boards, credibility and crises. *Economic Systems, 26* (4), pp. 381-386.
19. Munteanu, I. (2012). Bank Liquidity and its Determinants in Romania. *Procedia Economics and Finance,* 3 (1), pp. 993-998.
20. Nenovsky, N. & Hristov, K. (2002). The new currency boards and discretion: empirical evidence from Bulgaria. *Economic Systems, 26* (1), pp. 5-72.
21. Peterson Institute for International Economics, Chapter 5: *Currency boards*, pp. 21-32. Retrieved on 24th November 2013 from: http://www.iie.com/publications/chapters_preview/342/5iie3365.pdf
22. Roger, S. (1993): The management of foreign exchange reserves. Basel: *BIS Economic Papers series* 38.

23. Vodova, P. (2011). Liquidity of Czech Commercial Banks and its Determinants. *International Journal of Mathematical Models and Methods in Applied Sciences*, (6), pp. 1060-1067.
24. Vodova, P. (2012). Liquidity of Slovak commercial banks and its determinants. In Stavarek, D. and Vodova, P. (Eds.): *Proceedings of the 13th International Conference on Finance and Banking. Karviná, Silesian University*, pp. 487-494.
25. *The Economist*. (2002, February 28). Argentina's collapse: A decline without parallel.

## BANKE U SUSTAVU VALUTNOG ODBORA I LIMIT NA MINIMALNU LIKVIDNOSNU POZICIJU U NACIONALNOJ VALUTI

### Sažetak

Banke u državama s valutnim odborom izložene su riziku nelikvidnosti u nacionalnoj valuti, a koja ovisi o stabilnosti aranžmana. U skladu s apetitima u preuzimanju rizika likvidnosti, banke trebaju ograničiti vlastitu izloženost riziku, koristeći limit na minimalnu likvidnosnu poziciju u nacionalnoj valuti. U ovom se radu prezentiraju matematički izvodi minimalne likvidne pozicije u nacionalnoj valuti, u ovisnosti od poslovnog okruženja i valutne strukture bilance. Algebarski izračun, prezentiran u radu, od posebnog je interesa za banke, koje posluju u uvjetima valutnog odbora.