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Risk Management of Dollarization in Banking: Case of Post-Soviet Countries

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ABSTRACT

Dollarization of bank assets and liabilities is a typical phenomenon with multi-faceted effects. Primarily, this phenomenon raises risks of imbalance in assets and liabilities following a sharp local currency devaluation. However, dollarization may deliver additional returns. This calls for development and implementation of strategies for dollarization risk management. This study aims at designing risk management strategies for ensuring optimal currency structure of loan and deposit portfolio under an extremely high level of devaluation risk in six post-Soviet countries. The study is based on risk modeling methods and asset liability management techniques. The value-at-risk methodology is applied to measure and identify main risks banks face under dollarization. Two types of risk are identified: the strategic risk measured as a ratio of deposits in foreign currency; and the tactical risk measured as a ratio of foreign currency deposits transformed into local currency loans. Suggested effective risk management strategies are based on the optimization of these two types of risks. The first strategy deals with deposit de-dollarization and non-transformation of foreign currency deposits into local currency loans. Under the second strategy, increased deposit dollarization is complemented with non-transformation of foreign currency deposits into local currency loans. The third strategy involves deposit de-dollarization and conducting transformation of foreign currency deposits into local currency loans. Each strategy entails maximization of return with subsequent minimization of risk. The study concludes that the first strategy is appropriate for Ukraine and Belarus, the second one suits Azerbaijan and Moldova, and the third one fits Armenia and Georgia.

INTRODUCTION

Financial dollarization in transition economies is quite an ambiguous matter. The issue of financial dollarization is a complex one since there is no clear answer whether this phenomenon is positive or negative and whether it is a source of problems in the economy or a solution to those.

Under this phenomenon, a significant part of the liabilities and assets of financial institutions is presented in dollars (or, generally, in any stable currency). The existence and growth of dollarization phenomenon result from the lack of confidence in local currency due to risks of devaluation and inflation. Economic agents are afraid to keep savings in local currency because of possible loss of value. This leads to the trend of presenting a part of liabilities of financial institutions in foreign currency. These may include foreign currency deposits in banks, investment fund portfolios, etc. Moreover, insurance and pension savings in foreign currency contribute to financial institution's liabilities presented in foreign currency. Hence, financial intermediaries face the dollarized liabilities (Ize and Levy Yeyati, 1998, 2003).

Economic logic also implies the appropriateness of forming the assets of financial intermediaries in foreign currency. Inflation and devaluation risks, as well as dollarized liabilities stimulate this tendency. Bank's loan portfolios in local currency may be unprofitable because the profit can be "eaten up" by inflation. Nevertheless, for financial intermediaries having assets in local currency has some benefits from the return point of view (Kutan, Ozsoz, and Rengifo, 2012). Return on local currency assets includes, as a rule, high premiums for inflation and devaluation risks. It significantly exceeds the return in dollars, sometimes by several times. For example, a bank forms a significant part of its deposit portfolio in dollars, attracted at a relatively low-interest rate. Then, transforming the raised funds into local currency, it issues loans in local currency at an extremely high-interest rate. If marginal revenue exceeds losses from possible devaluation/inflation, then it becomes a profitable business for a bank.

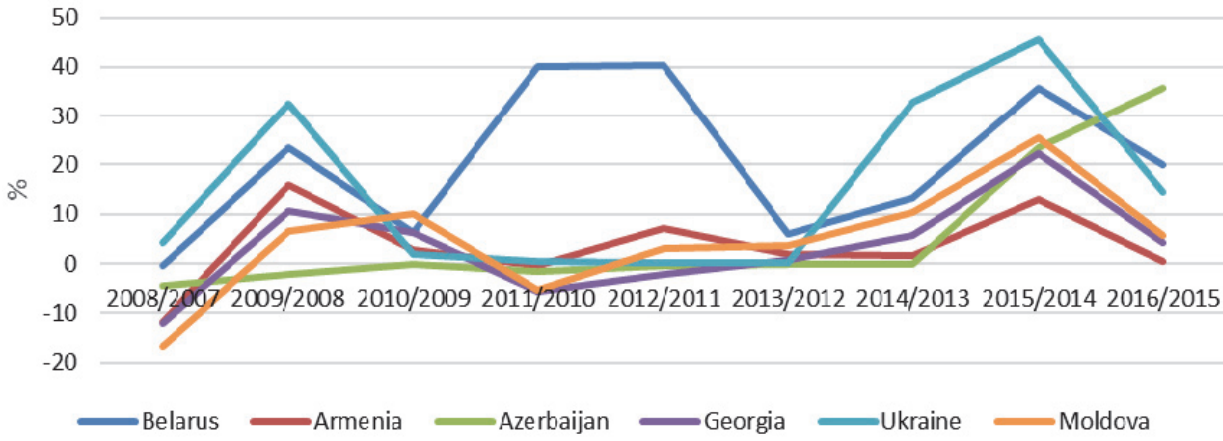
Thus, dollarization raises risk-return correspondence for financial institutions. Consequently, the question about risk management naturally appears. How can one build effective risk management for a financial institution in conditions of high dollarization? What is the optimal ratio of liabilities in different currencies and, in turn, assets in different currencies? This article discusses these questions. The goal of our study is to highlight the possibility of using of CVaR modelling for optimal currency structuring of a bank's loan and deposit portfolio under devaluation risk in transition economies.

We focus mainly on the bank's risk management. The reason is that dollarization is the prerogative of financial systems in emerging markets. In these markets, banking segment essentially dominates the structure of financial systems (Cihak et al., 2012). We believe that putting up an effective risk management system with regard to dollarization is an urgent task for banks operating in countries where its level is high.

Conceptually, we suggest an approach to risk management built around its classical interpretation: risk identification, risk analysis, its measurement, decision justification, and monitoring. At the same time, for each of these components, we introduce specific elements associated with dollarization. Thus, within risk identification, we distinguish two types of risks - strategic and tactical. Strategic risk is related to the bank's strategy in attracting dollar deposits. The tactical risk stems from the bank's decision on converting dollar deposits into loans in local currency. In our view, these two risks form the bank's general dollarization risk, formally expressed as the risk of total return of bank. Such returns have specific probability distributions characterized by long and heavy tails. Therefore, we propose to use Conditional Value-at-Risk (CVaR) as a risk measure in our model. The risk-return correspondence analysis leads to the optimal solution.

The model is tested out in six transition countries (Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine). The analysis encompasses the period from 2008 to 2017. These countries are chosen due to four main reasons. Firstly, they underwent a severe devaluation and it was one of the main shocks in these countries during the analyzed period. These countries faced two waves of currency devaluation during the analyzed period: the first resulting from the global financial crisis and the second resulting from the economic and political crises in the post-Soviet area (Figure 1).

Figure 1. Devaluation/appreciation of local currencies in selected countries, %

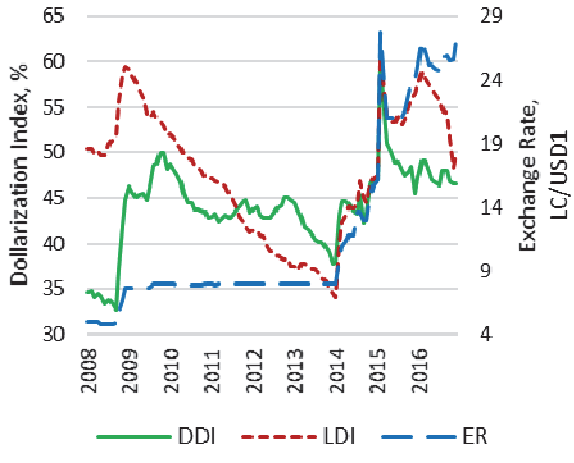


Source: Authors' calculation based on the official exchange rate (LCU per US$, period average) according to data gathered from the World Bank.

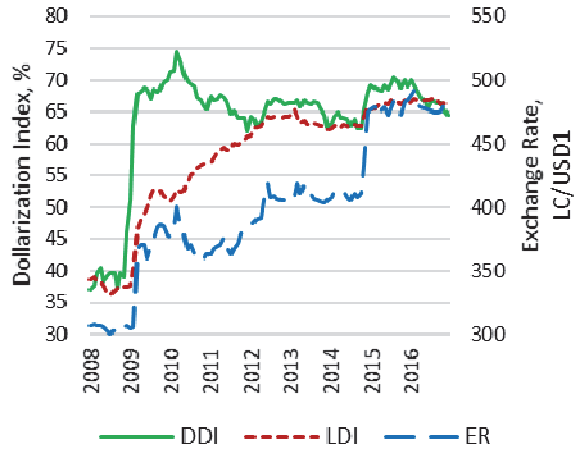
Secondly, these countries are characterized by high level of financial dollarization. We can observe a drastic increase in deposit (foreign currency deposits as a percent of total deposits - DDI) and loan (foreign currency loans as a percent of total loans - LDI) dollarization indices in the aftermath of the global financial crisis and economic and political problems of 2014-2016 years in selected countries. Both surges in financial dollarization were provoked by the high level of local currency devaluation shown in Figure 2. It had a serious impact on the structure of the bank balance sheet and resulted in the appearance of currency mismatches.

Figure 2. Trends in financial dollarization in selected countries

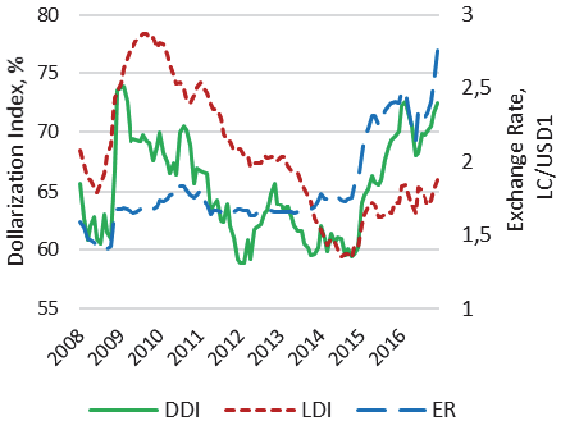
Trends of DDI, LDI, and ER, Ukraine



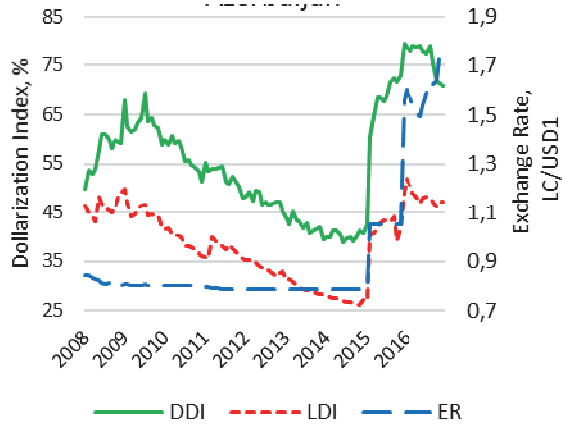
Trends of DDI, LDI, and ER, Armenia



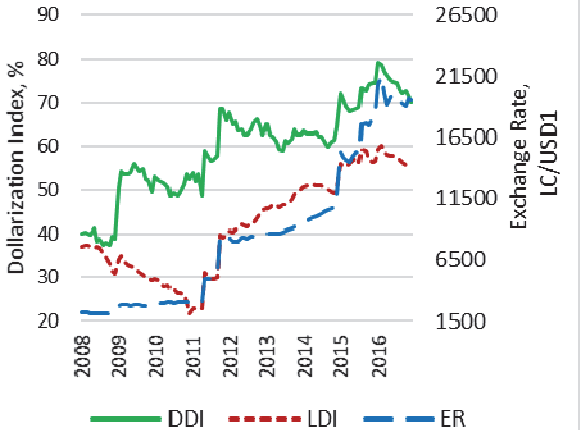
Trends of DDI, LDI, and ER, Georgia



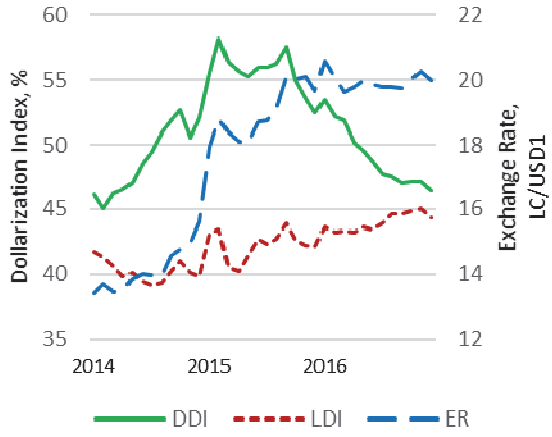
Trends of DDI, LDI, and ER, Azerbaijan



Trends of DDI, LDI, and ER, Belarus



Trends of DDI, LDI, and ER, Moldova



Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

Thirdly, the consequences of dollarization for banking system were not discussed under the issue of risk-return correspondence in case of a mismatch of the loan and deposit dollarization in these countries. Finally, they represent the post-Soviet countries from Eastern Europe and the Caucasus and the research of financial dollarization in the countries of this region has been limited over recent years.

Our findings are structuring bank's behaviour into three strategies based on the proposed model. The first strategy concentrates on the deposit de-dollarization and decreasing (not conducting) transformation of foreign currency deposits into local currency loans. Under the second strategy, we consider the idea based on the increase of deposit dollarization and also decreasing (not conducting) transformation of foreign currency deposits into local currency loans. The third strategy entails the deposit de-dollarization and conducting transformation of foreign currency deposits into local currency loans. The application of the proposed model, which is based on data on the interest rates on deposits and loans in local and foreign currency, as well as the foreign exchange rates, allowed us to identify the appropriate strategies for the banks in analysed countries. Based on the data of deposit dollarization as of the end of 2016, the model shows that the first strategy could be used by banks in Ukraine and Belarus, the second strategy – by banks in Azerbaijan and Moldova,

and the third strategy – by banks in Armenia and Georgia. The specificity of balancing of strategic and tactical risks is determined by input data to the model.

The structure of this paper is as follows. Section 2 provides a literature review. Section 3 describes the analysed data and considers the methodological approaches to research. Section 4 presents analysis of the suggested model. Section 5 deals with the findings of the study on the case of selected countries. Section 6 is devoted to further considerations and discussion. Section 7 provides some general conclusions.

1. LITERATURE REVIEW

Traditionally, when we mention financial dollarization we should distinguish between two of its components: deposit and loan dollarization. When looking into deposit dollarization, there is an implication of supply of deposits owners. Economic agents consider foreign currency to be a reliable asset worth of investing money in (Duffy, Nikitin and Smith, 2006). Main reasons for deposit dollarization in emerging markets can be explained by hysteresis or ratchet effect due to high inflation, exchange rate volatility, interest rates volatility, etc. J. Mongardini and J. Mueller (1999) analyse ratchet effects in currency substitution model on the example of the Kyrgyz Republic during 1993 – 1998. They conclude that the devaluation of local currency is the main factor in the growth of the consumer substitution ratio and that the interest rates on the deposits in local currencies are not high enough to ensure better profitability than the deposits in foreign currency. M. Brown and H. Stix (2015) deepen understanding of the issue of deposit dollarization by means of analysing households' behaviour under inflation expectations, devaluation expectations and negative experience with the local currencies in the past. They underline that experience of Eastern Europe countries shows the inevitability of deposit dollarization. P. Honohan and A. Shi (2002) explore the links between deposit dollarization and the pass-through of exchange rate changes, the ratchet effect, the volume and currency structure of bank lending in 58 emerging countries during 1990 – 2000. Nevertheless, some of these issues remain ongoing. For example, authors underline, that the links between the growth of dollarization and profitability of banks remain unclear, especially under existing of indirect currency risk for lenders. Also, banks in emerging markets do not have instruments for foreign exchange rate risk hedging. It means that the bank balance structuring is one of the very few instruments of protection against dramatic devaluation of local currencies. The other factors affecting deposit dollarization are a currency risk premium, a money flow from abroad (foreign direct investments, remittances etc.), currency competition in value storing etc. Thus, dollarization of deposits inevitably develops in banking systems of emerging markets. Moreover, according to Honohan and Shi (2002) and G. De Nicolo et al. (2005), it leads to specific risks that require clear identification and appropriate analysis, evaluation and managing.

In turn, loan dollarization occurs as the result of deposit dollarization (Luca and Petrova, 2008), high inflation expectations under low volatility of exchange rate (Luca and Petrova, 2008; Brown and De Haas, 2012), currency competition in interest rates, etc. It should be pointed out, that loan dollarization is rarely explored as an autonomous phenomenon. It is especially applicable to banking activity, because loan dollarization in banks' balance sheet is closely linked to deposit dollarization, and usually this linkage brings to currency mismatch. This raises the question of optimal bank balance sheet structuring in terms of risk-return correspondence, especially in the case of sharp devaluation of local currencies under a high level of financial dollarization.

It is important to note that currency shock for the emerging markets is particularly painful because banks get used to working under a fixed exchange rate for a relatively long time. Moreover, on the eve of the crisis, the analysis of macroeconomic indicators showed a high probability of devaluation, but banks failed to predict its level. In fact, W. Choi and D. Cook (2004) note that under a fixed exchange rate, bank balance sheets are more stable in the conditions of dollarization. They have been right and that has become especially obvious when we observe the situation in coun-

tries we analysed. H. Basso, O. Calvo-Gonzalez, and M. Jurgilas (2011) provide an analysis of deposit and loan dollarization in transition countries during 2000 - 2006 and conclude that the indices of deposit and loan dollarization do not always closely correlate, and that interest rates play a special role in decisions on the formation and allocation of funds in local or foreign currency. K. Neanidis and C. Savva, (2009) note, that deposit and loan dollarization is a way to minimize portfolio risk and analyse the problem in terms of both depositors and banks in the short term period.

Research by A. Ize and E. Levy Yeyati (2003) proposes a portfolio model, which represents the idea of currency composition in assets and liabilities of banks. Such considerations have formed one of the pillars of our study. Also, A. Armas, A. Ize and E. Levy Yeyati (2006) mention return volatility – credit risk correspondence depending on currency resilience. We attempt to use this concept in developing dollarization risk management tools for the banking sector. Also, I. Marcelin and I. Mathur (2016) examine effects of dollarization in countries with high dollarization level and conclude that currency risk devaluation is crucial in terms of risk-return correspondence in banks, especially under assets and liabilities currency mismatch of banks customers. The consequences of financial dollarization need to be evaluated, that is why we consider the risk-return correspondence in the situation of high volatility of foreign exchange rates in selected highly dollarized post-Soviet countries.

It has transpired that there have been only a few country-specific research papers that describe the trends in the financial dollarization on the eve and in the aftermath of the global financial crisis, and also provide the solution to the currency mismatch issues. N. Versal and A. Stavytskyy (2015) conduct analysis of deposit and loan dollarization in Ukraine during 2005 – 2014 and propose the model, which explains household decision making on deposit placing in the banks under the high level of dollarization, inflation expectations, and foreign exchange vulnerabilities. A. Skrypnyk and M. Nehrey (2015) propose a model of optimal currency structure of deposit portfolio under exchange rate instability. They verify this model on historical data of Ukraine in 2002 – 2007. O. Loiseau-Aslanidi (2012) suggests using a money-in-utility function model for dollarization evaluating and approves it on monthly data from Georgia during 1996 – 2007. The results show an important role of the exchange rate, interest rates on foreign and domestic currencies time deposits, and domestic and foreign inflation.

The review of the literature and the results obtained by the scholars prompted us to conduct a study that would clarify some aspects of currency structure of bank's loan and deposit portfolio under high-level dollarization, sharp devaluation of local currencies and existing interest rates in six post-Soviet countries from Eastern Europe and the Caucasus. This means that banks should find possibilities to respond to challenges of deposit as well as loan dollarization under poor access to hedging instruments. We would like to test two main hypotheses:

i. The risk-return correspondence of dollarization phenomenon can be effectively represented by the application of two criteria to the general model of a bank's expected profit/losses distribution. One criterion is the minimisation of risk measured by CVaR. The risk measure CVaR is significant. Different aspects of this measure are analysed in G. Scego (2004). Another criterion is the maximization of expected return.
ii. The essential grounding of risk-management of dollarization lies in considering strategic risk (presented by a ratio of deposits in foreign currency) and tactical risk (identified through a ratio of foreign currency deposits transformed into local currency loans and vice versa).

2. DATA AND METHODOLOGY

2.1 Data

In the study, we use data from six countries. They include three parameters that are included in the proposed risk management system.

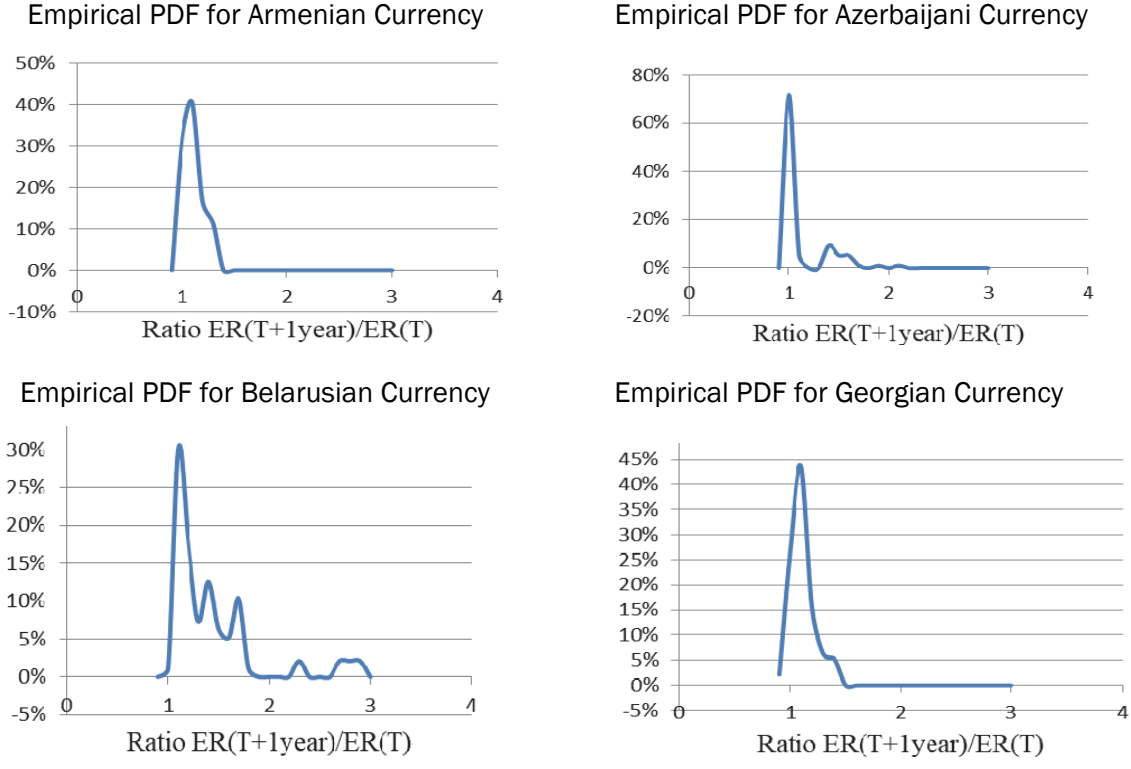
The first parameter – the deposit dollarization data (the percentage of deposits attracted by banks in foreign currency). Data show that the deposit portfolio of a bank contains a significant part in foreign currency. This is shown in Figure 2. Apparently, in four countries, the level of dollarization at the end of 2016 exceeds 60%, and in two countries, it is within the range of 45-55%.

The second parameter – the loan interest rates data. These rates determine the profitability of lending activities of banks in national and foreign currencies, as well as the yield from the transformation of deposits in one currency into loans in another currency. We used data from the statistical bulletins of central banks of selected countries. The completeness of these data is the subject of discussion. One should note that in reality, lending has a number of special features in selected countries. First, the conditions of loans are not transparent due to latent interests, fees, insurances, etc. That is why the interest rates data from central banks are not fully representative because they do not include all these payments. Second, interest rates vary for different types of loans. In particular, interest rates on loans to corporations and to households can differ significantly. With regard to deposits, it should be stressed that the income from them, as a rule, is subject to taxation and therefore the real interest rate may be lower. Nevertheless, we chose data from the statistical bulletins of central banks of the selected countries because of their comparability.

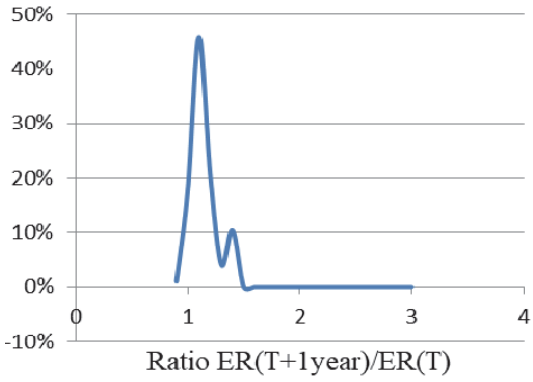
The third parameter – the foreign exchange rates data. We used exchange rates for the period from January 2008 to December 2016 (96 months). The ratio $\frac{ER(T+1year)}{ET(T)}$ formes the basis for our analysis. These calculations indicate probability distribution functions (PDF) which are asymmetric and have right-skewed tails.

Figure 3 displays PDF values for monthly average data. It is obvious that all graphs illustrate the long tails of PDF. This explains the logic for introducing CvaR (Conditional Value-at-Risk) as a quantitative measure of risk.

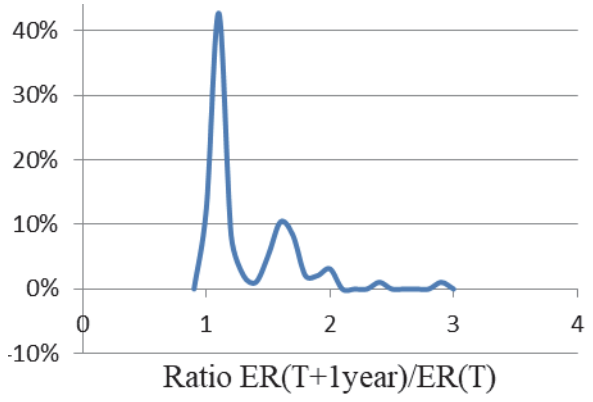
Figure 3. Empirical PDF for currencies ratios in selected countries



Empirical PDF for Moldovan Currency



Empirical PDF for Ukrainian Currency



Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

2.2 Methodology

Bank attracts deposits in local and foreign (dominated by US dollars) currencies and issues loans in local and foreign currencies. Bank's depositors use potentials of both currencies. Deposits in local currency are characterized by high deposit rates and, simultaneously, high risk of possible depreciation. Contrariwise, deposits in dollars are characterized by low deposit rates and resistance to depreciation risk.

Simultaneously, bank issues loans in both currencies. Granting loans in local currency is attractive because loan rate is high whereas loans in dollars have a lower rate. Therefore, banks need to consider the issue of ensuring an optimal mix of currencies on both sides of the balance sheet. We propose the following formalization of this problem and management approach.

Let us consider one-time interval, for instance, of one year. At the beginning of interval t_0, bank attracts deposits in both currencies and immediately issues loans, also, in both currencies. Currencies exchange rate is Er_0. At the end of period t_1, bank plans to receive payments from borrowers and pay back deposit payments. The exchange rate at period t_1 will be Er_1, which is a random variable with some probability distribution.

Assumption 1. Bank's goal is to maximize total return on local currency.

Assumption 2. Bank wants to measure risk in an adequate way.

Assumption 3. Optimisation should be considered from the "risk-return correspondence" standpoint.

Additional assumptions have technical character. Reserve ratio is 0%. All interest payment will be paid at period t_1. There are no restrictions on loan granting. There are no fees or commissions either.

We denote volumes of attracted deposits in local and foreign currencies as D_{lc} and D_{fc}. Deposit interest rates are denoted as $i_{D_{lc}}$ and $i_{D_{fc}}$. Naturally, $i_{D_{lc}} > i_{D_{fc}}$.

Volumes of loans granted are denoted as L_{lc} (in the local currency) and L_{fc} (in the foreign currency). Credit interest rate in local currency $i_{L_{lc}}$ is higher than the similar rate in the foreign currency $i_{L_{fc}}$.

Our first suggestion for the model to be constructed concerns attracted money in local currency. It is logical to transform all volume D_{lc} into the loans in local currency taking into account that $i_{D_{lc}} > i_{D_{fc}}$ and $i_{L_{lc}} > i_{L_{fc}}$. Moreover, as long as a bank does so, the dollarization risk is not present.

The second suggestion is to divide attracted deposits in foreign currency according to a certain proportion (v_1, v_2); $v_1 \geq 0$; $v_2 \geq 0$; $v_1 + v_2 = 1$, where v_1 indicates part of D_{fc} to be transformed into loans in foreign currency, and v_2 indicates part of D_{fc} to be converted (by exchange rate Er_0) into the local currency and transformed into loans in local currency. Differences in these two approaches constitute a basic case of risk-return correspondence. Indeed, $v_1 \cdot D_{fc}$ is low return and no direct currency exchange risk, while $v_2 \cdot D_{fc}$ is high return but highly prone to currency exchange rate.

Let us analyse risks and returns at abovementioned three parts. Net profit from borrowing and lending in local currency at the time t_1 will be:

$$P_{lc} = L_{lc} \cdot (1 - BR_{lc})(1 + i_{L_{lc}}) - D_{lc} \cdot (1 + i_{D_{lc}}), \qquad (1)$$

where BR_{lc} is the bad rate for loans in local currency. The bad rate is defined as the annual percentage of expected losses for a diversified credit portfolio (it is a little different from classical bad rate presented in percentage of defaulted loans). Recovery rate is not included in the BR_{lc}.

According to our first suggestion $L_{lc} = D_{lc}$, and we can rewrite formula 1 as:

$$P_{lc} = D_{lc} \cdot R_{lc}, \qquad (2)$$

where $R_{lc} = (1 - BR_{lc})(1 + i_{L_{lc}}) - (1 + i_{D_{lc}})$.

It is useful to note that BR_{lc} depends on the currency exchange rate. Since a drop in exchange rate usually reflects some problems in economy, the BR_{lc} may increase.

Assume that v_1 ($v_1 \in [0,1]$) is a part of attracted deposits in foreign currency transformed into loans in foreign currency. The formula for profit in foreign currency is the following:

$$v_1 \cdot D_{fc} \cdot (1 - BR_{fc})(1 + i_{L_{fc}}) - v_1 \cdot D_{fc} \cdot (1 + i_{D_{fc}}), \quad (3)$$

where BR_{fc} is the bad rate for loans in foreign currency. It is useful to note that BR_{fc} also depends on the currency exchange rate. Part of borrowers receive their incomes in local currency and depreciation of local currency increases debt pressure and raises non-performance.

Return for deposit-lending activity in foreign currency is as follows:

$$(1 - BR_{fc})(1 + i_{L_{fc}}) - (1 + i_{D_{fc}}) \quad (4)$$

Expression of (4) in local currency will essentially depend on currency exchange rate at period t_1:

$$R_{fc} = \left((1 - BR_{fc}) \cdot (1 + i_{Lfc}) - (1 + i_{Dfc})\right) \cdot \frac{Er_1}{Er_0} \quad (5)$$

Therefore, a higher exchange rate Er_1 has two implications: higher return under depreciation and lower return under increased bad rate.

The remainder of deposits in foreign currency is transformed into loans in local currency at Er_0: $v_2 \cdot D_{fc} \cdot Er_0$ ($v_2 = 1 - v_1$) where the interest rate is $i_{L_{lc}}$. The main economic logic for this is the higher level of $i_{L_{lc}}$ than i_{Lfc}.

Net profit (expressed in local currency) from transforming deposits in foreign currency into loans in local currency ($P_{fc\to lc}$), is:

$$P_{fc\to lc} = v_2 \cdot D_{fc} \cdot \left(Er_0 \cdot (1 - BR_{lc})(1 + i_{Llc}) - Er_1 \cdot (1 + i_{Dfc})\right) \quad (6)$$

Therefore, the return $(R_{fc\to lc})$ from this operation will be:

$$R_{fc\to lc} = (1 - BR_{lc}) \cdot (1 + i_{Llc}) - (1 + i_{Dfc}) \cdot \frac{Er_1}{Er_0} \quad (7)$$

This expression is crucial for understanding risk-return correspondence under dollarization. If $Er_1 \approx Er_0$, then profit may be high because of $i_{L_{lc}} \gg i_{Lfc}$. By the other way, if $Er_1 \gg Er_0$, then losses may be high.

Aggregated financial results, expressed in local currency, equal to:

$$P_{Total} = P_{lc} + P_{fc} + P_{fc\to lc} \quad (8)$$

Deeper insight into "generating return" implies decomposing return into three generators: D_{lc}; $v_1 \cdot D_{fc} \cdot Er_0$ and $v_2 \cdot D_{fc} \cdot Er_0$. The weights of each amount in the structure of bank's attracted money are equal:

$$w_{lc} = \frac{D_{lc}}{D_{lc}+v_1 D_{fc}\cdot Er_0+v_2\cdot D_{fc}\cdot Er_0} \quad (9)$$

$$w_{fc} = \frac{v_1\cdot D_{fc}\cdot Er_0}{D_{lc}+v_1\cdot D_{fc}\cdot Er_0+v_2\cdot D_{fc}\cdot Er_0} \quad (10)$$

$$w_{fcd\to lcl} = \frac{v_2\cdot D_{fc}\cdot Er_0}{D_{lc}+v_1\cdot D_{fc}\cdot Er_0+v_2\cdot D_{fc}\cdot Er_0} \quad (11)$$

Consequently, the total return on local currency will be:

$$R_{Total} = w_{lc} \cdot R_{lc} + w_{fc} \cdot R_{fc} + w_{fc\to lc} \cdot R_{fc\to lc} \quad (12).$$

Er_1, BR_{lc}, BR_{fc} are random variables.

2.3 Risk management model

The variability of R_{Total} in our risk management model is identified as the risk of dollarization. The risk escalates under the local currency devaluation and is dependent on deposit dollarization level in a bank. Indeed, the values of R_{Total} depend on the percentage of dollar deposits in total deposits (denote it d) and on the percentage of their transformation into the local currency (v_2). The level d will be called a strategic risk, and v_2 – a tactical risk. The risk management of dollarization is carried out on the base of the bank's choice of d-values and v_2-values. Also, we assume that the bad rate is zero. This assumption is used to focus on the risk associated with the transformation of foreign deposits into local loans.

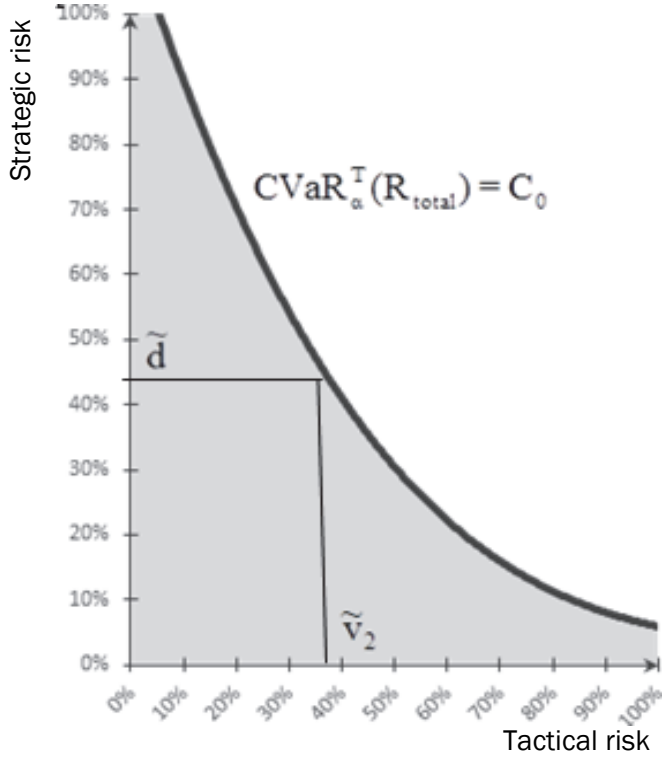
As a measure of risk, we propose Conditional Value at Risk for variable R_{Total}: $CVaR_{\alpha}^{T}(R_{Total})$. T – the period of modelling (1 year), α – confidence level (95%). Details about CVaR are presented in G. Scego (2004), as an example. There are several reasons for our choice of such measure of a risk. Firstly, it is logical to use the Value-at-Risk methodology, which is widely used for modelling marketing risks in the banking. This measure is proposed by Basel Committee on Banking Supervision. Secondly, the nature of dollarization risks in emerging markets is characterized by a long and heavy right-skewed tail of probability distributions of exchange rates

$\frac{Er_1}{Er_0}$. These risk characteristics are effectively measured by Value-at-Risk and Conditional Value-at-Risk. For this reason, we choose these measures for Assumption 2.

The risk management model implies a restriction on $CVaR_\alpha^T(R_{Total})$: $CVaR_\alpha^T(R_{Total}) \geq C_0$ and maximization of expected value $E(R_{Total})$ under this condition.

Reduced restriction on $CVaR_\alpha^T(R_{Total})$ generates the area of $\tilde{d}$ and $\tilde{v}_2$, which outline set for maximization of return. This area is pictured in grey on the picure OAF (Figure 4).

Figure 4. Risk estimation in model of risk management



The maximum value of profitability is determined by the ratio between interest rates and expected exchange rates. Optimal value by strategic risk is connected with correspondence between $(i_{L_{lc}} - i_{D_{lc}})$ and $E\left(\left(i_{L_{fc}} - i_{D_{fc}}\right) \cdot \frac{Er_1}{Er_0}\right)$. If the first value is greater, it is logical to reduce the level of dollarization, if the second one is greater, then the level of dollarization should be increased. So, it will tend to the 0% or to the 100%.

An optimal level of tactical risk is defined by the correspondence between $E((1 + i_{L_{lc}}) - (1 + i_{L_{fc}}) \cdot \frac{Er_1}{Er_0})$ which denotes expected return of dollarization procedure and $E\left(\left(i_{L_{fc}} - i_{D_{fc}}\right) \cdot \frac{Er_1}{Er_0}\right)$. If the first term is higher, it will stimulate transformation of dollar deposits to local currency loans. If the second term is higher, it will lead to loan granting in dollars.

The widespread case is characterized by some (approximately stable) level of dollarization of deposits $\tilde{d}$. The optimization, in this case, is characterized by segment $\tilde{d}C$. The optimal solution

will be point C or point $\tilde{d}$. The points are defined by correspondence between abovementioned terms.

Therefore, the risk management model based on CVaR measure provides optimization problem in the grey area. The optimal solution is attained by a combination of strategic and tactical risks (d, v_2).

3. APPLICATION OF THE MODEL TO POST-SOVIET COUNTRIES

We applied the constructed model of risk management to six post-Soviet economies: Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine. In these countries, the high level of dollarization and the issues with managing it are relevant both for bank management and for regulators. We used the data of the central banks in these countries from 2010 to 2017. As the parameter for the exchange rate, we used the ratio $\frac{Er_1}{Er_0}$, where Er_0 — the exchange rate of the local currency against the foreign currency for a certain day from the specified interval, and Er_1 - the rate one year after the Er_0.

The ratio $\frac{Er_1}{Er_0}$ is close to 1 when the exchange rate is stable and higher than 1 if local currency edges lower. The base period is the period "0", i.e. calculations were made "ahead". This approach is explained by the logic of the model, which is the assessment of profitability and risk for the year ahead. Table 1 illustrates basic statistical indicators of historical values of $\frac{E_1}{E_0}$ in considered countries.

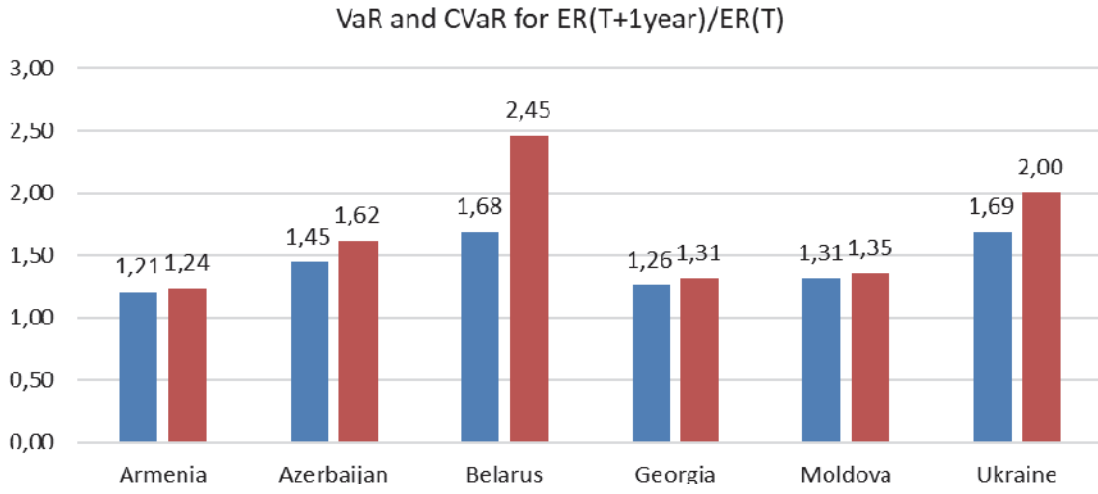
Table 1. Statistical indicators for exchange rates for currencies in selected countries

	Armenia	*Azerbaijan*	*Belarus*	*Georgia*	*Moldova*	*Ukraine*
Range	0,334	1,0932	1,8994	0,48319	0,4975	1,839
Mean	1,0615	1,1045	1,3734	1,065	1,0907	1,2604
Variance	0,00765	0,04909	0,19412	0,01244	0,01362	0,12656
Std. Deviation	0,08744	0,22156	0,44059	0,11155	0,11669	0,35575
Coef. of Variation	0,08237	0,2006	0,32081	0,10475	0,10698	0,28225
Std. Error	0,00892	0,02261	0,04497	0,01139	0,01191	0,03631
Skewness	0,81165	1,9882	2,0977	1,0772	1,0157	1,6185
Excess Kurtosis	-0,41506	3,6543	4,139	0,70942	0,67313	3,2163

Source: Authors' calculation according to data gathered from the statistical bulletins of central banks of the selected countries

As one can see, distributions of $\frac{E_1}{E_0}$ have positive skewness and excessive kurtosis (except for Armenia). Positive skewness is the indicator of a right tail and positive excess kurtosis is the indicator of "heavy" tail. Values of VaR, CVaR and correspondence between them based on historical values for the analysed period are presented in Figure 5. The analysis shows two countries with the essentially high difference in these values, namely Belarus and Ukraine. Ratios CVaR/VaR for them are 1,45 and 1,18 correspondingly. This is an additional indicator, characterized by heavy tails for probability distribution functions (PDF).

Figure 5. VaR and CvaR for $\frac{ER(T+1year)}{ET(T)}$



Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

Our calculations for strategic and tactical risks following considered model are based on indicators of deposit interest rates and loan interest rates in both currencies. We use deposit interest rates and loan interest rates as the average values in the 2016 year. $\frac{Er_1}{Er_0}$ values are estimated on monthly data for period Jan 2008 – Dec 2016 (Er_0 runs from Jan 2008 – Dec 2015, Er_1 runs from Jan 2009 – Dec 2016). The results are shown in Table 2.

Table 2. Strategic and tactical risks and dollarization management

Country	*Strategic risk*			*Tactical risk*		
	$(i_{L_{lc}} - i_{D_{lc}})$	$\left(i_{L_{fc}} - i_{D_{fc}}\right) \cdot \mathrm{E}(\frac{Er}{Er}$	Dollarization	$\frac{(1+i_{L_{lc}})}{(1+i_{L_{fc}})}$	$E(\frac{Er_1}{Er_0})$	Transformation dollar deposits into local currency loans
Armenia	0,0574	0,039	Decrease	1,076	1,062	Increase
Azerbaijan	0,0498	0,0525	Increase	1,019	1,105	Decrease
Belarus	0,0945	0,0781	Decrease	1,147	1,373	Decrease
Georgia	0,102	0,0605	Decrease	1,093	1,065	Increase
Moldova	0,0358	0,0415	Increase	1,079	1,091	Decrease
Ukraine	0,077	0,0506	Decrease	1,097	1,260	Decrease

Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

Following the results of the model application, it is reasonable to divide markets into two groups according to the management of strategic risk (Table 2). Countries from the first group (Armenia, Belarus, Georgia, and Ukraine) should decrease deposit and loan dollarisation because the interest margin in local currency (the difference between interest received on local currency loans and interest paid on local currency deposits) is higher than the interest margin in foreign currency (the difference between interest received on foreign currency loans and interest paid on foreign currency deposits) corrected on the expected value of $\frac{Er_1}{Er_0}$ and denominated in local currency. Countries from the second group (Azerbaijan and Moldova) should, on the contrary, increase the deposit and loan dollarization due to higher interest margin in foreign currency. Also, the risk premium in lending interest rates in local currency does not cover the devaluation risk.

Based on the tactical risk, we can also divide countries into two groups. The first group (Azerbaijan, Belarus, Moldova, and Ukraine) is characterized by a decrease in transformation of foreign currency deposits into local currency loans. The explanation is based on the fact that expected value of $\frac{Er_1}{Er_0}$ is higher than the ratio of lending rates in local currency. The second group (Armenia and Georgia) is characterized by the logic of increasing transformation of foreign currency deposits into local currency loans.

Thus, we see that, based on a combination of strategic and tactical risk, the banks of the analysed countries can choose the following strategies. The first strategy, which involves reducing the dollarization of deposits and reducing (not conducting) the transformation of deposits in foreign currency into loans in national currency, is appropriate for Belarus and Ukraine. These countries are characterized by a decrease of both indicators – the decrease of deposit dollarization and the decrease of the transformation of foreign currency deposits into local currency loans. This can be explained by two factors. The first factor is the high expected value of $\frac{E_1}{E_0}$ - 1,3734 for Belarus and 1,2604 for Ukraine. This is a reason for excessive risk of transforming dollar deposits into loans in local currency. The second factor is connected with relatively high returns on local currency loans due to strong demand for such loans and a risk premium for the devaluation of the local currency. Thus, these countries have unique opportunities for using lending in local currency due to high-interest rates on such loans.

The second strategy, which implies an increase in the dollarization of deposits and the reduction (not conducting) of the transformation of deposits in foreign currency into loans in local currency, is suitable for banks in Azerbaijan and Moldova. The interest margin in foreign currency corrected on the expected value of $\frac{Er_1}{Er_0}$ is higher than the interest margin in local currency, or, more simply, it is better to do banking in foreign currency because the devaluation of local currency provides a better return for this case.

The third strategy involves reducing the deposit dollarization and at the same time increasing (conducting) the transformation of deposits in foreign currency into loans in local currency. This strategy is suitable for banks in Armenia and Georgia. This is possible due to high-interest rates on loans in local currency, which cover the risk of its devaluation, and low-interest rates on deposits in foreign currency.

The difference between strategic and tactical risks is essential. Strategic risks are connected with the strategy of attracting deposits in foreign currency. Hence, there may be some contradiction with the tendency of supplying deposits. In turn, the tactical risk is determined exclusively by risk-return correspondence. Taking into account this distinction, we can assume that ratio of deposits in foreign currency is determined by “external” factors. Thus, we have a predetermined dollarization level. The case with predetermined dollarization level is shown in Table 3 and Table 4, which provide the values of $E(R_{Total})$ and $CVaR_{\alpha}^{T}(R_{Total})$, calculated for the existing levels of dollarization in the selected countries. Graphical interpretation is also given below (Figure 6).

Table 3. $E(R_{Total})$ for the existing levels of dollarization in selected countries

Expected Return $E(R_{Total})$	Dollarization level $(1-w_{lc})$	Tactical risk (v_2)					
		0%	20%	40%	60%	80%	100%
Armenia	60,30%	4,64%	4,86%	5,08%	5,30%	5,51%	5,73%
Azerbaijan	70,70%	5,17%	4,34%	3,51%	2,67%	1,84%	1,01%
Belarus	70,10%	8,30%	5,29%	2,28%	-0,73%	-3,74%	-6,75%
Georgia	72,50%	7,20%	7,81%	8,43%	9,05%	9,67%	10,29%
Moldova	51,30%	3,86%	3,69%	3,52%	3,35%	3,19%	3,02%
Ukraine	46,30%	6,48%	4,79%	3,10%	1,41%	-0,28%	-1,97%

Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

The illustration of finding the optimal level of transformation of dollar deposits into local currency loans can be effectively seen in Tables 3 and 4. Indeed, the countries form group 1 according to tactical risk (Azerbaijan, Belarus, Moldova, and Ukraine) indicate minimization of such transformation. The banks from countries presented in group 2 according to tactical risk (Armenia and Georgia) should choose an acceptable level of risk and find point $\widetilde{v_2}$ (see Fig.5). Therefore, for example, if we choose CvaR with 0%, the solution (point C at the Fig.4) will be 40% for Armenia and Georgia. If we choose CVaR -6% it will be 100% for Armenia and 80% for Georgia.

Table 4. $CVaR_{\alpha}^{T}(R_{Total})$ for the existing levels of dollarization in selected countries

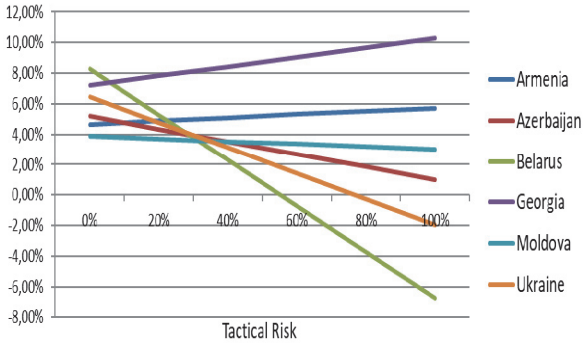
Risk $CVaR_{\alpha}^{T}(R_{Total})$	*Dollarization level* $(1-w_{lc})$	*Tactical risk* (v_2)					
		0%	20%	40%	60%	80%	100%
Armenia	60,30%	4,39%	2,70%	0,31%	-2,08%	-4,47%	-6,86%
Azerbaijan	70,70%	4,77%	-3,43%	-14,24%	-25,06%	-35,87%	-46,68%
Belarus	70,10%	6,82%	-8,40%	-30,09%	-51,79%	-73,48%	-95,18%
Georgia	72,50%	6,58%	4,70%	1,10%	-2,51%	-6,11%	-9,71%
Moldova	51,30%	3,52%	1,19%	-2,01%	-5,22%	-8,43%	-11,63%
Ukraine	46,30%	6,46%	-5,13%	-18,96%	-32,80%	-46,64%	-60,48%

Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

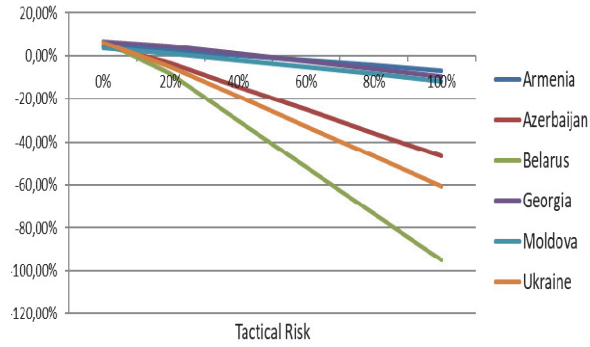
Graphs in Figure 6 also illustrate differences in rates of decreasing CVaR and rates of decreasing/increasing expected return. These are the essential components of risk-return correspondence for markets from group 2. Bank management should compare the rate of increased expected value with the ratio of decreased CVaR.

Figure 6. Dependency expected return and CVaR from tactical risk in selected countries

Expected Return: Dependency from Tactical Risk



Conditional Var: Dependency from Tactical Risk



Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

4. FURTHER CONSIDERATIONS AND DISCUSSION

The first discussion issue is the choice of the model distribution of exchange rates. In the calculations presented in the previous paragraph, we used the distribution of annual returns based on the data of seven years (2010-2016). For each currency, this period includes both stable periods and periods of sharp devaluation. In stable periods, it is logical to use one distribution and another one in the period of falling. A generalization in this direction can be the use of shorter time intervals and modelling them using a certain family of probability distributions. The family of distributions is characterized by certain parameters that vary depending on the trend of the exchange rate. Each trend corresponds to certain values of the parameters.

When identifying a trend, distribution functions with appropriate parameters can be applied. Considering the fact that the real data $\frac{E_{r_1}}{E_{r_0}}$ show distributions with heavy right tails, it makes sense to use distribution families that would model well such characteristics. Such families are, for example, Gumbel, Freshet, Weibull, Generalized Extreme Value (GEV) distribution and others, as it is pointed out in Coles (2001).

Based on the "EasyFit 5.6 professional" software, we obtained fitted distributions. One of the adequate families was Generalized Extreme Value distribution (for all analyzed countries except Azerbaijan). This family of distribution includes three parameters: a location parameter m, a scale parameter σ, and a shape parameter ξ, the values of which are given in Table 5.

Table 5. Parameters ξ of fitted GEV distribution

	Armenia	*Azerbaijan*	*Belarus*	*Georgia*	*Moldova*	*Ukraine*
Shape parameter ξ	0,10	0,57	0,37	0,10	0,05	0,34

Source: Authors' calculation according to data gathered from the statistical bulletins of central banks in selected countries

Development of such approach entails structuring time intervals. Modelling distribution from GEV is the next step. Then, it is necessary to analyse the behaviour of parameters through the time. Let us illustrate this for the Georgian foreign currency exchange rate.

Table 6. Dynamics of parameters of GEV distribution: Georgia

Time period	*Shape parameter* ξ	*Std. Deviation*	*Mean*
Jan 2010 –Dec 2010	0,06905	0,03668	0,92325
July 2010- June 2011	-0,20048	0,02912	0,92862
Jan 2011 –Dec 2011	-0,91997	0,0267	0,97913
July 2011- June 2012	-0,22298	0,00809	0,99805
Jan 2012 –Dec 2012	-0,0103	0,00814	1,0029
July 2012- June 2013	-0,22906	0,02718	1,0251
Jan 2013 –Dec 2013	0,10785	0,01148	1,0535
July 2013- June 2014	0,02565	0,08146	1,1009
Jan 2014 –Dec 2014	-0,70788	0,08216	1,2754
July 2014- June 2015	-0,65608	0,17403	1,1773
Jan 2015 –Dec 2015	0,14202	0,064	0,99763

Source: Authors' calculation according to data gathered from the statistical bulletins of central bank of Georgia

Dynamics of parameter ξ has cyclical character, which is connected with currency exchange rate behaviour. Indeed, growth $\frac{Er_1}{Er_0}$ tends to growth ξ and reverse. In the period of the falling exchange rate, the estimated ξ is high, but after the fall we get the stabilization of exchange rate and we may suppose that ξ should be low, instead this parameter is high. That is why it is possible to use in the model a supposed (estimated) ξ.

Another important question is linked to the dependency of the bad rate on currency devaluation. Bad rates for loans in foreign currency, as a rule, react stronger to sharp devaluation in case when borrowers get incomes in local currency. Under such conditions, sharp devaluation eats up income when calculated in foreign currency and increases the probability of borrower's default.

Different types of lending may also become an important factor for the proposed model. First of all, there may be a different configuration of "loan interest rates - bad rates". For example, consumer lending vs corporates lending.

The foreign exchange restrictions introduced by central banks may also affect the model application. Central banks may introduce some restrictions on the transformation of attracted deposits into loans in different currencies or may restrict consumer lending in foreign currency. For instance, in some countries (Ukraine, Belarus) loans to households, who do not have earnings in foreign currencies, were banned after the Global financial crisis.

CONCLUSIONS

This paper presents findings of deposit and loan dollarization management in banking for six post-Soviet countries: Armenia, Azerbaijan, Belarus, Georgia, Moldova, and Ukraine. The level of dollarization in banks in these countries is high and ranges from 45% to 75%. This naturally raises questions about an optimal economic strategy for banks under these conditions. The proposed model of risk management enables to identify a strategy for resolving the dilemma of how to balance loan and deposit dollarization. The model is based on analysis of risk-return correspondence for a total return of bank that tries to balance loan and deposit dollarization. Effective strategy under dollarization should be built around two factors. One is linked with an opportunity of getting high returns from converting attracted deposits in dollars into loans in local currency. However, this will only be justified in case of relatively stable exchange rates. Another is risk burden of such conversion. The study proves that risk management of dollarization is based on the combination of two main types of risks. The first is the strategic risk of deposit structure presented by the ratio between attracted deposits in foreign currency and local currency. The second is tactical risk presented by the ratio of dollar deposits transformed into local currency loans. Risk measure in this model is introduced as Conditional Value-at-Risk. Such approach is justified by a possibility of an extreme devaluation of local currency presented in the long tail of probability distribution function.

Our model provides an effective tool for the choice of an adequate strategy. The first strategy concentrates on the deposit de-dollarization and not conducting transformation of foreign currency deposits into local currency loans. The second strategy implies, on the contrary, the increase of deposit dollarization, but at the same time also not conducting transformation of foreign currency deposits into local currency loans. The third strategy entails the deposit de-dollarization and conducting transformation of foreign currency deposits into local currency loans. According to our calculations, the banks of four countries can conduct deposit de-dollarization, using the first (Ukraine, Belarus) and the third (Armenia and Georgia) strategies. Banks of the two countries (Azerbaijan and Moldova) can be guided by the second strategy, which involves an increase in the dollarization of deposits. In the latter case, proceeding from the fact that the level of deposit dollarization in these countries is quite high, it is also necessary to take into account other factors, in particular, currency restrictions. Further model development entails taking into account the rate of non-performing loans in foreign and local currency. Also, country-specific regulatory restrictions on currency structure of deposits and loans could be considered.

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