INTERNATIONAL BLACK SEA UNIVERSITY

FACULTY OF BUSINESS MANAGEMENT

DOCTORATE PROGRAM IN BUSINESS ADMINISTRATION

Analyzing and Modeling Vulnerabilities of Financial Sector Using Stress Testing Methodology (Case of Armenia)

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Extended Abstract of Doctoral Dissertation in Business Administration

Tbilisi, 2017

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INTRODUCTION

The significance of having prudent financial system that is able to absorb the challenges of the fast growing global economy is being accepted worldwide as a non-divisible part of financial regulation. Especially after the recent US subprime crisis that shook almost every economy and every financial system, international organizations like IMF, Basel Committee of Banking Regulation, and Financial Stability Board in line with regulatory authorities from countries with advanced financial systems are year by year disseminating new projects and regulatory standards trying to increase the attention towards financial stability and various aspects of it. Moreover, for increasing the awareness of regulatory authorities of different countries IMF has been developing the project of Financial Soundness Indicators and the stress testing as a tool for evaluating the stability.

From the time of establishing the project of FSIs IMF has been disseminating the guidelines and the suggestions of compiling those indicators and using as a signaling tool for financial instability. FSIs include various aspects of the financial system and are able to decode the hidden information one can get about the financial stability within a country. They include coherent information about the capital requirements of the financial institutions, indicators of household debt and income in line with the information about the non-financial corporations. In spite of the fact that they touch all the economic agents who can affect financial stability by their actions, FSIs contain valuable indicators about the different types of risks that deposit takers face. A set of risks is addressed in the core set of FSIs including credit risk, liquidity risk and solvency risk.

While addressing the credit risk within a country FSIs contain valuable information about the overall non-performing loans in the country. This is the non-performing loans ratio (NPL). With this indicator it is possible to model the credit risk of a country and conduct a stress test with various adverse scenarios trying to reveal possible gaps in the financial system regulations. These procedures allow controlling for the country-wide credit risk and creating a regulatory framework which will provide a cushion to the financial institutions or deposit takers in the form of capital and ensuring smooth fluctuations of the system-wide financial indicators. Nowadays various methodologies for calculation of capital requirements exist. However those methodologies need to be revised and adapted from time to time to make them up-to-date and to assure economic agents that financial system is firm and well-capitalized. Under well-capitalized not only the overall capitalization is meant. Regulatory authorities and the existing literature divide the capital requirements of the deposit takers also between the certain type of activity, concrete type of risk and the amount of risk exposures.

Regarding the amount of risk exposures it is worth mentioning that the FSIs and stress testing allow to assess and evaluate the risks that have been lying behind the recent US subprime crisis and not only. According to part of the literature one of the main factors affecting the crises across the globe is the household debt, consumer debt as part of it and household indebtedness in general. As for many examples like the US, Cyprus, Greece, the Netherlands, Portugal, Ireland and Spain household debt and consumer debt played the key role in the disturbances of the financial systems and, hence, triggered the failure of the main players in the system. That is why these kinds of risks have to be initially defined, modeled, assessed and controlled with the help of plenty of tools nowadays available.

Problem Statement

Considering the above mentioned developments in the worldwide financial markets and the financial systems of particular countries and having the bad example of those countries regulatory authorities and research institutions must give an increasing role to the mentioned risks and try to take actions on modeling them and building a comprehensive framework for controlling those risks and trying to reduce the potential future losses arising from this or that factor. The case of consumer loans should be especially overviewed given their high riskiness with high levels of expected/unexpected losses and the fact that these credits are not backed with any type of collateral. Moreover the problem of controlling the credit risk of these particular credit types becomes more significant in an environment where those credits are growing with a geometrical progression.

Goal Statement and Research Questions

As far as consumer credits are one of the strong driving forces of the credit risk among all other credits, current research concentrates on modeling credit risk for non-collateralized consumer loans on the example of Armenia using the stress testing methodology for assessing the vulnerabilities related to the credit risk of consumer loans. Armenia has not been chosen by chance. This country has a relatively short history of capitalism and especially very short history of financial system with banks as almost the only financial intermediaries. Moreover, Armenia is facing a growth in consumer loans with huge pace, and there is a pre-estimation suspect that consumer loans in Armenia are not backed with enough capital. Consequently, several research questions have been raised that are supposed to get answered in the end:

1. What macroeconomic fundamentals are explaining the consumer credit risk? Especially does the credit risk depend on the international money transfers?
2. Does the model of ARDL (autoregressive distributed lag) allow conducting a proper forecasting based on the proposed consumer credit risk model?
3. Is the level of capitalization of consumer loans in Armenian banking sector enough according to current RWA's calculation methodology?
4. Does the level of outstanding loans affect output on the sample data of the Republic of Armenia? In other words, is there a trade-off between financial stability, i.e. credit risk mitigation, and the real output growth?

Fourth research question has risen in the process of the consumer credit risk assessment and stress testing and turned into a controversy argument for the believed outcomes of the research.

Novelty and Relevance

This topic is quite essential for a country like Armenia, where after the collapse of Soviet Union financial system has just been established and the regulatory framework is still subject to certain gaps resulting to a vulnerable financial sector. It becomes more topical considering the recent enormous growth in the level of consumer debt and the household indebtedness in Armenia and the absence of researches concerning the issue of consumer credit risk macro-modeling. Moreover, by choosing the country of research the work aims to link the remittances to the consumer credit default rates, trying to show that these credits can be directly affected by foreign factors such as the remittances. Hence the work will incorporate these two variables into the macro-model, where the remittances will appear as the independent variable and the default rates as the dependent one. The novelty of the research lies behind the fact that using stress testing methodology it addresses the level of capitalization of particularly one type of credit, the consumer loans. Another aspect of novelty supporting the research is the attempt to oppose two equally significant bulks of the topic, and to reveal the possible trade-off between financial stability (credit risk mitigation) and economic growth that regulatory authorities face.

The relevance of the paper stems, at first, from importance of the topic that IMF, BIS, ECB and other regulatory authorities are assigning to it. The question of household debt has been a topic of hot debates especially after the US subprime crisis. Moreover, the issue of the consumer loans has been a growing problem during the recent years in Armenia. Armenia has quite high levels of financial intermediation relative to the countries with similar past and similar indicators. During the first half of 2015 it turned out that Armenian banks, almost the only financial intermediaries

in Armenia, are prone to not only domestic but also foreign risks mirrored in the international money transfers. Thus, this work will fill in the gap in the analysis of that external factor concerning the evolution of Armenian financial sector. Another evidence of novelty of current work lies behind the calculations of the RWA's of consumer loans. This work sets a doubt on the methodology currently applied in Armenia, agreeing with the Basel Committee that their proposed methodology has a country specific discretion, which needs to be considered when setting the required level of capital and the methods of RWA's calculations.

Significance of the problem

Analyzing vulnerabilities of the financial system and the risks it is exposed to gives a unique chance to avoid the possible downturns in the entire economy. If the regulatory authorities do not pay attention to the issues like credit risk and the capital requirements will not be enough to cover the possible unexpected losses, then the whole financial system stands in front of a big risk as financial institutions may even face solvency issues, besides huge losses.

Practical and Theoretical Value

The most important theoretical value of current work is the choice of the comprehensive model for conducting the credit risk assessment and the stress testing based on the model specification. The research is going to use the ARDL model to account for the inter-temporal processes that exist among the macroeconomic fundamentals and to make it possible doing a forecast based on that model. The ARDL model is proved to be a proper one with very simple and easy to conduct framework and with comprehensive forecasting results.

The practical value of the research lies behind the determination of the possible gaps in the regulatory framework of the consumer credit market in Armenia. An important finding can be whether the level of capitalization of the consumer loans is enough or the regulatory authorities have to change it. Another very significant practical value of the work stems from the question, whether there is a trade-off between financial stability and economic growth.

Research Methods

For the purposes to answer the imposed research questions the quantitative research methods have been applied in the work. Mainly an econometric ARDL model has been built for

explaining the consumer credit risk in Armenia, with the autoregressive processes in the independent variables. After finding the model specification the work proceeds with stress testing by choosing a comprehensive stress scenario and a statistical forecasting. At the final part again using the Keynesian classical model and referring to the author Driscoll (2003), another quantitative analysis is conducted to find out the impact of loans on the real output growth by using the Instrumental Variable approach.

Structure of the Dissertation

Dissertation consists of 127 pages, includes 3 chapters, 11 sub chapters with their sub headings and conclusions. It contains 22 tables and 8 figures. Author has published three scientific articles devoted to the various aspects of study. All of them are relevant to the dissertation.

The structure of the dissertation includes the literature review on the important aspects of financial stability, methodologies of stress testing, credit risk modeling and analyzing the impact of loans on the real output growth. Particularly, a focus is placed on the credit risk macro-modeling. This is the most important task in terms of getting correct results. In the pre-last subchapter of the literature review the existing literature on the topic of the interdependence of loans and the real output is discussed. In the second chapter the data description and the methodologies are discussed for conducting the quantitative analysis, particularly the data of the credit risk modeling and estimations and the data of the analysis of the impact of loans on real GDP growth. In the methodology part applied methods are presented, both for the credit risk modeling and stress testing and the methodology of the analysis of the loan supply's effect on real output growth. The third chapter discusses the results and the estimation process, while the last chapter concludes based on the findings of the research and gives recommendations. The dissertation also provides the lists of tables, figures and abbreviations as well as appendices presented separately.

LITERATURE REVIEW

"What constitutes financial system? Typically, financial system consists of financial markets, instruments, institutions and infrastructure." (Crockett, 1997) The regulatory structure on the other hand plays an important role in regulating and monitoring the system. Financial system stability can be defined as the resilience of the financial system to internal and external shocks, be it economic, financial, political or otherwise. It can also be described as the absence of

macroeconomic costs of disturbances in the system of financial exchanges between households, businesses and financial institutions. Financial system stability is evidenced by and reflected through an effective regulatory infrastructure, effective and well developed financial markets and effective and sound financial institutions. Financial instability, on the other hand, is manifested through the failures of significant institutions, intense asset price volatility and the collapse of market liquidity. (Davis, 2001)

Regarding the concern of financial instability International Monetary Fund (IMF) propounds the project of Financial Soundness Indicators (FSI) and Stress testing as a tool of assessing that instability. FSIs are indicators of the current financial health and soundness of the financial institutions in a country, and of their corporate and household counterparts. The purpose of FSIs is to support the macro-prudential analysis (IMF 2006). This is the assessment and surveillance of the strengths and vulnerabilities of financial systems, with the objective of enhancing financial stability and, in particular, limiting the likelihood of failure of the financial system.

Two sets of FSIs are proposed by IMF in the FSI dissemination guidelines. Most central banks and policy makers are focusing mainly on the Core set of the indicators which are the aggregated data of an entire system. This set basically touches almost all the risks the deposit takers face (credit risk, liquidity risk, foreign exchange risk and finally solvency risk). Macro-prudential analysis touches only the macro aspects of the abovementioned risks and after compiling FSIs one can model any of them which will show how FSIs are affected by macroeconomic fundamentals. It will reveal the weaknesses of the financial system. On contrary, micro-prudential analysis focuses on the institutional level of the research. That is in reality the analysis of the effect of different factors, which arise from the macroeconomic shocks, on the balance sheet of a particular financial institution.

One of the FSIs, non-performing loans (NPL), represents the quality of deposit takers' assets. In other words, it shows the credit risk in the financial and the non-financial sectors. The credit risk is "the risk of loss of the loan principal amount and any potential return thereon arising from borrowers' failure to repay loans in full or in part according to the repayment terms agreed upon" (Elsiefy 2012). The credit risk is one of the most significant risks that can highly reflect the weakness of financial system and banking sector. The recent US financial crisis proved it. NPL ratio shows the ratio of the non-performing loans and the outstanding loans. The data for the entire financial system is constructed through aggregation of the non-performing loans data across all institutions. Regulatory authorities also present the separated NPL ratio for the different types of

credits with different criteria (NPL of business loans, NPL of consumer loans etc.)

As far as there is a need to handle with credit risk, regulatory authorities proposed different methodologies for evaluating and controlling credit risk. The Basel Committee has issued a document named "Principles for the Management of Credit Risk" in order to encourage banking supervisors globally to promote sound practices for managing credit risk. "Since exposure to credit risk continues to be the leading source of problems in banks world-wide, banks and their supervisors should be able to draw useful lessons from past experiences. Banks should now have a keen awareness of the need to identify, measure, monitor and control credit risk as well as to determine that they hold adequate capital against these risks and that they are adequately compensated for risks incurred." (BIS, 2000)

This research focuses on a statement by BIS indicating the need to define proper levels of capital for the coverage of credit risk losses. Thus the approaches of the capital requirements calculation have been reviewed. The important part of the capital requirements calculation is the calculation of risk weighted assets of a bank, because all of the risks that an institution is exposed to are aggregated in total RWAs. Hence, RWAs besides the capital of an institution are the second component of calculating the Capital Adequacy Ratio (CAR). This means that RWAs define the capital requirements. If the risk weight decreases the capital requirement decreases and vice versa. The possible action for controlling credit risk is to assign proper risk weights. That is why one needs to look at the existing methodologies of RWAs calculation.

The Basel II regulatory framework proposed two different approaches for regulatory capital calculations. The first approach is to measure the risk in a standardized manner, while the second one relies on the banks' internal model which must be approved by the supervisory authorities. Banks can adopt either the standardized approach or the internal ratings based approach (IRB). The first approach is easy to use and it is based on the credit ratings of borrowers assigned by external credit assessment institutions, which has been criticized so far. One can encounter a simpler version of the standardized approach, according to which regulatory authorities assign risk weight to a particular product be it a corporate or any type of retail loan. Those product types are grouped in the same risk category thus they have the same risk weight.

Calculating RWAs with IRB approach allows the banking institutions to give their own ratings and thus the risk weights to their clients, yet with the allowance of the regulatory authorities. Institutions are supposed to use their own internal quantitative models to estimate the main indicators that define the expected loss from banking activities. The IRB approach can rely on plenty of statistical models and quantitative analyses. However, the standardized approach is

more widely spread one which is the case for the country under this study as well. That is why the work concentrates on that exact method of RWA's calculation. The Basel Committee also has been paying an increasing attention on the standardized approach "to ensure that capital requirements reflect the inherent riskiness of exposures and that the standardized approaches constitute a suitable alternative and complement to internal models". (BIS, 2015)

The methodology Armenian financial system is using in calculations of risk weighted assets is a somewhat standardized approach, where regulatory authorities define the ratings of the borrowers. Credits are not the only components of the risk weighted assets as all of the components of the financial institutions balance sheet have to be weighed by their exposures with the predetermined risk weights by CBA. This is illustrated in the CBA banking regulation standards defining credit risk calculation methods in the risk weighted assets. In the regulatory document all of the balance sheet articles of an institution starting from cash and cash equivalents till off-balance sheet articles have their own weights that vary from 0 to the ones even higher than 100 per cent. For instance, cash and cash equivalents have the weight zero, besides the ones in the second basket of currencies excluding Russian ruble. For consumer loans the risk weight has been set, as the Basel Committee suggested for the retail credits risk, to 75 per cent. Meanwhile all other credits, be it retail credits or business loans, in domestic currency should be weighed with 75 percent and ones in foreign currency with 110 percent.

According to this methodology CBA calculates the CAR as the indicator of the level of capital in the banking system. This ratio is set at 12 percent in Armenia and CBA on a regular basis keeps track of this indicator for every bank to make sure they have enough capital to withstand negative shocks and realizations of the different types of risks. In other words CBA wants to make sure that the banking sector capitalization level is enough for smooth operation of the financial system in general. As far as CAR is the ratio between the regulatory capital and the risk weighted assets, it means that for instance one unit of capital corresponds to the on schedule consumer loans of 16 units, such that the ratio is 12 percent. Thus this methodology backs the non-collateralized consumer loans of 16 units with 1 unit of capital. This methodology, concretely for the case of consumer loans, is questioned in the scopes of this research.

For the purposes of assessing whether the aforementioned methodology works properly, one has to model at first the risk that is intended to be not well capitalized. In the case of this research that risk is the credit risk which has its indicator among the FSIs compiled by IMF, NPL ratio. However, before using the NPL ratio as a proxy for the credit risk one needs to build a comprehensive model which allows conducting a stress test later on. A bulk of literature touches the topic of the stress testing and credit risk modeling methodologies. Those methodologies are

divided into two types. The first type is the 'piecewise approach', when one estimates a direct relationship between macroeconomic variables and a FSI. Then one can test the stability of the financial system under bad circumstances. The next type is the 'integrated approach'; when different risk factors are modeled together for assessing overall losses under the stress scenario.

The choice of macroeconomic variables is crucial in stress test modeling of credit risk. Jakubík and Schmieder (2008) were the first in the literature who compared two countries, Germany and Czech Republic. Schmieder do credit risk modeling and stress test by a Merton-type one factor model. This model was used by Hamerle et al. (2004), Rösch (2005) and Jakubík (2007) and it is also the basis Basel II capital requirements calculation (Gordy, 2003). They modeled the aggregated credit risk conditional on the macroeconomic environment and tried to keep the model as simple as possible. They did the estimation and the stress test for the corporate and the household sectors. Finally, they found enough evidence that in both countries the same variables significantly affect the default rate in the household sector. However the corporate default rates in those countries were not linked to the same factors. For the household sector the most relevant variables were found to be unemployment rate, real wage rate and the interest rate.

Jan Willem van den End, Marco Hoeberichts, Mostafa Tabbae (2006) provide another way of modeling the credit risk. They use a non-linear logit model as Jakubík and Schmieder. The purpose of it is to capture the non-linear possible relationship between macro-variables and the default rate and to extend the domain of the dependent variable to the negative side as well. They have chosen such regressors that have the best fit into the model. Unlike Jakubík and Schmieder, in this paper stress test is analyzed based on the LLP instead of NPL. These two FSIs can be used almost equivalently when doing a research. Loans loss provisions are used for the write off of poorly classified assets. NPLs show how much a bank has lost. Hence, using NPLs can be more relevant as after predicting NPLs provisions to loans losses can be adjusted but the other way round is impossible. Furthermore, in this specification there is a new term for fixed effects. It takes into account firm specific characteristics.

Another paper by Virolainen (2004) does a stress test of NPL for Finland. He used the model of Wilson (1997) as Boss (2002) and adapted for the case of Finland. Instead of the credit quality Virolainen uses NPL ratio and again as Tabbae he uses logistic model. The author uses a logistic transformation of NPLs and does a stress test using SUR (Seemingly unrelated regression). The period of their study was from the year of 1983 till 2003. This period includes 1990s when the corporate default rate in Finland was high and the banking sector was in a recession. They

found GDP, interest rates and corporate indebtedness to be highly significant in defining the default rates.

It becomes obvious that a huge part of the literature on the stress test of the credit risk follows the methodology propounded by Wilson. He was one of the first who explicitly modeled the relationship between the corporate sector default rate and the macroeconomic factors. Boss applied that model for the aggregate corporate sector of Austria. He stressed the banking sector of Austria with a bad scenario. In the end, he found suggestive evidence that the nominal short-term interest rate, inflation, the oil price and the industrial production are the most significant variables that affect the corporate sector default rate (Boss 2002). In 2011 Schetchman and Gaglianone (2011) conduct a credit risk stress test for the household sector of Brazil. They use the traditional model of Wilson as Virolainen and Boss. It is adapted for the case of Brazil and they used the structural VAR modeling. In terms of methodology, current study as well adapts the existing models and conducts the research using ARDL model.

Another question that this research aimed to answer stemmed from the idea that if the credit risk model and stress tests reveal that unexpected losses of consumer loans are exceeding the capital buffer assigned to those credits then their risk weight must be increased which corresponds to a state with a lower credit supply, given the fixed level of capital. The literature and the economic theory suggests that the credit supply can have a positive relationship with real output growth. Hence another analysis is needed to find out whether there is a trade-off between the financial stability and the real output growth. Various authors in various countries have conducted a similar research trying to find out the aforementioned relationship.

Traditional models of business cycle developments are neutral to the developments in credit market, following Modigliani-Miller theory (1958), that financial markets are efficient, and there is no information asymmetry. However, part of the literature shows the dual nature of the relationship between credit and GDP growth. The credit flow increases aggregate demand. Then, this is reflected in the formation of total output in the economy, in the range of a positive elasticity of GDP to the lending dynamics. However, recent financial crises reveal that credit rationalization can have a negative impact on the real economy. Bernanke (1993) and Friedman and Kuttner (1993) have found evidence showing that the downturn in the U.S. in early 1990 was strengthened by credit supply restrictions, while following studies have included financial sector dynamics as an explanatory function of business cycles. Bernanke, Gertler and Gilchrist (1999) developed a dynamic general equilibrium model that includes credit market frictions in explaining the evolution of the business cycle. The key point of the existing framework is that financial system

is not independent and it behaves as an intermediary of exogenous events. This approach shows the role of financial markets in spreading macroeconomic shocks.

Moinescu and Codirlasu (2011) state, that not every supplement of economic growth is positive for the long-term welfare of society, especially if it is obtained through increasing indebtedness. Sustainable welfare is not created by excessive debt. The desire to rapidly advance in living standards by resorting to loans was one of the ingredients of the unsustainable growth for number of CEE countries. GDP growth above its potential is a signal of overheated economy, which may amplify country's vulnerability to external shocks. Beneficiaries of bank financing, mostly individuals, have boosted domestic consumption above internal production capacity and prices have followed an upward trend masked by a pseudo convergence process, not only for consumer goods and services or real estate, but mostly for labor costs. Reducing the propensity of savings decreases the ability to finance investment using domestic resources.

Koivu (2002) specifies that increase in loans has not always been sustainable and it may have reduced the growth rates. It is demonstrated that in transition economies the presence of an efficient banking sector accelerated economic growth. Banking sector in transition economies has shown a rapid expansion in the second half of the 1990s. Tahir and others (2015) have conducted a vector error correction model analysis, as far as the variables showed to be co-integrated, and the bank lending showed a negative impact on real GDP. The abovementioned papers used a methodology in which the key assumption is the independency of bank loans.

Another notable paper by Driscoll (2003) answers the question whether bank lending affects output in the US and conducts the analysis with no assumption of loan supply being independent. Instead, he accepts that loans may endogenously rise in response to the expected future increases in output. Endogeneity of bank loans imply using the two-stage least squares method, where the first regression is the loans regressed on money demand shocks (instrumental variable). On the second stage the level of output is regressed on the instrumental variable, which reveals the possible relationship between bank loans and output. One of the working papers of European Central Bank by Cappiello and others (2010), referring to the work of Driscoll adapted the methodology and conducted a similar research for European Union.

METHODOLOGY

From the methodological point of view current research uses mostly quantitative analysis tools for getting the answers to the initially proposed questions. The first thing that was done for the purposes of doing this analysis was the data collection from the various credible sources. Those

sources contain the databases of the CBA, National Statsitical Service of Armenia, IMF and World Bank. Finally the research ends up with a monthly dataset starting from the beginning of the year of 2005 till December 2015 for the first quantitative analysis, which is the credit risk modeling and the stress testing. The dataset for the second part of the research contains the data from March 2003. The data has been cleaned and made useful in the process of the statistical analyses.

For the purposes of conducting a credit risk analysis, modeling and the stress testing in the end the existing methodologies has been adapted for the case of Armenia. At first the credit risk model has been built according to the inter-temporal processes that the variables contain. The research constructed an ARDL model with two equations for this purpose.

$$y_t = \beta_0 + \sum_{i=1}^{p} \beta_i \, y_{t-i} + \eta_0 x_t + \sum_{j=1}^{q} \eta_j x_{t-j} + u_t \quad (1)$$

$$x_{i,t} = \gamma_{i,0} + \gamma_{i,1} x_{i,t-1} + \cdots + \gamma_{i,m} x_{i,t-m} + \eta_t \quad (2)$$

The equation number one is the main equation showing the relationship between the logit transformation of the NPLs and the macroeconomic fundamentals and their time lags. Meanwhile the second equation is an auxiliary regression that helps in the evolution of the NPLs predicted values and it is the autoregressive process of the regressors from the main equation. There is a difference in the methodology of current work and what theory uses. For the case of Brazil, by Scetchman for example, a structural VAR is used to estimate the model. This means that they capture the effect of the auxiliary regressions' residuals on the macroeconomic index. For this purpose they need to estimate the covariance matrix of the residuals from the auxiliary regressions and the residuals of the main equation. In contrast this study uses an ARDL (autoregressive distributed lags) model which can be estimated with a linear regression. The only problem is the correlations of the residuals from the main and from the auxiliary regressions (that is the correlation of Corr(u_t, η_t)). This problem can be solved and the correlations can be made almost zero (hence the effects of the auxiliary regressions' residuals can be made almost zero) if more lags of explanatory variables are included in the model. This methodology has its advantage over the others used by Virolainen and Schetchman and others. ARDL model is easy to use and the results are easy to interpret as it is a linear regression. It makes easy the forecast of the model as well which allows using linear prediction

On the stage of defining the methodologies for the research the next column of this research is the methodology that has been elaborated for the analysis of the interdependence of the loans and the real output growth. As part of the literature, particularly Drsicoll (2003) and Capiello et al. (2010), this research as well makes the widely used assumptions for the model set-up. The first

one is the imperfect substitutability of deposits for banks as a source of funding. Banks cannot easily turn to any other form of financing. The second one ensures that loans are not perfectly substitutable (for firms and households) with bonds or equity or any other form of debt. After building the environment for the model we use the proposed by Driscoll (2003) framework of banks' lending channel. As far as there may be a causal interrelationship between loans and output we use the method of instrumental variable to overcome this issue. Shocks in money demand which are correlated with the loan supply but not with shocks in output and loan demand can be the instrumental variable in the regression of output on loans.

To illustrate the above mentioned, imagine a positive money demand shock take place for a given output and interest rates. Since households and firms are trying to hold more money deposits will increase. If the lending channel does operate, the increase in the deposits will bring changes in the levels of loan supply just because bank's have more available resources to lend. Consequently, as loans are not substitutable for firms and individuals the increase in the loan supply will have its effect on the output. Summarizing, one can state that what this part of the work does is estimating the levels of GDP growth rates depending on the levels of loans which is instrumented via the shocks in the money demand side. Referring to a basic Keynesian aggregate demand model the equations at the equilibrium has been constructed which help estimating the relationship of the outstanding loans level and the real output growth.

At this stage of research we do not separate the loan supply of consumer loans from other types of credit contracts, because otherwise it would be impossible to build a model where the endogeneity of loans is solved out. Hence the exercise is done for the overall supply of loans in Armenia just by making another assumption that it does not matter the supply of which type of loan is decreasing as a consequence of increasing the required level of capital for consumer credits. This question could be viewed as our analysis limitation, and it will be elaborated later on.

RESULTS

Having in the hands the necessary data for the research and a proper methodology to follow one can conduct a set of estimations for deriving the useful outcomes from the data. And based on those outcomes one can conclude with certain results and make suggestions and policy implications. For the case of this research two columns of research has been built. On the one hand it is the credit risk modeling and the stress testing based on that model, on the other hand it is the

loans' impact on the real GDP growth. Hence, two estimation procedures have been done and the policy implications and the suggestions lie in between those two columns of the research.

The consumer credit risk estimation for Armenia has been conducted using the main equation where the real GDP growth, interest rates on loans in domestic currency, remittances and the unemployment rate with their lags took place in explaining the NPL ratio. All of these variables proved to be statistically significant having an inter-temporal relationship with the NPLs ratio and explaining its evolution over time. The aforementioned specification seems to be the best fit to the model, due to two important factors. At first the residuals of the main equation have almost zero correlations with the residuals of the auxiliary regressions, which allows to claim that the ARDL model works and is a good substitute for the VAR model, and at second the R-squared of the model is quite high, more than 0.8.

The most significant variable explaining the NPL ratio is its first lag and the inclusion of it in the model R-squared improves significantly. The construction of the dependent variable makes it difficult to explain the results as the coefficient estimates differ from the ones that explain the NPLs due to the logit transformation of the NPLs. The first derivative of the main equation with respect to the first lag of the dependent variable is not constant hence its change is not constant as well. However, the interpretation of the results is not impossible. The relationship between the dependent variable and its first lag is positive. The relationships of the other variables lie behind the economic theory as well. For instance the unemployment rate proved to have inverse relationship with NPL ratio. The real GDP growth has a positive impact on the NPLs, which means that the level of default is decreasing while there is evidence of economic growth in the country. The relationship between the default rate of the consumer loans and the interest rates of loans in domestic currency is also positive which means the increase in the interest rates brings to a decrease in the default rates. This is mainly because at times of crisis increasing interest rates make the loans unaffordable for individuals because of the increasing debt service ratio and indicate tightened credit standards.

Finally, the last variable of our interest which has been set as one of the goals of current research and proved to be statistically significant is the remittances. The remittances and its first two lags show statistical significance answering to the research questions whether the international money transfers explain the evolution of the consumer credit risk. Remittances have a positive parameter sign as it was anticipated. The transfers from abroad are part of the income of economic agents. Even if the borrowers are not the ones who directly receive money, the increase in inflow has overall positive effect on the economy, the aggregate demand and indirectly on creditors.

Thereafter, creditors become less likely to default. On contrary to current remittances the first lag has a negative parameter estimate which comes from the model specification. Considering this factor the overall effect of remittances on default rate is positive.

After having the model parameters evaluated, the next step that is required to highlight the vulnerabilities of the financial system a stress test of the consumer credit risk is needed. The work proceeds at first with a linear prediction of the variables for a time horizon of a quarter. This is the range from December of 2015 till February of 2016. More precisely, the values of the baseline prediction for this period of stress event are changed to an unfavorable way by 10 per cent. This future value generation allows making a dynamic forecast. Furthermore, changing a variable to an unfavorable way means changing it in the direction where the macroeconomic index will decrease which by construction corresponds to a worse state of the economy.

Under the first stress scenario the research finds that during the stress period NPL ratio is more than the baseline prediction. Comparing the values of the NPL ratios one can see that the stress scenario has an effect of wave on it. The reason is that the regressors have inter-temporal effects and their effects have been outweighed by the variables themselves. It is worth noting that the baseline prediction and the stress scenario move together that is they have similar trends. As the macroeconomic index has been transformed back into the NPL ratios, one can observe the difference between the baseline prediction and the prediction under the stress scenario, which will give a rigorous imagination of the banks' financial losses arising from the increase in consumer loans NPL ratio. NPLs of consumer loans under the stress scenario are on average by 1 unit (which is 1 percent of the total consumer loans) more than the NPLs of the baseline prediction for the prediction period. However, the possible effects on deposit takers are still blurry at this stage.

As it was proposed two stress scenarios has been elaborated. The first one has already been discussed which was basically hypothetical scenario. The second one is the historical scenario based on the changes in the historical data of the explanatory variables. The stress scenario includes the shocks to all variables the economy of Armenia faced during the year of 2009. This choice was not by chance, but rather motivated by the fact that from the year of 2009 the banking system and financial system of Armenia in general have been developing and evolving. Moreover, the development was accompanied with an intense growth in the levels of consumer loans and overall loans in general. Why the level of loans is important? From the year of 2009 and so far the debt burden of households and individual economic agents has been growing. Thus, a shock at this moment will have undoubtedly worse consequences than before. For the whole economy it will be much harder to service its debts and the consequences also will be tougher, partly because of

the level of uncollateralized, high-risky and a fastest growing consumer loans portfolio on the banks' balance sheets. These loans will bring big losses with them, which was not present during the year of 2009.

The predicted values of NPLs till the December of 2015 under the second stress scenario and the baseline prediction of NPLs are kept the same. One can infer that the stress testing is done for the time horizon after December 2015 for a full year till the end of 2016. Thereafter, the predicted value of the NPL ratio has been forecasted based on the stress event and the stressed explanatory variables. As it was suspected the shock now will have much worse consequences than the shocks in the past. The analysis shows that the historical stress scenario makes the whole banking sector of Armenia exposed to a consumer credit risk higher than the anticipated baseline prediction to the extent of 7.9 per cent of total outstanding consumer loans during the stress horizon. Under the second stress scenario the consumer loans NPL ratio reaches to the level of 22.3 per cent during the particular months. This should be of real concern from the side of regulatory authorities because the insolvency in the banking sector of Armenia even of a bank and not of a two may have the effect of domino in the system if one takes into account the contingency risk because the correlation between the banks is very high in terms of interbank loans. Besides there is high correlation between the credit portfolios of the banks, concerning the fact that one client has credits in different banks, moreover, they have credits from different credit types, including both retail loans and business loans as an entrepreneur.

One can immediately reject the idea that the first scenario will have crucial impact on the healthiness of the financial system and financial stability. However, in case of the second event the probability of default breaks the barrier of 22 per cent. Unfortunately the research fails to conduct the stress testing at the micro-level, because of the data limitations. However, the work proceeds with estimations of the level of necessary risk weight for consumer credits that will be justified by the losses related to the second stress scenario. As far as the capital is held for the unexpected fluctuations in the PD of the credits, given the level of CAR, the risk weight must ensure that the modeled unexpected losses will be covered by the regulatory capital. If the required CAR is 12 per cent and, moreover, consumer loans have the weight of 75 per cent in calculations of RWAs, then Armenian banks will not be able to absorb the losses equal to 22 per cent which means the level of capital requirement is not enough for covering the unexpected downturns in the consumer loans defaults. Using the RWAs calculation formula provided by Basel Committee, the work calculates the necessary risk weight of the uncollateralized consumer loans for the loss equal to 22 per cent and it is 183 per cent. However, the stress tests show that the maximum losses from

the macroeconomic shock that the banking sector can suffer are not present during the entire stress horizon. Instead, the calculations for the average loss has been done and the resulting risk weight was 142 per cent not taking into account the fact that the existing risk weight of these loans is underestimated. This level of risk weight will ensure as much capital in the banks as they need to cover the additional 7.9 per cent unexpected loss they may have if an adverse scenario like the one in the second scenario, which everyone once has been a witness to, happens again.

In the end, one can surely claim that the consumer loans being affected from different factors, especially the international transfers as a source of income for households, are not backed with enough capital and in case of historical repetition of a stress event of 2009 the overall financial stability in the country will be placed under a big question. The calculations of the necessary level of capital showed that the risk weight of these credits must be almost doubled. This suggestion has its shortcoming, as far as the level of credit supply depends on the level of capital banks have and requiring them to keep more capital for the same amount of credit portfolio binds them from supplying more loans. That is why the second part of the research tries to answer the question: "Does the level of loans affect real GDP growth?"

Finally, the relationship between the loan supply and the level of real GDP growth was estimated, doubting that the decrease in the loans supply can bring to a worse state of the real output growth. Using the Instrumental Variable (IV) approach and instrumenting the loan supply by the money demand shocks the regression analysis with two stages was conducted. The implementation of the IV approach solves the problem of endogeneity of the loans, i.e. the interdependence between the loan supply and the real output growth. Final results of the estimation show that the loans instrumented by the money demand shocks have positive impact on the real GDP growth. Moreover the variables of loans instrumented via money demand shocks proved to be statistically significant.

LIMITATIONS OF THE RESEARCH

As far as a research does implications based on the modeling of a phenomenon it is studying and makes forecasts based on that modeling, it finally ends up with making certain assumptions and meets several limitations of the basic model set-up. Current work is not an exception either. That is why it is worth noting the limitations that the work encountered during the research. It will allow to fully understand the methodology of the work and to realize the model errors that can appear and affect the results if one does not abstract from the assumptions that the model makes, and attempts to use the model in decision-making. Those limitations are:

1. The first limitation of the adopted methodology for current work, one can argue, is the choice of the piece-wise approach of modeling a financial soundness indicator. For the well-known reason, stating that the piece-wise approach estimates a direct and linear relationship between the risk measure and the macroeconomic fundamentals, meanwhile the integrated approach estimates the probability distributions of the losses (Sorge and Virolainen, 2006).
2. The next limitation of the chosen model of macroeconomic stress testing in current study can be the specification of the model. The proposed model is an ARDL (autoregressive distributed lag model) with auxiliary regressions of the explanatory variables that are included in the main ARDL equation. Theoretically there are correlations between the auxiliary regressions error terms and the error terms of the main equation, which will make the forecast results biased. However the work reduces the bias from this issue by including more lags of the variables in the auxiliary regressions, trying to force the correlations of the error terms of the auxiliary regressions and the main equation to tend to zero.
3. Current analysis finds that the increase of the risk weight of consumer loans decreases the credit supply through the entire economy. However, when analyzing the effect of diminishing credit supply on the real GDP growth rates, current work uses the total credit supply in the economy instead of using the supply of consumer loans. It is not illogical because at first the smaller the credit supply of consumer loans the smaller the overall credit supply and at second when increasing the risk weight of consumer loans one does not know whether it will have negative effect on the supply of consumer loans or on any other type of loans. Elaborating a little bit the second statement, one can obviously note that consumer loans in the case of Armenia being the most profitable loans may not decrease in supply. Hence, for clearly stating that increasing the risk weight of consumer loans will decrease the supply of the same type of credits is ambiguous and a subject of another research.
4. The most wide-spread problem in every research is the lack of data. For the case of current research data has obviously been one of the main problems that even limited the future extension of the research. It is worth noting that the data limitations are related to not only the length of the time series but also to the frequency of it. The work lacks of a useful estimation procedure of the out of sample performance due to the data availability, because all of the available data was used for model estimations.

5. Finally, one can note that the assumption about the status of the loans, made in the estimations of the relationship between the loans and the real output growth, is yet another limitation, because in reality there exist different sources of financing firms can switch to. However there is a justification for this limitation saying that for the country of our study the channels like interest rate or the liquidity channel does not work properly. That is basically why the bond yields did not take part in the analysis.

CONCLUSION AND RECOMMENDATIONS

The significance of having prudent and stable financial system that is able to absorb the challenges of the fast growing global economy has been an issue for the recent decades. The academic world pays great attention to the concept of financial stability and its various aspects because economic history of the entire world shows how devastating consequences shocks in financial system can bring to the real sector of a particular economy. There is an experience of The Great Depression, the most recent financial crisis in the US that shook all the world and dozens of crises across the globe. These crises showed that the financial sector of a country and financial institutions operating there can be vulnerable and, thus, can trigger crises. This issue gave rise to several projects implemented to estimate the healthiness of a country's financial system and to prevent the upcoming crises. That is why IMF has been developing the project of Financial Soundness Indicators and the stress testing as a tool for assessing that stability. FSIs contain valuable indicators about the different types of risks that deposit takers and their household and corporate counterparties face. Current research has been focusing on the credit risk from the list of those that are addressed in the set of FSIs. With the help of the indicator of NPL ratio current research has modeled the consumer credit risk of Armenia and conducted stress tests with two adverse scenarios trying to reveal the weaknesses and vulnerabilities of the financial system and possible gaps in the regulation standards.

First of all it is worth mentioning why current work has been devoted to the issue of uncollateralized consumer credits, their credit risk, the level of capitalization and the possible impacts this credit type can have on the whole financial stability of the country. During the last two-three decades there have been paid increasing attention to the household debt, especially after the US sub-prime crisis. Many scholars do believe and many of them have even proved for different countries that the increasing indebtedness of the households (corporates as well) at some

point may become uncontrollable and can be a sign of the expected financial and macroeconomic shocks in the country. As different countries witnessed, many recent crisis have been preceded by quite high output growth rates and, as a "rule", by drastic increases in household indebtedness. For the case of Armenia this issue has a place of a real concern as far as the historical data for the household debt shows that in Armenia after two recent crises, one in 2009 after the US financial crisis and one in 2014, the latter started with the exchange rate fluctuations, the household indebtedness is continuously increasing. Furthermore, from all the types of credits only the consumer loans that are not pledged have been chosen as a subject of the study. This is explained by the facts that, at first, these loans are treated to be the riskiest ones in the whole set of credits in the Armenian banking system. At second, there was an initial belief that in case of Armenia consumer loans are serviced partly by the international money transfers of the individuals and this external factor must be taken into account when imposing regulatory standards on them. Taking into account the abovementioned remarks, a suspect arose that these credits are not backed with enough capital and their risk weight in the calculation of the RWAs for maintaining the regulatory capital requirements does not reflect their true riskiness.

Nowadays various methodologies exist for calculation of capital requirements for the financial institutions or deposit takers, which need to be reviewed from time to time for assuring the economic agents that financial system is prudent and well-capitalized. Under well-capitalized not only the overall capitalization is meant but also regulatory authorities and the existing literature divides the capital requirements between the certain types of activity, certain type of risk and the most important one the certain amount of risk exposures. Before conducting the research, several objectives have been set and certain goals were supposed to achieve. Initially the work differentiated the most essential research questions that were going to be answered as presented in the introductory part. At first glance those questions do not seem very well linked to each other, however the questions have been chosen based on the objective of the work. During the process of the analysis all of the research questions have been answered.

Starting from the very beginning, one can state that at first the research succeeded to model the consumer credit risk, linking it to the proposed variables. Part of the initially chosen macro-variables did not prove to be statistically significant, which means they did not show any sign of explaining the consumer credit risk. The list of the variables explaining the evolution of consumer credit risk consists of the real GDP growth, loans interest rate in domestic currency, the unemployment rate and the most important one the level of remittances. All of these macro-fundamentals proved to have significant effect in explaining the consumer credit risk of Armenia.

Moreover they had also inter-temporal relationships which allowed conducting a stress testing with the forecasted data. The sub-question of the first part of the research also has been answered. The international money transfers (remittances) proved to be highly significant in explaining the consumer credit risk as it was anticipated. The stress testing has been done based on the proposed credit risk model.

The second question has also been answered as far as the research showed that the ARDL model can be used in the credit risk macro-modeling and allows to conduct reasonable forecasting if the correlations between the residuals of autoregressive processes of the regressors from the main equation and the residuals of the main equation tend to zero, which was done in the dissertation. This procedure ensures that there is no evidence of endogeneity of the regressors and no evidence of autocorrelation in the main regression. That is why the consecutive results of consumer credit risk modeling are highly significant and it allows forecasting the NPL ratio with the number of iterations one needs.

The third question that has been raised is the main pillar of this research; it is basically the question that gave birth to current work. All other questions that have been answered and the analysis that has been conducted are supplementary ones. This question has been answered only when the stress testing has been done based on the results achieved from modeling the credit risk. Having in the hands the model coefficients, two stress scenarios have been imposed on the macroeconomic variables, and as a result the banking system of Armenia showed fragility, from the ability to cover the costs that may arise from the uncollateralized consumer credit defaults at times of crisis. Hence it was concluded that the risk weight of the uncollateralized consumer loans in Armenia has been underestimated and must be adjusted and increased.

The last question is of a great interest because it proved part of the international experience of having a positive relationship between the levels of outstanding loans and the real GDP growth. By conducting the modified version of the Driscoll's (2003) analysis the work finds that the loans instrumented by the money demand shocks have highly significant effects on the real GDP growth though the coefficient estimates were not very big. Hence the regulatory authorities face a trade-off between the financial stability and the real output growth. Where does this trade-off come from? On one side of the coin there are financial stability issues that may arise, as the work suggests, from the consumer credit defaults during crises and on the other side the banking system faces a limited ability to lend money to the economy if the regulatory requirements are increased (the risk weight is increased). Hence if the supervisory authorities decide to enhance financial stability in the country and to make sure that the banking sector is able to absorb shocks in the

consumer credit default rates by increasing the level of capital institutions must keep for those credits, they will be about to give up additional loans that would never be injected into the market, thus the country will end up with lower growth rates.

A proper research is conducted for achieving certain results with certain implications based on which one can find a solution of a problem and give certain recommendations. This dissertation is not exclusion. After reviewing the relevant literature, conducting statistical analysis and making implications based on the results, the work combines all of those procedures and makes certain recommendation trying to offer proper solutions for the problems raised in the work:

1. The first recommendation that the dissertation comes up with is related to the financial stability maintenance policies implemented by Central Bank of Armenia in different states of the financial system. As it has been mentioned in the review of the regulatory standards of the Armenian banking system, Central bank differentiates three different policies: preventive, corrective and recovering policies. The dissertation shows that there is a need for corrective changes in the capital requirements for the consumer credits however the economy and the financial system show quite stable behavior. This means that corrective actions in the regulatory standards must be in place in the stage of preventive policy. Basically, it is the advantage of macro-prudential analysis and stress testing, which allows revealing the weaknesses and vulnerabilities of the financial system before a need for corrective actions arises. Summarizing, this research suggests to combine several aspects of the two, preventive and corrective policies, and to conduct macro-modeling and stress testing analyses while implementing the preventive policy and to adjust the regulatory standards in advance.
2. The second recommendation is related to the fact that there is a need to model the consumer credit risk, thus the regulatory capital requirements for these credits must be backed with a macro-prudential analysis. At this period of time this research finds that variables like, real GDP growth, unemployment rate, interest rates on loans in domestic currency and remittances have statistically significant impact on default rates of uncollateralized consumer credits with their corresponding coefficients. However, it is necessary to emphasize that the model parameters are subject to changes in different economic conditions and there is a need to conduct such macro-prudential analyses on a continuous basis.

3. For the purposes of statistical analysis it is highlighted in the dissertation that the ARDL model can be a good alternative to the structural VAR methodology. ARDL makes it easier to interpret the coefficients and gives a chance as the VAR models to conduct a forecast with number of iterations. Therefore, it is recommended to use ARDL approach for credit risk modeling with no hesitation.

4. As a result of the conducted credit risk modeling and stress testing current work has an important finding, stating that current risk weight of the uncollateralized consumer credits does not reflect all the exposure to credit risk that may arise as a consequence of an adverse macroeconomic shock. Consequently, the level of CAR equal to 12 per cent will not be enough to cover the unexpected losses. According to the findings, in order to assure, that the level of capital, in the scopes of 12 per cent CAR, is enough to cover the losses that may arise during the stress horizon, the risk weight of the uncollateralized consumer credits in the banking sector of Armenia must be increased from 75 per cent to 142 per cent. This increase will make sure that the CAR equal to 12 per cent is enough to cover the additional unexpected losses of 7.9 per cent from these credits because the new CAR of 12 per cent will correspond to a higher absolute level of capital.

5. The next and final recommendation is based on findings of the last statistical analysis which shows the impact of loans on real GDP growth. One of the keystones of this research was the wish to link the concept of financial stability (or instability connected to the consumer credit risk) with the economic growth. An important implication from the results of stress testing has been done, saying that the level of risk weight of consumer credits must be increased to match the possible losses that the banking sector of Armenia may face in case of a macroeconomic shock. However from the increase in the risk weight, the ability of banks to lend shrinks given the level of capital. Having in the hand the results of the last statistical analysis, one can claim that the real output growth suffers from the increase of the risk weight of the credits under study (in other words from enhancing financial stability). Hence, the last recommendation is that the regulatory authorities must pay attention to the trade-off between financial stability and economic growth they will face when trying to increase the financial stability. The work does not elaborate on the issue of how much real output growth may suffer from the increase in the risk weight of uncollateralized consumer loans by 67 points, because at first the research is bound by the lack of institutional level data, which the CBA acquires, and at second this is a topic of another research as it implies conducting a sensitivity analysis

between different credit types to find out the supply of which particular credit type decreases when the risk weight of the consumer loans are increased and the most important one, to which extent the credit supply decreases, taking into consideration the abilities of banks to fulfill the additional capital.

Summarizing all the analyses that have been done in the dissertation, it is worth mentioning that the work managed to conduct all the initiated research. The work was successful in: identifying the possible threats to the financial stability of Armenia and Armenian banking system arising from the credit risk of the uncollateralized consumer loans; the evaluation of the magnitude of those threats with stress testing analysis; the disclosure of the inability of Armenian banking system to withstand those threats under the existing regulatory standards; providing a solution to increase the stability of the banking system and, finally, opposing the two important concepts of financial stability and economic growth, showing that there is a trade-off between these two under the set-up of the research and alternative costs do apply. In spite of the fact that the main goals of the dissertation have been achieved, the data availability bound the research and questions concerning the analysis of separate institutions on a micro-level are left to the regulatory authorities who acquire the data or to those curious researchers that will have the access to the data. The dissertation itself has opened a place for further research concerning the topic of conducting a sensitivity analysis of the supply of different credit products, and finding the degree of credit supply deterioration as a consequence to the proposed policy changes. Hence, the topic can be expanded in the future for the sake of firm and stable financial systems.

LIST OF PUBLICATIONS

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