MEASURMENT OF CREDIT RISK BY MACROECONOMIC FACTORS: ALBANIAN CASE

By
Klevis Qazimllari

Thesis submitted for the degree of Master of Science of Banking and Finance

Epoka University

July 2015

APPROVAL PAGE

Thesis Title	:	Measurement of Credit Risk by Macroeconomic factors: Albanian Case.
Author	:	Klevis Qazimllari
Qualification	:	Master of Science
Program	:	Banking and Finance
Department	:	Banking and Finance
Faculty	:	FEAS
Thesis Date	:	September 2015

I certify that this thesis satisfies all the legal requirements as a thesis for the degree of Master of Science (MSc)

Assist. Prof. Dr. Urmat RYSKULOV

Head of Department

I certify that I have read this study that is fully adequate, in scope and quality, as a thesis for the degree of Master of Science (MSc).

Assist. Prof. Dr. Urmat RYSKULOV

Supervisor

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ABSTRACT

Stress testing is a macro–prudential analytical method of assessing the financial system's resilience to adverse events. This thesis describes the methodology of the stress tests and illustrates one of the stress testing models (VARs) for measurement the credit risk by the macroeconomic factors. This approach is important because it gives a significance result about how independent variables affect in a crucial way dependent variables.

A novity to this paper is the fact of building and linking together three main models of estimating the credit risk like Johansen test, Unit Root test and least but not last VAR. These three models give an insight about the significant role of credit risk in an economy, especially in developing countries like Albania.

Credit risk is captured by the non-performing loans in Albania, evaluating this element as the main factor that has a significant impact on the financial stability of the economic environment of the country. The important part of the paper is to give a conclusion about how the macroeconomic impact or effect credit risk seeing the co-integration and the trending movements of the variables taken in study. This relationship is crucial because the economy always depends on the lending procedures of the banks.

In developing countries, as others paper have related, macroeconomic factors impact credit risk or other risks as well in a notable way. What was really surprising about the thesis was that while using the VARs approach to see the critical dependence between variables, the conclusion was very clear: NPLs is affected mainly by the historical data of the default rate. So the trending changes of the NPL over years, has proven to have a decisive impact on non-performing loans. Other factors taken in consideration like GDP, inflation rate or interest rate didn't affect much the non-performing loan rate.

Keywords: Non-performing Loans, Determinants, Banking System, VARs approach, Albania

Jel Classification: E44, G21, G32

ABSTRAKT

Stres Testing është një metodë makroprudenciale analitike për vlerësimin e qëndrueshmërisë te sistemit financiar ndaj ngjarjeve qe kane nje impakt negative ne ekonomi. Kjo tezë përshkruan metodologjinë e stress test-eve dhe ilustron një nga modelet e stress testing qe eshte perqasja VARs e cila sherben për matjen e rrezikut të kredisë nga faktorët makroekonomikë. Gjithashtu kjo teme përqëndrohet ne testing Unit Root e cila perdoret kryesisht për të vlerësuar lidhjen midis variablit të varur dhe variablave të pavarura.

Rreziku i kredisë perfaqesohet nga faktori kreditë me probleme në Shqipëri, duke vlerësuar këtë element si faktorin kryesor që ka një ndikim të rëndësishëm në stabilitetin financiar të mjedisit ekonomik të Shqipërisë. Pjesë e rëndësishme e temes është që të japë një pasqyrë për mënyrën se si rreziku makroekonomik ndikon apo impakton kredite me problem. Kjo marrëdhënie është e rëndësishme për shkak se ekonomia gjithmonë varet nga procedurat e kreditimit të bankave. Në vendet në zhvillim, faktorët makroekonomikë ndikojne ne mënyrë vendimtare dhe te rendesishme kredite e keqija. Ajo që ishte me të vërtetë e habitshme në lidhje me tezën ishte se duke përdorur qasjen VARs për të parë lidhjen midis variablave, u arrit ne nje perfundim mjaft sinjikativ: NPL ndikohet nga të dhënat historike të ecurise se saj gjate viteve. Faktorë të tjerë të marrë në konsideratë si PBB, norma e inflacionit apo norma e interesit nuk ndikojne dukshem, ashtu sic edhe pritej.

Fjale kyce: Kredite me probleme, Sistemi Bankar, Shqiperia, Faktore, Perqasja VAR.

Klasifikimi Jel: E44, G21, G32

DEDICATION

…dedicated to all my loved ones

ACKNOWLEDGEMENTS

The most important acknowledgement and my sincere gratitude go to my advisor, at the same time the head of Banking and Finance department Assist. Prof. Dr. Urmat RYSKULOV. His continuous support, motivation, recommendation, advises and patient helped me complete this thesis and added considerably to my academic experience. I also appreciate his tendency to force me search deep within my ability and belief in me in reaching always higher aims.

Besides my advisor I would like to express my gratitude to other member of Banking and Finance department but especially the dean of the faculty Prof. Dr. Güngör Turan for his advices during the B.A. and MSc. Studies as well as for his continues support as one of my advisers. Also, I would also like to thank all my MSc. Studies professors. Last but not the least; I would like to thank my always spiritual supporting team, my family.

DECLARATION STATEMENT

1. The material included in this thesis has not been submitted wholly or in part for any academic award or qualification other than that for which it is now submitted.

2. The program of advanced study of which this thesis is part has consisted of

i) Research Methods course during the undergraduate study

ii) Examination of several thesis guides of particular universities both in Albania and abroad as Well as a professional book on this subject.

Klevis Qazimllari

September 2015.

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LIST OF ABBREVIATIONS

NPL: Nonperforming Loans

GDP: Gross Domestic Product

PROB: Probability

VAR: Vector auto regressions

BOA: Central Bank of Albania

INF: Inflation

EXCH: Exchange Rate

LIR: Interest Rate

UNEM: Unemployment

ADF: Augmented Dickey Fuller

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Introduction

In 1999 the International Monetary Fund and the World Bank build a program where the macro stress tests were the significant part of the financial stability toolbox as a part of the national regulators and supervisors. Furthermore, in the effects of the financial crisis, stress testing was seen as a crucial element that could identify potential events that may have an impact on the economy of a country.

Stress testing means to measure the risk exposure of the financial system to severe shocks that could help different institutions to evaluate the financial system's vulnerabilities. Different financial institutions use their own stress-testing models, regarding their structure and main purpose.

Even though there have been different studies that have implements different stress testing models, there are no ways how should these models set or how the results should interpret. The main element here is how to build a stress testing model in order to evaluate reality in the most appropriate way. Focusing the attention in different literatures, it can be seen that the application of stress testing models is based on the real financial sectors developments. Different of studies have given a conclusion about the relationship between the NPLs and macroeconomic variables. There are a various previous studies analyzing the macroeconomic factors of non-performing loans in the banking system. Some of them are the study that Pesola (2001) made for the Nordic countries, Kalirai and Scheicher (2002) made for Austria, and Delgado and Saurina (2004) made for Spain. In conclusion, these different studies founded that loan loss provisions are negatively correlated to GDP growth and positively correlated to interest rates. Some of the studies applied the estimated models to stress test the development of the banking system.

What it can be noticed is that while other papers pay attention about the empirical and theoretical parts of the stress testing, our study sees stress testing as a way of measuring the credit risk by various economic shocks**.** While the banking system is the most important sector of the economic development of the financial stability of Albania, non-performing loans are the main key to measure the economic changes. So, seeing the non-performing loans as the main cause of financial instability should lead a country to not providing incomes anymore because of the fact that the payment of the principal and interest is not achieved after the maturity date of the loan itself.Nonperforming loans cause mismatches of maturities between assets and liabilities; they decrease profitability and increase liquidity problems so their continuous increase may bring banks to insolvency.Consequently, a low level of nonperforming loans means that there is a stable financial system while a high level of nonperforming loans means that there is no stability.

What happens in Albania recently, according even to the studies made by the Bank of Albania is that non-performing loans are increasing rapidly since 2012. This has caused for banks the tightening their lending activities.

Focusing on the importance that non-performing loans has on an economy, basically in Albania, the paper aim to study how different macroeconomic factors impact it. The paper gives attention to these determinants that are more likely to affect non-performing loans like: GDP, inflation rate, interest rate, exchange rate, unemployment rate and also seeing the impact those non-performing loans has on itself. These factors are the main elements that are also evaluated by the Bank of Albania that have caused an increase in non-performing loans over the years. So, the key problem here is to evaluate if these factors are crucial in measuring and giving a higher performance of the credit risk level in the current economic situation of Albania.

The objective of the thesis is to see through a linkage between NPLs and macroeconomic factors by using a Johansen test, Unit Root test and a VAR approach (a derivation of stress testing model). Unit root tests can be used to determine if trending data should be first differenced or regressed on deterministic functions of time to render the data stationary. Moreover, economic and finance theory often suggests the existence of long-run equilibrium relationships among nonstationary time series variables. On the other hand, the Vector auto regressions (VARs) combine the effects of an exogenous shock into various macroeconomic variables which are then used in the scenario chosen (Foglia 2009). These kinds of models are used as an alternative model to macroeconomic models. Being a substitute model, VARs models are more flexible and produce a set of mutually consistent shocks, although the main problem is that they do not include the economic structure that is attached in the macroeconomic modelling approach. From the range of risks that can be examined the paper focuses on the credit risk. While the market risk is relatively easy to calculate, the credit risk, which is the main risk that financial institution faces, deserves a greater attention. Before the simulation of the impact of the particular stress scenario on the credit risk exposure, usually it is needed to link the macroeconomic variables with the relevant credit risk measures via so–called NPL. So, using the Unit Root test it is determined where there is a correlation between the default rate and the macroeconomic factors, while the VAR models gives the thesis the information about how each of macroeconomic factors and NPLs impact the default rate.

The thesis is structured as follows: Chapter one provides an overview of related literature. Chapter two describesthe general theoretical background of risk management, credit risk and stress test. Chapter three develops the macroeconomic credit risk models focusing on the relationship between NPL and macroeconomic factors; showing the results of the thesis regarding the information provided by Unit Root test and VAR approach. In the last part of the paper there are the conclusion and future discussions.

Chapter One: Literature Review on Risk Management, Credit Risk and Stress Testing

Being constantly changing, the business world is facing unpredictable, volatile and complex environment every single day. This changing world could be only fraught with risks. Consequently risk can be identified as a potential loss or harm that may arise as a result of a present event. This kind of loss could be directly a financial loss or a loss in terms of credibility, future business. On the other hand, Van Scoy (1992) stated that risk in itself is not bad; risk is essential to progress, and failure is often a key part of learning. But we must learn to balance the possible negative consequences of risk against the potential benefits of its associated opportunity.

Historically, businesses have seen risk as a necessary evil that should be minimized or mitigated whenever possible. In recent years, increased regulatory requirements have forced businesses to expend significant resources to address risk, and shareholders in turn have begun to scrutinize whether businesses had the right controls in place. The increased demand for transparency around risk has not always been met or met in a timely manner, however—as evidenced by the financial market crisis, where the poor quality of underlying assets significantly impacted the value of investments. In the current global economic environment, identifying, managing, and exploiting risk across an organization has become increasingly important to the success and longevity of any business.[1]

1.1 Literature on Risk Management

Risk management is a very important task of financial institutions. While companies are exposed to a number of risks like credit risk, liquidity risk or operational risk, giving significance to risk management is playing a crucial role in identifying risks. Over the recent years, banks have worked and devoted many models for the purpose of identifying the financial risks that they might face in order to assess better way possible the economic capital. Boehm (1989) stated that risk management could be identified as a process or a series of steps in order to clarify, address or eliminate software risk items before they become either threats to successful software operation or a major source of expensive rework. Risk Management deals with the identification,

[1]Laurie Williams (2004) :" Risk Management"

assessment and various strategies that help mitigate the adverse effects of risk on the organization. Management uses risk management as a strategic tool to reduce the loss of property and increase the success chance of the organization. There are various kinds of risk and the risk management deals with their timely identification, assessment and proper handling. The types of risk management differ on the basis of the nature of operations of a particular organization and other factors like its overall goals and performance. All these types of financial risk management processes and risk management reports play a significant role behind the growth of an organization in the long run. For example, commercial enterprises apply various forms of risk management procedures to handle different risks because they face a variety of risks while carrying out their business operations. Effective handling of risk ensures the successful growth of an organization.

1.1.1 Types of Risk Management

Williams (2004) concluded that there are many types of Risk Management, but the most important one are listes as follows:

***Enterprise Risk Management*:**It is a strategic framework that checks the potential risks that have adverse impacts over the enterprise. These risks could be in the terms of risk related to resources, product and services on the market environment in which the enterprise operates. Enterprises develop risk management capabilities to deal with these risks and proper action plan.

Operational Risk Management:Operational risk management arises due to the execution of the business functions of the enterprises. Enterprises need to assess these risks and prepare action plans to meet the impact of the risk. At the primary level, these kind of risks deal with technical failures and human errors like: a) mistakes in execution b) system failures c) policy violations d) rule breaches e) legal infringements f) indirect and direct additional risk taking.

***Financial Risk Management*:**The process of financial risk management can be defined as minimizing exposure of a firm market and credit risk using various financial instruments. Financial risk managers also deal with other risks related to foreign exchange, liquidity, inflation, non-payment of clients and increased rate of interest. These risks affect the financial position of the organization.

Market Risk Management: Enterprises need to understand the risks present in the market, inherent to the industry or arising out of competition. Organizations need to properly assess itand develop their capabilities. It deals with different types of market risks, commodity risk and currency risk.

Credit Risk Management:Managing credit risk is one of the fundamental works of the financial institution. Credit portfolio management is largely becoming essential for the enterprise to keep track of risk. It deals with the risk related to the probability of nonpayment from the debtors.

Quantitative Risk Management:In quantitative risk management, an effort is carried out to numerically ascertain the possibilities of the different adverse financial circumstances to handle the degree of loss that might occur from those circumstances.

Commodity Risk Management:Commodity risk management it handles different types of risks such as price risk, political risk, quantity risk and cost risk.

Bank Risk Management:It deals with the handling of different types of risks faced by the banks such as market risk, credit risk, liquidity risk, legal risk, operational risk and reputational risk.

Nonprofit Risk Management:This is a process where risk management companies offer risk management services on a non-profit seeking basis.

Currency Risk Management:Currency Risk Management deals with changes in currency prices.

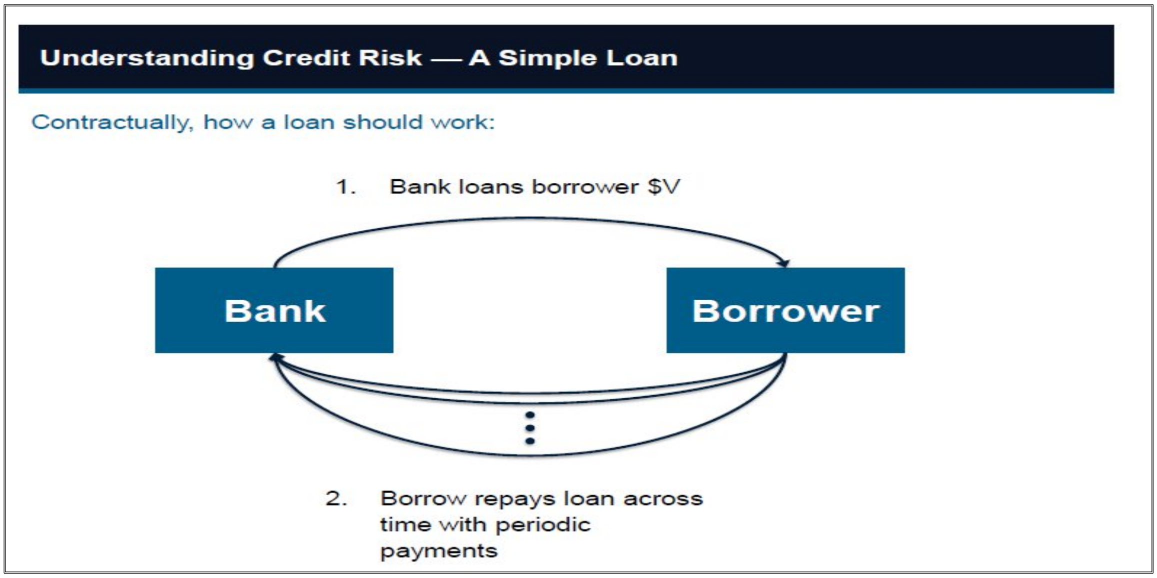
Project Risk Management:Project Risk Management deals with particular risks associated with the undertaking of a project.

Integrated Risk Management:Integrated Risk Management refers to integrating risk data into the strategic decision making of a company and taking decisions, which take into account the risk tolerance degrees of a department. In other words, it is the supervision of a market, credit, and liquidity risk at the same time or a simultaneous basis.

1.2 Literature Review on Credit Risk

In general credit risk is seen as a loss of principal or financial reward caused by the borrower failure to repay a loan or otherwise meet a contractual obligation. It can be said that credit risk arises in the moment when the borrower tends to use future cash flows in order to pay a current debt. The problem in this case is that when assessing a credit risk, the borrowers are exposed to a higher interest rate.In the picture listed below an insight about credit risk and its definition can be seen:

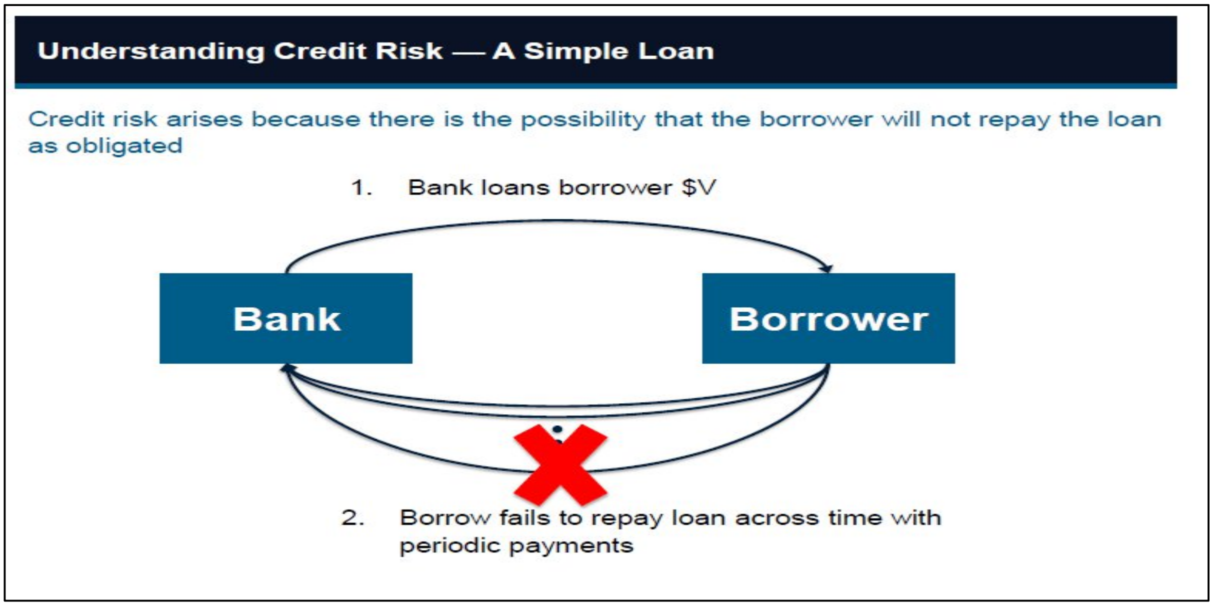
Figure 1: Understanding Credit Risk



Source: Global Association of Risk Professionals

When the loan is not repaid another situation accompanies the first one. The problem itself become more complex, leading a financial institution not covered up while trying to consider a loan as a bad debt. A very simple loan can raise a credit risk situation. In this case banks need to make a better valuation of the situation and of the customer that demands a specified loan. In the picture listed below, it can be seen very clear the situation of the arising of a credit risk.

Figure 2: Understanding Credit Risk



Source: Global Association of Risk Professionals

1.3 Literature Review on Stress Testing

The beginning of systematic stress testing dates back to the early 1990s, when banking supervisors and regulators sanctioned it as an important component of market risk monitoring (Blaschke et al., 2001). Stress tests are widely considered to play a central role in financial stability monitoring and in avoiding crises. There are serious consequences to be avoided — research has shown that output losses resulting from a financial crisis are about 9% on aver-age (Reinhart and Rogoff, 2009), which is substantially larger than the losses caused by non-bank crises (Haugh et al., 2009).

The latest World Economic Outlook (2009) reports a historical average loss of 10% but also emphasizes substantial variations between countries, as the middle 50% of crisis episodes caused losses ranging between −26% and +6%. 1 In this light the importance of the regular monitoring of risks is more than clear. Thorough risk analysis may give early warning signals, indicating vulnerability in the financial sector, and encouraging the regulatory body to take precautionary actions to avoid the crisis. Early warning is an important function of the monitoring and stress testing procedure. Frydl (1999) showed that the materialized loss depends on the speed with which regulatory bodies resolve the crisis. The speed of action depends heavily on how quickly the authorities are warned about possible problems and the proportion of losses that can still be avoided.

Under Basel II, banks are required to have a routine, robust process for stress testing and scenario analysis to support their measures of capital adequacy, such as establishing events or environmental changes that could lead to adverse development, identifying the impact of such events given current positions, and determining the strategy and processes for managing their portfolios given such events. According to the Basel II guidelines, the processes for stress testing should cover events as: economic or industry downturns, market events and increased liquidity. Likewise, under Pillar II, banks must be able to prove that the current capital levels are sufficient to resist a "range of severe but plausible events" and that different approaches are utilized in the measurement of the firm's overall capital.[2]

Models for performing stress tests vary greatly between institutions and the choice of modeling framework is often predetermined by the availability of data. Individual financial institutions operating in the market are closer to the relevant data and are better able to analyze their own credit risk than is a supervisory body, and therefore the choice of tools is larger for an individual institution than for a supervisory agency or a central bank. Nevertheless, it is important for a supervisory body and/or a central bank to have a tool for evaluating potential problems that may occur in severe economic conditions. The focus in this case is not only on individual banks but on the banking system as a whole (Basel Committee on Banking Supervision, 2000a), and on top of this the Basel Committee on Banking Supervision (2000b) sees the role of a supervisory agency as requiring that banks have an effective system in place to identify, monitor and control this risk.

1.3.1 Definition of Stress Testing

Stress testing describes a range of techniques used to assess the sensitivity of a portfolio due to major changes in the macroeconomic environment or to exceptional situations. The main objective of stress testing is to make risk very assessable by evaluating potential failures in a abnormal market. So here it can be seen that the main element of stress testing is not to examine

[2] Basel II guidelines for stress testing framework.

when will the next crisis will happen but to evaluate the impact of situations that may happen in the future in the financial system. In general, stress tests performed by financial institutions focus primarily on traded market portfolios as they can be marked to market on a regular basis. These portfolios include interest rate, equity, foreign exchange, commodity and credit market instruments. Stress tests on loan books are conducted less frequently and, sometimes, by separate business units of the financial institutions. In addition, stress testing of liquidity risk is employed regularly. On the liabilities side, funding liquidity for individual institutions is tested at various levels by most banks. Scenarios include changes in: client behavior (e.g. the withdrawal of deposits); own credit rating (e.g. a ratings downgrade); funding costs; and collateral requirements (e.g. how much collateral an institution has available and what haircut might be required). These tests may form part of an overall liquidity contingency plan and are generally conducted by the funding division of a financial institution's operations.

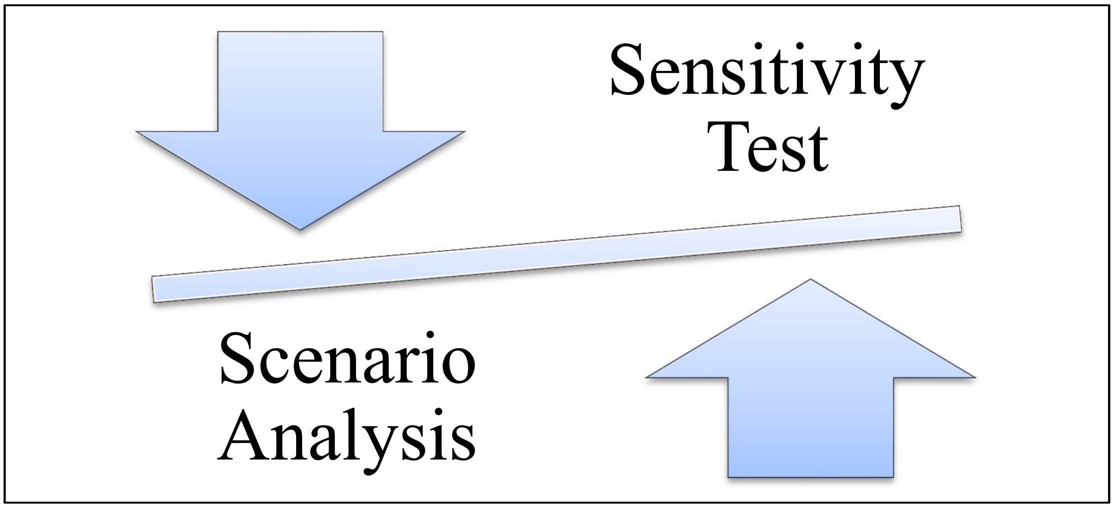
Stress testing of operational risks remains work in progress, owing primarily to data problems, although most institutions have established contingency plans. At present, financial institutions employ operational risk stress tests using internal or shared databases. Furthermore, banks use this model to make credit risk more transparent and in this case they can evaluate credit risk characteristics.

1.3.2 Stress Testing Model Steps

The first step of the stress testing is to define the type of risks that should be taken in consideration and the models to use. Stress test may include an individual risk such as credit risk or interest rate risk or multiple risks. The next level of building a stress test model is to focus on the range of factors to take in consideration, but this should be followed with the specification of the scenario build. Consequently we have two main stress testing:

- **Sensitivity test**
- **Scenario Analysis**

Figure 3: Stress Testing Models



A sensitivity test focuses on estimating the changes that a single risk factor may cause. On the other hand the second stress testing is translated in the impact that a group of factor may cause in an exceptional situation. The sensitivity test is an approach for assessing one risk factor's impact on the financial data. Analyzing one shock in isolation has its advantages and disadvantages. The strengths of the sensitivity analysis are (a) it conveys important information on the performance of the model itself and (b) it brings out the most important factors that drive clients into insolvency. The most crucial drawback of the approach is that it ignores the simultaneity or interdependence of risk factors.[3]

Stress testing can be buid in historical scenarios, which means focusing in a situation that have happened in the past or can be based on hipothetical scenarios. Creating a scenario based on historical data gives financial institutions an intuitive approach of a situation that have happened in the past. In this case, we recreate the same situation simulating the impact that it might have in the current state. Scenario analysis is a more complicated way of exploring the risks. It provides an integrated view of economic fundamentals and financial data, as risk factors are projected to evolve in a consistent manner. Due to its multivariate nature, scenario analysis is generally believed to be more realistic than sensitivity tests, since in reality all the risk factors interact (van den End et al., 2006). Literature on this subject distinguishes between two types of scenario: historical and hypothetical. Historical scenarios draw their financial data from macro episodes

[3] Credit Risk Model for Estonian Market, Rasmus Kattai (2010)

that have already occurred, whereas hypothetical analysis tries to see what happens in circumstances that have never occurred before (Hadad et al., 2007). Hypothetical scenarios are more flexible because they are not restricted in formulating potential events (Blaschke et al., 2001). It may be difficult to justify a hypothetical scenario without any historical comparison, but they are realistic in the sense that new shocks may have nothing in common with what has been experienced in the past. Hypothetical scenario analysis becomes the only option when structural breaks in the financial system (deregulation, consolidation, change of currency) have annulled the information content of past episodes (Quagliariello, 2009).

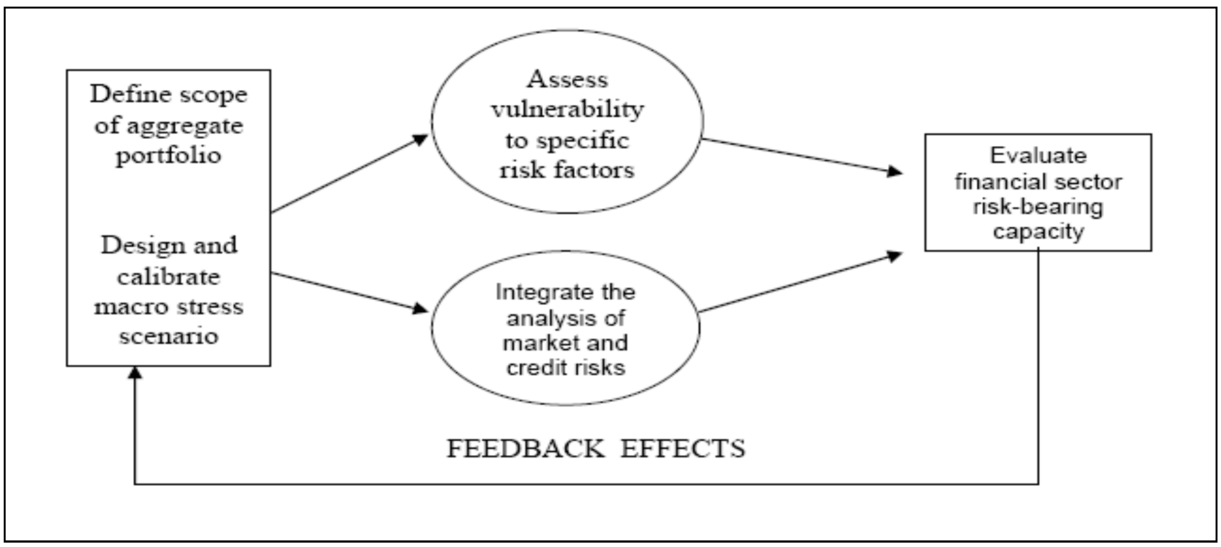
For example, Lily and Hong (2004) created a model stress tests in Singapore based on historical scenarios. Their study was focused on the increased terrorism threats in the wake of September'11 attacks slowing the economic growth in Europe and Japan. The disavantages of this model is that it is backward looking, and may loose consistence over period of times because of the changes that might happen in the economical environment.

Basing a study in a hipothetical scenarios helps financial institution to anticipate a situation that might occur in the future, examining the volentivility of a portofolio in the pressure of different risk factors. Beign a flexible approach, potential events can be formulated easily. In difference with historical scenario, the hypothetical one is forward looking. Furthermore, Virolainen (2004) in his study of Finland created a hypothetical scenario. He based the stress testing approach of an interest rate shock. He concluded that the short-term interest rate increased by one percentage point for four consecutive quarters, and then remained at the highest level for a period of two years. Maybe the only difficulty in the hypothetical scenario could be the impossibility of estimanting an event that may or not occur, since it's not based on historical data.
Creating a stress test scenario is maybe the most difficult part of the stress testing process, because specifying the scenario may lead to a lot of decisions, including which are the risk factors, how much to stress them and the time horizon. Important to note is that when creating a stress testing approach, the model should always be based on the current financial situation of the environment build.

A macro perspective of the stress testing it can be analyzed. For example, Macro Sorge (2004) illustrated that a macro stress test can include the following stages:

- The first step is to define the scope of the analysis in terms of financial institutions and portfolio
- The second step is to create a macroeconomic stress scenario
- Identifying the direct impact of the created scenario on the balance sheet of the financial sector, either focusing on the impact of a single risk factor under stress or integrating the analysis of multiple risks factors, estimating the probability of the distribution of aggregate losses that are the effect of the stimulated stress scenario.
- Interpreting the results focusing on the risks factors that impact financial system
- Focusing on the feedback effects[4]

Figure 4: Stress Testing Model Overview



Source: Macro Sourge 2004

[4] Bis Working paper No 165, Macro Sorge 2004.

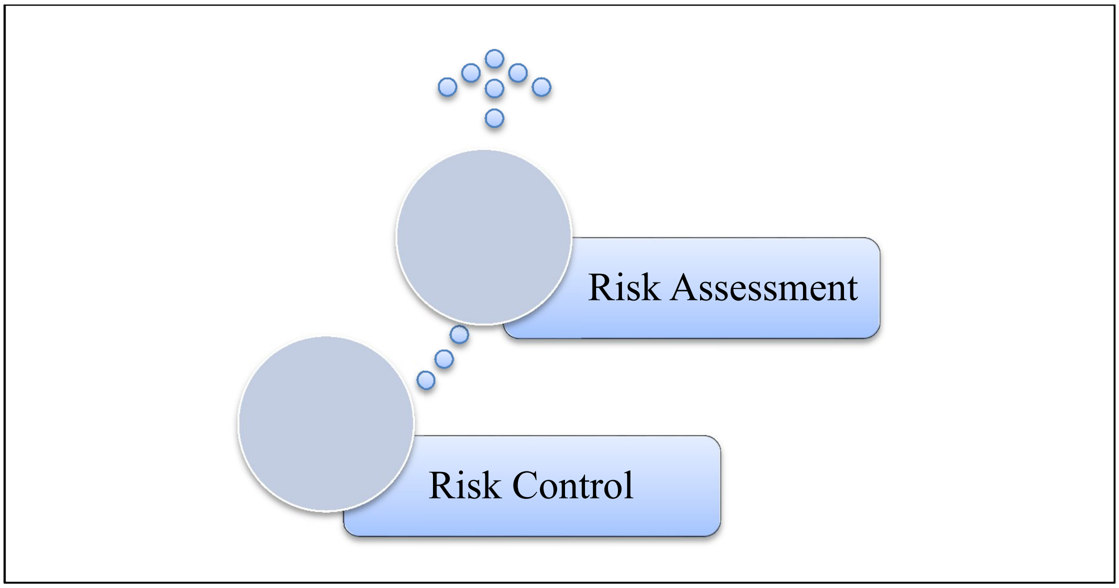
Chapter Two: Overview of Risk Management, Credit Risk and Stress Testing

2.1 Risk Management

The risk management process itself is a complex one. While analyzing different types of risks which business face, it is also important to give an insight of the elements that are a crucial part of the process itself.

Basically as many literatures have concluded, risk management process includes two main interrelated phases:

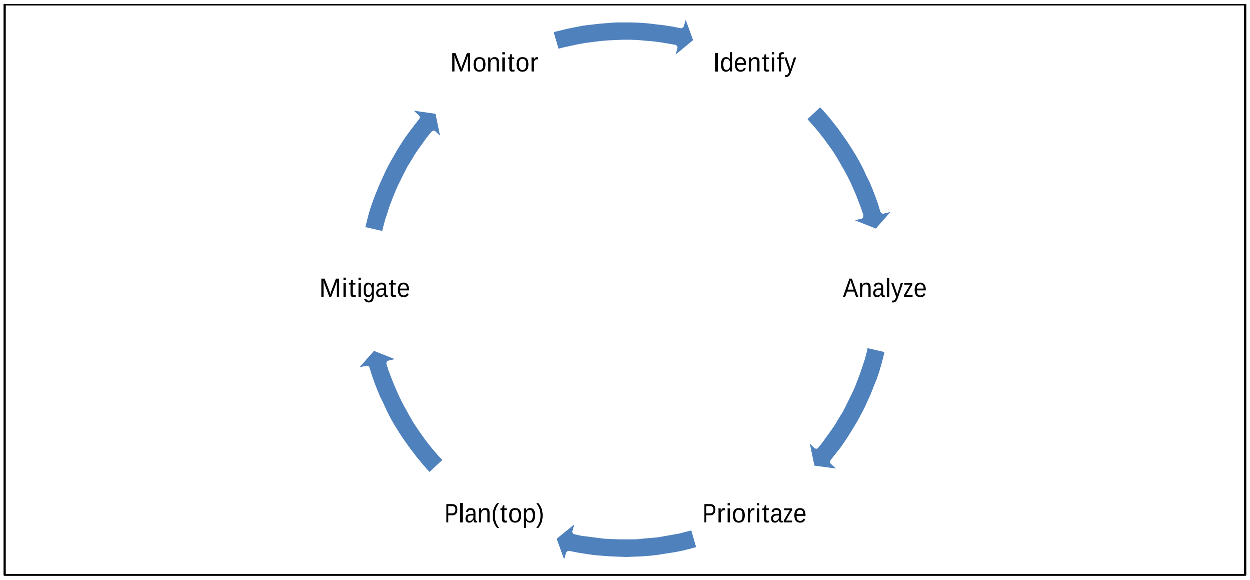
Figure 5: Risk Management Phases



Risk assessment provides a mechanism for identifying which risks represent opportunities and which represent potential pitfalls. Done right, a risk assessment gives organizations a clear view of variables to which they may be exposed, whether internal or external, retrospective or forward-looking. A good assessment is anchored in the organization's defined risk appetite and tolerance, and provides a basis for determining risk responses. A robust risk assessment process, applied consistently throughout the organization, empowers management to better identify, evaluate, and exploit the right risks for their business, all while maintaining the appropriate controls to ensure effective and efficient operations and regulatory compliance.

Risk control as Boehm (1989) defined, includes risk monitoring, risk planning and mitigating. On the figure below as Boehm evaluated, it can be seen the risk management cycle. The process itself is very complex and significant:

Figure 6: Risk Management Cycle



Source: Boehm (1989) on Risk Management Cycle Process

What makes risk management so important is the fact that is a process of thinking and monitoring systematically about all possible risks before they happen, and setting up systems or procedures that will or avoid risk or minimize it. Furthermore, it is seen as a realistic process of the true evolution of the risk's level.

The financial crisis of 2007 changed a lot of balances in the economical and financial environment. While in the past, financial institutions hadn't given a lot importance of the concept of risk, nowadays ways of assessing risks is being analyzed carefully. Furthermore, banks are trying to create better task of evaluating especially the credit risk.

2.2 Credit Risk

Comparing credit risk with market risk, we know that market risk is caused due to the changes or the fluctuations in the prices. In this case the time horizon is typically one day. On the other hand, as mentioned credit risk is caused due to a nonperformance of a financial contract. The time horizon could be less than one year, one year or even more. In this moment, credit risk is more important than market risk for banks. Furthermore, banks are obligated to consider the behavior consideration of the borrower. [5]

When talking about credit risk is better to make a difference between it and credit collection difficulties. The distinction between them refers to the concept of the past and the future. So, credit collection difficulties refer to defaults, failure, losses that have been experienced and recorded after the fact. On the other hand the concept of credit risk is a forward-looking concept, focusing on the losses or failure that would happen in the future. Making a distinction between prospective and retrospective risk leads to better ways of measuring the risk. Important in this situation is not to know what have happened but what would happen in the for-coming months or years if financial institutions are exposed to risk. But how can credit risk be measured? How can it get a clear situation of credit difficulties in the future? One way is to determine the characteristics of credit that determine the collection of difficulties and then to measure the impact that these characteristics have in the credit structure while changing over time.If, for example, the loan-to-value ratio on home mortgages is found to be correlated with subsequent foreclosure experience, then a time series of the average loan-to-value ratio on all existing home mortgages should tell us something about the probable incidence of home mortgage foreclosures in the period ahead. If debt-payment to-income ratios of consumer installment borrowers have been established as being related to credit risk, then a change in the average payment-to income ratio should tell us that the risk of installment credit difficulties has changed in the corresponding direction; similarly for other risk-related loan and borrower characteristics (maturities, financial ratios of business firms, etc.).[6]While analyzing these characteristics, it can be said that there are other elements that will impact risk and would give sometimes a contradictory conclusion. A country economical health would give an impact on evaluating risk whiles other characteristics of credit that will not be affected if we have changes in the economy employment, income. So, when the business conditions change over the economy fluctuations, this would impact the most important credit characteristics. When we have changes in personal incomes and unemployment, this would have an impact in the repayments-to-income and liquid-asset ratios on consumers credit installment. Variations in the resale value of homes or cars or farms will alter loan-to-value ratios on out-standing loans. A climb or fall in profitability will make a big difference in

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[5] Credit Risk Management, GARP Risk Series
[6] The Quality of Consumer Installment Credit.

the liquidity and working-capital ratios of business borrowers. And these changes in the composition of risk-related characteristics in the continuing stock of credit outstanding will have an important impact on the incidence of collection difficulties.

The economic environment will have an influence on the way that consumers analyze credit. Their belief of the economical future of their country will impact the way if they want to invest or borrow. As a result, as the economy changes, so will lenders will focus on establishing new lending standards and, their policies procedures if they see signs of difficulty in the repayment process. But no doubt the most significant effect that business conditions exert on the risk of credit collection difficulties comes about through the process described above, i.e., through the changes to the risk-related characteristics in the outstanding stock of credit.[7]To make a conclusion about the ways of measuring the credit risk, important is to evaluate the loan and borrower characteristic in relation to risk, in order to give a better insight of how the risk-related characteristic impact the credit stock.

When economists talk about credit risk, they refer to in the aspect of costs and consequences. In this case, the problem of credit risk is viewed as arising from the extension of credit and in a volume beyond productive use of the borrower, leading and creating a spiral deflation and general economic depression. But there is a problem extending the credit terms and in a quantity less than a borrower can use safely and productively. In this case, the low level of credit risk can cause low level of employment and income in an economy. On other words in short terms, the cause of credit risk could be a bilateral problem. Credit risk could be risky or too safe, and the consequences of one situation can be as significant and serious as consequences of another.

Following the 1930's, in the Great Depression the level of credit risk was low. In this situation, Moore Atkinson and Kilberg addressed a study gathering Hickman's data on corporate bonds. They examined the differences in risks and credit costs of small versus large borrowers, and the record developed by Hickman of the promised yields, loss rates and realized yields on bonds classified by asset size of obligor during four-year intervals from 1900 to1943. They commented:

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[7]Quality of Credit in Booms and Depressions.

"In short, the aggregate results, from the point of view of an investor, during these 4-year periods were often more satisfactory but, occasionally, less satisfactory in the case of bonds of small than of large corporations. It is interesting to observe that the differentials in promised yields against the smaller corporations became especially large in 1908-11 and in every period since 1932, after the heavy losses on the issues of small firms in the immediately preceding periods (1904-07 and 1928-31). As it turned out, these differentials were by no means required to off-set differential losses in the subsequent periods (except in 1932-35). Hence, realized yields on outstanding issues of small obligors substantially exceeded those on the issues of large obligors".[8]

This study showed that the credit risk on small business was extremely low in the period taken in consideration. The shocks and losses of the crisis of 1907-08 and the Great Depression were still making an impact in the borrowers and lenders. In this case lenders were skeptic of landing their money on a market that had suffered very high level of losses. This situation led back in deepening the depression and not helping at all in the recovery of the economy.

Another example of the impact of credit risk in the economy is in the study that John Lintner made on mortgage lending policies of mutual savings bank during 1931-45. The saving bank was making a lot of losses while lending a large amount of mortgage loans during the period of Depression, being very risky. Furthermore, savings banks failed to take advantages of the opportunities that this period had, opportunities that were taken in consideration by other. [9]

These examples were taken in consideration, to give an insight that a higher level of credit risk is not necessary undesirable or a lower level of credit risk is not always a better idea. Having a low level of credit risk is translated in decrease of the output and employment rate.

Following the importance of credit risk in the economic fluctuations and specifying credit risk as the level of value fluctuations in debt instruments regarding the changes that underlie credit

[8]Moore, Atkinson and Kilberg, Report to the Committees on Banking and Currency.

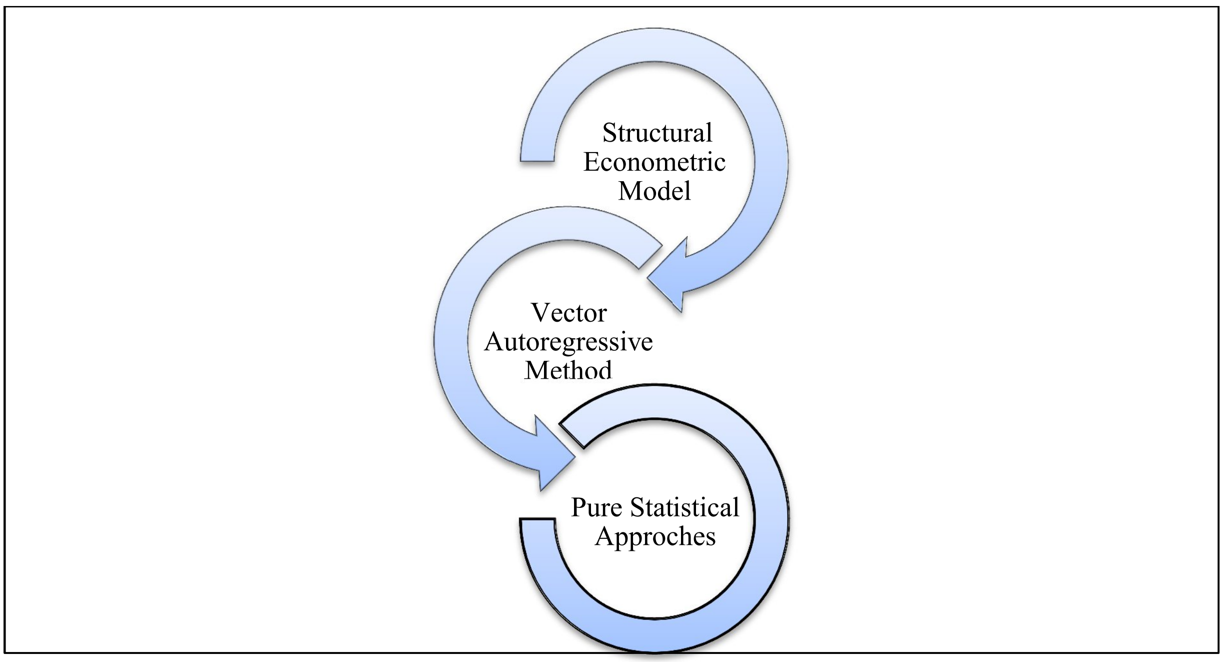
[9]John Lintner, Mutual Savings Banks in the Savings and Mortgage Markets, Cambridge, Mass.

quality of borrowers and counterparties, recent studies and institutions such as the International Swap Dealers Association (ISDA, 1998) and the Institute of International Finance Working Group on Capital Adequacy (IIF, 1998), had given the idea that credit risk models should be used to formally determine risk-adjusted, regulatory capital requirements. In this case, we can evaluate that implementing the right model to evaluate the risk is an important task that financial institution should take in consideration while thinking to lend.

2.3 Stress Testing

Focusing on the paper main objective, there is a vast wealth of literature that shows how stress scenarios should be build and insert in the stress testing model. In general, stress scenarios can be produced regarding the macroeconomic environment using a structural econometric model, pure statistic method or a VAR model (Foglia 2009).

Figure 7: Stress Testing Models under macroeconomic conditions



Existing structural macroeconomic models, such as those used by the central bank for forecasts and policy analysis) are used to project the levels of key macroeconomic indicators under various scenarios including a set of initial exogenous inputs over a given scenario horizon. Typically all FSAPs tend to build macroeconomic models used for monetary policy purposes and in some cases are extended to create international effects (Foglia 2009). The advantage in using these models is in the fact that they impose consistency across the predicted values in the stress scenario. Furthermore, they tend to allow endogenous policy reactions to the initial shocks. On the other hand, the disadvantage of these models is that they are designed for “normal business” times and the linearity added in them may fail to represent the nonlinear relation or behavior characteristic in times of stress. In this case it is difficult to evaluate the likelihood of a specific scenario and to implement it in a stress testing.

A second approach used by several banks is the Vector auto regressions (VARs) to combine the effects of an exogenous shock into various macroeconomic variables which are then used in the scenario chosen (Foglia 2009). These kinds of models are used as an alternative model to macroeconomic models. Being a substitute model, VARs models are more flexible and produce a set of mutually consistent shocks, although the main problem is that they do not include the economic structure that is attached in the macroeconomic modelling approach.

A third approach is used by OeNB in its Systemic Risk Monitor, in which a statistical approach is used to design a scenario. Macroeconomic and financial variables are designed through a multivariate tcopula. The advantage of this approach is that it can identify the marginal distributions, which can be different from the multivariate distributions that characterize the joint behavior of the variables. Moreover, the relationship between macroeconomic and financial variables display tail dependence (correlation increases when the system is under stress). However, being a statistical approach it does not identify the main transmission channels that link the shock with its effect on the degree of the credit risk.

2.3.1 Overview literature about stress testing modelling approaches

The discussion about the objectives, the modelling process and the challenges of the macro stress tests can be found in Drehmann (2008). Sorge & Virolainen (2006) discuss the two main approaches to the stress testing, the econometric analysis of the balance–sheet data (balance–sheet models) and the Value–at –Risk (VaR) models, applying both of them to the Finish economy. In the balance–sheet models the macro variables are linked with the balance– sheet items. The obtained coe□cients are then used to simulate the impact of some shock to the system. The VaR models combine the risk factor analysis with the estimation of the distribution of loss, providing the quantification of the portfolio sensitivity to the several sources of risk.

Ciha´k (2007) elaborated a comprehensive framework that concerns on the design of the stress tests and the scenarios, assuming the wide range of risks. He provides the illustration of possible stress–testing application to the bank's data. The paper discusses strengths and weaknesses of the several methods and provides the summarization of the stress tests conducted by the national regulators and supervisors. Sorge (2004) provides an overview of the methodologies for the stress–testing of the financial systems, with discussion about the methodological challenges such as the measure of the endogenous risk or the correlation between the credit and the market risks. Berkowitz (2000) discusses namely the choice of the proper scenario under which the stress test is conducted.

Most of the research in the area of macroeconomic credit risk modeling is based on the approach that Merton (1974) and Wilson (1997) made. Different countries have used this kind of test in order to get a better way of evaluating the risk that come from credit. On the other hand, Cihak (2007) states that two approaches are common. One is based on loan performance, such as NPLs, the LLPs or the historical default rates; and the other is based on micro-level data related to the default risk of the household and/or the corporate sector. In models based on loan performance, the key dependent variables are the NPL ratio, the LLP ratio and the historical default frequencies.

Blaschke et al (2001) model unexpected credit losses arising from external shocks by empirically estimating the determinants of observed default frequencies as captured by NPL ratios, which can be interpreted as a default frequency ratio. They propose regressing NPL to total assets ratio on a set of macroeconomic variables, including the nominal interest rate, inflation, GDP growth and the percentage change in terms of trade. In addition, they propose estimating this equation by using disaggregated NPL data across homogenous groups of borrowers. If we assume linearity in the risk exposures, the volatility of the NPL ratio to total assets can be expressed as a function of the variances of the regresses and the correlations between them. However, in his study Blasche recommend the use of the Monte Carlo simulation techniques when this assumption is relaxed.

In 2002, Boss applied a credit risk model on Austrian corporate sector's using aggregate data based on the way of financing households and corporate. Using a stress scenario in both cases, Boss estimated the expected and unexpected losses for a defined credit portfolio. On the other hand, a study from Virolainen was made in 2004, studying the credit risk in the Finish sector using specific defaults rates. Default rates were modeled using the logistic function and a seemingly unrelated regression model was used to determine the influence of macroeconomic variables on sectorial default rates. The variables that impacted more the credit risk model were GDP growth, sectorial indebtedness, and interest rates in the macroeconomic perspective.

Wong et al (2006) studied the effects of macro variables on total credit risk and the mortgage credit risk in Hong Kong. The model involves the construction of two macroeconomic credit risk models, each consisting of a multiple regression model and a set of autoregressive models which include feedback effects from the default rate on bank loans to different macroeconomic values estimated by the method of the seemingly unrelated regression.

The stress testing framework uses the models developed by Wilson (1997), Boss (2002) and Virolainen (2004), which consist in following a more realistic dynamic process in which the macroeconomic variables are mutually dependent. Most importantly, it explicitly captures the feedback effects of bank performance on the economy by letting the macroeconomic variables depend on past values of the financial variables. The set of equations define a system of equations governing the joint evolution of macroeconomic performance, the associated default rates and their error terms. By taking non-zero error terms in the default rate equation and allowing for randomness in the behavior of the macroeconomic variables with the various stochastic components being correlated, Wong et al take into account the probabilistic elements and use Monte Carlo simulation to obtain frequency distributions for the default ratios in various scenarios. The default rate is hypothesized to depend on the real GDP growth of Hong Kong, the real GDP growth of mainland China, real interest rates and real property prices in Hong Kong. Non-linearity is taken into account by using a logit transformation of the NPL ratio and the first differences are used to avoid spurious regression in the presence of non-stationarity in the variables.

Stress tests are most often performed in the spirit of extreme value theory, maximum loss approach (also known as worst case scenario analysis) or contagion analysis. Extreme value theory, as its name suggests, deals with extreme events in financial markets. Rather than the distribution of all returns, it concentrates on the distribution of extreme returns, which are considered to be independent over a long time period (Longin, 1999). The maximum loss approach finds the combination of market moves that would cause the greatest loss to the portfolio (Committee on the Global Financial System, 2000). Contagion analysis quantifies the transmission of one financial institution's failure to others and the possible impact on the whole financial system.

Van Den End et al (2006) develop reduced-form balance sheet models to estimate the impact of the macro variables on the LLPs using data for the 5 largest Dutch banks. In modelling credit risk, they use two basic equations. First, it is estimated the relationship between borrower defaults and real GDP growth, long-term interest rates, short-term interest rates and the term spread. In a second step, they develop a fixed effect regression model explaining the LLPs using the default rate together with some macro variables. By using different constant terms, the structural differences in the level of provisions for each bank are taken into account. In the equations, non-linear functions of the default rate and the ratio of LLPs to total credit-the logit-are used to extend the domain of the dependent variable to negative values and take into account possible non-linear relationships between the macro variables and the LLPs.

For the simulations, van den End *et al* (2006) use the version developed by Sorge and Virolainen (2006), who simulate default rates over time by generating macroeconomic shocks to the system. The evolution of the related macroeconomic shocks is given by a set of univariate autoregressive equations of order 2, i.e. AR(2), or alternatively, by a VAR model. The latter model takes into account the correlations between the macro variables. Van den End *et al* (2006) use the vector of innovations and a variance-covariance matrix of errors in the equations governing the macroeconomic variables, and in the default rate and LLP/credit equations. By using a Cholesky decomposition of the variance-covariance matrix, they are able to obtain correlated innovations in the macroeconomic factors, default rate and LLP/CRED, and obtain future paths of the macroeconomic variables, the default rate and LLP/CRED by simulation with a Monte Carlo method. With these outcomes and the information on outstanding exposures of the banking sector, the distributions of credit losses are determined.

Moretti et al. (2008) give an overview of the different types of stress test used in the IMF's FSAP and show that contagion analysis has become more common over the years. The increased popularity of the method stems from the tightened linkages between financial institutions within each country and across borders. Seeing another side of the process, Howard (2009) argued that the choice of variables should be based on stress scenarios and the types of risks that will be analyzed with the model. Scenarios for the developed credit risk model are produced using Eesti Pank's forecast model, and so the macro indicators used in the function of PD are those which also appear in the macro model — unemployment, real output growth, nominal interest rates and inflation, the last two are used to calculate the real interest rate on stock. These coincided with the conventional list of variables used in similar models, and they also meet the key requirement of economic plausibility, stressed by Foglia (2009), which stated that all predictive variables must have clear meaning and an interpretable relationship with the dependent variable.

Alessandri et al. (2009) refer to an unpublished study by Gai and Kapadia (mimeo, Bank of England) which finds that the effect of the greater connectivity of financial networks is twofold. Firstly, it enhances risk sharing and therefore lowers the likelihood of crises. But secondly, if a crisis does occur, the impact of it would also be more severe. This effect is reinforced by financial innovations and general macroeconomic stability (Gai et al., 2008).

More recently, Castren et al (2009) studied the effects of macroeconomic shocks on VaR for different banks through two steps. First, they estimate a GVAR (Global Vector Auto regression) model to obtain impulse responses for real Gross Domestic Product (GDP), real stock prices, inflation, short-term and long-term interest rates, and the Eurodollar exchange rate. In the second step, the results of these macroeconomic shocks are regressed on the sector specific probability of default (PD) values.

Kattai (2010) investigated the credit risk model that has been developed for the Estonian banking system. The non-performing loans and loan loss provisions of the four largest banks and the rest of the banking sector have been modeled conditional on the underlying economic conditions: economic growth, unemployment, interest rates, inflation, indebtedness and credit growth. The model distinguishes between consumption credit, mortgage clients and corporate loans.Regardless of the modelling technique or stress test approach that is applied, no results represent a final truth. Bunn et al. (2005) stated that ***"no single model is ever likely to capture fully the diverse channels through which shocks may affect the financial system. Stress testing***

models will, therefore, remain a complement to rather than a substitute for, broader macro prudential analysis of potential threats to financial stability." Any model built on economic data is a simplification of reality and unable to take into account all the complex structures and sources of shocks as they occur in the real world.

2.4 Stress Testing in Albania

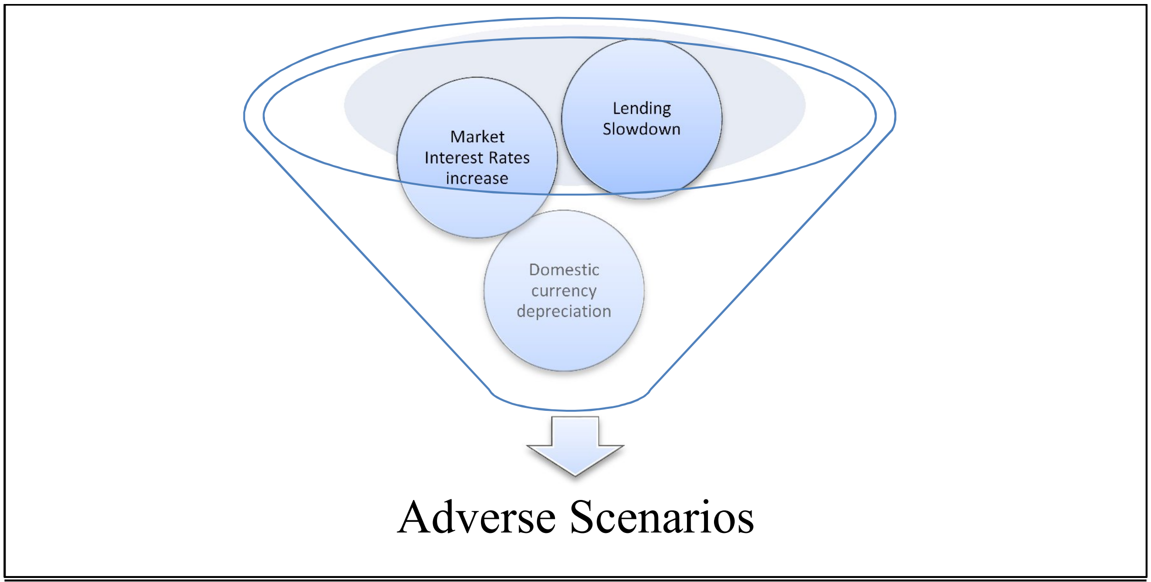
Stress test results reveal that the banking sector is resilient to macroeconomic shocks. However, because of the lower initial level of capital adequacy ratio, their exposure to adverse scenario is higher. The assessment of the spill-over effect in the banking sector shows that certain banks are exposed to the market risk in relation to investment in securities, whereas exposure to sovereign risk is limited. Exposure to placement in parent banking groups is significant for medium-sized banks as Greek and French-owned banks.[10]

A forward-looking stress-test or analysis is run to assess the financial system's stability and banking sector's capital adequacy, for a period extending to the end of 2016. The stress-test exercise assesses the impact of macroeconomic situations on the banking sector's financial standing, excluding the possibility of an increase in the paid-in capital during the period under review. This analysis includes three scenarios: the baseline scenario and two adverse scenarios.

The adverse scenarios assume a "stressed" situation with a low probability of occurrence, based on three probable shocks to the Albanian economy: a) lending slowdown; b) market interest rates increase; and c) domestic currency depreciation.

[10] Financial Stability Report 2014, Central Bank of Albania.

Figure 8: Stress Testing Scenarios



Source: Bank of Albania

In the baseline scenario, economic growth is assumed to gradually improve at 3% as at end-2016. In the first adverse scenario, the assumptions on the depreciation of the Albanian lek exchange rate to 25% increase of interest rates by 5 percentage points and a slowdown of annual lending rate at 3% as at and 2016, drive to a weak economic growth of 0.6% for 2015 and a shrinkage by 2.6% for 2016. In the event of second adverse scenario, the assumptions on the Albanian lek exchange rate depreciation by 30%, accompanied by an increase of interest rate by 8 percentage points and annual shrinkage of loan at 4%, are reflected at shrinkage of the economic activity for both years included in the exercise, by 2% and 3.7%, respectively.[11]

Baseline scenario shows that non-performing loans ratio will gradually improve for the period 2015-2016. At the end of 2015, this ratio will be considerably impacted by the process of writing off loss loans, pursuant to the regulatory requirement that enters into force in January 201547. This accumulated effect will be transmitted during 2016 and will be strengthened further by the economic sustainability, the low interest rates and the gradual improvement of lending activity in Albania. The trajectory of loan quality reflects the impact that originates from the payment of Government’s arrears and the improvement in terms of collateral execution pursuant to the legal changes undertaken by the authorities.

[11] Research Department, Central Bank of Albania

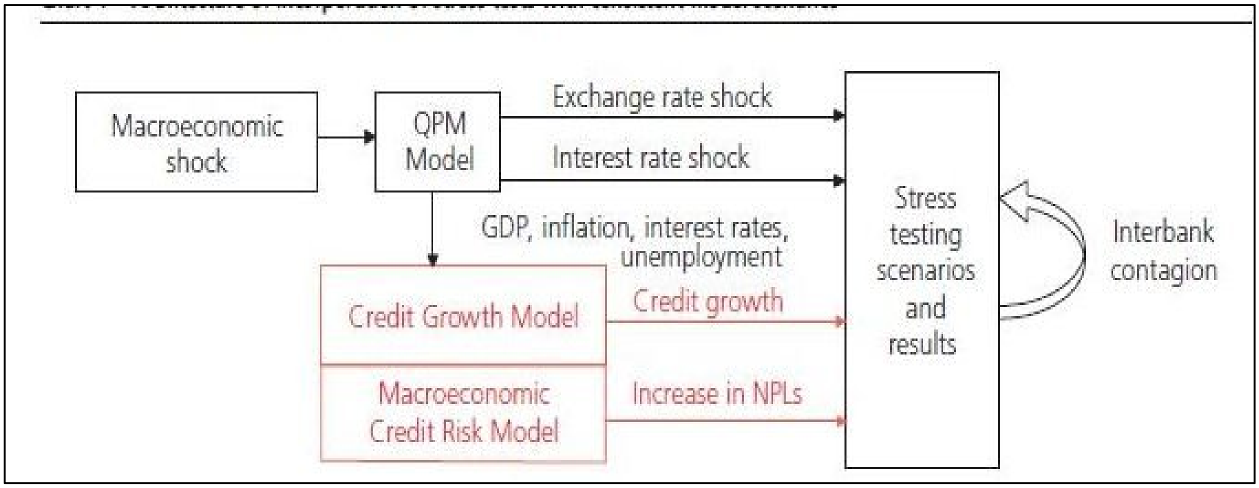
In the event of adverse scenario, credit risk is the main exposure of banking sector activity, where loan quality deteriorates considerably. Related to foreign currency loan, the economic slowdown and the exchange rate depreciation in adverse scenarios, are reflected in a rapid increase of non-performing loans ratio. For lek-denominated loan, the main effect arises from the shrinkage of economic activity, or from the assumed increase in interest rates. The combined effect of deteriorated economic activity, depreciated exchange rate and increased interest rate in the event of first scenario, is reflected in the increase of non-performing loans ratio by 6 percentage points at end of 2015 compared to baseline scenario. In the second adverse scenario, the NPLs ratio deteriorates by 13.2 percentage points.

The deterioration of non-performing loans ratio drives to the increase of provisioning expenses by draining the banking sector's profitability. Profits from open foreign position which remains in long position, hedges partially banks from losses related to loan, given the depreciation of exchange rate. Increase of interest rates also reflects losses for banks in the light of transformation process of maturities. The increase at the same rates of deposits and loans drive to a more rapid increase of interest expenses than interest income being reflected in loss of net interest income. [12]

The different sensitivities of corporations and households to the macroeconomic environment, along with the changing structure of the loan portfolio, calls for an extension of the credit risk model to include separate estimates for individual sectors. The estimated models of sectoral credit risk and credit growth serve for revision of the stress tests both for the aggregate loan portfolio and for the separate portfolios of the household and non-financial corporation sectors. The predictions obtained from the estimated models are used in simple tests of loan portfolios and in a stress test linked to the BOAs quarterly macroeconomic forecast. The incorporation of the newly developed credit growth and credit risk models into the stress testing methodology is described as in figure 10:

[12] Financial Stability Report 2015 H2, Central Bank of Albania

Figure 9: Architecture of incorporation of stress testing



Source: Bank of Albania

The Central Bank of Albania gave an insight about the way that stress testing could help banks better evaluate risks and give a significant impact of the variables tested in the near future. Although BOA makes three base scenarios for seeing the impact of three variables in non-performing loans, there is a conference paper that gives even better information about how should a stress testing model build.

The methodology of stress testing for credit risk in the BOA is based on directly stressing the growth in non-performing loans of the banking system and measures the effect on the capital adequacy of the banking system. It also stresses GDP growth and estimates its effect on the change in the NPLs of the banking system. The relation between real GDP growth and the growth of the NPLs is assumed to be linear which implies that a shock to the nominal growth rate at a given time causes, other things being equal, a corresponding growth of 5 times the shock in the NPL ratio (NPLR). Under the assumption of zero growth in total loans, the relative change in NPLR equals the relative change in NPLs.

In a second step, by assuming a zero value for *e*, and by shocking the GDP growth rate of the given year, a point estimate of the growth of the NPLs is obtained. These predicted values are (point) estimates of the expected values of the NPLs conditional on the occurrence of the scenario. Another scenario includes the effect on the NPLR of a currency depreciation capturing the credit risk arising from foreign currency lending and the effects of indirect credit risk from an increase in credit interest rates. For the former, assuming the increase in total debt after a given currency depreciation by ΔrFX , denoted as $D \cdot \Delta rFX$, is incurred all within a year and not amortized throughout the lifetime of the debt, borrowers will face a yearly income loss proportional to the debt in foreign currency to income ratio *D/I*. For the indirect credit risk arising from an increase in interest rates and the total increase in debt is faced by the borrowers, the same assumption holds, i.e. all income loss through the increase in debt is incurred within a year.

The paper presents several improvements in the methodology of stress testing of indirect credit risk in Albania. It finds a significant effect of the changes in the euro exchange rates and the Euribor interest rates on the non-performing loan ratio while the effect of GDP growth, *albeit* small, is found to be significant too. Most importantly, the methodology provides a measure of uncertainty of the estimates through the computation of the probability distribution of the variables of interest both under the stressed and the unstressed scenarios.[13]

[13] A credit risk model for Albania, Kliti Ceca and Hilda Shijaku.

Chapter Three: Data Description, Methodology and Analysis Results

3.1. Data Description

The data gathered for implementing in the right way the thesis were basically data given by the Central Bank of Albania. The aim of the study is to create a macroeconomic credit risk model which links a set of macroeconomic variables like GDP growth, inflation rate, interest rate, unemployment rate and exchange rate.

The sample period include a quarterly time range from 2003 to 2014. The period is unique in the sense that includes even the financial crisis that hit the most important industrial countries all over the word. Adding even the unemployment rate as a determinant that would affect negatively the default rate is a new thing because this rate could have a significant impact in the way that Banks consider loaning to individuals or different companies.

The paper consists in linking three models, in order to make a significant and satisfactory decision. The variables studied are the dependent variable which is the NPLs rate and the independent variables which are: GDP, interest rate, unemployment rate, inflation and exchange rate.

Basically all these variables have a significant impact on nonperforming loans. Analyzing them separately means that:

GDP is negatively correlated with nonperforming loans rate. Consequently, an increase of GDP is translated as economic development to a country so when it increases the level of NPL decreases.

Unemployment rate is positively correlated with nonperforming loans. An increase in the unemployment level means that there will be an increase in the level of people who don’t have a job, making them bad clients in the eye of the banking system.

Inflation is positively related with nonperforming loans. An increase of inflation forces monetary regulators to increase interest rate to control inflation which means that there will be an increase in the cost of borrowing. Interest rate is positively related with nonperforming loans because it means that the cost of borrowing will increase so people with have to pay more and they may not be able to make this payment if the loan interest rate increases.

So the aim of the study is not only to measure or evaluate the impact that these determinants has on NPLs but also how these variables impact each other and NPLs. Maybe this fact is a new element to the thesis because other papers have been focusing only on studying the relationship or correlation between the independent variables and dependent variable. However, the paper implements three different models in order to estimate or make a better assumption of the importance of NPLs in an economy.

3.2. Methodology

The methodology of stress testing for credit risk in the banks of Albania is based on directly stressing the growth in non-performing loans of the banking system and measures the effect on the capital adequacy of the banking system.
However, the purpose of the study is to firstly use the Johansen Multivariate Co-integration Test which specifies the application of this test on a multiple regression to prove if there exists a long run relationship among variables. Secondly, the paper uses the Unit Root test in order to evaluate if for a significance level of 5 % based on the hypotheses build, concluding if the variables are stationary or not. Non stationary means that a series does not fluctuate around a mean value and does not have a tendency of coverage toward mean value. If for 1%, 5% and 10% level the probability is greater than 0.05 it means that the variable has a unit root (nonstationary). In this moment the variables should be first differenced in order to become stationary meaning that for 1%, 5% and 10% level the probability is lower than 0.05. The long run relationship that exists between nonperforming loans and all five other variables (real GDP, unemployment, inflation, loan interest rate, exchange rate) is shown by using Johansen co-integration test. If in the Johansen co-integration test the value of Trace statistic is greater than 5% critical value or if the Max-Eigen statistic is greater than 5% critical value it means that in the long run there exist a strong co-integration between nonperforming loans and: real GDP, unemployment, inflation, loan interest rate and exchange rate.

Thirdly, the thesis concludes it estimations by using a VARs model. The vector auto regression (VAR) model is one of the most successful, flexible, and easy to use models for the analysis of multivariate time series. It is a natural extension of the univariate autoregressive model to dynamic multivariate time series. The VAR model has proven to be especially useful for describing the dynamic behavior of economic and financial time series and for forecasting. It often provides superior forecasts to those from univariate time series models and elaborate theory-based simultaneous equations models. [14] In our case, the VAR models it is used to estimate if the independent variables are significant in order to explain the development or changes that occur in the dependent variable. So, to make an appropriate decision the P-value is important to evaluate for the significant assurance.

3.3 Analysis Results

3.3.1 Johansen Co-Integration Test

Table 1: Estimation of the Equation Output

Variables	Coefficients	Eigen Value	Trace Statistic	0.05 Critical Value	Prob	St Error
NPL	-0.09378	0.729074	139.6351	107.347	0.0001	-0.102
INF	-0.26887	0.547762	90.01059	79.34145	0.0063	-0.070
LIR	-0.09139	0.472886	59.85582	55.24578	0.0186	-0.060
EXCH	9.319173	0.397393	35.52296	35.01090	0.0440	25.4251
UNEM	-0.05317	0.247262	16.27634	18.39771	0.0966	-0.034
GDP	-0.05029	0.134361	5.482909	3.841466	0.0192	0.035

Table 2: Estimation of the Equation for Max-Eigen Statistic

Variables	Coefficients	Eigen Value	Max-Eigen Statistic	0.05 Critical Value	Prob	St Error
NPL	-0.09378	0.729074	49.62452	43.41977	0.0001	0.0094
INF	-0.26887	0.547762	30.15477	37.16359	0.0063	0.2554
LIR	-0.09139	0.472886	24.33286	30.81507	0.0186	0.2516
EXCH	9.319173	0.397393	19.24662	24.25202	0.0440	0.2003
UNEM	-0.05317	0.247262	10.79343	17.14769	0.0966	0.3282
GDP	-0.05029	0.134361	5.482909	3.841466	0.0192	0.0192

The sample include the quarterly time range from 2003-2014. In total there are made 38 observations. The tables listed below gives information about the relationship between the NPL and the other determinants.So if GDP can be increased by 1 unit, this should be translated in

[14] Vector Autoregressive Models for Multivariate Time Series, Faculty of Washington, pg 383

decreasing the NPL rate by 5.029 units. A contradictory and surprising fact is about the unemployment rate, the inflation rate and interest rate. It can be seen that while the unemployment rate increases by 1 unit, the nonperforming loan rate decreases by 5.317 units. On the other hand, increasing the inflation by 1 unit means decreasing the nonperforming loans by 26.887 units. Furthermore, if the interest rate is increased by 1 unit, NPL decreases by 9.139 units.

From these results is seen that there exist a negative relationship between nonperforming loans inflation, unemployment rate and interest rate. These results are against the related studies results from which is concluded that there exists a positive relationship between nonperforming loans and these variables. Returning to the most important part of the paper, to see if the data are co-integrated together it have to be a comparison between Trace Statistic and 5 % critical value. If the Trace statistic is greater than 5% critical value or if the Max-Eigen statistic is greater than 5% critical value it means that in the long run there exist a strong co-integration between nonperforming loans and: real GDP, unemployment, inflation, loan interest rate and exchange rate. Seeing the information listed in table it can be estimated that there is a strong co-integration between NPL and independent variables, expect for the unemployment rate where the Trace Statistic is less than 5 % critical value. On the other hand, in the table 2 it can be seen for the variables inflation rate, exchange rate, unemployment rate and interest rate, the Max-Eigen statistic is less than 5 % critical value. In conclusion based on what Hill (2008) stated, nonperforming loans and the other variables: real GDP, unemployment, inflation, interest rate, and exchange rate are co-integrated to each other; however, in the long run this co-integration is weak.

3.3.2 Unit Root Augmented Dickey Fuller Test

The next step of the thesis includes evaluating if the variables have a unit root or not. In this case the Unit Root test should be used. In case of Dickey Fuller test, there is a problem of autocorrelation. However, this kind of test has developed a kind of test called ADF (Augmented Dickey Fuller) that includes three main equations:

Equation 1:Δ? = ? 1 + ??? − 1 + ?? + ?? (includes the constant)

Equation 2:Δ? = ? 1 + ?? + ??? − 1 + ?? + ?? (includes the constant and trend)

Equation 3:Δ? = ??? − 1 + ?? + ?? (doesn't include the constant and trend)

Linked together, these three models should come to the same conclusion and satisfy the main purpose of the study in order to make a decision.

As mentioned before the Unit Root test is built in order to see if the variables have a unit root or are stationary. Consequently, the model itself demands constructing two main hypotheses. Relating to this the thesis focuses in:

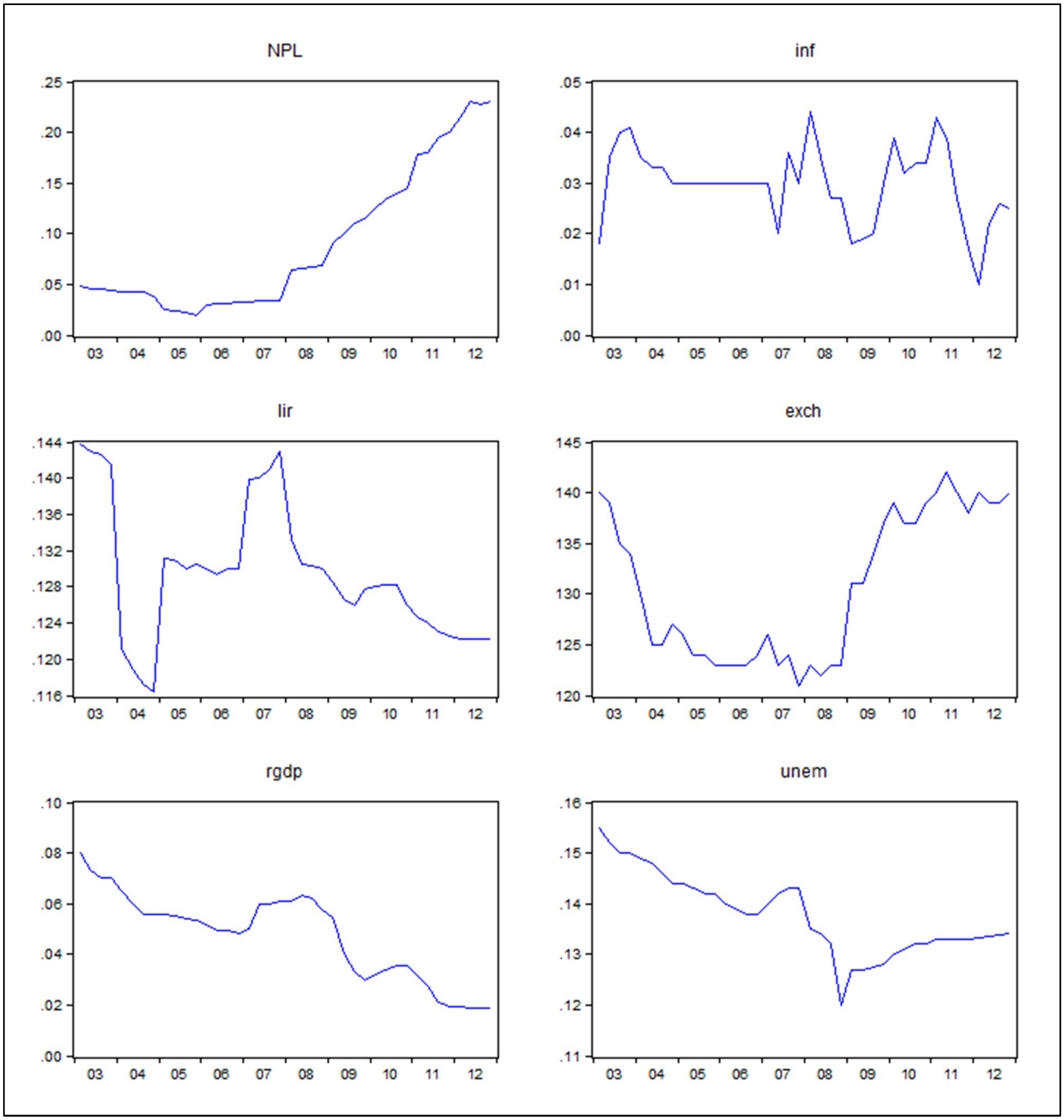
Null Hypothesis: The variables have unit root or are not stationary

Alternative Hypothesis: The variables are stationary.

To get in conclusion if the variables are stationary or not, it has to be evaluated in a level of 1%, 5 % or 10 % the t-statistic and the critical value of the model. In this moment, the t-statistic should be more than the critical value in order to reject the null hypothesis. On the contrary the null hypothesis cannot be rejected leading to conclude that the variables are not stationary. To make the conclusion more based and strong, a comparison between the level of 1%, 5 % or 10 % with the P-value should be made. In this case the P-value should be lower than the percentage level in order to reject the null hypothesis. But if the variables are not stationary, they are first differenced in order to make them stationary.

Before getting in a conclusion about the variables taken in study, it is better to see a trending of the six factors in a graphic way. In this case, it can be seen a clear situation about the historical trending of the data gathered throw years.

Figure 10: Historical Trending of GDP, inflation, interest rate, unemployment and exchange rate



As seen in the graphics below, all the variables have their trending regarding the changes during 2003-2012. It can be clear that the changes occurred during these period, doesn't affect the variables in the same way. NPL has an increasing trending meaning that during this time of period, the customers haven't paid the loans making them bad clients and increasing the non-performing loan rate. These graphics give an indication even about the linkage and the correlation between the dependent variable and the independent variables.

Figure 11: ADF test in NPL, INF, LIR, EXH, UNEM, GDP

Variables	1 % Level	5 % Level	10 % Level	T-Statistic	P-Value
NPL	-3.61045	-2.93899	-2.60793	2.110780	0.99900
INF	-3.63941	-2.95113	-2.61430	-3.86753	0.00560
LIR	-3.61045	-2.93899	-2.60793	-2.47339	0.1296
EXCH	-3.61045	-2.93899	-2.60793	-1.00946	0.7405
UNEM	-3.61045	-2.93899	-2.60793	-2.23447	0.1979
GDP	-3.61559	-2.94115	-2.60907	-0.91782	0.7716

Comparing the T-statistic value and the critical value for the 5 % level of probability it can be concluded:

For the NPL variable, the t-stat value is less than the critical value making the null hypothesis impossible to reject. So, NPL has a unit root or it’s not stationary. To reinforce this conclusion, the p-value of 0.999 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

For the inflation variable, the t-stat value is less than the critical value making the null hypothesis impossible to reject. So, inflation has a unit root or it’s not stationary. To reinforce this conclusion, the p-value of 0.00560 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

For the interest rate variable, the t-stat value is more than the critical value making the null hypothesis reject able. But it to make a better conclusion, the p-value of 0.1296 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

For the exchange rate variable, the t-stat value is greater than the critical value making the null hypothesis again reject able. But to make a better conclusion, the p-value of 0.7405 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

For the unemployment rate, the t-stat value is more than the critical value making the null hypothesis reject able. For making a better conclusion, the p-value of 0.1909 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

For the real GDP, the t-stat value is more than the critical value making the null hypothesis reject able. For making a better conclusion, the p-value of 0.7719 it can be compared with the level of 5 %. In this case the P-value is greater, stating that the variable is not stationary.

Concluding regarding the comparison between the P-value and the level of 5%, the null hypothesis cannot be rejected. In this case the variables have a unit root or are not stationary. To convert them in stationary variables, all of them should be first differenced.

Figure 12: ADF test on D(NPL,INF,LIR,EXCH, UNEM,GDP)

Variables	1 % Level	5 % Level	10 % Level	T-Statistic	P-Value
NPL	-3.615588	-2.941145	-2.609066	-5.337829	0.0001
INF	-3.615588	-2.941145	-2.609066	-6.905957	0.0000
LIR	-3.615588	-2.941145	-2.609066	-5.509449	0.0000
EXCH	-3.615588	-2.941145	-2.609066	-5.403109	0.0001
UNEM	-3.615588	-2.941145	-2.609066	-6.684888	0.0000
GDP	-3.615588	-2.941145	-2.609066	-3.826687	0.0049

After first differencing all the variables, it can be made a comparison between p-value of probability and level of 5 %.

For the NPL variable, the p-value is less than the level of 5 % making the alternative hypothesis accepted. In this case, NPL variable is stationary and doesn't have a unit root. The same way is for other variable. After making the last consumption, for concluding the Unit root test, it can be said that the null hypothesis can be rejected only when the variables are first differenced.

To conclude the Unit Root test, an altogether first differenced assumption is made in order to evaluate if the variables are stationary and the alternative hypothesis stands.

Figure 13: All together ADF test

Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-11.3588	0.0000	6	228
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-11.3826	0.0000	6	228
ADF - Fisher Chi-square	123.079	0.0000	6	228
PP - Fisher Chi-square	137.467	0.0000	6	228

Estimating a comparison between the P-value and the level of 5 % it can be concluded that while the variables are first differenced, they are stationary.

3.3.3 VAR Model approach

After arriving at a conclusion that all the variables are co-integrated in the short run and stationary, the paper focuses on building a model where evaluating the significance of every factors in the default rate, in this case NPL is important. VAR model itself helps estimates if the independent variables are crucial or not to explain the dependent variable. So, if the economy of Albania faces changes in macroeconomic factors like GDP, Inflation or interest rates how can these factors affect non –performing loan? This VAR model every variable is treated like a dependent variable, so the approach has as many model as the variables on the study. In this case, it can be conducted six models: one for NPL, one for GDP, one for inflation, one for exchange rate, one for interest rate and on for unemployment. After building the model, it can be seen how each of the independent variables affect the dependent variable. In the study even the changes that have happened on a factor a year or two before is added as an independent variable that could impact in a way the dependent variable.

In the Albanian case it should be found six models in total. For every model it should be tested whether the endogenous variables including even the variables that have two lag, are significant enough to explain the dependent variable? Regarding to this declaration, the dependent variable could be NPL, GDP, INF, EXCHANGE, and UNEMPLOYMENT OR INTEREST RATE.

The VAR approach lists six models integrated with 13 endogenous variables which are added in order to evaluate whether each one of them is significant to explain the dependent variables. The

VAR estimation includes the coefficients for every variable, the standard error and t-statistics. However for having a better conclusion the p-value needs to be computed and compared with 5 % level of probability in order to evaluate for each independent variable the impact that it has on the dependent value. Before focusing in answering the question below, the model needs to be computed. In total the VAR model includes 78 coefficients. The most important model, which is the objective of the paper to study, is based in 13 coefficients.

Model 1: NPL = C(1)*NPL(-1) + C(2)*NPL(-2) + C(3)*INF(-1) + C(4)*INF(-2) + C(5)*LIR(-1) + C(6)*LIR(-2) + C(7)*EXCH(-1) + C(8)*EXCH(-2) + C(9)*RGDP(-1) + C(10)*RGDP(-2) + C(11)*UNEM(-1) + C(12)*UNEM(-2) + C(13).

The model is transformed as followes while the Var test is done and list all the coefficent and the p-value, which it can be find in the appendix 15 section.

Model 1: NPL = 0.784167*NPL(-1) + 0.234739*NPL(-2) + (-0.322288)*INF(-1) + 0.454360*INF(-2) + 0.418151*LIR(-1) + 0.370709*LIR(-2) + 0.000409*EXCH(-1) + (-0.000396)*EXCH(-2) + (-0.609021)*RGDP(-1) + 0.364798*RGDP(-2) + (-0.951194)*UNEM(-1) + 0.488173*UNEM(-2) + (-0.029093)

For every model estimate, the p-value of every coefficient listed in the appendix section should be compared to 5 %. If the p-value is less than 5 % the independent variable is not significant to explain the dependent variable. For the first model, if it can be compared the P-value with 5 %, it can be concluded that only the coefficient C1 individually is significant enough to explain the default rate. In other words, in Albania the non-performing loans are impacted significally by the historical performance of NPL one year before.

The VAR model tend to gives the thesis an idea about how several macroeconomic factors could impact each other if we build a co-integrated system. Important is that while different studies have showed and inhenced the fact that factors like GDP, inflation, unemployment, interest rate have a significant role in impacting the NPL, in the case taken in consideration for Albania, the results derivates, leading the paper to new estimates. It is better that in the near future, a more deep study to be done about the fact that how it can be explained that the NPL factor depend by the historical performance of the NPL one lag. Even though the conclusion made by the Var model is a little bit contradictory following other literatues, it can be stated that while the perfomance of NPL is positively correlated with the historical data of NPL one lag, this factors is also impacted by macroeconomic determinants. The study showed that while the NPL one lag factor was more significant, even the other factors taken in consideration impact NPL performance. The historical data of NPL one year before always can show a way or a trend that the non-performing loan could follow regarding the economic environment of a country. Currently in Albania, the economic situation is not stable and the financial development has been in a low level, making the Banks not gathering in the right way the loan conducted to clients. In this case, they have even stricted the procedures of lending.

CONCLUSIONS

The issue of non-performing loans (NPLs) has gained increasing attentions in the last few decades. The immediate consequence of large amount of NPLs in the banking system is bank failure. It is argued that the non-performing loans are one of the major causes of the economic stagnation problems. Each non-performing loan in the financial sector is viewed as an obverse mirror image of an ailing unprofitable enterprise. From this point of view, the eradication of non-performing loans is a necessary condition to improve the economic status. If the non-performing loans are kept existing and continuously rolled over, the resources are locked up in unprofitable sectors; thus, hindering the economic growth and impairing the economic efficiency.

Focusing on the importance of the non-performing loans on an economy, the thesis focuses on three main approaches in order to create an appropriate model to measure the credit risk by macroeconomics variables. These three main approaches are: Johansen test, Unit Root test and VAR model.

While studying the models, implementing Johansen co-integration test gave the possibility to evaluate if the variables tested where or not co-integrated. So a model was created based on six variables: NPL, GDP, Inflation, Interest Rate, Unemployment, and Exchange Rate. The Johansen test proved that these factors were co-integrated with each other, but only on the short-run because the Max-Eigen statistic is less than 5 % critical value, showing that in the long run the cooperation between variables is weak.

For the Unit Root ADF test, two main hypotheses were build interpreting whether the variables were stationary or not. In the first part, the variables were not stationary or they had a unit root based on the comparison between the t-statistic and the critical value. On the second part, the variables were first differenced, getting to the conclusion that the variables are stationary.

Making the variables was an important step on building the VAR approach in which consisted in six models estimating the relationship and the significance of each variable to one another. The model concluded that the non-performing loan is explained significally by the historical performance of the NPL one lag. The other macroeconomics factors were not significant regarding the comparison that was made for each model for the P-value with the 5 % level. So in

Albania case the macroeconomic factors does not tend always to impact to non-performing loan. Trending situations are even more important in estimating and making a crucial impact in NPL.

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APPENDIXES

Appendix 1. ADF test for D(EXCH)

Null Hypothesis: D(EXCH) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.403109	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCH,2)
Method: Least Squares
Date: 10/05/15 Time: 15:07
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXCH(-1))	-0.895597	0.165756	-5.403109	0.0000
C	0.029063	0.390587	0.074409	0.9411

R-squared	0.447798	Mean dependent var	0.052632
Adjusted R-squared	0.432459	S.D. dependent var	3.195837
S.E. of regression	2.407593	Akaike info criterion	4.646328
Sum squared resid	208.6741	Schwarz criterion	4.732516
Log likelihood	-86.28022	Hannan-Quinn criter.	4.676993
F-statistic	29.19358	Durbin-Watson stat	2.006138
Prob(F-statistic)	0.000004		

Appendix 2. ADF test for EXCH

Null Hypothesis: EXCH has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.009455	0.7405
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCH)
Method: Least Squares
Date: 10/05/15 Time: 15:05
Sample (adjusted): 2003Q2 2012Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCH(-1)	-0.053605	0.053103	-1.009455	0.3193
C	7.000233	6.944966	1.007958	0.3200

R-squared	0.026802	Mean dependent var	0.000000
Adjusted R-squared	0.000500	S.D. dependent var	2.361980
S.E. of regression	2.361389	Akaike info criterion	4.606298
Sum squared resid	206.3179	Schwarz criterion	4.691609
Log likelihood	-87.82280	Hannan-Quinn criter.	4.636906
F-statistic	1.019000	Durbin-Watson stat	1.736852
Prob(F-statistic)	0.319313		

Appendix 3. ADF test for Inflation

Null Hypothesis: INF has a unit root
Exogenous: Constant
Lag Length: 5 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.867526	0.0056
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INF)
Method: Least Squares
Date: 10/05/15 Time: 15:03
Sample (adjusted): 2004Q3 2012Q4
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF(-1)	-1.175062	0.303828	-3.867526	0.0006
D(INF(-1))	0.750962	0.273372	2.747030	0.0106
D(INF(-2))	0.830227	0.234414	3.541709	0.0015
D(INF(-3))	0.248595	0.223077	1.114391	0.2749
D(INF(-4))	0.248093	0.209696	1.183109	0.2471

D(INF(-5))	0.591356	0.172309	3.431944	0.0019
C	0.035009	0.009308	3.761409	0.0008

R-squared	0.540628	Mean dependent var	-0.000235
Adjusted R-squared	0.438546	S.D. dependent var	0.006981
S.E. of regression	0.005231	Akaike info criterion	-7.487305
Sum squared resid	0.000739	Schwarz criterion	-7.173055
Log likelihood	134.2842	Hannan-Quinn criter.	-7.380137
F-statistic	5.295990	Durbin-Watson stat	2.029178
Prob(F-statistic)	0.001015		

Appendix 4. ADF test for D(Inflation)

Null Hypothesis: D(INF) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.905957	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INF,2)
Method: Least Squares
Date: 10/05/15 Time: 15:03
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	-1.060589	0.153576	-6.905957	0.0000
C	-0.000250	0.001104	-0.226796	0.8219

R-squared	0.569853	Mean dependent var	-0.000474
Adjusted R-squared	0.557904	S.D. dependent var	0.010232
S.E. of regression	0.006803	Akaike info criterion	-7.091677
Sum squared resid	0.001666	Schwarz criterion	-7.005488
Log likelihood	136.7419	Hannan-Quinn criter.	-7.061012
F-statistic	47.69224	Durbin-Watson stat	2.097862
Prob(F-statistic)	0.000000		

Appendix 5. ADF test for Interest Rate

Null Hypothesis: LIR has a unit root
Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.473385	0.1296
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LIR)
Method: Least Squares
Date: 10/05/15 Time: 14:59
Sample (adjusted): 2003Q2 2012Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LIR(-1)	-0.240027	0.097044	-2.473385	0.0181
C	0.030557	0.012597	2.425658	0.0203

R-squared	0.141882	Mean dependent var	-0.000551
Adjusted R-squared	0.118690	S.D. dependent var	0.004743
S.E. of regression	0.004453	Akaike info criterion	-7.940570
Sum squared resid	0.000734	Schwarz criterion	-7.855259
Log likelihood	156.8411	Hannan-Quinn criter.	-7.909961
F-statistic	6.117632	Durbin-Watson stat	1.688343
Prob(F-statistic)	0.018099		

Appendix 6. ADF test on D(Interest Rate)

Null Hypothesis: D(LIR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.509449	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LIR,2)
Method: Least Squares

Date: 10/05/15 Time: 15:01
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LIR(-1))	-0.915057	0.166089	-5.509449	0.0000
C	-0.000497	0.000793	-0.626122	0.5352

R-squared	0.457456	Mean dependent var	2.11E-05
Adjusted R-squared	0.442385	S.D. dependent var	0.006502
S.E. of regression	0.004856	Akaike info criterion	-7.766195
Sum squared resid	0.000849	Schwarz criterion	-7.680006
Log likelihood	149.5577	Hannan-Quinn criter.	-7.735530
F-statistic	30.35402	Durbin-Watson stat	1.997499
Prob(F-statistic)	0.000003		

Appendix 7. Full ADF test for GDP

Null Hypothesis: RGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.917821	0.7716
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP)
Method: Least Squares
Date: 10/05/15 Time: 15:08
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP(-1)	-0.031078	0.033861	-0.917821	0.3650
D(RGDP(-1))	0.459921	0.144583	3.181024	0.0031
C	0.000780	0.001719	0.453731	0.6528

R-squared	0.231975	Mean dependent var	-0.001426
Adjusted R-squared	0.188087	S.D. dependent var	0.003676
S.E. of regression	0.003313	Akaike info criterion	-8.506542
Sum squared resid	0.000384	Schwarz criterion	-8.377259
Log likelihood	164.6243	Hannan-Quinn criter.	-8.460544
F-statistic	5.285705	Durbin-Watson stat	1.944547
Prob(F-statistic)	0.009864		

Appendix 8. Full ADF test for D(GDP)

Null Hypothesis: D(RGDP) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.826687	0.0058
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RGDP,2)
Method: Least Squares
Date: 10/05/15 Time: 15:10
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RGDP(-1))	-0.550391	0.143830	-3.826687	0.0005
C	-0.000703	0.000584	-1.204570	0.2362

R-squared	0.289149	Mean dependent var	0.000182
Adjusted R-squared	0.269403	S.D. dependent var	0.003867
S.E. of regression	0.003305	Akaike info criterion	-8.535390
Sum squared resid	0.000393	Schwarz criterion	-8.449201
Log likelihood	164.1724	Hannan-Quinn criter.	-8.504725
F-statistic	14.64353	Durbin-Watson stat	1.939306
Prob(F-statistic)	0.000498		

Appendix 9. Full ADF test on UNEM

Null Hypothesis: UNEM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.234471	0.1979
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEM)
Method: Least Squares
Date: 10/05/15 Time: 15:11
Sample (adjusted): 2003Q2 2012Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEM(-1)	-0.119934	0.053674	-2.234471	0.0316
C	0.015994	0.007411	2.158139	0.0375

R-squared	0.118898	Mean dependent var	-0.000538
Adjusted R-squared	0.095084	S.D. dependent var	0.002790
S.E. of regression	0.002654	Akaike info criterion	-8.975623
Sum squared resid	0.000261	Schwarz criterion	-8.890312
Log likelihood	177.0246	Hannan-Quinn criter.	-8.945014
F-statistic	4.992862	Durbin-Watson stat	2.183920
Prob(F-statistic)	0.031577		

Appendix 10. ADF test on D(UNEM)

Null Hypothesis: D(UNEM) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.684888	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UNEM,2)
Method: Least Squares
Date: 10/05/15 Time: 15:13
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEM(-1))	-1.097763	0.164216	-6.684888	0.0000
C	-0.000528	0.000467	-1.131010	0.2655

R-squared	0.553835	Mean dependent var	8.16E-05

Adjusted R-squared	0.541442	S.D. dependent var	0.004168
S.E. of regression	0.002822	Akaike info criterion	-8.851413
Sum squared resid	0.000287	Schwarz criterion	-8.765224
Log likelihood	170.1768	Hannan-Quinn criter.	-8.820747
F-statistic	44.68772	Durbin-Watson stat	2.010068
Prob(F-statistic)	0.000000		

Appendix 11. ADF Test on NPL

Null Hypothesis: NPL has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		2.110780	0.9999
Test critical values:	1% level	-3.610453	0.001
	5% level	-2.938987	0.05
	10% level	-2.607932	0.1

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(NPL)

Method: Least Squares

Date: 10/05/15 Time: 14:55

Sample (adjusted): 2003Q2 2012Q4

Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NPL(-1)	0.045667	0.021635	2.110780	0.0416

C	0.000739	0.002336	0.316533	0.7534

R-squared	0.107474	Mean dependent var	0.004664
Adjusted R-squared	0.083352	S.D. dependent var	0.009220
S.E. of regression	0.008827	Akaike info criterion	-6.571979
Sum squared resid	0.002883	Schwarz criterion	-6.486668
Log likelihood	130.1536	Hannan-Quinn criter.	-6.541370
F-statistic	4.455394	Durbin-Watson stat	2.040908
Prob(F-statistic)	0.041610		

Appendix 12. ADF test for D(NPL)

Null Hypothesis: D(NPL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.337829	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(NPL,2)
Method: Least Squares
Date: 10/05/15 Time: 18:39
Sample (adjusted): 2003Q3 2012Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NPL(-1))	-0.877525	0.164397	-5.337829	0.0000
C	0.004260	0.001702	2.502500	0.0170

R-squared	0.441795	Mean dependent var	0.000108
Adjusted R-squared	0.426289	S.D. dependent var	0.012323
S.E. of regression	0.009334	Akaike info criterion	-6.459114
Sum squared resid	0.003136	Schwarz criterion	-6.372925
Log likelihood	124.7232	Hannan-Quinn criter.	-6.428449
F-statistic	28.49242	Durbin-Watson stat	2.066850
Prob(F-statistic)	0.000005		

Appendix 13. ADF test on all variables.

Group unit root test: Summary
Series: NPL, INF, LIR, EXCH, RGDP, UNEM
Date: 10/05/15 Time: 15:15
Sample: 2003Q1 2012Q4
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 5
Newey-West automatic bandwidth selection and Bartlett kernel

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.85983	0.9685	6	228
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.28152	0.6108	6	228
ADF - Fisher Chi-square	18.8142	0.0931	6	228
PP - Fisher Chi-square	19.3438	0.0806	6	234

** Probabilities for Fisher tests are computed using an asymptotic Chi -square distribution. All other tests assume asymptotic normality.

Appendix 14. VAR autoregression model test

	NPL	INF	LIR	EXCH	RGDP	UNEM
NPL(-1)	0.784194	0.007190	-0.077064	5.152621	-0.030482	-0.036955
	(0.20994)	(0.14799)	(0.11424)	(43.1611)	(0.06413)	(0.06550)
	[3.73532]	[0.04859]	[-0.67458]	[0.11938]	[-0.47533]	[-0.56419]
NPL(-2)	0.234697	-0.089970	0.021236	-10.29028	-0.011177	-0.027663
	(0.22423)	(0.15806)	(0.12201)	(46.0981)	(0.06849)	(0.06996)
	[1.04670]	[-0.56921]	[0.17405]	[-0.22323]	[-0.16319]	[-0.39543]
INF(-1)	-0.322298	0.543499	0.001313	-10.11511	0.118729	-0.017265
	(0.30055)	(0.21186)	(0.16354)	(61.7895)	(0.09181)	(0.09377)
	[-1.07236]	[2.56535]	[0.00803]	[-0.16370]	[1.29325]	[-0.18412]
INF(-2)	0.454375	-0.308670	-0.172064	-45.94243	-0.091878	-0.077419
	(0.27438)	(0.19341)	(0.14930)	(56.4091)	(0.08381)	(0.08560)
	[1.65601]	[-1.59591]	[-1.15244]	[-0.81445]	[-1.09623]	[-0.90437]
LIR(-1)	0.418241	-0.224088	0.663059	23.83628	0.188396	-0.087477
	(0.39402)	(0.27775)	(0.21441)	(81.0057)	(0.12036)	(0.12293)
	[1.06147]	[-0.80680]	[3.09254]	[0.29425]	[1.56529]	[-0.71159]
LIR(-2)	0.370620	0.169946	-0.055786	-97.43845	-0.071827	0.028983
	(0.39736)	(0.28010)	(0.21622)	(81.6914)	(0.12138)	(0.12397)
	[0.93272]	[0.60673]	[-0.25801]	[-1.19276]	[-0.59176]	[0.23379]

EXCH(-1)	0.000409	-0.000242	0.000311	0.554128	-0.000238	0.000273
	(0.00093)	(0.00065)	(0.00050)	(0.19066)	(0.00028)	(0.00029)
	[0.44109]	[-0.36987]	[0.61582]	[2.90630]	[-0.83895]	[0.94285]
EXCH(-2)	-0.000396	0.000859	-0.000193	0.389485	0.000201	0.000134
	(0.00093)	(0.00066)	(0.00051)	(0.19150)	(0.00028)	(0.00029)
	[-0.42540]	[1.30855]	[-0.38078]	[2.03382]	[0.70627]	[0.45988]
RGDP(-1)	-0.608940	0.688503	0.171793	15.37943	1.111987	0.098083
	(0.57960)	(0.40857)	(0.31539)	(119.158)	(0.17705)	(0.18083)
	[-1.05063]	[1.68517]	[0.54470]	[0.12907]	[6.28078]	[0.54240]
RGDP(-2)	0.364714	-0.644274	-0.270064	9.306180	-0.414399	-0.212850
	(0.47790)	(0.33688)	(0.26005)	(98.2507)	(0.14598)	(0.14910)
	[0.76316]	[-1.91248]	[-1.03851]	[0.09472]	[-2.83871]	[-1.42754]
UNEM(-1)	-0.951403	0.217928	-0.197394	-396.4606	-0.354225	0.510316
	(0.65059)	(0.45861)	(0.35402)	(133.753)	(0.19873)	(0.20298)
	[-1.46238]	[0.47520]	[-0.55758]	[-2.96414]	[-1.78244]	[2.51413]
UNEM(-2)	0.488346	-0.352682	0.153191	112.1849	0.502637	0.331135
	(0.70484)	(0.49685)	(0.38354)	(144.906)	(0.21530)	(0.21991)
	[0.69285]	[-0.70984]	[0.39942]	[0.77419]	[2.33456]	[1.50581]
C	-0.029104	-0.026420	0.056022	56.82791	-0.014664	-0.010228
	(0.07095)	(0.05001)	(0.03861)	(14.5866)	(0.02167)	(0.02214)
	[-0.41020]	[-0.52825]	[1.45105]	[3.89589]	[-0.67659]	[-0.46206]
R-squared	0.990178	0.565378	0.696588	0.960144	0.982706	0.909534
Adj. R-squared	0.985463	0.356759	0.550950	0.941014	0.974405	0.866110
Sum sq. resids	0.001796	0.000893	0.000532	75.91846	0.000168	0.000175
S.E. equation	0.008476	0.005975	0.004612	1.742624	0.002589	0.002645
F-statistic	210.0202	2.710100	4.783015	50.18881	118.3814	20.94558
Log likelihood	135.3141	148.6020	158.4382	-67.06907	180.3792	179.5753
Akaike AIC	-6.437585	-7.136948	-7.654644	4.214161	-8.809433	-8.767123
Schwarz SC	-5.877358	-6.576721	-7.094417	4.774388	-8.249206	-8.206896
Mean dependent	0.091782	0.029895	0.128687	130.3684	0.045766	0.136924
S.D. dependent	0.070302	0.007450	0.006883	7.175111	0.016184	0.007227

Determinant resid covariance (dof adj.)	2.18E-24
Determinant resid covariance	1.77E-25
Log likelihood	759.3756
Akaike information criterion	-35.86188
Schwarz criterion	-32.50051

Appendix 15. P-value Calculation

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.784167	0.209941	3.735174	0.0003
C(2)	0.234739	0.224227	1.046883	0.2968
C(3)	-0.322288	0.300553	-1.072317	0.2853

C(4)	0.454360	0.274387	1.655908	0.0998
C(5)	0.418151	0.394000	1.061298	0.2903
C(6)	0.370709	0.397358	0.932933	0.3524
C(7)	0.000409	0.000927	0.440962	0.6599
C(8)	-0.000396	0.000931	-0.425409	0.6711
C(9)	-0.609021	0.579586	-1.050786	0.2950
C(10)	0.364798	0.477877	0.763373	0.4464
C(11)	-0.951194	0.650596	-1.462033	0.1458
C(12)	0.488173	0.704829	0.692612	0.4896
C(13)	-0.029093	0.070951	-0.410042	0.6824
C(14)	0.007190	0.147989	0.048586	0.9613
C(15)	-0.089970	0.158060	-0.569214	0.5701
C(16)	0.543499	0.211862	2.565346	0.0113
C(17)	-0.308670	0.193414	-1.595909	0.1126
C(18)	-0.224088	0.277750	-0.806800	0.4211
C(19)	0.169946	0.280101	0.606730	0.5449
C(20)	-0.000242	0.000654	-0.369869	0.7120
C(21)	0.000859	0.000657	1.308550	0.1927
C(22)	0.688503	0.408565	1.685174	0.0940
C(23)	-0.644274	0.336879	-1.912481	0.0577
C(24)	0.217928	0.458606	0.475196	0.6353
C(25)	-0.352682	0.496848	-0.709837	0.4789
C(26)	-0.026420	0.050014	-0.528247	0.5981
C(27)	-0.077064	0.114239	-0.674583	0.5010
C(28)	0.021236	0.122013	0.174051	0.8621
C(29)	0.001313	0.163545	0.008026	0.9936
C(30)	-0.172064	0.149304	-1.152441	0.2510
C(31)	0.663059	0.214406	3.092539	0.0024
C(32)	-0.055786	0.216221	-0.258005	0.7968
C(33)	0.000311	0.000505	0.615819	0.5389
C(34)	-0.000193	0.000507	-0.380778	0.7039
C(35)	0.171793	0.315388	0.544703	0.5868
C(36)	-0.270064	0.260050	-1.038507	0.3007
C(37)	-0.197394	0.354017	-0.557584	0.5780
C(38)	0.153191	0.383537	0.399416	0.6902
C(39)	0.056022	0.038608	1.451053	0.1489
C(40)	5.152621	43.16113	0.119381	0.9051
C(41)	-10.29028	46.09813	-0.223225	0.8237
C(42)	-10.11511	61.78950	-0.163703	0.8702
C(43)	-45.94243	56.40907	-0.814451	0.4167
C(44)	23.83628	81.00565	0.294254	0.7690
C(45)	-97.43845	81.69142	-1.192762	0.2348
C(46)	0.554128	0.190665	2.906300	0.0042
C(47)	0.389485	0.191504	2.033820	0.0437
C(48)	15.37943	119.1581	0.129067	0.8975
C(49)	9.306180	98.25065	0.094719	0.9247
C(50)	-396.4606	133.7525	-2.964135	0.0035
C(51)	112.1849	144.9058	0.774192	0.4400
C(52)	56.82791	14.58664	3.895888	0.0001
C(53)	-0.030482	0.064129	-0.475329	0.6352
C(54)	-0.011177	0.068493	-0.163186	0.8706
C(55)	0.118729	0.091807	1.293246	0.1979
C(56)	-0.091878	0.083813	-1.096225	0.2747
C(57)	0.188396	0.120359	1.565288	0.1196
C(58)	-0.071827	0.121378	-0.591761	0.5549
C(59)	-0.000238	0.000283	-0.838954	0.4028

C(60)	0.000201	0.000285	0.706270	0.4811
C(61)	1.111987	0.177046	6.280784	0.0000
C(62)	-0.414399	0.145982	-2.838707	0.0052
C(63)	-0.354225	0.198730	-1.782438	0.0767
C(64)	0.502637	0.215302	2.334564	0.0209
C(65)	-0.014664	0.021673	-0.676592	0.4997
C(66)	-0.036955	0.065500	-0.564195	0.5735
C(67)	-0.027663	0.069957	-0.395431	0.6931
C(68)	-0.017265	0.093770	-0.184121	0.8542
C(69)	-0.077419	0.085605	-0.904371	0.3672
C(70)	-0.087477	0.122932	-0.711592	0.4778
C(71)	0.028983	0.123973	0.233787	0.8155
C(72)	0.000273	0.000289	0.942850	0.3473
C(73)	0.000134	0.000291	0.459877	0.6463
C(74)	0.098083	0.180831	0.542401	0.5883
C(75)	-0.212850	0.149103	-1.427538	0.1555
C(76)	0.510316	0.202979	2.514125	0.0130
C(77)	0.331135	0.219905	1.505808	0.1342
C(78)	-0.010228	0.022136	-0.462063	0.6447

Determinant residual covariance 1.77E-25

Equation: NPL = C(1)*NPL(-1) + C(2)*NPL(-2) + C(3)*INF(-1) + C(4)*INF(-2) + C(5)*LIR(-1) + C(6)*LIR(-2) + C(7)*EXCH(-1) + C(8)*EXCH(-2) + C(9) *RGDP(-1) + C(10)*RGDP(-2) + C(11)*UNEM(-1) + C(12)*UNEM(-2) + C(13)

Observations: 38

R-squared	0.990178	Mean dependent var	0.091782
Adjusted R-squared	0.985463	S.D. dependent var	0.070302
S.E. of regression	0.008476	Sum squared resid	0.001796
Durbin-Watson stat	1.978426		

Equation: INF = C(14)*NPL(-1) + C(15)*NPL(-2) + C(16)*INF(-1) + C(17) *INF(-2) + C(18)*LIR(-1) + C(19)*LIR(-2) + C(20)*EXCH(-1) + C(21) *EXCH(-2) + C(22)*RGDP(-1) + C(23)*RGDP(-2) + C(24)*UNEM(-1) + C(25)*UNEM(-2) + C(26)

Observations: 38

R-squared	0.565378	Mean dependent var	0.029895
Adjusted R-squared	0.356759	S.D. dependent var	0.007450
S.E. of regression	0.005975	Sum squared resid	0.000893
Durbin-Watson stat	2.219590		

Equation: LIR = C(27)*NPL(-1) + C(28)*NPL(-2) + C(29)*INF(-1) + C(30) *INF(-2) + C(31)*LIR(-1) + C(32)*LIR(-2) + C(33)*EXCH(-1) + C(34) *EXCH(-2) + C(35)*RGDP(-1) + C(36)*RGDP(-2) + C(37)*UNEM(-1) + C(38)*UNEM(-2) + C(39)

Observations: 38

R-squared	0.696588	Mean dependent var	0.128687
Adjusted R-squared	0.550950	S.D. dependent var	0.006883
S.E. of regression	0.004612	Sum squared resid	0.000532
Durbin-Watson stat	2.196551		

Equation: EXCH = C(40)*NPL(-1) + C(41)*NPL(-2) + C(42)*INF(-1) + C(43) *INF(-2) + C(44)*LIR(-1) + C(45)*LIR(-2) + C(46)*EXCH(-1) + C(47) *EXCH(-2) + C(48)*RGDP(-1) + C(49)*RGDP(-2) + C(50)*UNEM(-1) +

C(51)*UNEM(-2) + C(52)
Observations: 38

R-squared	0.960144	Mean dependent var	130.3684
Adjusted R-squared	0.941014	S.D. dependent var	7.175111
S.E. of regression	1.742624	Sum squared resid	75.91846
Durbin-Watson stat	2.344950		

Equation: RGDP = C(53)*NPL(-1) + C(54)*NPL(-2) + C(55)*INF(-1) + C(56)
*INF(-2) + C(57)*LIR(-1) + C(58)*LIR(-2) + C(59)*EXCH(-1) + C(60)
*EXCH(-2) + C(61)*RGDP(-1) + C(62)*RGDP(-2) + C(63)*UNEM(-1) +
C(64)*UNEM(-2) + C(65)
Observations: 38

R-squared	0.982706	Mean dependent var	0.045766
Adjusted R-squared	0.974405	S.D. dependent var	0.016184
S.E. of regression	0.002589	Sum squared resid	0.000168
Durbin-Watson stat	1.755643		

Equation: UNEM = C(66)*NPL(-1) + C(67)*NPL(-2) + C(68)*INF(-1) + C(69)
*INF(-2) + C(70)*LIR(-1) + C(71)*LIR(-2) + C(72)*EXCH(-1) + C(73)
*EXCH(-2) + C(74)*RGDP(-1) + C(75)*RGDP(-2) + C(76)*UNEM(-1) +
C(77)*UNEM(-2) + C(78)
Observations: 38

R-squared	0.909534	Mean dependent var	0.136924
Adjusted R-squared	0.866110	S.D. dependent var	0.007227
S.E. of regression	0.002645	Sum squared resid	0.000175
Durbin-Watson stat	2.245900		