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MASTER THESIS

The impact of macroeconomic factors on financial institutions credit risk during the global financial crisis, case in Czech Republic

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Declaration of Authorship

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Abstract

This study aims to estimate the ratio of non-performing loans to total loans (NPL ratio), its determinants and its response to different macroeconomic shocks. As the last financial crises had negative impact on the economy of many countries of the world, we have to strive for preventive measures that would help us to fully or at least partly avoid future crises. It should be achieved by sound risk management practices of all financial institutions.

Important part of these risk management practices shall be – among others - stress tests that would test the health of the institution under severe conditions and negative shocks. For this study the vector autoregression model (VAR methodology) is used to see the response of credit risk (in terms of NPL ratio) to macroeconomic shocks in the Czech Republic. The variables used for this study are quarterly time series data of the period from 2002 to 2011 (GDP, inflation rate, unemployment rate, koruna exchange rate (CZK/USD), and interest rate). For each of these variables the impulse response function was created, to show the impact of macroeconomic shocks and the speed of adjustment of NPL ratio to these shocks.

Keywords: Financial Crises, Credit Risk Management, Non-performing loans, Macroeconomic Shocks, Czech Republic, VARs

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List of abbreviations:

AE	-	Advanced economies
CBs	-	Central banks
CDOs	-	Collateralized debt obligations
CDS	-	Credit default swaps
CEE	-	Central eastern European countries
CNB	-	Czech National Bank
EAD	-	Exposure at default
EME	-	Emerging market economies
ER	-	Exposure risk
EU	-	European Union
IR	-	International Reserve
IRF	-	The impulse response function
LGD	-	Loss given default
LIBOR	-	London Interbank offered rates
MBOs	-	Mortgage backed securities
M2	-	Intermediate money
NPLs	-	Non-performing loans
PD	-	Probability of default
RWA	-	Risk-weighted assets
RR	-	Recovery rate
TED	-	T-bills and Eurodollar future contracts
TBTF	-	Too big to fail
US	-	United States
VARs	-	Vector auto regressions models

Chapter I. Introduction

As each business, individual states also go through recession and boom cycle, and the same happens globally. The world has not been hit by any major crises very long, some experts date as far as to the depression of 1930s.

The financial crises of 2008 were caused mainly by the house bubble that was created and fed by unrealistic expectations in the United States until 2007. As the housing prices were increasing in the period of 2000-2006, people were eager to obtain mortgage loans before the prices increase further. The banks provided loans to institutions, firms and especially households with doubtful quality (which often was not revealed until 2008) and that generally increased the number of risky loans (mortgage loans) in the portfolios of banks. Risky loans are known as subprime loans. The banks packed these risky loans into “baskets” and issued against them securities (“asset backed” securities), hoping to spread the risk arising from individual loans among many investors. The securities backed by mortgages are known as MBOs (mortgage backed securities). However, the increasing amount of subprime loans, the default loans and the loans in foreclosure increased, thus the value of securities that were backed by these loans decreased. Consequently the capital of the financial institutions (that invested in these securities), has been absorbed by the losses. As the securities prices started to fall economy got into stress, families lost their houses (mainly in the United States), many businesses bankrupt, and unemployment rate increased. Despite the fact that many financial institutions employed sophisticated risk management system to prevent the losses, many ended with large amount of financial losses during the coming years.

In order to mitigate the impact of the financial crises, the governments and the central banks tried to respond by setting exceptional policies, special fiscal stimulations, expanding monetary policies and institutional bailouts. With these interventions the financial crises got to certain extent under control in 2009 (this is explained more in chapter 2), while there were still some aftershocks that occurred. The recession period is a longer process, where the advanced economies are having a slower recovery, while

the emerging markets are becoming more favorable for investment. Indeed, there has been more positive economic development in the period of early 2011, equity markets more or less recovered and the risk appetite has expanded.

Many countries were hit by the crises and the Czech Republic was not an exception.

The Czech banking system since 1991 went from socialism to a bank system with commercial and private banks and financial institutions. These banks were important for the Czech economy and its growth, however, the monetary policy loosened and the quality of assets in banking system became very weak during the 1990s when privatization process of state owned enterprises began. Czech economy fully recovered at the beginning of the new century, also in the context of the bailout of the big banks and their privatization. However, the Czech Republic was also affected by the recent global financial crises. As Czech Republic had earlier financial crises it had lessons learned, and during the recent financial crises the Czech National Bank (CNB) did not provide subsidies to financial sectors as other countries, because it was not necessary. However, it provided further liquidity with two weeks repo transactions, which were also intended to help banks to invest into securities of high quality. Nonetheless, Czech Republic was also threatened by increased unemployment and lower growth of GDP as demand for Czech export was weaker. Czech banking sector kept excess liquidity, which disrupted the market. As time passed and the global financial crises were coming to an end the Czech Republic have had progress with profits in the banking sector. Thus, there have been done different scholar papers and tests for managing credit risk. Among others a sophisticated stress-testing framework has been established by risk management in forecasting and understanding economic cycles, mostly macroeconomic shocks, balance-sheets, and capital requirements. For this paper Czech Republic will be used as a case to assess the impact of macroeconomic shocks in credit risk using vector autoregression model (VAR) with quarterly time-series data from, January 2002 to December 2011. Main purpose of choosing the Czech Republic is that, as part of Central Eastern European (CEE) countries, it is the country relatively little affected by global financial crisis. Moreover since 2001, Czech economy has been steadily growing.

Chapter II. Literature Overview

2.1 Background of global financial crisis

The global world has not been hit with significant financial crisis since depression of 1930's, while the recent global financial crises had a large impact in many countries. In all around the world, the recent crisis caused the bailout of banks, collapse of financial institutions and downturns in stock markets. Housing market in mainly in US was going down, which resulted in foreclosures and extending unemployment. The financial crisis affected crucial firms; consumer wealth declined and lost trillions of USA dollars and with these there was huge economic activity decline that lead to global economic recession in 2008, (Baily & Elliott, 2009).

The banking system in the USA of 2008 went through complex relationship of the valuation and liquidity problems that caused the financial crises. The USA had a housing bubble that peaked in 2007 and the consequence of this was that the values of securities that were tied to US real pricing felt, which damaged worldwide financial institutions, (Simkovic, 2012). Furthermore, during this time there were doubts about bank solvency, the availability of credits declined, the confidence of investors was damaged. All these impacted the global stock market leading to large losses of securities in period of 2008 and 2009. Moreover, this also slowed the global economies with less credit availability and decreased international trade, (IMF, 2009). In order to improve the financial system, the governments and the central banks tried to respond by setting exceptional policies. Some of the policies were fiscal stimulations, expanding monetary policies and institutional bailouts. With these interventions the financial crises were coming to an end in the period of late 2008 and mid 2009, while there were still some aftershocks that occurred, (Atanda & Idowu, 2012).

The current financial crisis, as sub-prime mortgage that started in middle 2007 and 2008 increased, affected negatively many countries' monetary policies. Consequently, banks and other financial institutions lost trillions of money during 2007-2009. There were estimates of the losses that occurred during the financial crises. The estimates that

International Monetary Fund (IMF) made about the losses of big EU banks were about \$1.6 trillion and the losses of USA banks were about \$1 trillion, (Cutler, Slater, & Comlay, 2009). In these losses were included the toxic assets and bad loans from the period of January 2007 to September 2009. While the recovery period continues in 2007 to 2010 the IMF estimates that the losses will increase to \$2.8 trillion. Out of this amount the US banks were estimated to have \$1 trillion, while the EU banks losses would be \$1.6 trillion, (Cutler, *et.al*, 2009).

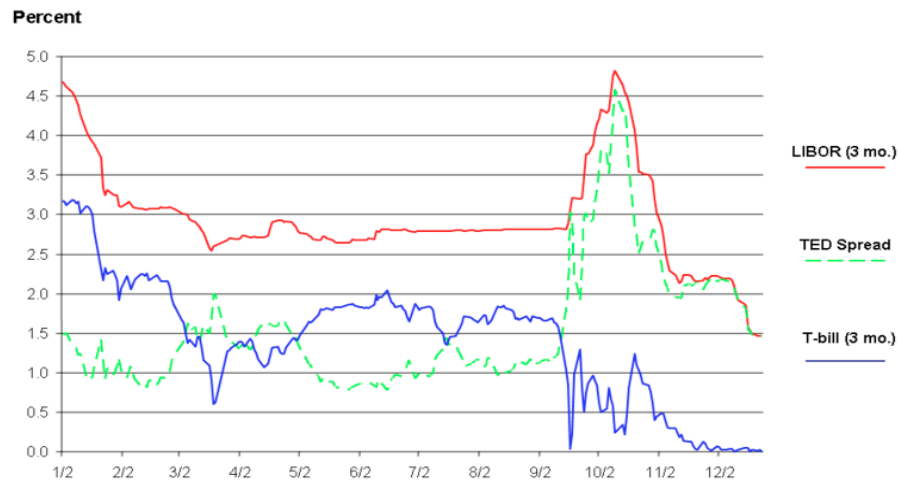
In the beginning of crisis, central banks were facing challenges in their operations since their effort to handle and defend liquidity issues resulted as dysfunctional and reduced further the interest rate, which is one of the compulsory tools of central banks operations, (Allen & Calrletti, 2009). To prevent somehow these situations central banks were trying to protect price-stability, as one of the major objective, and to ensure the financial stability in long run. According to these two objectives of central banks in economic point of view it is impossible that both objectives to be achieved simultaneously if we take into consideration that interest among price-stability and financial stability are inconsistent. Thus, the central banks to keep the financial stability rarely have to deviate from price stability that impacts also the inflation rate target, (Kent & Debelle, 1999).

The financial industry has gone through quite drastic changes over the past 20 years whereas banks have increased their reliance on “wholesale funding as compared to retail deposits, in addition to the more recent emergence of a shadow banking sector, (Frank & Hesse, 2009, p. 7-8).” Indeed, the 2007-08 financial stress has diminished significantly the efficacy of the monetary policy transmission mechanism. Frank and Hesse 2009 argue that this has happened because instead of cutting interest rates in order for the cost of unsecured borrowing to decline, they have maintained LIBOR (London Interbank Offered Rates) fixings on high levels because of leverage and credit risk that was being experienced in all financial markets. In fact, the reliance of banks in wholesale money markets has increased while funding share of deposits declined “from over 50 percent in 1980 to under 20 percent in 2008” as IMF reported in 2008, (Frank & Hesse, 2009, p. 7-8).

The financial crises were at a more critical stage during September 2008. The banking system in the US at that time was comparable to a bank that operates through money market mutual funds, by investing on different corporations' commercial papers, in order to cover financially their operations and payrolls. In US there were large withdrawals from money markets at \$144.5 billion per week, while comparing to previous week were \$7.1 billion, (Gullapalli & Ananda, 2008). With this system in place the corporations had less ability to replace their short-term debts. Thus, the US government intervened to extend the insurances through a temporary guarantee for money market accounts that were similar to the insurances of bank deposits, and at the same time there was a program from Federal Reserves to buy commercial paper, (Gullapalli & Ananda, 2008).

Furthermore, TED (T-bills and Eurodollar future contracts) spread that is an indicator of perceived credit risk in the general economy, measures the credit risk for inter-bank lending. It is measured as the difference of US T-bills rate and the LIBOR rate on in three months basis. The TED spread spiked up in July 2007, while in September 2008 TED spread spiked even more, where it reached a record of 4.65 percent in October 2010, (Bloomberg). The higher the TED spread it means that the banks see each other as more risky as counter parties.

Figure 1. TED Spread and Components (October 4, 2008)



The TED spread is measure of credit risk for inter-bank lending. It is the difference between the three-month U.S T-bills rate and the three-month LIBOR rate, which represents the rate at which banks typically lend to each other. A higher spread indicates banks perceive each other as riskier counter parties.

It is especially significant to emphasize the causes of the most recent economic recession in order to understand the undertakings that it led. One of the explanations of the financial crisis is that the U.S. was facing high-risk investments in its financial markets. There were plenty of investors that held high-risk shares in financial markets, which in itself made the return in the financial assets risky as well, (Sen, 2008). Indeed, Sen (2008) explains that new investments were generated anytime there was a need to avoid an impending default or “to compensate the losses already incurred on previous investments.

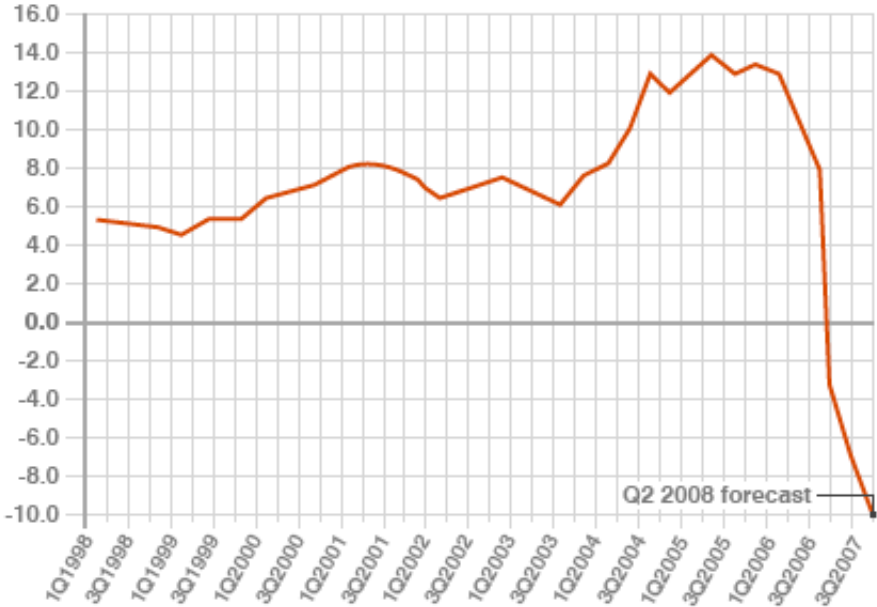
This author goes further by explaining that the innovations in financial markets such as future derivatives which implied the purchase or selling of an underlying financial asset at a future date created an almost barrier-free environment in acquiring and investing in financial assets. Indeed, this implies that different types of traders, e.g. hedgers, could lock into positions that would ensure a minimum loss and the profit would depend on the trends in the market at the expiration date of the contract. Furthermore, this rise in

the stock market inferred a generation of wealth, which in turn increased consumption. This consumption was particularly present in the housing market, Baker explains, as acquiring wealth is an incentive to spend as well.

During the last global financial crisis thousands of families lost their houses and many businesses bankrupt, unemployment rate all over the world reached highest level in last twenty years, especially in US and Europe. Macroeconomic shocks that have caused the global financial crisis are housing market, decline in stock market, and movement in oil prices. The major shock is housing prices. Since, 2000 and 2006 housing prices started to increase rapidly over 30 percent. Inspired by low interest rate and by the belief that housing prices will continue increasing, many of credit borrowers replaced or took out their mortgages by purchasing houses. This caused mortgage insurance claims. This majority of borrowers so called sub-prime borrowers did not meet the obligations in financial institutions, because of high debt existing ratios or poor credit records.

Figure 2. US House price trend

Percentage increase/decrease year-over-year (yoy)



Source: Center for Responsible Lending

The beginning of the credit crisis in 2007 occurs from the sub-prime mortgage markets in US. As financial institutions provided loans to diverse credit risk ratings (not only AAA), among which were some very risky loans, the prices of housing continued to increase as the demand increased. As the loans were provided to risky credit ratings, the sub-prime loans increased, thus there was a creation of the house bubble. Down payments on mortgages that was increasing and it was difficult for debtors to repay their loans. The sub-prime loans have usually been issued at fixed interest rates; however since 2000 these loans were issued at adjustable rates.

Most of the time the adjustable rates meant that the sub-prime loans rate in the introductory period was about 1 percent, which is quite low. Consequently, when this period ended the monthly payment of these loans was significantly higher. The introductory period of a low rate at 1 percent attracted borrowers to take these loans, that in 2006 the loans that started with this percentage accounted at about 80 percent of all sub-prime loans.

The monthly payment of these sub-prime loans differed from year to year, but a study showed that there would be a larger increase of the monthly payment of these 80 percent loans by more than 25 percent since 2004 compared to the coming years. The higher monthly payments, besides regular payments, were also impacted by delinquent sub-prime loans or the loans that were in foreclosure by February 2008. With the rising number of sub-prime loans that were in foreclosure in 2008, the value of mortgage that was used as securities by investors and banks started to fall. A few important characteristics of sub-prime loans boost were that the investment banks used the security that is backed by mortgage, collateralized the debt obligations (CDOs), and in order to spread the risk of loans and free up capital for lending they used several complex financial instruments. Even though, the sub-prime loans were considered as risky and not accounted as investment-grade, the ability to make mortgages backed as security and collateralizing the debt obligation allowed banks to spread the loss from the loans that defaulted among many of them thus minimizing the loss for the investors.

As the sub-prime loans were backed by security mortgage and were of higher risk, this meant that the returns were higher on prime-backed securities. The high risks made the investment on these loans popular and increased the interest of investors that included banks, hedge funds, and asset management firms. With the increasing amount of sub-prime loans, the default loans and the loans in foreclosure increased, thus the value of securities that were backed by these loans decreased. This meant that the investors were facing larger losses and had to reallocate their capital from other investments to building capital in order to cover the losses of sub-prime related securities. As the losses increased from these securities, the capital of the financial service firms decreased for other means of usage. In the USA the companies of many industries tend to rely on these financial firms for money support through different loans, this support was decreased as these financial firms capital decreased. In this way, the companies of different industries could not keep growing, which impacted the whole economy.

This was as a chain of problems that started with issuing large number of sub-prime loans, then having large default loans, which required more capital by investors to cover the losses, that decreased the capital for other companies to be supported in their growth, thus created losses throughout the economy that led to crises. According the International Monetary Fund (IMF) results the total losses in US assets exceeds \$4,000 billion. Explanations of this crisis are many including government actions and interventions, which prolonged and made this financial crisis worst, (Taylor, 2008).

2.2 Managing Global Financial Crisis

Despite the fact that many financial institutions employed sophisticated risk management system to prevent the losses, many ended with large amount of financial losses during these years. Losses that occurred in financial institutions do not imply the failure of risk management system, since big losses can happen even if the risk management system remained perfect, (Stulz, 2008). In financial institutions, specifically in the risk management sector, application of risk management systems is not designed only to identify the risk, but also to quantify and forecast the risk indicators, which may affect the project. In general, the level of risk is set by risk

managers' tolerance, which depends on their behavior. For example, measuring the risk of a project may have an outcome that has an acceptable or unacceptable risk. Thus, whether the project risks will be accepted or not is evaluated based on the tolerance of the risk managers.

In a working paper prepared by Aizenman, Menzie, and Ito "The Financial Crisis, Rethinking of the Global Financial Architecture, and the Trilemma", there are several important factors discussed. One of the main goals of the paper was to identify how was output volatility affected by the trilemma policy choices, which means that among the three goals that a country has for "monetary independence, exchange rate stability, and financial integration" (Aizenman, *et.al*, 2009, p. 1) they may choose only two of them simultaneously. Moreover, the paper also tries to evaluate the performance of economies in crisis, and how the trilemma configurations worked in the repercussion of economic crisis and what they would imply. They have found that the macroeconomic variables were in line with the theory behind them. Indeed, those countries that have a higher level of income on a per capita basis experience smaller losses in times of crisis; on the other hand, those countries that experience a crisis after having an economic boom incur larger output losses. There is a tendency of the developing countries to rely on pro-cyclical fiscal policy, which in fact, leads to greater output losses among crisis economies. Some of their findings after running regression analyses, were that the estimated coefficient of the duration of economic crisis was significantly positive which indicated that if the crisis remains present for more than a year, the output loss might increase by 3 percentage point; whilst the estimated coefficient on financial development is insignificantly negative which means that those countries which were open to international trade before the crisis cope better with the crisis, (Aizenman, *et.al*, 2009).

Furthermore, this report shows that regarding pre-crisis conditions, the level of the exchange rate stability is the only variable, which matters in calculating the output loss in economic crisis. The economies, which had a higher level of exchange rate stability suffered lower output losses when in crisis which is also due to financial openness, a statistically insignificant variable. However, if we take into account the regressions

computed in regards to the conditions during crisis, a variable that mattered was also the international reserve (IR) holding. At this point, the higher the level of international reserves a country holds, the output loss is lower. Indeed, the exchange rate stability has been estimated to be highly significant statistically when taking into account during-crisis conditions. Furthermore, those countries that have stable exchange rate wise can signal investor in capital markets and it can also “avoid facing high volatility in the prices of goods and services” (Aizenman, *et.al*, 2009).

Another important variable, which was looked at in this report, was the effect of monetary independence during the crisis. It has been estimated to be significant but not very transparent. If the threshold of IR holding is 14–15 percent of GDP, monetary independence is a negative element in regards to the cost of economic crisis; however, if the threshold of IR holding is above that range, its impact will be positive. Therefore, for the countries that lie in the former IR holding to GDP ratio, it is better to have higher levels of stability in the exchange rate and lower in monetary independence to be able to reduce the cost of output losses when experiencing economic crisis. In order for them to seek weaker exchange rate stability and monetary independence, those countries “must pursue a higher level of financial openness since these three policy goals need to be linearly related” (Aizenman, *et.al*, 2009, p.29).

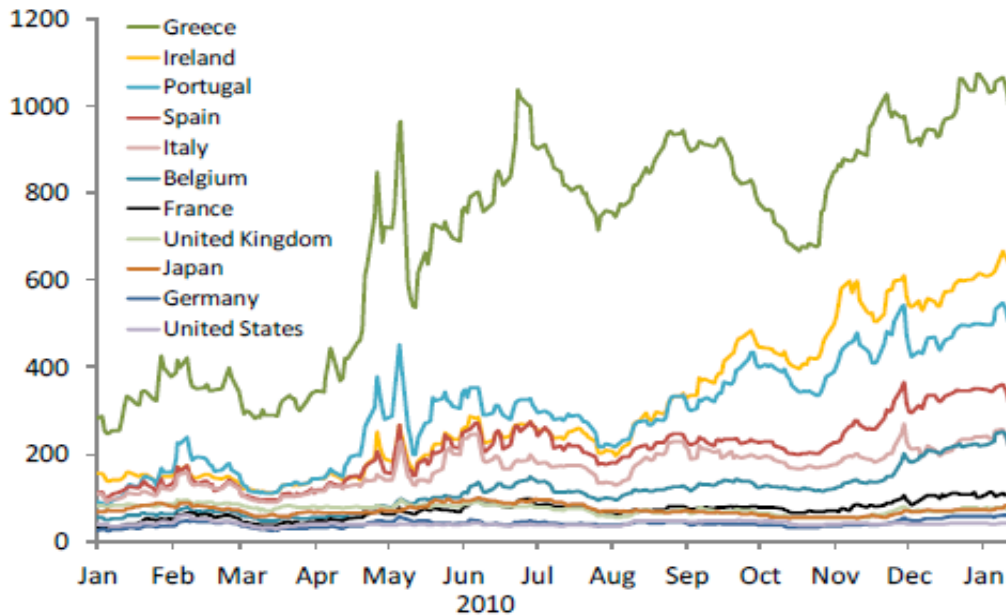
Even though, countries hit by the global crises are growing, there is still a long way required to have a global financial stability. As the improvements from the financial crises are happening all over the world, the developed countries are facing more challenges and are having a slower recovery. This is mainly because the developed economies had larger investment that failed, than the emerging markets. Furthermore, as some EU countries are having large financial problems the developed countries are also funding these euro areas. At the same time the emerging countries are becoming more favorable to invest on them, thus the developed countries are increasing their investment toward these countries. Moreover, since there have been recovery from the financial crises in the period of early 2011, the equity markets have raised and the risk appetite has expanded. The improvements are more visible in the emerging markets,

and the sovereign credit default swaps (CDS) spreads are larger in the advanced countries, (IMF, 2011).

In regards to European countries, some of the steps that IMF suggests the EU countries should take are: a) further meticulous and trustworthy bank stress testing as well follow-up plans for recapitalization and restructuring of feasible, undercapitalized institutions, b) countries that rely heavily on the banking sector should ensure the supply of sufficient funds, c) the creation of resolution mechanisms within the Euro area is very necessary, d) the supply of liquidity to banks and the activity of the Securities Markets Program is crucial, e) and the alleviation of the negative macro-financial linkages from the large inventory of houses for sale (those that are expected to default) is also significant, (IMF, 2011).

In Europe, the yield of Ireland, Greece, followed with Portugal, Spain and Italy have made the government bonds to spread even more in some cases than the turmoil of last May 2011, and increasing the risk of interaction between the sovereign and the banking sector. This issue has hit the European countries, while even the domestic banks are suffering and have lesser funds available, because of higher costs and short maturities. Thus, with the bank and sovereign debt-to-GDP increasing, the financial system remains fragile.

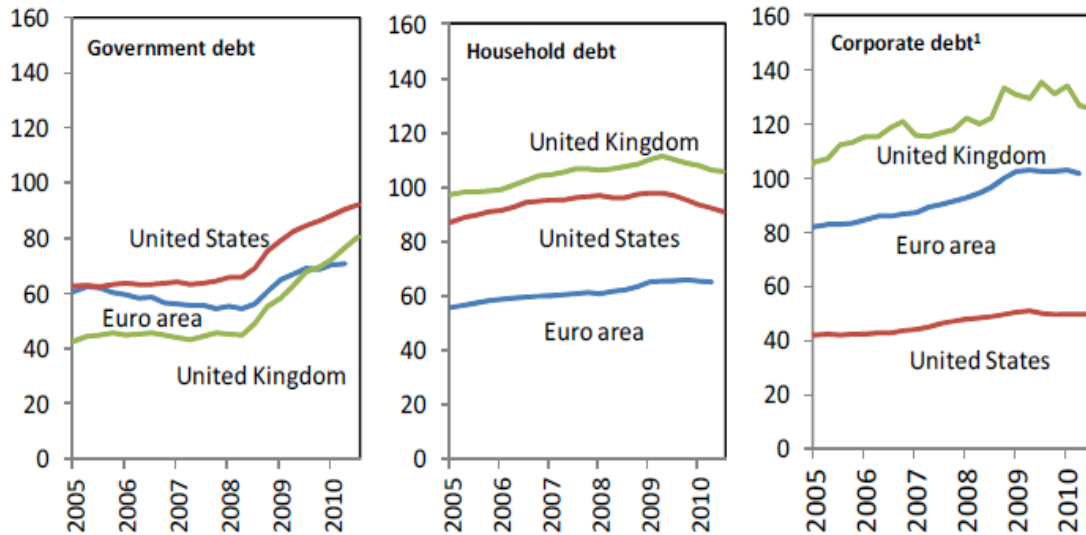
Figure 3 Sovereign CDS spreads, in basis points (IMF, 2011)



Source: Bloomberg L.P.; IMF Report 2011

Part of mitigating the effect of the financial crises, is played by the private sector, where with improvement of economy the private sector debt-to-GDP ratio should fall. However, even that the “banking system have reduced their vulnerabilities by increasing their Tier 1 capital ratios”, (IMF, 2011, p.3) the above-mentioned ratio have had a significant fall. Besides, Europe banks system is more vulnerable; the US still has nonperforming loans that keep high the government debt-to-GDP ratio. As the accommodative monetary policies are supposed to encourage the recovery, even with the low interest rates there is still high level of private sector debt, while the low interest rates may also bring risky investments and create challenges for fixed income investors, (IMF, 2011).

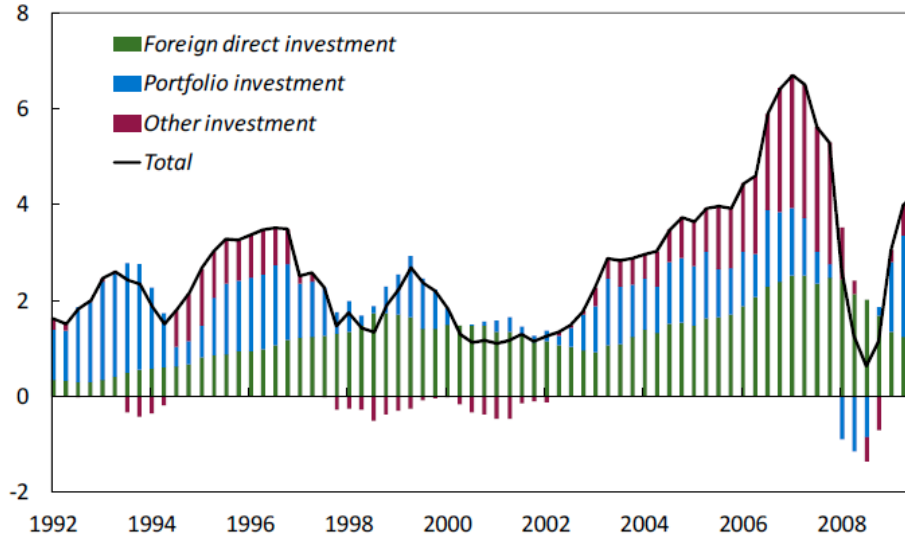
Figure 4. Debt-to-GDP by sector



Sources: Haver Analytics; and IMF staff calculations, 2011.

As mentioned above, with low interest rates in the advanced countries, the capital flow has gone to the emerging markets largely through equity and bond issuance. This cash flow is happening mainly because of two reasons, where the assets of emerging markets are becoming more favorable, and investors are using the higher interests' rates of emerging market to invest in them and expecting that the exchange rate would appreciate eventually. The emerging countries that receive this capital ought to benefit from it; however, as the inflow increases these countries do not have a financial system that absorbs this continuous capital inflow. Also, the lower-rated entities now will be able to issue more debt, thus decreasing the quality of assets held by investors. While in some states the capital inflow may have negative impact, in other countries it could bring a healthier economy, nonetheless the government should observe each case, (IMF, 2011).

Figure 5. Capital Flows to Emerging Markets



Sources: IMF, International Financial Statistics; Haver Analytics; and IMF staff estimates.

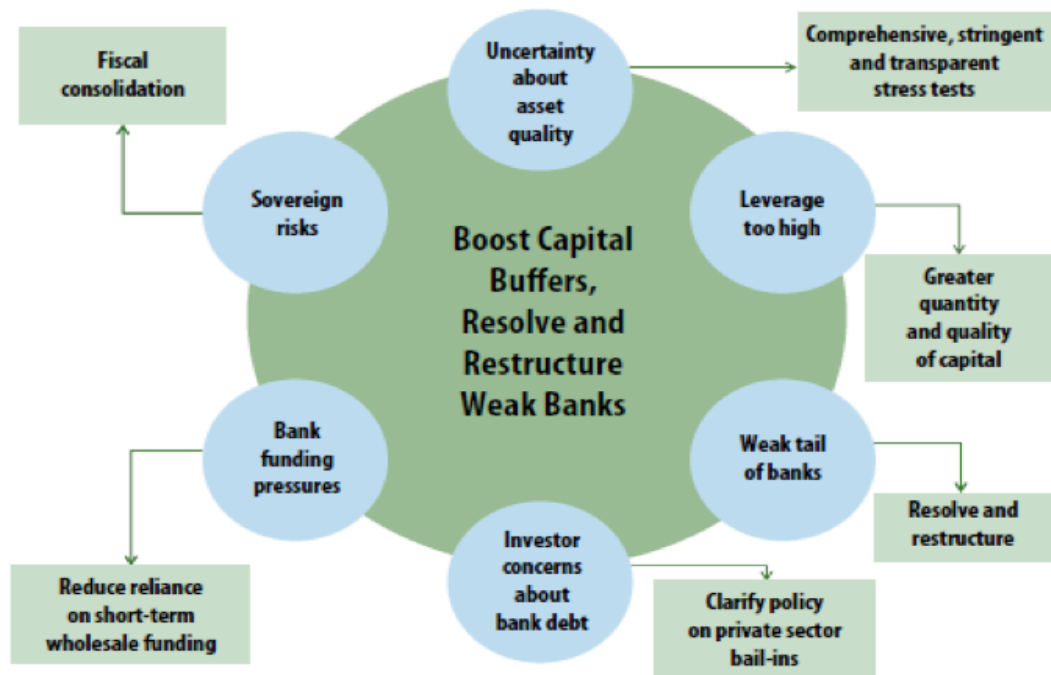
Since the global financial market is still not stable, there should be set new policy priorities. As the balance sheet leverage is quite high and its reconstruction is in slow process the IMF suggests that the balance sheet repair is essential to take place faster. While at the same time the regulatory reforms are important to help the financial sector be on a sounder footing. Indeed, the fiscal and monetary stimulus, help mitigate the problems in short term, thus for longer term the policy should foresee structural solutions to these problems in different scenarios. Thus, the government should construct the capital structures carefully to best fit the problems of their country in order to have financial stability, (IMF, 2011).

The countries hit by the crises, specifically the European ones, should focus more in improving the interaction of sovereign and bank sector. It is important that the government of these countries influence the markets that it is possible that their debt maturity will get longer, while the reliance on rollovers will decrease. Even though, several countries are in this process it will take time to be fulfilled and for the market to be convinced, while the impact could be different on each country, (IMF, 2011).

However, in order to be more specific, it is important to distinguish the intervention measures in advanced and emerging market economies. Before the 2007-08 crises, central banks (CBs) in advanced economies have “implemented monetary policy by guiding a single short-term interest rate (IMF, 2010, p. 3).” Nonetheless, the same report shows that to recover from the crisis, CBs lowered interest rates, such as the Bank of Canada (BoC) keeping overnight rates at 0.5 percent, while the Fed in US has also integrated similar policies, (IMF, 2010).

Furthermore, many of the central banks in advanced economies have switched to balance sheet policies, some of which are: a) *Systemic liquidity easing* (intended to enhance liquidity and ease liquidity deficits in financial markets); b) *Purchase of long-term public sector securities* (their aim is to cut longer-term interest rates and lessen stress in longer-term credit markets which will also increase the level of CB reserves); c) *Purchase of private sector securities* (intended to increase credit in financial markets); and d) *Foreign exchange liquidity provision* (which aims foreign exchange liquidity injection in “the form of sales of foreign reserves or foreign exchange swaps or other derivatives” which increases both sides of the CB’s balance sheet, (IMF, 2010, p. 4-6).

Figure 6. Visual representation of bank policies to recover from the financial stress



Source, IMF, This figure is created by the International Monetary Fund Global Financial Stability Report/Durable Financial Stability on April 2011, which is simply a visual representation of bank policies to recover from the financial stress.

Indeed, the IMF background paper *Exiting from Monetary Crisis Intervention Measures* shows that the banks that provided the most liquidity in relation to GDP were the European Central Bank (ECB), the Bank of England (BoE), and the Fed, (IMF, 2010). However, the authors of this report show some of downsides of the aforementioned balance sheet policies, which may create financial risks and distort relative prices of credit instruments, as well as central banks may face difficulties of maintaining the expanded policy role that they took because of the crisis (IMF, 2010). To this point, though, it is difficult to assess the real effectiveness of these intervention measures; however, they seem to have helped economies in certain manners.

As mentioned above, there are some differences between the financial crises in diverse countries; hence, now the intervention measures of central banks in emerging market economies will be elaborated. It is argued that some of the differences between

advanced economies (AE) and emerging market economies (EME) are the degree of financial stress which is much lower in EMEs, as well as the stage of policy interventions which was much later than in AEs. Because EMEs, including some of AEs were having problems mainly with the shortage of foreign liquidity, specifically American dollars, they introduced policies to facilitate such liquidity such as relaxing borrowing limits, organizing foreign exchange selling auctions, and lowering reserve requirements for lending to the private sector, (IMF, 2010).

Furthermore, Akhtar, Lorie, & Petersend (2009) show central banks interventions in low-income countries in region such as Caucus and Central Asia and South Asia. The authors conclude that excluding Nepal, these regions' banking systems were only indirectly affected by the financial crisis; however, it was caused quite damages. The most important shocks, according to this report, in such regions were the inability to borrow on external markets for both the public and private sectors. They have also had declines in their deposit base because of the declining overall economic activity, the value of cash flows, the decline of cash inflows, and the lack of confidence in the financial system (Akhtar, *et.al*, 2009).

Furthermore, In those places where financial markets are weak, “the transmission mechanism from policy rates to other interest rates directly affecting aggregate demand tends to be weak as well” (Akhtar, *et.al*, 2009, p.65). In areas like Armenia and Sri Lanka, nonetheless, policy rate modifications are more flexible, which is key in guiding market rates to their necessary level for inflation objectives, (Akhtar, *et.al*, 2009).

Chapter III. Crisis in Czech Republic

3.1 Beginning of banking crisis

Czech Republic prior to 1991 had a socialism economy, which after 1991 transitioned and the privatization of state owned firms started. This implied an increased demand for banking services, mostly for service such as credit lending. At that time in Czech Republic there were only four existing state-owned commercial banks, which lacked the ability to meet the demand for banking services. Due to insufficient capacity of state commercial banks, operations of some private financial institutions/banks were allowed. Thus, private banks started to issue credit to private firms and corporate, and meanwhile provided them with funds for privatization of state owned firms. On one hand, the services and operations that the new private banks were providing were important to the economic development of Czech economy, but, on other hand the monetary policy of Czech economy started to loosen, through combined money supply targeting and fixed exchange rate. Hence, country's economy became overheated and the quality of assets in banking system became very weak. Thus, there were also changes in regulatory and supervision of banks, and monetary policy that were implemented for improvement of economy. Such improvements and their implementation initiated the usage of tougher supervision and smarter monetary policy, (Frait, Gersl, & Seidler, 2011).

The banking system prior to 1991 was concentrated to operate only through high credit to GDP ratio and mostly with loans for corporate, thus the demand for households was not met. Since 1991, economic transition of Czech Republic has been impacted by crucial macroeconomic factors and monetary policies. In this period, capital flow and credit growth were major factors that have significantly influenced country's exchange rate and inflation, therefore they floundered the economic growth.

Banking crisis between 1997 and 1999 changed banking sector intensely and reduced the credit largely. The system improved through few years and in 2001 the banking sector was reconstructed and there was credit growth. The reconstructed banking sector

in 2001 has enlarged its portfolio for loans to households from local deposits. During this time the currency rate in Czech Republic has appreciated, there was low inflation, and the interest rate became low and stable. Furthermore, with improvement in banking sector, the Czech Republic commercial banks were purchased by banking groups of the EU. Moreover, the loans were extend even more to all those groups that earlier did not have the opportunity to obtain loans. With improved banking sector, the economy of Czech Republic accelerated and the non-performing loans decreased, (Gersl, *et.al*, 2011). During this period credit crunch started in Czech Republic and credit-to-GDP ratio remained relatively low.

Indeed, the financial and economic shocks in Czech Republic have been caused generally by excess of liquidity, massive leveraging, shadow banking system and failure of capital requirements. Moreover, impacts that led to economic crisis were risky investments, long-term overheating economy, where short run aggregate demand exceeds aggregate supply in the long run, low interest rates, and low inflation, (Singer & Tuma, 2008). Furthermore, the financial institutions variations on regulatory framework caused new loan standards, which allowed borrowers not to repay their mortgages issued by lenders, and allowed lenders to trade mortgages to third-party in order to secure and resell mortgages.

3.2 Development of credit cycle and its impact in financial system

Banking crisis in Czech Republic in 1999 affected the Czech economy for a variety of factors; however, the crisis was mostly caused by the development of credit crunch, (Pospiol & Singer, 1999). Nonetheless, Pospiol & Singer (1999) did not specifically define the term 'credit crunch'. In the meantime credit crunch referred to situations that were created because interest rates were incoherent with demand and supply of credit. Indeed, credit crunch regarding by authors was similar of credit rationing.

In CEE (Central Eastern European) countries credit growth has been one of the major factor, which took attention of many authors in order to do studies. Studies mostly have

attempted to examine causes of credit growth as well as its level of equilibrium, (Otker-Robe & Enoch, 2007).

The transition economies were worrying about the credit crunch as there was development of credit growth massive growth of credit would risk macroeconomic and financial stability, (Hilbers, Otker-Obe, Pazarbasioglu & Johnsen, 2005).

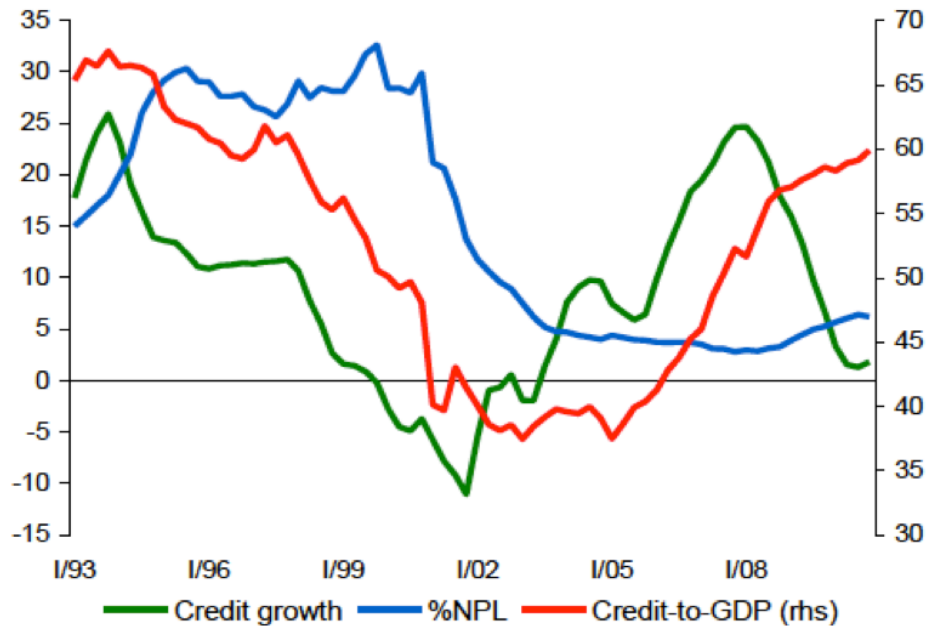
Macroeconomic and financial stability of a country can be threatened by the excessive credit growth in several ways. There are several ways how the excessive credit impacts the macroeconomic stability such as, the encouragement of consumption that comes as a result of lending and the overheat in economy that occurs because of the intensification of loans in private sector which falsely over-initiate aggregate demand beyond the real capacity of output, (Gersl & Seidler, 2011). Furthermore, this overheats the economy and has an indirect impact also on inflation rate, the interest rates, current account deficit and the real exchange rate. Meanwhile, in economic growth phase financial institutions may be very optimistic while predicting the borrowers' future ability to return the loan. Hence, they increase giving "bad" loans to high-risk borrowers during the upward phase of the credit cycle. Moreover, there are cases that foreign investors finance the domestic credit boom, which increases the risk that the domestic banks will not have enough balance-sheet liquidity. This process occurred in several excluding Czech Republic, (Gersl & Seidler, 2011).

Furthermore, as the interest rates in foreign markets were lower, thus the private loans were given in foreign currencies. As a result this may cause the domestic currency to depreciate thus the credit expressed in domestic currency increases, while the debt of servicing costs increases also and the risk of foreign exchange risk transforms into credit risk, (Gersl & Seidler, 2011).

Many studies support the idea the excessive credit growth may be one of the earliest and more reliable signs that foretell future problems in the banking sector. Given that the serious banking sector problems start with the burst of credit bubble and negative macroeconomic development, which lead to non-performing loans (NPLs) and external

financing constrains. Also, according to IMF (2004) more than 75 percent of the credit booms have ended by banking or currency crises.

Figure 7. Credit growth increase year-over-year in total bank credit



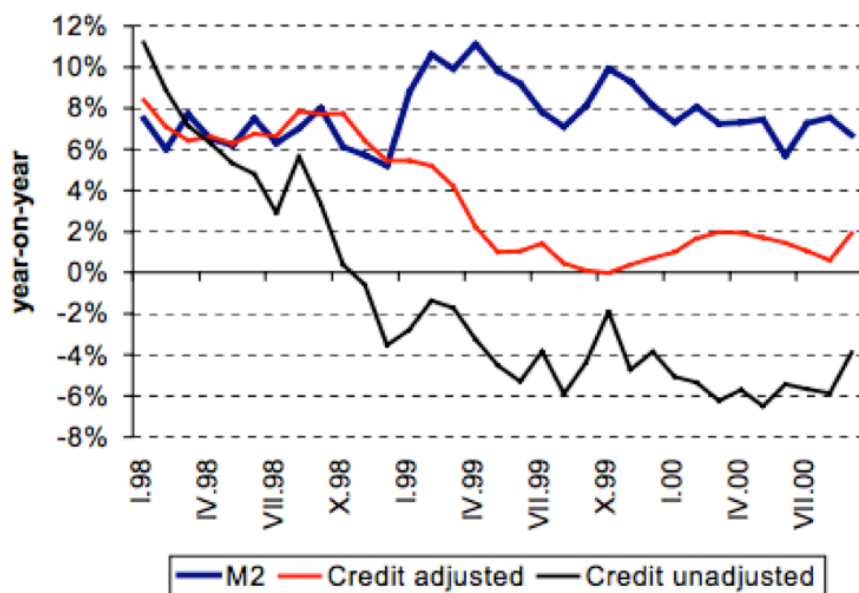
Source: Czech National Bank (CNB), Credit growth increase year-over-year in total bank credit. % NPL is the share of nonperforming loans on total bank credit

In Czech Republic, credit growth was the main issue that headed banking sector in crisis in late 1997. Studies that have been made to analyze the credit growth and its concentration in Czech Republic arise from relationship between economic and financial shocks including macroeconomic factors, which occur in credit market. There is a widespread believe that in credit market, crucial relationship that affects credit concentration are the amount of debt and GDP rather than relationship between money supply and nominal GDP, that plays important role in stability of financial markets. This relationship can be explained easy because it is based on principle or belief that much more we increase expenses on repaying back specific loans, which will imply a simultaneous growth in debt volatility similarly to any increase in expenses, (Friedman, 1993). Idea based on simple relationship of economic cycle and credit growth indicates that in credit market regarding to expenses, it is much more efficient to increase

investments, rather than to increase other varieties of expenses. According to Fischer and Dornbusch (1994), in economic cycle there is an expectation for relationship between GDP and amount of credits.

If we take a look at the case of Czech Republic economy, regarding the relationship of GDP and amount of credits, it is quite hard to have explanation based on empirical evidence, because domestic economy of Czech Republic has never completed one economic cycle yet. This may be prejudiced by appropriate factors, which has been included in current empirical evidence and impacts of different factors that were not standardized. Consequently, this may make stronger the connection between increase and decrease of amount of lending, and increase and decrease of economic growth. Even though, Czech Republic has not completed a full economic cycle yet, there are studies that show that there could exist a clear link in the relationship among money supply, real GDP and amount of nonadjusted credits, (Hampl & Matousek, 2000).

Figure 8. Credit growth and money supply in credit market



Source: Czech National Bank, 2000

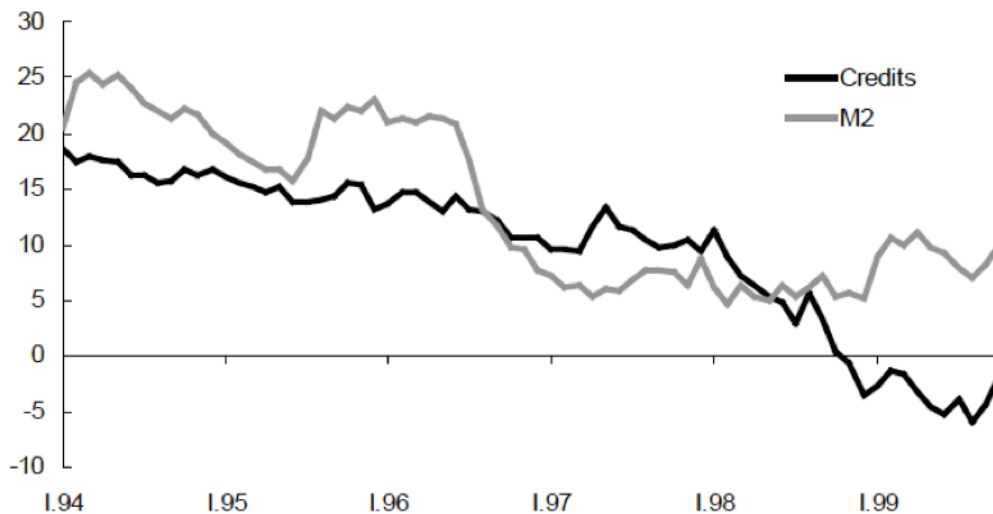
3.3 Stream of credit market and causes of credit concentration in Czech Republic

The transition phase that Czech Republic went through improved its credit market because the demand for credit increased, while with time passing the lending activity improved as well. During the transition phase the Czech Republic government aimed to privatize the public capital. This increased further the demand for credit by enormous investors and businesses. Lending to these investors was a benefit to Czech economy as it increased the flow of foreign capital in a short-term period. Furthermore, an advantage to make Czech banks more profitable and increase their source of credit was as a result of foreign lower interest rates. Rapid increase of wages, consumption and overall welfare improvement affected the growth of aggregate demand for credits.

Even though, the increased demand for credit and improved lending was a benefit, there were also some consequences related to it. The immediate increase demand for credits meant that the country will have more credit risk; more deficit and this also brought the monetary crises in the economy in early 1997, (Vodova, 2003). The problems related to the monetary policy indicated that the Czech credit market was going through financial crises.

Economic growth and investments mostly are financed by capital inflows, which are interconnected to demand and consumption; both factors that put pressure on prices. In credit market, credit expansions were covered by foreign capital inflows and this was one of the causes that influenced in monetary aggregate by making monetary policy more complex. Increase in foreign exchange reserves made the development of nominal fixed exchange rate more complicated. Growth in intermediate money (M2) was the largest during 1994-1995. The growth of M2 is correlated to the increased inflow of foreign capital at fixed exchange rate. Furthermore, at the same time the real GDP reached its highest level since the beginning of transition period in Czech Republic, (Hampl & Matousek, 2000).

Figure 9. Growth rate of credit and M2 (y-o-y, %)



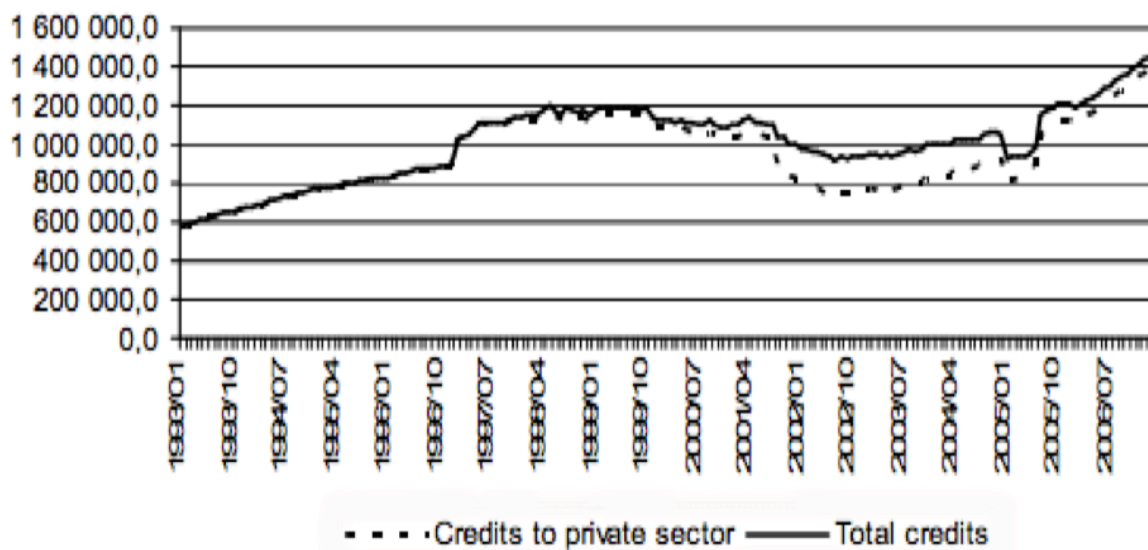
Source: Czech National Bank, 2000

Transition period during 1994-1995 of economy in Czech Republic went through two phases of credit and money cycle, which helped economic activity to raise money supply and budget constraints for financial institutions, which resulted by foreign capital inflow and not by internal economy. Due to these phases, real GDP of Czech Republic faced an increase and has been recorded as largest in overall the period of transition since it began, (Hampl & Matousek, 2000).

Banking framework in the Czech Republic needed improvements regarding credit cycle, as the monetary turbulence of 1997 caused the decline in lending and replacing the credit with safer trading in government securities. At that time banks issued loans to people that did not meet several conditions that a borrower should meet, as they had short credit history, not the required experience. This meant that the loans were not in line with the legislation, there were problems with small and medium banks, while at the same time there was the economic recession. With these conditions created, in Czech Republic there were created large number of classified loans, thus, in 1998 the banks decreased the number of loans that were issued to private borrowers. Hence, volume of credits declined in years 1999-2004. As the volume declined until 2004, after

2004 the volume started to increase slowly as banks begin to issue mortgage and consumer loans to households.

Figure 10. Credits provided to private and public sector in Czech Republic during period 1999-2004 (mil. CZK)



Source: Czech National Bank,

During the transformation period in 1990s the banking sector in Czech Republic was concentrated, where the largest banks had 66% of market share due to their asset volume. Comparing these large banks to the European ones, they were less efficient than the banks in other states in Europe, as they did not have wide range of services and were inefficient. Moreover, the small and medium size banks in the Czech Republic rapidly expanded in the beginning of 1990s up to twenty banks. Even though, there was a rapid development of banking sector and presence of foreign banks in the system, nineteen of these domestic banks stopped their activities or merged with other banks because of their low efficiency in comparison with foreign banks. These banks had lower percentage of market share due to their total assets, but their importance was that they issued loans to new business being small or medium size, (Hampl & Matousek, 2000).

Furthermore, the decreased volume of credit and the decreased growth rate in the Czech

Republic impacted the economy negatively. Furthermore, with these negative impacts of the banking system, the domestic banks of Czech Republic suffered more. Thus it is necessary to find other ways in capital markets to finance those in need in the standard market economies. Regarding the Czech Republic, these other ways of financing are slightly fulfilled. Thus, it shows that banks play quite an important role for financing in the Czech Republic, as in other EU member states, (Vodova, 2010).

3.4 Czech banking system and global financial crisis

The recent Global Financial Crisis has impacted many countries including the Czech Republic, as it faced same troubles like all other countries in converging economies concerning the credit crisis. However, as Czech Republic during the period of 1997-1999 has gone through bad performing of credit market as a consequence of domestic crisis on financial institution, it has been recovered on late 2001. Thus, the Czech economy grew and banking system has been improved. The crises of 1997-1999 played an important role for the Czech Republic to face the recent global financial crises. The earlier experience on economy transition in 1991 and banking crisis in 1997, benefited Czech Republic as it had lessons learned on pre-crisis, therefore during the last global financial crisis caused by excess liquidity, Czech Republic as able to recover fast and catch up with other developed economies in EU, (Frait, *et.al*, 2011).

Recalling the 1990s crises and the lessons learned from it, Czech National Bank (CNB) established framework as a counter-measure to the upcoming crises. As a result, CNB created a definition of financial stability which encompassed the financial stability goal of that time, year 2004 that was: a condition where the financial system will function without grave failures or unwanted impacts on current and futures of the economy and meanwhile showing a high level of flexibility to shocks. An essential part of the financial stability framework is the definition of the financial stability analysis as a study that can use different sectors of economy, macroeconomic development and financial markets in order to depict the possible risk that can affect the financial system, (Frait, *et.al*, 2011).

Given the high integration of the foreign possession of the banking sector in Czech Republic and its external position in the overall financial market, the global financial crisis impact in the Czech Republic is of no surprise. Even though, Czech Republic had lower exposure to sub-prime securities, its off-balance sheet totals were higher compared to the on-balance sheet. Furthermore, there have been concerns regarding Czech bank subsidiaries in relation to the general market health, because of their increased exposure to emerging Europe. The new tendency of loans in this market is also an increase of short-term loans as in other countries, (IMF, 2008),

The financial sector of the Czech Republic is known to be massively liquid as it has large deposits that made it resistant to the impact of the global financial havoc. Most of the European governments had to provide subsidies to their financial sectors; however, this was not the case in the Czech Republic. Nonetheless, the Czech National Bank (CNB) provided further liquidity with repos of two week and three month maturities. These were provided in order to support the operation of government bonds and to make them eligible to be used as collateral. Although the financial sector remained liquid and positive steps were taken towards it, the whole Czech economy was affected nevertheless. Indeed, the Czech Republic is an exporting country and therefore it is sensitive to outside factors such as the diminished demand for Czech products from foreign countries, particularly from the West. It made the country's economy set back as the GDP and unemployment rates increased although moderately in comparison to other central and eastern European countries, (Babicky, 2010.)

It is significant to highlight the first signs of the financial crisis, which were notable in the interbank Czech market in fall of 2008. Institutions began keeping excess liquidity, as there was a lack of confidence among foreign banks. Indeed, regardless of the liquidity surplus, the insufficiency of the bank sector confidence created a disruption in the market. Besides the aforementioned repo operations of the government, there have been visible differences in the financial markets in regards to interest rates. After the crisis, there have been increases of 1.5 percentage points in the interbank and repo rates at the end of 2008 and remained higher for 0.6 percentage points in comparison to the pre-crisis rates, (Vojtisek, 2010).

Because of the major issues of foreign parent companies, the Czech financial sector had significant problems with excess liquidity and exposure of the banks, which needed auditing. The Czech Republic had started to oppose risk-taking, as other countries in Europe needed excessive external funding. With that being said, the financial turmoil has not had a direct effect on the Czech economy per se; however, it was mostly visible through policy and money market changes. Indeed, as previously mentioned, because the Czech Republic is export-oriented, it had economic losses because of the reduction of the demand from foreign trading partners that affected the domestic market. Therefore, the low foreign demand might be considered to be largest impetus of the financial crisis in the country.

Moving forward on the bank liquidity and market relationship there has been a negative liquidity spiral, a term coined to explain the decline of market liquidity in Czech Republic that leads to an increase of risk to fund liquidity outflow and creates problems for the countries indirectly hit by the financial crisis. Hence, the first area to be audited was the liquidity development which was done through required reports of daily information on volume of liquid assets, demand and term deposits, expected transactions that could decrease liquidity, bank exposures in relation to parent companies, and so on, from the banking sector. The key actors of the money market in the country and the outflows of money between subsidiaries and parent banks, were monitored given Czech banks were property of international groups, (Gersl & Komarkova, 2009).

The financial segment of the Czech Republic in 2007 has seen optimistic progress. Indeed, there were outrageous profits in the banking sector, which showed continuous lending opportunities in the economy. The Czech insurance companies as well have been highly liquid passing the required margins in their life and non-life insurance sectors. However, the latter and pension funds have experienced growing costs when establishing new contracts which could affect the future gain. Households have engaged in mutual funds making them a very common investment opportunity among the Czech Republic. Funds like mixed funds, foreign guaranteed funds, and alike that have dispersed risks were also appealing opportunities for the aforementioned, (CNB, 2011).

According to the “Analyses of Czech Republic’s current economic alignment with the euro area, 2011” some of the reasons of the Czech economic growth in 2007, were the impacts of the fiscal policy reforms and implementation of Basel II and Solvency II frameworks. These implementations brought some changes in credit risk regulation, investment institutions and insurance institutions in Czech Republic. Although there was a decrease in the economic production, including a decline in credit portfolios and market interest rates, the year 2009 was financially profitable in Czech Republic.

It is important to note that although interbank rates declined, there was experienced an increase in interest margin because there was a decline in deposit interest rates and the preservation of a quite high level of lending interest rates. This type of policy was undertaken because of the expectancies of the risk crisis in the country’s economy, (CNB, The financial stability report 2007). The elevated income from interest is now used to make up for the losses in non-performing loans (NPLs); however, the interest margins are expected to decrease because of expected future growth, but future developments will exert downward pressure on interest margins. The present interest margin is seen as quite high which as aforementioned is expected to decline because of slight recovery in the economy, and decrease in credit risk, (CNB, Financial stability report 2009-2010).

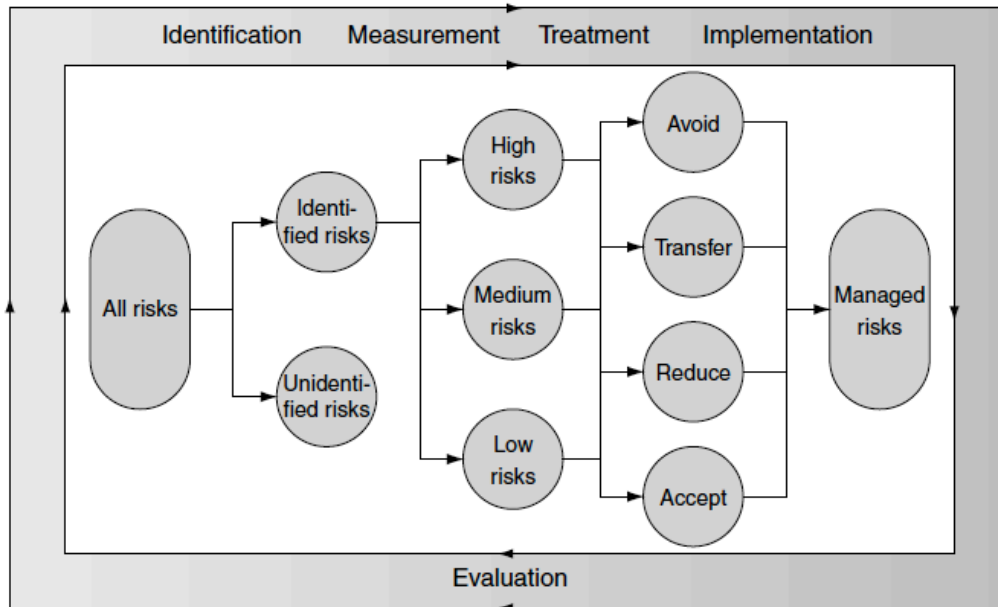
CHAPTER IV. Risk management process in financial institutions

The essential objective of risk management is lowering profit volatility and avoiding large losses. The objective that concerns the most risk management is to identify the high exposures with high default risk. Defining risk is one of the most crucial steps to understand the accomplishments of financial institutions into managing them. There is always a certain degree of doubt on objectives that may be positive or negative which deals with taking risks, (Heather Rolfe, NIESR, 2010).

Managing risks, therefore, includes the identification, evaluation, and arrangement of risks in order for the reduction of undesirable occurrences and the maximization of opportunities. There are many areas that involve risks such as financial markets, project

failures, natural phenomena, credit risks, and so on. The manners of managing the risk differ on what area the risk falls and which one is more suitable for the occasion.

Figure 11. Phases of risk management process

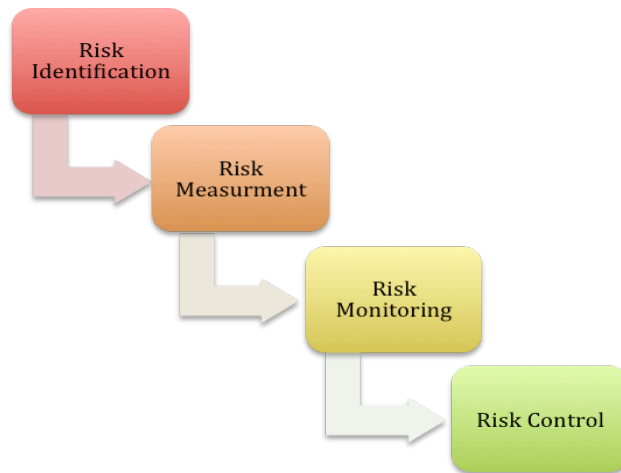


Source: Gestel and Baesens. Credit Risk Management, 2009

It is significant to grasp the varieties of managing the risk that may be faced in financial markets such as shifting it to another group, lowering its negative effects, and acknowledging some of its consequences. However, there have been some proclamations that there are no set standards to measure the risk although the belief in estimates is higher, (Sean, 2010).

Different banking institutions should have different risk management system, because each financial institution has different risks that they undertake. Hence, there is no universal risk management system that would apply to all, (Lumpkin, 2002). Therefore, each financial institution should create a risk management program that would best apply to their needs and situation. However, despite the differences on risk management design, every platform should contain: risk identification, risk measurement, risk monitoring and risk control, (HSE, 2011).

Figure 12. Risk management system



Source: HSE 2011, counstructed by author

4.1 Risk Identification

An institution in order to manage the risks accurately must firstly identify and understand the possible risks which may occur as a consequence of both new and already existing business initiatives i.e. risks that accompany the lending activity are liquidity, credit, interest rate and many other risks. On the other hand, risk identification should be an ongoing process that should be looked at both transaction and portfolio levels, (Gestel and Baesens, 2009, p.40).

4.2 Risk Measurement

In order to assess the influence that risks will have on the banking institutions, hence once the risk have been recognized they should be measured. The measurement can be conducted using different techniques starting with the simplest and to continue the most complicated. Moreover, a good risk measurement system must measure the risk in individual transaction and in portfolio. It should be emphasized that the precise and timely risk measurement are the core factor for the effectiveness of the risk management system. Furthermore, an institution, which does not have a risk measurement system, does not have the capability to monitor and control the risk

levels. Furthermore, the institutions should make sure that their risk systems are well functioning, this would be done by testing them periodically, (Gestel and Baesens, 2009, p.40).

4.3 Risk Monitoring

In order to monitor risk levels and to assess the risk positions and exceptions, all institution should establish a management information system (MIS). The monitoring should be reported accurately, timely, frequently and of course the reports should carry vast information, which should be passed to the competent people who will make sure to act properly, if needed, (RBOM, 2007).

4.4 Risk Control

Once the risk has been measured than the institution should make sure to embody the risk limits on policies, procedures, standards and clearly define who is the responsible for the execution of these limits. Such limits are created with the purpose of controlling various risks that arise on the activity of banking institutions. However, when institutions are warned, they can make exceptions and change the existing limits. On the other hand, if banking institutions want to minimize the exposure to different risks, they may use different mitigating tools, (RBOM, 2007).

In addition, a risk management system should be safe and stable. In order to achieve that the system should have the following elements:

- a. Board of directors and senior management supervision
- b. Proper guidelines, techniques and restrictions
- c. Sophisticated risk quantity, management information system and monitoring

4.5 Credit risk

Credit risk is the possibility that the bank-borrower may not fulfill the requirements upon which was agreed. The credit risk management is highly important, because

through its operation the credit risk is meant to be minimized, while at the same time to “maximize bank’s risk adjusted rate of return” which would be achieved by keeping the credit exposed to the acceptable norms, (MFSA, 2002).

Credit risk is composed of two elements that are quantity of risk and quality of risk. Quantity of risk is considered the large loan balance on the date of default. On the other hand, through quality of risk is explained the harshness level of losses which are identified by both probability of default (PD) and Loss given default (LGD). Therefore, credit risk results of default risk and exposure risk (ER), (Raghavan, 2003). One of the core functions that banks have always exercised is lending which of course has been realized by evaluating accurately borrower’s creditworthiness. However, the methods used differ depending from the borrower. Also, they will differ depending on the nature of lending that is being considered, (Gestel & Baesens, 2009).

During 1990s because of the moral hazard and negative selection, banks in Czech Republic started to invest client’s money in poorly analyzed and monitored agreements. Moreover, many small banks were related personally with their clients, therefore the credits that they released were on bases of ‘political’ or personal relations, rather than economic attributes, (Matousek, 1998). Additionally, since during 1990s the loans and credits composed a high portion of banking assets, the CNB supervised closely the credit policies and credit risk management, (Gersl & Seidler, 2011). It is important to draw attention to the fact that Czech Republic compared to other countries in transition has the highest amount of loans granted to corporation, in relation to GDP. Many states like Germany and Belgium leave their banks to make and manage their own provisioning policy. On contrary, CNB was quite strict regarding the provisioning policy, and the rationale behind this action was that Czech banks were not enough reliable in making provision, which would reflect the expected credit loss, (Craigwell & Elliot, 2011). The method used by CNB was quite simple and it was a guarantee for a minimum level of provision. Furthermore, it is important to emphasize that the credit risk was not restricted only to small banks.

As other emerging economies, the Czech Republic banking sector has had continuous high level of classified loans. However, comparing Czech Republic small banks to other big or international banks, on average the Czech Republic small banks promised higher yields on deposits and granted high yield, risky loans. Furthermore, small banks had a restricted access to inter-banking market of Czech Republic and the international one, and were not eligible for sustainable financial aid from the government as they were small banks and considered as non-TBTF (too big to fail). The Czech Republic losses from the credit risk were valued to be 400 billion (or USD 19 Billion), which in per capita terms was CZK 40,000 (USD 1,900), (Mejstřík, Pečená & Teplý, 2008).

4.6 Credit analysis as important role in risk management

Credit analysis is very important when lending money as it evaluates the companies that apply for loans for their eligibility. In order to submit new loan request the credit analysis estimates the ability of companies to repay the loan and monitors their existing relationships, (Andrew Fight, 2004). In order to do this analysis several aspects of the companies are observed, such as the “the size and nature of the enquiry, the potential future business with the company, the availability of security to support loans, the existing relationship with the customer”, (Andrew Fight, 2004). Besides these key issues that should be observed, to have detailed and exact information other issues should also be taken into consideration. Some of these issues are the financial conditions, credit references, loan agreements, etc.

Checking all these issues for the borrowers, the credit analysis will have in-depth information to make the decision for loan agreement and whether the loan required will be covered by the borrower’s financial conditions. There are also cases that the analysts look at the financial conditions of the sector that the borrower belongs to have a clearer view.

CHAPTER V. Macroeconomic scenarios and stress-testing framework in banking sector

After the crisis and occurrence of different macroeconomic shocks, financial institutions are facing different risks, mainly credit risk. Hence, the risk management sector is trying to establish a sophisticated stress-testing framework as essential element, which plays a key role in forecasting and understanding economic cycles, mostly macroeconomic shocks, balance-sheets, and capital requirements. Stress-testing framework is applied to ensure an efficient risk management and it helps to estimate losses of financial institutions that may suffer from financial downturns, (Oracle, 2011).

In general central banks use empirical models to assess credit risk by using stress test analysis where central banks employ macroeconomic credit models, but some of the central banks operate with different models such as sensitivity analysis, (Jakubik, 2011). In Czech Republic, the CNB as regulatory supervision for financial institutions does the stress-testing model for macroeconomic shocks in order to forecast the development of some key indicators that may cause financial depressions in the future. Stress testing helps to design macroeconomic stress scenarios based on particular risk.

When making comparisons of the results of stress with the most probable outcomes, the examinations include present macroeconomic forecasts of the CNB. In order to foresee the growth of the GDP, inflation rate, and similar aggregate economic variables for the eight quarters ahead, the usage of credit risk and growth models are used. These credit risk models are helpful in determining the probable credit risk parameters, specifically the probability of default (PD) for non-financial companies, consumer credit, household and other types of loans. On the other hand, estimations on the increase of bank portfolios in regard to the economic situation and also evaluate the development of risk-weighted assets (RWA) are done through credit growth models, (Gersl & Seidler, 2010).

In regards to stress tests, all the macroeconomic and financial variables that are done on quarterly basis reflect the prediction of balance-sheets and the indicators of flow in the

banks. These tests are dynamic so that for individual assets, liabilities, income, and expenditure there is a stock to which the impact of a quarterly shock is added/deducted giving the final stock for a certain period. Then, this final stock is regarded as the initial one for the anteceding quarter. The same system is repeated for eight quarters when predicting financial variables along with modeled changes of flow and stock variables consistently, (Cornford, 2005).

Credit risk has a crucial role in risk management, specifically for banking institutions which rely on credit risk models, at times prepared by them, to improve the quality of bank portfolios. In 2004 there was introduced a New Basel Capital Accord known as Basel II from and thereby a new wave of interest originated, (Jakubik, 2007).

To calculate the expected credit losses, we can use the loss given default (LGD) by multiplying it with the probability of defaults (PD). The loss given default is calculated as 1 deducting the recovery rate on defaulted debt instruments (RR). Even though both of the LGD and PD are very important in measuring the credit risk, the PD is more developed in this aspect.

The Czech-banking sector is mainly focused on credit risk, which is usually quantified using the non-performing loans (NPL) to total loans ratio. It is also one of the essentially significant areas when testing stress, (Cihak, Hermanek & Hlavacek, 2007). The portfolio default is used on four segments as product, origination credit score, acquisition channel and geographic region of the loan, (Breedon, Thomas and McDonald III, 2008). Another risk parameter is the abovementioned loss given default (LGD) which is usually quantified based on judgment and specific scenarios and credit sections while taking into account rules, banking practices, housing prices, market data and so on. Another parameter needed for the analysis, which is the exposure at default (EAD) and usually represent a clean number, and experts base it on judgment.

It is important to emphasize the effects that increases in PD or LGD risk have on banks. Firstly, the losses in CZK millions that were expected from loans were valued by multiplying probability of defaults (PD), loss given defaults (LGD), and exposure at

default (EAD) for every quarter. Founded on them, banks provide the same quantity and account them as impairment charges on the side of expenses of profit. Afterwards, total assets are reduced in a symmetric manner based on the quantity of these expenses (CNB – Financial department)

When forecasting the level of the non-performing loans (NPL) the probability of defaults (PD) is used in this case as well. It is necessary to account for a specific amount of gross outflow of the current NPLs making possible for individual banks and the entire sector to generate NPLs for eight subsequent quarters.

Models that are used in credit growth generate a valuation of the gross level of loans in individual segments. Indeed, to gain an understanding of the stance of the banking sector, using the non-performing loans (NPL), we can find NPL/total loans ratio, which is a great sign of the mentioned issue. Secondly, when estimating capital requirements the RWA capital regulations supports the innovation that would avoid regulatory requirements, and alters banks focus away from their main economic operation. There is another advanced manner, which is done through Basel II as a function of probability of defaults (PD), loss given defaults (LGD), and exposure at default (EAD) (Nomura, 2005). This approach is the most widely used in most of the banks of Czech Republic, and hence it is applied to all banks for easier assessment of the entire banking sector. In a general view, for a specific volume of a portfolio, when the probability of defaults (PD) and the loss given defaults (LGD) increase, the risk-weighted assets increase (RWA) as well (CNB – Financial department)

Chapter VI. Methodology

6.1 VAR methodology

The vector autoregressions (VARs) are a macro-econometric models provided in 1980 by Sims. Based on this provision, a univariate autoregression can be defined as a linear model which uses one variable which is described by its lagged values. Extending this model, the vector autoregression is a multi-variable linear equation where variables are explained by their individual lagged values, as well as the values of other past lasting variables as $n-1$. This macroeconomic model has assisted to understand various time series and has a very easy statistical background to be used. The vector autoregressions (VARs) have been observed as very helpful in describing data, prediction, and analysis of policies. This simplistic framework engages linear equations to observe the relations of variables that are endogenous. The VAR model accounts for all of variables as symmetrical and does not include a theory to show the variables as dependent or independent. They are based on previous data and analyzed afterwards.

The VAR model treats all variables as endogenous and has a system with multi-equation. It is a model that has one equation for every variable as dependent variable. Furthermore, in these equations there are included lagged values of all variables of the model as dependent variable including the independent variable. These equations have the same form, because for VAR model there are no contemporaneous variables that are used as explanatory variables.

For example, in a VAR model with variable as y the equations of the model would be as below:

$$y_t = a_1 y_{t-1} + \dots + a_k y_{t-k} + e_t^y$$

Furthermore, in this model the endogenous variable serve also as explanatory variables in lagged form, while the amount of lags is determined at the estimation stage. In order to see that which lag length suit my estimation better, I run the information criterion for lag length. According to information criterion Akaike (AIC) the goodness of fit that relatively suits my model better is number of lags between three or four.

The VAR model has several properties' that are:

- It is a reduced form as the on right-hand side variables there are no contemporaneous variables.
- The variables in the VAR model depend on each other, as they are all considered as endogenous variables
- The shocks in the VAR model are unobserved structural shocks. Thus as the data in VAR estimation are real data, the estimates obtained are of combined shock and are denoted as e to be differentiated from the structural shocks. With these shocks there are constructed impulse response analyses.
- The VAR model is usually used to forecast, while it is not used for structural analysis and policy evaluation.

6.1.1 Impulse response function

When the impulse response function (IRF) to structural shocks is calculated a certain recursive structural VAR could be the adequate model. To proceed with the impulse response function of dynamic equation, in general the output of the the impulse response function is a dynamic reaction of particular variable (e.g. NPL ratio) in response to other macroeconomic variable (e.g exchange rate). The impulse response function describe the reaction of variables in equation as function of time of explanatory variables that may cause the dependent variable.

These structural shocks impact the variables present in the model. And through the model impulse graph can be constructed as response to a certain shock.

In my case, my aim is to see the response of credit risk to macroeconomic shocks. Defining credit risk, I used the ratio of non-performing loan to total loans and as key macroeconomic variables I have collected variables such as long-term interest rate, inflation, exchange rate (czk/usd), GDP, and unemployment rate. Every structural

shock affects every other variable. Thus, I can construct an impulse graph for credit risk variable as the response to a certain macroeconomic shock.

- The impulse response of *credit risk* in response to a *long-term interest rate* shock
- The impulse response of *credit risk* in response to a *inflation* shock
- The impulse response of *credit risk* in response to a *exchange rate* shock
- The impulse response of *credit risk* in response to a *GDP* shock
- The impulse response of *credit risk* in response to a *unemployment* shock

The variables in equation tend to have the same kind of dynamics, which means that they have same dynamic equation representation, thus, the shape of impulse response functions tend to be the same in general. Furthermore, the impulse responses will become zero if the system is stable, while the timing effect will make a difference.

The impulse responses begin with the first period of a particular shock in relation to the first variable, and continue as a casual chain. Furthermore, the shocks sizes are usually set to standard deviation of the independent variables in to understand its reaction of the impulse responses clearer.

6.2 Data and variables description

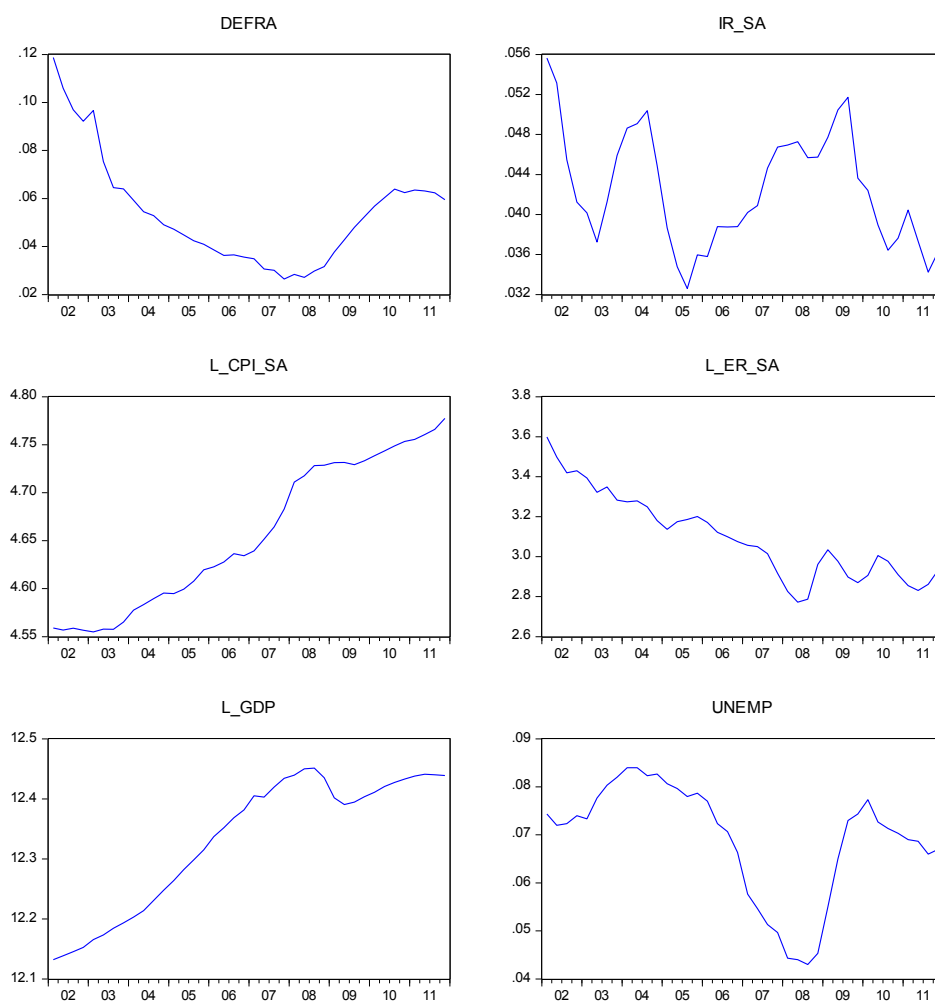
I collected time-series quarterly data covering the period from, 2002 to 2011, including main macroeconomic variables and credit risk in banking sector in Czech Republic. Data were collected from ARAD time-series database provided by CNB official web page and OECD online statistic library. In order to quantify the credit risk as a key measure for quality of loan, I used the NPL ratio. As main macroeconomics variables causing the NPL ratio, I used variables such as real GDP, the long-term interest rate (IR), the exchange rate of CZK/UDS (ER), the inflation (CPI), and unemployment rate (UNEMP).

The VAR methodology is used to estimate the empirical model over the quarter period of 2002 to 2011. In order to assess the impact of macroeconomic variables in credit risk (NPL ratio) the impulse response analysis is used (response of NPL ratio to macroeconomic shocks). Data that I collected are expressed in percentage (the long-term interest rate and unemployment rate) except real GDP, exchange rate and CPI they were not expressed in percentage, therefore I used logarithm of these variables. Variables were not stationary regarding Augmented Dicky-Fuller test (ADF), (Appendix 1). Thus, in purpose to proceed further and to estimate my model by using unrestricted VAR method, and to observe the impact of macroeconomic shocks reaction on credit risk, data has to be stationary. I used the level of first log difference in order to transform data into stationary. Unit root test for cointegration specifies that the variables are level stationary series (see Appendix 1) and that all variables are I (1). While, in terms of long-term interest rate, exchange rate and inflation, I used the seasonally adjusted (using Eviews software) in order to remove the seasonality.

Table 1. Descriptions of variables

Indicators	Variable	Description
Credit Risk	DEFRA	Credit risk defined as NPL ratio
Interest rate	IR_SA	Long-term interest rate, seasonally adjusted
Inflation	L_CPI_SA	Inflation of CPI, seasonally adjusted
Exchange Rate	L_ER_SA	Exchange rate (CZK/USD), seasonally adjusted
GDP	L_GDP	Real GDP based on expenditures approaches (sum of investments, net exports, consumption and government purchases)
Unemployment rate	UNEMP	Unemployment rate

Figure 13. Graphic view of macroeconomics indicators in level series expressed percentage



Note: Data used from CNB, constructed by author. Variables are expressed on percentage (CPI, ER and GDP are in log). Only long-term interest rate is stationary.

6.2.1 Czech Republic is GDP Growth Rate

GDP in a country serves as an indicator of country's economy wealth and living standards. However, as there are transactions that are not reported to the government, some critics say that GDP does not clearly show the real economic wealth of a country. If we take a look for the average quarterly GDP growth from 2002 to 2011 was 0.78 percent, where the highest GDP growth since 2002 was 2.37 percent in first quarter of

2007 and the lowest was recorded -3.30 percent on March of 2009. Specifically, in fourth quarter of 2011 the GDP in Czech Republic contracted 0.1 percent over earlier quarter. Czech economy is considered as one the most developed and industrialized. Czech Republic is one of the most stable and successful among of the previous Communist countries in comparison with other emerging democracies in CEE countries. Furthermore characteristics, which makes the country's economy stable and developed is that as country has developed infrastructure and its population is well educated

6.2.2 Czech Republic is inflation rate (CPI)

In the Czech Republic the inflation rate is measured based on the Consumer Price Index (CPI), which shows the price changes of standard packages of goods and services households consume. The inflation is measured based on how much the CPI increases in percentage terms for a period compared to the CPI of the preceding period. If the prices have increased, it means there is inflation in a country, but if the prices decrease it means that there is deflation.

Thus, the inflation rate in the Czech Republic for the period of 2002 to 2011 was on average 1.06 percent, and reached the highest level in the fourth quarter of 2011 at 1.18 percent and the lowest rate in the fourth quarter of 2002 at 0.94 percent. Specifically, in the last quarter of 2011 the inflation rate was at 1.18 percent.

6.2.3 Czech Republic unemployment rate

The labor force in a country encompasses all the people that are employed and those people that are able to work but are unemployed. The people that are not accounted to be in labor force are people serving in military, people which are retired and those who not seeking to work. Thus, based on this, the unemployment rate in the Czech Republic during the period of 2002 to 2011 the average unemployment rate was 6.9 percent, reaching the highest level of unemployment at 8.4 percent in the first six months of 2004, while the lowest level of unemployment was at 4.3 percent in the third quarter of 2008. Specifically in the last quarter of 2011 the unemployment rate was 6.7 percent.

6.2.4 Czech koruna exchange rate (CZK/USD)

The spot exchange rate of Czech Koruna, shows the worthiness of one currency, in this case USD, in terms of the other currency that is CZK, which is quoted and exchanged in the same day. While the Czech Koruna forward rate is quoted as today in order to be delivered and paid in a future date. The Czech Koruna exchange rate against dollar on average was 22.62 in the period of 2002 to 2011, where the highest rate was in the first quarter of 2002 at 36.2, while the lowest was in the second quarter of 2008 at 15.9. Specifically, in the last quarter of 2011 this exchange was at 18.7.

6.2.5 Czech Republic interest rate

The Central Bank in a country play an important role as they impact the increase or decrease of the interest rate of their currency, due to the rate of various macroeconomic variables such as, inflation, unemployment, currency, thus overall economic performance.

The CNB is the institution that comes up with the interest rates in the Czech Republic, meaning that it is the discount rate that the commercial banks use to place their excess fund daily with CNB. In the period of 2002 to 2011 the average rate of long-term interest rate was 4.3 percent, which was the highest in the first quarter of 2002 at 5.4 percent, while the lowest rate was in the third quarter of 2005 at 3.3 percent. Specifically, the long-term interest rate in the last quarter of 2011 was 3.5 percent.

6.3 Empirical results

In order to interpret the results that macroeconomic shocks cause the credit risk, the impulse response function is used. The VAR model allows doing estimation of macroeconomic shocks and their impact on credit risk (NPL ratio). The VAR functions show the period of a variable in response (NPL ratio) to a shock in macroeconomic variables. This shows which, shock provokes the variation in an endogenous variable (NPL ratio). The execution is done by identifying the structural innovations from the

reduced form residuals, which in this case is used as Choleski-decomposition as it imposes zero restrictions.

In addition, to verify that the lags of endogenous variable are significant to enhance the estimated performance of the other variables for the credit risk (NPL ratio), the Granger causality test was used. Specifically, these are pair wise tests of the null hypothesis that the coefficients of an endogenous variable in equation equal zero and thus Granger causes it. Hence, if the null hypothesis is rejected by a standard F-test, it means that there is inclusion of a specific variable in the equation of other variable

The Granger causality tests on my model, shows that long term interest rate (IR_SA) does not Grangerly causes credit risk (NPL ratio), which means that long-term interest rate does not help to predict the credit risk (see table 2). Therefore, null hypothesis that long-term interest rate does not Grangerly causes NPL ratio is not rejected. The impact of inflation (L_CPI_SA) to credit risk (NPL ratio), is significant on 90% of confidence interval with the p-value 0.0647. So, null hypothesis has been rejected. Hence, inflation does Granger causes credit risk, and helps on predicting it. Important to note is that inflation has impact on credit risk, but credit risk does not Granger causes the inflation. In terms of exchange rate (L_ER_SA) as impact on credit risk Granger causality test shows that exchange rate does not Grangerly Causes credit risk. So the exchange rate does not help to predict the credit risk. Therefore, null hypothesis is not rejected. According to GDP (L_GDP) and unemployment rate (UNEMP), results show that both macroeconomic variables do not Granger causes the credit risk; even credit risk do not Granger causes shocks on GDP and unemployment rate. Thus it means that GDP and Unemployment rate, referring to Granger causality test do not help to predict the credit risk and null hypothesis are not rejected. In a nutshell, almost all macroeconomic variables are insignificant and do not Granger causes the credit risk, except the inflation, which has a significant impact on credit risk.

Table 2. Granger Causality Tests

Pairwise Granger Causality Tests			
Date: 05/08/12 Time: 22:55			
Sample: 2002Q1 2011Q4			
Lags: 4			
Null Hypothesis:	Obs	F-Statistic	Prob.
IR_SA does not Granger Cause NPL ratio	36	0.84247	0.5105
NPL ratio does not Granger Cause IR_SA		0.97006	0.4400
L_CPI_SA does not Granger Cause NPL ratio	36	2.51689	0.0647
NPL ratio does not Granger Cause L_CPI_SA		1.12151	0.3670
L_ER_SA does not Granger Cause NPL ratio	36	1.97476	0.1269
NPL ratio does not Granger Cause L_ER_SA		1.45798	0.2425
L_GDP does not Granger Cause NPL ratio	36	1.90003	0.1394
NPL ratio does not Granger Cause L_GDP		0.43495	0.7822
UNEMP does not Granger Cause NPL ratio	36	1.28249	0.3014
NPL ratio does not Granger Cause UNEMP		0.77143	0.5533

From doing the pairwise Granger causality test, it is shown that granger causality runs from 6 variables at four lags. These results show that most of the variables are not significant enough to explain the changes in performance of credit risk (NPL ratio). Even though the theory states that it is enough to use three or four observations of macroeconomic variables changes, the results from the model that used four observations based on quarter could not observe the changes, except for inflation.

Variance decomposition

Variance decomposition determines the contribution of each exogenous variable and forecasts error variance for each macroeconomic variable that explains the specific effects of a shock in the future. Variance decomposition shows the effect of macroeconomic variables (long-term interest rate, exchange rate, GDP, inflation and unemployment rate) to the NPL ratio. The results show that the impact of macroeconomic shocks on NPL ratio, start from the second quarter until the eight quarter (the last quarter of forecasting). Furthermore, the results show that the NPL ratio will be caused mostly by exchange rate in initially, (L_ER_SA) with an average of

12.75 percent (including quarters from second to sixth, see table 3). In last two quarters of forecasting (seventh and eighth quarters), NPL ratio gradually will be caused by long-term interest rate (IR_SA) with an average of 15.61 percent (including both last quarters, see table 3).

The forecast of variance decomposition of NPL ratio has been observed for next eight quarters.

Table 3. Variance decomposition of NPL ratio

Period	S.E.	NPL ratio	Long-term IR	Inflation (CPI)	Exchange Rate	GDP	Unemployment rate
1	0.003658	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.004396	91.75761	0.016064	0.592785	6.458444	0.028729	1.146374
3	0.005009	85.01307	0.325911	0.597962	11.38083	1.087571	1.594657
4	0.005430	79.15064	2.169041	0.510470	13.81979	2.682789	1.667266
5	0.005800	72.94821	5.735998	1.348859	13.58772	4.894068	1.485151
6	0.006218	65.45052	10.27387	4.306096	12.17908	6.416078	1.374350
7	0.006709	57.51655	14.26325	9.263673	10.50603	6.897726	1.552768
8	0.007228	50.75756	16.94888	14.75182	9.061562	6.523662	1.956511
Cholesky Ordering: NPL ratio IR_SA L_CPI_SA L_ER_SA L_GDP UNEMP							

6.3.1 Impulse response analysis of NPL ratio to macro shocks

The impulse response function is used to observe, how macroeconomic variables are causing credit risk (how long and in what manner). It may give one standard deviation shock to the residual and how the variables are reacting to credit risk. I gave one positive standard deviation shock to residuals of all variables, where the model has error-term and it may cause a shock.

I choose residuals one unit for next 8 periods/quarterly (e.g. how macroeconomic shocks causes credit risk in next 8 quarters). The impulse response function follows with Cholesky one standard innovation.

The impulse response analysis of NPL ratio due to one standard deviation shock in NPL ratio shows that, if there is one standard deviation increase in NPL ratio, it causes the

NPL ratio to decrease sharply with an increasing rate until the second quarter. Moreover, the NPL ratio after the third quarter starts to decrease at decreasing rate until the six quarter. Although it is decreasing first at increasing rate and next at decreasing rate, the NPL ratio remains above the initial level. The trend continues after the sixth quarter and the NPL ratio will stabilize above its previous level.

To the contrary the impulse response of NPL ratio, due to one standard deviation shock increasing in the long-term interest rate (IR_SA), shows that in response to one standard deviation shock in the long-term interest rate, the NPL ratio remains stable until the second quarter and after the third quarter it starts to increase sharply. However, this trend changes after the seventh quarter because the NPL ratio starts to stabilize. Generally, it can be said that there is divergence of NPL ratio from its initial level due to one standard deviation innovation in the long-term interest rate (IR_SA) or this innovation have long-term effect on the NPL ratio. Thus, it is observed that the impact of long term interest rate and the NPL ratio is positive in the long-term.

According to the impulse response function (see Figure 14), it is shown that one standard deviation shock increasing in inflation (L_CPI_SA) cause a small decrease in the NPL ratio until the second quarter, while after the third quarter even if it remains below the initial level until the fifth quarter, it has moderate increment. Nonetheless, after the fifth quarter it increases more than its initial level. Commonly, it is shown that there is a mean reversal because initially it decreases and later on it started to increase after several quarters. Thus, it is observed that the impact of inflation and the NPL ratio in the long term is negative.

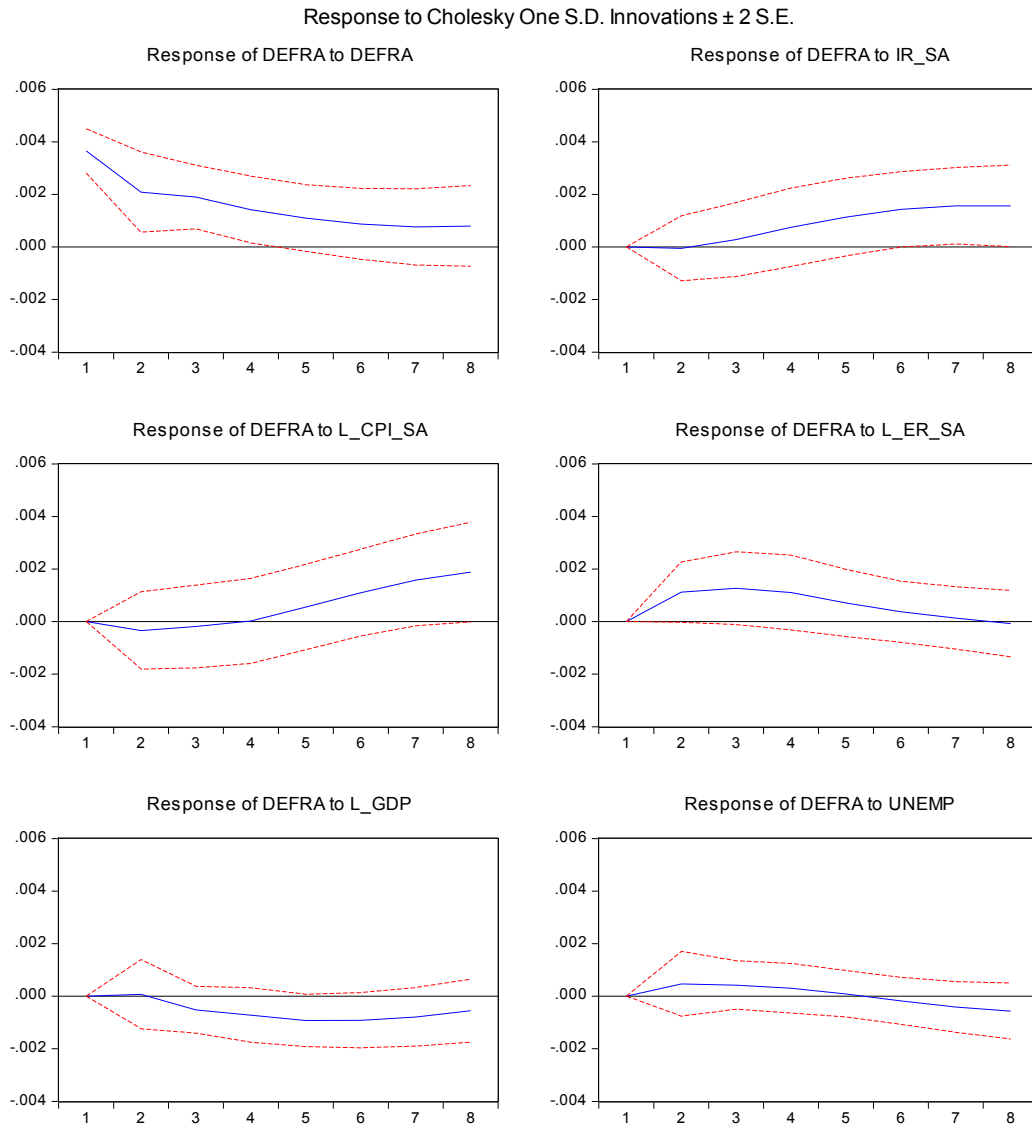
In similar manner the impulse response of NPL ratio, due to one standard deviation shock increasing in the exchange rate (L_ER_SA), reveals the convergent of NPL ratio after some quarters. Specifically, it is shown that the NPL ratio increases sharply until the second quarter, while after the third quarter it starts to decline, although, it declines moderately. Indeed, the NPL ratio will start to converge to its initial level after sixth quarters. Thus, from the results it is shown that the impact of exchange rate and NPL ratio is positive in the short-term, while in the long run there will be no impact.

Furthermore, impulse response analysis of NPL ratio due to one standard deviation shock increasing in GDP will cause the NPL ratio initially to remain stable until the second quarter, after that it starts to decrease below its initial level starting from the end of second quarter until the fifth quarter. Nevertheless, it starts to stabilize starting from the fifth quarter and remains stable until seventh quarter. However, after the eighth quarter it starts to increase by very tiny amount and remains below the initial level. The results show that the impact of GDP and NPL ration is positive for the long-term.

At last but not least, the impulse response of NPL ratio due one standard deviation shock increasing in unemployment rate (UNEMP) shows that the NPL ratio increases slowly until the second quarter, although this trend is reversed after the second quarter because the NPL ratio starts to decrease by very small amount in the same manner. In addition after fifth quarter the NPL ratio farther decreases and starts to be below the previous level of NPL ratio. Therefore, it is shown that there is a mean reversal of the NPL ratio because initially it increases and later on it decreases. Thus, the results show that the impact of unemployment rate and NPL ratio in the long-term is negative.

Indeed, the impulse response function of NPL ratio to the macroeconomic shocks shows that there is a long-term effect in the NPL ratio due to increase of one standard deviation innovation to the macroeconomic variables. However, in the case of exchange rate (L_ER_SA) it is shown that there is no long-term effect on the NPL ratio. Similarly, a study done by Baboucek and Jancar (2005) used the comprehensive unrestricted VAR in order to quantify the impacts of macroeconomic shocks on the Czech banking sector loan quality. Furthermore, the NPL ratio was used as an indicator to show the loan quality. The impulse response analysis of this study showed that there was a robust causal relationship between the loan quality and some of the macroeconomic variables. The variables such as the unemployment, CPI inflation were shown to have negative impact on the NPL ratio, which confirms the theory and other related empirical studies. Results of the impulse response function of my model are presented in Figure 14.

Figure 14. Impulse response function of NPL ratio (DEFRA) to macroeconomic innovations



Note: Data used from CNB, results are based on author's estimates of the impulse response function

Chapter VII. Conclusion

The purpose of this study is to examine the NPL ratio, its determinants and its response to different macroeconomic shocks.

Among other risks, the credit risk is one of the main parts that risk management of banks should be aware of. The credit risk plays very important role when defining the losses that may occur in a particular bank. In order to forecast the credit risk, the risk management observes the macroeconomic variables and measures their influence in credit risk.

Macroeconomic variables are caused by changes in different factors, and in the global financial crises of 2008 the main trigger to impact the macroeconomic variables was the house bubble that was created and fed by unrealistic expectations in the United States until 2007.

As the house prices in the US increased in the period of 2000 to 2006, people used their opportunity to obtain mortgage loans before the prices of houses increased further. The banks provided loans to institutions, firms and especially households with diverse credit rating (doubtful quality), which increased the number of risky loans (mortgage loans) in the portfolios of banks. These risky loans were known as sub-prime loans, thus, the banks in hope to spread the risk coming from these loans pooled them together and issued against them securities. The more these loans increased, the default loans and the loans in foreclosure increased, which decreased the value of securities that were backed against these loans. Consequently, the financial institutions from all around the world that invested in these securities have been facing large losses. Thus, the financial crises arose and many families lost their houses (mainly in the US), many businesses went bankrupt, the unemployment rate increased and the confidence in international financial institutions decreased.

As the world was impacted by the global financial crises of 2008, Czech Republic was no exception. Since Czech Republic has gone through financial crises in earlier period, it had lessons learned on how to cope with the recent global financial crises. Among

other challenges, the Czech Republic is an exporting country, thus, the demand for its export decreased worldwide, which increased the unemployment rate and lowered the growth of GDP.

As the governments and central banks worldwide were setting exceptional policies to mitigate the global financial crises, models and tests to forecast various indicators for credit risks were being established.

Therefore, when assessing the implications on credit risk of Czech Republic, the VAR methodology is used by implying some useful information for quantifying the impact of macroeconomic shocks on financial institutions credit risk and shows which shock provokes the inconsistency of NPL ratio. Making comparisons of the results of different shocks, the examinations include present macroeconomic forecasts. In order to see the response of NPL ratio to macroeconomic variables for the eight quarters ahead, the credit risk and macroeconomic variable model is used. Empirical results show how the impulse response function of NPL ratio to macroeconomic shocks have a long-term effect in the NPL ratio due to one standard deviation innovation in the most of macroeconomic variables. However, in the case of exchange rate it is shown that there is no long-term effect on the NPL ratio.

Specifically, the impulse response function of NPL ratio in relation with the interest rate will be positive for the long-term, while the relation of NPL ratio with the inflation rate will be negative for the long term. Moreover, the NPL ratio with the exchange rate is positive in the short term, however, there will be no relation for the long-term. As far as the relation of the NPL ratio and the GDP is concerned, it is shown that it will be positive for the long-term. Lastly, the relation of the NPL ratio and the unemployment rate is found to be negative for the long-term.

Overall, the results show that the changes in the macroeconomic variables may have an impact on the NPL ratio in both short-term and long-term, or in just one of these terms. While it is also important to notice that while some of the macroeconomic variables may have a positive impact in the NPL ratio others will have negative impact.

References:

- Aizenman, J., Menzie, C., & Ito, H. (2010). "The Financial Crisis, Rethinking of the Global Financial Architecture, and the Trilemma". *Asian Development Bank Institute Working Paper Series No. 213*
- Allen, F., & Carletti, E., (2009). "The role of liquidity in financial crisis". *Federal reserve bank of Kansas city*
- Atanda, A. A., & Idowu, O. F. (2012). "Accountants in the global financial crisis bail-out: the outlook". *Munich Personal RePEc Archive Paper No. 35871*
- Babicky, V. (2010). "The international banking crisis and domestic financial intermediation in the Czech Republic". *Bank for International Settlements Paper No 54*
- Babouček, Ivan and M. Jančar, 2005, "Effects of Macroeconomic Shock to the Quality of the Aggregate Loan Portfolio", *Czech National Bank, Working Paper Series, No. 1, pp. 1 – 62.*
- Baily, M. N., & Elliott, D. J. (2009). "The US Financial and Economic Crisis: Where Does It Stand and Where Do We Go From Here?". *The Initiative on Business and Public Policy*
- Bárta, V., & Singer, M. (2006). "The banking sector after 15 years of restructuring: Czech experience and lessons". *Bank for International Settlements Papers No 28*
- Berkmen, P., Gelos, G., Rennhack, R., and Walsh, J. P., (2009). "The Global Financial Crisis: Explaining Cross-Country Differences in the Output Impact". *IMF working paper: WP/09/280*

- Christopher, K., & Guy, D. (1999). "Trends in the Australian banking system: Implications for financial system stability and monetary policy". *RBA Research Discussion Papers 1999-05*
- Cihak, M., Hermanek, J., & Hlavacek, M. (2007). "New Approaches to Stress Testing the Czech Banking Sector". *Czech Journal of Economics and Finance, 57(1-2)*
- Cornford, A. (2006). "The global implementation of Basel II: Prospects and outstanding problems". *United Nations, Policy Issues in International Trade and Commodities Study Series No.34*
- Crouhy, M. G., Jarrow, R. A., & Turnbull, S. M. (2008). "The Subprime Credit Crisis of 07". *Social Science Research Network Working Paper Series*
- Cutler, D., Slater, S., and Comlay, E. (2009). FACTBOX-U.S., European bank writedowns, credit losses. *Reuters*
- Czech National Bank (CNB) (2011). "Analyses of Czech Republic's current economic alignment with the euro area, 2011"
- Czech National Bank (CNB). (2007). "Financial Stability Report 2007".
- Czech National Bank (CNB). (2010). "Financial Stability Report 2009-2010".
- Czech National Bank (CNB). "Banking sector stress test methodology". *Financial Stability Department*
- Enders, W., (2004). "Applied Econometric Time Series. Second edition". *Wiley*
- European Industrial Relations Observatory (EIRO). (2009). Czech Republic. Industrial relations profile. *Eurofound*
- Fight, A. (2004). "Credit Risk Management". *Elsevier Butterworth-Heinemann, Burlington, MA*

- Frait, J., Geršl, A., & Seidler, J. (2011). “Credit Growth and Financial Stability in the Czech Republic”. *The World Bank Europe and Central Asia Region Office of the Chief Economist, Policy Research Working Paper 5771*
- Freixas, X. (2009). “Post Crisis Challenges To Bank Regulation”. *Economic Policy*
- Geršl, A., & Komárková, Z. (2009). “Liquidity Risk and Banks’ Bidding Behavior: Evidence from the Global Financial Crisis”. *Czech Journal of Economics and Finance, 59, 2009, no. 6*
- Geršl, A., & Seidler, J. (2010). “Conservative Stress Testing: The Role of Regular Verification”. *Institute of Economic Studies Working Paper 12/2010. Charles University in Prague*
- Geršl, A., & Seidler, J. (2011). “Credit Growth and Capital Buffers. Empirical Evidence from Central and Eastern European Countries. Research and Policy Notes 2”. *Czech National Bank*
- Gestel, T. V., & Baesens, B.(2009). “Credit Risk Management. Basic Concepts: Financial risk components, rating analysis, models, economic and regulatory capital”. *Oxford University Press Inc. New York, NY*
- Gullapalli, D., & Anand, S. (2008). “Bailout of Money Funds Seems to Stanch Outflow”. *The Wall Street Journal*
- Hampl, M., & Matoušek, R., (2000). “Credit Concentration in the Czech Republic: Causes and Effects”. *WP No. 19, Praha*
- Health and Safety Executive. (2011). “Five steps to risk assessment”.
- International Monetary Fund (IMF), (2010). “Monetary and Capital Markets Department. Exiting from Monetary Crisis Intervention Measures”
- International Monetary Fund (IMF). (2008). “Czech Republic—2008 Article IV Consultation, Concluding Statement of IMF Mission”.

- International Monetary Fund (IMF). (2009). "World Economic Outlook. Crisis and Recovery".
- International Monetary Fund (IMF). (2011). "Pursuing Equitable and balanced growth. Annual report"
- Jakubik, P. (2007). "Macroeconomic Environment and Credit Risk". *Czech Journal of Economics and Finance, 2007, 57(1-2)*
- Jones, C. (2009). "The Global Financial Crisis: Overview". *A Supplement to Macroeconomics (W.W. Norton, 2008), Iowa State University*
- Jorion, P. (2009). "Risk Management Lessons from Credit Crisis". *European Financial Management*
- Lang, W. W., & Jagtiani, J. (2010). "The Mortgage and Financial Crises: The Role of Credit Risk Management and Corporate Governance". *Wharton Financial Institutions Center*
- Lumpkin, S. (2002). "Supervision of financial services in the OECD area". *OECD secretariat*
- Malta Financial Service Authority. "Banking Notice: Notice on the management of credit risk by credit institutions authorized under the banking act 1994". Ref: BN/01/2002
- Mejstřík, M., Pečená, M., & Teplý, P. (2008). "Základní principy bankovníctví / Basic Principles of Banking". *Karolinum press*
- Ministry of Finance of Czech Republic. (2009). "Report on Financial market developments in 2008".
- Monura Fixed Income Research. (2005). "Basel II and Banks: Key aspects and likely market impact". *Nomura*

- Nathaniel, F., and Hesse, H. (2009). "The Effectiveness of Central Bank Interventions during the first phase of the subprime crisis". *International Monetary Fund, Working paper no. WP/09/206*
- Oesterreichische National bank (OeNB) & Financial Market Authority (FMA). (2005). "Guidelines on Credit Risk Mitigation: Legal Framework in the Czech Republic".
- Oracle Financial Services (2009). "Framework for stress testing".
- Raghavan, R.S. (2003). "Risk management in banks".
- Reserve Bank of Malawi (RBMO), (2007). "Risk Management guidelines for banking institutions". *Supervision of Financial Institutions*
- Rolfe, H. (2010). "Learning to take risks, learning to succeed". *NIESR , National Endowment for Science, Technology and the Arts.*
- Shamshad, A., Lorie, H., & Arne Petersend, (2009). "Effectiveness of Central Banks and Their Role in the Global Financial Crisis: Case of Selected" Economies. *Asian Development Bank*
- Simkovic, M., (2012). "Competition and crisis in mortgage securitization". *Seton Hall University School of Law.*
- Stock, J. H., & Watson, M.W. (2001). "Vector Autoregressions". *Journal of Economic Perspective Volume 15, No:4 pp.101-115*
- Stulz, R. M. (2008). "Risk Management Failures: What are They and When do They Happen?" *Ohio State University (OSU) Charles A. Dice Center Working Paper No. 2008-18*
- Sunanda, S. (2008). "Global Financial Crisis: A Classic 'Ponzi' Affair?" *Institute for Studies in Industrial Development, Working paper no. 2008/12*

- Sůvová, S., Kozelková, E., Zeman, D., & Bauerová, J. (2005). "Eligibility of External Credit Assessment Institutions". *Czech National Bank*
- Svetloskova, Z., (2008). "The Impact of the Financial Crisis on Euro-Adoption Strategies in Central Europe". *Bologna Center Journal of International Affairs Volume 12*
- Tomášková, E., Dávid R., Neckář J., Sehnálek D. (Editors). (2009). "Economic Crisis and the Czech Republic". *Brno: Masaryk University*
- Tuma, Z., & Singer, M. (2008). "Financial Crisis: Likely Impacts on the Czech Economy and on the Czech Economy and Lessons for Supervisors". *Czech National Bank*
- Vodova, P. (2003). "Credit Market and Prediction of its future development in the Czech Republic". *Silesian University in Opava, Czech Republic*
- Vodová, P. (2003). "Credit risk as a cause of banking crises". *CIEF 2nd Workshop*
- Vojtisek, P. (2010). "Using high-frequency data to monitor developments in the banking sector – the case of the Czech Republic". *Irving Fishing Committee, Bulletin No 33*

APPENDIX

1. Unit root test for integration

Null Hypothesis: DEFRA has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 2 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.087819	0.5353
Test critical values:		
1% level	-4.226815	
5% level	-3.536601	
10% level	-3.200320	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(DEFRA)
 Method: Least Squares
 Date: 05/02/12 Time: 16:15
 Sample (adjusted): 2002Q4 2011Q4
 Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEFRA(-1)	-0.082462	0.039497	-2.087819	0.0449
D(DEFRA(-1))	0.009514	0.171021	0.055629	0.9560
D(DEFRA(-2))	-0.131297	0.170993	-0.767849	0.4482
C	-0.002010	0.003243	-0.619796	0.5398
@TREND(2002Q1)	0.000238	9.85E-05	2.417770	0.0215
R-squared	0.378195	Mean dependent var		-0.001013
Adjusted R-squared	0.300469	S.D. dependent var		0.004942
S.E. of regression	0.004133	Akaike info criterion		-8.014310
Sum squared resid	0.000547	Schwarz criterion		-7.796618
Log likelihood	153.2647	Hannan-Quinn criter.		-7.937563
F-statistic	4.865763	Durbin-Watson stat		1.914707
Prob(F-statistic)	0.003522			

Null Hypothesis: D(DEFRA) has a unit root
 Exogenous: None
 Lag Length: 2 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.229101	0.0267

Test critical values:	1% level	-2.630762
	5% level	-1.950394
	10% level	-1.611202

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(DEFRA,2)

Method: Least Squares

Date: 05/02/12 Time: 16:15

Sample (adjusted): 2003Q1 2011Q4

Included observations: 36 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(DEFRA(-1))	-0.407392	0.182761	-2.229101	0.0327
D(DEFRA(-1),2)	-0.387770	0.177830	-2.180564	0.0364
D(DEFRA(-2),2)	-0.325135	0.150098	-2.166144	0.0376
R-squared	0.433628	Mean dependent var		5.19E-05
Adjusted R-squared	0.399302	S.D. dependent var		0.005747
S.E. of regression	0.004454	Akaike info criterion		-7.910258
Sum squared resid	0.000655	Schwarz criterion		-7.778298
Log likelihood	145.3846	Hannan-Quinn criter.		-7.864201
Durbin-Watson stat	2.095172			

Null Hypothesis: IR_SA has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.444731	0.0604
Test critical values:	1% level	-4.219126
	5% level	-3.533083
	10% level	-3.198312

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(IR_SA)

Method: Least Squares

Date: 05/02/12 Time: 16:16

Sample (adjusted): 2002Q3 2011Q4

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IR_SA(-1)	-0.295165	0.085686	-3.444731	0.0015
D(IR_SA(-1))	0.501758	0.140728	3.565440	0.0011
C	0.012539	0.003902	3.213710	0.0029

@TREND(2002Q1)	-9.23E-06	4.03E-05	-0.228986	0.8203
R-squared	0.371930	Mean dependent var	-0.000444	
Adjusted R-squared	0.316512	S.D. dependent var	0.003244	
S.E. of regression	0.002682	Akaike info criterion	-8.905494	
Sum squared resid	0.000244	Schwarz criterion	-8.733116	
Log likelihood	173.2044	Hannan-Quinn criter.	-8.844163	
F-statistic	6.711372	Durbin-Watson stat	2.054367	
Prob(F-statistic)	0.001116			

Null Hypothesis: D(IR_SA) has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.987921	0.0002
Test critical values:		
1% level	-2.627238	
5% level	-1.949856	
10% level	-1.611469	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(IR_SA,2)
 Method: Least Squares
 Date: 05/02/12 Time: 16:17
 Sample (adjusted): 2002Q3 2011Q4
 Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IR_SA(-1))	-0.598769	0.150146	-3.987921	0.0003
R-squared	0.299814	Mean dependent var	0.000120	
Adjusted R-squared	0.299814	S.D. dependent var	0.003583	
S.E. of regression	0.002998	Akaike info criterion	-8.755730	
Sum squared resid	0.000333	Schwarz criterion	-8.712635	
Log likelihood	167.3589	Hannan-Quinn criter.	-8.740397	
Durbin-Watson stat	1.859350			

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

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.614107	0.2766
Test critical values:		
1% level	-4.219126	
5% level	-3.533083	

10% level

-3.198312

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(L_CPI_SA)

Method: Least Squares

Date: 05/02/12 Time: 16:17

Sample (adjusted): 2002Q3 2011Q4

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L_CPI_SA(-1)	-0.161409	0.061745	-2.614107	0.0132
D(L_CPI_SA(-1))	0.503362	0.137117	3.671046	0.0008
C	0.731991	0.279052	2.623135	0.0129
@TREND(2002Q1)	0.001099	0.000414	2.653370	0.0120
R-squared	0.366986	Mean dependent var		0.005806
Adjusted R-squared	0.311131	S.D. dependent var		0.006040
S.E. of regression	0.005013	Akaike info criterion		-7.654360
Sum squared resid	0.000854	Schwarz criterion		-7.481983
Log likelihood	149.4328	Hannan-Quinn criter.		-7.593030
F-statistic	6.570417	Durbin-Watson stat		2.220598
Prob(F-statistic)	0.001268			

Null Hypothesis: D(L_CPI_SA) has a unit root

Exogenous: None

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

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.207968	0.0280
Test critical values:		
1% level	-2.627238	
5% level	-1.949856	
10% level	-1.611469	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(L_CPI_SA,2)

Method: Least Squares

Date: 05/02/12 Time: 16:17

Sample (adjusted): 2002Q3 2011Q4

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_CPI_SA(-1))	-0.255696	0.115806	-2.207968	0.0335
R-squared	0.113384	Mean dependent var		0.000356

Adjusted R-squared	0.113384	S.D. dependent var	0.006156
S.E. of regression	0.005796	Akaike info criterion	-7.437278
Sum squared resid	0.001243	Schwarz criterion	-7.394183
Log likelihood	142.3083	Hannan-Quinn criter.	-7.421945
Durbin-Watson stat	2.269360		

Null Hypothesis: L_ER_SA has a unit root
 Exogenous: Constant, Linear Trend
 Lag Length: 2 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.789560	0.6895
Test critical values:		
1% level	-4.226815	
5% level	-3.536601	
10% level	-3.200320	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(L_ER_SA)
 Method: Least Squares
 Date: 05/02/12 Time: 16:18
 Sample (adjusted): 2002Q4 2011Q4
 Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L_ER_SA(-1)	-0.203072	0.113476	-1.789560	0.0830
D(L_ER_SA(-1))	0.567983	0.150010	3.786294	0.0006
D(L_ER_SA(-2))	-0.383866	0.161213	-2.381109	0.0234
C	0.664103	0.391418	1.696658	0.0995
@TREND(2002Q1)	-0.002407	0.002027	-1.187058	0.2439

R-squared	0.421640	Mean dependent var	-0.013159
Adjusted R-squared	0.349345	S.D. dependent var	0.056085
S.E. of regression	0.045240	Akaike info criterion	-3.228582
Sum squared resid	0.065493	Schwarz criterion	-3.010891
Log likelihood	64.72878	Hannan-Quinn criter.	-3.151836
F-statistic	5.832211	Durbin-Watson stat	2.093610
Prob(F-statistic)	0.001214		

Null Hypothesis: D(L_ER_SA) has a unit root
 Exogenous: None
 Lag Length: 1 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-5.160110	0.0000
Test critical values:		
1% level	-2.628961	

5% level -1.950117
 10% level -1.611339

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(L_ER_SA,2)

Method: Least Squares

Date: 05/02/12 Time: 16:19

Sample (adjusted): 2002Q4 2011Q4

Included observations: 37 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_ER_SA(-1))	-0.836100	0.162031	-5.160110	0.0000
D(L_ER_SA(-1),2)	0.418164	0.148658	2.812921	0.0080
R-squared	0.430078	Mean dependent var		0.004045
Adjusted R-squared	0.413795	S.D. dependent var		0.063253
S.E. of regression	0.048429	Akaike info criterion		-3.164882
Sum squared resid	0.082089	Schwarz criterion		-3.077805
Log likelihood	60.55031	Hannan-Quinn criter.		-3.134183
Durbin-Watson stat	2.042185			

Null Hypothesis: L_GDP has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-1.148954	0.9067
Test critical values:		
1% level	-4.219126	
5% level	-3.533083	
10% level	-3.198312	

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

Augmented Dickey-Fuller Test Equation

Dependent Variable: D(L_GDP)

Method: Least Squares

Date: 05/02/12 Time: 16:19

Sample (adjusted): 2002Q3 2011Q4

Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
L_GDP(-1)	-0.038152	0.033206	-1.148954	0.2586
D(L_GDP(-1))	0.614333	0.138729	4.428301	0.0001
C	0.470325	0.403040	1.166942	0.2514
@TREND(2002Q1)	0.000154	0.000333	0.463323	0.6461

R-squared	0.478625	Mean dependent var	0.007900
Adjusted R-squared	0.432622	S.D. dependent var	0.010770
S.E. of regression	0.008112	Akaike info criterion	-6.691558
Sum squared resid	0.002238	Schwarz criterion	-6.519180
Log likelihood	131.1396	Hannan-Quinn criter.	-6.630227
F-statistic	10.40407	Durbin-Watson stat	2.061906
Prob(F-statistic)	0.000053		

Null Hypothesis: D(L_GDP) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.182710	0.0297
Test critical values:		
1% level	-2.627238	
5% level	-1.949856	
10% level	-1.611469	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(L_GDP,2)
Method: Least Squares
Date: 05/02/12 Time: 16:19
Sample (adjusted): 2002Q3 2011Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(L_GDP(-1))	-0.224996	0.103081	-2.182710	0.0355

R-squared	0.113595	Mean dependent var	-0.000206
Adjusted R-squared	0.113595	S.D. dependent var	0.008965
S.E. of regression	0.008441	Akaike info criterion	-6.685546
Sum squared resid	0.002636	Schwarz criterion	-6.642451
Log likelihood	128.0254	Hannan-Quinn criter.	-6.670213
Durbin-Watson stat	2.137473		

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

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.259827	0.4446
Test critical values:		
1% level	-4.219126	
5% level	-3.533083	
10% level	-3.198312	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(UNEMP)
 Method: Least Squares
 Date: 05/02/12 Time: 16:20
 Sample (adjusted): 2002Q3 2011Q4
 Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UNEMP(-1)	-0.097605	0.043191	-2.259827	0.0304
D(UNEMP(-1))	0.675819	0.126271	5.352111	0.0000
C	0.007737	0.003555	2.176562	0.0366
@TREND(2002Q1)	-4.83E-05	4.73E-05	-1.019687	0.3151
R-squared	0.472222	Mean dependent var		-0.000132
Adjusted R-squared	0.425653	S.D. dependent var		0.003779
S.E. of regression	0.002864	Akaike info criterion		-8.774003
Sum squared resid	0.000279	Schwarz criterion		-8.601626
Log likelihood	170.7061	Hannan-Quinn criter.		-8.712673
F-statistic	10.14034	Durbin-Watson stat		2.341200
Prob(F-statistic)	0.000064			

Null Hypothesis: D(UNEMP) has a unit root
 Exogenous: None
 Lag Length: 0 (Automatic - based on SIC, maxlag=9)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-2.943028	0.0043
Test critical values:		
1% level	-2.627238	
5% level	-1.949856	
10% level	-1.611469	

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

Augmented Dickey-Fuller Test Equation
 Dependent Variable: D(UNEMP,2)
 Method: Least Squares
 Date: 05/02/12 Time: 16:20
 Sample (adjusted): 2002Q3 2011Q4
 Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UNEMP(-1))	-0.375165	0.127476	-2.943028	0.0056
R-squared	0.189089	Mean dependent var		8.77E-05
Adjusted R-squared	0.189089	S.D. dependent var		0.003270
S.E. of regression	0.002944	Akaike info criterion		-8.791952
Sum squared resid	0.000321	Schwarz criterion		-8.748857

Log likelihood 168.0471 Hannan-Quinn criter. -8.776619
Durbin-Watson stat 2.102654

2. VAR estimation

Vector Autoregression Estimates

Date: 05/02/12 Time: 16:29

Sample (adjusted): 2002Q4 2011Q4

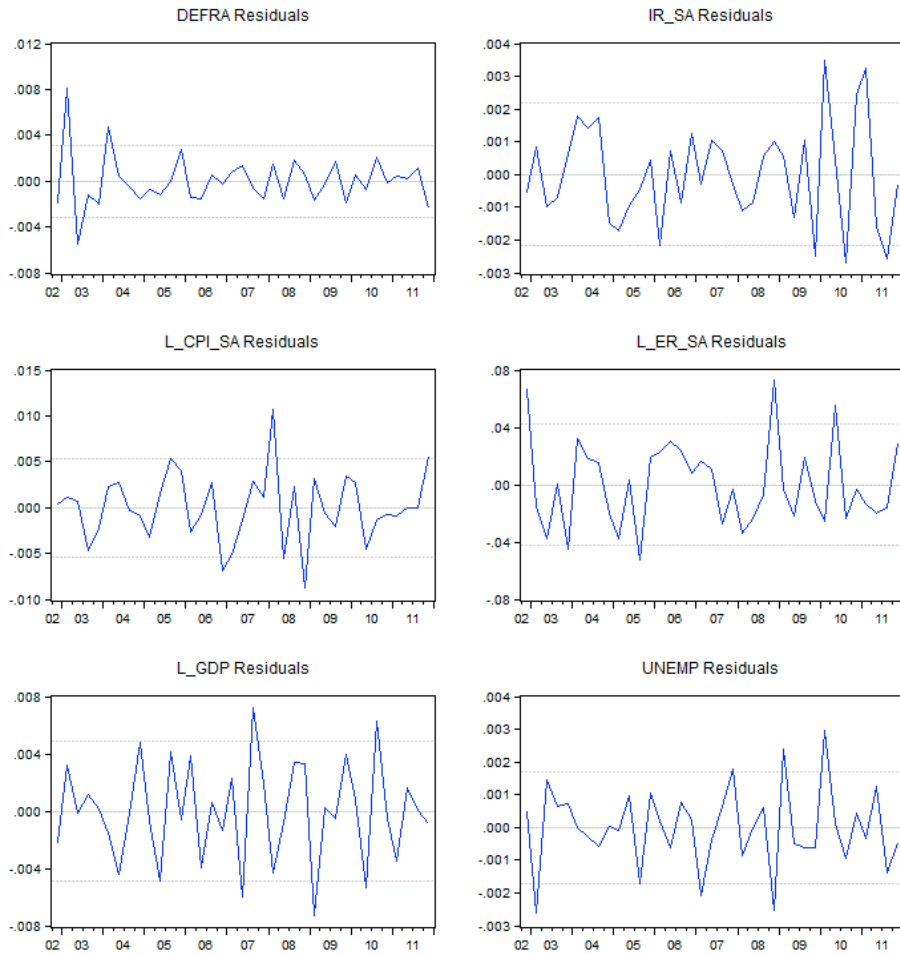
Included observations: 37 after adjustments

Standard errors in ()& t-statistics in []

	DEFRA	IR_SA	L_CPI_SA	L_ER_SA	L_GDP	UNEMP
DEFRA(-1)	0.581111 (0.20060) [2.89690]	-0.258317 (0.13873) [-1.86203]	-0.129058 (0.34177) [-0.37761]	-0.255344 (2.69017) [-0.09492]	0.392357 (0.31148) [1.25965]	-0.172701 (0.10904) [-1.58382]
DEFRA(-2)	-0.167383 (0.22449) [-0.74562]	0.289990 (0.15525) [1.86788]	0.296466 (0.38248) [0.77512]	1.673061 (3.01056) [0.55573]	0.192770 (0.34858) [0.55302]	-0.076042 (0.12203) [-0.62316]
DEFRA(-3)	0.296355 (0.16571) [1.78836]	0.082321 (0.11460) [0.71831]	0.428246 (0.28234) [1.51679]	-1.655108 (2.22234) [-0.74476]	0.059144 (0.25731) [0.22985]	-0.130687 (0.09008) [-1.45081]
IR_SA(-1)	0.003640 (0.27888) [0.01305]	0.877168 (0.19287) [4.54804]	0.694610 (0.47515) [1.46188]	-2.606302 (3.74001) [-0.69687]	-0.225874 (0.43304) [-0.52161]	-0.135961 (0.15159) [-0.89688]
IR_SA(-2)	0.065480 (0.36837) [0.17776]	-0.105330 (0.25476) [-0.41345]	-0.374749 (0.62762) [-0.59709]	1.701576 (4.94017) [0.34444]	-0.509917 (0.57200) [-0.89147]	-0.129069 (0.20024) [-0.64457]
IR_SA(-3)	0.289216 (0.25372) [1.13990]	-0.043803 (0.17547) [-0.24963]	0.415940 (0.43228) [0.96219]	-0.919943 (3.40260) [-0.27036]	1.342299 (0.39397) [3.40713]	-0.196225 (0.13792) [-1.42276]
L_CPI_SA(-1)	0.029997 (0.13402) [0.22382]	0.049896 (0.09269) [0.53833]	1.010554 (0.22834) [4.42563]	-1.282248 (1.79732) [-0.71342]	0.098171 (0.20810) [0.47174]	0.137749 (0.07285) [1.89083]
L_CPI_SA(-2)	0.170486 (0.18658) [0.91373]	-0.021505 (0.12904) [-0.16666]	-0.307304 (0.31789) [-0.96668]	-1.901308 (2.50222) [-0.75985]	0.124027 (0.28972) [0.42809]	-0.152809 (0.10142) [-1.50665]
L_CPI_SA(-3)	-0.035470 (0.14732) [-0.24077]	-0.129300 (0.10189) [-1.26908]	-0.143389 (0.25101) [-0.57126]	2.950896 (1.97572) [1.49358]	-0.886493 (0.22876) [-3.87524]	0.283409 (0.08008) [3.53897]
L_ER_SA(-1)	0.049802 (0.01884) [2.64274]	-0.001289 (0.01303) [-0.09893]	-0.045404 (0.03211) [-1.41413]	0.942204 (0.25273) [3.72817]	-0.085628 (0.02926) [-2.92629]	0.009313 (0.01024) [0.90910]

L_ER_SA(-2)	-0.028045 (0.02196) [-1.27681]	0.016282 (0.01519) [1.07188]	0.051236 (0.03742) [1.36909]	-0.784658 (0.29457) [-2.66377]	0.088590 (0.03411) [2.59746]	-0.003128 (0.01194) [-0.26202]
L_ER_SA(-3)	0.035278 (0.02013) [1.75238]	-0.023902 (0.01392) [-1.71677]	-0.086378 (0.03430) [-2.51831]	0.140333 (0.26998) [0.51978]	-0.006992 (0.03126) [-0.22368]	0.005795 (0.01094) [0.52957]
L_GDP(-1)	0.003707 (0.12186) [0.03042]	-0.116719 (0.08428) [-1.38494]	0.269658 (0.20763) [1.29876]	-0.852557 (1.63428) [-0.52167]	0.822695 (0.18922) [4.34772]	-0.160574 (0.06624) [-2.42403]
L_GDP(-2)	0.163315 (0.17319) [0.94296]	0.151758 (0.11978) [1.26701]	-0.014087 (0.29508) [-0.04774]	0.995760 (2.32266) [0.42871]	0.480270 (0.26893) [1.78587]	-0.142163 (0.09414) [-1.51004]
L_GDP(-3)	-0.148228 (0.12573) [-1.17893]	0.031331 (0.08695) [0.36032]	0.024120 (0.21422) [0.11260]	-1.230643 (1.68615) [-0.72985]	0.241419 (0.19523) [1.23659]	0.060111 (0.06834) [0.87953]
UNEMP(-1)	0.472900 (0.37663) [1.25563]	-0.076642 (0.26047) [-0.29425]	0.382139 (0.64169) [0.59552]	0.137832 (5.05084) [0.02729]	1.326018 (0.58481) [2.26744]	0.274834 (0.20473) [1.34244]
UNEMP(-2)	-0.252390 (0.46586) [-0.54177]	0.536557 (0.32218) [1.66541]	0.604268 (0.79372) [0.76131]	-3.088746 (6.24754) [-0.49439]	1.103706 (0.72337) [1.52579]	0.196357 (0.25323) [0.77540]
UNEMP(-3)	-0.140248 (0.30183) [-0.46466]	-0.449246 (0.20874) [-2.15222]	-0.669728 (0.51424) [-1.30235]	1.759468 (4.04773) [0.43468]	-1.008892 (0.46866) [-2.15269]	0.093606 (0.16407) [0.57054]
C	-1.185233 (0.58193) [-2.03671]	-0.316375 (0.40245) [-0.78612]	-1.232402 (0.99149) [-1.24298]	16.84074 (7.80420) [2.15791]	-3.762416 (0.90361) [-4.16378]	1.778004 (0.31633) [5.62075]
R-squared	0.983210	0.911575	0.997410	0.973008	0.998789	0.990586
Adj. R-squared	0.966420	0.823151	0.994819	0.946016	0.997578	0.981172
Sum sq. resid	0.000178	8.51E-05	0.000517	0.032011	0.000429	5.26E-05
S.E. equation	0.003145	0.002175	0.005358	0.042171	0.004883	0.001709
F-statistic	58.55894	10.30908	385.0443	36.04779	824.6831	105.2271
Log likelihood	174.0264	187.6713	154.3110	77.97218	157.7451	196.5807
Akaike AIC	-8.379806	-9.117365	-7.314111	-3.187685	-7.499733	-9.598956
Schwarz SC	-7.552578	-8.290137	-6.486883	-2.360457	-6.672505	-8.771728
Mean dependent	0.049808	0.041848	4.664183	3.064164	12.34704	0.068739
S.D. dependent	0.017160	0.005171	0.074435	0.181502	0.099210	0.012457
Determinant resid covariance (dof adj.)		6.79E-29				
Determinant resid covariance		9.00E-31				
Log likelihood		964.8702				
Akaike information criterion		-45.99298				
Schwarz criterion		-41.02961				

2.1 Residuals of VAR estimation



3. Cointegration test

Date: 05/02/12 Time: 16:40
 Sample: 2002Q1 2011Q4
 Included observations: 37
 Series: DEFRA IR_SA L_CPI_SA L_ER_SA L_GDP UNEMP
 Lags interval: 1 to 2

Selected
 (0.05 level*)
 Number of
 Cointegrating
 Relations by
 Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept

	No Trend	No Trend	No Trend	Trend	Trend
Trace	5	6	5	6	6
Max-Eig	2	6	5	6	3

*Critical values based on MacKinnon-Haug-Michelis (1999)

Information
Criteria by
Rank and
Model

Data Trend:	None	None	Linear	Linear	Quadratic
Rank or No. of CEs	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend

	Log Likelihood by Rank (rows) and Model (columns)				
0	862.9435	862.9435	869.7664	869.7664	878.2718
1	888.5351	898.2404	904.7877	907.8860	916.2510
2	907.7350	921.1512	927.1884	930.6068	938.9717
3	919.3665	939.2476	945.0974	952.5648	958.6440
4	928.8597	950.4642	955.6956	967.1690	969.6475
5	936.4060	959.6059	963.8715	976.8957	977.4643
6	936.7383	964.8702	964.8702	984.7125	984.7125

	Akaike Information Criteria by Rank (rows) and Model (columns)				
0	-42.75370	-42.75370	-42.79819	-42.79819	-42.93361
1	-43.48838	-43.95894	-44.04258	-44.15600	-44.33789
2	-43.87757	-44.49466	-44.60478	-44.68145	-44.91739
3	-43.85765	-44.77014	-44.92418	-45.16566	-45.33211*
4	-43.72215	-44.67374	-44.84841	-45.25238	-45.27824
5	-43.48141	-44.46518	-44.64170	-45.07544	-45.05213
6	-42.85072	-44.04704	-44.04704	-44.79527	-44.79527

	Schwarz Criteria by Rank (rows) and Model (columns)				
0	-39.61894	-39.61894	-39.40220	-39.40220	-39.27639
1	-39.83116	-40.25818*	-40.12413	-40.19401	-40.15821
2	-39.69789	-40.22791	-40.16387	-40.15346	-40.21525
3	-39.15551	-39.93739	-39.96081	-40.07168	-40.10751
4	-38.49755	-39.27499	-39.36258	-39.59240	-39.53118
5	-37.73435	-38.50043	-38.63342	-38.84946	-38.78261
6	-36.58120	-37.51629	-37.51629	-38.00329	-38.00329