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A STUDY TO ASCERTAIN THE MACROECONOMIC LEADING
INDICATORS OF THE FINANCIAL CRISIS OF 2008–2009 IN SELECTED
DEVELOPING COUNTRIES USING A PARAMETRIC EARLY WARNING
SYSTEM

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A Study to Ascertain the Macroeconomic Leading Indicators of the Financial Crisis of 2008-2009 in Selected Developing Countries Using a Parametric Early Warning System.

Seçili Gelişmekte Olan Ülkelerde 2008-2009 Finansal Krizinin Makro Ekonomik Öncü Göstergelerini Parametrik Erken Uyarı Sistemi Kullanarak Belirlemeye Yönelik Çalışma

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ABBREVIATIONS

AIC : Akaike information criterion

CDF : Cumulative Distribution Function

CDO : Collateralized debt obligations

CDS : Credit Default Swaps

EMPI : Exchange Market Pressure Index

EWS : Early Warning System

FED : Federal Reserve System

HP : Hodrick-Prescott

GDP : Gross Domestic Product

GSE : Government Sponsored Enterprises

IMF : International Monetary Fund

EU : European Union

MLE : Maximum Likelihood Estimation

MBS : Mortgage backed securities

NBER : National Bureau of Economic Research

OECD : Organization for Economic Co-operation and Development

SIC : Schwarz information criterion

SPE : Special purpose entities

SSNR : Social Science Research Network

US : United States

LIST OF SYMBOLS

β	.....	Regression coefficient
Σ	.....	Sum
Π	.....	Multiplication
E	.....	Expected value function
$M1$	.....	Narrow type money supply
$M2$	Intermediate type money supply
$M3$	Broad type money supply
P	Probability
Y	Dependent variable

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ABSTRACT

The objective of the study herein presented is to ascertain both the macroeconomic as well as the financial indicators of the financial crisis of 2008-09 in selected developing countries using binary-multivariate logit econometric model which is a type of Early Warning Systems (EWSs). Data covers the period of 1980-2016 from eight developing countries. We first estimate a plain regression equation, then we estimate three different regression equations by employing data transformation, using country fixed effects and omitting data after crisis years (post-crisis bias correction). Our purpose is also to investigate the effects of these improvements to the significance of variables.

Results indicate that apparent declines in real gross domestic growth (GDP) and nominal exchange rate (local currency appreciation) are strongly interconnected to the likelihood of occurrence of global financial crash in developing countries. In terms of the financial variables, increasing domestic credit growth could be regarded as a predictor of crisis with 5% level of significance. An increase in credit to private sector/GDP is a significant predictor of the crisis at %1 level in the post-crisis bias correction regression. Data transformations, country fixed effects and post-crisis bias correction additions to the regression contributes to the total significance levels of most variables weakly and similarly. Results confirm the importance of some basic macroeconomic variables and financial liberalization type of financial indicators about determining financial crises. As previously shown in literature, we also show the hazardous effect of credit booms to the health of the economies of developing countries.

Keywords: logistic regression, economic indicators, early warning systems, financial crises, international finance

ÖZET

Bu çalışmanın amacı global ekonomik krizin gelişmekte olan ülkelerdeki makroekonomik ve finansal öncü göstergelerini bir erken uyarı sistemi türü olan ikili bağımlı değişkenli-çoklu bağımsız değişkenli lojistik regresyon modeli ile belirlemektir. Çalışmanın verileri 1980-2016 dönemini kapsamakta ve 8 farklı gelişmekte olan ülkeyi içermektedir. Yalnızca sade bir regresyon tahmini yapılmamış olup ayrıca veri transformasyonu içeren (standardizasyon ve/veya log alma), ülke sabit etkiler değişkenini içeren, kriz sonrası sapmanın düzeltilmesini (kriz sonrası yılların verisinin silinmesini) içeren lojistik regresyonlar ayrı ayrı hesaplanmıştır. Aynı zamanda amacımız söz konusu geliştirmelerin değişkenlerin anlamlılık düzeyine etkilerini tespit etmektir.

Sonuçlar incelendiğinde belirgin biçimde azalan reel gayrisafi milli hasıla büyümesinin ve kur seviyesinin (yerel para değer artışı) global finansal krizin gelişmekte olan ülkelerdeki ortaya çıkabilirliği ile güçlü bir şekilde ilişkili olduğu görülmüştür. Finansal veriler incelendiğinde ise artan yurtiçi kredilerdeki büyümenin %5 anlamlılık düzeyinde tahmin gücüne sahip bir belirleyici faktör olabileceği tespit edilmiştir. Özel sektör kredileri/Gayrisafi yurtiçi hasıla verisi kriz sonrası sapmanın düzeltilmesini içeren regresyonda %1 anlamlılık düzeyinde krizi tahmin etmektedir. Veri transformasyonu, ülke sabit etkileri değişkeni veya kriz sonrası sapmanın düzeltilmesi ilavelerinin düz regresyona ayrı ayrı uygulanması, değişkenlerin toplam tahmin güçleri üzerinde benzer ve zayıf katkılar yapmıştır. Sonuçlar bazı temel makroekonomik değişkenlerin ve finansal liberalleşme ifade eden bazı finansal değişkenlerin finansal krizleri işaret etmek konusundaki önemini teyit etmiştir. Sonuçlarımız literatür ile uyumlu olarak kredi balonlarının krizlerin oluşması açısından gelişmekte olan ülkelerde de tehlike yaratan durumlar olarak tanımlanabileceğini göstermiştir.

Anahtar Sözcükler: lojistik regresyon, ekonomik göstergeler, erken uyarı sistemleri, finansal krizler, uluslararası finans

INTRODUCTION

Governments and communities are struggling with financial crises from past to present. The last financial crisis of the world unsettled the economies of many countries. The financial crisis of 2008-09 that began as a banking sector crisis in the United States (US) reminded the importance of crises to scientists and policy makers. According to Racickas and Vasiliauskaite (2012) the recent crises are more severe and important due to rising globalization of financial sectors. When the frequency of crises (bank, currency and twin crises) are evaluated, the emerging countries' frequency is more than the double of the industrialized countries' frequency between 1973-1997 confirming that crisis concept can be named as an emerging markets' issue (Bordo, Eichengreen, Klingebiel and Martinez-Peria, 2001). Although the crisis of 2008-09 began in industrialized countries, emerging markets also deserve to be investigated in relation to the global crisis. The consequences of a financial crash with its costs as well as its effects to economic activity are serious events for both emerging and developed countries. Policy makers and economists want to prevent financial crises. Researchers studied the causes, signals and the underlying mechanisms of crises (Demirgüç-Kunt and Detragiache, 1998). Hence, predicting the crises with early warning systems are of great importance.

The pioneering and keystone study which used the logistic regression type of early warning systems for banking crises within the context of emerging and developed countries is Demirgüç-Kunt and Detragiache's (1998). Results have shown that while a great decrease in real GDP growth is significant at 1% level in every regression; inflation is also significant at 1% level in three of them and significant at 5% level in five of the regressions. From the financial liberalization indicators; real interest rate is strongly and positively associated to the possibility of crisis while M2/reserves is significant at 1% level in half of the regressions. Another important study is performed by Davis and Karim (2008) who discovered that the real GDP growth together with the terms of trade are significant at 1% level

with negative sign. The credit growth and deposit insurance interaction term had also 1%, 5% and 10% significancies changing due to the lag level. They also compared the logit and signal approaches and found that logit models are proper for global EWSs (Early Warning Systems). In Ganioglu's (2013) study for developing countries, results indicate that domestic credit supplied by banks to private sector/GDP has a positive sign and 1% significance level.

This paper aims to address not only the macroeconomic but also the financial determinants of the crash of 2008 and 2009 in emerging countries. The method is binary-multivariate logistic regression. Our study included only selected emerging countries and focused only on global financial crisis of 2008-09. After the logit estimation is done, the logit with logged-standardized estimation, logit with country fixed effects estimation and logit with correction of post-crisis bias estimations are done separately to compare them with first estimation. On the single variable side; most distinct difference is from correction estimate in which credit to private sector/GDP has risen from 10% to 1% level of significance level. The mentioned variable had turned from 10% to 5% in the fixed effects and standardized estimations. These additions had provided small advantages to plain estimation that was not parallel to our expectations. Results indicate that real GDP growth decrease and nominal appreciation are strong indicators of global crash in the selected emerging countries. Also, the two years lagged domestic credit growth have a positive sign and 5% significance level and credit to private sector/GDP is significant at 1% level in one of the estimates with the expected sign.

Although the literature about financial crises is exhaustive, the global financial crisis of 2008-09 is relatively a recent issue. Studies about banking sector as well as currency crises with EWSs in emerging markets are clustered between 1995-2007 and the studies that contain the determination of predictors of global financial crisis for emerging countries are few. This paper also includes a wide period of time series between 1980-2016. In some papers from recent literature that worked on emerging countries; the countries are often selected from 1 region like

Asian countries or European Union (E.U.) candidate countries. Our paper contains emerging countries from almost all continents.

The organization of this study is as follows. The second chapter presents the definition, importance as well as the types of financial crises. It also gives place to the types of EWSs and the appearance and causes of subprime crisis and features of global crisis of 2008-09. Chapter 3 contains the theoretical overview of banking crises and literature of logistic regression type of early warning systems that focus on banking as well as currency crises. Chapter 4 not only describes the methodology and data sample, but also presents the results of the analysis. Chapter 5 concludes the paper.

CHAPTER 1

FINANCIAL CRISES AND EARLY WARNING SYSTEMS(EWSs)

1.1. FINANCIAL CRISES

A financial crisis can be explained briefly as a sharp decline in asset prices and the insolvency of financial actors together with a strong turmoil in financial markets which lead to a disorder in capital allocation ability of the financial system (Eichengreen and Portes, 1987). It is usually a mix of some situations which include severe movements in asset and credit markets, serious balance sheet problems, disruptions in financial intermediation, bank runs, government support needs of financial system (Claessens and Köse, 2013). However, Friedman and Schwartz (1963) related financial crises with banking panics while Mishkin (1994) emphasized on the increase and deepening of adverse selection together with moral hazard issues within financial markets.

Although some crises have idiosyncratic characteristics, several common features of financial crises enable them to be divided into various categories. They are essentially separated into four distinct types; currency crises, banking crises,

debt crises and balance of payments crises (Claessens and Köse, 2013). Some papers by International Monetary Fund's (IMF) (1998) add systemic crisis to above classification. Some mention the systemic banking crisis type when the classification is done according to the scale of crises like Racickas and Vasiliauskaite (2012). Systemic financial crisis creates an impact on the financial system that causes damaging effects to the efficiency of the financial system members. Contagion, effects on economic output as well as the need for policy response are some features (Marshall, 1998).

Regardless of the definitions and types financial crises leave huge social, economic and political costs behind. For example, increases in unemployment, losses in output, large declines in investment and incomes, increasing poverty, inequalities, social tensions, political and social imbalances are some consequences. Restructuring costs and bailout costs can reach to worrying levels. Reinhart and Rogoff (2009) points out that official government debt rises 86% averagely ensuing a financial crisis, what's more: its mostly due to the large declines in tax revenues interconnected with financial crisis. Furthermore, financial crises can initiate recessions and the ones that are interconnected with financial crises can be deeper than the others (Claessens, Köse, and Terrones, 2009 and 2012).

Banking sector crises, as are the other types of crises, are serious events that threat the economic health of countries, regions and the world. Banking crises are costlier than currency crises and their recovery periods are larger than the currency crises' periods (IMF, 1998). Banking crises have another troublesome feature that it can precede a currency crisis which is called as the twin crises introduced and revealed by Kaminsky and Reinhart (1999). Currency crises can be defined as an annual depreciation of currency that is equal to or exceeds 15%. Currency crises are events that have large and severe costs to general economy. They are the crises that include attacks to local currency and a large depreciation or a fast erosion in foreign reserves or a surge in interest rates (Claessens and Köse, 2013). Currency crises are frequently appearing in developing countries for the last 15 years of 20th

century and turned into an easily expanding phenomenon. Currency crises not only caused serious output losses but also reduced the confidence of investors to emerging countries in general; these crises sometimes spread regionally or globally. 1994 Mexico crisis affected the Latin America region. The 1997 Asian crisis triggered 1998 Russian crisis which then triggered 1999 Brazil crisis (Dabrowski, 2002).

The frequency of financial crises has increased since 1970's owing to the effects of the collapse of Bretton Woods system as well as the growing size of financial markets. This rise in frequency together with the devastating effects of crises induce a growing concern about understanding, predicting and preventing them among researchers and economists. Government policymakers need to make more effort on limiting and avoiding financial crises and to cope with costs of them. As a result, international institutions and some central banks developed and worked on early warning systems so as to anticipate crises. Through 1990s increases in the appearance of the banking crises are observed. Reinhart and Rogoff (2009) documented that banking crises are more frequent after 1973.

The most detrimental economic crash in the world after the Great Depression, the global financial crisis of 2008-09 caused world GDP per capita to decline 2,9% in 2009. World fiscal balance to GDP moved from 2005 level of -0,9% to -6,3% in 2009.

The last global crisis showed that financial crises are becoming more severe and expansionary and also reminded again the importance of EWSs.

1.2. THE EARLY WARNING SYSTEMS

In respect to detecting the leading signs of crises, the early warning systems are the most frequently used frameworks. The methods used in early warning systems are categorized into parametric and non-parametric methods. Most commonly used parametric methods are the ones that use discrete choice of

econometric regressions with a probit or logit approach. It can be named also as limited regression approach or limited dependent variable model approach. Limited term is the expression of dependent variable value that is restricted. Binary variable is an example to this type; $Y \in \{0,1\}$. The aim is to find the likelihood of incidence of financial crisis. One of the earliest studies is done by Frankel and Rose (1996), who employed probit model for crises. Logit/probit models give advantages of analyzing the impact of every different variable on the crisis likelihood (Gaytan and Johnson, 2002). By employing logit or probit models, researchers forecast the likelihood of crises by using different link functions.

Logistic regression model has some advantages and disadvantages like the other models. First, it is simpler and quicker than others. Second, it is not necessary to distribute the explanatory variables normally (makes it more robust) and variances in each group don't have to be equal. Third, it is proper for discrete dependent variables. Fourth, it does not assume linear relationship between explanatory variables and response variables. Fifth it "may" cope with non-linear effects. Sixth, logistic regression is better when you remove variables that are unrelated to the response variable and also variables that are correlated or alike (Like linear regression does). First disadvantage is that it cannot detect more complicated relationships. Second it can't deal with big numbers of categorical variables. Third disadvantage is the incidental parameter problem (bias) that takes place when fixed effects are implemented (Verbeek, 2004). Fourth is the problem of separation or quasi-separation which may occur in the models with categorical outcome. And if it cannot be solved, the problem avoids to calculate fixed effects. Fifth is the need for large sample size of Maximum Likelihood Estimation (MLE) especially for time periods.

The signal approach is the most frequently used type of non-parametric methods. It involves the examination of the variables during the pre- crisis period; what's more, if pre-determined threshold levels are exceeded, they signal a crisis. The leading studies that used the method are; Kaminsky, Lizondo and Reinhart

(1998) for the currency crises together with Kaminsky and Reinhart (1999) for banking crises, currency crises as well as the twin crises.

1.3. SUBPRIME CRISIS

Starting in the second half of 2007, the subprime mortgage crisis, which originated from financial markets in the United States of America, was generated by the explosion of a housing bubble. Mortgage loans with floating interest rates were serviced to excessive numbers of subprime customers which had weak repayment incentives and low incomes. They were persuaded to take on debts which were above their ability to pay by the brokers of mortgage companies. The revenue from high transaction fees in the mortgages were the motivation of the companies and banks. Continuous rise in house prices enabled borrowers to take new loans for other purposes which increased the indebtedness of households and the low mortgage interest rates encouraged them. While mortgage origination, securitization and house demand were increasing, the house prices also went up naturally.

Standard and Poor's Financial Services' Case-Shiller, U.S. national home price index was 100,00 in January 2000 and rose up to 184,61 in June 2006. During the pre-crisis period middle class and prime class households also rapidly joined the market for mortgage loan who had higher credit amounts. As a result, beginning from 2000 mortgage credit(debt) volumes increased continuously up to 2007 as shown in Figure 1.

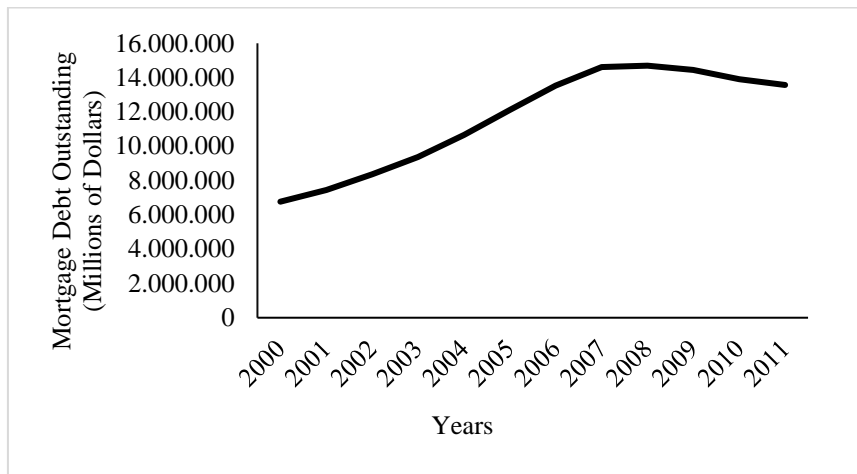


Figure 1.1. U.S. Outstanding mortgage debt progress through years. Data is from *Board of Governors of the Federal Reserve System*. <https://www.federalreserve.gov/data/mortoutstand/current.htm>

Additionally, banks securitized the mortgage loans and sold them so they could remove low-quality mortgages from their balance sheets. They established special purpose entities (SPE) to hold the mortgages and SPE is divided into shares to form the mortgage backed securities (MBS). They sold those securities to intermediary banks to be bundled in different forms and to be marketed to the investors in US and in the rest of the world. MBS were sold to banks, pension funds, hedge funds and insurance companies. Not only the MBS but also CDO (Collateralized debt obligations) were the popular derivatives during that period. Those are also a type of asset-backed securities like MBSs and the assets had the role of collaterals. Difference of CDO is that the underlying assets that can be a combination of mortgage-backed securities, real estate bonds, loans and corporate bonds. The government sponsored enterprises (GSEs) also bought mortgage loans and they created these securities and sold them. So, these enterprises could provide more money/credit to borrowers. The sellers had no problems in finding investors to sell the securities since the global liquidity had begun to rise from 2003 and continued till 2008. Eventually the rise in volume of CDO was significant; the outstanding volume in US increased 574% between 2000 and 2007. In addition, the mortgage market participants were acting as though the house prices would never

decrease. Consequently, the volume of those loans and securities increased continuously. In the meantime, banks created more complex securities. The complexity amplified the existing asymmetric information between seller of securities and investors. Investors did not know anything about the solvency of mortgage borrowers and were not aware of the risk that they had taken. Credit rating agencies contributed to the process by giving high ratings to those risky instruments.

Another subject was the derivatives tools referred to as credit default swaps (CDS) highly used during the period in question. In appearance, they were used to insure the default risk of the sellers/issuers. But in fact, even some financial companies which did not have any security trade relationship with the issuer bank bought the CDS for the default risk of those banks: manipulators were in charge (Stiglitz, 2010). Some CDO holders bought CDS to be able to buy more CDO. In the end CDS volume was so large that when the market collapsed the world's number one American insurance company had no enough capacity to pay the claims on structured securities and was on the edge of bankruptcy before rescue by the government.

Lack of strong financial regulations let the hazardous course continue and accelerate. There were no limits for issuance of structured products. Besides, before cancellation, the Glass-Steagall act was keeping commercial banks away from capital markets. Cancellation of the act caused the commercial banks to enter into very risky businesses that investment banks did before. Cancelling also allowed merger of commercial and investment banks. They became "too big to fail". Knowing they could get rescued with the help of the state, big banks did not necessarily avoid doing dangerous business (Stiglitz, 2010).

Interest rate increases were initiated in 2004 by Federal Reserve System (FED) to avoid possible inflation. In June 2004 FED funds rate was 1.25% and in June 2006 rate reached to 5.25%. The process increased the monthly interest

payments of outstanding mortgage loans. Subprime mortgage loans began to default. When sub-prime defaults grow up, banks ceased lending and house prices began to decrease. Banks foreclosed on the houses but sold them to prices which were lower than the loan amounts and eventually banks faced losses. Delinquency rates of middle and prime class loans also began to increase. MBS and CDO values went down rapidly and trade stopped in the secondary market. Those securities began to be called toxic assets. Asset side of bank balance sheets deteriorated. Liquidity problems began to occur in financial system. The 85-year-old investment bank Bear Stearns posted loss of 854 million dollars for the last quarter of 2007 which stemmed from mortgage-related write-downs. On March 16, 2008 J.P. Morgan Chase declared the decision of buying Bear Stearns with the help of FED so that it could avoid bankruptcy. Confidence between banks disappeared after these events. They stopped lending each other. Liquidity problems deepened. One of the biggest investment banks, Lehman Brothers, declared bankruptcy in 2008, which resulted in a stock market crash in US and on September 25th, 2008 Dow Jones declined 778 points. It was the largest one-day point drop in history. Between 2008 and 2012, 465 banks were closed in United States. By the way, the two well-known American GSEs were saved from collapse in last quarter of 2008 by the U.S. government.

1.4. GLOBAL FINANCIAL CRISIS

The subprime mortgage crisis beginning within a specific part of American financial markets rapidly grew into a global crash. The European, Asian together with Oceanian financial institutions were holding these toxic instruments and some European countries also had the house price bubbles. In every continent of the world, banks had owned those toxic instruments. Japan, Indonesia, Germany, New Zealand were some examples of countries whose financial market participants bought securities from mortgage markets in US. The transmission was inevitable. As a result, it turned out to be a global financial crash.

Furthermore, some emerging countries like Estonia, India, South Africa, Czech Republic, China, Argentina and Hungary had housing bubbles before 2007 (Cesa-Bianchi, Cespedes, and Rebucci, 2015).

These realities led the crisis to expand to the world financial system. United Kingdom government recapitalized eight of the banks in country. Iceland government had to nationalize largest three banks of the country. Hungary was the one that asked help of International Monetary Fund (IMF). Japan entered into a deep recession and stock market crashed. South Korean capital account deficit reached to 20% of gross domestic product. Malaysian export amount declined 45%. Many more examples regarding similar effects of the crisis followed all around the world.

Although the crisis was an incident of industrialized countries, the developing countries or small and open countries were also affected by a certain degree (Rose and Spiegel, 2009). Some early literature like Naude (2009) described the developing countries as more immune to the crisis but after a while and with different point of view, other researches like Didier, Hevia and Schmukler (2012) did not confirm it. They did not concentrate on the growth rates solely; they centered upon evaluating growth rates relative to the pre-crisis growth rates, industrial production data and volatility data. When they viewed the change in GDP values between 2007 and 2009, it was -7.2% for the emerging countries (low-income countries excluded) and -6.2% for the developed countries. Industrial production downturns of developed countries and emerging countries (low income excluded) during crisis were very close to 25.4% and 24 % respectively. The volatility values of GDP growth in 2009 were higher in emerging countries (5.2%) than developed ones (4.4%). These results confirm that developing countries and developed countries were both severely affected from 2008-09 global financial crash.

The transmission to developing countries occurred by a sudden stop and then reversal of capital flows to them, decreasing trade and decreasing capital of banks due to falling prices of stock market and housing (Naude, 2009). About 20 million people lost their jobs in China (Stiglitz, 2010). A negative world GDP growth occurred in 2009; -1.73% which was 4,36% in 2004. Turkey, Argentina, Hungary and Mexico had the growth rates between -4% and -6% in 2009. In some countries the deterioration in real sector was so strong that it spread to financial sector.

CHAPTER 2

THEORETICAL OVERVIEW OF BANKING CRISES AND LITERATURE REVIEW

2.1. THEORETICAL OVERVIEW OF BANKING CRISES

Although the effort to predict the banking crises is intense, banking crises are still the ones that is more complicated and harder to predict than the other types of crises. Banking sector is generally more fragile than other sectors in economy. This stem from the specific features of banks and financial intermediary role of them. They deal with the liquidity creation, lending, maturity transformation, and funding problems. They work with leveraged balance sheets. They are subject to sudden and dangerous demand of depositors which is an issue of liability section of their financial reports. In addition, the insolvency of one bank can spread to all sectors quickly. If insolvency expand to majority of the banking sector or to entire banking sector, generally a systemic banking crisis happens. Banking panics and bank runs may accompany banking crises but all banking crises does not include bank runs like Nordic banking crisis (Claessens and Köse, 2013; Demirgüç-Kunt and Detragiache, 1998). Bank runs may include factors behind or they can be associated with some fundamentals as Gorton (1988) determined.

Adverse macroeconomic factors put pressure on the banking system and when combined with the weak members of the banking sector failures and crises may occur (Gavin and Hausmann, 1996). Asset side problems like unreturned loans also cause deteriorations in the health of banks. When loans are evaluated, economic environment issues must be considered. Theory accepts that adverse economic conditions negatively affect the repayment ability of borrowers (Demirgüç-Kunt and Detragiache 1998). If fiscal balance, GDP growth rate, inflation, terms of trade values before the crisis periods are viewed, they are relevant with bank insolvency issue (Caprio and Klingebiel, 1996).

Huge decline in GDP growth can cause the increased levels of unpaid loans through the breakdown in the economic performance of borrowers. These types of loans are nowadays called the non-performing loans which reflects realization of credit risk (Gavin and Hausmann, 1996). Besides, some threshold levels of non-performing loans are also used as criteria for determining the banking crisis event itself in most of the literature.

High inflation is acknowledged to be one of the most fundamental and damaging issues in an economy. Higher inflation rates invite more fluctuations on inflation rate itself. The volatility makes it harder to anticipate the future values of inflation resulting with the unclearness of factor prices in production. This leads to declines in the efficiency of the economy and adverse effects to productivity (Friedman, M. ,1977). This happening also concludes with an unfavorable effect to the performance of the borrowers.

Terms of trade collapses or great downfalls in developing countries can adversely affect the balance sheet of banks which are substantially creditors of domestic sector through the increase in non-payable loans (Mishkin ,1996).

Financial liberalization periods with the contribution of entering funds to banks encourage financial actors to take much more risks than they did before. In

addition, there may be lack of knowledge about the newly faced risks due to low experience level. The risk-taking behavior can reach to threatening levels to financial health. Large expansion of credit volumes occurs with effect of capital inflows (Goldstein and Weatherstone, 2001; Claessens and Köse, 2013). Interest rates and/or the foreign exchange market liberalization may augment the market risk of banking sector (Honohan, 1997). Increased real interest rates and increased volatility of interest rates are often observed. If at the times of the liberalization in developing countries, there is insufficient indirect monetary policy instruments, due to booming economy real interest rates may rise (Galbis, 1993). The interest rate increase to a certain level may lead to the rising credit risk. Because in high interest rate periods the risky investment owners are more willing to borrow (Mishkin, 1996). On the other hand, during very low interest rate periods both banks and customers tend to buy riskier instruments as safe ones give extremely low yields. Low interest rate environment may comfort banks to widen too much in credit market (Rajan, 2006). For the periods before the financial crisis of 2008-09, Ioannidou, Ongena and Peydro (2009) studied empirically on the risk-taking behavior of banks in Euro area together with the United States and found that low interest rates increase the risk-taking behaviors resulting with giving loans.

During financial liberalization periods increased risks and the overheating in the economy raise the importance of government policies. Fiscal surpluses may be helpful to protect the financial health. Fiscal deficits reflect the policy mistakes of government (Davis and Karim 2008).

It is a fact that financial crises frequently come after credit booms (Gorton, 2012). Sudden credit expansions can be admitted as threats to financial systems. Some crises in the past had included credit booms in pre-crisis periods like Nordic banking crisis (1991-93), Asian region financial crisis (1997) as well as the global crash of 2008-09 (Claessens and Köse, 2013). Credit indicators are important factors to include in the studies about banking crises. Honohan (1997) suggests that sometimes banks can survive during severe macroeconomic conditions and boom-

bust cycles of economies. Occurrence of a banking crisis generally rests on the banks' behaviors during these boom times. If they behave very positively by exaggerating the lending and leading to abnormal pricing behaviors, they will contribute to increasing risks. Another banking crises example from past is Japan (1992).

External factors are important and triggering elements in banking crises in most of the developing countries (Claessens and Köse, 2013). A sudden depreciation in developing countries is seen as a stimulating factor to banking crises due to the possible debts of banks denominated in foreign currency (Mishkin, 1996). Volatility of real exchange rate force the health of banks in two ways. First through foreign liability of banks and second through impaired financial health of customers due to their foreign debts to banks (Goldstein and Turner, 1996). An appreciation may affect the competitiveness of exporters and can cause losses in exporter firms. If a correction occurs, corporates with foreign debts face risks (Hardy and Pazarbaşıoğlu (1998). So as a predictor, the volatility of real exchange rates is defined by empirical studies as the large appreciation of domestic currency before a sudden depreciation.

With large capital outflows, a pressure occurs on the domestic currency of small and semi-fixed exchange rate system of countries subjected to these flows. Government may need to protect domestic currency by selling foreign reserves. It's important for preventing currency crises. Another important point about the subject is that if a government sells the foreign reserves, this means bank's foreign assets will reduce simultaneously as the central bank's reserves mostly consist of banks required reserves. According to Kaufmann (2000) in these conditions, currency crises may trigger banking crises.

One fundamental element that shows the government's power to prevent the domestic currency is the ratio of M2/reserves. Higher ratio reflects the danger of

higher amount of money (than foreign reserves) which can be used to demand more and more foreign currency (Davis and Karim, 2008).

When there is large fiscal deficit, the banks are generally forced to buy government bonds by the authorities in emerging markets. If government bond prices decrease, there occurs a probability of deterioration of balance sheets and credit rationing may rise. Subsequently, the risks in the financial systems may increase (Joyce, 2009). Also, empirical studies indicate that strong credit growth drops are observed very short time before crisis or during crisis (Demirgüç-Kunt and Detragiache, 2005).

The possibility of sovereign default as well as banking distress can affect each other reciprocally (Acharya, Drechsler and Schnabl, 2014). As banks hold government bonds on the asset side, a debt distress or debt default causes losses and may lead to solvency problems. Government defaults may precede banking crises (Noyer, 2010; Brutti 2008). The case of Greece in 2010 can be shown as an example. Balteanu and Erce (2013) introduced the concept of twin debt-bank crises; sovereign distress triggers the banking crises. Based on the assessments, it can be said that government debt indicators are important part of banking crises studies.

2.2. LITERATURE REVIEW

One of the prominent researches in the early period, Friedman and Schwartz (1963)), referred to the role of the market participants' panic acts as the occurrence of banking crises. Kindleberger's (1973a) emphasized behavioral features of crises mostly. In other study, Kindleberger (1973b) mentioned leadership of a country to coordinate the necessary action-taking process to struggle a global crisis. Then Diamond and Dybvig (1983) focused on the bank runs together with large/sudden withdrawal of deposits. They point out that banks that have not only liabilities with short maturity but also have assets with long maturity are unstable. As a result, panic among the banks' depositors may lead them to withdraw their cash from the

deposit account and a crisis may in turn follow. These studies reflect the self-fulfilling approach that also relate the causes of crisis with the expectations of investors.

Then the fundamental-based approach (information-based approach) began to arise. Gorton (1988) was one of the first studies that find links between banking crises and fundamentals (Goldstein, 2013). Gorton (1988) searched the association between bank depositors' panic behavior and the business cycle through the risk perception of depositors. The paper showed that for the period between 1863 and 1914 in United States if failed businesses reach a critical level (as an indicator of recession) the risk perception also exceeds the threshold level and banking panics began. As a result, a relation between recession signal and banking crises can be revealed.

The earliest users of logit regression for banking sector problems did not implement the macroeconomic variables as explanatory variables. Martin (1977) studied indicators on the failure of U.S. banks. He searched the financial ratios of banks that can be obtained from balance sheets. Gross capital/risk assets and also commercial loans/aggregate loans showed substantial results.

One of the leading studies in empirical literature that find the macroeconomic and financial fundamentals of the banking crises is performed by Demirgüç-Kunt and Detragiache (1998) by using logit regression method. They worked on the systemic banking crises during 1980-1994 period in both industrialized and emerging countries by employing a binary-multivariate logit model. Since their aim was to work on all the systemic crises in the period and the systemic crisis must be distinguished from general fragilities, the systemic banking crisis variable must be identified perceptibly. So Demirgüç-Kunt and Detragiache (1998) formed a criterion using five primary and recent studies. A situation was regarded as a crisis if at least 1 of the 4 circumstances which are stated in their paper must occur. The results of their paper indicated that strong decrease in real GDP

growth lead to increased likelihood of banking crises with 1% level of significance in all regressions. Inflation increase was also significant at 1% level in predicting the likelihood of crisis in three of the regressions and significant at 5% level in five of the regressions. They found relation between crises and financial liberalization regressors also. Real interest rate showed an outcome of 1% significance level with positive sign in all the regressions while M2/reserves was significant at 1% level in half of the regressions and significant at 5% level in the other half with positive sign.

Other pioneering study was done by the Hardy and Pazarbaşıoğlu (1998) to determine the indicators of banking crises which took place in 38 countries between 1980-1997. Model was a multinomial-multivariate logit. They have done a series of regression analysis and in their third regression, dependent dummy variable took the value of 2 for crisis years, 1 for pre-crisis years and 0 for other years and the explanatory variables are lagged or non-lagged. They also had estimated two other regression functions: Regression 1, with dependent variable that took the value of 1 for pre-crisis years and 0 for other years and also regression 2 with dependent variable that took the value of 1 for crisis years and 0 for other years. They did not give place to the results of these two regressions in the paper as their results were very similar to their third regression. In “crisis” estimations of the third regression, indicated that large decline in real GDP growth and 2-years lagged/positively-signed inflation were significant at 1% level. Rise in inflation with 1-year lag and large decline in real exchange rate (large appreciation) with no lag was significant at 1% level to predict “crisis” in one of the sub-parts of third regression and significant at 5% level in the other. No-lagged real interest rate was significant at 5% level in one part and significant at 1% level in the other part with expected signs. No-lagged credit to private sector/GDP was positively significant at 5% level in one of the sub-parts. In “pre-crisis” estimations of the third regression, fall in non-lagged inflation and rise in 1-year lagged inflation were significant at 1% level. Also, a trade shock predicted the “pre-crises” periods with expected negative sign and 5% level of significance. Another estimation (fourth regression) in the same

paper searched the banking crises and banking distress in the same regression. In the fourth regression, dependent dummy variable took the value of 2 for crisis years, 1 for banking distress years without systemic crisis and 0 for other years. For “crisis” predictions, real GDP growth was significant at 1% level in all sub-parts. Differences from the third regression were that 2-years and 1-year lagged inflation rates became non-significant. Exchange rate appreciation with no lag was significant at 1% level in predicting “crisis” in all sub-parts. Trade shock was not associated with the “crisis.” Expansion of credit had no association with “crisis”. In “distress” estimations of the fourth regression, 1-year lagged inflation was significant at 5% level or 1% level with negative sign and 2-years lagged inflation was significant at 1% level. Appreciation with no lag has a 10% level of significance in predicting “distress”. Trade shock was associated with the “distress” in %5 level. No-lagged expansion of credit had negative and high association with “distress” in one of the sub-parts.

Rossi in 1999 searched the indicators of banking crisis using a binary logit model with country fixed effects for fifteen developing countries between 1990-1997. They shed light on the fact that slowing down economic growth, strong increase in credit provided to private sector and controls for capital outflows raises the likelihood of banking crises. Real interest rate (of deposits) was significant in one of the regressions they computed but with a negative sign. Rossi comments this result as; financial liberalization lowers the probability of banking crises, which is in contrast to the other studies in the literature.

Lestano, Jacobs and Kuper, G. (2003) worked on the predictors of currency, banking as well as debt crises for six Asian countries (Malaysia, Indonesia, Philippines, Singapore, South Korea, and Thailand) using a binary-multivariate logit method for the periods of 1970:01-2001:12. They had twenty-six variables that were divided into four types: external, global, domestic, as well as financial indicators. As they could not include the variables altogether in logit due to multicollinearity problem, they instead calculated five group of factors for each

type of indicators. Results indicated that; domestic real interest rate, M1 and M2 growths, growth of foreign reserves, commercial bank deposits, national savings, M2/foreign reserves as well as inflation rate were the variables that associated with banking crises.

Demirgüç-Kunt and Detragiache (2005) reviewed approaches which were used to find the determinants of the banking crises and the consequences of banking crises. In this paper, they also updated the data of their previous study of Demirgüç-Kunt and Detragiache (1998). The period covered widened to 1980–2002 from 1980-1994. The countries included reached to ninety-four from sixty-five. Results showed that real GDP growth together with real interest rate were significant at 1% level as they were in the previous study. Inflation results were a little weaker than previous study; 1% level significant in predicting the likelihood of crisis in one of the regressions and 5% level significant in four of the regressions. M2/Reserves was also a little weaker; in half of the regressions it had a significant result at 1% level and in the other half a result with 10% level. Credit to private sector/GDP was obviously stronger here; significant at 1% level in all four regressions while it was significant at 5% level in one of eight regressions and significant at 10% level in two of eight regressions in the previous study. Fiscal balance/GDP was stronger; significant at 5% level in one of two regressions while it was insignificant in all 8 regressions in previous work but the sign is unexpectedly positive.

Another remarkable study was performed by Davis and Karim (2008) in order to compare binary-multivariate logit method and signal approach method for the banking crises between 1979-2003 in hundred and five developing and developed countries. They studied logit and also tried another separate regression with transformed variables (standardization and logarithmic transformation) without fixed effects and another regression that contain added interaction variables to find the best model fit. In all forms of the model they performed (six regressions), they calculated two logits with different dependent variable definitions. First was the logit that contains Demirgüç-Kunt and Detragiache's (2005) style of banking

crisis dependent variable (first style logit) and second was the logit that contains Caprio and Klingebiel's (2003) style of banking crisis dependent variable (second style logit). They compared the regression results of these two style logits first and then they compared their double logit models with Demirgüç-Kunt and Detragiache's (2005) original study and then with the model of signal approach. The first style logit had a higher predictive ability of crises periods while the second style logit had a higher predictability in non-crises periods in general. For both logits, the crisis predictive ability was higher in regressions where standardization and logarithmic transformation were used and in the ones with interaction terms and further lags used. When comparing Demirgüç-Kunt and Detragiache's (2005) original study and Davis and Karim (2008) in terms of total prediction; first style logit outperformed Demirgüç-Kunt and Detragiache's (2005) original study while the second style logit underperformed. Finally, when logit models in their paper and signal approach model in their paper are compared Davis and Karim (2008) indicated that logistic regressions are proper for global type of EWSs while signal approach models are proper for country-specific EWSs. In their results, real GDP growth was a strong significant indicator of banking crises with negative relationship in all logit regressions they worked on. Terms of trade was not only significant at %1 level in first four regressions (variables were added step by step in the first four regressions) and had a negative sign (expected) in all of them but also it had a positive sign and insignificant result in the fifth regression which is with standardization, logarithmic transformation and more lags. The result was the same in the sixth regression which has interaction terms. After standardization (fifth regression) fiscal balance became significant at 1% level with expected negative sign and inflation became significant at 1% level (in one of the logits). The standardization process also carried private credit variable to 1% significance level from insignificance. Credit growth and deposit insurance variables were interacted in the sixth regression and calculations were done for all the lags between t and $(t-5)$. Although credit growth variable was insignificant in most of the previous regression types, when it was interacted, the interaction terms became significant in most of the lags. This shows the increasing nature of moral hazard when there is

deposit insurance. Results also showed that the interaction term is negatively signed when lags were closer to crisis (from t to $t-3$) and positively signed when lags are farther ($t-4$, $t-5$). This showed the rising risks during credit boom periods and reflects that when credit rationing starts downturn effects appear.

Barrell, Davis, Karim and Liadze (2009) worked on the banking crises in member countries of Organization for Economic Co-operation and Development (OECD) for the years between 1980 and 2006 for in sample estimation. They studied with logistic EWS on fourteen systemic and un-systemic crises and on fourteen countries. Distinct from others in literature, they did not use a variable to determine crisis periods; they collected their crisis periods from datasets of IMF and World Bank. Reason is that they think the former leads to some problems in specifying the starting and end date of crisis. They used some basic variables such as real GDP growth, real domestic credit growth as explanatory variables but differently from general tendency they also used 1-year lagged liquidity ratio (%), unweighted capital proficiency ratio (%) and 3-years lagged real property price growth (%). Results indicated that if the two bank health variables rise, the probability of banking crises fall. The real property price growth was also closely related with the appearance of banking crises according to results. It can also be said that elongated price bubbles and effusive mortgage lending might magnify the likelihood of crises.

Joyce (2009) searched the determinants of banking crisis in 20 emerging countries during the period 1976-2002. The method implemented was logit regression with time fixed effects. He used real, macroeconomic as well as financial fundamentals but also the trade and financial openness variables. He started the estimations with basic variables. Not surprisingly, real growth had 1% significance level with expected sign. Banking sector credit/GDP resulted with 5% level of significance and positive sign. After basics, trade/GDP and foreign type assets and liabilities/GDP were added, but they were all non-significant. Then the later variable was split into foreign type of assets/GDP and foreign type of

liabilities/GDP and added to their baseline regression equation. Again, the variables are found to be non-significant. In another regression, Joyce omitted foreign liabilities/GDP and instead added direct investment in foreign currency/GDP, debt in foreign currency for investments/GDP and portfolio equity/GDP; the first two showed significant results at 5% level with positive sign. Then Joyce introduced an index that is a measure of more liberal capital regime and results show that more open regime lowers the likelihood of crisis. They also tested the effect of more liberal capital regime on the duration of crisis. The results showed that if a crisis occurs in more liberal regime, the crisis will take longer time.

Barrell, Davis, Karim and Liadze (2010) again worked on systemic and un-systemic banking crises in fourteen OECD member countries. The data include the years 1980-2008. Thus, it contains the subprime crisis period. To determine the crisis periods, they benefited from the World Bank database of banking crises and definitions from Borio and Drehmann (2009). They used the same explanatory variables which they studied in 2009 with the addition of the current account balance/GDP variable. They implemented nested logit in which the process begins with all variables, and then one variable with least significant results is omitted and estimation was redone without the variable. This act was repeated until there was no insignificant variable. The bank regulatory variables; unweighted bank capital proficiency and liquid assets(narrow)/assets were significant. Also, real house price growth and current account balance/GDP ratio were the significant ones with expected signs. They also wanted to compare the mentioned indicators of all crises in fourteen countries between 1980-2008 with indicators of U.S. subprime crisis to understand if subprime was unique or not. They calculated the contributions of these four variables to the probabilities of U.S. crisis between 2005 and 2008. Results showed that all four variables had effects on U.S. crisis probability. So, according to the comparison, the previous crises and subprime are similar events.

Gourinchas and Obstfeld (2011) studied the default, banking, and currency crises with country fixed effects of binary-multivariate logit for the period 1973-

2010. They placed the dummy variables of crisis types to the equation and it took the value of 1 in wide range including crisis, pre-crisis and post-crisis times to compare tranquil times. They calculated the equation for twenty-two developed countries and fifty-seven emerging countries separately using eleven variables from real, external, domestic and financial area. Emerging countries' results for banking crises showed that increase in the ratio of domestic credit to output, the real exchange rate (appreciation), public debt/GDP (in some regressions) and decrease in ratio of reserves to GDP variables were significant at 5% level to anticipate the likelihood of banking crisis in the coming 1 year and 1-3 years' period (lags). Researchers revealed the outputs also by calculating the difference in probability of crisis (Δp , where p stand for probability) after the incidence of 1-unit standard deviation movement in the variable. This standard deviation increase in the ratio of domestic credit to output, the real exchange rate and ratio of reserves to GDP effects the banking crisis probability as increasing it by 6,4% and reducing it by 4,7% and 5,22% respectively. Output gap (the bias of the real output from trend) was significant at 5% level for the following 1-3 years' period in predicting banking crises. The effect of 1 deviation increase on the probability is 7,3% increase.

Bucevska (2011) searched the determinants of financial crisis (triad of banking, currency and debt crisis) based upon the financial crisis of 2008-09. Binary- multivariate logit model was used for the purpose. Data covered the period from Q1-2005 to Q4-2009 and E.U. candidate countries which are Turkey, Croatia and Macedonia. For the analysis the dependent variable exchange market pressure index (EMPI) analogue to the one that was developed by Eichengreen, Rose and Wyplosz (1996) is used. The index contains shifts in exchange rate and weighted shifts of reserve change and weighted interest rate differential between the countries the study considers and a center country (one industrialized country). The index dated the crisis as 1st quarter of 2009 for Turkey and 2nd quarter of 2009 for Croatia and Macedonia. Model included eleven independent variables. The model contained some frequently used independent variables from previous literature; for instance, GDP change, real interest rate and trade balance. But none of these eleven

variables had 1% level of significance. Only some variables in the model were significant at 5% level. The author asserts that the noise from large number of variables caused the aforementioned problems and omitted the non-significant variables from the model. When the number of variables dropped to seven, one variable became significant at 1% level and other variables became significant 5% level. External debt/export indicated 1% significance level with expected positive sign. In the results of paper, real effective exchange rate as a divergence from Hodrick-Prescott (HP) trend, current account deficit/GDP, bank loans/GDP, decline in bank deposits/GDP and government fiscal balance/GDP were significant at 5% level with (expected) positive sign.

Ganioglu (2013) used a logit fixed effect model to analyze the determinants of banking crises including the first year of financial crisis of 2008-09 that contained the years between 1970 and 2008 in 50 countries. She searched the determinants of banking crises separately for developing and advanced countries. Domestic credit provided by banks to private sector/GDP with 1-year lag together with current account balance/GDP with 1-year lag were found to be the strong indicators of financial crises. If it is evaluated on the basis of country types, credit variable was more significant in developed countries while the current account deficit variable was more significant in developing countries. Credit variable had a positive relationship with banking crises for developed and developing countries while current account variable had a negative relationship with banking crises for both.

Caggiano, Calice and Leonida (2013) considered countries with small income and searched the predictors of systemic banking crises that occurred between the period 1980-2008 using a multinomial multivariate - logit. The dependent variable had three possible values; 0 for tranquil periods, 1 for the first year of crises, or 2 for crises years other than the first year. They used Reinhart and Rogoff's (2009) definition of crisis to form the dependent variables. Results indicated that decrease in GDP growth, banking sector members' illiquidity as well

as large net open positions are important determinants of banking crises in lower income countries. The results emphasized the banking sector variables in predicting crises. Authors suggested that literature asserts the overperformance of multivariate logit models against signal approach models. In addition, they suggested that multinomial estimations had better results in identifying the crisis from non-crisis periods.

Anundsen, Gerdrup, Hansen and Kragh-Sorensen (2016) searched the banking and financial crises in sixteen OECD countries from 1st quarter of 1975 to 2nd quarter of 2013. The crises that they worked were mostly the banking crises. The binary logit model with country fixed effects concluded that private credit growth, change from inclination of private credit/GDP, output's change from trend as well as difference from trend of house prices/income had a high positive sign and 1% significance level about the likelihood of crisis.¹ After change from inclination of private credit/GDP is divided into two groups of non-financial enterprise credit/GDP's change from trend and household credit/GDP's change from trend, these two sub-groups also had positive and 1% level significant results about the probability of crisis. Then, global credit/GDP's bias from trend together with the global house price/income's bias from trend was added to the model. Results indicated that former had no significant effect on probability but the second one had a 1% significance level (with positive sign) on the likelihood of a crisis.

Papadopoulos, Stavroulias and Sager (2016) studied four types of estimation methods; logit, probit, linear panel regression and combined. They searched the financial crisis of 2008-09 on fifteen E.U. countries. They had quarterly based data from the first quarter of 2001 to the first quarter of 2014. Their aim was not to predict crisis itself, but to predict the pre-crisis period, seven to twelve quarters before the crisis. In the logit model, unemployment rate and the total general government expenditure were the variables that reflected significant results at 1%

¹ . Trend components are constructed using one-sided HP filter. Output growth variable indicates the log of GDP.

level. Total general government revenue was a variable that reflected 5% level significant result.

Logit models are also used in predicting the determinants of currency crises that include emerging countries. Kumar, Moorthy and Perraudin's (2002) paper is one of the most important studies in literature. They used monthly data from January 1985 to October 1999 and worked on emerging countries from six regions and four continents of the world. They used an index that contained the exchange rate changes to define the currency crashes. The numerator in the change ratio contained the investors yield if they short the domestic currency and buy U.S. bonds. The index also included domestic and foreign interest rate differentials. Index had cut-off points in 5% and 10%. Two estimations were done according to these cut-off points for unexpected depreciations. They also formulated these issues for "total" depreciations and again there is an index with cut-off points in 5% and 10%. Two estimations were done again and the total reaches to four estimations. Results of these four estimations showed that foreign exchange reserves amount, real GDP, reserves/imports, portfolio investment, debt/total debt and lagged real effective exchange rate are significant variables. Reserves/imports, portfolio investment, real GDP, foreign exchange reserve amount as well as debt/total debt have negative signs in all of the estimates.

Another important paper by Bussiere and Fratzscher (2002) searched currency crises of emerging countries with a wide number of indicators which contain external, domestic, financial (real) and public sector variables and also global factor and contagion variables using a pool logit model with thirty-two countries. They aimed to see the effects of using big numbers of variables on the crisis's prediction. To define currency crises, they used EMPI. The index contained average of the change of the real effective exchange rate, change in the interest rate and change in foreign exchange reserves. The financial contagion variable showed significant results for 32 countries. They also checked the model with twenty central countries and it gave better results in terms of predictive power of crises. In

addition, to compare the two, they used multi-nominal logit with three dummy variables (a normal time period, a pre-crisis period, and a post-crisis/recovery period) working on 20 countries for the years between 1993 and 2001. Dependent dummy variable took the value of 1 for pre-crisis years (12 months before the crisis) and 2 for post-crisis years (12 months after the end of crisis) and 0 for the other years. The reason for this specification was to omit post-crisis bias which is the abnormal behaviors of variables in the recovery (post-crisis) periods that may affect the results. As a result, multi-nominal performed better than pooled logit. From the in-sample results, when dummy variable is equal to 1, exchange rate overvaluation, credit to the private sector (lending boom), ratio of short-term debt to reserves, contagion of financial system, current account balance/GDP and real GDP growth variables had 1% significance level in predicting the currency crises. All had correct signs. Current account balance/GDP and GDP growth variables were negatively associated and others positively. When the dummy variable is equal to 2, the same variables were significant at 1% level except current account/GDP. All had positive sign except real GDP growth and exchange rate. Only the exchange rate variable's sign was not the expected one.

Lestano, Jacobs and Kuper, G.'s (2003) study which is mentioned above had also results for currency crises. They used four methods to identify the currency crisis dates. Methods were adopted from the important studies of previous literature with small changes. They used the logit as a model. M1 and M2 growths and commercial bank deposits variables were significant for all currency crises identification models. Growth of foreign reserves and global indicators (change in world oil prices, U.S. interest rates together with OECD countries GDP growth) were significant in three of currency crises models and only insignificant in Frankel and Rose (1996) model. The local real interest rate and inflation rate variables were significant in the Kaminsky, Lizondo and Reinhart (1998) as well as the Frankel and Rose (1996) versions of the currency model and insignificant in the other two.

Gourinchas and Obstfeld's (2011) study that we mentioned in banking crisis part of our literature review section had also a part in which estimations are done to evaluate currency crisis. The results revealed that the domestic credit/output and reserves/GDP were significant in predicting crises with one-year (lag). One standard deviation increase in domestic credit/output and reserves/GDP increased the currency crisis probability by 9.4% and decreased it by 5.4% respectively. Real exchange rate was significant for the crisis following one-to-three years lag. One standard deviation increase in real exchange rate decreased the currency crisis probability by 2.5%.

Comelli (2013) worked on parametric style as well as non-parametric style estimations and compared them on the basis of currency crises that are experienced by emerging countries. For parametric EWS he used binary logistic regression with fixed effects. To identify the currency crises, he used the exchange rate pressure index. It contains the differences in exchange rate (nominal) of country currency and weighted differences in the amount of foreign reserves of country. He found that real GDP growth rate, the current account amount /GDP, growth of foreign exchange reserves, money amount/foreign exchange reserves, and foreign exchange reserve amount/external debt with short maturity shows important predicting powers of crises in both types of EWSs. In logistic regression all coefficient signs were as expected; money amount/foreign exchange reserves with positive sign and all others with negative sign.

CHAPTER 3

THE ANALYSES

3.1. DATA AND VARIABLES

3.1.1. Data

The data set consists of panel data that includes annual observations for eight countries starting from 1979 to 2016. All countries in the sample are chosen from developing countries. They are, namely, Turkey, Argentina, Hungary, India, Mexico, Brazil, South Africa and China.

The dataset is mostly collected from the World Bank's 'World Development Indicators' online database together with database archive (beta version) as well as various IMF sources. The IMF printed databases used are International Financial Statistics (IFS) Yearbooks 1984, 1990, 1991, 1994 and the Government Finance Statistics (GFS) Yearbook 1988. Another source is the IMF's online World Economic Outlook Database 2017. An IMF Country Report (2016) and World Bank Policy Research Working Paper by Mello (2006) is used for gathering data².

For some, albeit small parts of the data an electronic journal, a rating report and a working paper is used. Electronic journal is from Social Science Research Network (SSNR) by Martner (2006) and rating report is from Fitch Ratings by Arispe and Shetty (2016). Working paper is from website of National Bureau of Economic Research (NBER) created by Reinhart (2010).

In addition, some other parts of the data are collected from printed books, internet pages of some banks, organizations and government institutions and various websites. The organizations, banks and institutions whose online data sources used are web pages of OECD, United Nations, InterAmerican Development Bank, Magyar Nemzeti Bank, South African Reserve Bank, Economic commission for Latin America and the Caribbean. Webpages of government institutions are: Revenue Administration of Republic of Turkey, The Central Bank of the Republic of Turkey, Ministry of Treasury and Finance of Turkey, General Directorate of Budget and Fiscal Control of the Republic of Turkey.³

² IMF Country Report is stated in reference list.

³ Further information is given at Appendix A.

Finally, printed books and a printed yearbook are also utilized for data gathering. Books are Mitchell (1998)'s International Historical Statistics: The Americas, Euromonitor's European Marketing Data and Statistics (1991), Türkoğlu, Aktaş and Sönmez (2010)'s book as well as Eğilmez and Kumcu (2002)'s book are also used. United Nations Statistical Yearbook 1983 -84 is used for gathering a part of Hungary's reserve data.

Data from various websites and data computed by interpolation is stated in table A.1. of Appendix A. Explanations about some sources of real net domestic credit data and computations about this data are given in Appendix B. Calculations about lending interest rate data and real interest rate data and explanations about sources are stated in Appendix C⁴.

3.1.2. Variables

3.1.2.1. Explanatory Variables Used

The explanatory variables are; real gross domestic product (GDP) growth, change in terms of trade, change in nominal real exchange rate, real interest rate, inflation, fiscal balance/GDP, debt/GDP, broad money/total reserves, credit to private sector/GDP, domestic credit growth, change in total reserves. See Table 3.1. for explanatory variables' definitions and for further information about variables' content.

Table 3.1.

Definitions of explanatory variables

Variable	Definition	Further Information
Real GDP growth	It is the annual percentage change of real GDP.	GDP is valued according to market prices. Amounts are

⁴ Few data are obtained from Google Books and NBER books online. For detailed information see appendix A and appendix B.

		in constant local currency unit.
Change in terms of trade	It is the annual percentage change of "terms of trade".	Net barter terms of trade index are used (2000 = 100). Formula is; export unit value indexes ÷ import unit value indexes.
Change in exchange rate	It is the annual percentage change of "official and nominal exchange rate".	Exchange rate is the local currency per one U.S. Dollar. It is the annual average computed from monthly averages.
Real interest rate	It is the lending interest rates of banks adjusted for inflation.	GDP deflator (%) is used for inflation adjustment. For periods which lending rate data are unavailable; calculation used is stated in Appendix C.
Inflation	It is the annual percentage change of "consumer price index".	It is computed from period averages.
Fiscal balance/GDP	It is the percentage ratio of net lending (+) or net borrowing (-) to GDP. Net lending (borrowing) formulation is; government revenue - expense - net investment in non-financial assets.	Government refers to "central government". Variable includes the social security funds' operations. Amounts in calculation are in local currency unit.

Debt/GDP	It is the ratio of central government total debt to GDP.	Debt includes domestic and foreign liabilities. Debt point out the debt stock measured usually on the last day of the fiscal year.
Broad Money/Total Reserves	It is the ratio of M3 to total reserves. Total reserves data include gold.	The gold component is priced according to year-end values (December 31). Generally, London prices are used.
Credit to private sector/GDP	It is the percentage ratio of domestic credit that is provided to private sector members to GDP. Credit includes loans, purchases of nonequity securities, and trade credits and other dues that establish a claim for repayment which is provided by all financial corporations.	The financial corporations include monetary authorities, banks, and other financial corporations. Other financial corporations refer to finance and leasing companies, insurance corporations, pension funds, and foreign exchange companies.
Domestic credit growth	It is the percentage annual growth rate of real net domestic credit. Net domestic credit is the sum of net claims from the central government and claims from other sectors of the local economy.	Domestic credit is purged from inflation by using GDP deflator. Net domestic credit data are in own currencies of countries.

Change in total reserves	It is the annual percentage change of total reserves. Total reserves include monetary gold, Special Drawing rights, reserves of IMF members and holdings of foreign exchange under the control of monetary authorities.	Total reserves data include gold. The gold component is priced according to year-end values (December 31) and generally London prices are used. Data are in current U.S. Dollars.
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3.1.2.2. Overview of Explanatory Variables on The Basis of The Empirical Studies.

The explanatory variables used in this paper are chosen from variables which are generally preferred as indicators of financial crises in the literature.

Terms of trade, real GDP growth and real interest rates are the macroeconomic factors in which some changes can have a damaging influence on the banking sector by distinctly increasing non-performing loans (Demirgüç-Kunt and Detragiache, 1998).

Real GDP growth is one of the key measurements in the economy that reflects the general economic condition. Furthermore, crises usually come to exist in poor growth cycles and the beginning of a financial crisis has a connection with sharp fall of growth rate. (Eichengreen and Rose, 1998; Demirgüç-Kunt and Detragiache, 2005)

Kaminsky and Reinhart's (1999) financial liberalization indicators signaled correctly 71% of banking crises and real interest rates did it with 100% accuracy rate. Generally, during the financial liberalization periods, high real interest rates seem to occur (Galbis, 1993). These conclusions respectively induce that real

interest rate variables can be studied in banking crises researches and they can be named as one of the financial liberalization indicators.

According to Eichengreen and Rose (1998) small countries with narrow variety of export goods tend to be open to terms of trade shocks which deteriorates the banks' balance sheets through non-performing loans of exporters. Terms of trade declines effect the banking system negatively by hampering the payment of loans (Rossi, 1999).

Inflation has a strong and adverse effect on banking system performance (Boyd, Levine and Smith, 2001). Inflation process damages the credit allocation mechanism and causes banks to select weak and bad borrowers to lend (De Gregorio and Sturzenegger, 1994). Most results in the empirical studies show that if the rising inflation exceeds a threshold level it began to affect the growth of financial sector negatively. While Boyd, Levine and Smith pointed out the threshold level as 15%, Huang, Lin, Kim, and Yeh (2010) found it between 7.31% and 7.69% and Rousseau and Wachtel (2002) found it between 13% and 25%. Barro (1995) in his empirical study found the relationship between high inflation and declined investment and growth. His results show the indirect effect of inflation to banks.

In the face of a crisis, large as well as sudden depreciation of the domestic currency can have an inverse effect on the profitability of banks. This can occur directly if banking system has an open foreign currency position or by the effect of borrowers who has foreign currency liabilities to banks. After a depreciation, borrowers can fail to pay back their foreign currency loans causing a rapid movement in the non- performing loans in banks' financial reports (Demirgüç-Kunt and Detragiache, 1998). On the other hand, one of the leading studies about crises in empirical literature; Kaminsky and Reinhart (1999) points out that at pre-banking crises periods and at pre-balance of payments crises periods (especially one year before the crisis time) an 'overvalued' exchange rate is observed which is higher than the ones in normal periods. Hardy and Pazarbaşıoğlu (1998) indicate that

banking crises are related to a wide depreciation that comes after an appreciation. So, depreciation can be stated as a crisis period event while the strong appreciation as the leading indicator. Before the subprime crisis domestic macroeconomic factors were at dangerous levels in the developing countries, but, additionally, the exchange rates were among the important factors signaling non-resilience in these nations (Jorda, Schularick and Taylor, 2011).

Large capital inflows may partially turn into deposits in local currency as in the case of Mexico which occurred during and after the financial liberalization period 1988 -89 (Calvo and Mendoza, 1996). This M2 expansion means an increase in liabilities of banks. However, this is not the main issue. M2/total reserves is one of the main indicators that reflects an economy's risk to go through a currency crisis. When a devaluation or depreciation occurs and if people withdraw cash to change their deposits to foreign currency, larger amount of M2 than total reserves can cause total reserves to drain away and may result with the abolition of fixed exchange rate order (Calvo and Mendoza, 1996). The sample in this paper contains broad money instead of M2 as the M2 data is unreachable. The increase in M2/reserves ratio is also found to increase the likelihood of banking crisis in the Demirgüç-Kunt and Detragiache's (1998) study. According to Velasco and Cespedes (1999) if bank runs occur bank vulnerability will be much higher if there is fixed exchange rate regime and it will be lower if there is floating exchange regime. So, the high ratio of M2/reserves is especially dangerous if exchange rates are pegged.

Domestic credit consists of the loans of every single sector in domestic economy; central government and private. Each sectors' debt individually or together could play an important role in the outbreak of a financial crisis. Kaminsky and Reinhart (1999) studied and compared the movements of various macroeconomic variables before and after the crisis period for 20 countries. Countries consisted of developed and emerging ones. Their study focused on currency, twin and banking crises periods separately. The study stated that domestic

credit variable tends to boost saliently before the currency and twin crises and at the first stage of banking crises. There are many other examples from empirical studies that document the relationship. We mention two of them here. Borio and Drehmann (2009) stated the association between banking distress and credit expansion in industrial countries while Elekdag and Wu (2011) establish the connection between credit growth and financial imbalances in emerging countries. The findings of empirical literature show that credit growth could be an important crisis predictor.

The unpaid loans of borrowers are elements that deteriorate the banks' asset side of balance sheets. A rapid and sector-wide increase in these loans raise vulnerability of banking system. During the financial liberalization periods or boom cycles, credit expansions occur and these expansions can be the result of bank managers' excessive risk taking and herding behavior which results providing credit to customers who have weak pay-back capacity. Consequently, credit expansions can be related with the banking crisis periods (Demirgüç-Kunt and Detragiache, 1998).

Credit to private sector/GDP reflects the indebtedness of the corporates and households. According to Mishkin (1994) corporate indebtedness is an essential element that boosts the likelihood of a crisis as high indebtedness levels walk with adverse selection as well as moral hazard issues. The households' indebtedness was one of the major sources of subprime crisis. Pill and Pradhan (1995) defines private sector credit/GDP as the leading reflector of advancing financial liberalization. Demirgüç-Kunt and Detragiache (1998) also sees enlarged private credit in the sector as a factor that increases the banking sector vulnerability.

Expansionary fiscal policies have strong contributions to dangerous lending booms; after some time, inflation reaches to undesirable levels and if these policies needed to be changed into tight ones rapidly this policy change may cause a recession. Such a change is more common in developing countries and it effects the

repayment capacity of borrowers and eventually it affects the banks negatively (Eichengreen and Rose, 1998). Fiscal deficit/surplus can generally reflect the fiscal policy type and it is proper to include it in the study.

Debt/GDP is an important item to include because of its relationship with growth rate and inflation. Reinhart and Rogoff's (2010) study is the one that focuses on this issue in literature. When debt/GDP reaches a threshold level an association begins between debt and growth levels in both developed and emerging countries and between debt and inflation in emerging countries. After exceeding the threshold an increase in debt level apparently ends up with lower growth rates and higher inflation rates (Sachs, Tornell and Velasco, 1996).

Change in reserves is often used as an item in indexes (exchange market pressure index or currency market turbulence index) with exchange rate changes to study the explanatory role of the indexes on crises (Komulainen and Lukkarila, 2003 and Kaminsky and Reinhart, 1999).

3.1.2.3. Dependent Variable

The goal of this paper is to find the predictors of the global crisis which is stemmed from sub-prime mortgage crisis. Dependent variable in the study is a binary element which takes value of 1 for the actual years of financial crisis and takes value of 0 for the rest of the years. The dependent variable takes the value of 1 for the years 2007, 2008 and 2009. The crisis period started at 2007 with sub-prime and quickly began to spread to all over the world (Stiglitz, J.E., 2010). The process intensely continued through 2008 and 2009 (Mishkin, 2011) and often named as the 2007-2009 financial crisis (Acharya and Skeie's, 2011). Naoui, Khemiri and Liouane (2010) find high correlation coefficients between the emerging markets and U.S. financial market during 2008 -2009 period.

3.2. METHODOLOGY

We used a multivariate logit regression to model the association of the explanatory variables with the dependent variable. This is obviously a probabilistic association as the outcome from the regression exercise is a probability value.

Our dependent variable is categorical variable which becomes crisis or non-crisis. It belongs to dichotomous type of categorical variable. Dichotomous categorical variable has only two levels of forms (like head and tail or male and female). When we label them as 0 and 1 to be numerical for regression, dependent variable can be defined as also a discrete variable. As our dependent variable is not continuous, logistic regression is more suitable than linear regression.

Since in our study we have a binary dependent variable which is a sub-type of dichotomous variable, linear regression forms are not suitable. Linear regressions require to have continuous dependent variables in the equations. Using simple linear regression may cause predictions to go out of boundaries (0,1) and error terms to be not normally distributed. Two types of binary choice models; logit or probit models are generally preferred if there is a dichotomous response (dependent) variable. They relate explanatory variables to the probability of the dependent variable which cannot exceed 1 and drop below 0 (probability of crisis occurrence or non-occurrence). They do it with the help of link functions. Logit models is constructed based on the cumulative distribution function (CDF) of logistic probability distribution, while probit models is constructed with the use of the CDF of standard normal probability distribution. In this work logistic regression model is preferred to probit model since logistic regression model is mostly used in banking sector problems in literature. However, logit and probit models are alike but logit has some advantages which made it a bit more preferable; it is simpler than probit and has direct interpretability (Fox, 2006).

The logistic regression equation on the probability scale is the following;

$$Prob(Y_{it} = 1) = F(\beta X_{it}) = \frac{e^{\beta' X_{it}}}{1 + e^{\beta' X_{it}}} \quad (1)$$

Y_{it} is the crisis dummy for country i at time t , $F(\beta X_{it})$ is the function of cumulative logistic distribution, β is the vector of coefficients, X_{it} is the vector of explanatory variables and e is the base of the natural-logarithm.

Maximum likelihood estimation (MLE) is the ideal method that is used to estimate the coefficients of logistic regression. The likelihood function is expressed by the formula;

$$\prod_{t=1}^T P^{Y_{it}} (1 - P)^{1-Y_{it}} \quad (2)$$

And can be written as;

$$P^{\sum Y_{it}} (1 - P)^{n - \sum Y_{it}} \quad (3)$$

To maximize the likelihood, natural logarithm of the above equation is in the form;

$$\log_e L = \sum_{i=1}^n \sum_{t=1}^T [(Y_{it} \log_e F(\beta' X_{it})) + (1 - Y_{it}) \log_e (1 - F(\beta' X_{it}))] \quad (4)$$

Then, coefficients of the estimating equation can be found by taking the derivative of the above equation with respect to each coefficient and by setting the resulting equation equal to zero.

We estimated the logit model in four different forms; plain form with no fixed effects and standardization, with standardization and some logs, with country

fixed effects and with post-crisis bias correction. E-views version 9 is the software used for the calculations.

CHAPTER 4

RESULTS

Table 4.1. contains the results of binary logistic regression which is estimated to reveal the leading indicators of financial crisis of 2008-09 in selected developing countries. The regression does not include any fixed effects. Change in exchange rate variable is lagged 1 year, and domestic credit growth is lagged 2 years. Credit to private sector/GDP is shown as; CPS/GDP in result tables.

Table 4.1.

Results of Binary Logit Method: Regression 1

Variable	Coefficient (C)	Standard error	z	P
Real GDP growth	-0.2048	0.0690	-2.9679	0.0030
Change in terms of trade	0.1095	0.0526	2.0828	0.0373
Change in exchange rate(t-1)	-0.0917	0.0325	-2.8204	0.0048
Real interest rate	0.0393	0.0280	1.4026	0.1607
Inflation	0.0028	0.0100	0.2790	0.7802
Fiscal balance/GDP	0.0392	0.0937	0.4184	0.6757
Debt/GDP	-0.0264	0.0152	-1.7364	0.0825
Broad Money / Total Reserves	-0.7618	0.2314	-3.2927	0.0010
CPS/GDP	0.0141	0.0076	1.8529	0.0639
Domestic credit growth(t-2)	0.0422	0.0236	1.7883	0.0737
Change in total reserves	0.0169	0.0088	1.9077	0.0564
AIC: 0.4525 SIC: 0.6051				
Number of Observations: 288				

As we are looking for the best predictability, different lag levels for all variables are measured to find better significancies and model fit. Lagging is also useful for reducing endogeneity bias through simultaneity. For all the variables 1-year lag and two-years lags are tried out. These lags are also tested for some variables together in the model with some non-lagged variables. As another attempt; lags are tried out one by one for each variable. The best combination of lags in terms of significancy and Akaike information criterion (AIC) and Schwarz information criterion (SIC) is shown in the above table: We see 1-year lag for change in exchange rate, 2-year lag for domestic credit growth and no lags for the others. Credit growth lags are tried from (t-1) to (t-5). Lag (t-2) gave the best result in terms of significancy. Its sign is also as expected. We tried highest number of lags on credit growth variable since banking sector troubles usually arrive after strong credit expansion (Demirgüç-Kunt and Detragiache, 1998).

Regression 1 shows that real GDP growth and nominal appreciation (decrease in exchange rate) have is significant at 1% level in predicting the financial crisis of 2007-09 for the selected developing countries. Greater levels of GDP growth indicate decreasing probability of crisis as expected and it is similar with the general findings in literature. The GDP growth variable is found significant in most studies of literature. Shift in exchange rate variable is the shift in nominal and official exchange rate. An increase in the variable indicates depreciation while a decrease indicates appreciation. The variable has a negative coefficient sign in regression 1 showing that an appreciation (overvaluation) in the currency may lead the crisis. This result is compatible with the suggestions made by Kaminsky and Reinhart (1999). Nominal appreciation is significant in our study only with using time lag of 1 year. Hardy and Pazarbaşıoğlu (1998) used real exchange rate for banking crises; real appreciation was significant at 1% level for banking crises, but differently from us because their variable was non-lagged. Gourinchas and Obstfeld (2011) found it significant at 5% level for banking crises and emerging countries.

In regression 1, rises in domestic credit growth and credit provided to private sector/GDP is significant at 10% level. The positive coefficient sign of credit to private sector/GDP and domestic credit growth can be related to its influence on the banking system vulnerability which was mentioned in previous sections. Results for credit variables are mixed in literature; while Barrell, Davis, Karim and Liadze (2009) found domestic credit growth insignificant and Davis and Karim (2008) (in plain regression) found private credit variable again insignificant, Demirgüç-Kunt and Detragiache (2005) as well as Davis and Karim (2008) (after controlling for deposit insurance) found both of them significant and Ganioglu (2013) for domestic credit found the results significant at 1% level. Broad money to total reserves variable has significant result at 1% level but with an unexpected negative effect. An increase in the ratio decreases the likelihood of the crash according to our results. But both in theoretical and empirical studies the sign is expected to be positive. Neither inflation, nor fiscal balance variables are significant. Other variables with 10% or 5% level of significance do not have the appropriate sign.

Real interest rate is not significant in the result of regression 1. It was found as significant in the two pioneering studies: Demirgüç-Kunt and Detragiache (1998) with 1% significance level as well as Hardy and Pazarbaşıoğlu (1998) with 1% or 5% significance level.

Table 4.2. contains the results of logit regression type and again with no fixed effects. Explanatory variables are all standardized and several data are logged before standardization. Change in exchange rate variable is lagged 1-year and domestic credit growth is lagged 2 years.

Table 4.2.

Results of Binary Logit Method-All Standardized and Several Logs: Regression 2

Variable	C	S.E.	z	P
Real GDP growth	-0.8664	0.3236	-2.6770	0.0074

Change in terms of trade	0.7668	0.3621	2.1176	0.0342
Log (Change in exchange rate) (t-1)	-1.6854	0.5726	-2.9435	0.0032
Log (Real interest rate)	1.0061	0.5896	1.7062	0.0880
Log (Inflation)	0.4365	0.5220	0.8362	0.4030
Fiscal balance/GDP	0.3004	0.3202	0.9382	0.3481
Debt/GDP	-0.7867	0.3847	-2.0448	0.0409
Log (Broad Money/Total Reserves)	-2.1293	0.5659	-3.7623	0.0002
CPS/GDP	0.4254	0.2820	1.5087	0.1314
Domestic credit growth(t-2)	0.6983	0.3003	2.3259	0.0200
Change in total reserves	0.3763	0.2864	1.3137	0.1890
<hr/>				
AIC: 0.4807 SIC: 0.6333				
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Number of Observations: 288				
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Standardization can lower the multicollinearity if it is present in the regression and can moderate variations in the magnitude of data across countries. It is added to model to see whether it will improve the results or not, in the absence of fixed effects. It provided small improvement.

The standardization formula consists of computing the difference of each observation from mean of the variable in which the observation took part and dividing it to the standard deviation of the mentioned variable. Mean and standard deviation of variable is calculated from the observations of mentioned variable (its separately done for all variables by one by) including all the countries in the model. $X_{kit}^* = (X_{kit} - \bar{X}_k) / S_k$ is the formula used. X_{kit} is the observation of variable k for country i at time t , \bar{X}_k is the mean of all observations of variable k , S_k is the standard deviation of all observations of variable k . The computation is done for each 11 variables respectively.

We also take logarithmic transformation of variables with high-level of skewness in order to make the data more interpretable and make it closer to normally distributed one before observing the results.

Real interest rate which was not significant in regression 1 became 10% significant in regression 2 with the expected coefficient sign after standardization and logarithmic transformation. Real GDP growth (with negative sign), broad money to total reserves (with unexpected negative sign) and nominal appreciation (with negative sign) are still significant at 1% level. Domestic credit growth which was significant at 10% level in regression 1 become 5% level significant in regression 2. Credit to private sector/GDP became non-significant. Although debt/GDP showed a 5% level of significance in this part, it still has unexpectedly and inexplicably negative coefficient sign. Most of the remaining variables have similar results with previous regression. As a result, the process provided small improvements in only two of the variables and small deterioration in one.

Davis and Karim (2008) were the ones who used logarithmic transformation and standardization in the literature. The most important improvement in their results were that the fiscal balance/GDP variable became significant at 1% level after standardization and private credit/GDP gave 1% level significant results as well after standardization and logarithmic transformation. In previous regressions, they were not significant. And inflation variable after standardization became significant at 1% level as well. M2/international reserves became 5% level significant, while it was non-significant after standardization and logarithmic transformation. The only important deterioration was the change in terms of trade as it became non-significant after standardization. Previously, it was significant at 1% level.

Table 4.3. contains the outcomes of logit regression with country fixed effects. Change in exchange rate variable is lagged 1-year, domestic credit growth is lagged 2 years. One new lag is introduced: credit to private sector/GDP is lagged 2 years. Other lags to remaining variables did not provide better results.

Country fixed effects are preferred in models including panel data by some researchers. Rossi (1999), Gourinchas and Obstfeld (2011) and Anundsen, Gerdrup,

Hansen and Kragh-Sorensen (2016) used country fixed effects in their papers. The aim is to control for the unobserved heterogeneity that derive from country specific effects. Thus, these effects can be taken into account. It is used in regression 3 with the same motivation. A set of country dummy variables is manually prepared and added on the data. In total the existing number of country variables is n. The number of included dummy variables is lowered to (n-1) to avoid the multicollinearity (dummy variable trap).

Table 4.3.

Results of Binary Logit Method-With Country Fixed Effects: Regression 3

Variable	C	S.E.	z	P
Real GDP growth	-0.5920	0.1616	-3.6629	0.0002
Change in terms of trade	0.2086	0.0744	2.8029	0.0051
Change in exchange rate (t-1)	-0.1475	0.0502	-2.9374	0.0033
Real interest rate	-0.0761	0.0787	-0.9671	0.3335
Inflation	0.0045	0.0484	0.0940	0.9251
Fiscal balance/GDP	0.4796	0.1840	2.6064	0.0092
Debt/GDP	-0.1179	0.0515	-2.2884	0.0221
Broad Money/Total Reserves	-2.9305	0.7473	-3.9216	0.0001
CPS/GDP(t-2)	-0.0923	0.0384	-2.4059	0.0161
Domestic credit growth(t-2)	0.0983	0.0441	2.2297	0.0258
Change in total reserves	0.0321	0.0166	1.9338	0.0531
AIC: 0.3847 SIC: 0.6263				
Number of Observations: 288				

In the third regression, whose results are shown above, decline in real GDP growth and nominal appreciation are still significant (at 1% level) variables as predictors of financial crises. This is parallel to the findings in the literature. Two-year lagged credit to private sector/GDP variable became 5% level significant after fixed effects, but the direction of the association changes into negative unlike those

observed in other two previous regression equations. Domestic credit growth is significant at 5% level which is better than the 10% significance level in regression 1. Broad money to total reserves is still significant at 1% level with the unexpected sign. Although change in terms of trade, debt/GDP, change in total reserves and fiscal balance/GDP have improvements in their significance levels, their coefficient sign is still the opposite of the expectations. Real interest rate is insignificant as it was in regression 1. As a result, the process provided small improvement in only one of the variables. Country fixed effects' contribution to regression 1 in terms of significance and correct sign is at the same level as the one we saw in regression 2. Therefore, we see that employing fixed effect in our model did not improve our findings from the first regression model significantly. The improvement was marginal; for some strongly significant variables in the previous two regressions, considering fixed effects only led to better numerical results.

In Rossi's (1999) and Gourinchas and Obstfeld's (2011) study, credit variables had a positive sign and 5% significance level (Rossi worked on private credit Gourinchas and Obstfeld worked on domestic credit). In Anundsen, Gerdrup, Hansen and Kragh-Sorensen's (2016) study the sign of the private credit/GDP variable was positively significant at 1% level. Our result of credit to private sector/GDP with negative sign differs from country fixed effect literature that we detected because the sign can't be explained by rationing process of banks as it is two years lagged (too early for rationing). We anticipated the reserve and debt variables to be at least significant at 5% level with expected sign like it was in the Gourinchas and Obstfeld's (2011) study but again signs are not proper. Growth variable results are matching with these three studies from literature. Appreciation variable's significance level is much stronger than Rossi's (1999) (which was insignificant) and stronger than Gourinchas and Obstfeld's (which was significant at 5% level).

Table 4.4

Results of Binary Logit Method- Correction of Post-Crisis Bias: Regression 4

Variable	C	S.E.	z	P
Real GDP growth	0.2668	0.0783	-3.4092	0.0007
Change in terms of trade	0.1528	0.0669	2.2851	0.0223
Change in exchange rate(t-1)	-0.0844	0.0393	-2.1487	0.0317
Real interest rate	0.0462	0.0284	1.6271	0.1037
Inflation	0.0006	0.0084	0.0686	0.9453
Fiscal balance/GDP	0.2235	0.1258	1.7766	0.0756
Debt/GDP	-0.0183	0.0149	-1.2304	0.2185
Broad Money/Total Reserves	-0.9416	0.2509	-3.7528	0.0002
CPS/GDP	0.0297	0.0096	3.0975	0.0020
Domestic credit growth(t-2)	0.0405	0.0244	1.6592	0.0971
Change in total reserves	0.0071	0.0093	0.7603	0.4471
AIC: 0.4456 SIC: 0.6239				
Number of Observations: 232				

Table 4.4. includes the correction of post-crisis bias in the way Demirgüç-Kunt and Detragiache (1998) did. They omitted the data after the crisis years. We omitted the years after 2009 to 2016. Bussiere and Fratzscher (2002) gave its name to the problem. The EWSs compare the movements of explanatory variables in normal times and in pre-crisis times. But the post crisis times are not normal exactly. As they are recovery times some abnormal behaviors of explanatory variables may appear. So, the EWS compares the pre-crisis times with normal times and also with these abnormal times if they are included.

In regression 4 the explanatory variable's lags are the same with regression 1 and there are no logarithmic transformations. Standardization or fixed effects usage are done similarly. Our aim is to compare the fourth regression model with the first one and see the effects of correction. Real GDP growth is still significant at 1% level with a better value than the first regression. Terms of trade is significant at 5% level but the sign is still not in the way we would expect to appear. Nominal appreciation becomes significant at 5% level. Domestic credit growth is significant

at %10 level as it was in the first regression. Only valuable improvement is in the credit provided to private sector/GDP which became this time significant at 1% level with the expected positive sign.

As a result, the contribution of post-crisis bias correction to the significance levels of variables in the first regression is at the same level that the country fixed effects and standardization did.

When the results are compared to Demirgüç-Kunt and Detragiache's (1998) study, nominal appreciation and credit provided to private sector/GDP variables' results are better in our study. Nominal appreciation is insignificant and credit provided to private sector/GDP is significant at 10% level or 5% level in their study. Our GDP growth result is similar with their study. But real interest rates and inflation have 1% and M2/reserves have 5% levels of significance in their results. In our paper these three variables are either insignificant or have signs different than what we would normally expect in the correction regression. In summary, significance levels of our regression with bias-correction are less strong than Demirgüç-Kunt and Detragiache's.

In all four regressions we worked on, terms of trade, debt/GDP, change in reserves and fiscal balance/GDP had unexpected sign. When we look at examples from literature, shift in terms of trade had the expected sign in Davis and Karim's (2008) study with 1% level of significance and in the Hardy and Pazarbaşıoğlu's (1998) study with 5% level of significance. In our literature list, 5 studies included fiscal balance/GDP and only Davis and Karim (2008) found it to be significant at 1% level and Bucevska (2011) and Demirgüç-Kunt and Detragiache (2005) (in 1 of the five regressions) found it significant at 5% level with expected signs. Debt/GDP is studied by three of the researchers that we previously mentioned in our study and only Joyce found it significant at 5% level with expected sign. But his variable was foreign debt/GDP. Inflation have no significance to predict the crisis in all of our estimations. Demirgüç-Kunt and Detragiache (1998) as well as Hardy and

Pazarbaşıoğlu (1998) found it significant at 5% or 1% level in their results and Davis and Karim (2008) found it significant at 1% level after standardization. Broad money/total reserves variable indicates negative and 1% significance level in all our estimations and gives better result when country fixed effects are used. But the sign is not explainable. Its usage is rare in literature and Demirgüç-Kunt and Detragiache (1998) found it to have 5% significance level in half of their regressions and significant at 1% level in the other half. Davis and Karim (2008) found it to be significant at 5% level.

The results of four regressions point out that real GDP growth could be regarded as one of the predictors of crisis. GDP growth indicates no significance when it is lagged in all of the regressions. In this case, the change in GDP can be considered as the quick effect of sharp worsening in real sector activity. Change in nominal exchange rate variable lagged one year is also a strong predictor (1% level) in most of the (3 of 4) estimates with negative association. Two years lagged domestic credit growth have a 10% significance level in half of the calculations; mainly in plain regression and bias-correction regression. It is significant at 5% level in the other half when standardized or country fixed effect is used. Credit to private sector/GDP is insignificant or have unexpected sign in two of the regression estimates. These are the regressions with standardized variables and country fixed effects. The variable is significant at 10% level in plain estimation, while it becomes significant at 1% level with correct sign when bias-correction method is implemented. Real interest rate gives the best result when it is used as a standardized and logarithmic transformed variable. However, even when standardized and transformed it is only significant at %10 level.

CONCLUSION

This thesis sought the macroeconomic and financial indicators of global financial crisis of 2008-09 in eight selected developing countries with a parametric EWS that consists of binomial-multivariate logistic regression. After estimating the

plain logistic regression, standardization/logarithmic transformation, country fixed effects and post-crisis bias correction are implemented one by one for comparison with the first regression. The purpose of this study is both to find the predictors of global crisis and to evaluate the contributions of these implementations to such studies.

Results indicate that the macroeconomic variables; decreasing real GDP growth and decreasing nominal exchange rate (appreciation) are strongly related with the likelihood of 2008/09 financial crisis in developing countries. Financial variables also have some prediction potential; domestic credit growth is a predictor with 5% level of significance. Credit to private sector/GDP is significant at 1% level in one of four estimates and at 10% level in one of four estimates. In total, standardization/logarithmic transformation, country fixed effects and post-crisis bias correction have similar and low levels of contribution to the significance of the study. On the basis of favorable effects to variables; standardization/logarithmic transformation process increases the significance of real interest rate and domestic credit growth slightly. The same happens with the domestic credit growth variable when country fixed effects is employed. Under the post-crisis bias-correction method, credit to private sector/GDP becomes significant at 1% level. Although the credit increase, if occurring with financial development, is often seen as a contributing factor of economic growth in developing countries, our paper, as it was previously done in the literature, confirmed that some credit booms can end with financial crises in developing countries (as they do in industrialized countries).

The results of decline in real GDP growth, decline in nominal exchange rate (appreciation), increases in domestic credit growth and in credit to private sector/GDP are compatible with the literature in general. The inflation, real interest rates variables and other variables that appear with opposite results from our forecasts can be explained by two ways. First, none of the EWSs are without limitations or flaws. As an example; the need of large sample size for MLE, the incidental parameter problem of fixed effects usage and sometimes the logit's

disability of detecting more complicated relationships. Secondly, the reality of global crisis; it sourced from the fundamentals of developed countries. Although the crisis affected developing countries intensely, it did not arise from developing countries. This not-being the source may be the reason of some variables resulting insignificantly.

The literature of the recent past about banking crisis predictors generally included institutional variables and banking sector ratios. Although we wanted to examine the bank liquid reserves/bank assets ratio (%) for our study, the data availability of bank micro data is absent for emerging countries especially for the years before 2000. In near future, quality of regulations, policy implementations on financial system and the capitalization data of banks are expected to be used as explanatory variables (Demirgüç-Kunt and Detragiache, 1998). Besides, the monthly data may capture short and steep movements in variables if it is possible to obtain the data. Future studies may employ market data such as stock market prices, liquidity of the interbank market and prices of bond market as independent variables (Demirgüç-Kunt and Detragiache, 2005). For currency crises, the contagion variables that Bussiere and Fratzscher (2002) used may gain more importance in the future.

Being aware of the limitations, some studies in the literature focus more on the financial crisis predicting ability of EWSs and set thresholds to see if a crisis happens when the threshold value is violated (Davis and Karim, 2008 or Beckmann, Menkhoff and Sawischlewski, 2005). On the other hand, some of the literature put emphasis on determining the factors related with the crises (Demirgüç-Kunt and Detragiache, 1998, 2005)). Both studies aim to improve our understanding on how to increase the chance to prevent crises and to intervene in the correct time. In our paper, we studied the second function of EWS. The EWSs will continue to gain importance with the recurrence of potential crises and with the effects of future improvements in the models in this field. EWSs can be thought as complementary

tools for policy making processes, but the sound judgement of policy makers is not a replaceable element by the EWSs.

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APPENDICES

Appendix A

Online Data Sources and Data by Interpolation

Table A.1

Source	Data	Country and Period
https://countryeconomy.com/gdp/hungary	Real GDP growth	Hungary 1979 -1991
Interpolation	Change in terms of trade	Argentina, Brazil, China, Hungary, India, Mexico, South Africa, Turkey 1979
http://www.econstats.com/wdi/wdiv1144.htm	Change in terms of trade	Hungary 1980 -1999
www.gib.gov.tr/fileadmin/mevzuat/ek/eski/files/sirano328ek4.rtf (Revenue Administration of Republic of Turkey) Website of World Bank (WDI).	Real interest rate (Lending rate part) (GDP deflator part)	Turkey 1979 -2001
https://evds2.tcmb.gov.tr/index.php?/evds/portlet/0QRrRj0ew0Y%3D/tr (Turkey's Central Banks website) Website of World Bank (WDI).	Real interest rate (Lending rate part) (GDP deflator part)	Turkey 2002 -2016

http://www.buenosairesherald.com/article/179735/indec-239-percent-inflation-in-2014	Inflation	Argentina 2014
https://www.worldfinance.com/special-reports/a-history-of-economic-trouble-in-argentina	Inflation	Argentina 2015
http://fortune.com/2017/11/23/argentina-inflation-rate/	Inflation	Argentina 2016
http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.505.4515&rep=rep1&type=pdf	Inflation	Brazil 1979
https://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?pr.x=62&pr.y=6&sy=1980&ey=1990&scsm=1&ssd=1&sort=country&ds=.&br=1&c=223&s=PCPI%2CPCPIPCH%2CPCPIE%2CPCPIEPCH&grp=0&a=	Inflation	Brazil 1980
https://www.measuringworth.com/chinadat/chinasources.xls	Inflation	China 1979 -1980
https://www.imf.org/external/pubs/ft/weo/2017/02/weodata/weorept.aspx?pr.x=13&pr.y=11&sy=1981&ey=2022&scsm=1&ssd=1&sort=country&ds=.&br=1&c=924%2C922&s=PCPIPCH&grp=0&a=	Inflation	China 1981 -1986
https://ssrn.com/abstract=2005024 (SSNR Paper, Cyclical indicators of fiscal policy in Latin American countries (with special reference to Chile), by Ricardo Martner (2006))	Fiscal balance/GDP	Argentina 2005 Mexico 2001-2005

https://www.cepal.org/en/publications/387 15-economic-survey-latin-america-and- caribbean-2015-challenges-boosting- investment (Economic commission of Latin America and the Caribbean's economic survey)	Fiscal balance/GDP	Argentina 2006 -2010
https://www.imf.org/external/pubs/ft/scr/2016/cr1669.pdf (One of the Country Reports of IMF, No: 16/69- 2016)	Fiscal balance/GDP	Argentina 2011 -2014
https://books.google.com.tr/books/about/The_Brazilian_Economy.html?id=qdBaM4nEefwC&redir_esc=y *(Google Book- by Werner Baer (2001) 5th edition-) Website of World Bank (WDI).	Fiscal balance/GDP (fiscal part) (GDP part)	Brazil 1979
http://www.nber.org/chapters/c7663.pdf *(Chapter in NBER Book-Volume title: Reform, recovery, and growth: Latin America and the Middle East (1996).(Chapter 12 Title: Stopping three big inflations: Argentina, Brazil, and Peru by Miguel A. Kiguel, Nissan Liviatan)	Fiscal balance/GDP	Brazil 1983
http://documents.worldbank.org/curated/en/626511468231268013/pdf/wps3812.pdf (World Bank Policy Research Working Paper- No 3812, By Luiz de Mello, 2006.	Fiscal balance/GDP	Brazil 1995 -1996
http://data.stats.gov.cn/english/easyquery.htm?cn=C01	Fiscal balance/GDP (fiscal part)	China 1979 -2015

Website of World Bank (WDI).	(GDP part)	
https://www.statista.com/statistics/455478/china-central-government-expenditure/	Fiscal balance/GDP	China 2016
https://www.statista.com/statistics/455219/china-central-government-revenue/	(fiscal part)	
Website of World Bank (WDI).	(GDP part)	
https://books.google.com.tr/books?id=rE3ODQAAQBAJ&pg=PA597&lpg=PA597&dq=hungary+net+domestic+credit+1979&source=bl&ots=EluEsc2i1f&sig=8ByG2GbFB_mJJQRtlqknBQIXfic&hl=tr&sa=X&ved=0ahUKEwjV5vbi_pTbAhVLISwKHU_uDvY4ChDoAQhRMAc#v=onepage&q=hungary%20net%20domestic%20credit%201979&f=false	Fiscal balance/GDP (fiscal part)	Hungary 1979-1980
*(Google Book- The Statesman's Yearbook 1983 -84) Editor: John Paxton, 2016.	(GDP part)	
IMF International Financial Statistics Yearbook 1984		
https://community.data.gov.in/deficit-of-the-indian-government-from-2000-01-to-2015-16/	Fiscal balance/GDP (fiscal part)	India 2014 - 2016
World Bank (WDI).	(GDP part)	
https://stats.oecd.org/Index.aspx?DataSetCode=SNA_TABLE12# (OECD-STATS., <i>National Accounts.</i>)	Fiscal balance/GDP (fiscal part)	Mexico 2006-2015
World Bank (WDI)	(GDP part)	
http://www.carmenreinhardt.com/data/browse-by-topic/topics/9/ (Excel files)	Debt/GDP	Argentina 1979 -2008 China

		1982-1989 2000 -2009 India- 1979 South Africa 1979-1989 2005-2009
http://www.econstats.com/sdds/Economic_Data_Argentina.htm Website of World Bank (WDI).	Debt/GDP (Debt part) (GDP part)	Argentina 2009
Interpolation	Debt/GDP	Argentina 2010 -2011
http://www.fixscr.com/uploads/1459946462570503deb330e.pdf (Fitch Ratings-Full rating report, Arispe and Shetty, April 2016-Figure 13)	Debt/GDP	Argentina 2012 -2013
Interpolation	Debt/GDP	Argentina 2014 -2015
https://www.ceicdata.com/en/indicator/argentina/government-debt--of-nominal-gdp/amp	Debt/GDP	Argentina 2016
https://www.clio-infra.eu/Countries/	Debt/GDP	Brazil-1979 1994 Mexico 1979 -1990 Turkey 1979 -1985
http://www.iadb.org/en/research-and-data/publicationdetails,3169.html?displaytype=&pub_id=DBA-007	Debt/GDP	Brazil 1995 -2006

(Page of InterAmerican Development Bank-Historical debt database)		
https://store.cato.org/system/files/ebook/Economic%20Reform%20in%20China-webPDF.pdf	Debt/GDP	China-1979
(*) Edited by Ross Garnaut, Ligang Song (2012)		
http://databank.worldbank.org/data/reports.aspx?source=WDI-Archives (The World Bank-WDI) Database Archive(beta)- Version 09.1992	Debt/GDP (external debt part)	China 1980-1981
https://books.google.com.tr/books/about/Economic_Reform_in_China.html?id=dSZ2DgEWfgUC&printsec=frontcover&source=kn_p_read_button&redir_esc=y#v=onepage&q&f=false *(Google Book-by James A. Dorn and Wang Xi (1990) Web site of World Bank (WDI).	(domestic debt part)	
http://databank.worldbank.org/data/reports.aspx?source=WDI-Archives# (The World Bank-(WDI) Database Archive(beta)- Version 07.2017)	Debt/GDP	China 1990 -1999
http://data.stats.gov.cn/english/easyquery.htm?cn=C01	Debt/GDP	China 2010 -2015
https://www.ceicdata.com/en/china/government-debt/central-government-debt-outstanding/amp	Debt/GDP	China 2016

https://www.mnb.hu/letoltes/magyarorszag-pe-nzu-gyi-sza-mla-i-1970-1989-en.PDF (Magyar Nemzeti Bank, Title: Financial Accounts of Hungary 1970–1989, Year: 2018)	Debt/GDP (debt part)	Hungary 1979
United Nations; <i>national accounts estimates of main aggregates section</i> http://data.un.org/Data.aspx?q=gdp&d=SNAAMA&f=grID%3a101%3bcurrID%3aNCU%3bpcFlag%3a0	(GDP part)	
http://www.nber.org/papers/w15815 (Working Paper from NBER website - By Carmen Reinhart, (2010).)	Debt/GDP	Hungary 1980
Interpolation	Debt/GDP	Hungary 1981 -1985
http://www.nber.org/chapters/c6018 *(Chapter in NBER Book- Volume title: The Transition in Eastern Europe, Volume 1 Volume editors: Olivier Jean Blanchard, Kenneth A. Froot and Jeffrey D. Sachs. 1994 (Chapter 4-Title: Hungary - Partial Successes and Remaining Challenges: The Emergence of a "Gradualist" Success Story? Author: Kemal Derviř, Timothy Condon)	Debt/GDP	Hungary 1985 -1990
http://shodhganga.inflibnet.ac.in/bitstream/10603/3669/15/15_chapter%206.pdf	Debt/GDP	India 1988 -1989
http://phdcci.in/image/data/Research%20Bureau2014/Economic%20Developments/Economic2016/feb/Status%20paper%20on.pdf	Debt/GDP	India-2014

https://www.thehindubusinessline.com/economy/high-growth-fiscal-gains-can-improve-indias-debt-to-gdp/article9674604.ece/amp	Debt/GDP	India-2015
https://www.ceicdata.com/en/indicator/india/government-debt--of-nominal-gdp/amp	Debt/GDP	India 2016
https://stats.oecd.org/index.aspx?queryid=8089 (OECD-STATS, <i>Finance</i> .)	Debt/GDP	Mexico 2001-2009
http://www.factfish.com/statistic-country/mexico/central%20government%20debt	Debt/GDP	Mexico 2010-2013
Interpolation	Debt/GDP	Mexico 2014-2015
https://www.ceicdata.com/en/indicator/mexico/government-debt--of-nominal-gdp/amp	Debt/GDP	Mexico 2016
https://databank.worldbank.org/data/reports.aspx?source=WDI-Archives (The World Bank-(WDI) Database Archive(beta)- Version 09.2006)	Debt/GDP	South Africa 2001-2004
http://www.factfish.com/statistic-country/south%20africa/central%20government%20debt	Debt/GDP	South Africa 2010-2012
www.resbank.co.za/webindicators/econfindataforsa.aspx (Website of South African Reserve Bank)	Debt/GDP	South Africa 2013-2016
https://www.hazine.gov.tr/kamu-finansmani-istatistikleri (Website of Turkish Treasury) Website of World Bank (WDI).	Debt/GDP (debt part) (GDP part)	Turkey 1986-1989
Interpolation	Debt/GDP	Turkey-1999

http://www.bumko.gov.tr/TR,7045/ekonomik-gostergeler-1950-2018.html Website of World Bank (WDI).	Debt/GDP (debt part) (GDP part)	Turkey 2000 -2007
Interpolation	Broad Money/Total Reserves	Hungary 1979
Interpolation	Credit to private sector/GDP	Brazil 1986-1987 Hungary 1979-1981 South Africa 1991
http://www.econstats.com/wdi/wdiv_440.htm	Credit to private sector/GDP	Hungary 1982-1990
Interpolation	Real net domestic credit growth	Argentina 1985-1989 Brazil 1986-1987 Hungary 1981,1989-1990 South Africa 1991
To turn gold reserves into USD: www.onlygold.com .	Change in total reserves	Hungary 1979-1982

Appendix B

The Calculation of Real Net Domestic Credit Data and Some Explanations About Sources

For the countries except Hungary all the years of the World Bank nominal net domestic credit data is turned into real by using GDP deflator data of the same source before computing the annual change. Real data is found by the formula; *(Nominal value of the variable × 100) ÷ GDP deflator*.

About Hungary the same calculation is done for the years between 1991 and 2016. In the matter of the years between 1983 and 1988 there is a World Bank data of nominal net domestic credit but deflator data does not exist. Deflator data is found from IMF's International Financial Statistics Yearbook 1994. But the data has base year of 1990 (1990=100) which is different from the World Bank's (2010=100). To solve this base year mismatch direct proportion formula is used. As there exists deflator data for year 1991 in both World Bank's and IMF's dataset, data of 1991 is used in direct proportion. For example, 1983 deflator value (base year 2010) is found by multiplying 1991 deflator value (base year 2010) with 1983 deflator value (base year 1990) and dividing the result into 1991 deflator value (base year 1990). The method is used for the years between 1983 and 1988 to find the values with base year 2010.

For the years between 1979 and 1981, for Hungary there is no World Bank data of both net domestic credit and GDP deflator. Both are gathered from IMF's International Financial Statistics Yearbook 1984 for the years 1979 and 1980. To find net domestic credit-1981 value, interpolation method is used and there exist a GDP deflator in IMF's International Financial Statistics Yearbook 1984. The deflator data has a base year of 1980(1980=100). As mentioned before the GDP deflator data used in the rest of the variable has base year 2010. Again, with direct

proportion method the deflator data with base year 1980 is turned into base year 2010. Data of 1983 is used in direct proportion to find 1979-1981.

Finally, for 1982 and Hungary there exists World Bank data of net domestic credit. GDP deflator data is gathered from IMF's International Financial Statistics Yearbook 1984. The deflator data has a base year of 1980 (1980=100). Same calculation described in last paragraph is repeated again.

Appendix C

Some Sources and Calculations Used for Real Interest Rate Data

For countries Argentina, Brazil, China, Hungary and Mexico real interest rate data are partly gathered from World Bank WDI source and are partly obtained by calculating an equation. The sum of “deposit rate” and “interest rate spread” is used to reach “lending rate”. Table C.1 shows the years of calculation and WDI source by countries.

Table C.1

Real Interest Rate Data Information by Years and Countries

Country	Years by Calculation	Years from World Bank WDI
Argentina	1979-1993	1994-2016
Brazil	1979-1996	1997-2016
China	1979	1980-2016
Hungary	1979-1991	1992-2016
Mexico	1979-1992	1993-2016

And then lending rate is adjusted for inflation by the formula of *real interest rate* = $[(1 + \text{nominal interest rate}) \div (1 + \text{inflation rate})] - 1$. For Turkey there is no calculation and the online sources used are stated in appendix A.

In the calculated parts of “real” interest rates, deposit rates are gathered from World Bank WDI data. Interest rate spread is mostly obtained from World Bank WDI database. For Brazil, the years 1993 and 1995 are taken from a Google Book which is edited by John Eatwell, Lance Taylor in 2002 and the years 1994 and 1996 are obtained by interpolation.

Some years of deposit interest rate data are not available in any of the sources. For these years averages of available data are taken. For both available and unavailable data crisis years are labeled. Crisis years are found from a working paper prepared to IMF: by Luc Laeven and Fabian Valencia (2012) and from an Economic and Social Research Institute of Government of Japan working paper by Claudio Monteiro Considera (1998).

To find unavailable data for crises years; the average of available data of crises years is taken and for non-crisis years the average of available data of all years is taken. Aforesaid computing is done for each country separately. As a result, some consecutive dates of deposit rate data had to take same values. For example; Hungary deposit rate data of 1979-1988 were missing and 1979-1981 were labeled as crisis years. To find 1982-1988, the average of all available data between 1989-2016 is computed. The average is 4.26 and it is used as the deposit rate data for all the years between 1982 and 1988. To find 1979-1981 data, the average of available crisis years between 1991 and 1993 is taken. The average is 7.72 and it is used as the deposit rate data for the years 1979-1981.

After reaching the lending rate, the rate is adjusted for inflation. Most of the values are adjusted by the GDP deflator (annual %) which is the tool for the purpose of inflation adjustment in World Bank database. But for only Hungary (1979-1991) there is no available data of GDP deflator (%) in World Bank WDI database. For these years the tool is the consumer prices (annual %) from World Bank WDI database.