# PREDICTABILITY OF FINANCIAL CRISES: TESTING K.R.L. MODEL IN THE CASE OF TURKEY

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**ABSTRACT**

*The aim of this study is to test predictability of 2007 Global Economic Crisis which hit Turkey by the help of macroeconomic data of Turkey. K.R.L. model is used to test the predictability. By the method of analyzing various leading early warning indicators, the success of the model in forecasting the crises is surveyed. The findings do not support K.R.L. models. Possible reasons for this are stated at the article.*

**Key Words**: Financial Crises, Leading Indicators, Signal Approach, K.R.L. Model
**JEL Codes:** G01

## 1. INTRODUCTION

Since internal dynamics of the capitalist system are inclined to cause crisis, the history of capitalism, in a way, has been the history of economic crises. Numerous destructive consequences of financial crisis such as loss in national income, problems in the structure of the economy and social- psychological trauma has made the case one of the most important fields of economics. By taking into account destructive consequences of financial crisis, economists have tried to find some ways to predict crisis in advance.

Crisis prediction studies begun following a series of crises which happened in Latin American countries; intensified with effects of 1992-93 ERM, 1994-95 Mexico, 1997 Russia and 1997-98 South Asia and became centre of attraction on a global scale.

In the early 2000s, no great scale crisis was seen. As a result of this development both politicians and academicians got in a confidence atmosphere for a while; some believed that crisis problem was completely disappeared, business cycles tamed and only important problem had to be solved was long-termed growth issues (Krugman, 2009). The global financial crisis; which began in 2007 and was different from all other previous crises both in volume and spreading speed, demolished that early confidence atmosphere, and indicated that crisis concept would not disappear; on the contrary it always has the potential of coming back with greater strength. Concordantly crisis studies which came to a stand still for a while restarted even faster compared to past.

## 2. LITERATURE REVIEW

### 2.1. DEFINITION OF CRISIS

First and most important element of economic crisis studies is to define the term 'economic crisis'. Economic crisis, which is one of the most attention attracting issues in economics studies, has been defined in different forms by researchers, and a consensus upon any of them has not been formed yet. Definition of Krugman (2011) is different and interesting: 'There is no accepted definition of currency crises but we know them when we see them. The key element is a sort of circular logic, investor flee a currency, because they fear that it might be devalued. According to Mishkin (1999) financial crisis is 'a nonlinear disruption to financial markets in which the asymmetric information problems of adverse selection and moral hazard become much worse, so that financial markets are no longer able to efficiently channel funds to those who have the most productive investment opportunities'. Edwards (2001) defines currency crisis as a very significant depreciation of the currency. Some similarities are generally observed in the way these crises unfold: A loss of foreign exchange reserves, capital outflow and a sudden depreciation of the currency. Gerard Caprio and Daniela Klingebiel (1999) investigated 117 systematic banking crises and defined them as much or all of bank capital being exhausted.

Kaminsky and Reinhart (1999) realized the links between banking and currency crises and called them twin crises. They found that 'problems in the banking sector typically precede a currency crisis—the currency crisis deepens the banking crisis, activating a vicious spiral; financial liberalization often precedes banking crises. The anatomy of these episodes suggests that crises occur as the economy enters a recession, following a prolonged boom in economic activity that was fueled by credit, capital inflows, and accompanied by an overvalued currency.

**2.2 PREDICTABILITY OF FINANCIAL CRISES**

Canova (1996) determines three basic questions in order to analyze predictability of financial crises:

a) Whether there are variables that reveal conditions conducive to crises,
b) Whether financial crises were forecastable on the basis of the information set available to agents,
c) Whether they were alike, in the sense that a set of statistical relationships was common to all episodes.

In order to answer these questions different models have been established. All these models try to reveal conditions conductive to crises. The ultimate aim of researchers is to figure out early warning signs and by doing this to predict and prevent financial crises. The attempts which try to find out early warning systems can be classified into three main groups.

i. Cross Country Regression
ii. Probit& Logit Models
iii. Signal Approach

**2.3 CROSS COUNTRY REGRESSION**

The first article on Cross Country Analysis was published by Sachs, Tornell and Velasco (1996) in order to explain the causes of Tequila Impact after 1995 Mexican Crisis. Researchers who analyzed basic economic features of 20 countries formed a crisis index for these countries. 3 basic variables were considered as very important. These are international reserves, foreign exchange rate and banking system.

Rabe (2000), by analyzing the first and second generation models constitutes the list of potential early warning indicators. Then he uses these potential indicators in order to predict Asia Crises. After doing extensive empirical testing he comes up with the table of leading indicators of financial crises. This study is especially important to understand the concept of vulnerability of countries.

**2.4 PROBIT-LOGIT MODELS**

Frankel and Rose (1996) used data of 102 countries between 1970 and 1992 to predict probit model. They defined monetary crises as 25% depreciation of currency in 3 months or 10% depreciation of currency in comparison to previous period. According the results of the model some indicators were useful to predict crises. However; Pseudo $R^2$ is ≈ %20 which means that model as a whole could not predict the crises well.

Woo (2000), tries to analyze the main reason of 1997-98 Asia Crises by using logit model. The independent variable is depreciation of real exchange rate. If depreciation exceeds 50% it means that there is a crisis (Y=1), if it is between 0%-10% (Y=0) it means that there is no crisis. Independent variables are M2 growth rate, fiscal deficit/GDP, foreign deficit/GDP, and foreign reserves at central bank/GDP. As a result of this analysis macroeconomic variables can't explain the monetary crises so Woo concludes contagion effect is the main reason of this crisis.

**2.5 SIGNAL APPROACH** (Kaminsky, Lizondo & C.M, 1998)**,** (Kaminsky & Reinhart, 1999)

Signal approach focuses on macroeconomic indicators to construct an early warning system. The most important study about this approach was applied by Kaminsky and Reinhart in 1996. In this study data of 5 developed and 15 developing countries between the years 1975-1990 were used. Indicated study was developed by Kaminsky, Lizondo ve Reinhart in 1997 and first letters of the names of writers are used to name KLR model.

Their study examines the empirical evidence on currency crises and proposes a specific early warning system. This system involves monitoring the evolution of several indicators that tend to exhibit an unusual behavior in the periods preceding a crisis. When an indicator exceeds a certain threshold value, this is interpreted as a warning "signal" that a currency crisis may take place within the following 24 months.

103 indicators are gathered in 6 big groups: Foreign sector, financial sector, real sector, public finance, structural and institutional variables, political variables. Critical (threshold) values are calculated for all indicators. If variation in a variable is upon threshold value, it is then recorded as a crisis signal. Each signal indicates a possibility of crisis that may occur in the following 24 months. In the following 24 months of any signal if there is a crisis, this signal is considered as a good signal, but if the case is just the opposite it is considered a bad one.

**(FIGURE 1) 2X2 Matrix, which Shows Every Possible Outcomes**.

| | CRISES | NO CRISES |
|---|---|---|
| SIGNAL | A | B |
| NO SIGNAL | C | D |

The variables that have the best track record within this approach include exports, deviations of the real exchange rate from trend, the ratio of broad money to gross international reserves, output, and equity prices. Indicators that have proven to be particularly useful in anticipating crises are international reserves, the real exchange rate, domestic credit, credit to the public sector, and domestic inflation. A+D represents correct signals and B+C represent false signals. The higher A+D indicates the better is the results of signal approach.

## 3. METHOD

### 3.1 DEFINITION OF CRISIS

In our study ISE index, exchange rates and industrial production index; which were used in the previous studies; were handled as indicators that define crisis period and it is concluded that years of 2008 and 2009 can be defined as crisis period for Turkey.

### 3.2 CRISIS PREDICTION MODEL

In our study; a simplified version of KRL model; 8 variables - regarded as the most important in Turkey sample – are used. These variables are expected to give signal in the crisis prediction. By means of them whether 2007 Crisis will able to be predicted or not is tested. Leading indicators that are used in the model are indicated below.

- Production Index
- International Reserves
- M1
- M2/Gross International Reserves
- Domestic Credits/GDP
- Real Exchange Rates
- Export
- Foreign Trade Rate
- Real Deposit Interest Rates

In the original model various early warning indicators are examined. Their rates in a specific month are compared with the rates of the previous 12 months and in theory, it is seen as a crisis signal when they pass the pointed border. The survey that is useful for avoiding from seasonality was softened a bit in our study, in some necessary cases the change according to previous month or general trends are observed just as in the studies of Frankel and Rose (1996).

### 3.3. DATA SET

Monthly data of leading indicators between January 2004 and December 2008 that are chosen for Turkey are used. In monetary indicators monthly data of November 2005 and December 2008 are used since it was believed that data two years before the crisis were adequate. Data set is compiled from CBT and IMF internet sites.

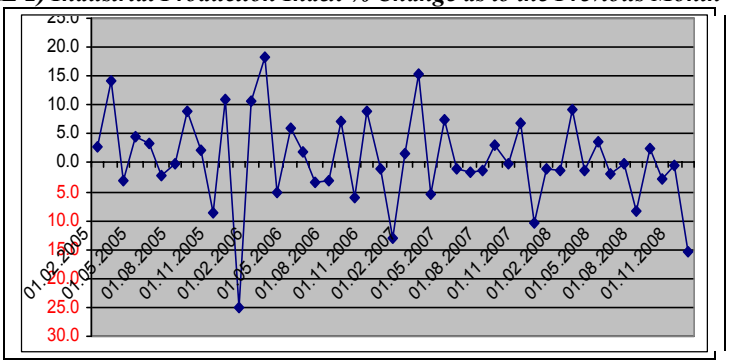
## 4. FINDINGS

### 4.1. INDUSTRIAL PRODUCTION INDEX

Changes that emerge in industry production which is regarded as the engine of national income growth show their effects in GDP numbers. In the first graphic which shows the growth of industrial production index between 2005 and 2009, there seem two downsizings in the early times of 2006 and 2007.

According to the model in which %10 decrease of industrial production was regarded as crisis signal so decrease in the month of 2006 January may be handled as a crisis signal (Figure 2). But there two issues are particularly important. The first of these is that industrial production indicated a floating cyclically in the first months of 2006, 2007 and 2008. Just after that decrease the second one index started to rise and there was lasting decrease. To put away cyclically floating, if the change of the index by the same month of the previous year is handled, decrease only seems in two months, and they do not pass beyond %3. In the evaluations by the previous year, decrease began in August 2008 and approached to %20 in the last month of the year. When we put signal frequency into consideration, regarding decreases in industrial production as crisis signal seems quite hard. The period in which index really gives signal is last months of 2008 and this should not be regarded as a crisis signal but should be regarded as itself.

*(FIGURE 2) Industrial Production Index % Change as to the Previous Month*

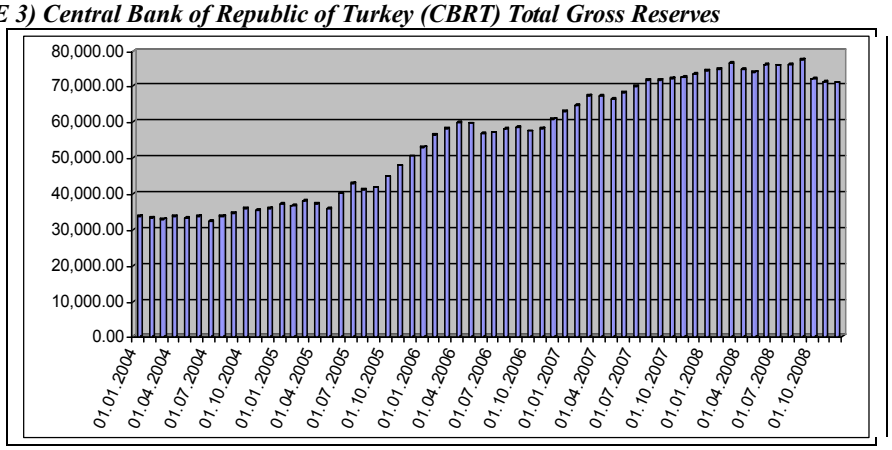



**4.2 INTERNATIONAL RESERVES**

Sudden decrease in international reserves is discussed in almost every crisis model as a sign for a crisis. In KLR model a 10% decrease in exchange reserves is also evaluated as a crisis signal.

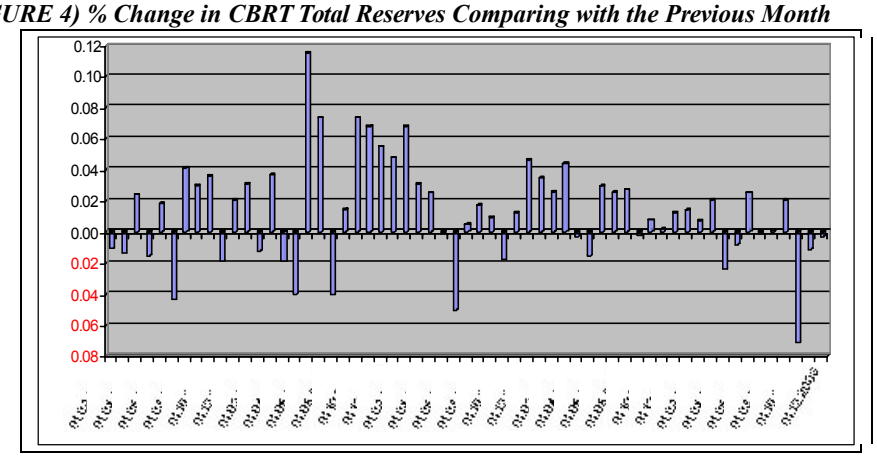
When we look at total reserves, we see that Turkey have been accumulating exchanges starting from 2004. While total gross reserves decreases according to market conditions, as overall tendency they are increasing in a strong way.

*(FIGURE 3) Central Bank of Republic of Turkey (CBRT) Total Gross Reserves*




When change of previous month in reserves is examined, it can be seen that there were decreases in various dates but these were under 10% and it can be strongly said that these did not point at a crisis.

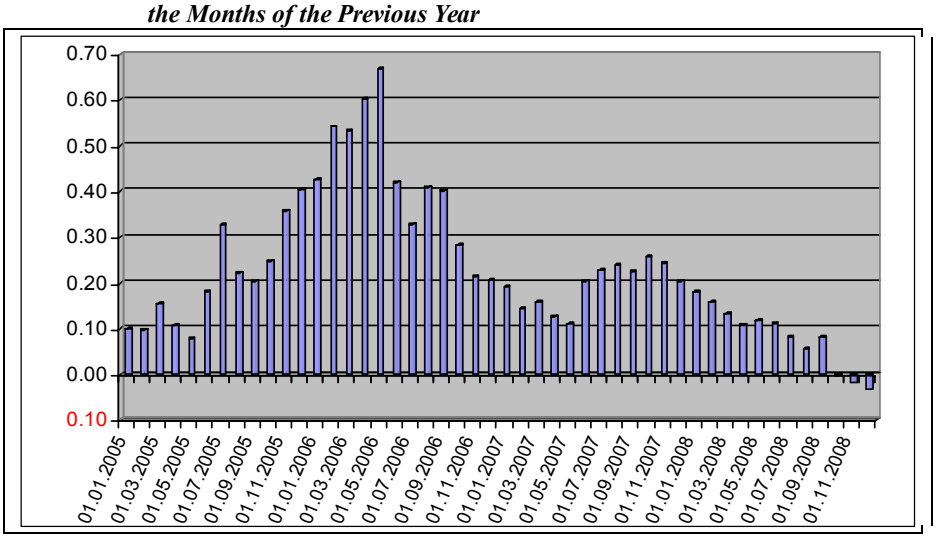
*(FIGURE 4) % Change in CBRT Total Reserves Comparing with the Previous Month*




Below in the graphic, which is made with the thought that there can be seasonal floating in reserves, it can be clearly seen that this criteria is far away from being a signal of a crisis. Till the period when crisis began, in the comparisons, which is made with the month of last year, there was no decrease in reserves; on the contrary there

were substantial increases.

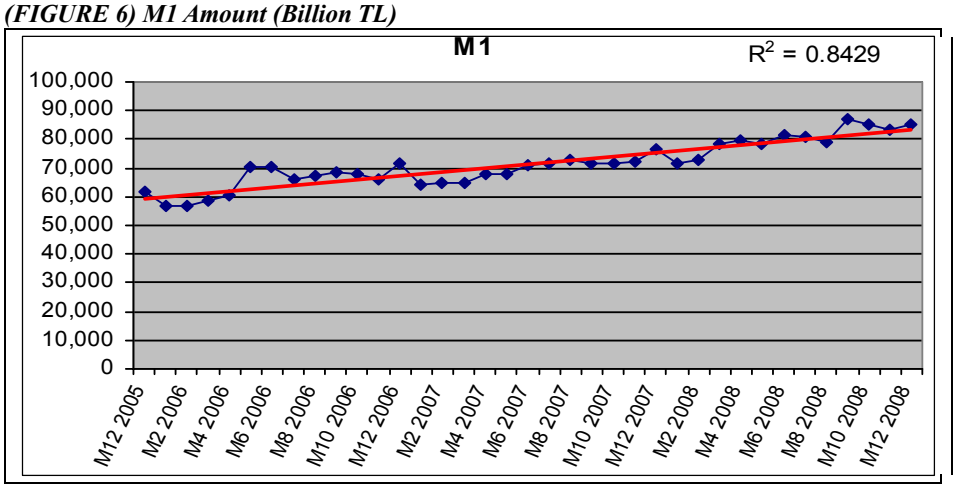
*(FIGURE 5) % Change in CBRT Total Gross Reserves Comparing with the Months of the Previous Year*




**4.3 M1**

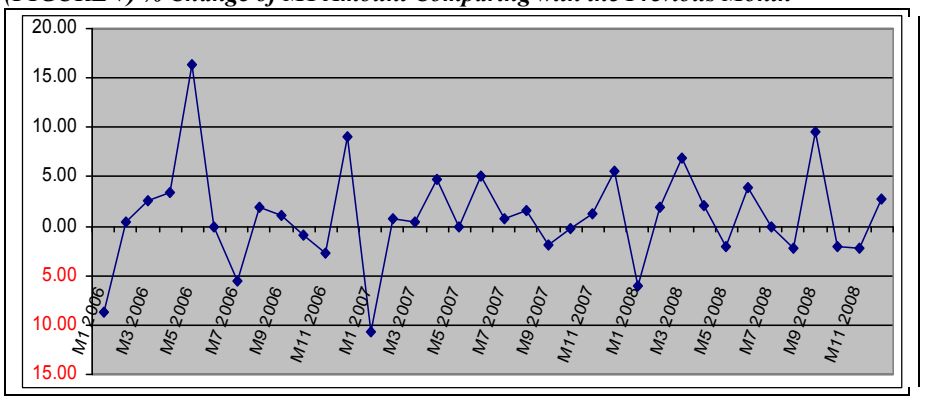
The increase of 17%, which took place at the same period of the previous year in money supply, is not considered as a crisis signal. When we look at the M1 level in Turkey, there seems a steady increase, which is compatible with upward trend between 2004 and 2008.

*(FIGURE 6) M1 Amount (Billion TL)*




When we look at percentage change in proportion to M1 money amount, overall tendency looks as floating in +,-5% rates. Only in May of 2006 an increase of 16% comparing with the previous month is observed and before this turns to a general increase trend, after a period it's returned to the trend. In evaluations, which were made in portion to the previous year's same month, when there were no seasonal effects, these results were confirmed. On the other hand, while the comparison of money supply of the years 2003 and 2008, when economy's long term trend had grown, and the previous year can cause a perception fail because of the growth, it would be more suitable to evaluate the monthly change.

*(FIGURE 7) % Change of M1 Amount Comparing with the Previous Month*

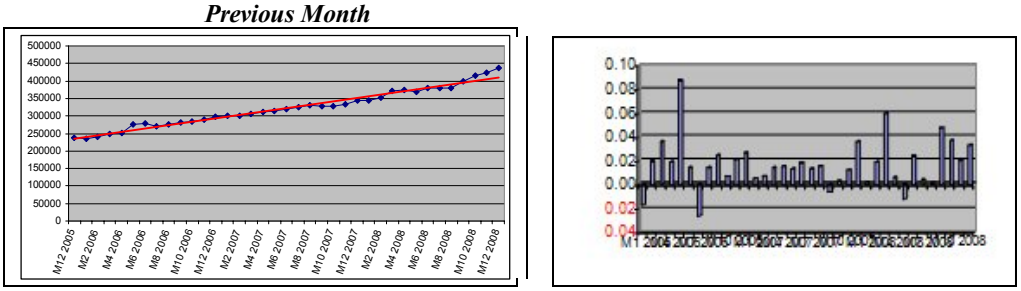



During the breakdown of the money in circulation and drawing account items, which are related to M1, it's observed that lower items also adapted themselves to general trend and there was not an increase, which can point an overheating at any of the items.

### 4.4. M2 / GROSS INTERNATIONAL RESERVES

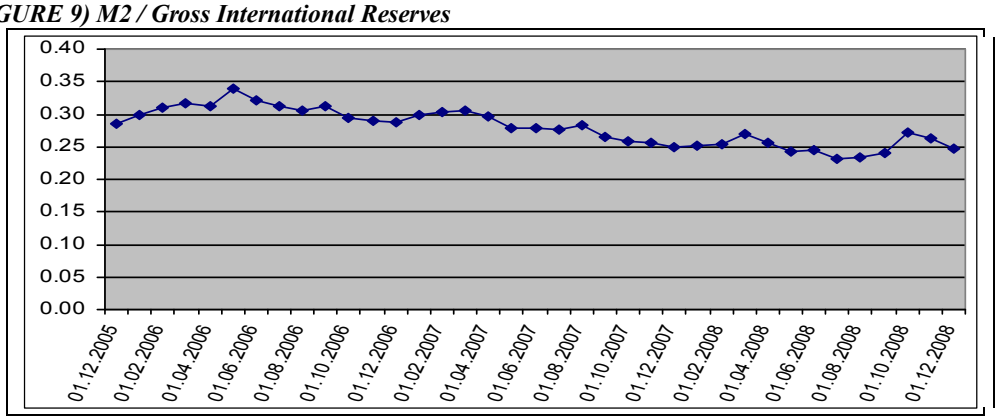
There seen a moderate development parallel to economic growth in M2, like in M1. M2 money growth's overall deviation tendency was +5%, - %2 in proportion to the previous month and proceeded in a really steady way. Confirming the above reached results this situation shows that economic crisis, that we live, is not predictable with the help of money indexes.

*(FIGURE 8) M2 Amount and the % Change in M2 Amount Comparing with the Previous Month*



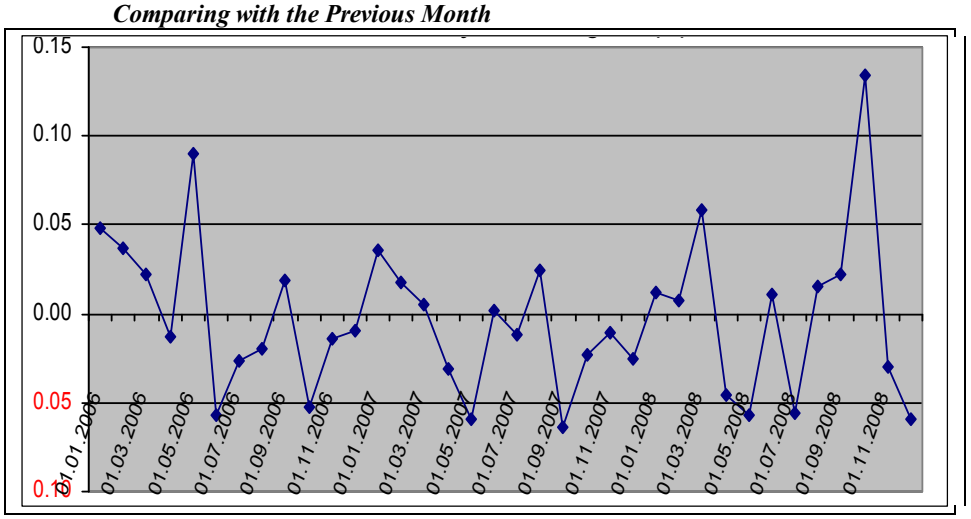

M2 / Gross International Reserves rate is an important indicator especially from the point that it shows self-defense strength of money authority in cases of speculative attack crisis. Reduction of this rate means decreasing of reserve rate according to size of the money and it also cuts central bank's intervention ability to sudden movements which can progress as an attack in exchanges. When we look at radio's trend, it seems not strong and there is seen a general decrease trend. As stated above, although there is a serious improvement in reserve position, credit growths' getting ahead of this by the effect of economic growth expresses this reduces in trends.

*(FIGURE 9) M2 / Gross International Reserves*

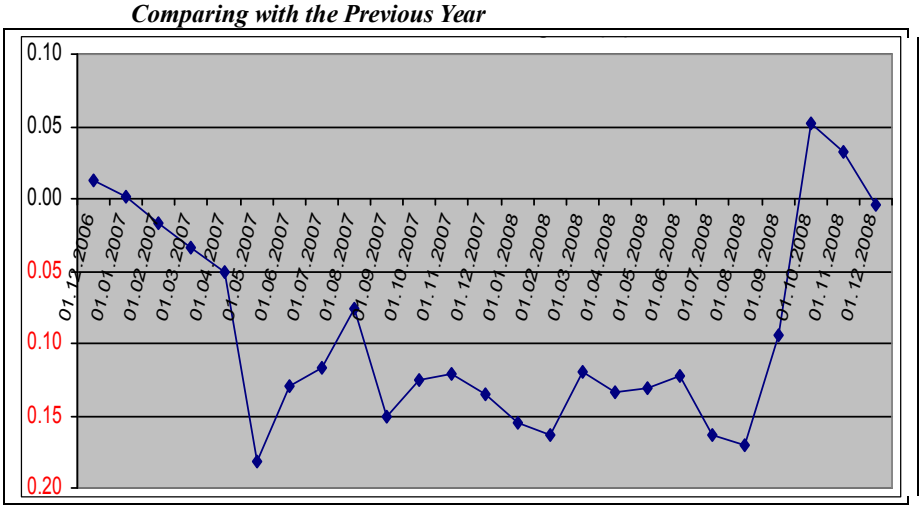


10% reduce, which is seen in M2 / Reserves rate comparing with the previous month, is accepted as a crisis signal. Being in the interim of +,-5% of volatility in ratio, which was formed till the period the crisis began, is seen that it is not a crisis signal. In the comparisons of the previous years, the rate strongly signalizes a crisis by continually crossing 10% threshold starting from 2007. Another reason for this is M2's high value in USD because of extremely valuable TL between the years 2006 and 2008. Trend showed a change after the third period of 2008, when the crisis began.

***(FIGURE 10) % Change in M2 Gross International Reserves Rate Comparing with the Previous Month***



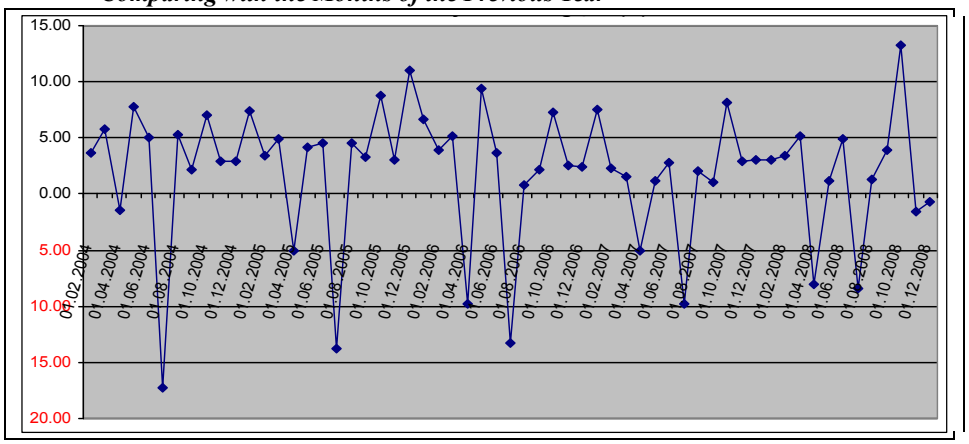

***(FIGURE 11) % Change in M2 Gross International Reserves Rate Comparing with the Previous Year***




**4.5 DOMESTIC CREDITS / GDP (GROSS DOMESTIC PRODUCT)**

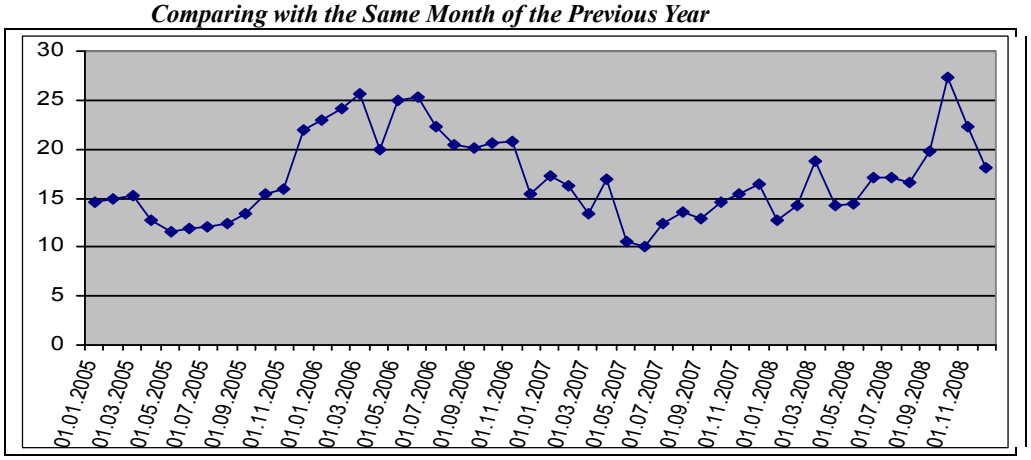
Since rapid expansion in domestic credits is perceived as a sign of economics' overheating, it has been placed in crisis signals. In literature an increase of 19% in domestic credits in proportion to GDP is seen as a crisis signal. The rate has a floating progress as it can be seen in the graphic which shows the changes in comparison with the previous month.

*(FIGURE 12) % Change in Domestic Credits / GDP Rate*
*Comparing with the Months of the Previous Year*




By the comparisons, which were made as to the previous year, it is seen that 19% threshold had been continuously passed over during the year 2006. When the deviation, which passed over 100%, from in 2006 planned inflation is taken in the account, the result of a rapid expansion in credits and consumption can be confirmed. Domestic credits/GDP rate had been giving a crisis signal throughout 2006.

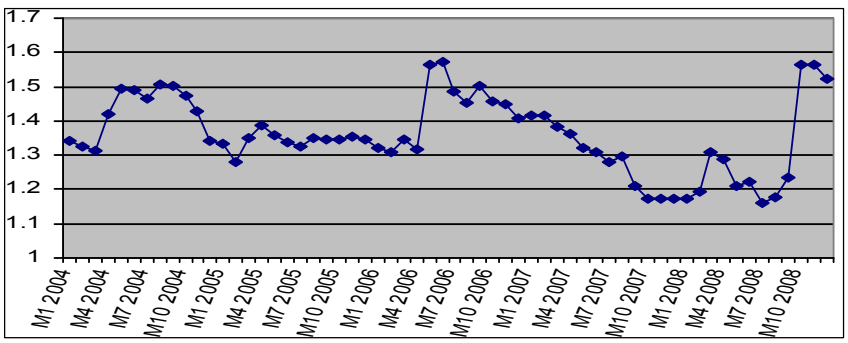
*(FIGURE 13) % Change in Domestic Credits / GDP Rate*
*Comparing with the Same Month of the Previous Year*




**4.6 REAL EXCHANGE RATE**

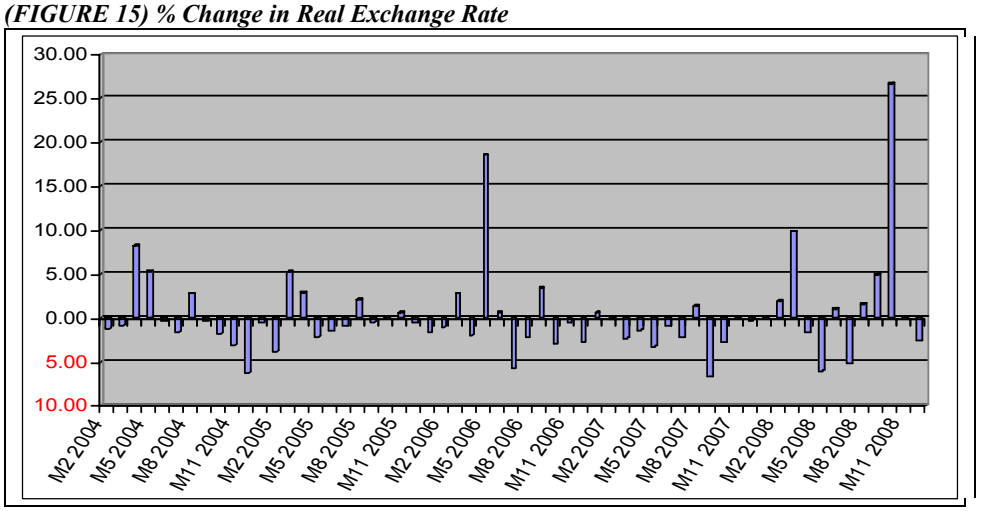
A 10% change in exchange rates is seen as a crisis signal. When we look at the previous crisis in our country, effectiveness of high interest – low rate spiral makes this criterion more important. When we look at general progress of the exchange rate, it is seen that it is fluctuating in a very wide band. This fluctuation, which occurred approximately between the rates 1.2 and 1.6, has lied in a long process and did not get stronger with the change on monthly basis.

*(FIGURE 14) Real Exchange Rate*



In the graph, which shows the changes comparing with the previous month, there was a loss in value near to 20% just in May 2006; other changes stayed quite under the critical threshold. While it is not possible to evaluate the changes in real exchange rate as a crisis signal, the irresponsive act of the rate to the growths in current account balance is also as remarkable as being a subject of another research.

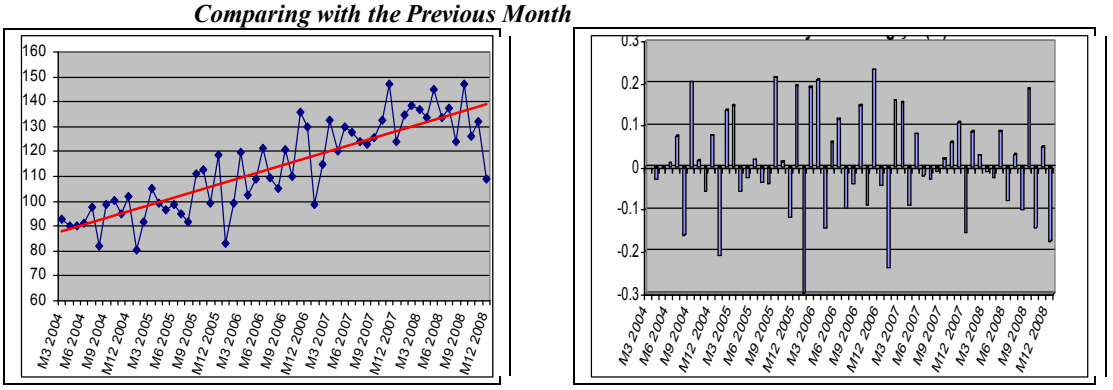
***(FIGURE 15) % Change in Real Exchange Rate***




**4.7. EXPORT**

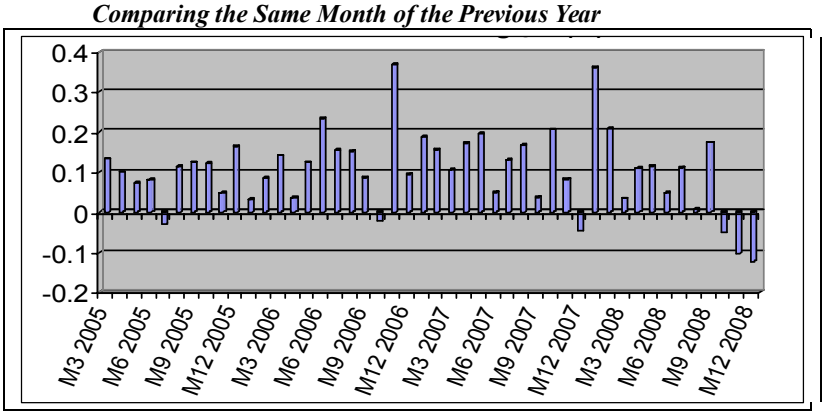
Export figures are important from the point of the situation of balance of payments of the country, and they also one of the important reasons of crisis' infectious structure. Since a county's exportation is the importation of others, reduction in exportation in country A for economical reasons reduces other country's importation and this affection may become an infection by spreading out other countries. Decrease of 10% in exportation comparing with the same month of the previous year is evaluated as a crisis possibility in following 24 months. Turkey's exportation rates, which are strongly prone to increase, show strong monthly and seasonal fluctuations at the same time.

***(FIGURE 16) Exportation and Percentage Change in Exportation Comparing with the Previous Month***




When we look in the point of changes, which happened in the previous year used as a base for threshold value, there had been seen decreases in exportation just for 3 months if last few months in 2008 are disregarded; and these were under the threshold values (approx. 2%). Exportation data does not give any crisis signal.

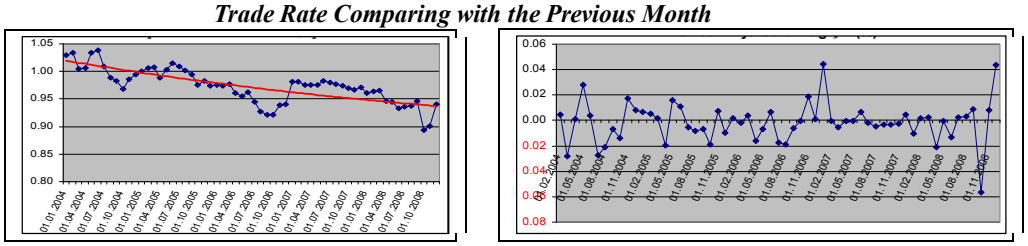
*(FIGURE 17) % Change in Exportation Amount Comparing the Same Month of the Previous Year*




## 4.8. FOREIGN TRADE RATE

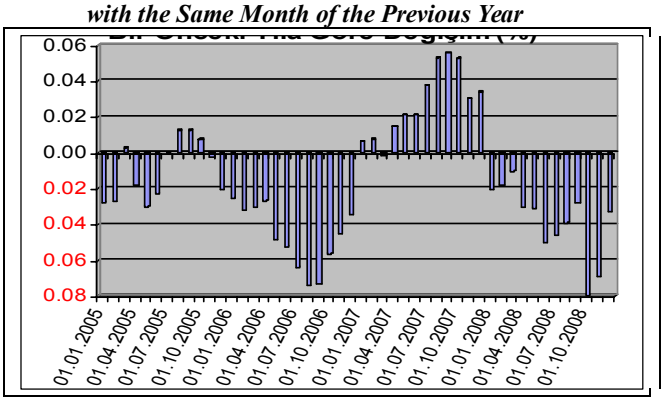
A reduction in foreign trade rate, which is defined as the rate of export goods price index to import goods price index, shows the reduction in competitive capacity of a country. An 11% decrease in this rate is evaluated as a crisis signal. When we look at the general trend, it's seen that foreign trade rate is continuously decreasing except for two periods, when there were rate changes. This situation, which is also expressed as overvaluation of Turkish Lira, shows itself in import and foreign trade deficit results. In the evaluations, which were made in comparison to the previous month, the changes in foreign trade rate is extremely low and there was no a sudden change.

*(FIGURE 18) The Change in Foreign Trade Rate and % Change in Foreign Trade Rate Comparing with the Previous Month*




When we look at the change comparing with the previous year, it can be seen that change level is quite under the threshold value. Through the graphs it can be said that foreign trade rate doesn't signalize a crisis.

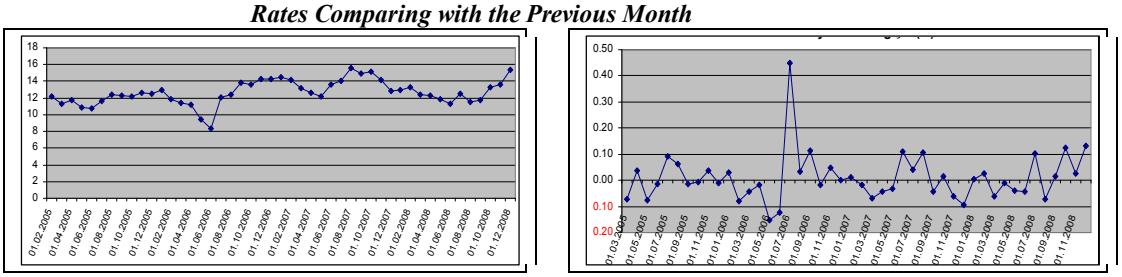
*(FIGURE 19) % Change in Foreign Trade Rate Comparing with the Same Month of the Previous Year*




## 4.9. COURSE OF REAL DEPOSIT INTEREST RATE

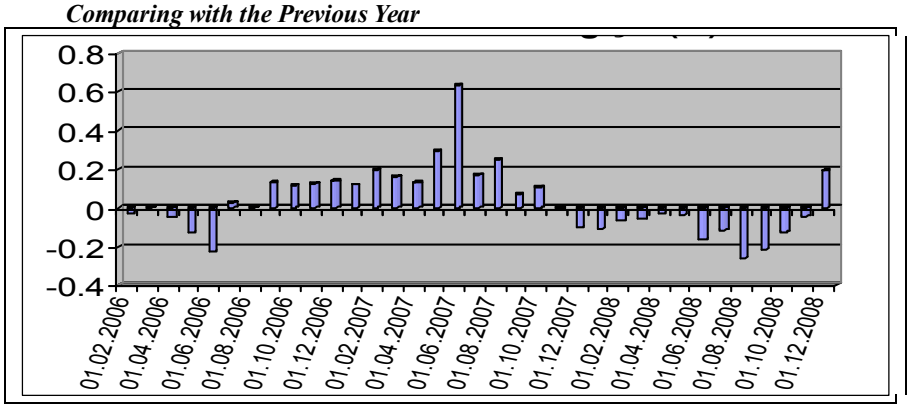
Despite of the decrease in real interest rates, which is gotten with the purification of nominal interest rates from the effect of inflation, in comparison with the previous years – with the decrease in inflation and stabilizing of macro economical balances - and the decrease in fluctuations, a rate between 8% and 16% is still too high according to world standards.

*(FIGURE 20) Real Interest Rate and % Change in Real Interest Rates Comparing with the Previous Month*



Fluctuation of real interest rates on such a wide band shows itself also in changes of the previous year. Real interest's 8.2% rate in June 2008 reached to 13.5% one year later and it is shown as a 60% increase in the graph. When it's thought that a 15% change is seen as a crisis signal, crossing this threshold 5 times in 2007 has to be evaluated as a strong signal for a crisis.

*(FIGURE 21) The Change in Real Interest Rates Comparing with the Previous Year*




## 5. GENERAL EVALUATION AND RESULT

2007 Crisis was not able to be predicted by any models caused the effectiveness of early warning systems that have been built so far to be questioned. KLR model, which we used in our study, was the most preferred early warning system between the years 1996 and 2006; it had been seriously criticized in last periods. This model's prediction had been tested for several countries and it was expressed that the model is not successive enough for predicting the crisis in 2007. The aim of our study is to test this model by using the economic data of Turkey.

As it can be seen in Figure 22, only 2 of 8 variables can be evaluated as crisis signals. While the rest is not seen as a crisis signal, most of these also show extremely strong macro-economic balances and a healthy development.

**(FIGURE 22) Indicators and Signals of 2007 Crisis**

| INDICATOR | SIGNAL |
|---|---|
| *PRODUCTION INDEX* | *N.A.* |
| *INTERNATIONAL RESERVES* | *N.A.* |
| *M1 LEVEL* | *N.A* |
| *M2/GROSS INTERNATIONAL RESERVES* | *STRONG* |
| *DOMESTIC CREDIT/GDP* | *N.A.* |
| *REAL EXCHANGE RATE* | *N.A.* |
| *EXPORT* | *N.A.* |
| *FOREIGN TRADE RATE* | *N.A.* |
| *REAL DEPOSIT INTEREST RATE* | *STRONG* |

If it had been researched whether there would be a crisis in next 24 months by using the Signal Approaching before crisis, it couldn't be possible to predict this crisis. To this respect, it can be said that the Signal Approaching is not successive in prediction of a crisis in the case of Turkey. Testing new developed models with Turkey's data should be the subject of other studies.

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