DISSERTATION

WERE TURKEY'S 1994 AND 2001 TWIN CRISES PREDICTABLE?

THE SIGNAL APPROACH

Submitted by

Timur Mihyaz

Department of Economics

In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2013

Doctoral Committee:

Advisor: Robert Kling

Nancy Jianakoplos
Ramaa Vasudevan
Stephen P. Davies

ABSTRACT

WERE TURKEY'S 1994 AND 2001 TWIN CRISES PREDICTABLE? THE SIGNAL APPROACH

This study presents a signal approach for predicting the occurrence of currency and banking crisis by using Kaminsky and Reinhart's (1999) Signal Model. The paper focuses on testing this theory by examining the twin crises that occurred in Turkey in 1994 and 2001. In the first step, leading indicators for twin crisis are chosen and then these indicators are used to calculate composite indicators. The out-of-sample performance will also be introduced for the period of 2007-2009. The estimation period is from Jan-1987 to Feb-2001. The real exchange rate (deviation from trend), Export/Import ratio, Excess M1 Balances, Bank Reserves/Bank Asset ratio, and oil prices are the top five indicators that are useful for predicting such crises. Short Term Debt/Reserves, Import, Reserves, and real interest rate are the other important variables that performed well for anticipating these crises.

TABLE OF CONTENTS

I. INTRODUCTION

Banking and currency crises have been costly for domestic economies and generated instabilities in international markets. This high cost has encouraged researchers to work on predicting and averting future financial crises. The best known model for predicting banking and currency crises is the Early Warning System. The aim of this model is to find the relationship between macroeconomic variables and crises episodes, and to warn the authorities about future crises so that they can make appropriate policies to prevent crises. Turkey experienced two financial crises in less than a decade and their cost to the Turkish economy was enormous. The speculative capital inflow is considered to be the main reason for these crises.

Capital flows are an important source for developing countries that need external funds to finance their economic growth. There are two types of capital flow. One is foreign direct investment (FDI) and the other is portfolio or equity investment (PI). FDI refers to a company from a foreign nation making physical investments into the domestic structure, equipment and organizations of a host country. Portfolio investment refers to investment into stocks, bonds and other securities. FDI is considered to be more useful for developing countries; at the same time, portfolio investment is risky for such economies because of the volatile nature of foreign hot money. A sharp withdrawal of foreign funds causes a decline in asset values in the host country and a painful economic downturn may follow. In our study we mainly focus on the aspects of portfolio investment (or hot money) and its effect on the Turkish economy.

Portfolio investment in a country is driven by two types of factors, internal and external. External factors are defined as low interest rates in the dollar market and recessions abroad, especially in industrial countries. When portfolio investors face a decline in investment opportunities in their home country, they look for other markets that offer higher returns. The

other force driving investor interest in developing countries is the opportunity for risk diversification. Internal factors are high local real interest rates, low and stable exchange rates, economic and political stability in the host country, financial integration into the world market, etc.

In the early 1980s with strong encouragement from world financial institutions, such as IMF and the World Bank, most developing countries, including Turkey, began the process of capital account liberalization, currency convertibility and financial deregulation. Since then there has been a huge amount of capital flow of portfolio investment from advanced countries to emerging market economies. At the beginning, this flow was considered an efficient means of transferring capital to countries where it is scarce. However, after a short time, the serious financial crises of the 1990s took place. Mexico and Turkey experienced financial shocks in 1994, and the Asian and Russian crises followed in 1997 and 1998, respectively. In 2001, Turkey again faced another financial crisis because of nearly the same problems. Even though some economists argued that these crises reflected exceptional circumstances, it has been generally agreed by most observers that capital movements, especially as a norm of portfolio investment, are a major source of imbalance for developing countries. These crises have demonstrated that the emerging market's reliance on speculative foreign capital flow and openness to hot money is destructive for such markets.

Even though all these crises were ignited by similar speculative attacks on countries' financial markets, the origins of the crises differed from country to country. The factors behind the crises in Latin America, Russia and Turkey were high budget deficits, high inflation, a high level of government debt, and a fragile financial sector. However, the Asian crises followed different patterns. Firstly, Asian governments were running budget surpluses and their inflations

and public sector borrowing requirements were low and steady. The crises in Asia stemmed mostly from the private sector. Investors put their money extensively into real estate and expected high earnings in return. Under such circumstances, booms and busts in the real estate sector produced instability in the financial system.

Turkey, like most developing countries, has engaged in a race to accumulate foreign capital. Turkey has adopted a flexible exchange rate, lowered legal reserve requirements and liquidity ratios, liberalized interest rates, created interbank money markets, and reopened the Istanbul Stock Exchange. With such a degree of financial deregulation, the Turkish stock and bond markets were open to foreign investors. However, all these reforms together did not bring adequate capital flow to the Turkish economy during the 1980s. Nonetheless, during the 1990s, internal and external factors did change to favor capital inflow to emerging market economies. This increase was due to low interest rates in industrialized countries, sounder fiscal policies in developing countries, more financial integration into the world market, and finally, major advances in technology and financial instruments. Although most of this foreign capital was received by developing countries in Asia and Latin America, Turkey began to increase its portion of total foreign investment in the world market during the early 1990s.

However, the preconditions of the Turkish economy were inadequate for utilizing foreign financial flow efficiently, thereby turning it into sound investment. Turkey experienced two economic crises in 1994 and 2001 mainly because of speculative attacks on the financial market. In the early 1990s, most of the capital inflow to Turkey was portfolio investment and short-term loans, and due to loss of confidence the outflow of capital, began to occur, especially in 1994. The result was a significant financial shock and negative economic growth for a long period of time.

The second crisis was preceded by the financial turmoil that erupted at the end of 2000, followed by the collapse of the exchange rate system. Consequently, the Turkish government was compelled to announce the implementation of a floating exchange rate system. One of the main reasons behind this second crisis was again international liquidity outflow, which was triggered by a political crisis that occurred in the government during the meeting of the powerful National Security Council in February 2001. The fragility of the banking sector in Turkey was a further element in fueling the crash. Some scholars have also blamed IMF programs and the inadequacy of governmental crisis management policies.

Virtually the same background is observed in the crises of 1994 and 2001. The main problem Turkey faces is liberalization without control of the public sector deficit, together with chronic inflation. A large public deficit financed by debt results in high domestic interest rates, motivating portfolio investors to move into the market. This leads to an increase in monetary aggregate and currency appreciation, which in turn raises the expectation of devaluation and inflation. Domestic currency appreciation in real term causes an increase in the current account deficit, which is another predictor of speculative attacks.

The effects of the second crisis were more destructive to the economy than those of the first. The second crisis severely hit the banking system and corporate sector. Several banks were taken over by the Saving Deposit Insurance Fund (SDIF). Average interest rates were four times higher than the previous level, the Turkish Lira lost 44% of its value at the beginning of the crisis, and the Central Bank had to use around $10 billion, which was nearly half of the total foreign reserves that it held in order to reduce the downward pressure on the Turkish lira. The GNP fell by 8.5%, while inflation rose to 86%.

There is now concern that such a problem could occur again in the near future. The amount of hot money entering Turkey has increased by a factor of eleven from $8.9 billion to $107.0 billion since 2002, and is mostly invested in the stock market. The number of shares owned by foreigners on the Istanbul Stock Exchange is around $72 billion, which is equivalent to 72.4% of the total shares. In order to keep global funds in the market, Turkey has to offer high interest rates in real terms. These high returns cause the appreciation of the Turkish Lira. The overvaluation of the Turkish Lira in turn result in high trade deficits, while high real interest rates results in financing by foreign funds. Because it is known that an interest rate increase in the US would have the effect of changing the direction of capital movement, each day, policy makers, bankers and stock market experts are waiting for the US Federal Reserve Bank's next move.

We argue that the 2001 Turkish crisis can be classified as a twin crisis since the currency crises and banking crises occurred simultaneously, the banking crisis having occurred in November 2000, followed by the currency crisis in February 2001. In addition to unfavorable external conditions in the world in 2000, namely increased interest rates in the United States, the rise in energy prices, the continuing appreciation of the Euro against the US dollar, Turkey's weak economic fundamentals, the government's mismanagement of crisis intervention, and inadequate IMF programs were important domestic factors leading to the crises. The other important aspect was the fragile structure of the banking sector. The case of twin crisis shows similarities to the earlier twin crisis of the 1990s. As Dooley (1997) and Krugman (1998) argue concerning the causes of the twin crises, Turkey's fixed exchange rate system collapsed due to moral hazard driven by governmental guarantees to the financial sector with inadequate banking regulation and supervision.

The aim of this paper is to construct an early warning system to predict twin crises and simultaneously *to test the ability* of Kaminsky and Reinhart (1998) model *to detect* 1994 and 2001 Turkish crises. This research also concentrates on finding certain variables that issue good signals. The remainder of this paper is organized as follows: Section 2 briefly reviews the theoretical literature of financial crisis; Section 3 summarizes Turkey's economic condition prior to its crises; and Section 4 introduces the Kaminsky and Reinhart (1998) model. In Section 5, the empirical results will be presented. The paper will end with the summary of the main arguments and conclusions in section 6.

II. LITERATURE REVIEW

There are three approaches to financial crisis, namely the first-generation models (FGM), the second generation models (SGM), and the third generation models (TGM) (a distinction offered by Eichengreen), which seek to explain what drives financial crises. The first-generation model (Krugman1979, Flood and Garber 1984) focuses on the problem of the balance of payment in a country. FGM is inspired by the Salant and Henderson (1978) model, which is the model of exhaustible resources. In such a model, central banks use their reserves in order to prevent a change in gold price. The model shows that the policy of selling reserves cannot halt the fall of the price of gold, since private agents keep buying the gold until the stock is exhausted. Krugman suggests similar assumptions in his currency crises model, which postulates that under a fixed exchange rate system, if a government finances its budget deficit by monetary expansion but has a limited amount of international reserves to maintain its fixed exchange rate system, it will face a balance of payment crisis. Anticipating the inability of maintaining the currency peg by investors generates a speculative attack on the currency, which eventually causes the crisis. Since the demand for domestic currency does not change, an increased money supply puts downward pressure on the currency. In order to hold the exchange rate constant, the country's central bank sells foreign currency reserves until the stock of reserves is exhausted. This process culminates in abandoning currency peg.

First Generation Models

Krugman (1979) argued that under a fixed exchange rate regime, a speculative attack is inevitable. When agents change their portfolios from domestic to foreign assets, the central bank continues to use reserves in order to peg the exchange rates. Expectation of abandoning the currency peg triggers speculative attacks. When foreign reserves reach the critical point, the

currency peg is no longer sustainable and finally the fixed exchange rate regime collapses. Since Krugman's BOP is the one of most influential models in this area, it is useful to examine it more closely.

The BOP model is as follows:

First: Purchasing power parity (PPP) prevails and uncovered interest parity holds between domestic and international interest rates. All variables are expressed in logarithms except interest rate and demand for money.

$$p(t) = p(t)^* + \varepsilon(t) \quad (1)$$

$$i(t) = i(t)^* + e(t) \quad \textbf{(2)}$$

p(t) represents domestic price level, p(t)* international price level, ε(t) the rate of devaluation of domestic currency, i(t) domestic interest rate, i(t)* international interest rate, and lastly e(t), the expected rate of depreciation of the domestic currency. PPP holds and international inflation is zero while domestic price level equals domestic exchange rate. Under perfect capital mobility and perfect foresight, the domestic interest rate equals the international interest rate.

$$m(t) - p(t) = -\alpha i(t) \quad (3)$$

$$m(t) = d(t) + r(t) \quad (4)$$

$$d = \mu \quad (5)$$

m(t) represents domestic money supply, αi(t) denotes demand for money, d(t) domestic credit, r(t) reserves, d domestic credit growth and μ constant rate. Equation (3) shows a state of money market equilibrium. Equation (4) indicates money supply equal to domestic credit and reserves.

Finally, equation (5) shows that domestic credit grows at a constant rate μ.

While an economy is in a fixed exchange rate system, $\varepsilon(t)$ and consequently $e(t)$ are zero, denoting that domestic price level and interest rate equal international price level and interest rate respectively. Under these assumptions, and if $i(t)^*$ and $p(t)^*$ are zero, we can derive the following equation:

$$r(t) = r(0) - \mu \quad (6)$$

$r(0)$ represents initial reserve held by the central bank. The above equation demonstrates that reserves decrease when domestic credit grows; in other words, the currency peg cannot be sustained if credit growth exceeds money demand. After some point, reserves will be exhausted and the fixed exchange rate system will be abandoned. In infinite time, $d(t)$ will be greater than money supply consistent with money market equilibrium under fixed exchange rate system. After a point of time (when reserves are either exhausted or reach a predetermined level), a fixed exchange rate regime is not viable. Let us assume that $r(1)$ is the predetermined level.

$$r(t) \geq r(1) \geq 0 \quad (7)$$

If reserves are higher than predetermined level ($r(t) > r(1)$), a fixed exchange rate regime is maintained. If not, the authorities allow the exchange rate to float.

Another assumption of the model is related to central bank policy decisions. $d(t)$ is the only instrument for policy makers. The authorities cannot change money supply or interest rate through a policy of sterilization (a method by which a central bank attempts to affect the value of

the domestic currency relative to a foreign currency). The model indicates that crises stem from the rational behavior of investors. The level of r(1) is known by market participants with perfect foresight. They anticipate that the central bank will abandon the fixed exchange rate system when reserves reach the predetermined level. Consequently, in order not to lose because of the change from a fixed to a floating exchange rate system, they will the attack currency.

The Krugman model demonstrates a failure to determine the time when a speculative attack may occur. Flood and Garber (1984) found the way to determine such time by using backward induction. Even though FGMs make it possible to understand the reasons behind crises, they fail to explain two aspects of such crises: first, why an agent's expectations may change so suddenly, and second, the process of contagion effect.

Second Generation Models

A second-generation model was developed by both Obstfeld (1994) and by Eichengreen, Rose and Wyplosz (1994). Criticisms of FGM were voiced, since FMG was unable to explain the currency crises in the European Union under the European monetary system in the early 1990s. In such cases, the budget deficit and depletion of international reserves which led to abandoning the currency peg were not the issue. Rather, currency crises arise as a matter of political references rather than as the result of policy inconsistencies. Speculative attacks can occur even under a successful exchange rate regime and a country can face trade-offs and decisions. Maintaining a fixed exchange rate system (e.g. import of credibility in reducing inflation) can be outweighed by short-run macroeconomic flexibility (e.g. a policy of pursuing growth and reducing the unemployment rate). This might lead to the decision to abandon the currency peg. If speculators question the governments' interest in fixing the parity, they may attack the currency, resulting in a self-fulfilling crisis of confidence.

There are several factors that push governments to abandon the fixed-exchange rate regime. One of these is the obvious fact that domestic debt is another policy concern for governments. In order to reduce the real domestic debt, governments may chose to reduce the value of the domestic currency, as it can be utilized as an option in reducing the unemployment rate. Obsfeld (1994) and Velasco (1996) argue that domestic public debt is one of the main factors leading to currency crises. And in addition to the level of public debt, debt maturity structure is another element that affects governmental decisions.

Eichengreen, Rose and Wyplosz (1996) find a self-fulfilling contagious effect among neighboring or trading partner countries. Currency crises in one country will increase the probability of a speculative attack of a trading partner of such country. There are several possible reasons for contagion effects. First, an economic shock to a country such as a war or oil shock can affect the economies of neighboring countries. Second, the devaluation of a currency can raise the expectation of devaluation in other countries either because the countries are neighbors or trading partners, or have similar economic conditions. However, the crises in Mexico and Asia focused attention on another aspect of financial crises, especially as earlier models, FGM and SGM, were weak in explaining the causes of crises in these countries.

Third Generation Models

A third-generation model was developed by Krugman (1998), Dooley (1997), and Radelet and Sachs (1998). Numerous studies, such as those of Kaminsky and Reinhart (1999), Chang and Velasco (1998), Berg and Pattillo (1999), relate to this model. According to these models, currency and banking crises generally occur together (Kaminsky and Reinhart term such crises as a "twin crisis"). Some of these authors predict that banking crises cause currency crises, while others argue a reverse causation. These studies also categorize financial crises into

three different groups: moral hazard (Dooley 1997 and Krugman 1998), contagion (Calvo and Reinhart 1996, and Eichengreen 1996), and herd-behavior (Calvo and Mendoza 1996).

Krugman's FGM assumes that a crisis is inevitable when agents expect domestic currency devaluation. However, FGM does not include what policies are needed in the face of crises. Krugman (1998) improves his model by adding policy recommendations for central banks during crises. He also examines the impacts of policies related to crises. The model argues that fragility in the financial market, especially in the banking sector, will result in financial crises in an economy. Krugman (1998) also argues that a new model is required in order to understand the Asian crises. His first model is able to capture various aspects of the Russian crises of 1988, which occurred mainly because the government printed money to finance the budget deficit. Obstfeld's self-fulfilling model can explain the sterling crisis in the United Kingdom in 1992. The government of UK faced a trade-off between exchange rate stability and its policy for decreasing unemployment rate. However, these two models were not relevant to the major crises in Asian countries. Such crises are more related to moral-hazard-driven lendings, or Diamond-Dybvig-type (1983) problems (a self-fulfilling loss of confidence that causes immediate sales of premature investments by financial intermediaries) or both in those countries. Krugman's suggestions to policy makers for preventing crises are, first, "transparency" in the financial market; second, better capital standards; third, better control of risk-taking investments, and finally, the ending of cronyism. Krugman (1998) argues that currency crises would likely occur if an economy faces high debt, low foreign reserves, expects devaluation, experiences domestic borrowing constraints, and subjected to repeatedly falling government revenue.

Kaminsky (1998) and Kaminsky and Reinhart (1999) used the signal approach to forecast currency crises. Kaminsky and Reinhart (1999) found that after 1980, twin crises were generally followed by financial liberalization in various countries. These authors could not find any connection between the currency and banking crises of the 1970s, since financial markets were almost closed to other countries at that time. Their work demonstrates that currency crises deepen banking crises, either by worsening existing banking crises or creating new ones. Twin crises bring recession in the economy as a result of worsening terms of trade, overvaluation of domestic currency, and an increase in the interest rate.

According to Kaminsky and Reinhart's (1999) empirical study, twin crises occur when the beginning of currency crises follows the beginning of banking crises within a period of 48 months. The authors' interest in the study was to determine which economic variables are related to twin crises. When the chosen variables exceed a specified level or point (threshold), a crisis may occur within a specific time period; (the time interval between crises and the signal for currency crises is determined to be 24 months, and that for banking crises 12 months). Sixteen variables are divided into four sectors, namely, financial sector, external sector, real sector, and fiscal sector. In the financial sector, seven variables are used. The ratio of domestic credit to GDP and the ratio of M2 to base money (M2 multiplier) are selected because it is argued that rapid growth in credit and the money supply are related to twin crises. The interest rate and the ratio of lending to deposit are selected because they are related to banking crises. A rise in interest rates shows an increase in risk-taking and also lending-deposit ratio increase indicates a decrease in loan quality. Additionally, excess M1 reserves and the ratio of M2 to reserves are also chosen because they show a loose of monetary policy. The final variable is bank deposits because capital flight and bank runs are the indicators of twin crises.

As external variables, six values were chosen. Export measures, terms of trade, and real exchange rate are considered, since overvalued domestic currency has a high impact on any currency crisis and also spells trouble for the financial sector. Import is also selected as a variable since a rapid increase in imports causes overvaluation of the currency. Real interest rate differentials (interest rates in domestic economy compared to that of the United States if the currency is pegged to the US dollar) and reserves are chosen as external variables since both variables may cause capital flight, and bank run. Output and stock prices were chosen as real sector variables because declines in asset prices and recession negatively affect financial markets and may deepen financial crises. Finally the ratio of budget deficit to GDP is used as a fiscal sector variable because budget deficit may result in balance of payment crises, as in Krugman FGM.

Kaminsky and Reinhart's (1999) study found that capital account indicators are the most effective signal both types of crisis. Financial liberalization indicators were also found to be important. The highest effectiveness among capital account indicators for signaling twin crisis is real interest rate differentials. Real interest rate and M2/ reserves in financial sector indicators demonstrate the highest performance in signaling twin crises. The other indicators are also somewhat important; excess M1 balances, bank deposits, and lending-deposits ratio are the least effective indicators. Current account indicators are next, and export has the highest rate. The fiscal variable is negligible in signaling a single crisis and twin crises.

Frankel and Rose (1996) used a probit model in a sample of 105 developing countries for the period 1971-1992. They state that a 25 percent or greater decrease in the value of domestic currency is termed a currency crash. These authors divide domestic variables into four groups, namely, macroeconomic indicators, external variables, debt composition, and foreign variables.

The macroeconomic indicators selected are the growth of domestic credit (monetary policy), budget/GDP, reserves/import, current account/GDP, the growth of GDP and appreciation of currency. Debt/GDP, reserves/import, current account/GDP and real exchange rate are chosen as external variables. As for debt composition, two values are compared each other, such as FDI vs. portfolio investment, long-term vs. short-term portfolio capital, fixed-rate vs. floating rate borrowing, and finally, domestic-currency vs. foreign-currency denomination.

Frankel and Rose (1996) argue that external factors were the major reasons for the crisis in Latin America and Asia in the early 1990s. Consequently, not only do domestic variables need to be examined but also economic variables globally. Short-term northern interest rates and real OECD output growth are included as foreign variables. Frankel and Rose (1996) found that as FDI flow decreases in comparison to portfolio flow, when reserves drop, when domestic credit growth is high and domestic currency is overvalued, a currency crash is expected to occur. It is seen that the current account and government deficit are not important indicators in the occurrence of currency crises.

Goldfajn and Valdes (1997) used a logit model utilizing data for 26 countries over a 13–year period to determine whether overvaluation of currencies and exchange rate expectations are significant causes of currency crises. They found that lagged overvaluation of exchange rate was a statistically significant variable; however, their results show that expectations alone cannot be used to signal crises. Rather, they should be included with other indicators in order to predict crises. These authors argue that exchange rate crises are unpredictable. Most empirical studies demonstrate that the real exchange rate is statistically significant and in fact is the most reliable indicator of currency crises. However, Goldfajn and Valdes (1997) argue that the real exchange rate is a variable with other macroeconomic fundamentals rather than a unique indicator of such

crises. They criticize some empirical studies which use only the samples of crisis episodes, as this restriction cannot identify false signals. The sample should be sufficiently large to include both crisis and non-crisis episodes.

Goldfajn and Valdes (1997) used three different measures to define crisis episodes. The first of these is defining a currency crisis as a large devaluation [from the methodology of Frankel and Rose (1996) and Meese and Rose (1996)]. If devaluation is greater than 1.96 times the standard deviation of the countries' nominal devaluations and 2% plus 1.5 times the devaluation rate of the preceding month, then devaluation is defined as a currency crisis. The second measure is a large jump in the real exchange rate. If such a rate is greater than 2 standard deviations from the mean, the country faces a crisis. The third procedure is taken from Kaminsky and Reinhart's (1996) study. According to this study, devaluation and reserve losses combined are indicators of a currency crisis. The authors find that the overvaluation variable in all three measures is significant in predicting a currency crisis. On the other hand, expected devaluation is found insignificant in all measures. Kaminsky and Reinhart (1996) also measured these two variables together and found that both variables are insignificant. They stated that this is due to a multicollinearity problem.

Esquivel and Larrain (1998) also used a probit model for 30 countries (15 high-income and 15 middle-income) between 1975 and 1996. They found that the ratio of reserve money to GDP, real exchange rate misalignment, the ratio of current account to GDP, changes in terms of trade, the ratio of money supply (M2) to international reserves and growth, and finally the contagion effect were all leading indicators of currency crises. Their work supports first and second generation models, which are complementary rather than serving as substitutes and are both important in understanding crises.

Esquivel and Larrain (1998) argue that currency crises occur "only when there is an abrupt change in the nominal exchange rate." Although they use a large sample, unlike Goldfajn and Valdes (1997) proposal, unsuccessful speculative attacks are excluded from the study. According to the authors, the reason for excluding such episodes is that it is hard to define an attack when it has occurred. Consequently, their interest is in focusing on successful speculative attacks. They use two criteria for the meaning of a large devaluation. First, the devaluation has to be large compared to previous devaluations, and second, devaluation should have an impact on the purchasing power of the currency. In other words, if depreciation of the currency is due to inflation differentials, this depreciation will not be considered a large devaluation. The authors look at changes in the real exchange rates' (RER) movements in order to detect currency crises, using the following conditions: The first condition is that the accumulated three-month real exchange rate change should exceed 15 percent, while the second condition is that the one month change in RER should be higher than 2.54 times the standard deviation of RER's monthly growth rate, and also greater than 4 percent. By applying these two criteria to a sample of 30 countries between 1975 and 1996, they identify 117 crises episodes.

Demirguc-Kunt and Detragiache (2005) used a logit model and found that bank crises tend to occur when GDP growth is low, and real interest rates, inflation and money supply (M2) are high. A deposit insurance dummy was found to be a significant variable in explaining banking crises. The authors argue that empirical models are useful for determining the factors causing banking crises but not for predicting them.

Eichengreen and Arteta (2000) used a probit model for 75 emerging economies between 1975 and 1997 to search for the causes of banking crises and their relationship to currency crises. They determined that rapid credit growth, high bank liabilities/reserves ratio and deposit rate

decontrol are the main factors in banking crises. They could not find any correlation between banking crises and exchange rate regimes. However, they proposed that a deposit insurance program and/or weak financial institutions cause financial markets to be more fragile. As pointed out by Demirguc-Kunt and Detragiache (2005), Eichengreen and Arteta (2000) also argue that, unlike currency crises, it is hard to predict dates for banking crises.

Berg and Pattillo (1999) examined three different models to determine whether they are suitable for predicting Asian crises. They find that two models fail to understand the crises, while a third is somewhat informative but still not reliable. They argue that crises are hard to predict by analyzing historical data on a panel or cross section of countries, since conditions vary significantly from country to country. For example, in some countries, mobility of capital is restricted. Hence, inadequate banking supervision, poor corporate governance or political instability may result in an environment that is more vulnerable to speculative attack in one country than in another.

Berg and Pattillo (1999) used the following three approaches, beginning with Kaminsky, Lizondo, and Reinhart (1998) Signals approach (KLR). According to this model, currency crises occur when a weighted average of monthly percentage depreciations in exchange rate and monthly percentage of declines in reserves exceeds its mean by more than 3 standard deviations. The KLR model argues that when any of the chosen variables exceeds threshold level, a signal is considered to be issued. They find that eight indicators are important, as proposed by KLR, namely, real exchange rate change, ΔM2/Reserves, export growth, change in reserves, excess M1 balances, change in domestic credit/GDP, real interest rate, and growth in terms of trade. These variables were used to determine whether the KLR model predicted the crises that occurred

between May 1995 and December 1997. According to the authors, since it is not possible to predict most crises and most alarms fail, the KLR model does not provide good predictions.

The second model is Frankel and Rose's (1996) probit model, which uses annual data for 105 developing countries to predict currency crashes. Berg and Pattillo (1999) made a comparison between predicted probabilities of crisis and actual values of nominal exchange rates. They found that the FR probit model had also not been successful in predicting the crisis of 1997.

The final model is Sachs, Tornell, and Velasco's (1996) Cross-Country regressions (STV), which examines the impact of the Mexican financial crisis of 1994 on other emerging markets. In other words, the model searches for the contagious effect of the Tequila crisis. It argues that the crisis affects only countries vulnerable to speculative attacks. Investors expect large devaluation and capital outflow in countries in which there is a weak banking system, together with an overvalued exchange rate with low reserves and weak macroeconomic fundamentals. This model uses the weighted sum of percent decrease in reserves and depreciation of currency as a crisis index. It predicts that a weak banking system (as a measure of the lending boom variable) and overvalued exchange rate (as a measure of the degree of depreciation) will bring about a more severe attack. The authors, moreover, find that these factors are important if countries have low reserves (measured as reserves/M2 ratio) and weak fundamentals (measured as RER and lending boom).

The STV model compares the effects of the Tequila Crisis of 1994-1995 particularly on eight different countries that received a high volume of capital inflow during that period. Sachs, Tornell, and Velasco (1996) found that the Mexico peso crisis affected such countries differently. While the financial panic was short-lived in some countries that have strong

fundamentals, some other economies were more vulnerable to investors' panic and inverse capital inflow. The model argues that all countries that face a possible financial crash have different economic structures and fundamentals, banking systems, and level of international reserves. Even though a country has weak fundamentals and banking system, it may still prevent a financial crisis in the case of sudden capital outflow if such a country has sufficient reserves in order to be able to keep down pressure on local currency depreciation. In other words, if investors know that a host country has sufficient reserves to defend its local currency, they will not expect a capital loss in case of a reversal in capital inflow. Therefore, the country will not face the high sudden capital outflow that causes financial crises. In short, capital outflow causes devaluation but reverse is not the case. Instead, the expectation of devaluation would result in capital flight.

Berg and Pattillo (1999) ask why all three of these models above were weak in predicting crises in 1997. They argue that the KLR model did not use some important variables which are considered to be leading determinants of crisis, such as M2/Reserves (growth rather than leveling of M2) and Current Account/GDP. The authors state that the level of M2/Reserves and Current Account Deficit/GDP are more definitive in predicting a crisis. For the FR Model, instead of "Reserves/Imports" as the explanatory variable, "Reserves/External Debt and Reserves/M2" would be more useful. According to Berg and Pattillo (1999), such variables are individually significant indicators of crisis. They find that more open economies are less likely to be affected by shocks; in other words, in more open economies, changes in terms of trade or debt composition become less effective on crisis. There is no need to add an additional variable to the STV model since the model uses small size samples and also rejects alternative explanatory variables.

Feridun (2007) used both the KLR signal approach and logit regressions for two periods (1980-2006 and 1989-2006) to indentify causes of crises in Turkey. For the first period, the leading indicators were the banking sector fragility index, the ratio of short-term debt to international reserves, the ratio of bank reserves to bank assets, and the US GDP, M1 and US 3-Month T-Bill rate. However, for the second period the study found the US Federal fund rates, US GDP, US 3-Month T-Bill and banking sector fragility index to be statistically significant variables. In other words, Feridun (2007) found that external factors were the main indicators for the crises.

Calvo and Mendoza (1996) examined the causes of the Mexican crises of 1994. They argued that these crises were different from earlier ones, terming them "a new kind of balance of payment crises". It is a new BOP since the matter is not fiscal deficit, but rather poorly-managed capital inflow, which results in bank-runs and bank bailout. The currency peg becomes vulnerable because of banking fragility in the country, a change in direction of capital flow, and improper government responses to the imbalances (large current accounts and appreciation of currency). Such vulnerability causes panic runs in the financial market, which in turn causes huge devaluation and a financial crash. According to these authors, runs against domestic assets are related to self-fulfilling or herd behavior. However, herd behavior is sufficient to explain the factors behind the crisis. It may be noted that government policies related to conditions existing prior to the crash were not optimal for preventing the worst recession in Mexican history.

Dooley (2000) introduced the concept of moral hazard, which played an important role in the Asian financial crisis of 1997. According to Dooley, governments hold reserve assets in order to prevent shocks to national consumption and to protect the financial sector as Lender of Last Resort (LOLR). However, governments have limited foreign reserves and cannot borrow

from the international financial market without showing collateral in the form of assets or an IMF/World Bank's line of credit, in which case, governments' insurance to the financial sector would not be credible. Dooley (2000) shows how his model is able to explain problems in case the country holds negative or zero reserves. Government insurance creates moral hazard behavior in banking sectors. If there is inadequate bank supervision and regulation, banks would have incentives for accepting deposits even with higher interest rates. Initially, domestic and foreign investors would not hesitate to invest their funds, knowing that they would be compensated by the government if the banks cannot fulfill their liabilities. This situation may be stable as long as the country has sufficient reserves. However, when international reserves for meeting government obligations become exhausted, investors may begin to withdraw their money from banks, believing that banks will not be able to honor all deposit liabilities. This model illustrates the fact that countries may face speculative attacks on their international reserves even under a floating exchange rate system.

Another moral hazard model is introduced by Krugman (1998). In this model, governmental guarantees to the banking system may result in a moral hazard problem if there is no sound financial system and adequate regulations to discipline the financial market. A deposit insurance program would increase the number of risky investments that cause capital stock to increase to a highly inefficient level. Krugman (1998) argues that an exhausted stock of reserves may not be a matter of financial crisis per se, since crises can still occur if investors feel that government will not bail out banks in case of bankruptcy.

Grabel (2003) criticizes these early warning systems from a different perspective. Her approach to these models is based on the Post-Keynesian view. She argues that the established indicators have failed to predict most crises, such as the European currency crisis, as well as

Mexican, Asian, and Argentinean and Turkish crises, because early warning models are constructed under the assumptions of the neoclassical approach (neoclassical predictors project).

According to Grabel (2003), there are several reasons why the neoclassical predictors project is problematic. First, the idea of agents (predictors) and events (crises) exogenous to each other is subject to question. In other words, predictors and crises are not independent of one another. The responses of agents to new information may result in market destabilization instead of stabilization. Second, the assumption that the predictor has perfectly correct information about economic conditions and prior crises is unreasonable, especially in developing countries. Depending on inaccurate data to predict a crisis may cause false alarms and unexpected results. Third, the neoclassical approach assumes that there is a set of knowable macroeconomic fundamentals and agents who make the decision based on such fundamentals. However, she argues, there is no static or certain information about macroeconomic conditions; moreover, a certain economic condition or result can be interpreted differently by various agents. Fourth, she argues that financial crises occur not because of inadequate information, as the neoclassical approach assumes, but rather because free international capital mobility devoid of controls and financial liberalization promoted by international financial institutions without appropriate regulations make economies more vulnerable.

Grabel (2003) points out that financial liberalization and capital mobility without supervision in emerging economies may open to the door to several risks, such as currency, fragility, flight and sovereignty risk. In order to reduce these risks, she offers "the trip wire-speed bump strategy" ("trip wire" denoting indicators of vulnerability, and "speed bump" institutional and regulatory changes). Accordingly, when certain vulnerability indicators increase, authorities should take appropriate actions to minimize the risk and prevent the crisis.

Taylor (1998) is another significant contributor to the Post-Keynesian approach to financial crises. He argues that financial crises occur because inappropriate government policies and private sector responses to them destabilize markets. Moreover, a boom and bust episode is inevitable if an economy liberalizes its financial market and is more integrated with the global economy. In the 1980s, many emerging economies started opening their capital markets globally, thereby attracting international financial inflows to such economies. These uncontrolled capital inflows destabilized the domestic markets. The ensuing financial and economic crises were the result of regulatory failure and private sector investors' response to misguided government actions.

Taylor (1998) points out that external imbalance due to government policy, such as expansionary fiscal policy, may result in crises via different channels. Such policies will cause fiscal and current account deficits under fixed exchange rate regime if the private sector does not change its position. One channel is an increase in domestic borrowing, whereby fiscal expansion increases domestic borrowing-under the assumption of a government's foreign borrowing constraint, and the government's subsequent pursuing borrowing rather than printing money-in order to maintain financial market balance, resulting in an expansion of the money supply. The real value of domestic currency (assuming foreign price level to be unchanged) will appreciate, thereby causing an increase in imports and decline in exports, followed by a greater external imbalance. Another channel is to keep the domestic interest rate high in order to encourage the private sector to lend to the government. A high domestic interest rate will also attract international investors into the domestic financial market. If monetary authorities extend the money supply in response to a foreign reserve increase due to foreign capital inflow, interest rates must go up even more in order to keep the money market in balance, and to obtain more

capital inflow. An increase in money supply will keep upward pressure on the domestic price level. In such circumstances, the domestic currency will be overvalued since the authorities peg exchange rate fixed. Both channels will trigger a financial crisis.

Taylor (1998) has some suggestions for coping with financial market failures. First, all countries' financial systems are different. Consequently, the same packet is not an appropriate solution for all economies. International institutions should give support based on a specific country's needs. Second, international institutions should work with domestic authorities to find sound solutions. Third, IMF should receive more funds in order to better serve as a lender of last resort. Fourth, changes in international regulatory practices may help to reduce financial risks, such as discouraging international investors to lend to emerging economies. Fifth, IMF practices should be more transparent (especially in relation to the US government) and there should be independent, publicly available evaluations of the IMF's actions.

As Eichengreen and Arteta (2000) pointed out there is no consensus among empirical studies concerning the causes or consequences of the previously mentioned crises. All crises have different aspects, and since empirical studies use different explanatory variables, researchers are bound to obtain different results (see Table 10 in Appendix A which summarizes and compares the various studies and their results). Therefore, sometimes all models need to be examined in order to explain the causes and consequences of a crisis. We also argue that none of the above models alone can explain the roots of recent Turkish crises. Rather, combination of such models needs to be analyzed in order to understand the causes of such crises.

III. THE BACKGROUNDS OF SECTORS DURING THE RECENT TURKISH CRISES

In 1980, Turkey began a new industrialization program. This program changed the country's strategy from import substituting industrialization to an export-led growth regime designed order to overcome the debt and balance of payment crises in the late 1970s. The first leg of this program was aimed at liberalizing trade policies with the deregulation of domestic goods and services, and the financial and labor markets. The second leg of the program, begun in 1989, was the liberalization of capital account. The last and final liberalizing project is Turkey's attempt to enter European Union (EU).

In the first half of the 1980s, this structural change and reform program achieved a significant success in economic development. Turkey experienced relatively high economic growth, a healthy balance of payment account, a modest public sector borrowing requirement (PSBR), and succeeded in lowering and stabilizing inflation at the beginning of the program. However, near the end of the 1980s, annual inflation began to accelerate, averaging around 60% during the last three years of the decade compared to 35-40% in the mid-1980s. In addition to this sudden increase in inflation, Turkey slipped into a low growth phase and PSBR returned to the level of the end of the 1970s (10% of GDP). According to Akyuz and Boratav (2002), there were two main factors of macroeconomic imbalance during that time. First, the policies of the military regime during 1980-83 and the subsequent civilian government succeeded in the program, which was cutting wages and lowering support to the agricultural sector. However, this phase changed following a new election and turned back to populist policies, such as those related to decreasing unemployment and increasing the living standard of farmers. Second, before maintaining fiscal discipline and stabilizing inflation, Turkey opened its capital market

and liberalized its domestic financial market. However, the change of policy regarding interest rate increased the cost of public financing.

The second leg of the Turkish export-led economic growth program was to open the domestic financial market to global financial competition. The first path of structural adjustment was mainly based on trade liberalization and pursuit of macroeconomic stability. The main characteristics of the program were export subsidies, exchange rate regulations, and removing controls on capital inflows. In 1989, like many emerging countries, Turkey implemented capital account liberalization, also known as the Washington Consensus. Unfortunately, as Onis and Senses (2003) argue, full capital account openness has negatively affected the Turkish economy, as the deficiency of Turkey's economic capacity worked against the establishment of a stable economic environment. Capital account liberalization without appropriate regulations of economic and fiscal activities, and maintaining fiscal and monetary discipline caused a boom-bust pattern of development, and at the same time caused the economy to depend heavily on volatile short term capital flow.

In the 1990s, twin crises became more common than single banking or currency crises in emerging markets, mainly because of increasing financial integration and volatile international capital mobility among the markets. Turkey experienced a banking crisis in November 2000, followed by a currency crisis in February 2001. Turkey also faced a financial crisis in 1994 but the one in 2001 was more severe and destructive to the Turkish economy than the crises of 1994. During the interval between these two crises, Turkey experienced a sudden outflow of capital. In November 2000 and February 2001, the capital outflow was $11 billion, and around $20 billion within one year, which was nearly 10% of GDP. It is obviously very difficult for an economy like that of Turkey to recover from that kind of sharp reversal of capital flow. With the support

of the IMF, the Turkish government was able to stick to its exchange rate peg, but only for a while. As mentioned previously, the political crisis at the beginning of 2001 triggered financial panic and resulted in an enormous amount of capital reversal in a matter of days. Three months after the first crisis, the government had to abandon the currency peg. Even though it is argued that the huge capital outflow occurred because of weak economic fundamentals, currency appreciation, a high domestic debt, a sharp increase in current account deficit, a delay in structural reforms, the fragility of the banking sector in Turkey played a decisive role in these twin crises. The disinflation-stabilization program, which was designed and supported by the IMF, and included pegging the exchange rate, was announced in January 2000. The aim of this program was to fight inflation. However, as some Turkish scholars, namely, Akyuz and Boratav (2002) and Alper and Onis (2002) argue, pursuing such a program was dangerous with the fully open financial market, fixed exchange rate system, and fragile banking sector.

III-1. The Real Sector

Turkey has experienced an unstable economic growth pattern since the 1950s. After the second oil shock, its most severe economic crisis since World War II was in 1978-79. Because the bill for imported oil constituted the major part of the total value of imports, in the late 1970s the sudden increase in the price of oil (about 150%), followed by the Iranian Islamic Revolution, worsened the capital account balance in the late 1970s. The main aim of the stabilization package implemented in 1980 was to fight the high debt and balance-of payment crisis.

During the early stage of the 1980 export-led growth program, the growth rate was impressive, with an annual average close to 6% during the 1981-1987 periods. However, during the late 1980s, the country experienced slower economic growth. The annual real GDP growth dropped to nearly 3.7 during this period. This instability of GDP growth was an indicator of

problematic structural transformation in the country. Such growth instability continued throughout the 1990s and the beginning of the 2000s (see Figure 1a). During this period, the Turkish economy recorded three negative growth rates, followed by two major crises in 1994 and 2000-2001. The economy contracted 5.5% and 5.7% in the aftermath of the 1994 and 2001 crises, respectively. However, it should be noted that the 1999 decline in growth was mainly due to the adverse effect of the 1999 earthquake and monetary authorities' response to the Russia financial crisis in 1998.

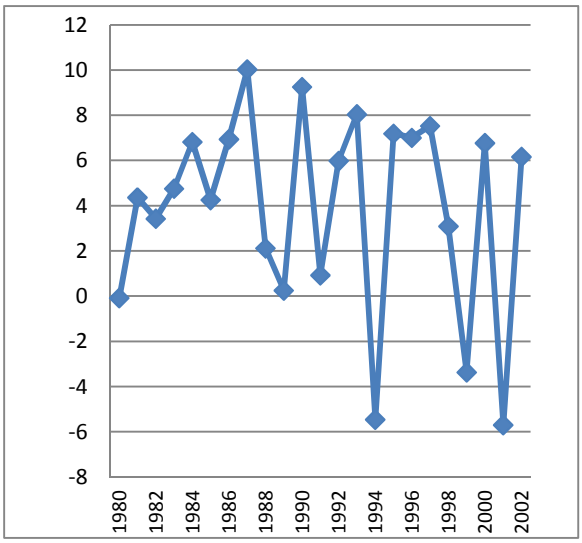

Figure 1a: GDP Growth 1980-2002, constant price
Source: IMF, 2008 World Economic Outlook

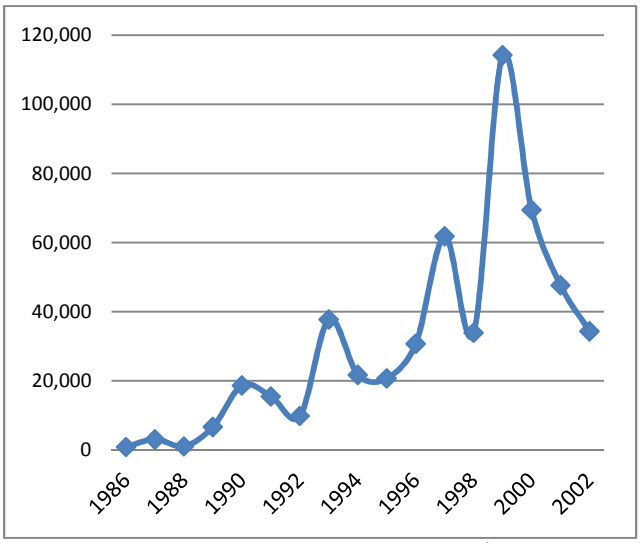

Figure 1b: Stock Prices 1986-2002, Million $
Source: Istanbul Stock Exchange (ISE)

Trade and financial liberalization during the 1980s also affected the Turkish stock market. The Istanbul stock market was reopened in 1986. In 1989, controls on capital movements were removed and domestic currency became fully convertible. ISE grew quickly in a short time. However, throughout the entire history of ISE, the movement of stock prices has been extremely volatile. As seen in Figure 1b, the Turkish stock market experienced boom-bust cycles throughout all periods, especially those of crises. Stock prices increased from $9.93 billion in 1992 to $37.83 billion in 1993. Such increases occurred approximately 4 times during that 1-year period but, fell to $21.79 billion in 1994. The direction of stock prices during the

1999-2001 periods is almost the same as those of 1992-1994. Subsequently, stock prices rose from $33.97 billion in 1998 to 114.271 billion in 1999, then dropped to 69.51 billion in 2000.

III-2. External Sector

The export-oriented growth regime involving exchange rate depreciation and export-promoting strategies accelerated the growth of Turkish export growth, which increased from $2.9 billion to $11.7 billion during 1980-1988. Moreover, in addition to export expansion, external balance also improved during this period, the proportion of imports covered by exports (X/M ratio) rose from 36.8% in 1980 to 81.4% in 1988. The sustained tendency of depreciation of the Turkish lira (TL) and export incentives were the driving force for this improvement in external deficit throughout the 1980s. During the same period, trade deficit to GDP ratio decreased from 7.0% to 2.9% (see Figure 2), and current account balance to GDP ratio increased from negative 2% in 1984 to positive 1.17% in 1988. However, starting in 1988, the rate of export growth slowed and trade deficit accelerated with a boom in imports. The reason for this reverse was mainly because of policy change in the late 1980s. The effectiveness of devaluation declined and the TL even appreciated 20% in real terms during the period of 1989-1990. Tariff reductions on imports and overvalue of currency led to an import boom and worsening trade and current account balance during this period. Financial liberalization in 1989 also increased the domestic interest rate, thereby adding another reason for currency appreciation. The Trade Deficit/GDP ratio doubled from 3% in 1989 to 6% 1990. Even though there was a slight improvement in 1991 and 1992, this ratio again reached 7.8% in 1993. The current account balance also deteriorated between 1988 and 1993. The ratio of current account deficit to GDP decreased from positive 2% in 1988 to negative 3.7% in 1993, despite the fact that the current account recorded a surplus in 1991. After deep depreciation of the Turkish Lira following the

1994 crisis, the domestic currency continued to appreciate during the period of 1994-2000 until 2001, when the crisis led to a rapid widening of the current account deficit. In 1998, the current account reached a $2 billion surplus, which rapidly dropped to a $9.8 billion deficit in 2000. In other words, it reached 4.9% as the ratio of GDP.

With financial liberalization in 1989, non-residents were allowed to purchase stocks from ISE and domestic residents were able to begin purchasing foreign securities. Starting in 1989, Turkey had been able to attract foreign investments. However, as we mentioned before, most capital flows are either portfolio investments or short-term loans that commercial banks and private sectors borrowed from abroad during the 1990s. Total foreign direct investment increased only from $113 million to $980 million within 16 years in 1984 and 2000, respectively. Compared to other emerging economies, the country did not receive substantial FDI flow during the previous two decades. During the period of 1999-2000, FDI flow to Turkey almost tripled, primarily due to the variant FDI definition used previously. Turkey adapted the definition of OECD for FDI. The omission of preferred stocks traded on the stock exchange, long term loans, and other marketable securities and bonds were included with FDI with this new definition. In 2001, $1.4 billion worth of long term credit was classified as FDI flow rather than foreign loan, as recorded prior to 2001. After its fall in 2001-2002, FDI continued to rise over the period of 2002-2007, reaching $22.2 billion in 2007.

This outstanding increase can be attributed to reforms in the investment and privatization program introduced in 2003. In addition, during this decade high expectations with regard to Turkey's European Union membership and rapid economic recovery attracted more investors. Between the 1994 and 2001 financial crises, portfolio investment was extremely volatile due to

the fact that a large amount of portfolio investment had been withdrawn during the crisis period, $6.7 billion in 1998 and $4.5 billion in 2001 (Figure 3c).

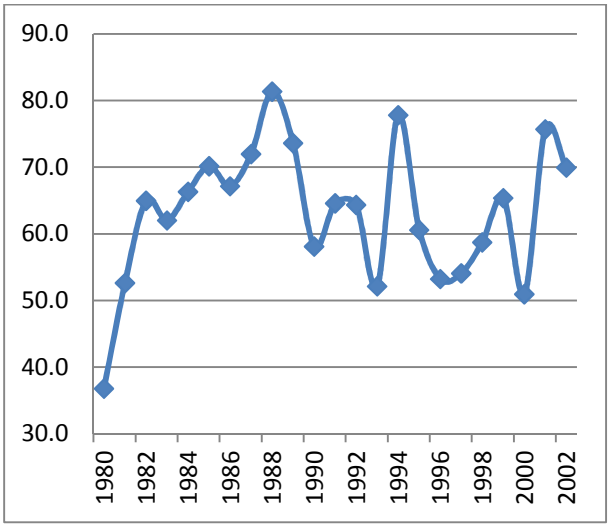

Figure 2a: X/M Ratio 1980-2002, Percent
Source: The State institute of Statistics

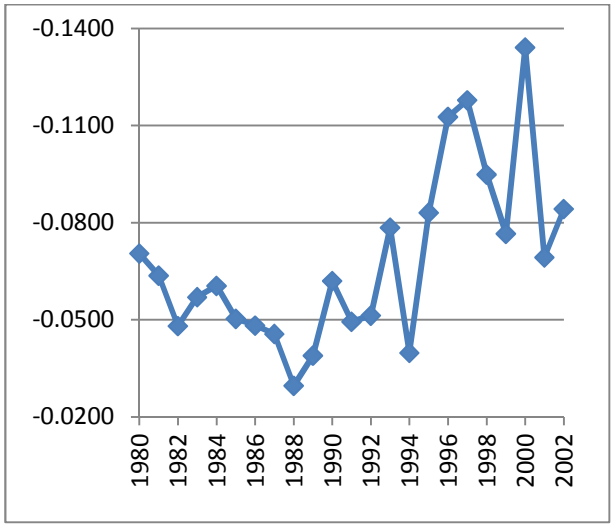

Figure 2b: Trade Deficit/GDP, 1980-2002, Percent
Source: The State Institute of Statistics

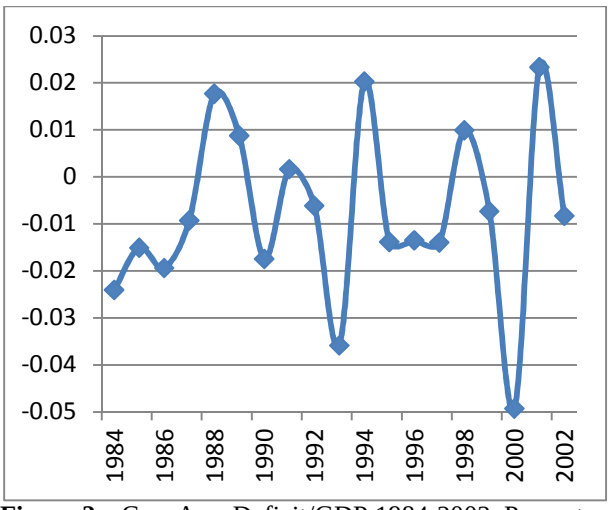

Figure 2c: Curr Acc. Deficit/GDP 1984-2002, Percent
Source: Central Bank of Turkey

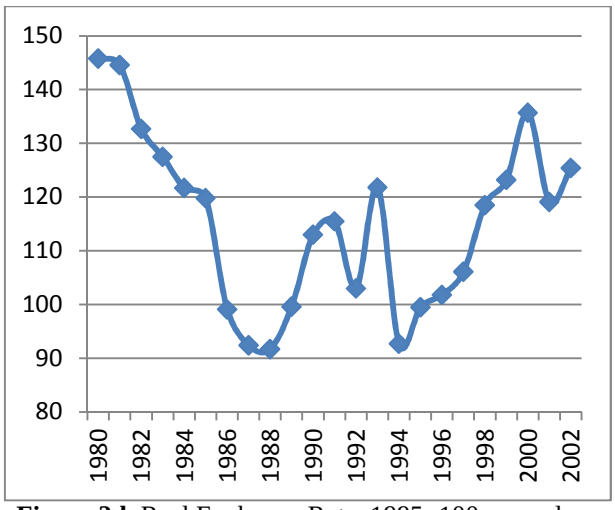

Figure 2d: Real Exchange Rate, 1995=100, annual
Source: Central Bank of Turkey

The economic policies pursued by the government during 1980-1990 obliged the Turkish economy to depend heavily on short-term capital. As mentioned several times previously, the liberalization of capital transactions without adequate regulation and disciplining the budget deficit moved all sectors into an environment dominated by large amounts of short-term capital, high interest rates, appreciated currency, and an unproductive external market. The inflow of

capital increased imports and domestic consumption due to the overvaluation of the currency, while simultaneously stimulating an increase in interest rates and public debt, mainly due to inadequate financial deregulation. Financial policies during the 1990s resulted in the private sector's borrowing from abroad and lending to the government. The external debt of the private sector, including banks, increased from $4.9 billion in 1989 to $93.5 billion in 2000 (see Figure 3b).

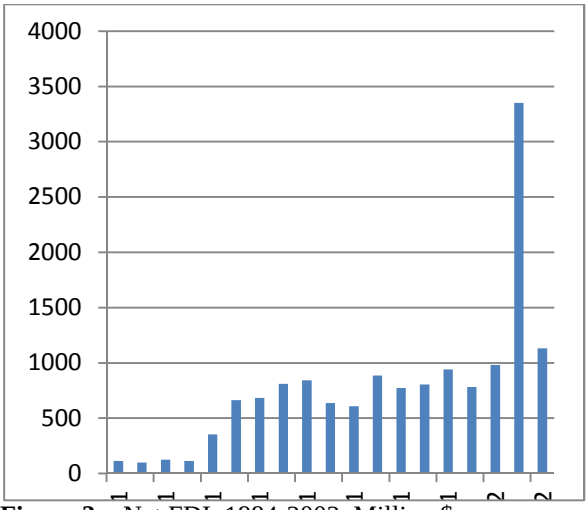

Figure 3a: Net FDI, 1984-2002, Million $
Source: Central Bank of Turkey

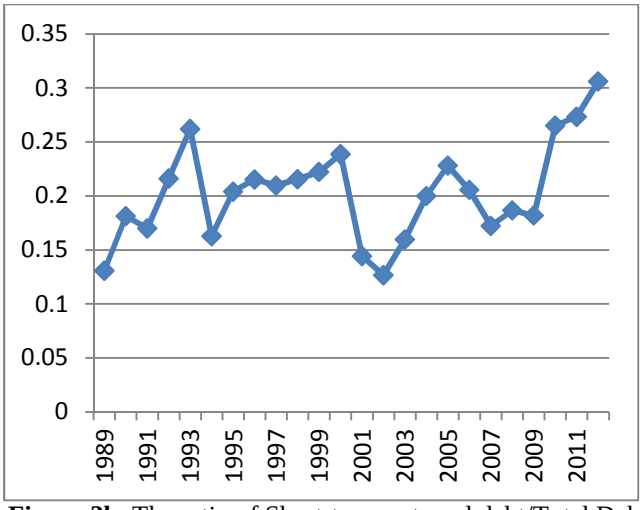

Figure 3b: The ratio of Short-term external debt/Total Debt
Source: Central Bank of Turkey

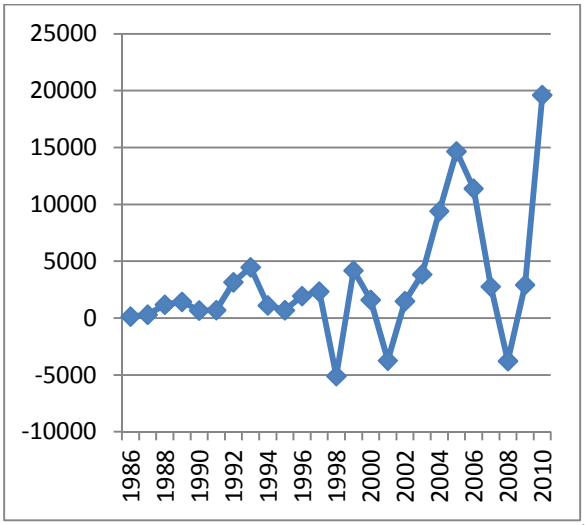

Figure 3c: Portfolio Investment, 1986-2010, Million $
Source: Central Bank of Turkey

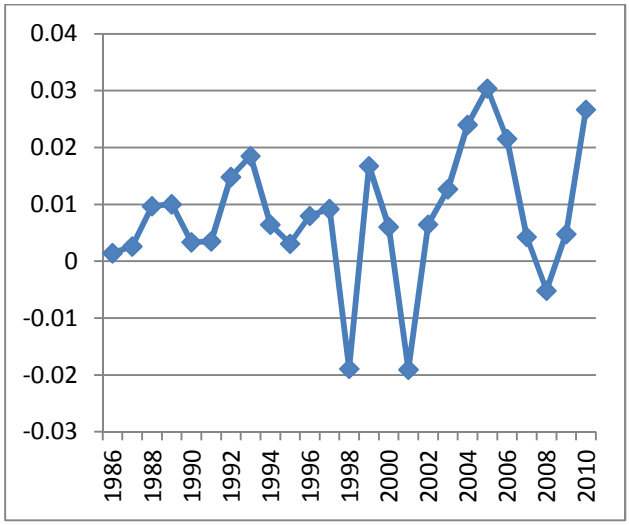

Figure 3d: Ratio of Portfolio Investment/GDP
Source: Central Bank of Turkey

III-3. Fiscal Sector

After stabilization program begun in 1980, the Public Sector Borrowing Requirement (PSBR) as percent of GDP decreased from 8.7% in 1980 to 3.9% in 1981, remaining at around 5% during the 1980s. After 1990, the ratio began to increase, reaching 10.5% in 1992. Although there were improvements in 1994 and 1995, the ratio continued to rise and reached a peak level of 16.4% in 2001.

The budget deficit followed the same pattern as PSBR. The radio of budget deficit to GNP dropped from 3.13% in 1980 to 1.54% in 1981 and remained at around 3% throughout the 1980s. However, the ratio showed a tendency to increase during the 1990s and rose from 3% in 1990 to 16.9% in 2001. Due to the massive domestic and foreign debt, interest payments comprised the largest share in the budget balance. Total net borrowing as a share of GNP increased from 2.5% to 12% in 2001. During this period Turkey had to borrow to pay its debt. Heavy borrowing escalated interest rates, which resulted in an additional burden of debt. Moreover, a rise in interest rates resulted in a higher investment cost to industries. At the same time, the crowding-out effect resulting from government competition for the funds in the market reduced investment.

It is worth to mentioning that domestic borrowing replaced foreign borrowing during the 1990s. In other words, the public sector borrowed from domestic agents who borrowed from abroad before lending to the government. The sterilization method of liquidity, which is used under heavy short-term capital movement, caused an increase in the public sector deficit. Instead of sterilizing excess liquidity in the financial market through the Central Bank, government bills were used to create funds.

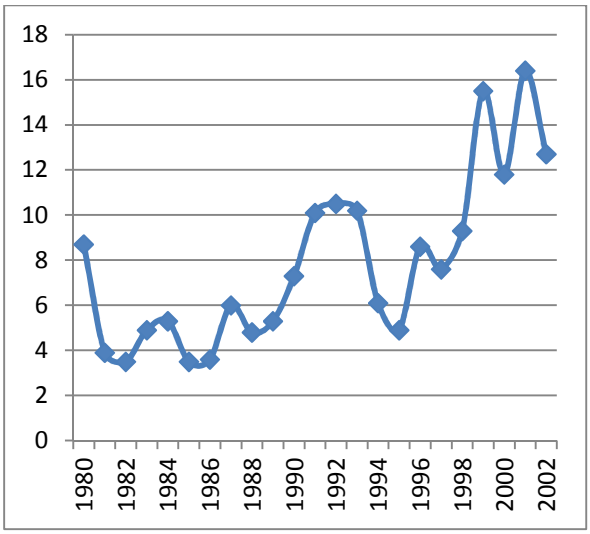

Figure 4a: PSBR/GNP, %Change
Source: Central Bank of Turkey

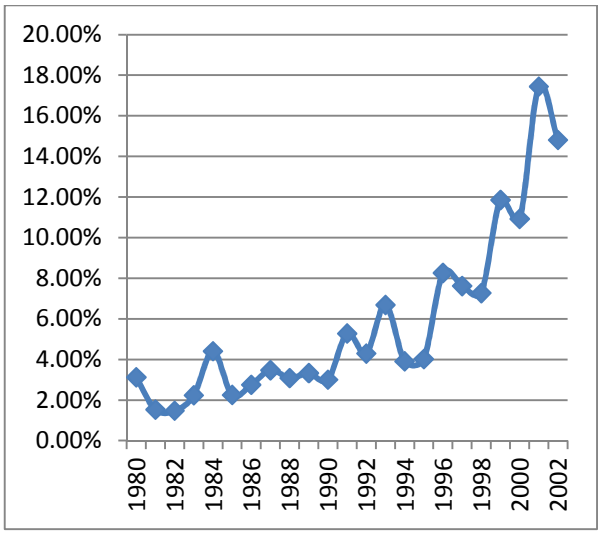

Figure 4b : Total Public Debt (net)/GNP, % Change
Source: Central Bank of Turkey

III-4. Financial Sector

Before the stabilization program was implemented in 1980, the financial sector was highly regulated. The liberalization program contained many deregulations of the repressed financial system. The restrictions on interest rates, such as a ceiling on deposit and lending rates, were removed, the short-money market and bond market was created, and the Central Bank began to conduct open market operations to maintain the stability of the financial system and control inflation. In addition, the restrictions on capital transfer and exchange controls were removed, a more liberalized exchange rate regime was adopted, and the full convertibility of Turkish lira was established.

In the late 1980s and throughout the1990s, Turkey experienced high inflation and a budget deficit. In order to finance the budget deficit, the government changed its strategy from printing money to selling securities to commercial banks, a policy that accelerated at the beginning of the 2000s after the implementation of the disinflation program in December 1999. This strategy has helped to combat high inflation to the extent that the inflation rate has shown a

downward trend since its highest level of 104.4% in 1994 (Figure 6b). However, the total public debt has increased steadily during this period (Figure 4b).

Consequently, instead of engaging in traditional banking activities, because of high interest rate margins between borrowing and lending rates, banks have preferred to buy government securities and have even begun to borrow funds from abroad and purchase high yield government bills when appropriate conditions existed. However, such a strategy is extremely risky in a country having unstable inflation and facing possible high currency depreciation (Boratav and Yeldan 2002). There are two risks banks face on both sides of their balance sheet. First, an increase in foreign currency liabilities; a rise in dollarization among households due to devaluation concerns would cause direct currency mismatch. Second, as mentioned above, borrowing funds from abroad or accumulating of assets in a foreign currency increases the default risk, which prevents borrowers from hedging their exposure to currency and exchange risk. Figure 5a shows how banks liabilities denominated in foreign currency during the period of 1985-2002. The share of foreign currency liabilities increased from 24% in 1989 to 50% in 1994, and the ratio displayed an upward trend throughout the second half of the 1990s. During the time the twin crisis occurred, the ratio reached 57.5%, its highest level throughout the past two decades. A similar pattern was seen on the asset side (Figure 5b).

Another problem the Turkish banking sector faces is bank financing by the government. As mentioned before, the government shifted the strategy from printing money to borrowing from the banking system in order to finance its deficit. Under such circumstances, banks also changed their asset management policy from direct loan extensions to purchasing government bonds (see Figure 6a). As a result, the share of government bonds and treasury bills in total assets rose from 15.1% in 1985 to 33.6% in 1993.

Among all these sectors in Turkey, the most fragile during the crisis period was the financial market. The aim of the liberalization program, which began in the late 1980s, was to reduce the inflation rate and maintain sustainable economic growth. However, the program caused the Turkish economy to depend heavily on short term capital inflow. Inefficiency in the Turkish financial system during that period created a risky environment for the entire economy. An unstable economic environment in which there were high inflation and interest rates, together with the fluctuations of the economic growth rate, increased uncertainties, particularly in the financial sector.

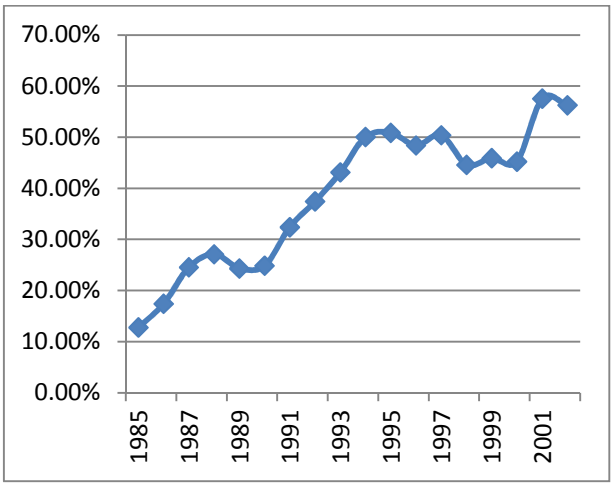

Figure 5a: Banks FX Liabilities/Total Liabilities
Source: State Planning Organizations

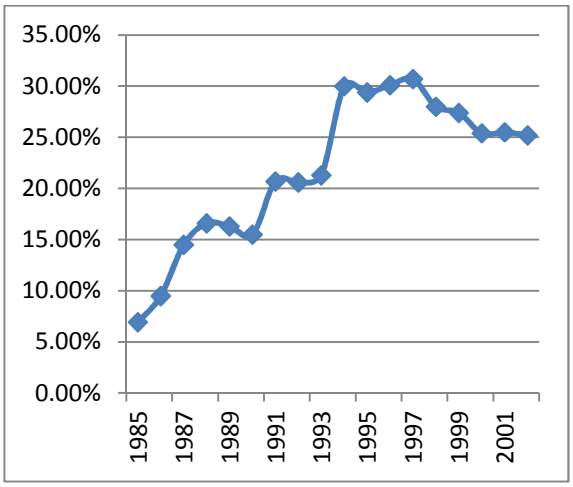

Figure 5b: Banks FX Assets/Total Assets
Source: State Planning Organizations

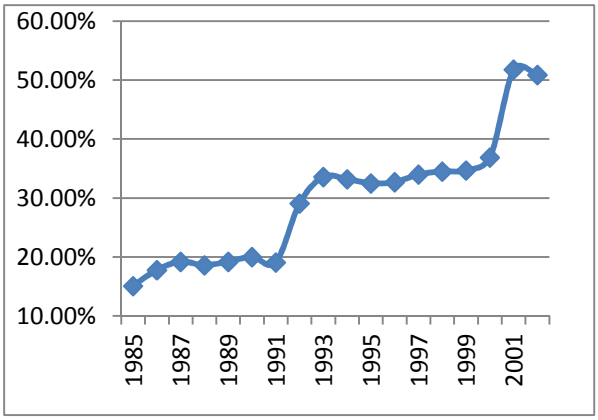

Figure 6a: Government Securities/Total Assets
Source: State Planning Organizations

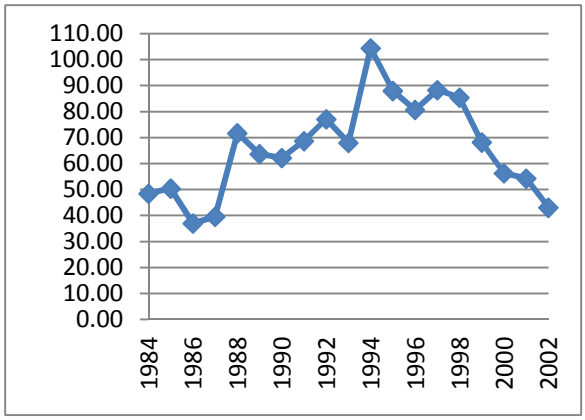

Figure 6b: Consumer Price Index, 12-month average
Source: State Planning Organizations

Public sector deficits were another factor leading to the instable banking sector. Instead of granting credit to the private sector, banks invested heavily in high-yielding Treasury bills. During that period, banks even borrowed money from the international financial market and invested in government securities in the domestic currency, thereby increasing the domestic banks' short positions and consequently their default risk.

IV. THE SIGNAL APPROACH

As we mentioned in the literature review, there are several models for investigating financial crises. Some of these are logit or probit regression models, mostly researching currency crises of emerging market economies. Some other studies are related only to banking crises. These empirical studies analyze the determinants of single crises independently of each other. However, the study examining twin crises together is of the greatest importance in the present context, namely, Kaminsky, Lizondo and Reinhart's model. We will use the KLR Model to investigate Turkey's twin crises in 1994 and 2001.

IV-1. Kaminsky & Reinhart Signal Model

IV-1a. Definitions

Kaminsky and Reinhart's approach (1999) defines currency and banking crises as follows: Currency crises are followed by either devaluation of the domestic currency or abandoning the fixed exchange rate system - i.e., allowing floatation of the exchange rate. The central bank can either conduct a contractionary monetary policy or open market operations in the foreign exchange market, or both, in order to reduce speculative exchange market pressure. If the central bank chooses open market operations, the result will be an increase in domestic interest rate and loss of foreign reserves.

The model uses an index, called the "Index of Currency Market Turbulence", also known as the Exchange Market Pressure-EMP index, for capturing speculative attacks. The index, denoted by *I*, is calculated as follows:

$$I = \frac{\Delta e}{e} - \frac{\sigma e}{\sigma R} \cdot \frac{\Delta R}{R} \qquad (8)$$

$\Delta e/e$: Change of rate of exchange rate

$\Delta R/R$: Change of rate of reserves

$\boldsymbol{\sigma}e$: Standard deviation of rate of change of exchange rate

$\boldsymbol{\sigma}R$: Standard deviation of rate of change of reserves

The index represents the weighted average of monthly percentage change in the exchange rate and monthly percentage change in the growth of international reserves (as negative). Crisis is assumed to occur if this index value is 3 standard deviations or more above its mean. If a country in the sample has hyperinflation, the calculation is modified accordingly.

On the other hand, banking crises occur when financial panic leads to the closing, merger, or take-over by authorities of at least one financial institution in closing. Even if there is no financial panic or bank runs, the closure, merger, take-over, or massive flow of government assistance to one important bank will cause similar outcomes for other financial institutions.

IV-1b. Variables

In addition to using their own arguments, Kaminsky and Reinhart (1999) search the literature to define economic variables related to twin crises. They argue that the variables chosen exhibit unusual behavior during periods preceding a twin crises. When an indicator exceeds a threshold within a specific time period, this is interpreted as a warning signal. Time interval between currency crises and its signal was determined to be 24 months, and that between banking crises and its signal was determined to be 12 months (Note that the total period is actually 24 months, 12 month before and after the crisis).

The model uses 16 variables that are divided into 4 different groups: real sector, financial sector, external sector, and fiscal sector. Seven variables in the financial sector are as follows: the ratio of domestic credit to GDP and M2 multiplier (ratio of M2 to base money), which are taken from which are taken from McKinnon and Phils' (1996) theory, which argues that rapid credit growth and monetary aggregate are related to twin crises theory, which argues that rapid credit growth and monetary aggregate are related to twin crises. Real interest rate and lending/deposit ratio are selected because of their links to bank crises. Kaminsky and Reinhart (1999) also argue that the high value of this ratio shows a decreased loan quality. Another variable, taken from Krugman (1979), is excess M1 balances, which reflects a loose monetary policy. The ratio of M2 to reserves is chosen from Calvo and Mendoza's (1996) study which defines this variable as effective in the 1994 Tequila crises. The final variable, according to Goldfajn and Valdés (1995), is bank deposits. A sudden decline in bank deposits indicates decreasing confidence of households and investors in the banking system, and causes capital flight and bank runs, which trigger twin crises. Six variables in the external sector are related to the current and capital accounts. Since currency appreciation is one the main indicators of a currency crisis which also exerts pressure on the banking sector, export, terms of trade, and real exchange rate were selected. Import was also selected due to the argument that rapid increase in imports may cause appreciation of currency and may indicate a boom in the economy. Real interest rate differentials and the stock reserves were included due to the possible bank run and capital flight these variables can trigger. Output and stock prices were chosen from the work of Calomiris and Gordon (1991), which shows that recessions and sudden declines in asset prices precede crises. And finally, one fiscal variable is the ratio of budget to GDP from the work of Krugman (1979), which argues that budget deficit indicates a loose fiscal policy.

Table 2 shows all threshold values of each variable calculated by Kaminsky and Reinhart (1999). The threshold values refer to the probability distributions of a variable for specific period. For instance, if the threshold value of the M2 multiplier for currency crisis shows >0.90, any value in the upper tail of the distribution would trigger the crisis. In other words, if whichever of the reserves for currency crisis indicates <0.15, any value in the bottom tail of the distribution could trigger the crisis.

IV-1c. The Definition of Noise-to-Signal Ratio

Threshold values are calculated in order to find optimal noise-to-signal ratio. In other words, if a single threshold is set too loose, the variable is able to catch many crises that never occurred, but if it is set too tight, the indicator can miss many of the most severe crises. Threshold levels are set depending on the characteristics of the variables and countries' conditions. The ratio is illustrated by the two-by-two matrix shown in Table 1.

If the indicator issues a signal and subsequently a crisis occurs during the following 24 months (cell A), the signal is accurate. If a signal is issued but no crisis occurs during the following 24 months (cell B, wrongly detecting non-existent crises), the signal is bad. Cell C refers to failure to detect a real crisis, since an accurate indicator would have entries in A and D.

Table 1: Noise to Signal Ratio (NSR) Matrix

	Crisis in 24 months	No crisis in 24 months
Signal	A	B
No Signal	C	D

Source: Kaminsky and Reinhart (1999)

The adjusted noise to signal radio is $(\omega) = \frac{B/(B+D)}{A/(A+C)}$ (9)

Table 2: Variables and Threshold Values (percentile) in KLR model

Sectors	Variables	Currency Threshold	Banking Threshold
Financial Sector	Domestic Credit/GDP (DCG)	>0.90	>0.95
	M2 Multiplier (M2M)	>0.86	>0.90
	Real Interest Rate (RIR)	>0.88	>0.80
	Lending/Deposit Radio (LDR)	>0.80	>0.87
	Excess M1 Balances (EM1B)	>0.94	>0.91
	M2/Reserve (M2R)	>0.87	>0.90
	Bank Deposits (BD)	<0.10	<0.16
External Sector	Terms of trade (TOT)	<0.16	<0.19
	Real Exchange Rate (REX)	<0.10	<0.10
	Imports (IMP)	>0.90	>0.80
	Exports (EXP)	<0.10	<0.10
	Reserves (RES)	<0.15	<0.28
	Real Interest Rate Differentials (RIRD)	>0.89	>0.81
Real Sector	Output (OUT)	<0.11	<0.14
	Stock Returns (STR)	<0.11	<0.10
Fiscal Sector	Deficit/GDP (DEFG)	>0.86	>0.86

Source: Kaminsky and Reinhart (1999)

Kaminsky and Reinhart compare all levels of variables within 24 months before the crisis to values in tranquil periods. An optimal threshold value for each variable is estimated and if the

indicator is above threshold, it gives the signal for a crisis during the coming 24 months. Periods when index values are greater than 3 times their standard deviations are called crisis periods.

Optimal thresholds are calculated for each country by maximizing their correct signals and their minimizing false signals. The ratio of correct signals to false signals indicates the accuracy of each value.

V. TURKISH TWIN CRISES

V-1. Currency Crises

As we mentioned above, currency crises are identified by the abnormal behavior of the "Index of Currency Market Turbulence". While there is no complete agreement among scholars about the method of calculation of this index, however, the basic manner of calculating the index is to combine movements in exchange rate, gross international reserves, and interest rates. Although there is a controversy about how to weight the three components of the index, most scholars agree on weighting the components to have the same conditional variance. Therefore, in our calculations, the conditional variance of the index with respect to each component is equal. Depending on the countries' economies and government policies at the time of financial crises, the interest rate can be included or excluded from the formula. Nevertheless, since the Turkish economy faces high inflation during the time of both financial crises and volatile market interest rates, we have included nominal interest rate in the formula. The original KLR model used a two-variable EMP index without nominal interest rate as a component, but that formula could not catch the 1994 Turkish currency crisis.

Including all three variables to construct the EMP index has become common lately. As Eichengreen et al (1994) pointed out, central banks use interest rates as a policy instrument to respond to speculative attacks. Additionally, as the Turkish financial market was open to the world during the time of both crises, interest rate should be taken into account in the calculation of the EMP index. Therefore, the formula we used is

$$EMP = \Delta_{e/e} - (\sigma_e/\sigma_r * \Delta_{r/r}) + (\sigma_e/\sigma_i * \Delta_i) \quad (10)$$

in which Δi is the change in the nominal interest rate and σi is the standard deviation of the change in the nominal interest rate (Δi). As mentioned previously, if the EMP index is 3 standard deviations or more above the mean, a currency crisis is expected to occur.

Some other studies define currency crisis as a situation in which the EMP index exceeds the mean 2.0 or 2.5. Since our calculation is not affected by this choice, for all three calculations (standard deviations taken as 3.0, 2.5 of 2.0), we were able to identify both currency crises in Turkey, determining that the dates of the currency crises were April 1994 and March 2001, with EMP values of 463.52 in April 1994 and 418.38 in March 2001, respectively (see Figure 7).

Figure 7: EMP Index for Turkey, 1987-2001
Note: The values 307.01, 255.37, and 203.72, represent 3, 2.5, and 2 standard deviations of the EMP from its means, respectively.

V-2. Banking Crises

Kaminsky, Lizondo and Reinhart (1998) argue that banking crises occur whenever a substantial number of financial institutions become bankrupt, or are merged and/or taken over by governments as a result of financial panic. Banking crises are also assumed to begin in case of government bailout for at least one major bank. However, as Hagen and Ho (2003) pointed out,

this method is problematic, especially for identifying the times of the crises. In order to determine crises times, we will use "the index of money market pressure" (IMP) used by Hagen and Ho (2003). This indicator is:

$$IMP = \Delta\gamma/\sigma(\Delta\gamma) + \Delta r/\sigma(\Delta r) \quad (11)$$

where γ denotes the ratio of central bank loans to bank deposits; r denotes the money market rate in real terms; Δ is the difference operator; and $\sigma(\Delta\gamma)$ and $\sigma(\Delta r)$ denote the standard deviations of the two components respectively. Banking crises are identified as periods during which the index is greater than a predetermined threshold. In our study for Turkey, the threshold value is set to the 1% upper tail distribution of the index period.

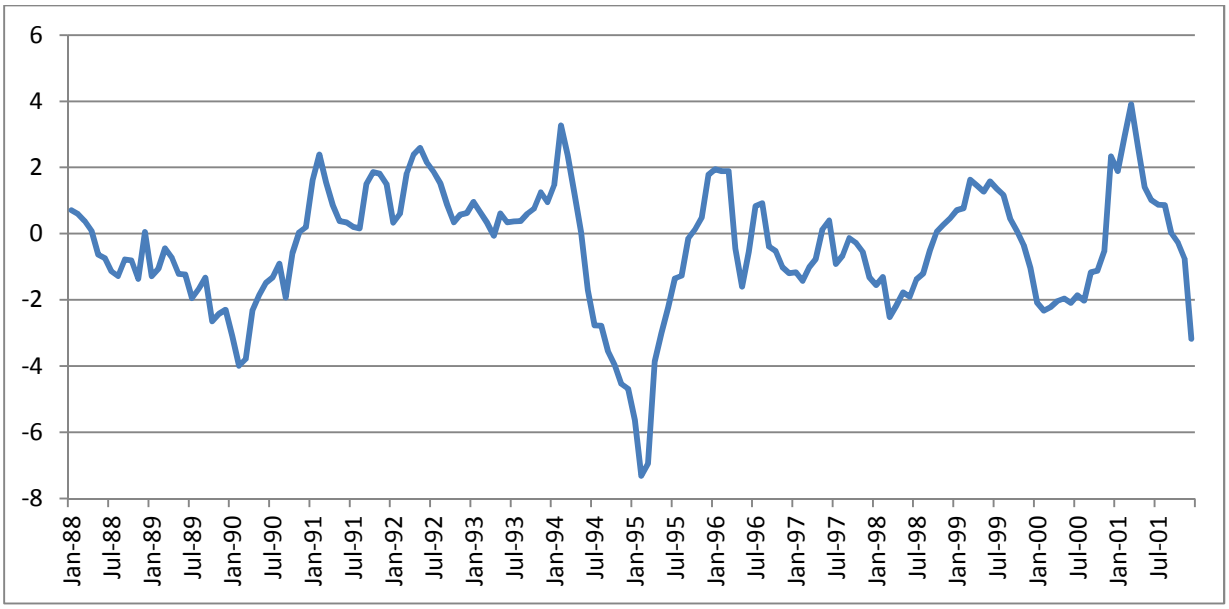

Figure 8: IMP Index for Turkey, 1988-2001

The 99th percentile of the sample distribution for Turkey was found to be 2.67. The IMP index value in February 1994 was 3.26 and in March 2001 had increased to 3.90. When the threshold value was set to 2% (the 98th percentile of the sample distribution), we found is 2.38

and we captured two more dates of banking crises, namely February 1991 and May 1992. Consequently, we set the threshold value to be 1% upper tail.

V-3. Choices of leading indicators

The model of Kaminsky, Lizondo and Reinhart (1998) uses 16 leading indicators for twin crises. However, the choice of indicators used in our study is based not only on the characteristics of the Turkish economy but also on the availability of monthly data. Most of the data used in this study come from the Central Bank of Turkey; the remainders are found in the "International Financial Statistics, IMF database". The lending to deposit ratio is excluded from this study because of the unavailability of monthly data. The GDP quarterly series are converted to a monthly frequency via linear interpolation. Our monthly data includes the period from January 1987 to March 2001, during which the second financial crises occurred, with a total of 170 measurements (158 measurements were recorded for indicators in which a 12-month percentage change is employed). Twelve-month percentage changes are used for all variables, other than real exchange rate, real interest rate, excess real M1 balances, and interest rate differentials.

Additional Indicators

In addition to the 16 variables in our study noted, four more variables were added (see Table 3). Two indicators, namely, oil prices and short term external debt over reserves ratio, are taken from the Hali Edison (2000) model. The third variable is Export/Import ratio, which is used in Ucer, VanRijckeghem, Yolalan (1998). The last additional indicator is Bank Reserves/Bank Assets taken from Demirguc-Kunt and Detragiache (1997).

Table3 : Indicators of the model

Indicators	Abbreviation	Expected Sign	Comments
Financial Sector			
Domestic Credit/GDP	DCG	(+)	Rapid credit growth is related to twin crises (McKinnon and Phils', 1996)
M2 Multiplier	M2M	(+)	Sudden increase in monetary aggregate would lead financial crisis (McKinnon and Phils', 1996)
Real Interest Rate	RIR	(+)	Both variables are linked to banking crisis. Besides, high value of Lending/Deposit ratio shows decreased loan quality (see Kaminsky, 1998)
Lending/Deposit Radio	LDR	(+)	
Excess M1 Balances	EM1B	(+)	An increase in Excess M1 balances reflects loose monetary policy (Krugman, 1979)
M2/Reserve	M2R	(+)	This variable was an effective factor in Tequila crisis. The ratio compares the level of domestic assets (M2) with foreign assets (Reserves) in case of a run on local currency (see Carlo and Mendoza, 1996)
Bank Deposits	BD	(-)	A decline in bank deposits indicates the decreasing confidence of household and investors in the banking system and causes capital flight and bank run, which trigger twin crises (see Goldfajn and Valdés, 1995)
Short Term External Debt/Reserves [b]	STDR	(-)	An increase in short term external debt and/or a decline in reserves makes a nation more vulnerable to a sudden capital outflow, which deepens the financial crises (see Edison, 2000)
Bank Reserves/Bank Assets Ratio [b]	BRBA	(-)	A decline in this ratio increases liquidity problem in the banking sector, thereby raising the probability of crisis (see Demirguc-Kunt and Detragiache, 1997)
External Sector			
Exports	EXP	(-)	These three variables are the main indicators of a currency crisis, and also exert pressure on banking sector. Weak external sector (decline in Exports, the value of Terms of Trade, and overvalued currency) decreases international competitiveness of the country (see Kaminsky, 1998)
Terms of trade	TOT	(-)	
Real Exchange Rate	REX	(-)[a]	
Imports	IMP	(+)	Imports may cause rapid appreciation of currency, which increase probability of crisis (see Kaminsky, 1998)
Reserves	RES	(-)	A decline in Reserves makes country more vulnerable to capital flight (see Sachs, Tornell, and Velasco, 1996)

Real Interest Rate Differentials	RIRD	(+)	An increase in this ratio triggers capital flight (see Kaminsky, 1998
Oil Prices [b]	OILP	(+)	Rising oil prices worsens balance of payments, damage terms of trade and drops the rate of growth, increases probability of crises (see Edision, 2000)
Export/Import Ratio [b]	EIR	(-)	A decrease in this ratio widens current account deficit, and causes an appreciation in local currency (see Ucer at all, 1998)
Real Sector			
Output	OUT	(-)	Recessions (decline in output) and sudden declines in asset prices precede crises (see Calomiris and Gordon, 1991)
Stock Returns	STR	(-)	
Fiscal Sector			
Deficit/GDP	DEFG	(+)	Budget deficit indicates a loose fiscal policy (see Krugman, 1979)

Note: The [a] indicates that we used opposite conversion, consequently it is positive for our analysis. The [b] shows the indicator is added in the analysis later time, not in KLR model.

Oil Prices (External Sector): Rising oil prices have a significant impact on oil-importing countries, often resulting in some damage to the terms of trade, worsening the balance of payments and dropping the rate of growth.

Short Term External Debt/Reserves (Financial Sector): An increase in short term external debt and/or a decline in reserves makes a nation more vulnerable to a sudden capital outflow, which deepens the financial crises.

Export/Import Ratio (EIR, External Sector): A decrease in Export and/or an increase in Import widens current account deficit, causes an appreciation in the country's currency, and reduces confidence in the economy.

Bank Reserves/Bank Assets Ratio (BRBA, Financial Sector): A decline in this ratio increases liquidity problem in the banking sector, thereby raising the probability of crisis.

As previously mentioned, the KLR (1998) model uses a 24 month horizon. In other words, the signal horizon for a currency crisis considered by authors is 24 months ahead of the

crisis itself, and that for banking crisis is 12 months before and after the date of a crisis. In our study, because the time period is narrow, as in many signal country studies in the literature, a 12-month window as signaling horizon was chosen (24- and 18-month horizons are also estimated and presented in Appendix C).

Although we have predetermined threshold values for each indicator obtained by KLR (1998), we will find our own optimal threshold values that minimize the adjusted "noise-to-signal" ratios (please see Appendix B for the method of calculation of optimal threshold values). The threshold range chosen for this study is 5-30% for lower tail and 70-95% for upper tail. The method of determining the power of the indicator in predicting crises is to find its NSR value. The lower the noise to signal ratio (NSR), the higher predictive power the indicator has. If the NSR of an indicator is greater than one, it means that the indicator emits more bad signals than good ones. It can therefore be assumed that indicator is extremely noisy and should be removed from the choices of possible leading indicators.

Domestic Credit/GDP

The threshold values of Domestic Credit/GDP for currency and banking crises predicted by KLR are too high for Turkey. According to the KLR model, the currency threshold is the upper 90th percentile and the banking threshold is the upper 95th percentile (see Table 2). However, if these values are used, NSR for currency crises is 5 and that for banking crises is 1.28. We, therefore, calculated the threshold values for Turkey and found that threshold value for currency crises is > 0.74 (NSR is lowest, at 0.63) and the same for banking crises, i.e., > 0.74 (NSR is 0.73). Currency and banking threshold for Domestic Credit/GDP is upper 74th percentile and the index numbers are 0.0908. Based on a 12 month horizon, we obtained only 1 signal prior to the 1994 currency crisis, but 8 signals before the 2001 currency crisis. No signal

was issued within the 12 months prior to the 1994 banking crisis, whereas 8 signals were noted before the 2001 banking crises (see Figure 9).

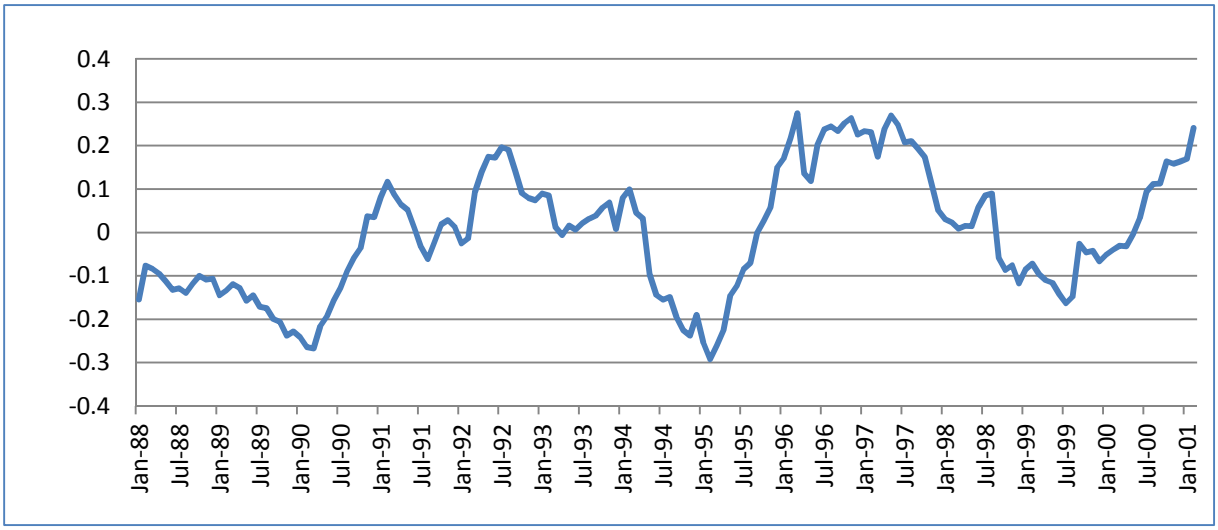

Figure 9: Domestic Credit/GDP for Turkey, 12 months % change, 1988-2001

M2 Multiplier

The M2 Multiplier is the ratio of M2 to base money. The monthly series, totaling 158, began in January 1988 and ended in February 2001. When a threshold value around the upper 90th percentile was chosen, we were unable to find any signal either for currency or banking crises within a 12-month horizon. When we selected lower percentiles such as 60, or 70, we faced many false signals which made the NSR value too high. We therefore determined the M2 Multiplier not to be a good indicator for both crises (see Figure 10). However, within a 24-month horizon, the threshold value of the M2 Multiplier was found to be > 0.82, with a NSR value for currency of 0.53. The number of months of signaling prior to crises was 13. These values demonstrate that the M2 Multiplier is a useful indicator for currency crises only if 24-month horizon is employed (see Appendix C for the results of 24 month horizon).

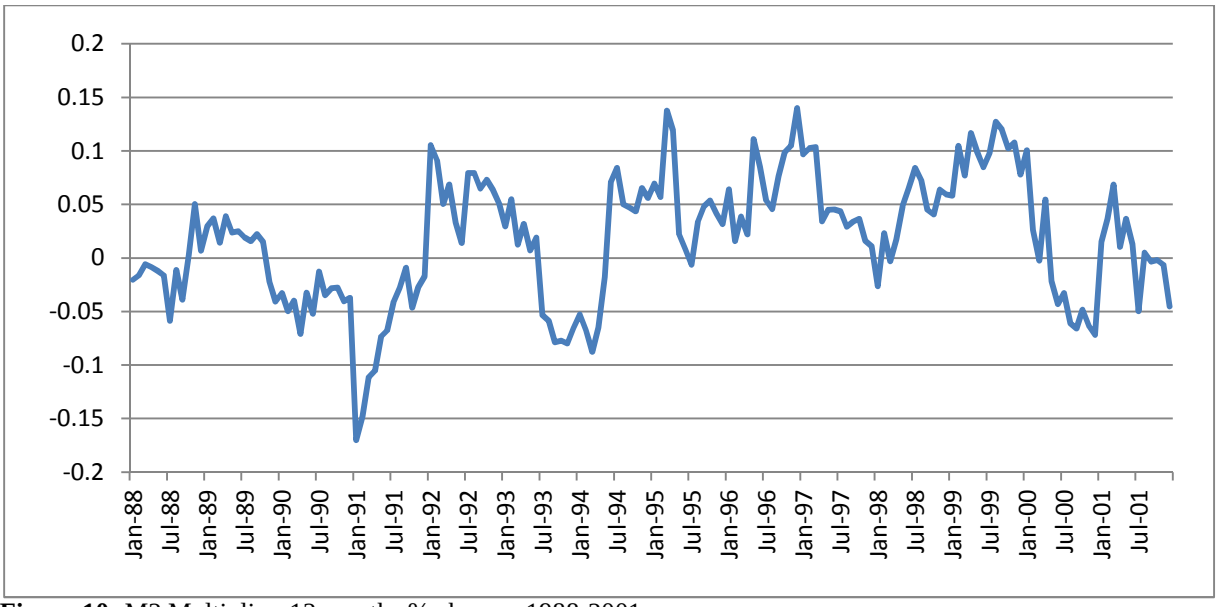

Figure 10: M2 Multiplier, 12 months % change, 1988-2001

Real Interest Rate

Real interest rate is calculated from 3 months deposits and consumer price index. We used a simple Fisher equation to determine monthly real interest rate by subtracting monthly actual inflation rate from monthly nominal interest rate. The formula we used is

Real Interest Rate = Nominal Interest Rate – Inflation

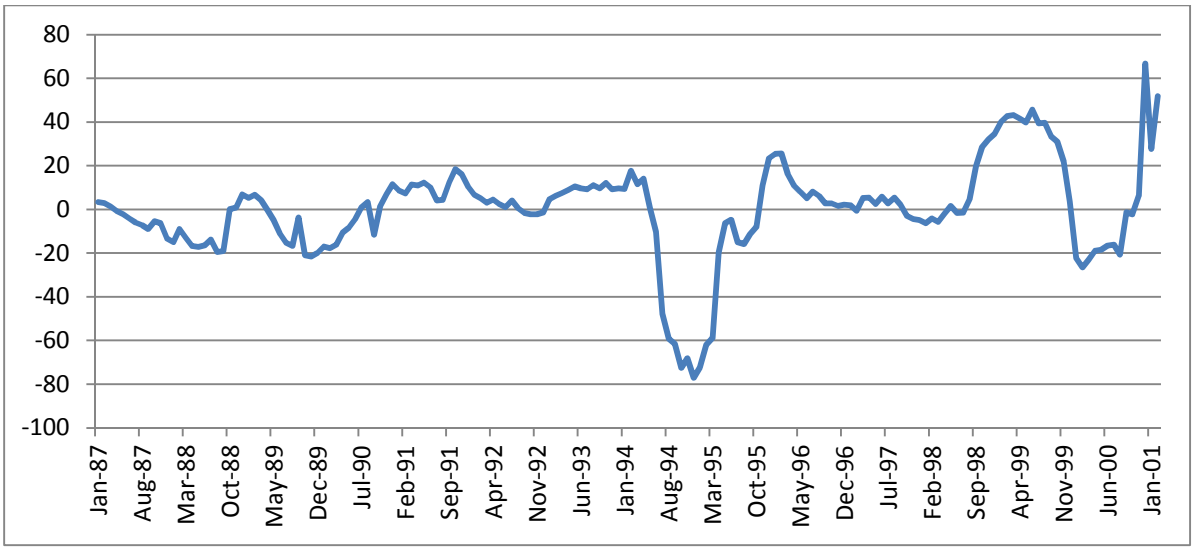

Figure 11 : Real interest rate, Jan 1987 - Feb 2001

The series start January 1987 and end in Feb 2001. Total measurement is 170.

As can be seen from Figure 11 above, the rate rose sharply just before the 2001 crises. No signal was issued during the 12 months preceding the 1994 crises. The number of months issuing signals for both crises is 2, and both issued right before 2001 crises. The threshold values of Real Interest Rate for currency and banking are the same and are found to be > 0.95, while NSR values are 0.57 (see Figure 11). Lower NSR values obtained for 18- and 24-month horizons are 0.07 and 0.11, respectively. In fact, this indicator is ranked number 1 if an 18-month signaling horizon is chosen (see Appendix C)

M2/Reserve

We have M2 data as thousands of TL. In order to convert M2 into US dollars, we multiply M2 by the current exchange rate of TL to US dollars (nominal exchange rate in the month observed). M2/Reserves is calculated by dividing M2 in US dollar into Reserves. The number of months in the series is again 158, and a 12-month percentage change is used to derive the ratio.

Threshold values for both crisis are the same, namely, >0.91. Currency NSR value is 0.71; however, banking NSR is more than unity, that is, 1.16. We therefore need to take this indicator out of our study for banking. However, this indicator gives a better result with a 24-month horizon: Eight signals were issued before the crises dates; the NSR value was 0.27, and it ranked fourth when a 24-month horizon was employed (see Appendix C).

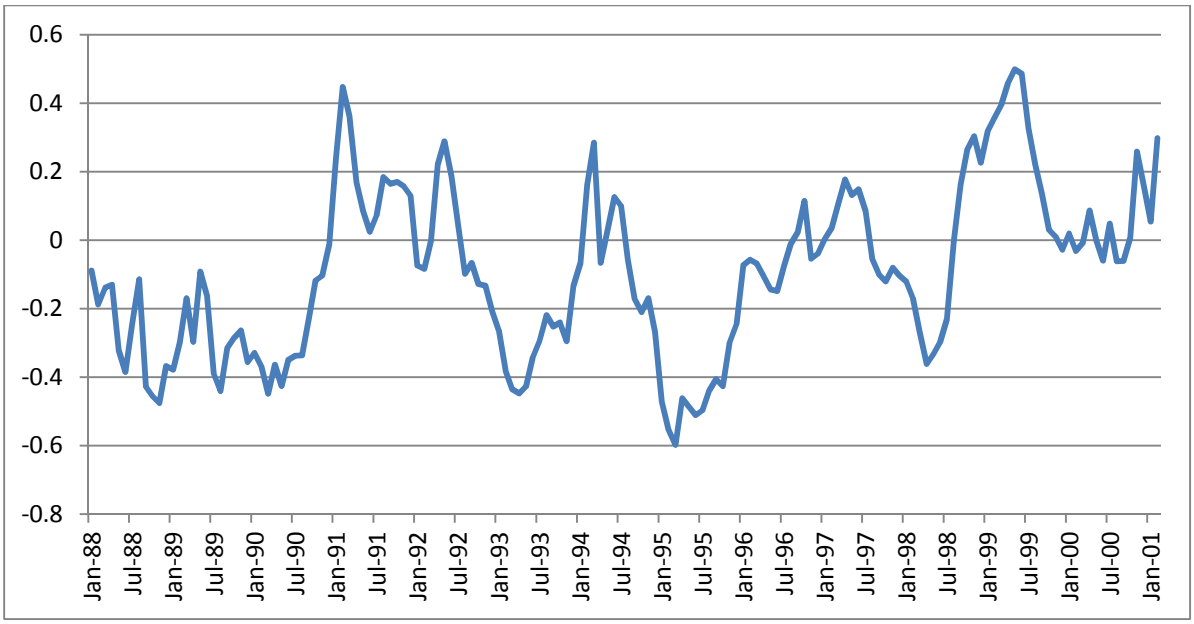

Figure 12 : M2/Reserves, monthly series, 12-month % change, 1988-2001

Bank Deposits

The data is given in thousands of TL. We converted the series to a 12-month percentage change. When we used KLR threshold values, we were unable to find any month that signaled a crisis, and consequently NSR has infinite value. However, by choosing a higher threshold value such as <0.25 to find a signal, we found many false signals, and the NSR value was 9.66.

This variable is not a good indicator of either currency and or banking crises. We had anticipated that the series would drop before times of crises but instead it decreased after the crises period. We tested this series with 3 different time horizons but the result was same for all (see Figure 13).

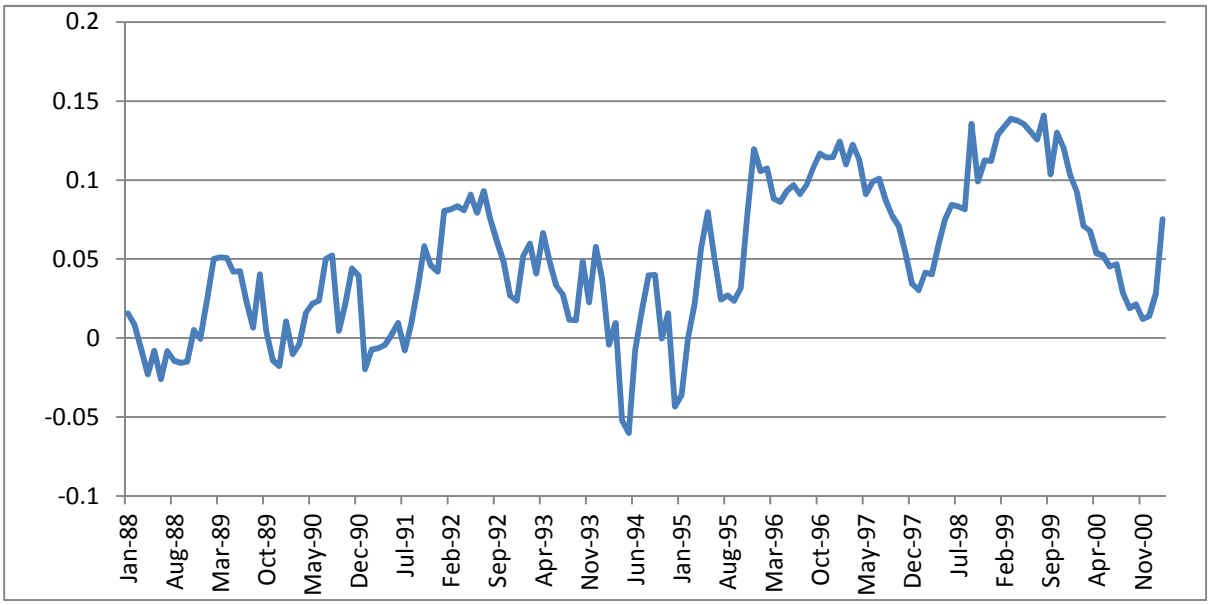

Figure 13 : Bank Deposits, monthly series, 12 month % change, Jan 1988- Feb 2001

Terms of Trade

This series is also a 12-month percentage change. As expected, it decreased before the 2001 twin crises but declined after the 1994 crisis. The series clearly fell in the months preceding the 2001 twin crises, and 7 good signals for currency and banking crises were received. However, in the earlier period, the indicator emitted many bad signals. The threshold values of both crises for the time period of Jan 1988- Feb 2001 were the same at <0.18, while the NSR values were also same at 0.61. The same variable can be utilized for analyses of both crises (see Figure 14).

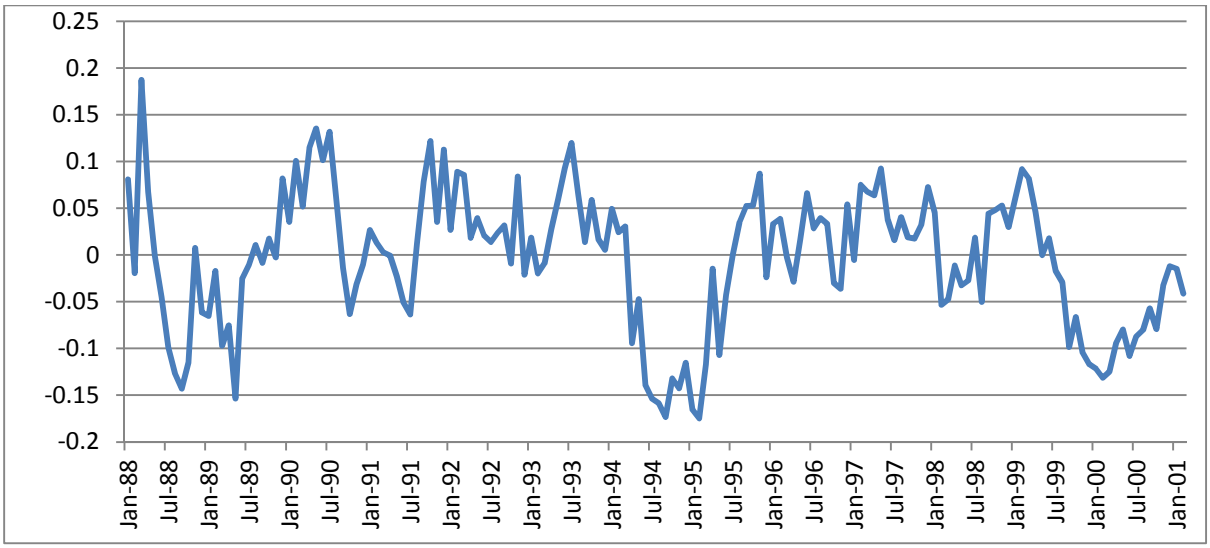

Figure 14: Terms of Trade, monthly series, 12 month % change, 1987-2001

Real Exchange Rate

Deviations from the existing trend are used. We set an equation to estimate residuals that give us deviations from trend. Ordinary least squares regression is used. The equation estimated is

$$REX_t = \alpha_1 + \alpha_2 T_t + \varepsilon_t \qquad (12)$$

REX_t represents real exchange rate in period t, T_t is a linear time trend variable, ε_t is the residuals. The series runs from Jan 1987 to Feb 2001 and total observations are 170.

As is expected, this indicator gives the best result among all other indicators. It is ranked number 1 for both crises. In contrast to the threshold value of this variable in the KLR model, namely, <0.10, 10% lower tail, the threshold for both crises is >0.89 (The reason for its being upper tail in our model is that we used a different conversion, that is, US dollar/TL rather than the TL/US dollar conversion used in the KLR model), whereas the NSR value for currency crisis is 0.06 and that for banking is 0.04. This variable clearly rose before both crises periods and drop tremendously in a very short time soon after the crises, dropping from 127.4 in Nov 1993 to

78.0 in Apr 1994, which means a 62% decrease within 5 months in real terms. The decrease is 46% during the second crisis period between Jan 2001 and Apr 2001. Thirteen signals for currency and 14 signals for banking crises were observed, and there were only 5 and 4 bad signals in entire time period, respectively.

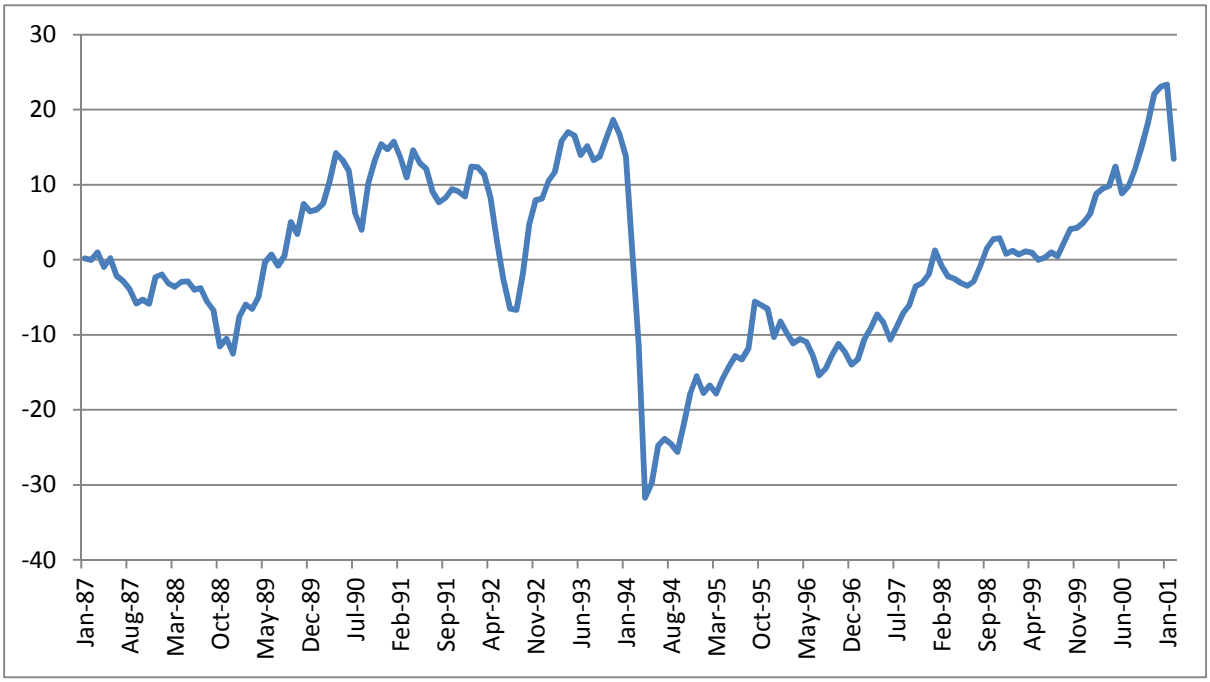

Figure 15: Real exchange rate, deviations from trends, 1987-2001

Imports

A 12-month percentage change was used for this series as well. Compared to KLR threshold values, we found lower percentile rates. Threshold values were > 0.74 and > 0.70 for currency and banking crisis, respectively. The NSR value is lower for banking crises and 0.37 compared to that of currency crises, which is 0.41. We found 12 good signals in the months prior to the currency crises and 15 before the banking crises (see Figure 16).

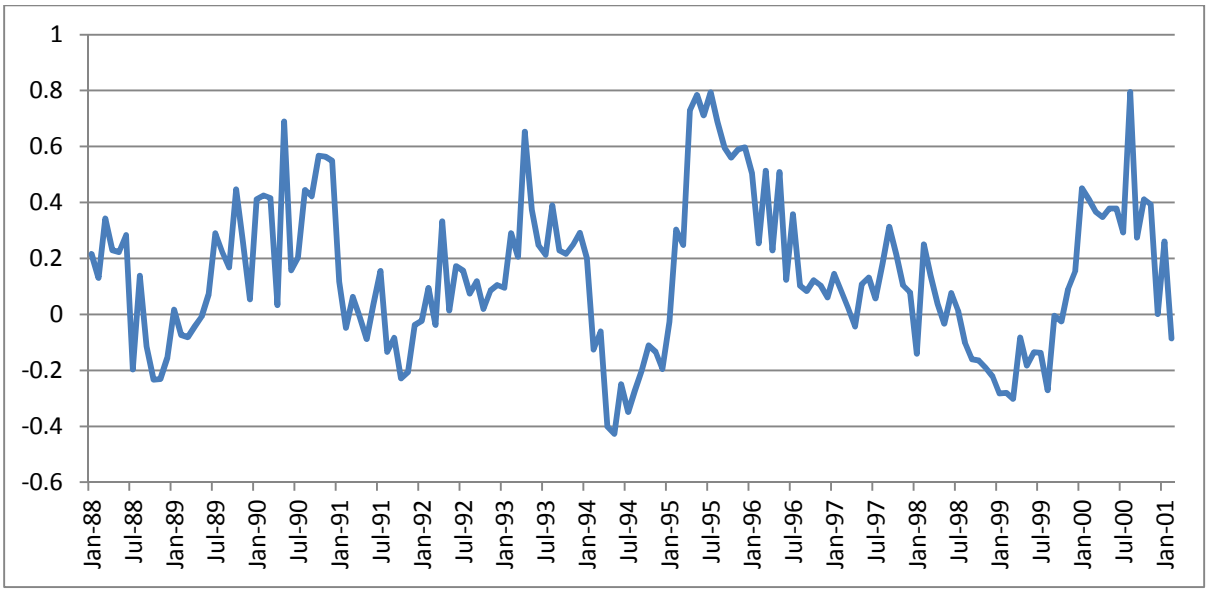

Figure 16: Imports, monthly series, 12 month % change, 1988-2001

Exports

This series is the same as the others. Total measurement is 158 and monthly series, and a 12-month % change is used. We found threshold values for both crises to be <0.11, which is 0.01 point higher than KLR model defined. NSR values are 0.89 for both currency and banking. Three signals were found to be in the 11th percentile of the distribution, with a 12-month horizon for currency and banking crises. These figures are lower in comparison to the import variable, but nonetheless a good indicator to keep in the analysis.

Reserves

This time period is the same as all the others and a 12-month % change is used. Threshold values for both crises are the same, <0.07. However, the NSR value, 1.97, is high for banking, while registering 0.53 for currency. We found 3 good signals for currency crises but only 1 good signal for banking (11 bad signals with a 12-month horizon).

As can be seen from Figure 18, the series drops either immediately after or before the beginning of the 12-month crises period, resulting in many bad signals, especially for banking crises analysis (see Figure 18).

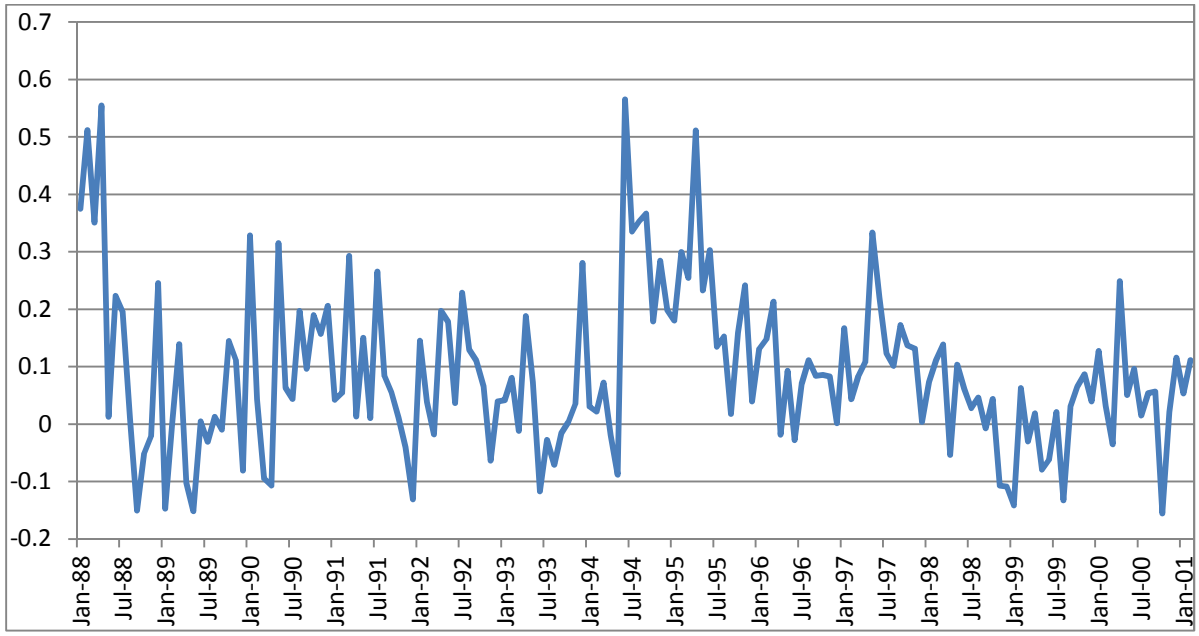

Figure 17: Exports, monthly series, 12 month % change, 1987-2001

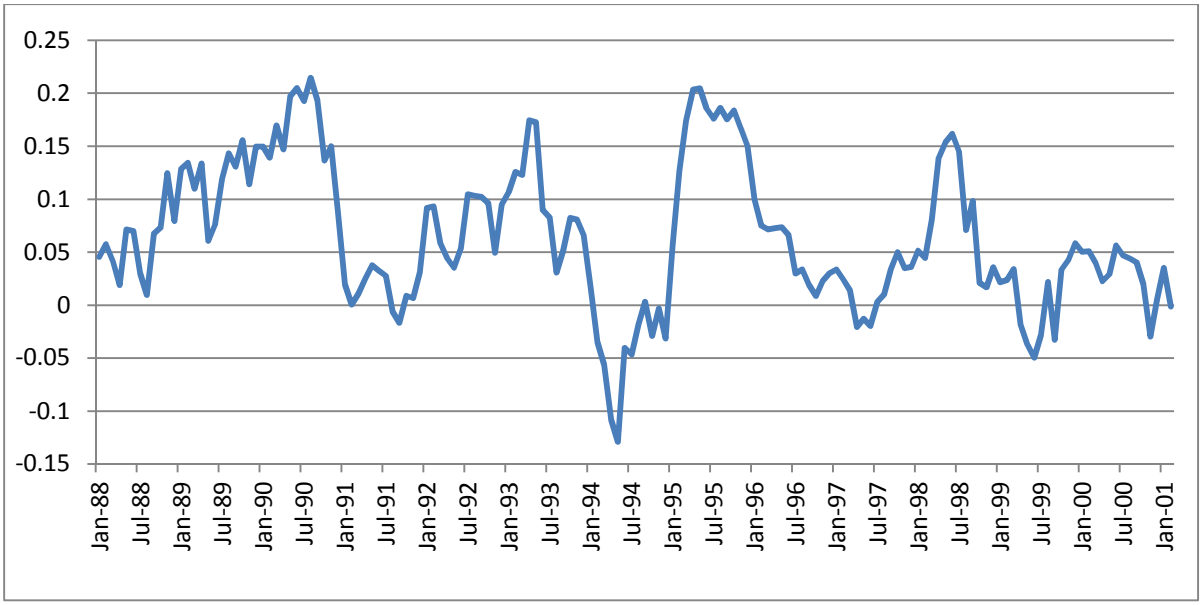

Figure 18: Reserves, monthly series, 12 month % change, 1987-2001

Excess M1 Balances

In order to calculate excess M1 balances, we set up another equation concerning demand for money. The equation for regression analysis is as follows:

$$RMD_t = \alpha_1 + \alpha_2 RGDP_t + \alpha_3 R_t + \alpha_3 T_t + \varepsilon_t \quad (13)$$

RMD_t is real money demand, $RGDP_t$ is real GDP (interpolated from quarterly to monthly series), T_t is the linear time trend variable, and finally ε_t is residuals of this equation. Excess M1 balances are these residual values estimated from this regression.

This indicator possesses a good predicting power for both crises. Threshold values for both crises are >0.94 and the same NSR value, 0.24, applies. Even though the number of good signals is 4, fewer bad signals, namely, 6, were emitted compared to those of some other indicators. The indicator is ranked as number 3 in the analysis of both crises.

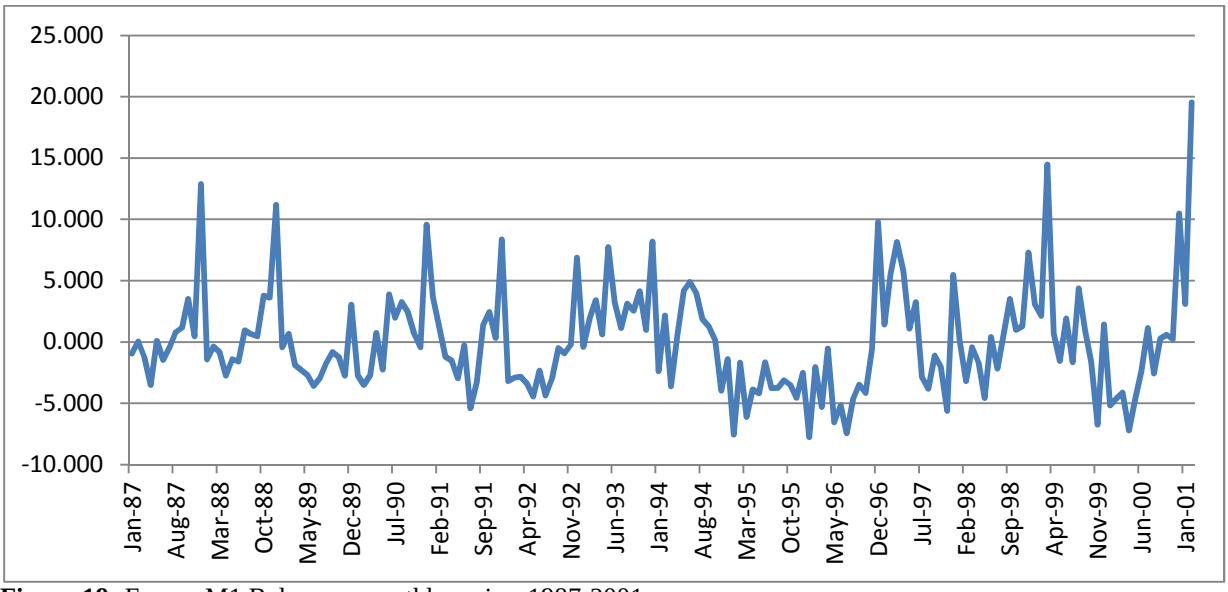

Figure 19: Excess M1 Balances, monthly series, 1987-2001

Interest Rate Differentials

The real interest rate differential is simply the difference between the real interest rates of the US and Turkey. We used 3-month deposit rates for both series.

As can be seen from Figure 20, the series increased during the months preceding the 2001 crises. However, it rose after the 1994 crisis instead of prior to 1994, as expected. Twelve of the total 30 bad signals were captured in the one year between July 1994 and Aug 1995. Even though there is a high volume of bad signals, it is still considered a good indicator. The threshold value is 79% upper tail for currency and 80% for banking. NSR values are the same for both, namely, 0.82.

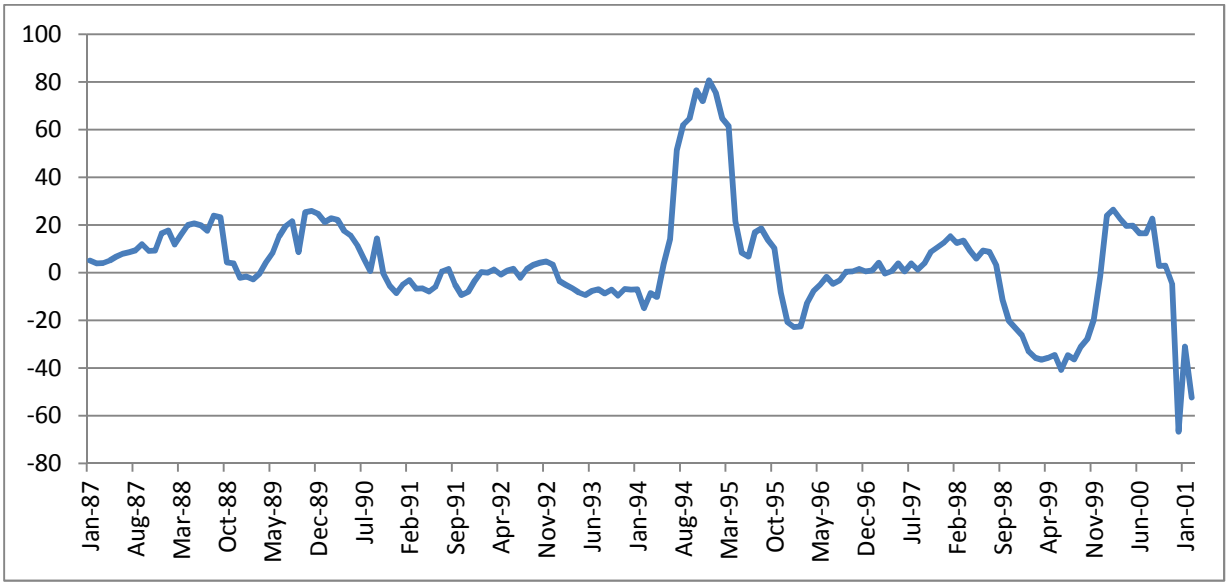

Figure 20: Real interest Rate Differential, Turkey-US, monthly series, 1987-2001

Industrial Output

A 12-month percentage change is used. The total observations equal 158. This indicator issues many false signals, resulting in high NSR values for both currency and banking. The result is the same for both crises with the 12-month horizon as well as the 18- and 24-month

horizons, and calculated NSR values are more than unity. It was therefore determined that this variable does not have the predictive power to signal both crises (see Figure 21).

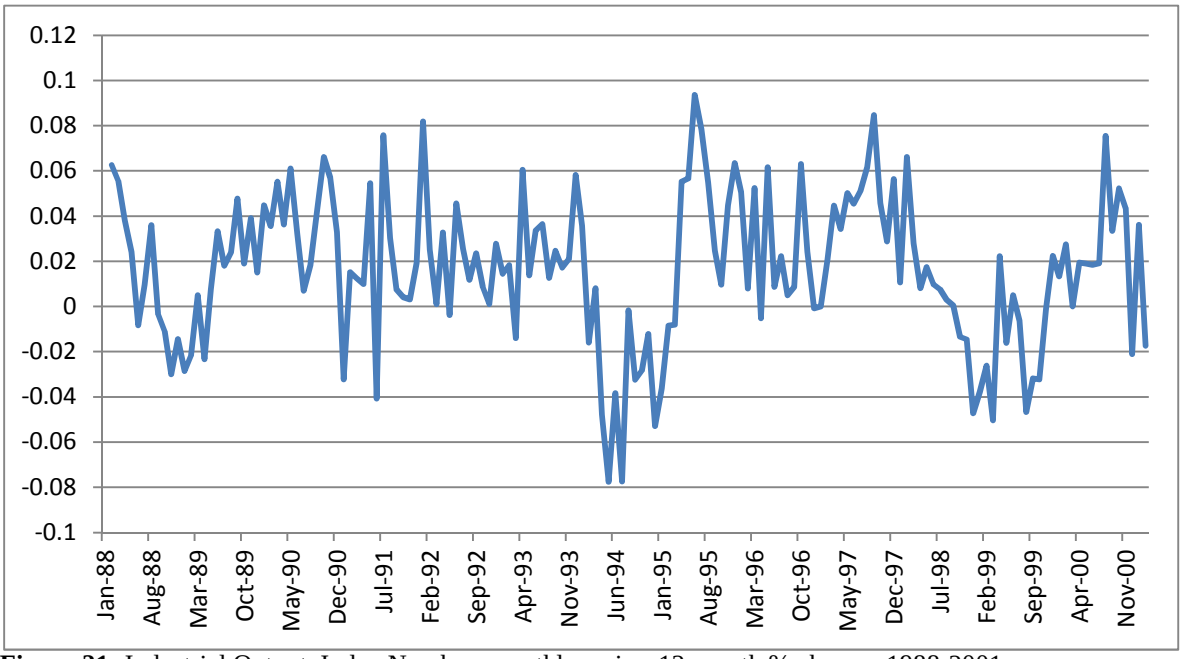

Figure 21: Industrial Output, Index Number, monthly series, 12-month % change, 1988-2001

Stock Prices

As in the KLR model, an index of Equity prices (in US dollars) is used with 12-month percentage change. The number of observations is again 158.

It was found that this indicator likewise does not provide a good result for analysis. NSR found for both are high. The lowest NSR with <0.8 threshold is 2.4 for currency and that with the same threshold is 1 for banking. As can be seen from Figure 22, the series does not show apparent trend in the months before the crises. Like industrial output, the stock price variable should be removed from the analysis.

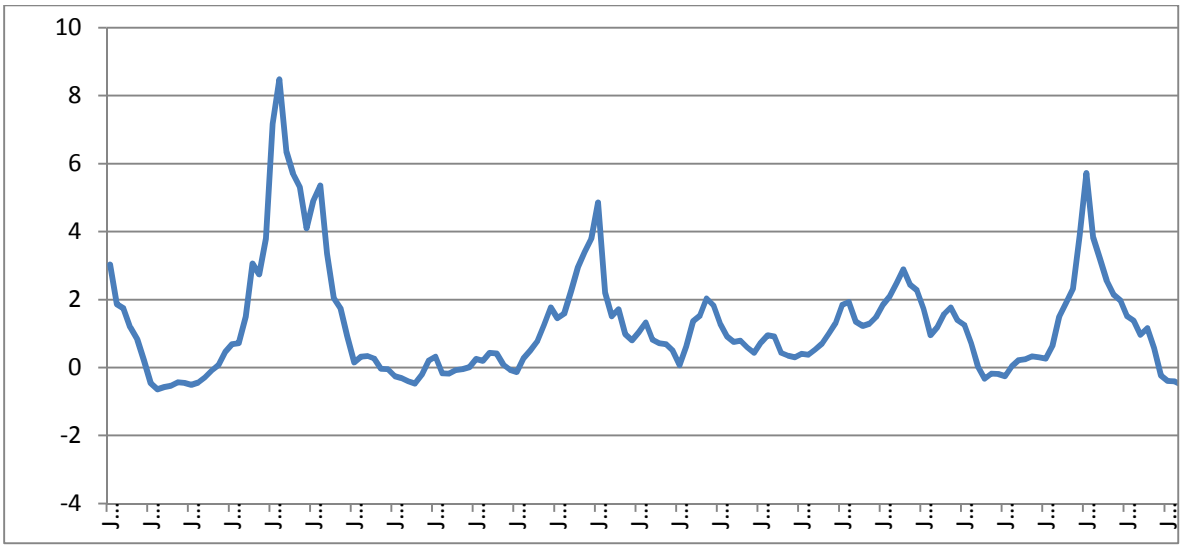

Figure 22: Stock Prices, constant, monthly series, 12-month % change, 1988-2001

Oil Prices

As we mentioned previously, this variable is not included in KLR model. A sudden increase in oil prices has a big impact on oil-importing countries such as Turkey. Rising oil prices not only widen current account deficits, but also increase inflation and have negative effects on growth. Therefore, as in the Edison (2000) study, we decided to include this variable in our model.

A 12-month percentage change is used for this series. The monthly series, totaling 158 observations, began in Jan 1988 and ended in Feb 2001. The currency threshold value of Oil Prices in the Edison study is in the upper 90th percentile. The NSR value is 0.49 if the threshold value is chosen as > 0.90. However, we found a lower NSR for currency and banking, 0.31 if the value of the threshold is > 0.86.

As can be seen clearly from Figure 23, the 12-month percentage change in oil prices shows higher values in the months preceding the 2001 crisis. All good signals, namely, 8, for both currency and banking crises were issued before the 2001 crisis. Nevertheless, this number

was still able to keep the NSR values low despite the fact that no good signal was emitted before 1994 crises.

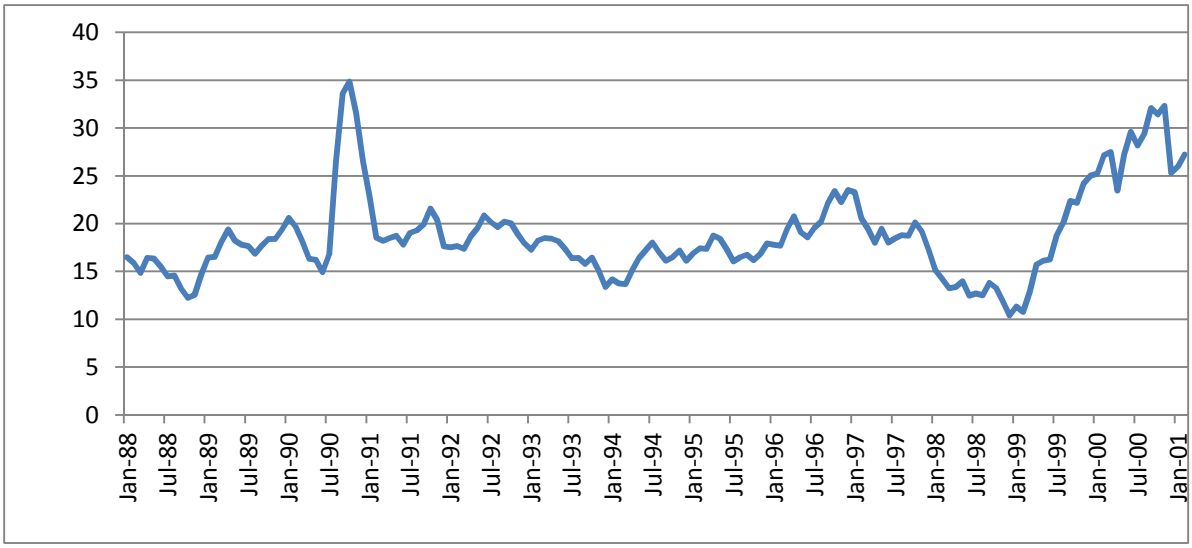

Figure 23: Oil Prices, monthly series, 12- month % change, 1988-2001

Change in Short-Term Foreign Debt/Reserves

This variable is also taken from the Edition (2000) study. The monthly series, totaling 158 observations, began in Jan 1988 and ended in Feb 2001. A twelve-month percentage change was used. Hali Edison (2000) chose the threshold value for this variable the upper 88th percentile. Based on our calculation, optimal threshold value for currency crisis is > 0.91 for both currency and banking. The NSR value for currency is 0.35 and that for banking crisis is > 0.65. Therefore, this variable should be added to our model.

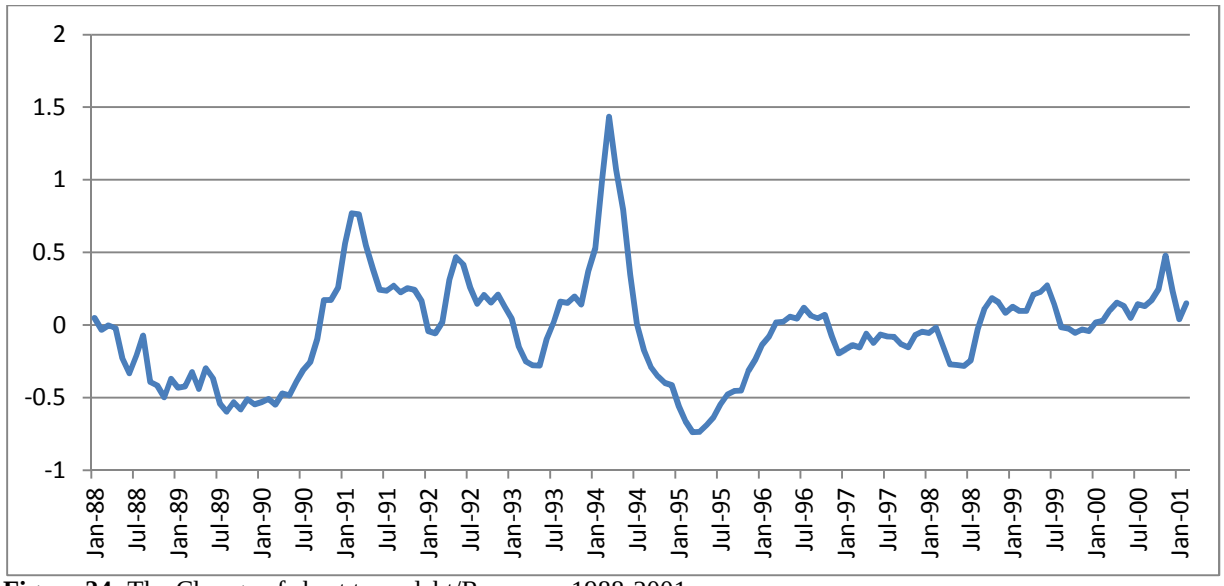

Figure 24: The Change of short term debt/Reserves, 1988-2001

The Export/Import Ratio

This is third additional variable that is not included in the KLR model. It is considered that this indicator can be added as an external sector variable, as it gives better result for our model compared to taking import and export variables taken alone.

The time period starts from Jan 88 to Feb 2001. Twelve-month percentage change isused. Since the expected sign is negative, we checked the lower tail of the distribution to find the lowest NSR values. The threshold associated with the lowest NSR value is <0.10 for both currency and banking crises. NSR values are the same for both, namely, 0.23. As expected, this ratio is found to be one of the best indicators among all those used our study. The series fell steadily during the months before both the 1994 and 2001 crises (see Figure 25). It ranked number 2 within a 12-month horizon during the analysis of both crises.

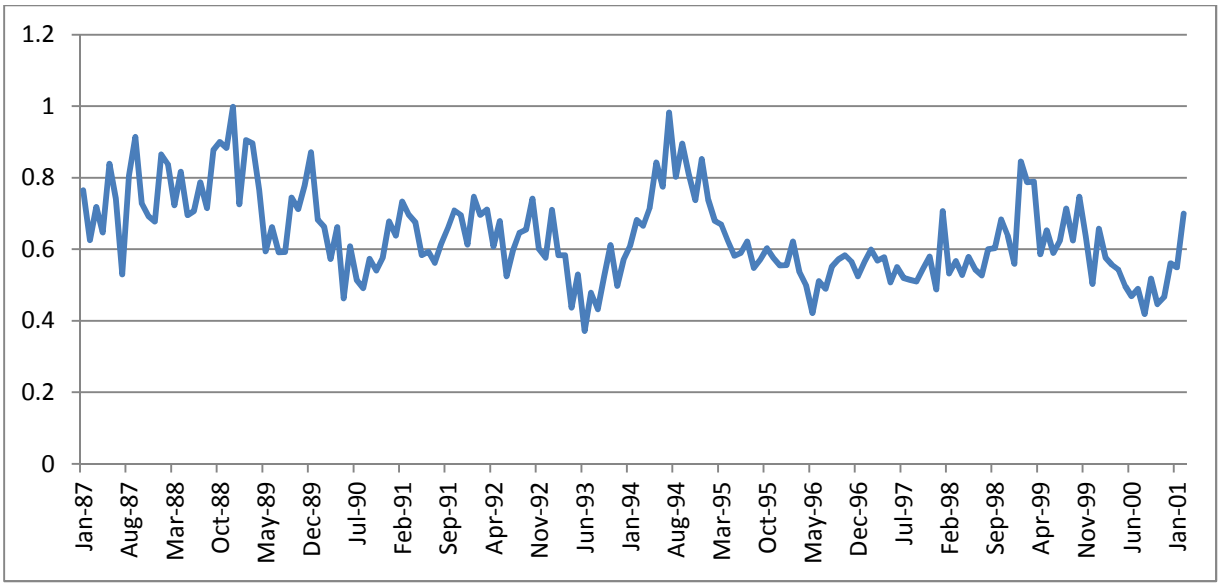

Figure 25: Export/Import Ratio, 12 month percentage change, 1988-2001

Bank Reserves/Bank Asset Ratio

This ratio is the last additional variable. The monthly series, totaling 158, begun in Jan 1988 and ended in Feb 2001, and a 12-month percentage is used. It was added as a financial sector variable and performed well for both crises analysis.

The expected sign of this variable was negative as well. In other words, if the indicator is below the estimated threshold value, it will give the signal for the crises in the coming 12 months.

Based on our calculation, threshold values for both crises are <0.15, and NSR values are 0.26. The graph clearly shows that the ratio is decreasing during crises period (see Figure 26).

Another good thing about this indicator is that it issues good signals before both crises. There are 7 good signals before 1994 crises, and 3 good signals before 2001 crises.

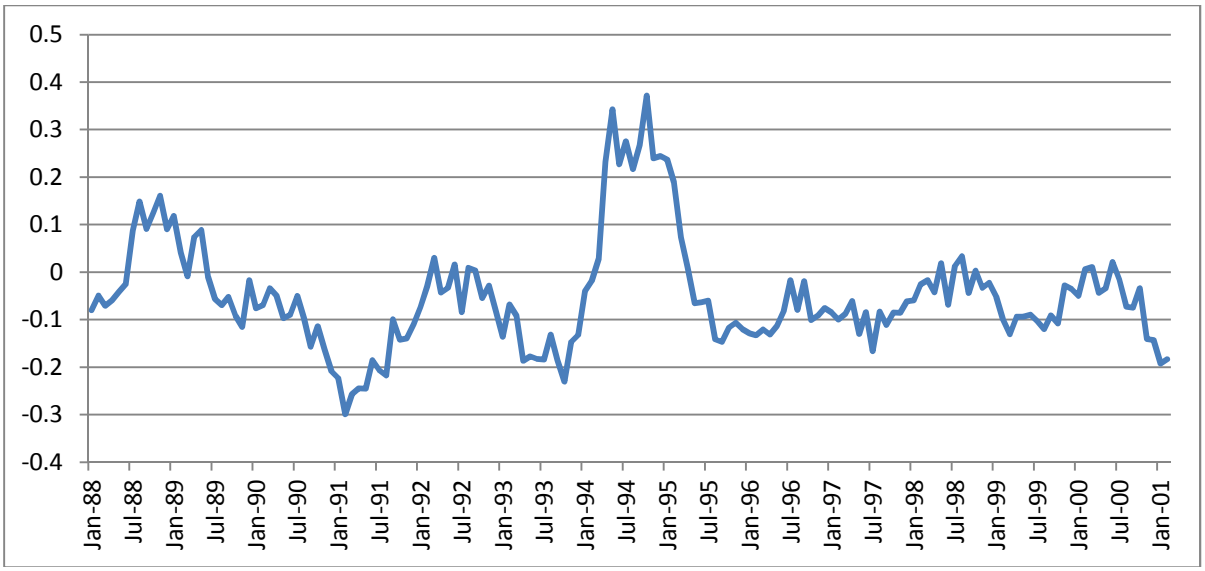

Figure 26: Bank Reserves/Bank Asset Ratio, 12 month percentage change, 1988-2001

V-4. Performance of the Indicators

As mentioned previously, we had added 4 additional variables to those of the KLR model and all performed well. However, due to missing data and poor performance indicators, it became necessary to remove four variables that were in KLR model. Based on the available data and our calculations, we can say the KLR model would have been able to predict both Banking and Currency crises of Turkey in 1994 and 2001. As Table 3 shows, the most significant influence on both crises among all the variables used is that of real-exchange-rate deviation from trend, which ranked number 1 for both the currency and banking crises. The second best performer was the Export/Import ratio.

Excess M1 balances and Bank Reserves/Bank Assets ratio are positively related to the crises and ranked as numbers 3 and 4, respectively. The fifth performer is Oil price indicator. As clearly noted, three out of five top indicators were added to the system at a later time. Another important outcome is that all these five indicators have the same ranking for both currency and banking crises analysis (see Table 4). Short term debt/Reserves ratio is the sixth

best indicator of the currency crises. It has a sufficient number of good signals to merit a low NSR value. However, we cannot say the same thing for banking crises. The indicator had only 3 good signals during the 24 months prior to the two crises periods and it is ranked 10th for banking crisis. Import is another important indicator for predicting both crises. It is ranked as number 7 for currency and 6 for banking crisis.

Table 4: Performance of Indicators, Jan 87-Feb 2001, 12-months window for Currency and Banking Crises

Indicator	Currency Threshold	Banking Threshold	NSR Currency	NSR Banking	Number of months good signal issued (Currency)	Number of months good signal issued (Banking)	Rank Currency	Rank Banking
Domestic Credit/GDP	**>0.74**	**>0.74**	**0.63**	**0.73**	**9**	**8**	**11**	**11**
Excess M1 Balances	**>0.94**	**>0.94**	**0.24**	**0.24**	**4**	**4**	**3**	**3**
M2 Multiplier	**-**	**-**	**-**	**-**	**0**	**0**	**16**	**16**
Real Interest Rate	**>0.95**	**>0.95**	**0.57**	**0.57**	**2**	**2**	**9**	**8**
M2/Reserves	**>0.91**	**>0.91**	**0.71**	**1.16**	**3**	**2**	**12**	**14**
Terms of Trade	**<0.18**	**<0.18**	**0.61**	**0.61**	**7**	**7**	**10**	**9**
Real Exchange Rate (deviation from trend)	**>0.89**	**>0.89**	**0.06**	**0.04**	**13**	**14**	**1**	**1**
Imports	**>0.74**	**>0.70**	**0.41**	**0.37**	**12**	**15**	**7**	**6**
Exports	**<0.11**	**<0.11**	**0.89**	**0.89**	**3**	**3**	**14**	**13**
Reserves	**<0.07**	**<0.28**	**0.53**	**1.34**	**3**	**6**	**8**	**15**
Real Interest Rate Differentials	**>0.79**	**>0.80**	**0.82**	**0.82**	**6**	**6**	**13**	**12**
Oil Prices	**>0.86**	**>0.86**	**0.31**	**0.31**	**8**	**8**	**5**	**5**
Short Term Debt/Reserves	**>0.91**	**>0.91**	**0.35**	**0.65**	**5**	**3**	**6**	**10**
Export/Import Ratio	**<0.10**	**<0.10**	**0.23**	**0.23**	**11**	**7**	**2**	**2**
Deficit/GDP	**>0.89**	**>0.89**	**1.07**	**0.57**	**3**	**5**	**15**	**7**
Bank Reserves/Bank Assets Ratio	**<0.15**	**<0.15**	**0.26**	**0.26**	**10**	**10**	**4**	**4**

Note: Currency Crises dates are Apr 1994, March 2001. Banking Crises dates are Feb 1994, March 2001.

The NSR values of the remaining are over 0.50. They are not as useful as the other indicators for predicting crises, but they are sufficiently good to keep in the analysis. However, budget deficit/GDP issued so many bad signals for currency and M2/Reserve ratio and the Reserves variables gave the same result for banking. These indicators will be taken out of our next analysis, calculating composite indicators.

V-5. Composite Indicators and Probability of Crises

Another criterion for measuring the performance of the model is to determine whether composite indicators have greater values during crises periods compared to their values in tranquil times. If the KLR model predicts Turkish crises successfully, then it is expected that the value of composite indicators would increase during crises periods.

The first composite indicator is simply the total number of signals issued at a point in time. The first composite indicator $CI1_t$ is as follows:

$$CI_t^j = \sum S_t^j \qquad (14)$$

Where S_t^j = 1 if indicator j crosses threshold in period t

S_t^j = 0, otherwise

Therefore, if five variables cross their own threshold values in period *t*, then each S_t would be 1 and $CI1_t$ would equal 5.

Kaminsky and Reinhart (1998) measured the frequency distribution of total signals both during periods of crisis and tranquility. Based on our calculations, the average number of signals for currency crisis during a 12-month crisis period is 3.83. Conversely, the mean in tranquil times is only 1.47. During the 12-month banking crises period, the mean the number of signals

again is 3.83, while in tranquil times it is 1.56. Since the crises dates of currency and banking are close to each other, the value of the composite indicator one for both crises measures almost the same, and the figures look similar (see Figures 27 and 28). The value of $CI1_t$ became bigger prior to crises dates and reached its highest level, 7, in Oct 2000. Four indicators had sent

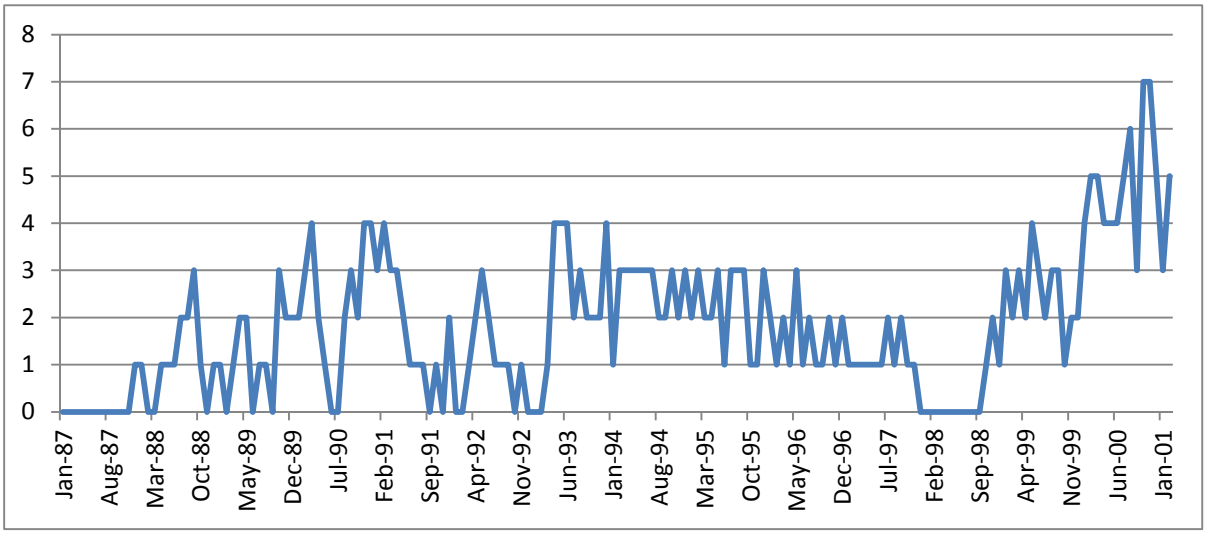

Figure 27: Composite Indicator one for currency crises, 16 variables, Jan 1987- Feb 2001
Note: M2 Multiplier and Budget Deficit/GDP variables are taken out from calculation since their NSR values are higher than unity.

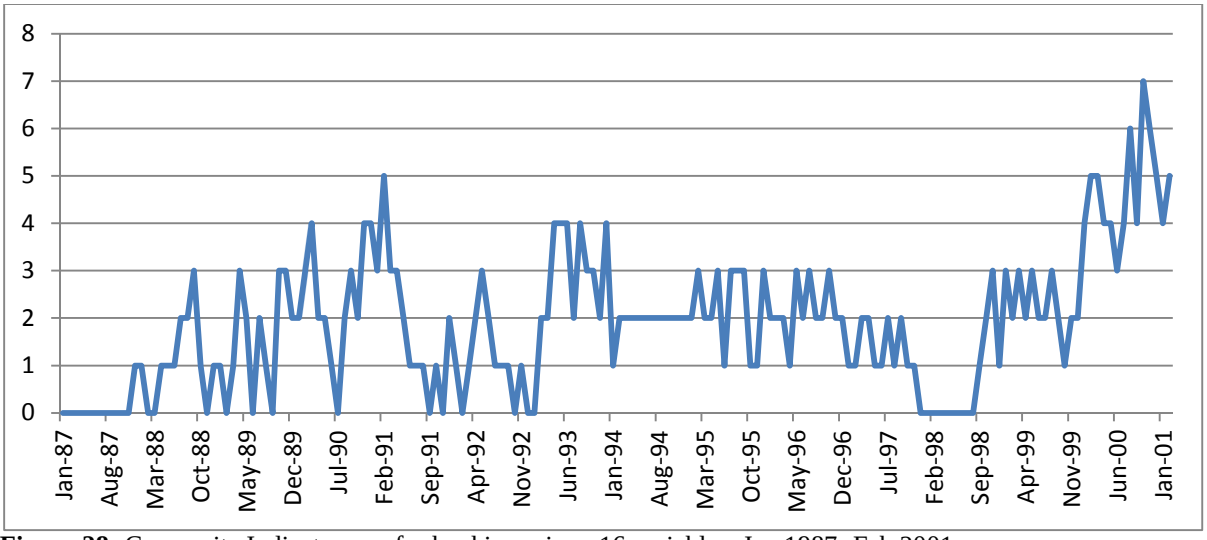

Figure 28: Composite Indicator one for banking crises, 16 variables, Jan 1987- Feb 2001
Note: M2 Multiplier and Reserves variables are taken out from calculation since their NSR values are higher than unity.

signals within the 12-month period preceding the 1994 crises, four times for currency crisis and five times for banking crisis. There are even more indicators that gave signals during the 2001 crises periods. The average number of signals for currency crisis goes up to 4.83 ($CI1_t$ is 7 in Oct 2000 and Nov 2000), and that for banking to 4.75. These numbers indicate that Turkey has faced more severe economic shocks during the 2000-2001 periods than in that of 1994.

Even though the first composite indicator gives us some valuable information for the model, it does not provide sufficient information for the role of the indicators that have most impact in predicting crises. The second composite indicator is measured in order to give more weight to the indicators that have fewer forecasting errors (low NSR values). While measuring this indicator, the variables with lower noise-to-signal ratios will get higher weight compare to the variables with higher noise-to-signal ratios. The second composite indicator is constructed as follows:

$$CI2_t = \sum S_t^j / \omega_t^j \qquad (15)$$

Where ω_t^j = the noise-to-signal ratio of variable *j*

If a variable crosses its own threshold value in period *t* (S_t =1) and its noise-to-signal ratio is 0.40, then $CI2_t$ will be increased by 1/0.40 = 2.5 due to that variable.

Based on our own calculation, the second composite indicator performs better in predicting the crises occurring in both periods (see Figures 29 and 30). During tranquil times, $CI2_t$ for currency has a mean of 3.45 and 17.55 in crises times. Conversely, $CI2_t$ for banking has a mean of 3.70 in tranquil times and 23.01 in crises times. Unlike the first composite indicator, the average value of the indicator drops slightly during the 2001 crises period relative to 1994 crises period. In other words, the second composite indicator performs better in predicting both

crises periods, 1994 and 2001. The maximum value of the second composite indicator for currency is 31.19, which occurred in Nov 2000, and that for banking is 39.41, in Oct 2000. However, the mean of the indicator during the 1994 crises period is higher than that in the 2001 period in both currency and banking. The mean for currency drops from 17.65 to 17.46. The mean for banking goes down from 25.07 to 20.95. The first composite indicator was not so informative in predicting the 1994 crises.

As clearly seen from Figures 29 and 30, $CI2_t$ had high values during 1990-1991, as in the 1994 and 2001 crises periods. A twin crisis during that period is expected if one looks only at these figures. In Dec 1990, $CI2_t$ was 27.12 for currency and 35.72 for banking. Four best performing indicators - Excess M1 Balances, Real Exchange Rate, Import and Bank Reserve/Bank Asset ratio - in the model are issuing signals in that date. Turkey might not have experienced financial and economic crises during that time as deep as the case in 1994 and 2001, but some economic fundamentals should have reached deterioration. The EMP index value started increasing after Jan 91 and reached 152.76 (see Figure 7). The IMP index value also began to rise in Jan 91, and reached 2.39 (see Figure 8). These numbers are not as high as the numbers at the dates of crises, Feb 1994 and March 2001. However, one may imagine that an economic crisis passed tangentially to Turkey in that period. One possible explanation for this finding is that of the impact of weak fundamentals in the economy. Variables issuing signals during that period might have taken longer than 12-month time horizon selected in the analysis. Another relevant explanation might be related to the level of openness of the domestic financial market to the world. Capital controls and inconvertible currency in a country prevent sudden capital flight, and as the STV model suggests, weak macroeconomic fundamentals may not result in domestic currency devaluation. Controls on capital movements had just been removed and

fully convertible currency was still new to the Turkish financial market. Financial intermediation was also largely dominated by state banks during early 1990s. Because of the interaction of all these factors, deterioration in certain economic fundamentals did not cause financial panic in the market during the 1991-92 periods. Net portfolio investment was counted in a positive number, $681 million in 1990 and $714 million in 1991.

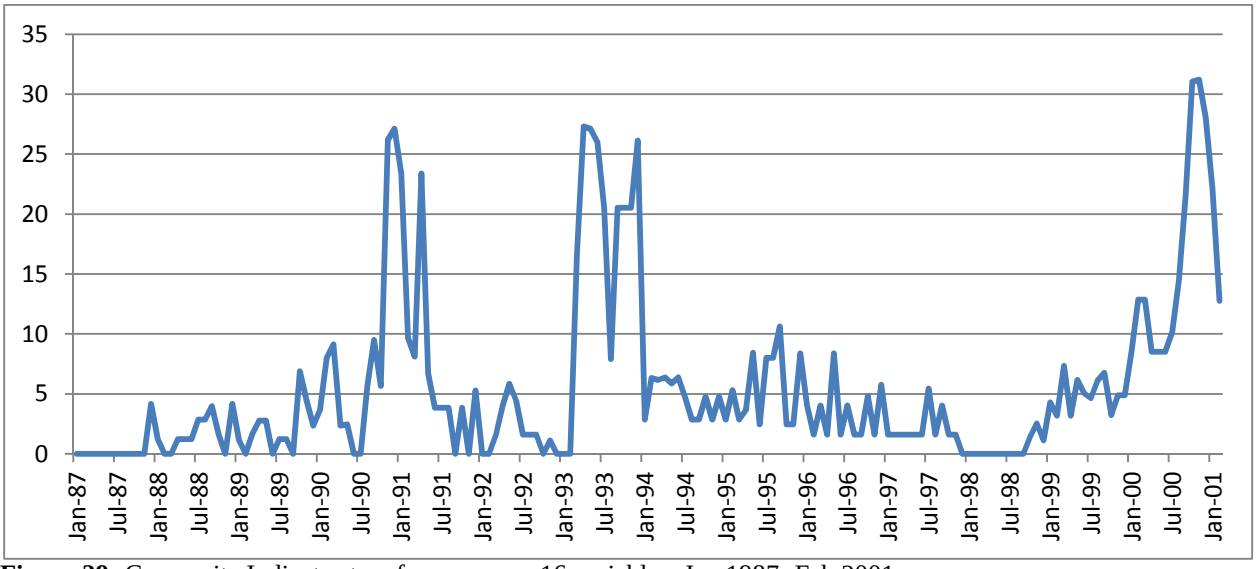

Figure 29: Composite Indicator two for currency, 16 variables, Jan 1987- Feb 2001
Note: M2 Multiplier and Budget Deficit/GDP variables are taken out of calculation since their NSR values are higher than unity.

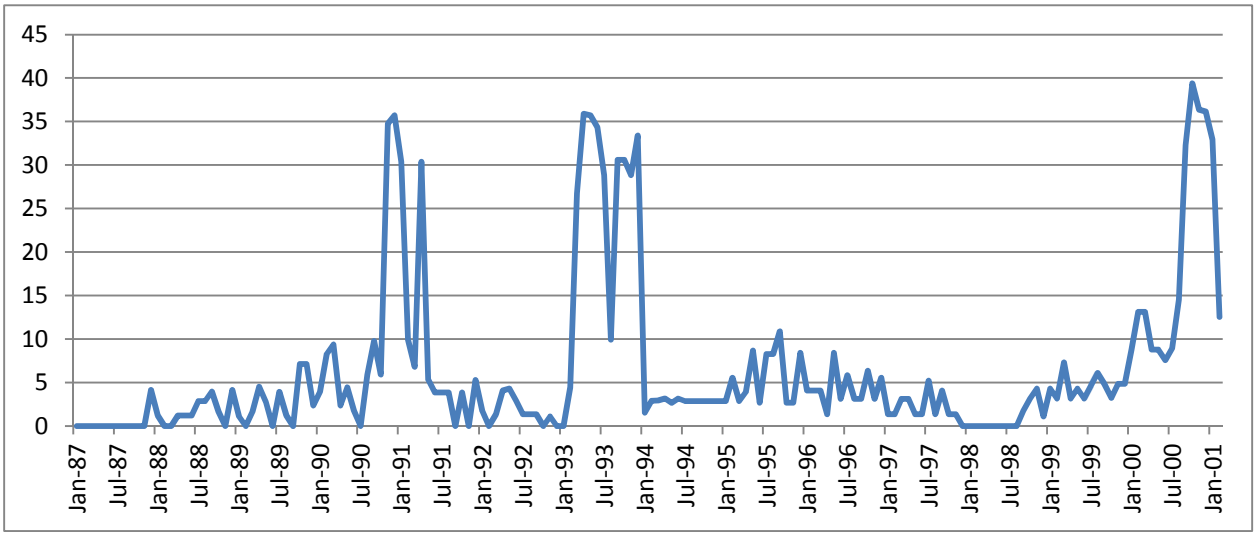

Figure 30: Composite Indicator two for banking, 16 variables, Jan 1987- Feb 2001
Note: M2 Multiplier and Reserves variables are taken out from calculation since their NSR values are higher than unity.

Kaminsky and Reinhart (1998) calculated the conditional probability of currency and banking crises by using the values of the second composite indicator. The conditional probabilities of a crisis are measured as follows:

$$\Pr\left(CI_{t,\,t+12} \mid CI2_i < CI2_t < CI2_j\right) = \frac{\sum months\ with\ CIi2 < CIt2 < CIj2 \text{ and a crises within 12 months}}{\sum months\ with\ CIi2 < CIt2 < CIj2}$$

Where Pr = probability of crises

$CI_{t,\,t+12}$ = occurrence of a crises within 12 months

$CI2_t$ = the value of second composite indicator in period *t*

Tables 5 and 6 show the conditional probability of currency and banking crises, corresponding to the values of the second composite indicator in case of the Turkish crises. The higher value of the Index number should be associated with the higher probability of a crisis, if the model predicts Turkish crises correctly. Based on our calculation for Turkey, the highest probability of a currency crisis is 76 percent if the value of the second composite indicator is 20 or higher. That of a banking crisis is 81 percent if the index value is 31 or more. As can be seen from both tables, the probability of crisis increases as the value of the second composite indicator rises, as predicted by the KLR model.

High $CI2_t$ values during the 1990-91 periods affected the result of the probability in last row of Table 5 and 6. The $CI2_t$ value for currency is over 20 in four different months at the end of the 1990s and beginning of 1991, and two months have over 31 values of $CI2_t$ for banking in the same period. If these dates had lower $CI2_t$ values, the probability of a crisis in that range would be higher.

Table 5: Conditional Probability of Currency Crises, 12 Month Window

Value of 2. Composite Index	∑ months	∑ months & crisis within 12 months	Probability of Crisis
0-4	88	1	0.01
4-7	40	2	0.05
7-9	11	4	0.30
9-14	6	2	0.33
14-20	4	2	0.50
20 and above	17	13	0.76

Table 6: Conditional Probability of Banking Crises, 12 Month Window

Value of 2. Composite Index	∑ months	∑ months & crisis within 12 months	Probability of Crisis
0-4	99	1	0.01
4-7	29	1	0.03
7-9	15	4	0.36
9-17	9	4	0.44
17-31	7	5	0.71
31 and above	11	9	0.81

Tables 7 and 8 show which indicators issued signals during both crises periods. As clearly seen, all indicators having NSR values lower than unity gave a signal at least one month prior to 2001 currency crisis. To summarize, most of the macroeconomic fundamentals were weak and vulnerable throughout the period. Three variables, Domestic Credit/GDP, Imports, and Oil Prices, were above their threshold values during 8 different months prior to crisis date. Terms of Trade, Interest rate differentials, Real Exchange Rate (deviation from trend) had issued signals seven, six, and five times, respectively. Almost the same picture can be seen for the 2001 banking crisis. This finding indicates that financial and external sectors are behind these various crises.

Table 7: Indicators signaling during crisis period, and *CI2*, currency crises

	DCG	EM1B	RIR	M2R	TOT	REX	IMP	EXP	RES	OILP	STDR	EIR	BRBA	RIRD	*CI2*
Apr-93						1/.06	1/.41					1/.23	1/.26		**27.30**
May-93		1/.24				1/.06	1/.41						1/.26		**27.12**
Jun-93						1/.06		1/.89				1/.23	1/.26		**25.98**
Jul-93						1/.06							1/.26		**20.51**
Aug-93							1/.41	1/.89				1/.23			**7.91**
Sep-93						1/.06							1/.26		**20.51**
Oct-93						1/.06							1/.26		**20.51**
Nov-93						1/.06							1/.26		**20.51**
Dec-93		1/.24				1/.06	1/.41				1/.35				**26.13**
Jan-94											1/.35				**2.86**
Feb-94	1/.63 *								1/.53		1/.35				**6.33**
Mar-94				1/.71					1/.53		1/.35				**6.15**
Total (1994)	**1**	**2**	**0**	**1**	**0**	**8**	**4**	**2**	**2**	**0**	**4**	**3**	**7**	**0**	
Mar-00					1/.61		1/.41			1/.31	1/.35	1/.23		1/.82	**12.87**
Apr-00					1/.61		1/.41			1/.31				1/.82	**8.52**
May-00					1/.61		1/.41			1/.31				1/.82	**8.52**
Jun-00					1/.61		1/.41			1/.31				1/.82	**8.52**
Jul-00	1/.63				1/.61		1/.41			1/.31				1/.82	**10.11**
Aug-00	1/.63				1/.61		1/.41			1/.31		1/.23		1/.82	**14.46**
Sep-00	1/.63					1/.06				1/.31					**21.48**
Oct-00	1/.63				1/.61	1/.06	1/.41	1/.89		1/.31		1/.23			**31.03**
Nov-00	1/.63			1/.71		1/.06	1/.41		1/.53		1/.35	1/.23			**31.19**
Dec-00	1/.63	1/.24	1/.57			1/.06							1/.26		**28.02**
Jan-01	1/.63					1/.06							1/.26		**22.10**
Feb-01	1/.63	1/.24	1/.57	1/.71									1/.26		**12.76**
Total (2001)	**8**	**2**	**2**	**3**	**7**	**5**	**8**	**1**	**1**	**8**	**2**	**4**	**3**	**6**	

Note: M2 Multiplier and Budget Deficit/GDP are taken out from calculation since their NSR values are more than unity for 12 month window. Currency Crises dates are Apr 1994, March 2001. The * indicates NSR value of the selected indicator

Table 8: Indicators signaling during crisis period, *CI2*, banking crises

	DCG	EM1B	RIR	M2R	TOT	REX	IMP	EXP	OILP	STDR	EIR	DEFG	BRBA	RIRD	*CI2*
Feb-93							1/.37					1/.57			**4.46**
Mar-93						1/.04						1/.57			**26.75**
Apr-93						1/.04	1/.37				1/.23		1/.26		**35.90**
May-93		1/.24				1/.04	1/.37						1/.26		**35.72**
Jun-93						1/.04		1/.89			1/.23		1/.26		**34.32**
Jul-93						1/.04							1/.26		**28.85**
Aug-93							1/.37	1/.89			1/.23	1/.57			**9.93**
Sep-93						1/.04						1/.57	1/.26		**30.60**
Oct-93						1/.04						1/.57	1/.26		**30.60**
Nov-93						1/.04							1/.26		**28.85**
Dec-93		1/.24				1/.04	1/.37			1/.65					**33.41**
Jan-94										1/.65					**1.54**
Total (1994)		**2**	**0**	**0**	**0**	**9**	**5**	**2**	**0**	**2**	**3**	**5**	**7**	**0**	
Mar-00					1/.61		1/.37		1/.31		1/.23			1/.82	**13.14**
Apr-00					1/.61		1/.37		1/.31					1/.82	**8.79**
May-00					1/.61		1/.37		1/.31					1/.82	**8.79**
Jun-00					1/.61		1/.37		1/.31						**7.57**
Jul-00	1/.73 *				1/.61		1/.37		1/.31						**8.94**
Aug-00	1/.73				1/.61		1/.37		1/.31		1/.23			1/.82	**14.51**
Sep-00	1/.73					1/.04	1/.37		1/.31						**32.30**
Oct-00	1/.73				1/.61	1/.04	1/.37	1/.89	1/.31		1/.23				**39.41**
Nov-00	1/.73			1/.71		1/.04	1/.37			1/.65	1/.23				**36.37**
Dec-00	1/.73	1/.24	1/.57			1/.04							1/.26		**36.14**
Jan-01	1/.73					1/.04	1/.37						1/.26		**32.92**
Feb-01	1/.73	1/.24	1/.57	1/.71									1/.26		**12.55**
Total (2001)	**8**	**2**	**2**	**2**	**7**	**5**	**10**	**1**	**8**	**1**	**4**	**0**	**3**	**4**	

Note: M2 Multiplier and Reserves are taken out from calculation since their NSR values are more than unity for 12-month window. Banking Crises' dates are Feb 1994, March 2001. The * indicates NSR value of the selected indicator

As mentioned previously, Turkey had faced a major challenge of high inflation and budget deficit throughout the 1990s. During that period, the successive governments opted to borrow money from the public instead of printing money in order to finance the deficit. This strategy, while contributing to reducing inflation, quashed the financial system's functioning. Banks began to use their deposits to buy government securities and treasury bills instead of lending these deposits to the private sector. Financial intermediaries even began to borrow funds from abroad for earnings from high yield government bills, and this in turn put the banks into a very risky position in the case of high currency devaluation. The share of foreign currency liabilities over total liabilities showed a pattern of increase during this period.

The weakness of the financial system can also be seen in our crisis analysis. Half of all variables used for calculating the composite indicator are linked to the financial sector and the remainder is correlated with the external sector. The unsound financial system also caused deterioration in the fundamentals of the external sector. Because of inadequate policies and regulations, Turkey had come to depend heavily on short-term capital inflow, which forced the country to keep the interest rate high and the currency overvalued in order to keep attracting capital inflows. Capital inflow and currency appreciation also resulted in an increase in Imports, leading to a decline in the Exports/Import ratio.

Similar arguments can be made for condition before the 1994 banking and currency crises. Although the indicators signaling the 1994 crises are not as many as those signaling prior to the 2001 crises, they are nonetheless related to the same sectors. The only difference is the Budget Deficit/GDP variable, which was an important indicator of 1994 banking crisis (the NSR value of this variable was high for currency crisis, and consequently was removed from calculation for currency crisis). The high budget deficit and public sector borrowing

requirements during that period caused some researchers to argue that the 1994 crisis is the first generation type. However, as we argued before, the crises of both the 1994 and the 2001 are twin crises, i.e., banking and currency crises occurring simultaneously. In the 1980-1990s, financial liberalization in many countries brought attention on the linkage between banking and currency crises. Consequently, the third generation model was developed by several scholars in order to understand this connection.

V-6. Out-of-Sample Performance

The purpose of examining out-of-sample performance is to test whether the model is able to predict future crises. More reliable leading indicators issuing signals indicates a higher probability of future crisis. However, in the case of Turkey, there is one problem with testing the performance of our model for future crises, namely, that Turkey has not experienced any major financial crises since Feb 2001. EMP and IMP index are calculated for the time period Jan 2002-Dec 2011, after the last twin crisis in Turkey.

Abnormal behavior is not detected either in the EMP index, calculated to identify currency crises, or in the IMP index, measured to define a banking crisis, during our sample period. EMP index values at the dates of currency crises were 463.52 and 418.38. The highest EMP index value during the time period of Jan 2002-Dec 2011 was 148.60, occurring in Jan 2002. The high value of the EMP index was completely normal 9 months after the crisis. In general, the effects of financial crises on economic fundamentals can take from 12 to 24 months. Accordingly, the highest IMP value during that period was 1.36 in Jan 2003, occurring 19 months after the date of the last banking crisis. It may be noted that 1.36 is very low compared to 3.26 and 3.90 in the months in which both crises occurred.

However, the out-of-sample forecast can still be informative in testing the effect of the last global financial crises on the Turkish economy. The global financial crises are believed to have started in the middle of 2007 and worsened near the end of 2008 with the failure of Lehman Brothers and Washington Mutual in Sept 2008. In such a manner, the financial crisis in US spread to all other countries. Hence, the out-of-sample performance will be analyzed for Jan 2007 – Dec 2009 period. The in-sample results calculated for the period of Jan 1987- Feb 2001 is used to generate the out-of-sample forecast for the period of Jan 2007- Dec 2009.

Figure 31: EMP Index, Jan 2002 - Dec 2011

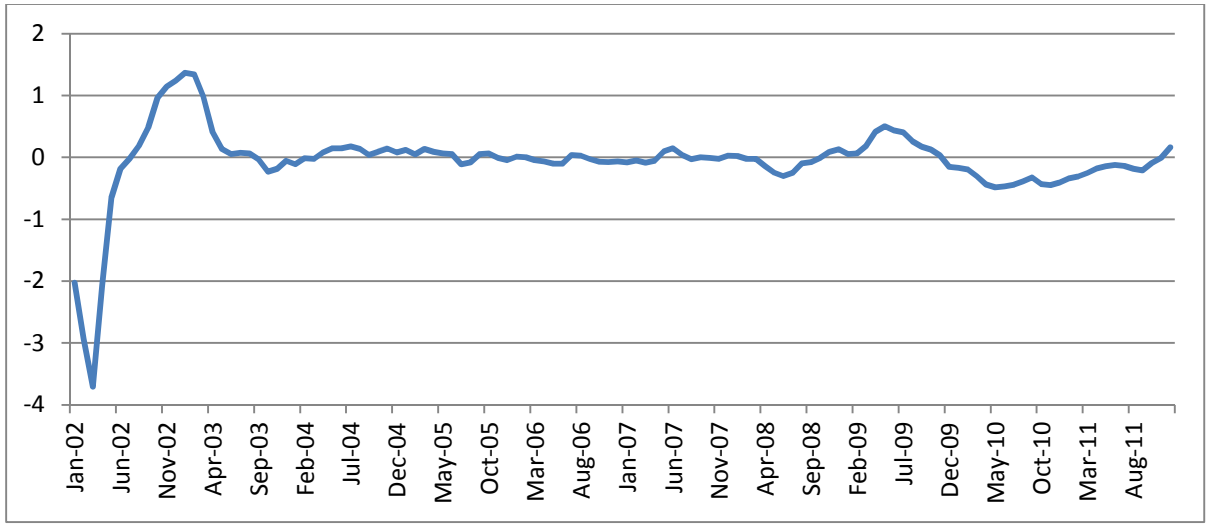

Figure 32: IMP Index, Jan 2002- Dec 2011

The values of the second composite indicator in the out-of-sample period for both currency and banking crises were high throughout the 2007-2008 periods (see Figures 33 and 34, Table 9). $CI2_t$ for currency reaches its peak level of 26.78 in Aug 2008. $CI2_t$, banking, on the other hand, reached its highest values at 34.05 in two different months, Jan- and July-2008. Five indicators of currency crisis made signals during the month of Aug-2008. These indicators were Domestic Credit/GDP, Real Exchange Rate (deviations from trend), Import, Oil Prices, and Short Term External Debt/Reserves. All indicators except one, Domestic Credit/GDP, are in external sectors. There are also five variables issuing signals for banking in Jan- and July-2008. However, Bugdet Deficit/GDP is replaced with Short Term External Debt/Reserves in the case of banking analysis; in other words, external sector variables are associated with a high probability of crises during the out-of-sample period. For instance, the Real exchange rate increased from 181.1 in Jul-2008 to 194.1 in Aug-2008; that is, 7% appreciation of the Turkish Lira in real terms within a month, with a 32.7% change if the variable is measured as a deviation from the trend. Sharp volatility in oil prices was also seen during the 2007-2008 period. The jump in the price of oil from $53.4 in Jan 2007 to $132.55 in July 2008 means 148% increase in less than two years. The level of Reserves showed a steady decline throughout the last quarter of the year 2008.

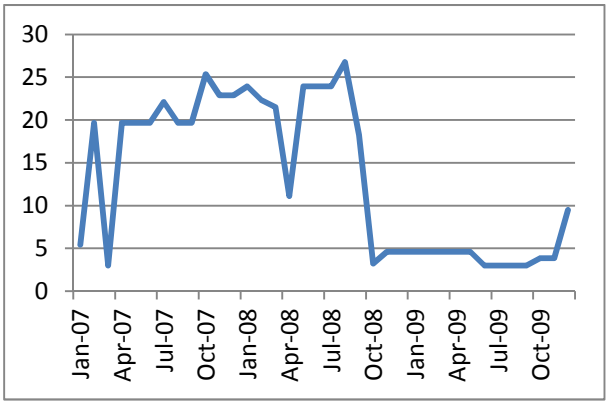

Figure 33: $CI2_t$, Currency, Jan 1997-Dec 2009

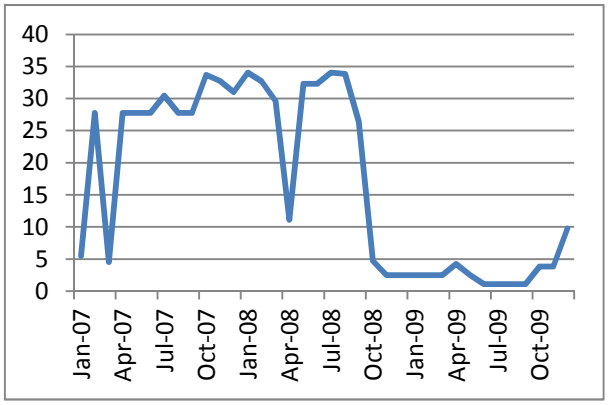

Figure 34: $CI2_t$, Banking, Jan 1997-Dec 2009

Even though Turkey did experience another financial crisis during that time, the last global financial crises passed tangentially to the Turkish economy, as we mentioned earlier for the 1990-91 period. How, then, did Turkey succeed in recovering from the recession of 2008-09?

The answer to this question underlies the STV model. Sachs, Tornell, and Velasco (1996) found that financial panic does not occur in a country if that country has strong economic fundamentals and a sound banking system. They also found that a country may still defend local currency if the country possesses sufficient international reserves. Even though the Turkish lira was overvalued and experienced a large-scale capital flight, exceeding $3.7 billion in 2008, expectation during that period did not turn to large exchange rate depreciation. Moreover, foreign direct investment accounted for $22 billion and $19 billion in 2007 and 2008, respectively, and international reserves were over $70 billion throughout 2008. In other words, capital outflow did not have too much effect on the capital account deficit, which would have resulted in financial panic among investors.

Turkish authorities had also learned lessons from the experience of the last two severe financial crises that occurred in less than a decade. Second, the Turkish economy was much stronger by that time compared to the period preceding the crises. Turkey pursued strong and stable economic growth throughout the 2002-2008 periods. The average growth rate during that period was 5.85%, resulting in the GDP's increasing from $196 billion in 2001 to $730 billion in 2008. Turkey was also able to reduce the inflation rate from two-digit to single digit numbers. While the annual inflation was 54.4% in 2001, it dropped to 6.3% in 2009.

Another of the country's economic successes was seen in export growth, which increased from $31 billion in 2001 to $132 billion in 2008. In addition to significant improvement in the

economy, Turkish policy makers had implemented effective monetary and fiscal policies during the recession. While the central government was able to keep the budget deficit low to achieve a

Table 9: Out of Sample Result, Jan 2007 – Dec 2009

	Currency		**Banking**	
Dates	CI_t^2	Prob of Crises	CI_t^2	Prob of Crises
Jan-07	5.43	0.05	5.48	0.03
Feb-07	19.66	0.50	27.78	0.71
Mar-07	3.00	0.01	4.53	0.03
Apr-07	19.66	0.50	27.78	0.71
May-07	19.66	0.50	27.78	0.71
Jun-07	22.10	0.76	27.78	0.71
Jul-07	19.66	0.50	30.48	0.71
Aug-07	19.66	0.50	27.78	0.71
Sep-07	19.66	0.50	27.78	0.71
Oct-07	25.33	0.76	33.71	0.81
Nov-07	22.89	0.76	32.76	0.81
Dec-07	22.89	0.76	31.00	0.81
Jan-08	23.92	0.76	34.05	0.81
Feb-08	22.33	0.76	32.68	0.81
Mar-08	21.48	0.76	29.60	0.71
Apr-08	11.10	0.33	11.14	0.44
May-08	23.92	0.76	32.30	0.81
Jun-08	23.92	0.76	32.30	0.81
Jul-08	23.92	0.76	34.05	0.81
Aug-08	26.78	0.76	33.84	0.81
Sep-08	18.25	0.50	26.37	0.71
Oct-08	3.23	0.01	4.76	0.03
Nov-08	4.60	0.05	2.49	0.01
Dec-08	4.60	0.05	2.49	0.01
Jan-09	4.60	0.05	2.49	0.01
Feb-09	4.60	0.05	2.49	0.01
Mar-09	4.60	0.05	2.49	0.01
Apr-09	4.60	0.05	4.25	0.03
May-09	4.60	0.05	2.49	0.01
Jun-09	3.01	0.01	1.12	0.01
Jul-09	3.01	0.01	1.12	0.01
Aug-09	3.01	0.01	1.12	0.01
Sep-09	3.01	0.01	1.12	0.01
Oct-09	3.85	0.01	3.85	0.01
Nov-09	3.85	0.01	3.85	0.01
Dec-09	9.51	0.33	9.77	0.44

moderate public sector borrowing requirement, the independent central bank had succeeded in controlling inflation. The Turkish authorities also reduced interest rates, restructured the financial sector, and enhanced banking regulation and supervision.

VI. CONCLUSION

There are many studies in the literature that examine the two Turkish financial crises under study using the signal approach. Some of these studies are concerned with only one crisis, either 1994 or 2001, while others analyze them together solely as balance of payment (currency) crises, rather than classifying them as twin crises. In this paper we argue that both crisis episodes are twin crises, in which currency and banking crises occur simultaneously within a short period of time. We also argue that the Turkish crises of 1994 and 2001 are third-generation types of crises. As previously noted, in third-generation models, currency and banking crises occur together, and these models investigate the fragility in the interaction of the financial and banking systems with a currency crisis. Additionally, Kaminsky and Reinhart (1999) argue that financial liberalization in various countries after 1980s is the primary causative factor behind twin crises.

Celasun (1998) argues that The 1994 Turkish crisis fits into the category of first-generation models. The high public sector budget deficit, overvalued domestic currency, rising public sector borrowing requirement, public sector intervention to lower the interest rate, and high expectations of inflation are the indicators preceding the 1994 crises. Even though the author mentions a minor banking crisis during that time, that crisis is not considered as twin crises. According to Kibritcioglu et al (1999), the 1994 crisis was a currency crisis that was related to the second-generation models. It is argued that the central government continued to push down interest rate to prevent further devaluation of the Turkish lira. This policy is considered as political references, and the crisis can be explained by the second-generation models. On the other hand, most studies agree that the 2001 crisis was a third-generation type. Based on our understanding, both crises contain elements of third generation models. In addition

to having balance of payment problems during both crisis periods, Turkey faced with financial sector issues, the impact of financial sector liberalization, weak bank regulation and supervision, and moral hazard-driven lending.

We measured "the index of money market pressure" (IMP) to identify banking crisis episodes for the period of 1988-2001 and discovered that the two highest index values were in Feb 1994 and March 2001. Central bank loans to private banks increased from 57 thousand TL in February 1993 to 147 thousand TL in February 1994. Additionally, real interest rate rose from 1.1 in the previous year to 11.5 during the same period. During both times of crisis, there was a 100% government guarantee on deposits, triggering moral hazard problems in the financial sector. Moreover, Turkey had also started the process of capital account liberalization and currency convertibility in the late 1980s. In this respect, all these elements of third-generation models were present not only in the 2001 crisis but also the 1994 crises.

The main aim of this paper is to test whether the KLR signal approach would have been able to predict the Turkish twin crises of 1994 and 2001, and whether it is likely to be useful in defining and avoiding possible future crises. Based on our calculation, the KLR model performs well for defining both crises in Turkey. We can also argue that both episodes were twin crises, both the currency and the banking crises occurred simultaneously. The main advantage of this model compared to logit/probit regression models is to give policy makers a clear picture of the variables that show abnormal behavior. Moreover, it may give policy makers an idea of how many variables should be taken into account, and to which indicators they should pay most attention. However, the weakness of the KLR model in our estimation is the selection of leading indicators. Three out of 16 variables in the KLR model were taken out of our analysis due to their high NSR values (issuing numerous false prediction signals. In addition, three out of five

top performing indicators in our calculation are the variables that are were added to the system later rather than during the KLR study. Another difference is the selection of the time horizon. Although a 24-month horizon was used in the KLR model, a 12-month horizon fits our analysis better (the result of 18 and 24 month horizon is presented in Appendix C). However, these limitations should be expected since our model is a single country analysis compared to the multi-country analysis of the KLR model, and overall, the model seems to be informative in explaining the twin crises in the case of Turkey. Furthermore, the composite indicators used by the KLR model provide valuable information tools in examining the effect of the global financial crisis on the Turkish economy during the 2007-2009 periods.

Most studies analyzing financial crises with the early warning system have yielded different results and implications, even for the same country. Kaminsky and Reinhart (1999) found that the top leading indicators of twin crises in their study are real interest rate differentials, real interest rate, deviations of the real exchange rate from the trend, the ratio of M2 to Reserves, and export. In the study of Edison (2000), the top-performing indicators are the deviation of the real exchange rate from trend, the ratio of short term debt to reserves, export, and equity prices. According to Frankel and Rose (1996), financial crises should be expected if reserves drop dramatically, FDI/Portfolio investment declines, and there is high domestic credit growth and overvalued domestic currency. Even though the countries and the periods chosen are similar, the results of these studies vary, and the differences can also even be seen in single country models. For instance, Feridun (2004) examined the Brazilian financial crisis in 1999 and concluded that inflation, exchange rate growth, US interest rate, public debt/GDP, and current account/GDP are the most influential indicators of the crisis. Trunin (2012) concluded that the best-performing indicators in the case of the last Russian financial crises (four different crises

period are examined) are current account, real interest rate, ratio of money supply to reserves, real effective exchange rate, and excess money supply in real terms. In our study, the best indicators for heralding the Turkish crises are the deviation of real exchange rate from trend, Export/Import ratio, Excess M1 Balances, Bank Reserves/Bank Asset Ratio, and oil price. Although the indicators are slightly different, Russia and Turkey have experienced similar root causes of financial crises, since the most fragile sectors in both countries are the financial and external sectors. In summary, because each country's economy is unique and has its own institutional strengths and susceptibilities, it is important for policy makers to develop models that will be most helpful during their particular country's crises episodes.

Could Turkey have prevented the previous financial crises, and what would be appropriate crisis management measures for Turkey in order to avoid future financial crises? As we mentioned above, the most fragile sector during the crises is the financial sector. Throughout the entire 1990 decade, the Turkish economy depended on short term capital inflow, which is mainly caused by inappropriate financial regulation and supervisions soon after liberalization of a capital account. The unlimited deposit insurance practice adopted in 1994, which resulted in moral-hazard driven lending, was terminated in 2004 and limited to only 50,000 Turkish lira. Another important step was the establishment of the Banking Regulation and Supervision Agency (BRSA) in 1999. Initially BRSA was open to political pressures; however, its rules were improved and strengthened on the financial market in the middle of the 2000s. In addition, in January 2002, the Capital Adequacy Ratio of all banks operating in Turkey was increased to 8% as the Basle risk based capital minimum, and subsequently raised again to 12% in 2006. Recently, the average ratio has been well above the legal requirement, and hence was counted as 16.4% in April 2012. Political stability and economic credibility for investors is also important

in helping to cushion the impact of financial shocks. Since the early 1980s, Turkey had suffered several periods of political instability. During the period of 1991-2001, the governments were two or three party coalitions. Turkey finally enjoyed single party government since 2002, and recently a two-party system is being debated among scholars and politicians.

It is important for authorities to have a model that helps them predict future crises and supports them to react against economic shocks prior to occurrence if crises occurred. In our study, we tried to find leading indicators during the last two Turkish financial crises and explored the effect of the 2008 global financial crisis on the Turkish economy during that time. However, work is still needed for deeper analysis. The next step would be to extend the time period (i.e., the period between 1970 and 2001) and/or analyze the Turkish economy at two separate times, before and after financial liberalization. Indicators are not exhaustive and more indicators can be added in the model, also. Moreover, Turkish financial crises can be elaborated with the Markov-Switching model (MSM) instead of signal approach and the results of both models can be examined. The advantage of MSM is that it is not necessary to either define the date of crisis before the analysis or to calculate the threshold values for each variable. In addition, the researcher would not have a concern about selecting crisis windows whether 12-month, 18-month, or 24- month horizon. Unlike signal and probit/logit regression models, MSM is the non-linear time series model which provides the most information about the dynamics of the crises, such as crises times, how long a crisis lasts, and which variables have more effect on ending the crises. One of the most important aspects of the model is to include shifts in expectations. Another proposal would be to set up a multi-country model in order to examine the contagion effect of Turkey's trading partners.

REFERENCES

Akyüz, Y., and K. Boratav (2002). The Making of the Turkish Crisis, *UNCTAD Discussion Papers*, No. 158, http://www.econturk.org/Turkisheconomy/boratav.pdf

Alper, C., and Z. Onis (2002). Emerging Market Crisis and the IMF: Rethinking the Role of the IMF in the Light of Turkey's 2000-2001 Financial Crises, *Research Papers*, Bogazici University, http://www.econ.boun.edu.tr/public_html/RePEc/pdf/200203.pdf

Berg, A., and C. Pattillo (1999). Predicting currency crises: the indicators approach and an alternative, *Journal of International Money and Finance*, 18(4), 561–586.

Boratav, K., and E. Yeldan (2002). Turkey, 1980-2000: Financial Liberalization, Macroeconomic (In)-Stability, And Patterns of Distribution, *CEPA and The New School for Social Research*, http://www.bilkent.edu.tr/~yeldane/B&YCEPA2002.PDF

Calomiris, C. W., and G. Gorton (1991). The Origins of Banking Panics: Models, Facts and Bank Legislation, in R. G. Hubbard (ed.), Financial Markets and Financial Crises, *NBER and the University of Chicago Press*, Chicago, 109-174.

Calvo, G., and E. Mendoza (1996). Petty crime and cruel punishment: Lessons from the Mexican debacle, *American Economic Review*, 86, 170-175.

Calvo, S., and C.M. Reinhart (1996). Capital Flows to Latin America: Is There Evidence of Contagion Effects? in: G.A. Calvo, M. Goldstein, and E. Hochreitter, eds., *Private Capital Flows toEmerging Markets*, (Washington DC: Institute for International Economics).

Celasun, O. (1998). The 1994 Currency Crisis in Turkey, *World Bank Policy Research Working Paper*, No: 1913.

Chang, R., and A. Velasco (1998). Financial Crises in Emerging Markets: A Canonical Model, *NBER Working Paper*, No. 6606.

Databank, The State Institute of Statistics, Ankara, Turkey, http://www.turkstat.gov.tr/jsp/duyuru/upload/vt_en/vt.htm

Demirguc-Knut, A., and E. Detragiache (1998). The Determinants of Banking Crises in Developing and Developed Countries, *IMF Staff Papers*, Volume 45, No. 1, Washington, D.C.: International Monetary Fund.

Demirguc-Knut, A., and E. Detragiache (1998). Financial Liberalization and Financial Fragility, *IMF Working Paper*, 98/83, Washington, D.C.: International Monetary Fund.

Demirguc-Knut, A., and E. Detragiache (2005). Cross-Country Empirical Studies of Systemic Bank Distress: A Survey." *National Institute Economic Review*, 192 (1): 68–83.

Diamond, D., and Dybvig, P. (1983). Bank Runs, Deposit Insurance, and Liquidity, *Journal of Political Economy* 91, 401-419, http://m.blog.hu/el/eltecon/file/diamond_dybvig83%20(1).pdf

Dooley, M.P. (1997). A model of crises in emerging markets, *International Finance and Discussion Paper*, No. 630, Board of Governors of the Federal Reserve System, Washington, DC.

Dooley, M.P. (2000). A Model of Crisis in Emerging Markets, *Economic Journal*, 256-272.

Edison, H. J. (2000). Do Indicators of Financial Crises Work? An Evaluation of An Early Warning System, *International Finance Discussion Paper*, No. 675, Washington, D.C.: Board of Governors of the Federal Reserve.

Eichengreen, B., A. Rose, and C. Wyplosz (1994). Speculative Attacks on Pegged Exchange Rates: An Empirical Exploration with Special Reference to the European Monetary System, *NBER Working Papers*, No. 4898.

Eichengreen, B., A. Rose, and C. Wyplosz (1996). Contagious Currency Crisis, *Centre for Economic Policy Research Discussion Paper*, No. 1453.

Eichengreen, B. and C. Arteta (2000). Banking crises in emerging markets: presumptions and evidence, *Working Papers*, 115, Center for International and Development Economics Research, California, Berkeley.

Esquivel, G., and F Larrain (1998). Explaining Currency Crises, *Development Discussion Paper*, No.666 (Massachusetts, Harvard Institute for International Development).

Feridun, M. (2004). Brazilian Real Crisis Revisited: A Linear Probability Model to Identify Leading Indicators, *International Journal of Applied Econometrics and Quantitative Studies.* Vol.1-1(2004).

Feridun, M. (2007). Speculative Attacks under Financial Liberalization, *Working Paper*, No. 15, 1-51, CAEI (Centre Argentino de Estudios Internationales)

Flood, R., and P. Garber (1984). Collapsing exchange-rate regimes: Some linear examples. *Journal of International Economics,* 17, 1-13.

Frankel, J., and A. Rose. (1996). Currency Crashes in Emerging Markets: An Empirical Treatment, *International Finance Discussion Papers*, No. 534, Board of Governors of the Federal Reserve System.

General Statistics, Central Bank of Turkey, Ankara, Turkey, http://evds.tcmb.gov.tr/yeni/cbt-uk.html

Glick, R., and M. Hutchison, (2000). Banking and Currency Crises: How Common Are Twins? *HKI Working Paper,* 1/2000, Hong Kong: Institute for Monetary Research.

Goldfajn, I., and R. Valdes, (1995). Balance-of-Payments Crises and Capital Flows: the Role of Liquidity, Cambridge, Mass: MIT Press.

Goldfajn, I., and R. Valdes (1997). Capital Flows and the Twin Crises: the Role of Liquidity, *International Monetary Fund Working Paper,* No. 97/87.

Grabel, I. (2003). Predicting financial crisis in developing economies: astronomy or astrology?, *Eastern Economics Journal*, 29 (2): 245.260.

Hagen, J., and Tai–Kuang Ho (2003). Money Market Pressure and the Determinants of Banking Crisis, *Center for European Integration Studies, University of Bonn,* 1-35, http://www.atl-res.com/macro/papers/vonhagen

International Financial Statistics, IMF database.

Kaminsky, G. L. and C. M. Reinhart (1996). The Twin Crises: The Causes of Banking and Balance-of-Payments Problems, *Board of Governors of the Federal Reserve System International Finance Discussion Papers*, 544.

Kaminsky, G.L. (1998). Currency and banking crises: The early warnings of distress, *Board of Governors of the Federal Reserve System International Finance Discussion Paper,* No. 629.

Kaminsky, G.L., S. Lizondo and C.M. Reinhart (1998). Leading Indicators of Currency Crises, *International Monetary Fund Staff Papers*, 45(1), 1-48.

Kaminsky, G.L., and C.M. Reinhart (1999). The Twin Crises: The Causes of Banking and Balance-of-Payments Problems, *American Economic Review*, 89 (3), 473-500.

Kaminsky, G.L., and C.M. Reinhart (2000). On crises, contagion, and confusion, *Journal of International Economics*, 51(1), 145-168.

Kibritçioğlu, B., B. Köse, and G. Uğur (1999). A Leading Indicators Approach to the Predictability of Currency Crises: The Case of Turkey, 1999, http://www.econturk.org/Turkisheconomy/bengi.pdf

Kibritcioglu, Aykut (2004). An Analysis of Early Warning Signals of Currency Crises in Turkey, *Presentation at Wiener Institut für internationale Wirtschaftsvergleiche Seminar*, Vienna, November 8, 2004

Krugman, P. (1979). A Model of Balance of Payments Crisis, *Journal of Money, Credit and Banking*, Vol.11, 311-25.

Krugman, P., (1998). What Happened to Asia?, http://web.mit.edu/krugman/www/DISINTER.html

Main Economic Indicators, The State Planning Organization (SPO), Ankara,Turkey, http://www.dpt.gov.tr/DPT.portal

McKinnon, R., and H. Pill (1996). Credible liberalizations and international capital flows: The "overborrowing syndrome.", *Financial deregulation and integration in East Asia,* 7-50. Chicago: The University of Chicago Press.

Meese, R. A. and A. K. Rose (1996). Exchange rate instability: Determinants and Predictability, *Mimeo*, Haas School of Business, University of California.

Obstfeld, M. (1994). The Logic of Currency Crises, *Cahiers Economiques et Monetaires* (Bank of France), 43, 189-213, http://www.j-bradford-delong.net/teaching_folder/Econ_202b_F2000/papers/Obstfeld,_Logic_Currency_Cr.pdf

Obstfeld, M. (1996). Model of Currency Crises with Self-fulfilling Features, *European Economic Review*, Vol.40, Nos.3-5, April, 1037-1047.

Onis, Z., and F. Senses (2003). Rethinking the Emerging Post-Washington Consensus: A Critical Appraisal, *ERC Working Pape,* No. 03/09, Ankara: Economic Research Center, http://www.erc.metu.edu.tr/menu/series03/0309.pdf

Otker, I., and C. Pazarbasioglu, (1994). Exchange Market Pressures and Speculative Capital Flows in Selected European Countries, *IMF Working Paper*, 94/21, Washington: International Monetary Fund.

Otker, I., and C. Pazarbasioglu, (1995). Speculative Attacks and Currency Crises: The Mexican Experience, *IMF Working Paper*, 95/112, Washington: International Monetary Fund.

Radelet, S., and J. Sachs (1998). The Onset of the East Asian Financial Crisis, *Working Paper*, Harvard University, Cambridge, MA.

Sachs, J., A. Tornell and A.Velasco (1996). Financial Crises in Emerging Markets: The Lessons from 1995, *Brookings Papers on Economic Activities*, 147 - 198.

Salant, S. and D. Henderson, (1978). Market Anticipation of Government Policy and the Price of Gold, *Journal of Political Economy*, 86, 627-648.

Stock Market Data, Istanbul Stock Exchange, http://www.ise.org/Data/StocksData.aspx

Taylor, L. (1998). Capital Market Crises: Liberalization, Fixed Exchange Rates and Market Driven Destabilization, *Cambridge Journal of Economics*, 22(6), 663-676.

Ucer, Murat., Caroline Van Rijckeghem, and R. Yolalan (1998). Leading Indicators of Currency Crises: A Brief Literature Survey and An Application to Turkey, *Yapi Kredi Economic Review*. Vol. 9. No. 2, December 1998. pp. 3-23.

Velasco, A. (1996). Fixed Exchange Rates: Credibility, Flexibility and Multiplicity,

European Economic Review, 40, 1023-35.

Trunin, P. (2012). The Use of the Signal Approach to Development of Early Warning Indicators of Financial Turmoil in Russia, *Gaidar Institute for Economic Policy,* August 2012, http://www.iep.ru/files/RePEc/gai/wpaper/0027Trunin.pdf

APPENDIX A

Table 10: Studies on leading indicators of financial crisis

Study/Date	Country(ies)	Time Period	Type(s) of crisis	Method of Analysis	Significant Indicators Identified
Kaminsky, Lizondo and Reinhart (1998)	20 countries	1975-1996	Twin Crisis	Signal Approach	- Real exchange rate (deviation from trend) - Export - Real interest rate differentials - Real interest rate - M2/Reserves
Frankel and Rose (1996)	105 Countries	1971-1992	Currency Crises	Probit	- The ratio of FDI to portfolio investment - Reserves - Domestic credit - Real exchange rate
Goldfajn and Valdes (1997)	26 Countries	1984-1997	Currency Crises	Logit	- Real exchange rate - Reserves
Esquivel and Larrain (1998)	30 Countries (15 middle income and 15 high income)	1975-1996	Currency Crises	Probit	- The ratio of reserve money to GDP - Real exchange rate - The ratio of current account to GDP - Terms of trade - The ratio of money supply (M2) to international reserves
Demirguc-Kunt and Detragiache (1998)	65 countries	1981-1994	Banking Crises	Logit	- GDP growth - Real interest rate - Inflation - Money supply - Deposit insurance dummy
Eichengreen and Arteta (2000)	75 countries	1975-1997	Banking Crises	Probit	- Credit growth - The ratio of Bank Liabilities to Reserves - Deposit rate
Berg and Pattillo (1999)	The model examines three different studies with their own method, KLR (1998), FR (1996) and STV (1996)			Probit and Signals	- Real exchange rate - The ratio of Current Account to GDP - The ratio of M2 to Reserves (growth) - Reserves
Sachs, Tornell, and Velasco's (1996)	8 countries	1990-1994	Currency Crises	Cross-Country Regression	- Reserves - Real Exchange Rate - The ratio of M2 to

					Reserves - Domestic Credit
Feridun (2004)	Brazil	1980-1999	Currency Crises	Probit	-Inflation -Real exchange rate -Import growth -US interest rate -The ratio of Public debt to GDP -The ratio of Current account to GDP
Feridun (2007)	Turkey	1980-2006	Currency Crises	Signal Approach	- The banking sector fragility index - The ratio of short-term debt to international reserves - The ratio of bank reserves to bank assets - US GDP - M1
		1989-2006			- The US Federal fund rates - US GDP - US 3-Month T-Bill - Banking sector fragility index
Kibritcioglu (2004)	Turkey	1986-2004	Twin Crisis	Signal Approach	- Exports to Imports Ratio - Real exchange rate (deviations from trend) - Real interest rate differentials - Trade balances to Output ratio - Oil prices
Hali Edison (2000)	20 Countries	1970-1995	Twin Crisis	Signal Approach	- Real exchange rate - Exports - The ratio of M2 to Reserves - Reserves - Output
Trunin (2012)	Russia	1995-2004	Twin Crisis	Signal Approach	- Current Account - Real interest rate - The ratio of money supply to Reserves - Real exchange rate - Excess money supply in real terms

APPENDIX B

The Method of Calculation of Optimal Threshold Values

All data are entered in an excel file. Percentile formula in excel program is used to calculate upper or lower tail distribution of the index period. For example, optimal threshold value of real exchange rate for a crisis is found as follows;

Currency threshold value of real exchange rate in the KLR model is the lower 10^{th} percentile of the distribution. Consequently, the one under this study would be the upper 90^{th} percentile since a different conversion is used. The formula was entered in an excel data sheet as =PERCENTILE(B4:B173,0.90) (B4 is column B and row 4 on the data sheet) and the threshold value was found to be 13.97. All monthly data for the real exchange rate within a 12-month period for values of more than 13.97 were checked. From the EMP index, the dates of the currency crises were determined to be April 1994 and March 2001. Consequently, it is evident we are looking at the data preceding these dates for determining each signal. If the real interest rate in a specific month is more than 13.97 for the coming 12 months, that month gives a good signal for a currency crisis. With this information, we calculated the adjusted noise-to-signal radio for that threshold value.

The adjusted noise to signal radio is $(\omega) = \frac{B/(B+D)}{A/(A+C)}$

A. If the indicator issues a signal and a crisis occurs during the following 12 months: We checked the data during the 12 months prior to April 1994 and March 2001 and found that there were 13 months that issued good signals during the 12-month period of the two crises (total 24 months). Therefore, A is found to be 13.

B: If a signal is issued but no crisis occurs during the following 12 months: We checked the months in which the real exchange rate value was more than 13.97, but not within 12 month crisis period. B was found to be 5.

C. If the indicator does not issue a signal but a crisis occurs during the following 12 months: We checked the data for dates 12 months prior to the two crises. If the real exchange rate value was less than 13.97 within the 12-month crisis period, such a date was included in C. Total dates found in C were 11.

D. If the indicator did not issue a signal and no crisis occurred during the following 12 months: Data was checked for the preceding 12 month period during which no signal was issued (the rate is less than 13.97) and no crisis occurred. D is found 141.

As the A and D values rose, the lower the ω value was and the better the results that were obtained. ω is calculated as 0.06 for the currency threshold value of real exchange rate that is set to the upper 89th percentile of the distribution. We checked ω values for the upper 88^{th} and 90^{th} percentile of the distribution and attempted to determine whether or not we were getting a lower ω. We found the currency threshold value for 88^{th} percentile to be 13.59 together with an ω of 0.07, while that for the 90^{th} percentile was 13.97 and ω 0.07. 0.06 was the lowest ω, and we determined the optimal currency threshold to be the upper 89^{th} percentile of the distribution.

APPENDIX C

Table 11: Performance of Indicators, Jan 1987-Feb 2001, 18-month window for Currency Crisis, 12-month window for Banking Crisis

Indicator	Currency Threshold	Banking Threshold	NSR for Currency	NSR for Banking	Number of months good signal issued (currency)	Number of months good signal issued (Banking)	Rank Currency	Rank Banking
Domestic Credit/GDP	**>0.72**	**>0.74**	**0.88**	**0.73**	**11**	**8**	**12**	**12**
Excess M1 B	**>0.94**	**>0.94**	**0.40**	**0.24**	**4**	**4**	**6**	**3**
M2 Mult	**>0.90**	**>0.90**	**1.10**	**-**	**4**	**0**	**15**	**16**
Real Int Rate	**>0.95**	**>0.95**	**0.07**	**0.57**	**7**	**2**	**2**	**8**
M2/Reserve	**>0.91**	**>0.91**	**1.18**	**0.71**	**3**	**3**	**16**	**11**
Terms of Trade	**<0.20**	**<0.18**	**0.43**	**0.61**	**13**	**7**	**7**	**9**
Real Exch Rate	**>0.89**	**<0.14**	**0.07**	**0.04**	**14**	**14**	**1**	**1**
Import	**>0.71**	**>0.70**	**0.46**	**0.37**	**17**	**15**	**8**	**6**
Export	**<0.11**	**<0.11**	**1.03**	**0.89**	**4**	**3**	**14**	**14**
Reserves	**<0.07**	**<0.28**	**0.59**	**1.34**	**4**	**6**	**9**	**15**
Real Int Rate Differ	**>0.79**	**>0.80**	**0.94**	**0.82**	**8**	**6**	**13**	**13**
Oil Prices	**>0.95**	**>0.86**	**0.09**	**0.31**	**6**	**8**	**3**	**5**
ST Debt/Res %	**>0.91**	**>0.91**	**0.59**	**0.65**	**5**	**3**	**10**	**10**
Exp/Imp ratio	**<0.10**	**<0.10**	**0.29**	**0.23**	**8**	**7**	**4**	**2**
Budget Def/GDP	**>0.70**	**>0.89**	**0.83**	**0.57**	**13**	**5**	**11**	**7**
Bank Res/Bank Assets	**<0.20**	**<0.15**	**0.37**	**0.26**	**14**	**10**	**5**	**4**

Table 12: Performance of Indicators, Jan 1987-Feb 2001, 24-month window for Currency Crisis and 12-month window for Banking Crisis

Indicator	Currency Threshold	Banking Threshold	NSR for Currency	NSR for Banking	Number of months good signal issued (currency)	Number of months good signal issued (Banking)	Rank Currency	Rank Banking
Domestic Credit/GDP	**>0.72**	**>0.74**	**0.66**	**0.73**	**17**	**8**	**14**	**12**
Excess M1 B	**>0.94**	**>0.94**	**0.39**	**0.24**	**5**	**4**	**6**	**3**
M2 Mult	**>0.82**	**>0.90**	**0.53**	**-**	**13**	**0**	**9**	**16**
Real Int Rate	**>0.95**	**>0.95**	**0.11**	**0.57**	**7**	**2**	**2**	**8**
M2/Reserve	**>0.92**	**>0.91**	**0.27**	**0.71**	**8**	**3**	**4**	**11**
Terms of Trade	**<0.20**	**<0.18**	**0.63**	**0.61**	**13**	**7**	**12**	**9**
Real Exch Rate	**<0.14**	**<0.14**	**0.11**	**0.04**	**14**	**14**	**1**	**1**
Import	**>0.71**	**>0.70**	**0.63**	**0.37**	**18**	**15**	**11**	**6**
Export	**<0.12**	**<0.11**	**0.74**	**0.89**	**7**	**3**	**15**	**14**
Reserves	**<0.07**	**<0.28**	**0.36**	**1.34**	**6**	**6**	**5**	**15**
Real Int Rate Differ	**>0.79**	**>0.80**	**1.37**	**0.82**	**8**	**6**	**16**	**13**
Oil Prices	**>0.93**	**>0.86**	**0.13**	**0.31**	**10**	**8**	**3**	**5**
ST Debt/Res %	**>0.91**	**>0.91**	**0.43**	**0.65**	**7**	**3**	**7**	**10**
Exp/Imp ratio	**<0.10**	**<0.10**	**0.43**	**0.23**	**8**	**7**	**8**	**2**
Budget Def/GDP	**>0.70**	**>0.89**	**0.65**	**0.57**	**20**	**5**	**13**	**7**
Bank Res/Bank Assets	**<0.20**	**<0.15**	**0.56**	**0.26**	**14**	**10**	**10**	**4**

Table 13: Conditional Probability of Currency Crises, 24-Month Window

Value of Composite Index	Probability of Crisis
0-3 (a)	0.08
3-6 (b)	0.19
6-9 (c)	0.26
9-12 (d)	0.60
12-16 (e)	0.75
16 and above (f)	0.92

Table 14: Conditional Probability of Currency Crises, 18-Month Window

Value of Composite Index	Probability of Crisis
0-3 (a)	0.05
3-5 (b)	0.11
5-8 (c)	0.27
8-12 (d)	0.50
12-17 (e)	0.50
17 and above (f)	0.68