

## **Similarities and Differences of The 1994 and 2001 Turkish Currency Crises: A Signal Approach**

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### **Abstract**

The paper will examine the 1994 and 2001 Turkish currency crises by using early warning system which is based on the “signal” approach proposed by Kaminsky, Lizondo and Reinhart (KLR) (1998). The “signal” approach is a non-parametric approach. In this approach, the behavior of a number of individual variables is monitored and they are evaluated against a certain threshold levels. If any of these indicator exceeds its threshold, it is said that indicator issues a “signal” that a currency crisis may occur within a given period.

The objectives of this paper are two folds: to investigate causes of currency crises under consideration and to compare similarities and differences of the 1994 and 2001 currency crises. The data consist of monthly data and range from January 1987 to November 2005 for the following variables: reserves, inflation rate, GDP growth, portfolio capital inflow to reserves, short term external debt to reserves, domestic debt, money supply to reserves, current account to GDP, real exchange rate overvaluation, regional stock market return, regional market pressure index, stock market index, export and import.

Results showed that 2001 crisis is deeper and costlier than 1994 crisis, external factors play more imported role in 2001 crisis than 1994 crisis and in both crises Weighted Composite Index increases sharply previous the both crises.

## Introduction

Turkey experiences two major currency crises in the post stabilization and liberalization period. After the April 1994 currency crisis, the Turkish economy once again found itself more severe and persistent currency crises in February 2001. The effect of the 1994 and 2001 currency crises on the Turkish economy were extremely costly. In 1994 and 2001, GDP (unemployment) decreased (increased) 4 % (7%) and 9 % (12%), respectively<sup>1</sup>.

Even though there are a great deal of studies related to the 1994 and 2001 Turkish currency crises, most of them investigate each crises separately<sup>2</sup>. Therefore, those studies can not reach a general conclusion about causes of the 1994 and 2001 currency crises and can not compare the similarities and the differences of the 1994 and 2001 currency crises. To fill up this gap, it is worth to study the causes of the 1994 and 2001 currency crises and try to show similarities and differences of both currency crises.

The paper will examine the 1994 and 2001 currency crises by using early warning system which is based on the “signal” approach proposed by Kaminsky, Lizondo and Reinhart (1998). The “signal” approach is a non-parametric approach. In this approach, the behavior of a number of individual variables is monitored and they are evaluated against a certain threshold levels. If any of these indicator exceeds its threshold, it is said that indicator issues a “signal” that a currency crisis may occur within a given period.

The paper is organized as follows. In section 2, we provide a brief literature review about financial crises models. In section 3, we introduce “signal approach”, data and variables. In section 4, we represent our results from “signal approach” model. Section 5 is conclusion.

## Financial Crises Models

There are mainly two approaches in the literature to explain the determinants of currency crises. The first-generation model was developed by Krugman (1979) and extended by Flood and Garber (1984) in response to currency crises in developing countries in the 1980s. According to the first-generation currency crises model, expansionary fiscal and monetary policies are inconsistent with fixed exchange rate policies. When the fiscal deficit is financed by expansion of domestic credit, reserves decrease to defend the fixed exchange rate and significant loss of reserves forces the authorities either to devalue or float the domestic currency.

Second-generation models are due to Obstfeld (1986) and later extended by him (1994, 1996) to respond to currency crises when the fundamentals of an economy were sound, as in the 1990s. According to second-generation models, changes in the government’s objective function change agents’ expectation and trigger currency crises. In Obstfeld’s (1994, 1996) model, the government favors lower unemployment and higher output: hence when the costs of defending the peg (such as higher interest rates, higher unemployment, lower growth) are more than the benefit of defending the peg (such as

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<sup>1</sup> T.C.M.B.

<sup>2</sup> Yeni Türkiye Dergisi (2001), Kriz özel sayısı 41 and Ekonomik Kriz Öncesi Erken Uyarı Sistemleri (2006).

gaining credibility and lower inflation) the government devalues even if macroeconomic fundamentals such as foreign debt, budget deficit, reserves etc are sound.

There are mainly two alternative methods to predict to currency crises. First one is limited dependent variables estimation which using logit or probit model to predict financial crises. Due to the failure of the limited dependent variables estimation method to predict the currency crisis, Kaminsky, Lizondo and Reinhart (KLR) came out a new approach in 1998, which is called "Signal Approach". In signal approach, each variable are monitored separately from each other and the deviation of the variable exceeds a certain "threshold" value before crises give us an early warning signal about a possible currency crisis within a specific period of time.

Signal approach has some advantages. First, if variables have sharp changes between crisis and tranquility periods, signal approach may predict crises better. Second, indicators can be ranked according to noise-to signal ratio, which ability of indicator to predict crises and avoid false signals.

KLR (1998) surveyed a large number of empirical studies to identify the most important indicators. Their survey covered 76 currency crises and included 15 developing and 5 developed countries during 1970-1995. Out of more than 100 indicators, they founded following (real exchange rate, real interest rate, imports, M2 multiplier, output, bank deposits, "excess" M1 balances, exports, terms of trade, international reserves, stock prices, real interest rate differential, M2/international reserves, lending rate/deposit rate and domestic credit/GDP) 15 indicators most important. In their empirical work for signal approach, they found that the best indicators of currency crises based on noise-to signal ratios are real exchange rate, export, stock prices and M2/ international reserves.

Ucer, Van Rijckeghem and Yolalan (1998) applied KLR's signal approach in to the April 1994 Turkish currency crisis. In their empirical work, first, they duplicated KLR's work for Turkey during the fourth quarter of 1989 to fourth quarter of 1997, with exception of the real interest rate differential, lending rate/deposit rate and bank deposits. Second, they examined seven additional variables (export/import, short-term advances to the treasury/GDP, short-term external debt/GNP, (reserves/M2Y), domestic government debt stock, domestic government debt maturity, government deficit/GDP and short-term advances to the treasury/GDP). In their finding, KLR variables performed very poor to predict the 1994 Turkish crisis. Out of the 12 KLR variables only excess M1 variables signaled two times, export, M2/reserves and stock prices variables signaled one time and seven variables did not signal. Additional variables performed well compared to KLR variables. Export/import, (reserves/M2Y), domestic government debt stock and short-term advances to the treasury/GDP variables signaled two times, short-term advances to the treasury/GDP variable signaled one time and short-term external debt/GNP signaled three times.

Studies related to 1994 and 2001 Turkish currency crises showed that exchange rate overvaluation, current account deficit, capital outflow, increase in external debt and money supply were main indicators of currency crises<sup>3</sup>.

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<sup>3</sup> C. Gerni, Ö. S. Emsen, M. K. Değer (2006), M. Alagöz, N. Işık, G. Delice (2006), M. Doğanlar (2006), and S. Değirmen, A. Şengönül, I. Tuncer (2006).

## Signal Approach

In this study, we use the “signal” approach model proposed by KLR (1998) to compare similarities and differences of the 1994 and 2001 currency crises.

### *Signaling Horizon and Threshold Level*

To make the signal approach model operational we need to define a signaling horizon and a threshold level. The signaling horizon or crises window can be defined as the period within or time interval over which crises would be anticipated by indicators. We use 12 months crises window for currency crises. The threshold level is chosen to minimize the “noise-to-signal” (bad signal to good signal) ratio. We will use following matrix to measure the “noise to signal” ratios for each indicators.

	Currency Crisis	No Currency Crisis
Indicator issues a signal	A	B
Indicator does not issue a signal	C	D

\* 12 months window was selected.

Where  $A(t)$  is the number of instances in which a indicator issues a signal and a currency crisis occurred in the next 12 months (i.e.  $A(t)$  is the number of the time the indicator provides “good signal” about the occurrences of currency crisis).  $B(t)$  is the number of instances in which a indicator issues a signal and a currency crisis did not occurred in the next 12 months (i.e.  $B(t)$  is the number of the time the indicator provides “bad signal” or “noise” about the occurrence of currency crises in the next 12 months ).  $C(t)$  is the number of instances in which a indicator did not issues a signal in the next 12 months when there was a currency crisis in the next 12 months (i.e.  $C(t)$  is the number of the time the indicator did not provide a good signal about the occurrence of currency crises in the next 12 months ).  $D(t)$  is the number of instances in which a indicator did not issues a signal in the next 12 months when there was no currency crisis in the next 12 months (i.e.  $D(t)$  is the number of the time in which neither indicator issue a signal and crises occurred in the next 12 months). It is obvious from above matrix that the perfect predictor will produce only observations A and D.

### *Data Sample*

The data consist of monthly data and range from January 1987 to November 2005. Most of the data are from the International Financial Statistics CD-ROM database. International Financial Corporation’s Emerging Market Dataset and Morgan Stanley Countries Index provide stock market indexes. Table 1 shows selected variables and references for expected signs.

**Table 1: Selected variables and expected signs**

<b>Explanatory Variables</b>	<b>Expected Sign</b>	<b>References</b>
Stock market index	-	Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999)
Return of regional stock market index ( <b>RSMI</b> )	-	Bilson, Brailsford and Hooper (2001)
Inflation rate	+	Fama (1981), Geske and Roll (1983), Stulz (1986)
GDP	-	Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999)
Reserves	-	Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999)
Portfolio capital inflow/Reserves	-	Bond (1999)
Export	-	Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999)
Import	+	Kaminsky, Lizondo and Reinhart (1998), Kaminsky and Reinhart (1999)
Real exchange rate	+	Frankel and Rose (1996)
Short term external debt / reserves	+	Sachs and Radelet (1998)
Short term domestic debt / reserves	+	Ucer and Yeldan (1998)
Ratio of money supply to reserves	+	Calvo and Mendoza (1996), Frankel and Rose (1996)
Ratio of current account to real GDP	-	Kaminsky and Reinhart (1999)
Regional market pressure index variable ( <b>RMPI</b> )	+	Eichengreen, Rose and Wyplosz (1996), Fratzscher (2002)

Regional Stock Market Index provided by International Financial Corporation's Emerging Market Dataset and Morgan Stanley Countries Index. Regional Market Pressure Index constructed individual countries market pressure index. The regional market pressure index for Turkey is the average of Greece, Russia, Germany, England, France, Italy and Spai's market pressure index.

### **Results from Signal Approach**

Results based on signal approach represented table 2 and 3. By using those two tables we can see the similarities and the differences of the 1994 and 2001 currency crises.

Table 2 reports performances of selected crises indicators for 1994 and 2001 crises. The first two columns show the number of times a signal was issued in the 12 months window preceding the indicated crises. The last two columns give aggregate information about the threshold level and noise-to-signal ratio. Based on the noise-to-signal ratio except inflation all variables appear useful because their noise-to-signal ratio is less than one. Lower noise-to-signal ratio is preferred. From table 2, we can reach following conclusions. All of the crises indicators (except inflation for 2001) issued at least one signal prior to 1994 and 2001 crises. Prior to 1994 (2001) crises

selected variables issued 27 (30) signals. Out of 14 variables import variable signaled seven times, reserves variable signaled three times and real exchange rate, export, CA/GDP, inflation and GDP variables signaled two times prior to 1994 currency crises. Out of 14 variables import and CA/GDP variables signaled six times, RSMI variable signaled three times and portfolioInv./reserves, domestic debt, external debt, RMPI and GDP variables signaled two times prior to 2001 currency crises. Regional market pressure index, regional stock market index, CA / GDP, PortfolioInv/Reserves and external debt variables issued six signals prior to 1994 currency crisis and fifteen signals prior to 2001 currency crisis. Therefore, we can say that external factors play more imported role in 2001 crisis than 1994 crisis.

Table 3 evaluates overall performance of crises indicators 12 months prior to crises. The first two columns show the number of indicators and number of signal issued in monthly base prior currency crises. The last column shows Weighted Composite Index (I)<sup>4</sup>. Weighted Composite Index is total number of signal divided by noise-to signal ratio and gives aggregate information about the likelihood of upcoming crises.

**Table 2: Overall Performance of Selected Variables**

	Number of Signals in Preceding 12 Months		Aggregate Information	
	February 1994	February 2001	Threshold	Noise-to-Signal
Reserves	3	1	-10	0.18
Real Exchange Rate	2	1	+10	0.48
Stock Market Index	1	1	-18	0.57
Export	2	1	-10	0.86
Import	7	6	+40	0.76
Portfolio Inv./Reserves	1	2	-10	0.81
Domestic Debt	1	2	+12	0.48
External Debt	1	2	+15	0.54
M2/Reserves	1	1	+9	0.63
CA / GDP	2	6	-6	0.49
RMPI	1	2	-0.45	0.94
Inflation	2	0	+5	<b>1.9</b>
RSMI	1	3	-7	0.87
GDP	2	2	-6	0.71

<sup>4</sup>

$$I_t = \frac{\sum_{j=1}^n S_{jt}}{W_j} \quad \text{where } S_{jt} \text{ is 1 if variables } j \text{ issued a signal in period } t, 0 \text{ otherwise and } W_j \text{ is the adjusted noise-to signal ratio of each variable } j.$$

**Table 3: Selected Variables Performance Monthly Base**

Summary of Prediction : 1994 Crisis				Summary of Prediction : 2001 Crisis			
Dates	Number of Indicator	Number of Signals	Weighted Composite Index	Dates	Number of Indicator	Number of Signals	Weighted Composite Index
Feb-1993	14	1	5.55	Feb-2000	14	1	2.04
Mar-1993	14	2	3.67	Mar-2000	14	1	2.04
Apr-1993	14	3	5.44	Apr-2000	14	2	4.05
May-1993	14	1	1.31	May-2000	14	2	3.35
Jun-1993	14	4	8.13	Jun-2000	14	2	3.50
Jul-1993	14	1	1.31	Jul-2000	14	1	1.31
Aug-1993	14	3	4.56	Aug-2000	14	2	2.47
Sep-1993	14		0.01	Sep-2000	14		0.01
Oct-1993	14	2	2.55	Oct-2000	14	4	5.95
Nov-1993	14	2	2.46	Nov-2000	14	5	11.35
Dec-1993	14	2	1.84	Dec-2000	14	3	4.98
Jan-1994	14	3	7.49	Jan-2001	14	4	7.34
Feb-1994	14	2	3.60	Feb-2001	14	3	7.85

Weighted Composite Index increases prior to both crises. Specially, started from October Weighted Composite Index higher prior to 2001 crisis than prior to 1994 crisis. Therefore, we can say that 2001 crisis is more predictable than 1994 crisis.

Table 4 shows the cost of 1994 and 2001 crises. We used three crises indicator to evaluate the cost of currency crises. For each indicator, we identified maximum level prior the crisis, minimum level, and recovery period. In 1994 currency crisis, reserves reached maximum level (17.8 Billion \$) at October 1993 then reached minimum level (12.4 Billion) at May 1993 (9 months period). Finally, reserves recovery at January 1995. Recovery of reserves took 27 months. In 2001 currency crisis, reserves reached maximum level (36 Billion \$) at July 2000 then reached minimum level (28 Billion) at November 2001 (11 months period). Finally, reserves recovery at October 2002. Recovery of reserves took 28 months. Recovery of SMI in 1994 (2001) crisis took 7 months (44 months). Recovery of industrial production in 1994 (2001) crisis took 19 months (34 months).

We can concluded from table 4 that 2001 crisis is deeper and costlier than 1994 crisis.

**Table 4: Cost of Currency Crises**

<b>Cost of 1994 Crisis</b>					
Indicators	Maximum	Minimum	Recovery		
Reserves	Oct. 93=17.8 B.	May 94=12.4 B.	Jan. 95=18.2 B.	9 months	27 months
SMI	Jan. 94=241	March 94=145	Aug 94=245	5 months	7 months
Industrial. Production	Dec. 93=86	June 94= 68	July 95=88	13 months	19 months
<b>Cost of 2001 Crisis</b>					
Indicators	Maximum	Minimum	Recovery		
Reserves	July 2000=36 B.	Nov 01= 28.	Oct. 02=36 B.	11 months	28 months
SMI	Apr. 2000=17200	March 01=8432	Dec.03=17326	33 months	44 months
Industrial. Production	July 2000=108	Jan. 01= 91	April 03=110	27 months	34 months

### **Conclusion**

In this study, we used signal approach to identify which variables tent to indicate that a country might be vulnerable to a financial crisis. Even if it is generally accepted that currency crises are unpredictable the results from table 2 show that all of the crises indicators (except inflation for 2001) issued at least one signal prior to 1994 and 2001 crises. Also, table 3 shows that in both crises Weighted Composite Index increases sharply. Specially, started from October Weighted Composite Index higher prior to 2001 crisis than prior to 1994 crisis. Therefore, we can conclude that both crises are predictable but 2001 crisis is more predictable than 1994 crisis.

External variables issued six signals prior to 1994 currency crisis and fifteen signals prior to 2001 currency crisis. Therefore, we can conclude that external factors play more imported role in 2001 crisis than 1994 crisis. Finally, the result from table 4 shows that 2001 crisis is deeper and costlier than 1994 crisis.



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**Appendices: Percentage change of selected variables 24 months prior crises.**









