An Analysis of Early Warning Signals of Currency Crises in Turkey, 1986-2004

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Thank you for inviting me
to Vienna to give seminars and
for giving me the possibility to make further
research on Turkey-EU related issues...

Research Visit to the ÖNB & WIIW
(Vienna, Austria, November 1-15, 2004)

- “An Analysis of Early Warning Signals of
  Currency Crises in Turkey, 1986-2004”
- “Real Exchange Rate Misalignment in Turkey,
  1987-2003”
- “An Overview of Macroeconomic
  Developments in Turkey”
  (with special reference to the AK-Party Era, 2002-04)

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  - Economics, Christian-Albrechts-Universität zu Kiel, Germany (Dr.sc.pol., 1989-1994)
- work:
  - Department of Economics, Ankara University
    - Research & Teaching Assistant (1986-1994)
    - Assistant Professor of Economics (1994-1999)
    - Associate Professor of Economics (1999-2004)
  - Chief-Advisor to the Minister of State for Economic Affairs (2000)
  - Visiting Scholar, University of Illinois at Urbana-Champaign, USA (2000-2002)

Personal Background (2)

- teaching specialization:
  - international economics
  - economics of growth and technology
  - (open economy) macroeconomics
  - economics of integration & EU
- current research specialization:
  - economics of European integration
  - financial and real sector crises
  - high inflation (Turkey)
- selected publications
  - 1994: Die internationale Wettbewerbsfähigkeit der türkischen verarbeitenden Industrie
  - 2000: “EMU, Euro and EU-Membership: An Evaluation From The Turkish Macroeconomic Perspective”
  - 2002: Inflation and Disinflation in Turkey (with Selçuk & Rittenberg)
  - 2003: “Monitoring Banking Sector Fragility”, ABR

An Analysis of Early Warning Signals of Currency Crises in Turkey, 1986-2004

Abstract: Within a signals approach framework à la Kaminsky, Lizondo and Reinhart, this paper aims both to detect the early warning signals of currency crises in Turkey and to discuss the reliability of an early warning system for this country. To determine major leading indicators of currency crises in Turkey, more than 45 variables are tested, and by using the most relevant 15 variables, a composite index is constructed to estimate the probabilities of currency crises in the country.

JEL Classification: E31, F31, F47, C22

Key Words: Currency crises, signals approach, early warning system, real exchange rate misalignment, foreign trade, Turkish economy

Outline of the Presentation

- Introduction: Motivation and Aims
- Macroeconomic Background
- Literature Review
- Signals Approach for Turkey
  - Overview of the Methodology
  - Identification of Crises Episodes
  - Comparison of Individual Performances of Potential Leading Indicators
  - Composite Leading Indicators and Estimation of Crisis Probabilities
- Concluding Remarks
Introduction: Motivation and Aims

Motivation

Turkey liberalized international capital movements in 1989.

The country experienced then two severe currency crises, firstly in 1994 and secondly in early 2001.

However, country-specific studies on the predictability of currency crises in Turkey are still far from being adequate.

By employing the signals approach for the period of April 1986 – April 2004, the current study is aimed both

- to determine the major macroeconomic indicators, which send early warning signals prior to currency crises in Turkey, and
- to discuss the reliability of an early warning system for Turkey.

The concepts of “currency crisis” and “financial crisis” are relatively new in economics.

Usage of the Concept of “Crisis” in Economics Literature
(according to JEL EconLit records, Jan. 1969 – Oct. 2004)

<table>
<thead>
<tr>
<th>Search Period</th>
<th>Debt Crisis (+Crises)</th>
<th>Balance of Payments Crisis (+Crises)</th>
<th>Exchange Rate Crisis (+Crises)</th>
<th>Currency Crisis (+Crises)</th>
<th>Financial Crisis (+Crises)</th>
<th>Banking Crisis (+Crises)</th>
<th>Contagion</th>
</tr>
</thead>
<tbody>
<tr>
<td>1969-1979</td>
<td>0 (1)</td>
<td>0 (1)</td>
<td>1 (1)</td>
<td>1 (1)</td>
<td>6 (6)</td>
<td>2 (2)</td>
<td>0</td>
</tr>
<tr>
<td>1980-1989</td>
<td>393 (409)</td>
<td>16 (39)</td>
<td>2 (14)</td>
<td>2 (3)</td>
<td>85 (156)</td>
<td>10 (17)</td>
<td>18</td>
</tr>
<tr>
<td>1990-1994</td>
<td>322 (334)</td>
<td>14 (47)</td>
<td>8 (18)</td>
<td>7 (130)</td>
<td>73 (138)</td>
<td>25 (39)</td>
<td>39</td>
</tr>
<tr>
<td>1995-2004</td>
<td>215 (264)</td>
<td>42 (88)</td>
<td>44 (99)</td>
<td>404 (4889)</td>
<td>1444 (2201)</td>
<td>225 (460)</td>
<td>640</td>
</tr>
<tr>
<td>1969-2004</td>
<td>930 (1008)</td>
<td>72 (185)</td>
<td>55 (132)</td>
<td>414 (5023)</td>
<td>1608 (2501)</td>
<td>262 (518)</td>
<td>697</td>
</tr>
</tbody>
</table>

Source: Kibritçioğlu (2001): “Economic Crises and Governments...”
Macroeconomic Background: Turkey, 1978-2004

The 1980-1989 Transformation

January 1980: Announcement of a substantial stabilization and structural adjustment program in order to gradually liberalize the economy
1980 - 1982: Domestic financial liberalization
May 1981: Abandonment of the fixed exchange-rate regime
June 1984 - August 1989: Capital account liberalization and convertibility of the Turkish lira

Post-1989 Macroeconomic Developments

December 1993 - April 1994: A major currency crisis and acceleration in the inflation
August 1999: Negative macroeconomic impacts of the Marmara earthquake
November 2000 & February 2001: Two successive banking and currency crises and political instability in Turkey
May 2001: Announcement of the new economic program

Governments & Political Instability in Turkey, 1969-2004


- 1969-2004 = 36 years = 432 months
- Average period between two general elections = 48 months = 4 years
- Average life of governments = 15.4 months = 1.3 years

ICRG=International Country Risk Guide
Volatility in Long-Run Growth (1950-2000)

- Turkey’s economic growth performance was highly volatile.
- Real GDP per capita rose 22 times, from 1950 to 2000.

Global Inflation & Disinflation and Turkey (1949-2003)

- In the late 1990s, Turkey was not able to join the global disinflation process that we observed explicitly.

Annual & Monthly Consumer Price Inflation in Turkey (1969-2004, %)

- Turkey suffered from high and persistent inflation since more than three decades. But, finally, it’s declining now...

Recent Developments in Inflation (1998-2004)

- Annual WPI and CPI increases fell below 15 percent as of September 2004.
- Inflationary expectations in the country are also changing in a positive direction.
In Turkey, the black-market for foreign exchange disappeared gradually since early 1980s.

Since May 1981, Turkey has a relatively flexible exchange rate system. This gradually removed the “black-market” for FX in Turkey.

In 2000, the monthly growth rates of nominal exchange rates were predetermined to gradually disinflate the economy.

High inflation and low credibility of government policies in the 1990s created a strong currency substitution. But it’s changing now...

There is a tendency towards reverse currency substitution during the AK-Party era.

Government’s success in disinflating the economy and its increasing credibility may significantly be contributing to this process.
During the last 27 months, nominal exchange rates do not show any tendency towards a sharp increase, as it has been observed in previous years.

Note that annual growth rate of nominal USD exchange rates turned to negative values between May 2003 and April 2004.

Following the 2000-2001 crisis, gross FX reserves of the Turkish Central Bank increased significantly. They are now about 38 percent higher than the level of reserves prior to the crisis.

The increasing deficit in net exports of goods is eliminated by an increasing surplus in net exports of services, and hence the CAB deficits are declining since March 2004.
However, the cumulative BoP data shows that the recent improvements have not fully translated into the annual data yet.

In 2003, the CAB/GDP ratio amounted to -2.8%. However, it will possibly climb to -4% in 2004.

One indication that Turkey’s policies are on the right track would be a return to positive short-term inflows at a steady and sustainable level. But a substantial increase in longer term capital inflows is not observed in Turkey.

Short-term capital outflows that rose following the 2000-2001 financial crisis declined significantly after January 2002.

Net short-term capital inflows (in terms of cumulative data) are positive in 2004.
The volatility of the CAB to nominal industrial output is significantly lower than that of the net short-term capital inflows to output ratio.

Turkish banking sector experienced difficulties many times within the last 25 years, as a result of their own excessive risk-taking behavior in the past. (The BSF3 index is a weighted average of real annual changes in foreign liabilities, claims on private sector, and total deposits. The BSF2 then covers only the first two of them.)

The recent developments in the FL to FA ratio indicate that the external "open", or "short", position of the Turkish banking system is decreasing now...

The volatility of the CAB to nominal industrial output is significantly lower than that of the net short-term capital inflows to output ratio.

Macroeconomic Background

Political instability
Volatile economic growth
High and persistent inflation
Inflation-depreciation spiral
Strong currency substitution
Volatile short-term capital flows
Large current account deficits
Fragile banking sector
Public sector deficits
External shocks (oil prices, etc.)
Moral hazard problems

BANKING & CURRENCY CRISSES

January 1980
1982-1985
Early 1994
November 2000 – February 2001

CAB deficits in 2003-04 !!!
Literature Review

Macroeconomic Crises

Real Sector Crises
- Crises in Markets for Goods and Services
- Crisis in Labor Market
- Banking Crisis

Financial Crises
- Currency Crisis
- Crisis in Stock Exchange

Inflation Crisis
Stagnation Crisis

General Definition:
"An economic crisis occurs, if the price and/or quantity in the market for goods, services, assets or factors drastically changes."

Main Channels of the Currency Crises (CCs) Literature

- Theoretical Models on Determinants of CC (Three Generations of CC Models)
- International Contagion Effects
- Timing, Possibility and Predictability of CCs
- Recent CCs and the so-called “New Financial Architecture” Debate
- Domestic Macroeconomic Effects of CCs and their Sectoral Diffusion Dynamics

"Weak" Macroeconomic Fundamentals
"Weak" Financial Structure
International Contagion Effects
Unexpected Events

Moral Hazard & Adverse Selection

Speculative Attack & Herding Effect

Market Sentiments

Sharp Depreciation
Loss of Intern. Reserves
Sharp Increase in Interest Rates

Currency Crisis
A Classification of Selected Empirical Studies of Currency Crisis

### Explanatory Variables to Predict CCs
(according to theoretical & empirical models)

- government budget deficits to GDP
- excess real money balances
- real appreciation of the domestic currency
- terms-of-trade
- export and import growth
- current account deficits to GDP
- loss of international reserves of the central bank
- foreign debt to exports
- real interest rates
- output growth
- stock prices
- domestic credits to GDP
- broad money supply (M2) to reserves
- stock prices and banking crises

### Single-Country Studies for Turkey

**Üçer et al. (1998):** signals approach.
The ratio of short-term foreign debt to GNP, the ratio of exports to imports, the ratio of short-term advances to Treasury over GNP, and the ratio of M2Y plus government domestic debt to GNP have strong predictive power for the 1994 crisis in Turkey, rather than the indicators which take place in the study of Kaminsky et al. (1998).

The deviation of effective real exchange rate from its trend value, and as well as the exports to imports ratio, foreign trade balance to GDP ratio, current account balance to GDP ratio and the short-term capital movements to GDP ratio are among the major leading indicators of Turkish currency crises.

Consumer price index, Turkish Lira/US dollar exchange rate, and domestic credit are the significant variables in explaining financial crises. Results of the out-of-sample tests indicate that the predictive power of the model is moderately high.

Their experiments with monthly and weekly models indicate that “real exchange rate, foreign exchange reserves and domestic credit/deposit ratio are the most important determinants of financial vulnerability”.

### Overview of the Methodology
Signals Approach for Turkey: Overview of the Methodology
Signals Approach

- The signals approach is based on monitoring the evolution of indicators that tend to show “unusual” behavior prior to currency crisis.
- When an indicator exceeds (or falls below) a predetermined threshold, then it is said to issue a “signal” that a currency crisis may occur within a given period, such as in 12, 18 or 24 months.
- For this purpose, at first one should clearly define which periods should we call as crisis and what do we mean by saying unusual behavior of indicators.
- One should also be specific about how many periods should be considered saying that “prior to crisis.”

For Turkey:

Identification of Crises Episodes

The foreign exchange market pressure \( P \) index is defined as an average of monthly percentage changes in nominal exchange rates and the negative of monthly percentage changes in gross foreign exchange reserves of the Turkish central bank.

According to the equation above, the \( P \) index, and hence the pressure in the foreign exchange market, increases with the depreciation of Turkish currency and/or the decline in foreign exchange reserves.

Signals Approach: Identification of Crises Episodes (1)

\[
P_t = \frac{(e_t - \mu_e) + (r_t - \mu_r)}{\sigma_e + \sigma_r} \times 2
\]

where \( e_t = (E_t - E_{t-1})/E_{t-1} \) and \( r_t = -(R_t - R_{t-1})/R_{t-1} \)

\( E \): nominal exchange rates (Turkish lira per US dollar)

\( R \): gross foreign exchange reserves of the Turkish central bank (USD)

The foreign exchange market pressure \( P \) index is defined as an average of monthly percentage changes in nominal exchange rates and the negative of monthly percentage changes in gross foreign exchange reserves of the Turkish central bank.

According to the equation above, the \( P \) index, and hence the pressure in the foreign exchange market, increases with the depreciation of Turkish currency and/or the decline in foreign exchange reserves.

When the value of \( P \) exceeds this certain threshold value \( (T_P) \), it means that the country has a currency crisis.

The threshold value, in this study, is determined as the mean of the index \( (\mu_P) \) plus 1.5 standard deviations \( (\sigma_P) \):

\[
T_P = \mu_P + 1.5 \times \sigma_P
\]

Then, a currency crisis (CC) can be observed when the \( P \) exceeds this threshold value:

\[
CC = 1, \ \text{if } P > T_P
\]

\[
CC = 0, \ \text{otherwise}
\]

(Since the historic means are distorted in high-inflation periods, we define three sub-samples according to whether annual change in consumer prices is below 40 %, between 40 % - 80 %, or higher than 80 % and construct \( P \) for each sub-sample.)

In this study, we employ a 12-months window as signaling horizon, as it is also the case in many single-country studies in the literature. The gray-shaded areas above show the 12-months windows prior to individual crisis periods.

In the second stage of the signals approach, one should define both (i) the specific thresholds for the indicators that are expected to send signals before currency crises, and (ii) the length of the signaling horizon in which the indicators would be expected to send a signal.

A signal, which is followed by a crisis within 12 months, is called a good signal, while a signal not followed by a crisis within 12 months is called a false signal or "noise".

An individual indicator, on the other hand, is only accepted as sending a warning signal, when it goes beyond its own threshold value.

Kaminsky et al. (1998) define an optimal threshold as the one that minimizes the noise to signal ratio (NSR), which is obtained by dividing false signals as a share of possible false signals, by good signals as a share of possible good signals. In fact, this approach requires a classification of signals into four groups, as seen in the following table.

An indicator is a perfect leading indicator, if it only has observations that belong either to cell A or to cell D. Contrarily, an indicator, which has only observations of type B or C, would not be an early warning indicator of currency crises at all.
Signals Approach: Classification of Signals Sent by an Early Warning Indicator (3)

Practically, however, it is almost impossible to find an indicator, which sends solely good or bad signals. In terms of the four possible combinations defined in the table, there are various measures that are used in the literature to compare individual performances of possible crisis indicators in many respects:

\[
\begin{align*}
A/(A+C) & \\
A/(A+B) & \\
B/(B+D) & \\
NSR = (B/(B+D)) / (A/(A+C)) & 
\end{align*}
\]

By definition, the higher (lower) the first (last) two ratios are, the better is the performance of an indicator in preceding currency crises.

Signals Approach: Classification of Signals Sent by an Early Warning Indicator (4)

Another criterion to measure the performance of individual indicators is to compare the probability of crisis conditional on signal from an indicator with the unconditional probability of crises, which is the difference between \(P(\text{crisis}|\text{signal})\) and \(P(\text{crisis})\), namely

\[
\frac{A}{A+B} - \left[ \frac{(A+C)}{(A+B+C+D)} \right].
\]

To the extent that an indicator has useful information in predicting currency crises, the conditional probability would be higher than unconditional one. The indicator, on the other hand, whose conditional probability is higher than the unconditional probability, is also the one whose NSR values is less than unity.

Signals Approach: Classification of Signals Sent by an Early Warning Indicator (5)

In the literature, many economists also consider the average persistence of signals sent within the window period prior to crises. It is usually measured as “the number of good signals per crisis period”.

Finally, to evaluate the performances of indicators, one should also consider the average number of months prior to crisis the first good signal occurs because an indicator with lower NSR can only be a useful predictor of currency crises, if it typically sends warning signals as earlier as possible, to give governments sufficient time to take the necessary measures to attempt to prevent approaching crises.

Signals Approach: Results for Individual Indicators (1)

By using monthly data for April 1986 – April 2004 (217 observations), 46 variables are examined to find out which of them were the best indicators of currency crises in Turkey in the past.

Depending on the theoretical expectation about the sign of the relationship between an individual indicator and the \(P\) index, some variables send signals when they fall below their specified threshold, while others are assumed as sending signals when they exceed their own threshold. Notice that the cut-off value for an indicator is measured in percentile of the observations.

In this study, to determine the variable-specific optimal threshold values, we employed one of the two grids of reference percentiles between 75 percent and 90 percent or 10 percent and 25 percent, depending on the direction of the expected change of \(P\) following a signal sent by the individual indicator.
Signals Approach: Results for Individual Indicators

The following table provides the comparative information about the performance of these selected individual indicators.

In this table, the potential early warning indicators of currency crises are ranked according to their NSR’s.

The results show that, in general, foreign-trade and exchange-rate related indicators give the best results in sending early warning signals prior to currency crises.
The results show that, in general, foreign-trade and exchange-rate related indicators give the best results in sending early warning signals prior to currency crises:

- A falling ratio of export-revenues to import-payments below 56 percent (S1),
- A sharp worsening in order-expectations of Turkish exporters (S2),
- A significant (more than 6.8%) real appreciation of the Turkish lira against foreign currencies (S3, S4 and S5), and
- A real interest rate differential more than –5.1 percent (S6)
**Signals Approach:**

**Best Three Individual Performers (2)**

Order Expectations of Exporters (S2) before CCs in Turkey

|------------------------------------------|------------------------------------------|-----------------------------------------|------------------------------------------|------------------------------------------|

Threshold = -6.2

Signals Approach: 

**Best Three Individual Performers (2)**

S2 that represents the order expectations of Turkish exporters is defined as the difference between the share of exporters who expect an increase in foreign orders for coming months and that of the exporters who expect a fall.

It is calculated from the Turkish Central Bank’s survey data on the amount of new orders received from the exports market (trend of the next 3 months, excluding seasonal variations).

The 10-percentile threshold for S2 corresponds a difference of –6.2, which means that the order falls exceeds the order increases.

**Signals Approach:**

**Best Three Individual Performers (3)**

Real Exchange Rate Misalignment (S3) before CCs in Turkey

|------------------------------------------|------------------------------------------|-----------------------------------------|------------------------------------------|------------------------------------------|

Threshold = -6.8

Signals Approach for Turkey: 

Composite Leading Indicators and Estimation of Crisis Probabilities
Signals Approach: 
Construction of a Composite Leading Indicator

We construct a weighted composite leading indicator (C) by using 15 of the best performing leading indicators, which are:

- S1 Exports to Imports Ratio
- S2 Turkish Exporters' New Order Expectations (Up - Down)
- S5 Deviation of JPM's Real Exchange Rate Index from its Trend
- S6 Real Interest Rate Differential (id-if)
- S7 Trade Balance to Output Ratio
- S8 Annual Increase in Crude-Oil Prices
- S12 Monthly Increase in ISE 100 Index
- S13 Monthly Growth in Central Bank's Gross FX Reserves
- S18 Quarterly Change in Banking Sector Fragility Index
- S20 Short-Term Capital Inflows to Output
- S21 Monthly Growth of Consolidated Budget Balance / Output
- S22 Monthly Increase in Wholesale Price Index
- S23 Monthly Increase in Consumer Price Index
- S24 Monthly Change in M2 Multiplier
- S33 Monthly Change in Foreign Exchange Deposits to M2 Ratio

Note: For weighting of Ss, the inverses of NSRs of individual indicators are used.

Signals Approach: 
Composite Leading Indicator and CCs in Turkey

Weighted Composite Index (C) before CCs in Turkey

To evaluate the overall performance of the model we used several statistical tests, such as quadratic probability score test, LPS, GBS, and unconditional probability indicators.
Concluding Remarks (1)

- As it is almost always the case in economics, there are no easy solutions for difficult problems.
- For the predictability of currency crises (CCs), this implies that it is almost impossible to explain and predict these events without considering the role of history and non-economic factors, such as cultural factors.
- For governments, however, it is highly crucial to have an early warning mechanism that can be used for informative purposes, although building a reliable early warning system to detect possible CCs is a very challenging task.

Concluding Remarks (2)

- This study attempted to construct an EWS à la Kaminsky, Lizondo and Reinhart. It has a pioneering nature within the existing literature on Turkey, because it is probably the first, Turkey-specific, single country study which has a very broad sample period and a long list of potential leading indicators of CCs for Turkey.
- The EWS built here show that, in general, foreign-trade and exchange-rate related indicators produce the best results in sending early warning signals prior to currency crises.
- For Turkey, we need further empirical investigation to compare the results of the signals approach employed here with that of the achieved/achievable within the logit/probit framework and/or newly developed Markov-switching techniques.

Appendix: Banking Sector Fragility

**Banking Sector Fragility Index and the Five Stages of Fragility**

Kibritcioglu (2003): “The BSF3 index is a weighted average of real annual changes in foreign liabilities, claims on private sector, and total deposits.”

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**Changes in the BSF Index and the Five Phases of a Hypothetical Banking Crisis**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Banks’ Behaviour</th>
<th>Direction of the Change in the BSF Index</th>
<th>Banking Fragility</th>
<th>Probability of Approaching Banking Crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>excessively risk taking</td>
<td>increases significantly above zero</td>
<td>falls * (optimistic, or boom, phase)</td>
<td>the probability starts to increase *</td>
</tr>
<tr>
<td>2</td>
<td>generally risk avoiding</td>
<td>suddenly begins to decrease</td>
<td>starts to increase</td>
<td>it increases furthermore (probably panic arises)</td>
</tr>
<tr>
<td>3</td>
<td>risk avoiding</td>
<td>falls below zero (but it’s still above –0.5)</td>
<td>increases significantly (medium fragility)</td>
<td>system is approaching the borderline to crisis</td>
</tr>
<tr>
<td>4</td>
<td>risk avoiding</td>
<td>falls below –0.5</td>
<td>continues to increase (high fragility)</td>
<td>most probably, a crisis occurs in this phase</td>
</tr>
<tr>
<td>5</td>
<td>gradually they start to take risk again</td>
<td>increases towards zero **</td>
<td>falls again (recovery period)</td>
<td>crisis is over if the BSF is very close or equal to zero again</td>
</tr>
</tbody>
</table>

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**Different Results about Timing of Banking Crises in Turkey**

<table>
<thead>
<tr>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Beginning of the Distress</td>
<td>Peak of the Crisis</td>
<td>Beginning of the Distress</td>
<td>Peak of the Crisis</td>
<td>Beginning of the Distress</td>
<td>State of Highes Fragility</td>
</tr>
</tbody>
</table>

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