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

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ONB **wiiw**

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ONB

Oesterreichische Nationalbank

wiiw

Wiener Institut für internationale Wirtschaftsvergleiche

Thanks 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)

http://dialup.ankara.edu.tr/~kibritci/wiiw.html

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Personal Background (1)

- ❖ born in Istanbul, Turkey, 1962
- ❖ *education*:
  - ❖ Istanbul High School, Turkey (1973-1980)
  - ❖ Economics, Ankara University, Turkey (B.A., 1981-1985; M.A., 1985-1988)
  - ❖ 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*
  - ❖ 2004: "Inflation, Output Growth, and Stabilization in Turkey, 1980-2002", *JEB* (with Diboöğlu)

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

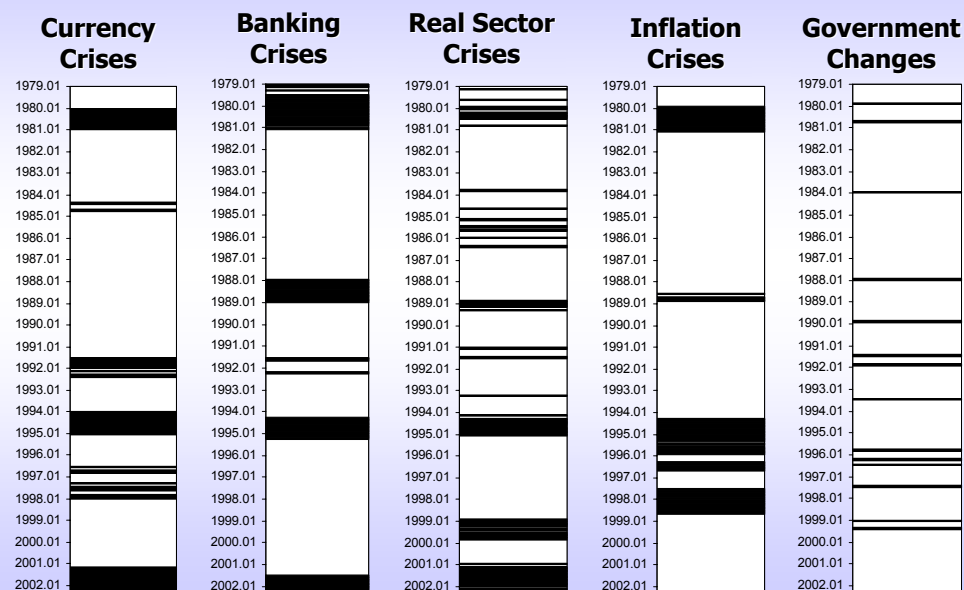Kibritçioğlu, November 8, 2004, (**9/79**)

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

Search Period	Debt Crisis (+Crises)	Balance of Payments Crisis (+Crises)	Exchange Rate Crisis (+Crises)	Currency Crisis (+Crises)	Financial Crisis (+Crises)	Banking Crisis (+Crises)	Contagion
1969-1979	0 (1)	0 (1)	1 (1)	1 (1)	6 (6)	2 (2)	0
1980-1989	393 (409)	16 (39)	2 (14)	2 (3)	85 (156)	10 (17)	18
1990-1994	322 (334)	14 (47)	8 (18)	7 (130)	73 (138)	25 (39)	39
1995-2004	215 (264)	42 (98)	44 (99)	404 (4889)	1444 (2201)	225 (460)	640
1969-2004	930 (1008)	72 (185)	55 (132)	414 (5023)	1608 (2501)	262 (518)	697

Krugman (1979)

❖ **The concepts of "currency crisis" and "financial crisis" are relatively new in economics.**

Kibritçioğlu, November 8, 2004, (**10/79**)

Timing of Macroeconomic Crises in Turkey
(January 1979 – December 2001)

Currency Crises Banking Crises Real Sector Crises Inflation Crises Government Changes

Source: Kibritçioğlu (2001): "Economic Crises and Governments..."

Kibritçioğlu, November 8, 2004, (**11/79**)

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.**

Kibritçioğlu, November 8, 2004, (**12/79**)

Macroeconomic Background:

Turkey, 1978-2004

The 1980-1989 Transformation

1978 - 1980: Balance-of-payments crisis, productivity slowdown and accelerating inflation

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

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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

December 1999: Announcement of an exchange-rate-based stabilization program for 2000-2002

November 2000 & February 2001: Two successive banking and currency crises and political instability in Turkey

May 2001: Announcement of the new economic program
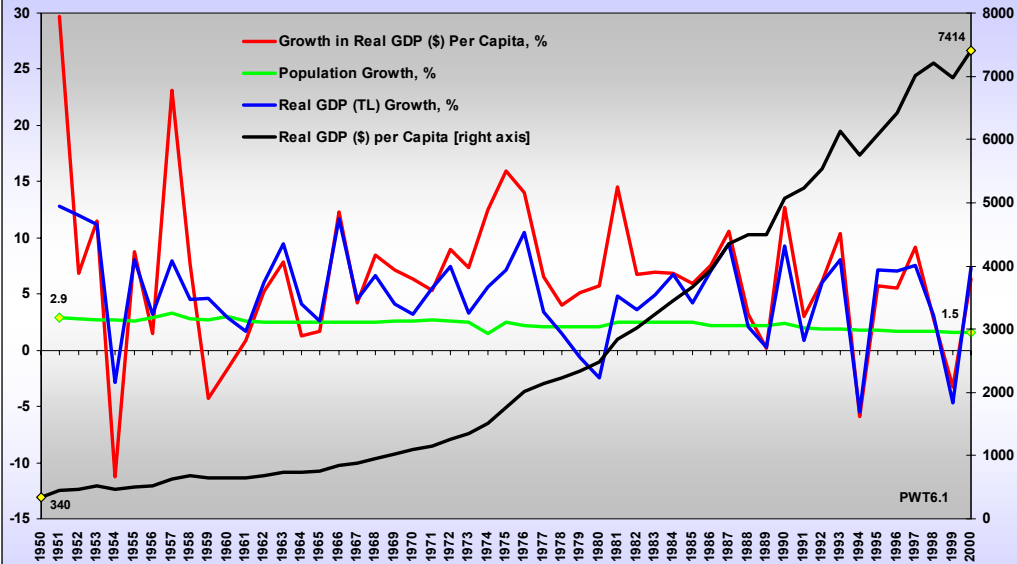

Governments & Political Instability in Turkey, 1969-2004

The Frequency of General Elections and Government Changes in Turkey (Jan. 1969 - Dec. 2004)

Government Changes (28 times) — ICRG's Political Risk Index for Turkey — General Elections (9 times)
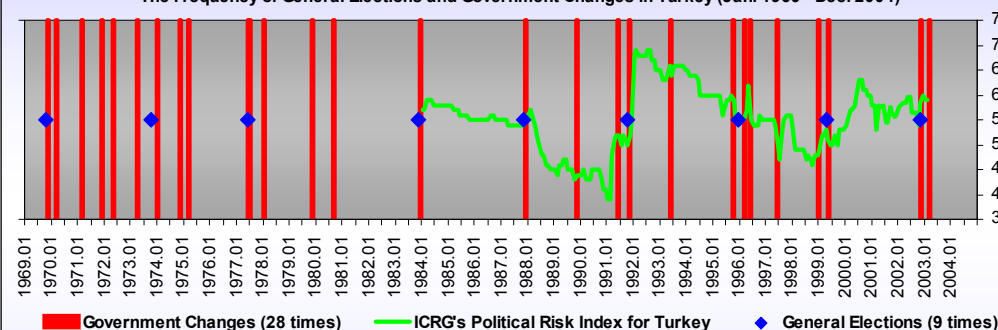
❖ **1969-2004 = 36 years = 432 months**

❖ **Average period between two general elections = 48 months = 4 years**

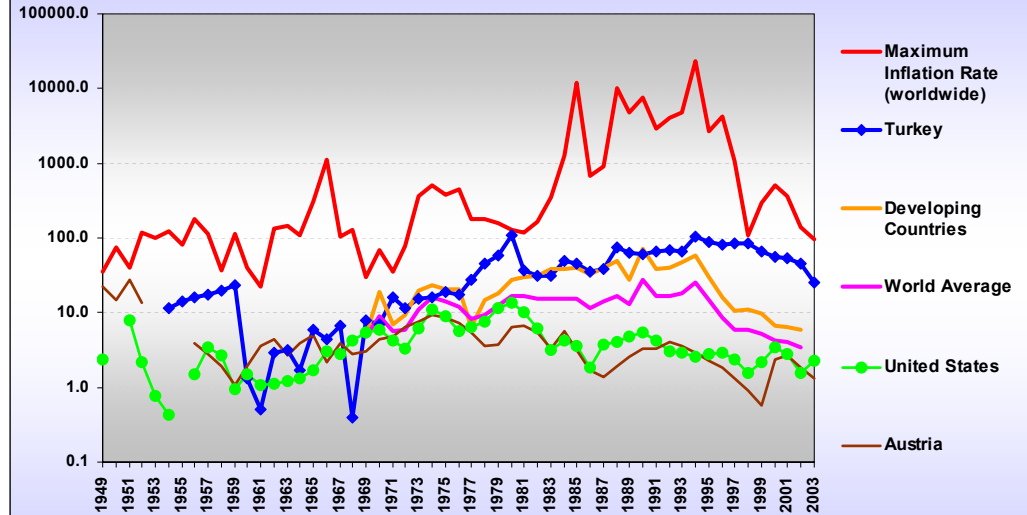❖ **Average life of governments = 15.4 months = 1.3 years**

ICRG=International Country Risk Guide

Volatility in Long-Run Growth (1950-2000)

Legend:
- Growth in Real GDP ($) Per Capita, %
- Population Growth, %
- Real GDP (TL) Growth, %
- Real GDP ($) per Capita [right axis]

- ❖ 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)

Legend:
- Maximum Inflation Rate (worldwide)
- Turkey
- Developing Countries
- World Average
- United States
- Austria

- ❖ 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, %)
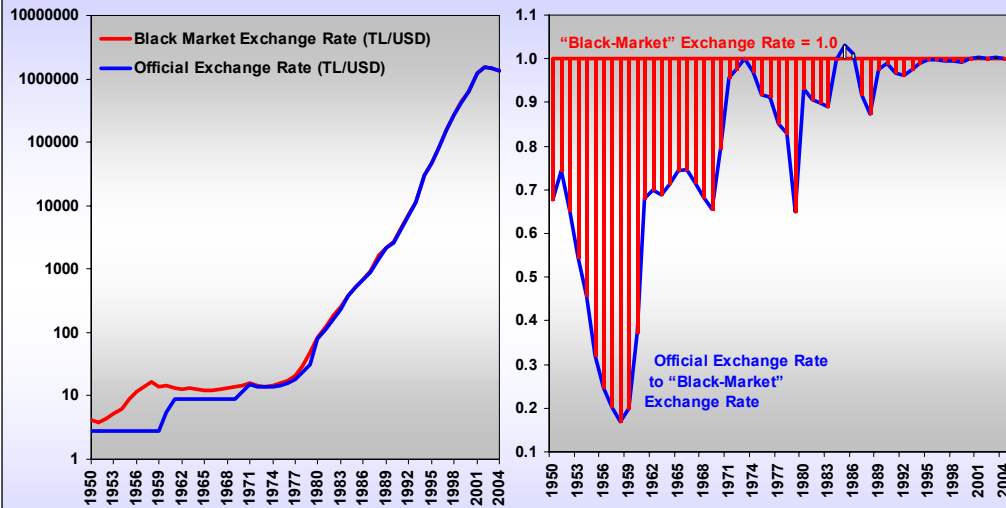
annual

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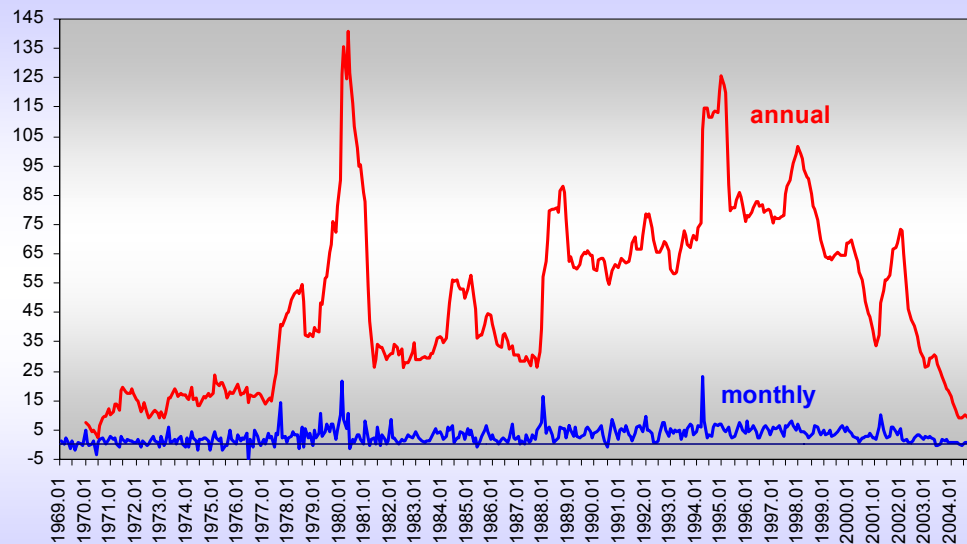
- ❖ Turkey suffered from high and persistent inflation since more than three decades. But, finally, it's declining now...

Recent Developments in Inflation (1998-2004)

11.9
7.5

Legend:
- Selected Events
- WPI
- CPI
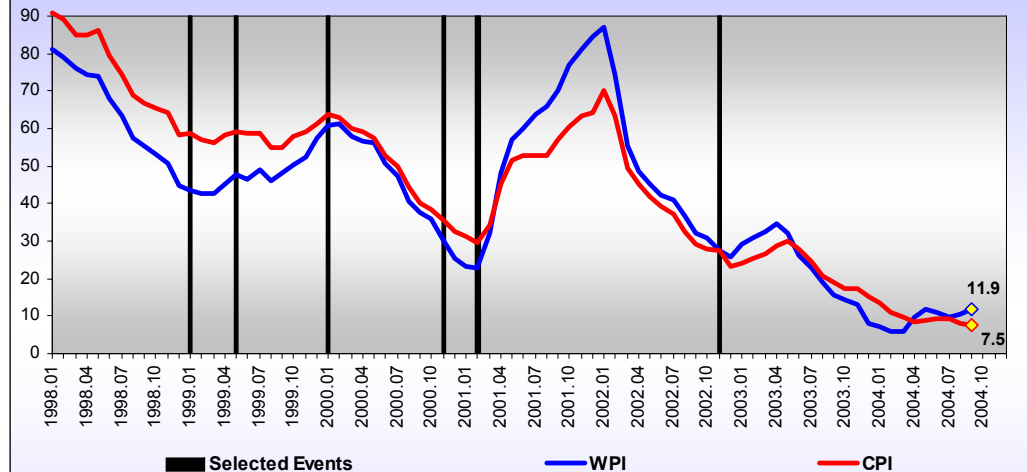
- ❖ Annual WPI and CPI increases fell below 15 percent as September 2004.
- ❖ Inflationary expectations in the country are also changing in a positive direction.

Foreign Exchange Market Developments

Legend:
- Black Market Exchange Rate (TL/USD)
- Official Exchange Rate (TL/USD)

"Black-Market" Exchange Rate = 1.0

Official Exchange Rate to "Black-Market" Exchange Rate

❖ In Turkey, the black-market for foreign exchange disappeared gradually since early 1980s.

"Black-Market" Exchange Rates (BMER) vs. Official Exchange Rates (OER) and Annual Increases in OER (1950-2004)

Legend:
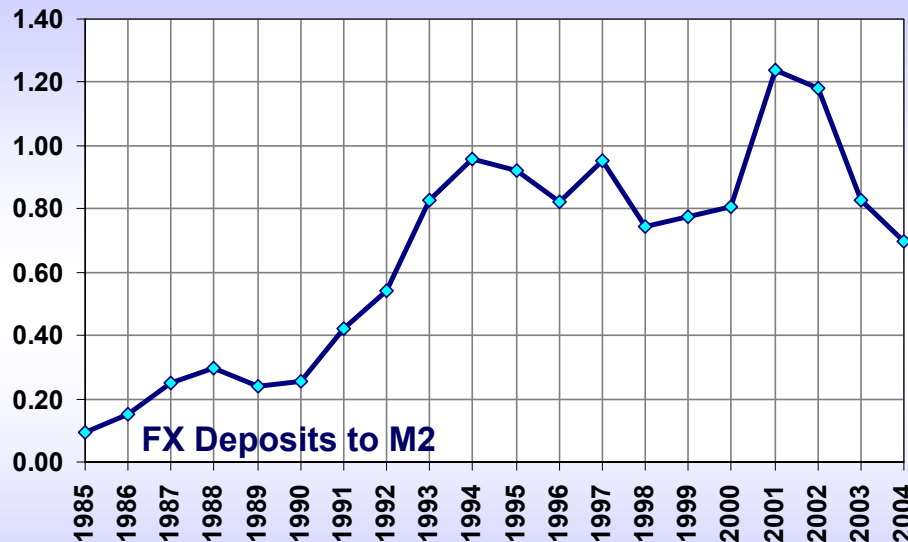- BMER / OER (left axis)
- Annual Increases in OER (right axis)
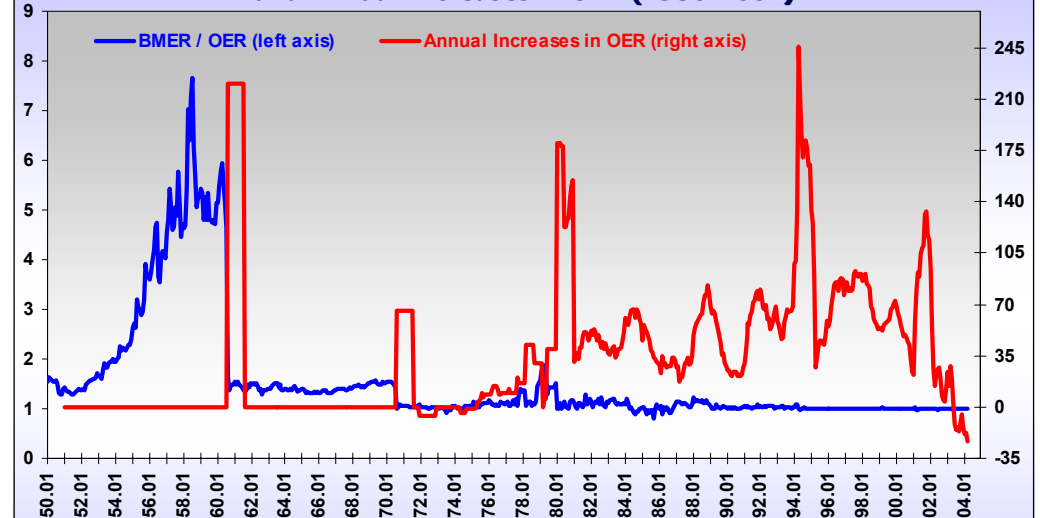
❖ Since May 1981, Turkey has a relatively flexible exchange rate system. This gradually removed the "black-market" for FX in Turkey.

❖ In 2000, the monthly growth rates of nominal exchange rates were pre-determined to gradually disinflate the economy.

Currency Substitution in Turkey (1985-2004)

FX Deposits to M2

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

Two Indicators of Currency Substitution in Turkey (1998-2004, %)

71.8

42.5

Legend:
- Selected Events
- Foreign Exchange Deposits / TL-denominated Deposits
- (M2Y - M2) / M2
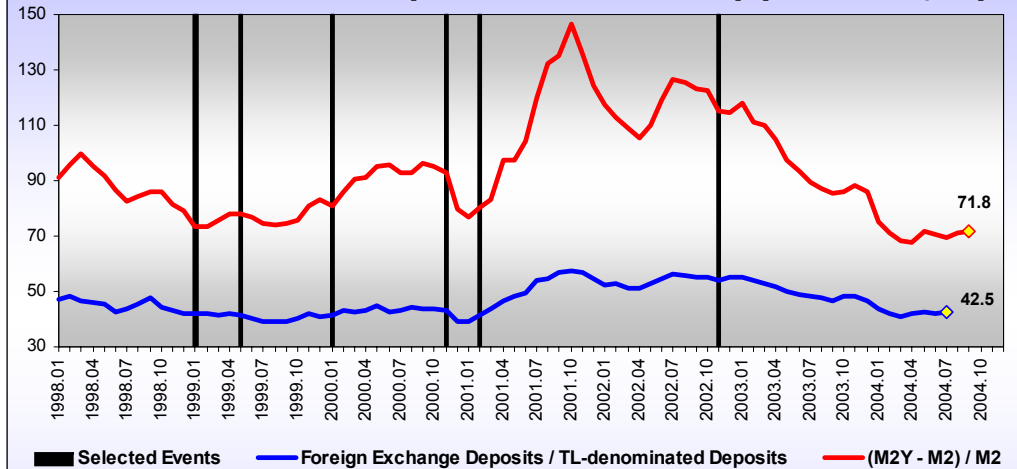
❖ There is a tendency towards reverse currency substitution during the AK-Party era.

❖ Government's success in disinflating the economy and its increasing credibility may significantly be contributing to this process.

Nominal Exchange Rates (TL/USD and TL/Euro)

- **Selected Events** — TL/USD Exchange Rate — TL/Euro Exchange Rate

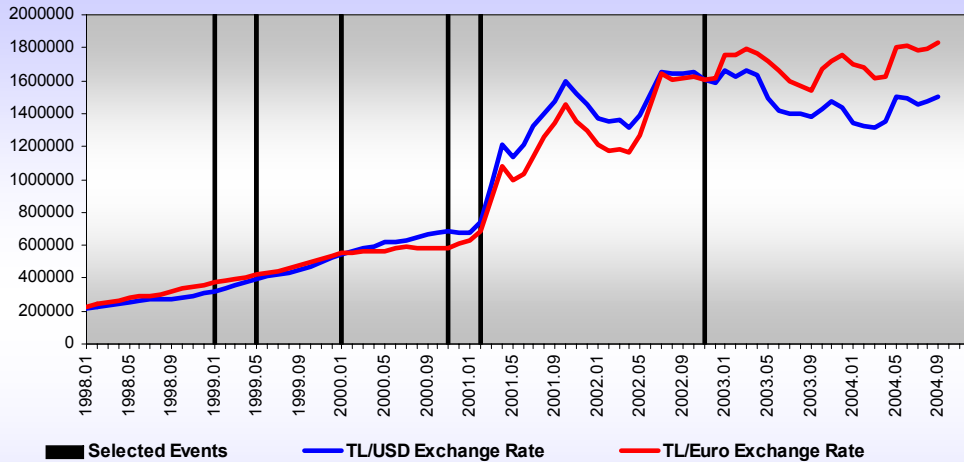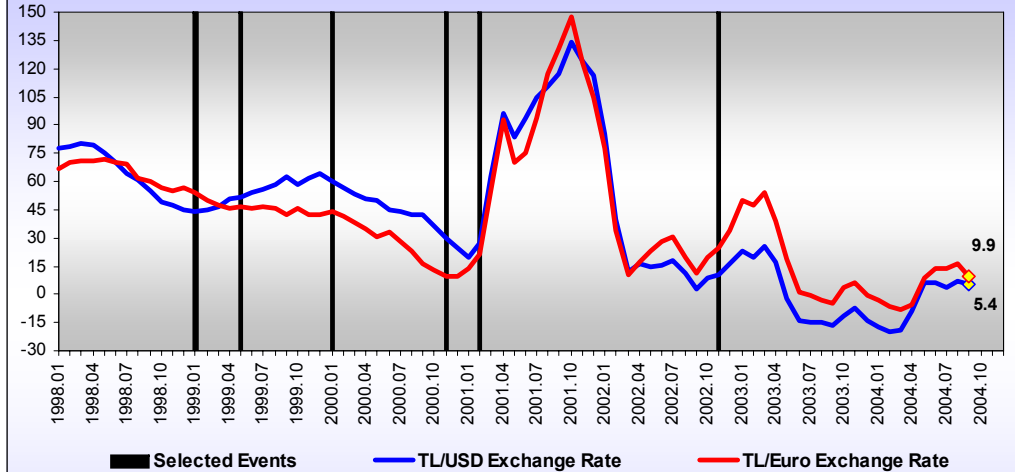❖ **During the last 27 months, nominal exchange rates do not show any tendency towards a sharp increase, as it has been observed in previous years.**

Annual Changes in Nominal Exchange Rates (%)

- **Selected Events** — TL/USD Exchange Rate — TL/Euro Exchange Rate

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

Central Bank's Gross FX Reserves (billion USD)
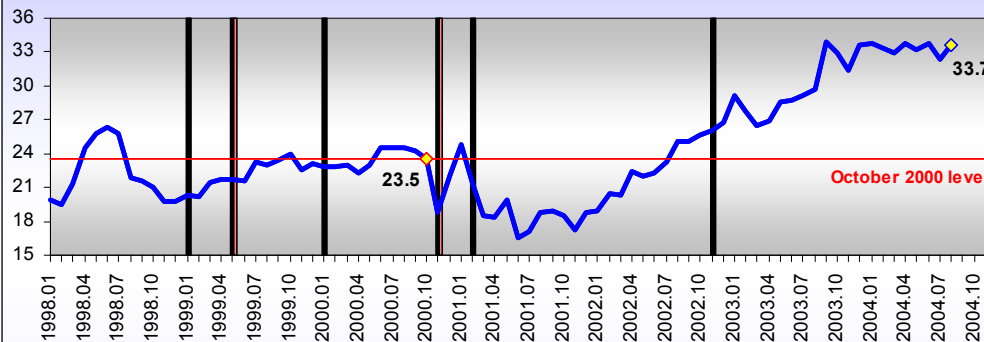
❖ **Following the 2000-2001 crisis, gross FX reserves of the Turkish Central Bank increased significantly.**

❖ **They are now about 38 percent higher than the level of reserves prior to the crisis.**

Current Account Balance: Selected Items
(billion USD, monthly)

- **Selected Events** — Net Exports of Goods (billion TL)
- Net Exports of Goods and Services (billion TL) — Current Account Balance (billion TL)
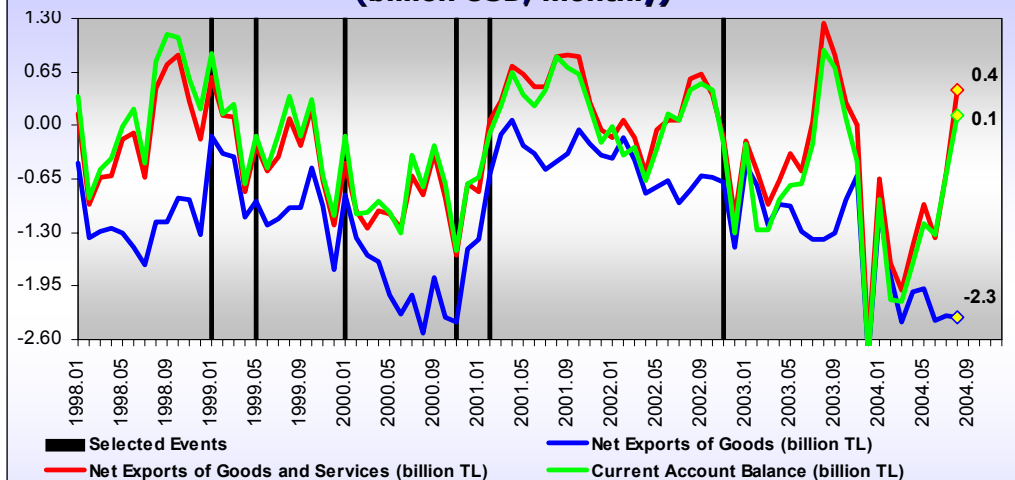
❖ **The increasing deficit in net exports of goods is eliminated by an increasing surplus in net exports of services, and hence the CAB deficits are declining since March 2004.**

Current Account Balance: Selected Items
(billion USD, as of12-monthly cumulative values)

Legend:
- Selected Events
- Net Exports of Goods (billion TL)
- Net Exports of Goods and Services (billion TL)
- Current Account Balance (billion TL)

Values shown: -9.8, -12.3, -21.9
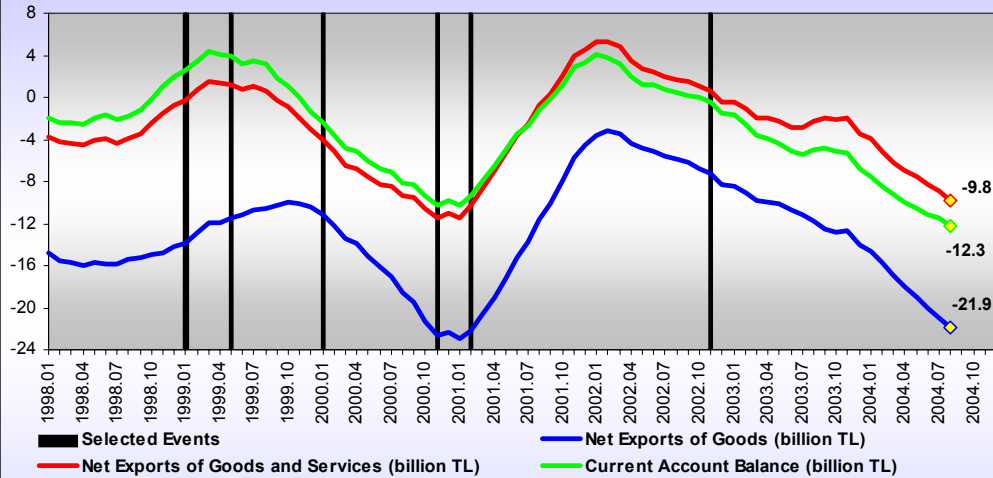
❖ **However, the cumulative BoP data shows that the recent improvements have not fully translated into the annual data yet.**

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

Erratic Nature of Net Short-Term Capital Inflows
(billion USD, annual data)

- capital account liberalization
- 1994 crisis
- 2000-01 crisis

Net Short-Term Capital Inflows (billion USD)

- capital account liberalization

Legend:
- monthly
- 12-monthly

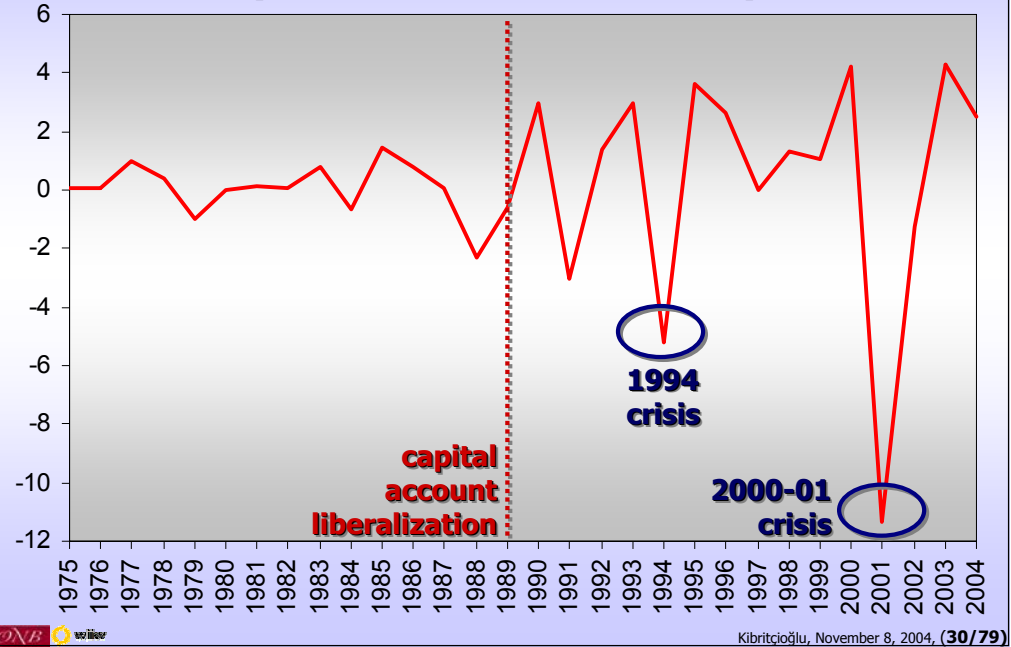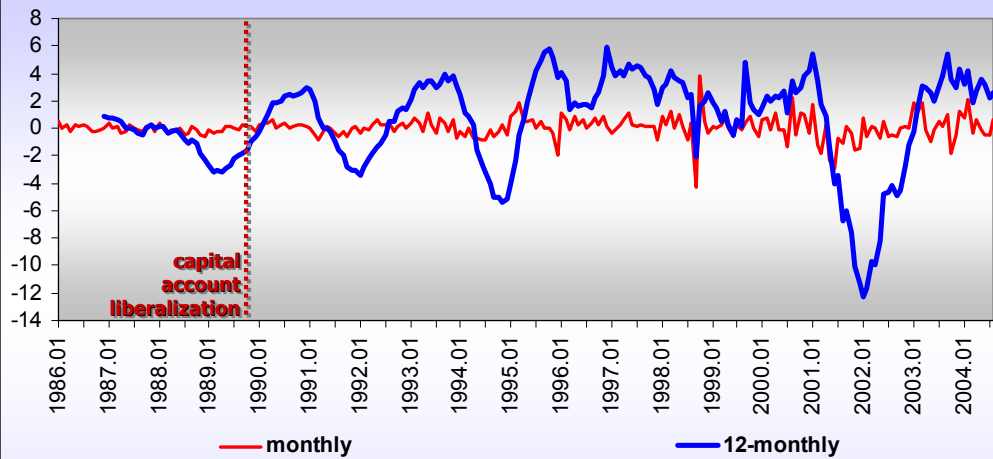❖ **One indication that Turkey's policies are on the right track would be a return to positive short-term inflows at a steady and sustainable level. But a substantial increase in longer term capital inflows is not observed in Turkey.**

Net Short-Term Capital Inflows (billion USD)

Values shown: 5.4, 5.4, 2.6, -12.3

Legend:
- Selected Events
- Monthly
- 12-monthly
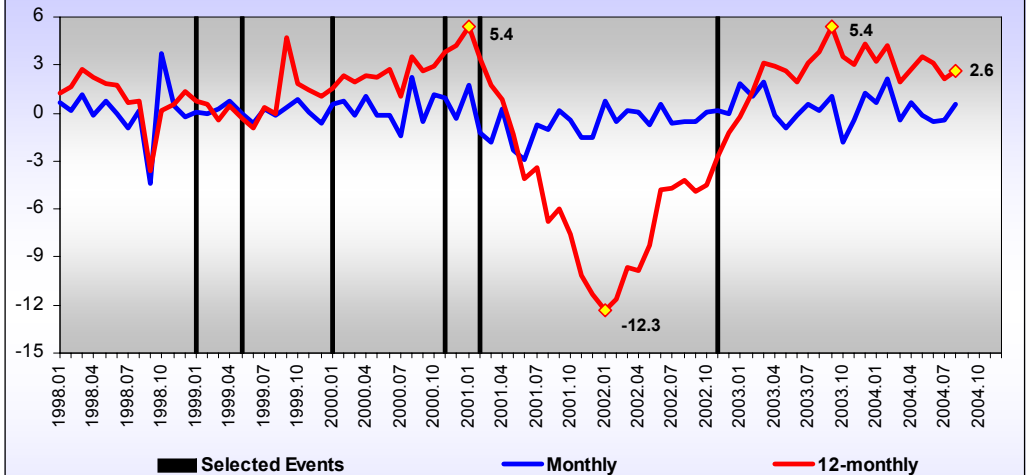
❖ **Short-term capital outflows that rose following the 2000-2001 financial crisis declined significantly after January 2002.**

❖ **Net short-term capital inflows (in terms of cumulative data) are positive in 2004.**

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Ratios of CAB & Net Short-Term Capital Inflows to Output
(January 1999 = 1.0 ; as of 12-monthly cumulative values)

Legend: Selected Events | Current Account Balance to Output | Net Short-Term Capital Inflows to Output
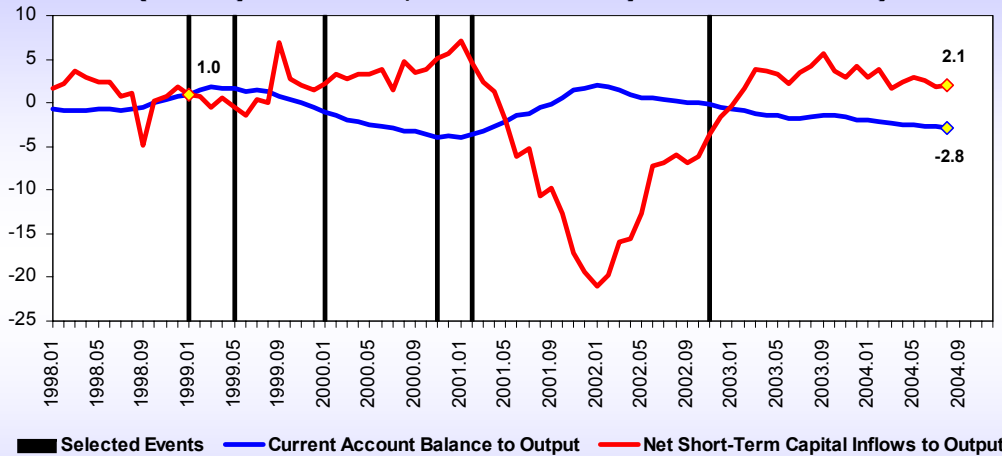
❖ **The volatility of the CAB to nominal industrial output is significantly lower than that of the net short-term capital inflows to output ratio.**

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Banking Sector Fragility in Turkey

Legend: High Fragility | BSF3 | BSF2
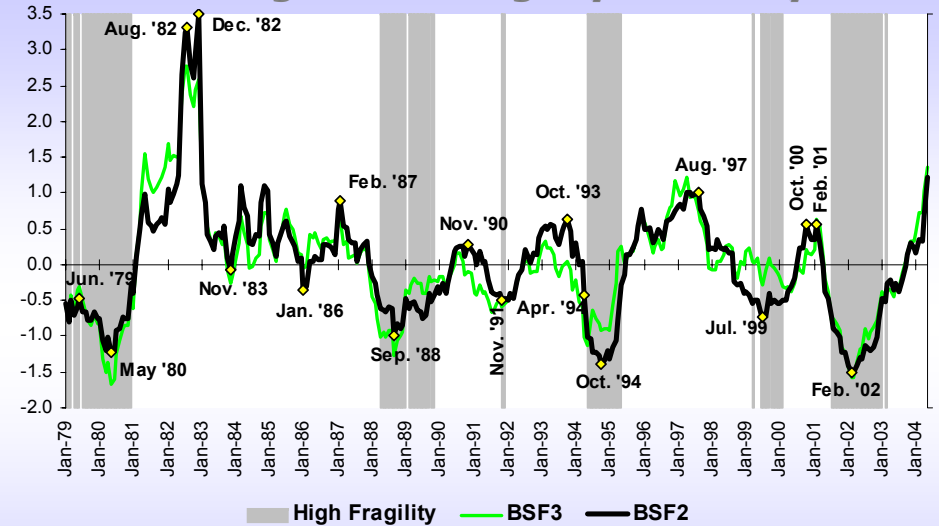
❖ **Turkish banking sector experienced difficulties many times within the last 25 years, as a result of their own excessive risk-taking behavior in the past.**

(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.)

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Banking Sector Fragility in Turkey

Deposit Banks: Foreign Liabilities to Foreign Assets (percent)
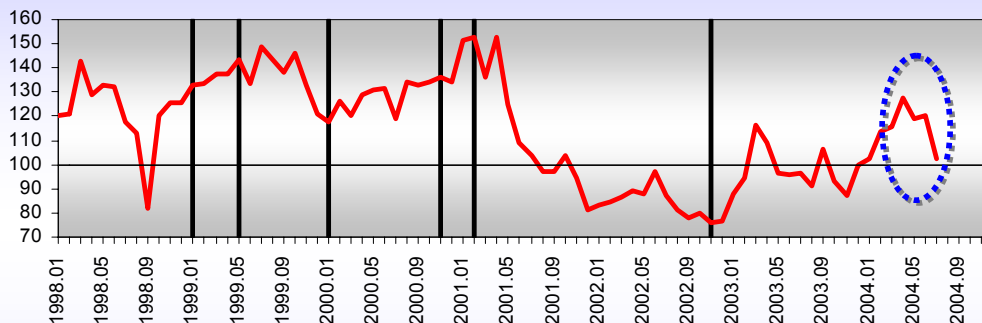
❖ **The recent developments in the FL to FA ratio indicate that the external "open", or "short", position of the Turkish banking system is decreasing now...**

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### Macroeconomic Background

MACROECONOMIC ENVIRONMENT (1978 – 2001)

- ❖ 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 CRISES

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

CAB deficits in 2003-04 !!!

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Literature Review

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Macroeconomic Crises

- **Real Sector Crises**
  - **Crises in Markets for Goods and Services**
    - Inflation Crisis
    - Stagnation Crisis
  - **Crisis in Labor Market**
- **Financial Crises**
  - **Banking Crisis**
  - **Currency Crisis**
    - Balance of Payments Crisis → **fixed exc. rate system**
    - Exchange Rate Crisis → **flexible exc. rate system**
  - **Crisis in Stock Exchange**
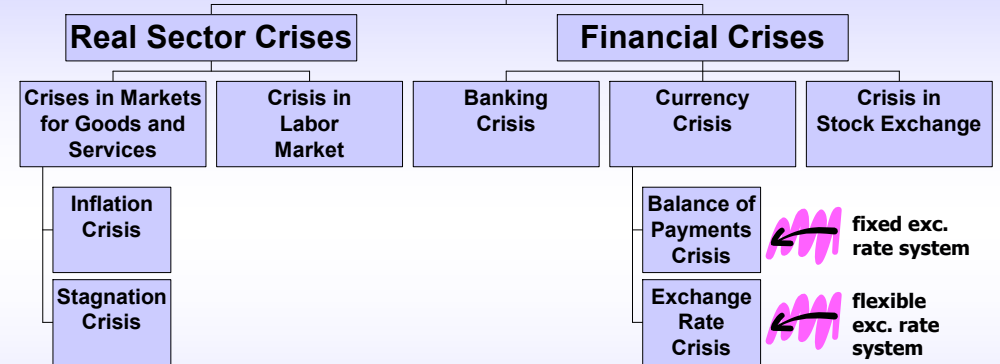
General Definition:
"An economic crisis occurs, if the price and/or quantity in the market for goods, services, assets or factors drastically changes."

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causes

- "Weak" Macroeconomic Fundamentals
- "Weak" Financial Structure
- International Contagion Effects
- Unexpected Events
- Moral Hazard & Adverse Selection
- Market Sentiments

→ **Speculative Attack & Herding Effect**

effects

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

→ **Currency Crisis**

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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**

A Classification of Selected Empirical Studies of Currency Crisis

	Structural Models		Non-Structural Models	
	Collapse Models (Standard Econometric Approaches)	Probit and Logit Models (Multivariate Approach)	Event Analysis (Parametric and Non-Parametric Tests)	Signals Approach (Early Warning System Approach)
Single-Country Analyses	Blanco and Garber (1986), Cumby and van Wijnbergen (1989), Goldberg (1994)	Schardax (2002: *selected Central and Eastern Europe countries*), Muradoğlu and Feridun (2004: *Turkey*)		Yap (1998: *Philippines*), Üçer *et al.* (1998: *Turkey*), Kibritçioğlu (2000: *Turkey*), Park (2002: *Korea*), El-Shazly (2002: *Egypt*), Tambunan (2002: *Indonesia*), Adiningsih *et al.* (2002: *Indonesia*), Edison (2003: *Mexico*), Plata and Schrooten (2003: *Argentina*)
Multi-Country Analyses	Edwards (1993), Klein and Marion (1994), Sachs, Tornell and Velasco (1996)	Eichengreen, Rose and Wyplosz (1996), Kaminsky ve Reinhart (1996), Frankel and Rose (1996), Goldfajn and Valdes (1997a), Kruger, Osakwe and Page (1998), Esquivel and Larrain (1998), Demirguc-Kunt and Detragiache (1999)	Eichengreen, Rose and Wyplosz (1994, 1995)**, Moreno (1995), Frankel and Rose (1996)	Kaminsky and Reinhart (1996), Kaminsky *et al.* (1998), Brüggemann and Linne (2001, 2002)

Kibritçioğlu, November 8, 2004, (41/79)

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

Kibritçioğlu, November 8, 2004, (42/79)

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).

Kibritçioğlu, B. (2000): signals approach; Feb. 1986 – Sep. 1999.
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.

Muradoğlu & Feridun (2004): probit model; 1991-2000.
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.

Mariano *et al.* (2004): Markov switching financial vulnerability (Abiad, 2002); Feb. 1981 – Oct. 2002.
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".

Kibritçioğlu, November 8, 2004, (43/79)

Signals Approach for Turkey:
Overview of the Methodology

Kibritçioğlu, November 8, 2004, (44/79)

Signals Approach

- ❖ **Literature: Kaminsky and Reinhart (1996) and Kaminsky *et al.* (1998)**

- ❖ **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 pre-determined 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."**

Signals Approach for Turkey:
Identification of Crises Episodes

Signals Approach: *Identification of Crises Episodes* (1)

$$P_t = \frac{\left(\dfrac{e_t - \mu_e}{\sigma_e}\right) + \left(\dfrac{r_t - \mu_r}{\sigma_r}\right)}{2}$$

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*.

Signals Approach:
Identification of Crises Episodes (2)

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 (μ_P) plus 1.5 standard deviations (σ_P):

$$T_P = \mu_P + 1.5 \times \sigma_P$$

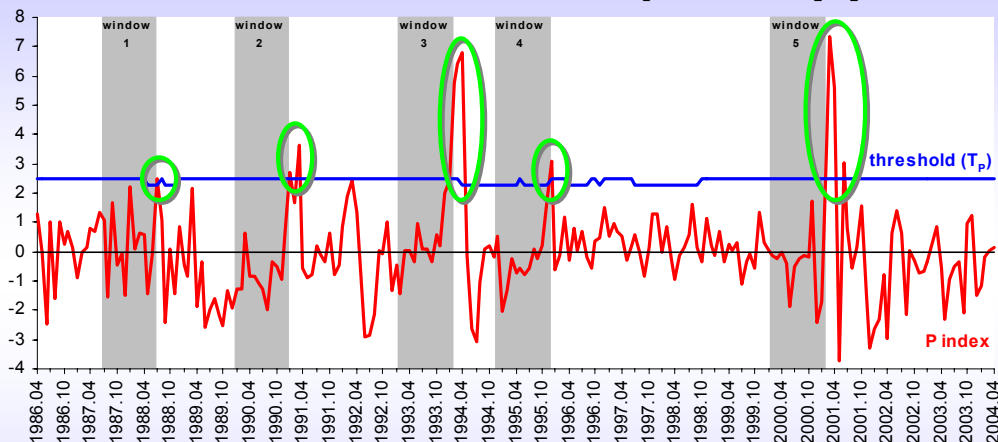**Then, a currency crisis (CC) can be observed when the P exceeds this threshold value:**

CC = 1, if P > T_P

CC = 0, 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.)

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There are *five major crisis periods* to be considered in this study: **(1)** July 1988, **(2)** January 1991 and March 1991, **(3)** February 1994 to April 1994, **(4)** December 1995, and **(5)** February 2001 to April 2001 and June 2001.

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.

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Signals Approach for Turkey:
Comparison of Individual Performances of Potential Leading Indicators

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Signals Approach: *Classification of Signals Sent by an Early Warning Indicator* **(1)**

❖ 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.

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Signals Approach: *Classification of Signals Sent by an Early Warning Indicator* **(2)**

	Realizations		
	Crisis within 12 months	**No crisis within 12 months**	**Total Observations**
Signal issued	A	B	A+B
No signal issued	C	D	C+D
Total Observations	A+C	B+D	A+B+C+D

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:

A/(A+C)
A/(A+B)
B/(B+D)
NSR = (B/(B+D)) / (A/(A+C))

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

	Realizations		
	Crisis within 12 months	No crisis within 12 months	Total Observations
Signal issued	A	B	A+B
No signal issued	C	D	C+D
Total Observations	A+C	B+D	A+B+C+D

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(crisis|signal) and P(crisis), namely A/(A+B) − [(A+C) /(A+B+C+D)].

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 (2)

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.

Signals Approach: Results for Individual Indicators (3)

Potential Early Warning Indicators of Currency Crises	Expected Sign	Threshold (in percentile)	Good Signals as a Percentage of Possible Good Signals, A/(A+C)	Bad Signals as a Percentage of Possible Bad Signals, B/(B+D)	Noise to Signal Ratio (NSR), [B/(B+D)]/[A/(A+C)]	P(crisis | signal) = A/(A+B)	P(crisis| signal) – P(crisis) = [A/(A+B)] – [(A+C)/(A+B+C+D)]	Number of Months Prior to Crisis the First Good Signal Occurs
S1 Exports to Imports Ratio	(-)	0.10	30.65	1.39	0.05	90.48	60.38	8.6
S2 Turkish Exporters' New Order Expectations (Up - Down)	(-)	0.10	22.81	3.10	0.14	76.47	45.83	4.2
S3 Deviation of Reuters' Real Exchange Rate Index from its Trend	(-)	0.10	25.81	4.17	0.16	72.73	42.63	4.0
S4 Deviation of SPO's Real Exchange Rate Index from its Trend	(-)	0.17	40.32	7.64	0.19	69.44	39.35	6.8
S5 Deviation of JPM's Real Exchange Rate Index from its Trend	(-)	0.20	46.77	9.72	0.21	67.44	37.34	8.4
S6 Real Interest Rate Differential (id-if)	(-)	0.17	37.10	9.03	0.24	63.89	33.79	5.6
S7 Trade Balance to Output Ratio	(-)	0.10	20.97	5.56	0.26	61.90	31.81	5.0
S8 Annual Increase in Crude-Oil Prices	(+)	0.90	20.97	6.25	0.30	50.09	28.99	5.6
S9 US 3-Month Treasury Bill Rates	(+)	0.75	48.39	14.58	0.30	58.82	28.73	8.4
S10 Nominal Interest Rate Differential (id-if)	(-)	0.14	29.03	9.03	0.31	58.06	27.97	7.2
S11 (Trade Balance + Short-Term Capital Inflow) / Output	(-)	0.11	17.74	5.56	0.31	57.89	27.80	4.4
S12 Monthly Increase in ISE 100 Index	(-)	0.11	16.13	5.56	0.34	55.56	25.46	3.8
S13 Monthly Growth in Central Bank's Gross Foreign Exchange Reserves	(-)	0.10	11.29	4.17	0.37	53.85	23.75	3.2
S14 CAB to Output Ratio	(-)	0.15	25.81	10.42	0.40	51.61	21.52	6.0
S15 Average Compound Auction Rates of the Treasury	(-)	0.22	38.71	16.67	0.43	50.00	19.90	7.2
S16 Crude-Oil Prices in USD/br	(+)	0.89	19.35	8.33	0.43	50.00	19.90	3.2
S17 Deposit Money Banks' Net Foreign Liabilities to Total Deposits	(+)	0.90	14.52	6.94	0.48	47.37	17.27	2.0
S18 Quarterly Change in Banking Sector Fragility Index	(-)	0.25	40.32	19.44	0.48	47.17	17.07	8.2
S19 Monthly Growth in Imports	(+)	0.86	20.97	11.11	0.53	44.83	14.73	10.8
S20 Short-Term Capital Inflows to Output	(+)	0.78	33.87	18.75	0.55	43.75	13.65	10.4
S21 Monthly Growth of Consolidated Budget Balance / Output	(-)	0.11	16.13	9.03	0.56	43.48	13.38	6.4
S22 Monthly Increase in Wholesale Price Index	(+)	0.88	14.52	8.33	0.57	42.86	12.76	4.4
S23 Monthly Increase in Consumer Price Index	(+)	0.90	12.90	8.33	0.65	40.00	9.90	5.4
S24 Monthly Change in M2 Multiplier	(+)	0.90	12.90	8.33	0.65	40.00	9.90	5.0
S25 Deposit Money Banks' Foreign Liabilities to For. Assets	(+)	0.88	14.52	9.72	0.67	39.13	9.03	2.0
S26 Deviation of Reuters' Real Exchange Rate Index from its Base-Year Value	(-)	0.25	32.26	22.22	0.69	38.46	8.36	5.4
S27 Ratio of Deposit Money Banks' Domestic Credits to Total Assets	(+)	0.74	33.87	23.61	0.70	38.18	0.00	5.8
S28 Monthly Growth in Exports	(-)	0.10	12.90	9.03	0.70	38.10	8.00	7.4
S29 M2 to CB's Gross FX Reserves	(+)	0.85	19.35	13.89	0.72	37.50	7.40	2.4
S30 Monthly Change in ICRG's Political Risk Index for Turkey	(-)	0.15	17.74	13.08	0.74	39.29	6.99	7.4
S31 Monthly Growth in Central Bank's Domestic Assets	(+)	0.76	25.81	19.44	0.75	36.36	6.27	9.4
S32 WPI to CPI Ratio	(+)	0.90	12.90	9.72	0.75	36.36	6.27	2.4
S33 Monthly Change in Foreign Exchange Deposits to M2 Ratio	(+)	0.75	24.19	22.22	0.92	31.91	1.82	7.6
S34 Monthly Growth in Deposit Money Banks' Real Total Domestic Credits	(+)	0.75	25.81	24.31	0.94	31.37	1.28	9.8
S35 Deposit Money Banks' Domestic Credits to Output	(+)	0.81	19.35	18.75	0.97	30.77	0.67	2.4
S36 Consolidated Budget Balance to Output	(-)	0.21	20.97	20.83	0.99	30.23	0.14	8.8
S37 Imports to Output Ratio	(-)	0.17	16.13	17.36	1.08	28.57	-1.53	3.6
S38 Monthly Growth in M1	(+)	0.77	19.35	22.92	1.18	26.67	-3.43	7.8
S39 Real Monthly Growth of Banking Sector Credits to Private Sector	(+)	0.76	19.35	25.00	1.29	25.00	-5.10	9.2
S40 Timing of Government Changes	(+)	0.00	4.84	6.25	1.29	25.00	-5.10	3.4
S41 Timing of General Elections	(+)	0.00	1.61	2.08	1.29	25.00	-5.10	1.6
S42 Real Monthly Growth in Deposit Money Banks' Net Past Due Loans	(+)	0.79	14.52	21.53	1.48	22.50	-7.60	8.2
S43 Monthly Growth in M2	(+)	0.89	6.45	9.72	1.51	22.22	-7.87	3.4
S44 Terms of Trade	(-)	0.24	16.13	25.69	1.59	21.28	-8.82	4.6
S45 Annual Growth in Manufacturing Production Index	(+)	0.23	12.90	24.31	1.88	18.60	-11.49	5.2
S46 Annual Growth in Ratio of M2 to Central Bank's Gross Foreign Exchange Reserves	(+)	0.80	4.84	22.92	4.74	8.33	-21.76	2.0
Conditional Probability (weighted index)	(+)	0.50	83.87	22.22	0.26	61.90	31.81	11.4

Signals Approach: Results for Individual Indicators (4)

- S1 Exports to Imports Ratio
- S2 Turkish Exporters' New Order Expectations (Up - Down)
- S3 Deviation of Reuters' Real Exchange Rate Index from its Trend
- S4 Deviation of SPO's Real Exchange Rate Index from its Trend
- 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
- S9 US 3-Month Treasury Bill Rates
- S10 Nominal Interest Rate Differential (id-if)
- S11 (Trade Balance + Short-Term Capital Inflow) / Output
- S12 Monthly Increase in ISE 100 Index
- S13 Monthly Growth in Central Bank's Gross Foreign Exchange Reserves
- S14 CAB to Output Ratio

NSR<0.5

- S15 Average Compound Auction Rates of the Treasury
- S16 Crude-Oil Prices in USD/br
- S17 Deposit Money Banks' Net Foreign Liabilities to Total Deposits
- S18 Quarterly Change in Banking Sector Fragility Index

NSR>0.5

- S19 Monthly Growth in Imports
- 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

Signals Approach: Results for Individual Indicators (5)

- S24 Monthly Change in M2 Multiplier
- S25 Deposit Money Banks' Foreign Liabilities to For. Assets
- S26 Deviation of Reuters' Real Exchange Rate Index from its Base-Year Value
- S27 Ratio of Deposit Money Banks' Domestic Credits to Total Assets
- S28 Monthly Growth in Exports
- S29 M2 to CB's Gross FX Reserves
- S30 Monthly Change in ICRG's Political Risk Index for Turkey
- S31 Monthly Growth in Central Bank's Domestic Assets
- S32 WPI to CPI Ratio

NSR<1

- S33 Monthly Change in Foreign Exchange Deposits to M2 Ratio
- S34 Monthly Growth in Deposit Money Banks' Real Total Domestic Credits
- S35 Deposit Money Banks' Domestic Credits to Output
- S36 Consolidated Budget Balance to Output
- S37 Imports to Output Ratio
- S38 Monthly Growth in M1
- S39 Real Monthly Growth of Banking Sector Credits to Private Sector

NSR>1

- S40 Timing of Government Changes
- S41 Timing of General Elections

Political variables do not perform very well.

- S42 Real Monthly Growth in Deposit Money Banks' Net Past Due Loans
- S43 Monthly Growth in M2
- S44 Terms of Trade
- S45 Annual Growth in Manufacturing Production Index
- S46 Annual Growth in Ratio of M2 to Central Bank's Gross Foreign Exchange Reserves

Signals Approach: Results for Individual Indicators (6)

| Potential Early Warning Indicators of Currency Crises	Threshold (in percentile)	Noise to Signal Ratio (NSR)	Number of Months Prior to Crisis the First Good Signal Occurs	Persistence of Signals per Crisis Period (in months)
S1 Exports to Imports Ratio	0.10	0.05	8.6	3.8
S2 Turkish Exporters' New Order Expectations (Up - Down)	0.10	0.14	4.2	2.4
S3 Deviation of Reuters' Real Exchange Rate Index from its Trend	0.10	0.16	4.0	3.2
S4 Deviation of SPO's Real Exchange Rate Index from its Trend	0.17	0.19	6.8	5.0
S5 Deviation of JPM's Real Exchange Rate Index from its Trend	0.20	0.21	8.4	5.6
S6 Real Interest Rate Differential (id-if)	0.17	0.24	5.6	4.6
S7 Trade Balance to Output Ratio	0.10	0.26	5.0	2.6
S8 Annual Increase in Crude-Oil Prices	0.90	0.30	5.6	2.6
S9 US 3-Month Treasury Bill Rates	0.75	0.30	8.4	5.8
S10 Nominal Interest Rate Differential (id-if)	0.14	0.31	7.2	3.6
S11 (Trade Balance + Short-Term Capital Inflow) / Output	0.11	0.31	4.4	2.0
S12 Monthly Increase in ISE 100 Index	0.11	0.34	3.8	2.0
S13 Monthly Growth in Central Bank's Gross Foreign Exchange Reserves	0.10	0.37	3.2	1.2
S14 CAB to Output Ratio	0.15	0.40	6.0	3.2
S15 Average Compound Auction Rates of the Treasury	0.22	0.43	7.2	4.8
S16 Crude-Oil Prices in USD/br	0.89	0.43	3.2	2.4
S17 Deposit Money Banks' Net Foreign Liabilities to Total Deposits	0.90	0.48	2.0	1.8
S18 Quarterly Change in Banking Sector Fragility Index	0.25	0.48	8.2	4.8
S19 Monthly Growth in Imports	0.86	0.53	10.8	2.4
S20 Short-Term Capital Inflows to Output	0.78	0.55	10.4	4.2
S21 Monthly Growth of Consolidated Budget Balance / Output	0.11	0.56	6.4	2.0
S22 Monthly Increase in Wholesale Price Index	0.88	0.57	4.4	1.6
S23 Monthly Increase in Consumer Price Index	0.90	0.65	5.4	1.6
S24 Monthly Change in M2 Multiplier	0.90	0.65	5.0	1.2
S25 Deposit Money Banks' Foreign Liabilities to For. Assets	0.88	0.67	2.0	1.8

Signals Approach: Results for Individual Indicators (7)

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)**
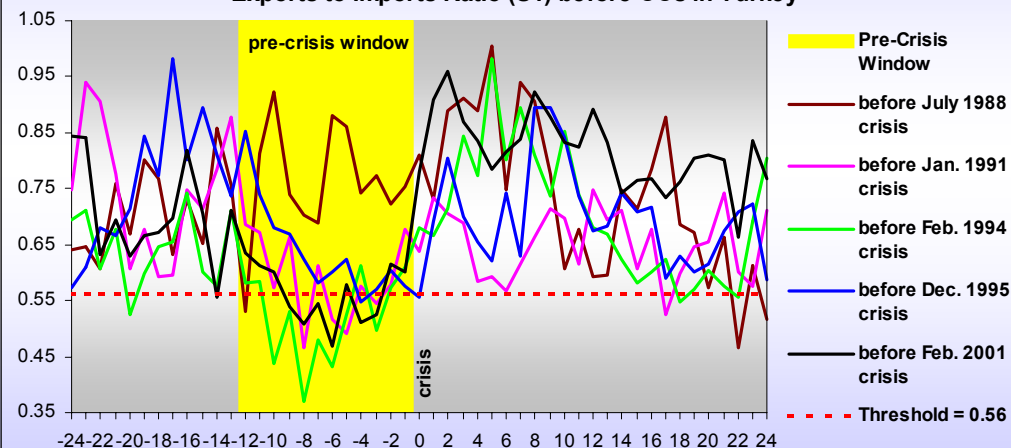

Signals Approach: FX Market Pressure Index and CCs

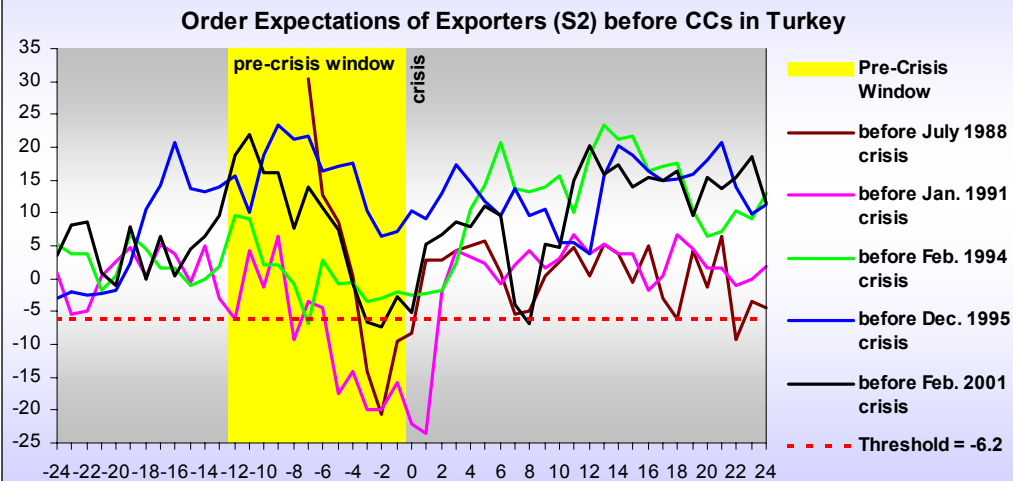FX Market Pressure Index (P) before and after CCs in Turkey

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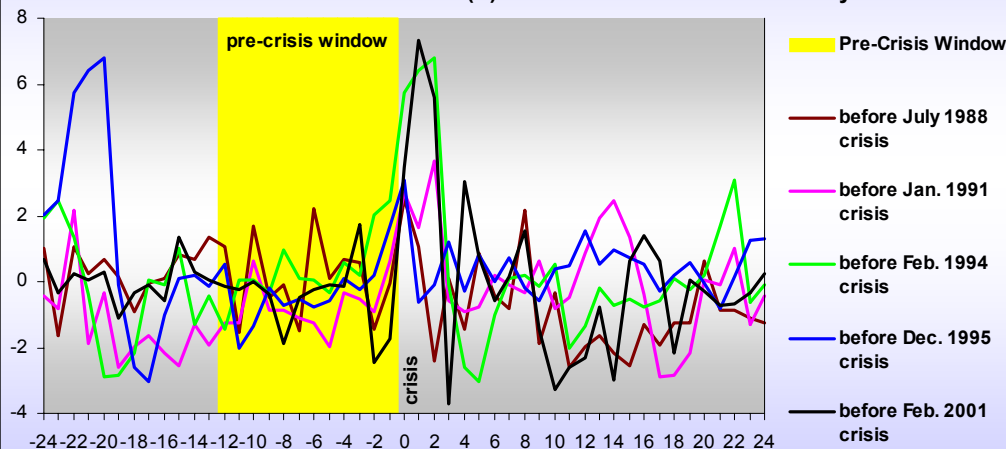
Signals Approach: Best Three Individual Performers (1)

Exports to Imports Ratio (S1) before CCs in Turkey

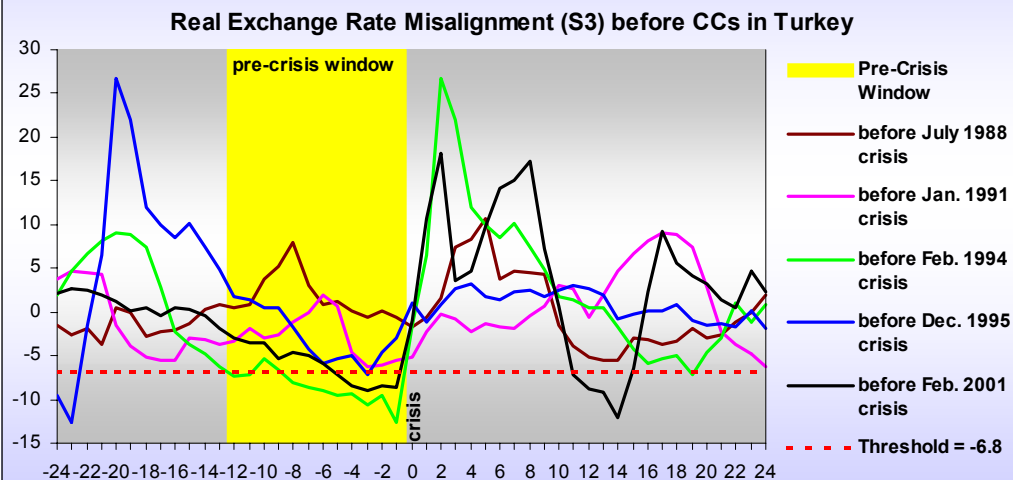## Signals Approach: *Best Three Individual Performers* (2)

Order Expectations of Exporters (S2) before CCs in Turkey

pre-crisis window

crisis

- Pre-Crisis Window
- before July 1988 crisis
- before Jan. 1991 crisis
- before Feb. 1994 crisis
- before Dec. 1995 crisis
- before Feb. 2001 crisis
- Threshold = -6.2

y-axis: 35, 30, 25, 20, 15, 10, 5, 0, -5, -10, -15, -20, -25

x-axis: -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24

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

pre-crisis window

crisis

- Pre-Crisis Window
- before July 1988 crisis
- before Jan. 1991 crisis
- before Feb. 1994 crisis
- before Dec. 1995 crisis
- before Feb. 2001 crisis
- Threshold = -6.8

y-axis: 30, 25, 20, 15, 10, 5, 0, -5, -10, -15

x-axis: -24 -22 -20 -18 -16 -14 -12 -10 -8 -6 -4 -2 0 2 4 6 8 10 12 14 16 18 20 22 24

Signals Approach for Turkey:

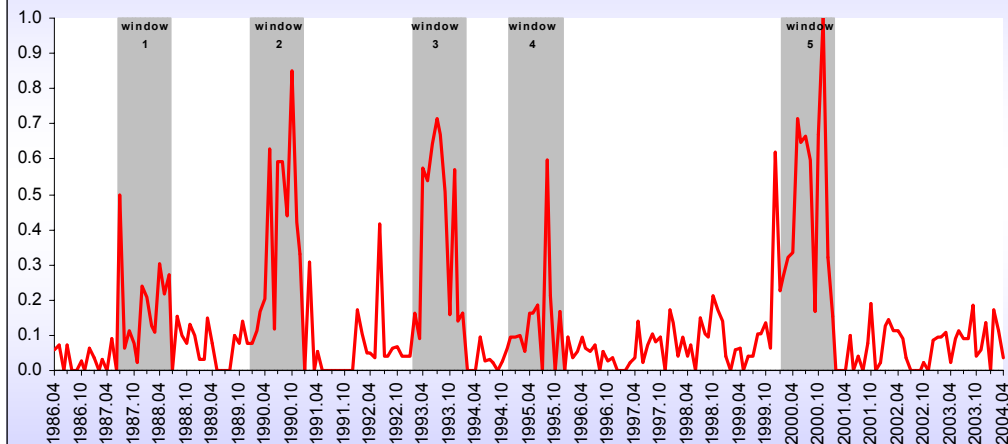## Composite Leading Indicators and Estimation of Crisis Probabilities

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
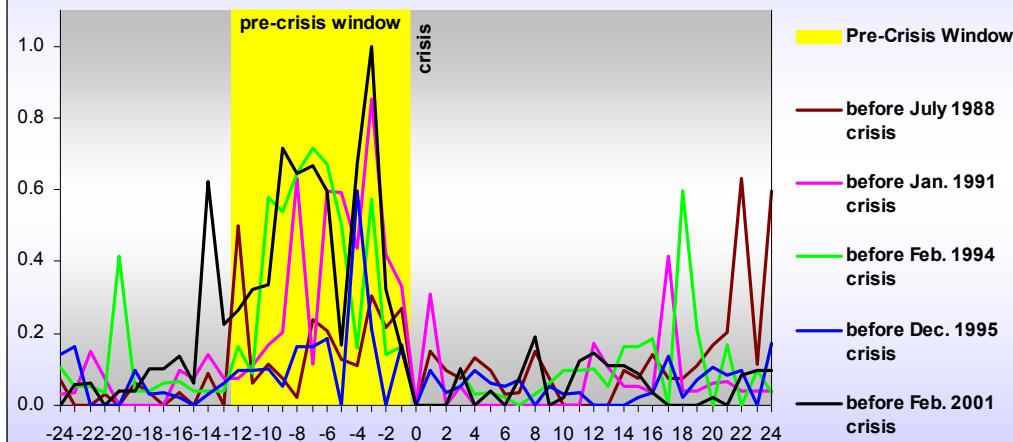S33   Monthly Change in Foreign Exchange Deposits to M2 Ratio

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

Signals Approach:
A Composite Leading Indicator (C) for Turkey

Signals Approach:
Composite Leading Indicator and CCs in Turkey

Weighted Composite Index (C) before CCs in Turkey

Pre-Crisis Window
before July 1988 crisis
before Jan. 1991 crisis
before Feb. 1994 crisis
before Dec. 1995 crisis
before Feb. 2001 crisis

Signals Approach:
Probabilities of Currency Crisis Estimated
(based on Weighted Composite Leading Indicator)
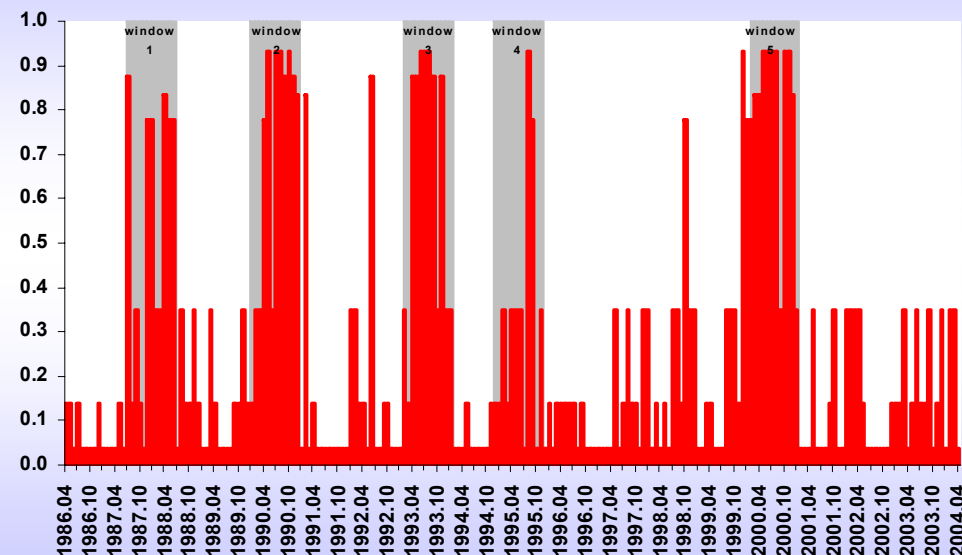
To evaluate the overall performance of the model we used several statistical tests,
such as quadratic probability score test, LPS, GBS, and unconditional probability indicators.

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.
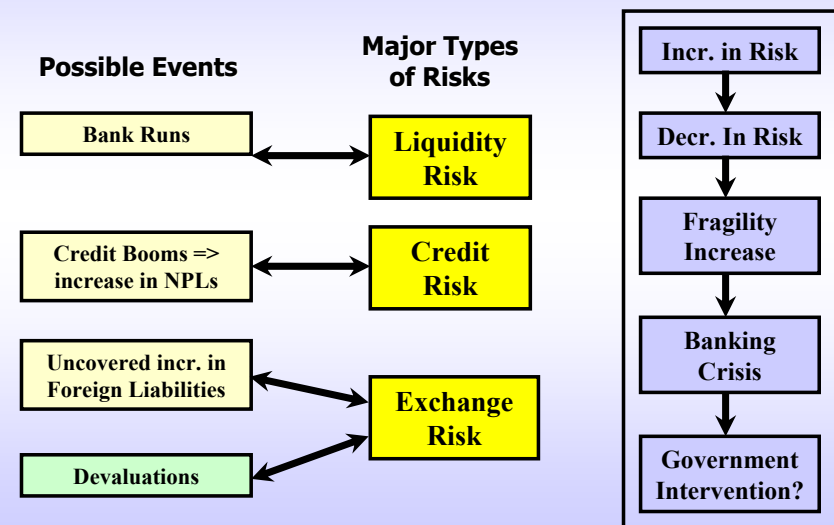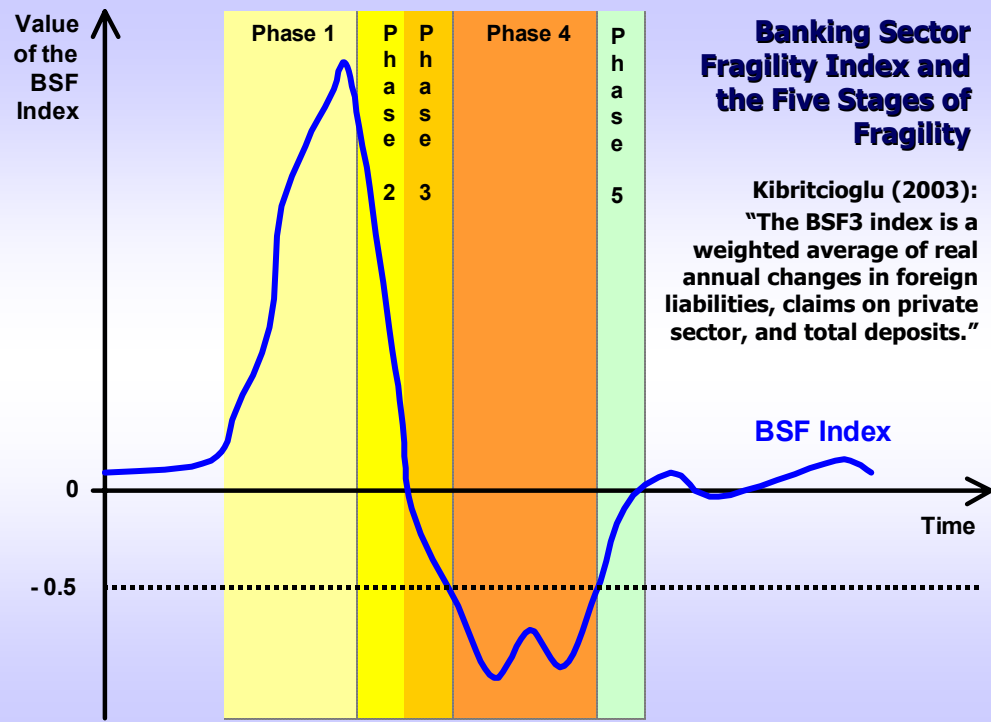
Concluding Remarks (2)

❖ 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*

Kibritçioğlu, A. (2003): "Monitoring Banking Sector Fragility".
Arab Bank Review (Jordan), 5(2): 51-66.
PDF: http://econwpa.wustl.edu:8089/eps/mac/papers/0312/0312011.pdf

Risk-Taking Behavior, Fragility and Crises in Banking

Possible Events

Major Types of Risks

Bank Runs → Liquidity Risk

Credit Booms => increase in NPLs → Credit Risk

Uncovered incr. in Foreign Liabilities → Exchange Risk

Devaluations → Exchange Risk

Incr. in Risk → Decr. In Risk → Fragility Increase → Banking Crisis → Government Intervention?

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Value of the BSF Index

Phase 1 | Phase 2 | Phase 3 | Phase 4 | Phase 5

0

- 0.5

Time

BSF Index

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."

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

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

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Different Results about Timing of Banking Crises in Turkey

Caprio and Klingebiel (1996, 1999, 2002 and 2003)	Lindgren, Garcia and Saal (1996)	Hardy and Pazarbaşıoğlu (1998)	Demirgüç-Kunt and Detragiache (1997 and 1998)	Kaminsky and Reinhart (1996 and 1999) Beginning of the Crisis	Kaminsky and Reinhart Peak of the Crisis	Glick and Hutchison (2000)	Bordo and Eichengreen (2002)	Current Study (the BSF2, or BSF2*, index) Beginning of the Distress	Current Study Date of Highest Fragility	Current Study Episode of High Fragility (if applicable)
								July 1979	May 1980	Jan. 1979 - Nov. 1980
1982-1985	1982	1982				1982-1985	1982	Sep. 1982	Nov. 1983	medium fragility
								Mar. 1987	Sep. 1988	Apr. 1988 - Oct. 1989
	1991		1991	Jan. 1991	Mar. 1991	1991		Dec. 1990	Nov. 1991	Nov. 1991 - Mar. 1992
1994*	1994**		1994-1995			1994-1995		Nov. 1993	Oct. 1994	Apr. 1994 - Apr. 1995
								Sep. 1997	July 1999	Mar. 1999 - Mar. 2000
2000-present								Nov. 2000	Feb. 2002	June 2001 - Dec. 2002

Kibritçioğlu (2003)

Kibritçioğlu, A. (2003): "Monitoring Banking Sector Fragility". *Arab Bank Review* (Jordan), 5(2): 51-66.
PDF: http://econwpa.wustl.edu:8089/eps/mac/papers/0312/0312011.pdf