Early Warning Signals of the 2000/2001 Turkish Financial Crisis

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EARLY WARNING SIGNALS OF THE 2000/2001 TURKISH FINANCIAL CRISIS

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ABSTRACT

The 2000/2001 Turkish crisis was one of the most impressive crises that hit the emerging market economies in the late 90s. The characteristic of this crisis is not only its violence but also its suddenness. We observe two rapid crisis sequences which are different from recent financial crisis examples. The analysis of the Turkish crisis in the literature generally presents an analytical aspect that only relates the stylized facts of the crisis omitting a strong econometric basis. This paper goes further: it presents two models (OLS and Logit) which will test the implication level of the macroeconomic and financial variables in the outbreak of the crisis.

Keywords: *Currency Crisis, Banking System Fragility, Third Generation Crisis Model, Turkey*

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INTRODUCTION

The last decade of the 20th century was marked by a new wave of international financial crises, thus weakening the world economy. Europe underwent the crisis of the European Exchange Rate Mechanism (ERM) in 1992/1993. It was at the end of 1994 a crisis hit the Mexican economy. It spread to the neighbouring economies, called later "tequila effect". In the summer of 1997, the devaluation of the Thai baht induced a chain reaction in many Asian economies. This unexpected and unforeseen phenomenon by the economic analysis touched Southeast Asian emerging markets (Thailand, Malaysia, Indonesia, and the Philippines), then contaminated the newly industrialized countries (Hong Kong, Singapore, Taiwan) and spread to South Korea, which is a quasi-industrialized country. One speaks then of a contagion effect which touches countries that do not have financial or even macroeconomic imbalances, and of systemic risk putting in danger the whole

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international financial system. Then, the 1998 Russian crisis was the most spectacular. Indeed, the Russian rouble was depreciated of more than 250%, the Russian State was almost insolvent and it was the first time that a literature appeared about the bankruptcy of a state. Finally, the Brazilian crisis hit at the beginning of 1999. These last two crises had a common point defined by their tendency to spread to neighbouring economies.

The beginning of the 2000s reminds us that financial instability is a stylized fact requiring a more amplified study. The 2001 Argentinean crisis was due to mismanagement of economic policies which led to unsustainable sovereign debt. It was in February 2001 that a financial crisis hit the Turkish economy. This crisis was certainly due to the failure of the banking sector and the deterioration of macroeconomic fundamentals, but was triggered by rumours of political instability. The crisis led to depreciation of the Turkish lira more than 70% and the decline of the GNP more than 8%.

Each one of these crises has a characteristic which defines it, so the generalization of an economic model to explain all these different cases is not possible in our sense. It would thus be necessary to distinguish the remedies according to the sources of the crisis, i.e. to consider solutions at the scale of a country or to restrict the application field to a group of economically homogeneous countries. However, all these crises present a key feature of the new international financial markets structure of the 80s and 90s, which is liberalization of capital flows. From then on currency problems have not necessarily come from the deteriorated economic fundamentals, but they may also appear through much more volatile capital flows. Indeed, countries have not had control over this determinant variable and the implemented economic policies need to take this into account.

Our analysis consists in developing a crisis indicator which will measure the vulnerability of a country towards an external shock initiated by a massive capital inflow and/or outflow. We present here a linear regression model and a binary regression model that will test the implication level of the macroeconomic and financial variables in the outbreak of the crisis. The aim of this study is to determine the indicators that precipitated the Turkish crisis.

This paper is composed of six sections. After the introduction, the second section will present the stylized facts of the 2000/2001 Turkish financial crisis. The third one will present a review of theoretical and empirical literature on crises. The fourth one will define the models and their variables. The estimation results of the models will be analyzed in the fifth section, and the last one will conclude and bring some remarks.

THE 2000/2001 TURKISH FINANCIAL CRISIS

Turkey entered the new millennium with a stabilization program anchored on a basket of currencies (American dollar and Euro). This program which pre-announced the exchange rate parity was supported by the IMF stand-by credits. The country undertook to decrease the inflation rate to 25% in 2000 then to 12% in 2001. The program was also accompanied by a restrictive budgetary and monetary policy, which enabled the Central Bank to increase the domestic liquidity only with capital inflows, giving the program a currency board character.

The program found a positive echo among economic agents: the capital inflows accelerated (15.2 billion USD in 2000), the interest rates strongly decreased (from more than 80% to about 40%), and the consumption sharply increased in particular with low cost bank credits[1]. However, the rigidity of the inflation to fall, especially because of the sharp increase of consumption mainly met by importations, led to an overvaluation of the Turkish lira (about 15%) compared to the pre-announced parity of the fixed exchange rate, which deteriorated in turn the trade balance (deficit of 27 billion USD at the end of 2000) and the current account balance (deficit of 9.8 billion USD, 4.9% of the GDP). Besides, the rise of the short-term debt associated to the failure to achieve the privatization goals increased the tensions in the Turkish money market and created doubts on the sustainability of the program. The international investors became then increasingly reluctant in renewing their credits, which increased the domestic interest rates and their volatility. Furthermore, the strong exposure of the banking system to currency and interest rate mismatches, and to credit and default risks enhanced these doubts. At the end of October 2000, Savings Deposit Insurance Fund (SDIF) took control over two small-scale banks (Etibank, Bank Kapital), which put out rumours on the insolvency of Demirbank, because the latter was the sixth leading bank in the country and above all the partner of Etibank. These events emphasized the tensions in the Turkish financial system and raised the interest rates at the beginning of November.

During the same time, as they do it each year, banks started to cover their short currency positions in order to strike their balance sheets at the end of the year. This accelerated the demand for liquidity and increased again the interest rates, weakening more the illiquid banks which began distress sales of their Treasury bonds in order to have liquidity. On November 20th, as the rumours on the illiquid banks were spread, the leading banks suspended their credit lines to the interbank market. The interest rates skyrocketed (overnight rate about 4000%) and the foreign investors started to leave the country. This was the beginning of the banking system liquidity crisis. In order to protect the banking

[1] See Akyuz and Boratav (2001), "The Making of the Turkish Financial Crisis".

sector and to limit the rise of the interest rates, the Central Bank suspended its currency board commitment and bailed out the illiquid banks. However, the operators were reassured only on December 6th, with the IMF's Supplemental Reserve Facility[2] of 7.5 billion USD. On the same day, the SDIF took control over Demirbank, main source of the liquidity problems in the Turkish banking system.

Nevertheless, the strong deterioration of the financial structure of the public banks and the SDIF banks and their massive requirements for short-term credits increased again the interest rates that led operators to question the sustainability of the fixed exchange system. Actually, it was the rumours of political instability that triggered the second shock. The country underwent a strong speculative attack against its currency and was forced to let it float. The currency crisis worsened in turn the already started banking liquidity crisis. Here is an example of so-called twin crises a la Kaminsky and Reinhart (1999).

The analysis of the Turkish financial crisis confirms mainly new crisis approaches by referring on the one hand to animal spirits and sunspots, on the other hand to the fragility and inefficiency of the banking system. Whereas the macroeconomic fundamentals of the country did not justify a crisis of such scale, the financial crisis started up with a rumour. Indeed, the speculative attack on the Turkish lira started, on February 19th 2001, with the disagreement between the Prime Minister and the President of the Republic, which was perceived by financial markets as a signal of political instability. The days following this scene were crucial in the country's crisis management, because Turkey defended the fixed exchange rate parity by mobilization of its reserve stocks (5 billion USD in three days) and increase of the nominal interest rates to 8000% (overnight rate). But following the investors' generalized distrust, the authorities were forced to let the currency float, on February 22nd, 2001. In only one day, the Turkish lira depreciated of more than 35% against the USD and lost 70% of its value until April 2001[3].

Indeed, the rumours of political instability triggered the speculative attack against Turkish lira but it was the total inefficiency of the Turkish banking system that drove it[4]. Actually, the banks do have an essential role in the economic organization, because they are in the centre of the monetary circuits and manage the payments system. Moreover, they occupy a central place in the mobilization and the distribution of the savings. Hence, their structure is a significant source of systemic risk,

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[2] IMF's Supplemental Reserve Facility is a sort of short-term credit granted to the countries which suffer balance of payments problems and/or currency crises.

[3] See Arı (2003), Dağtekin (2002b) and Uygur (2001) for an amplified study on the stylized facts of the 2000-2001 Turkish financial crisis.

[4] See Ozatay and Sak (2003) who confirm the relationship between the Turkish banking sector fragility and the outbreak of the 2000-2001 Turkish crisis. The authors also present an amplified study on the reasons of the Turkish banking system vulnerability.

thus weakness and/or inefficiency of the banking sector can create a risk for the whole financial system and even for the entire economy. This is why effective regulation and supervision are necessary so that the banks can carefully lead their operations and have enough capital stocks in order to face the inherent risks of their functions, particularly in the context of financial liberalization (Demirguc-Kunt & Detragiache, 1997).

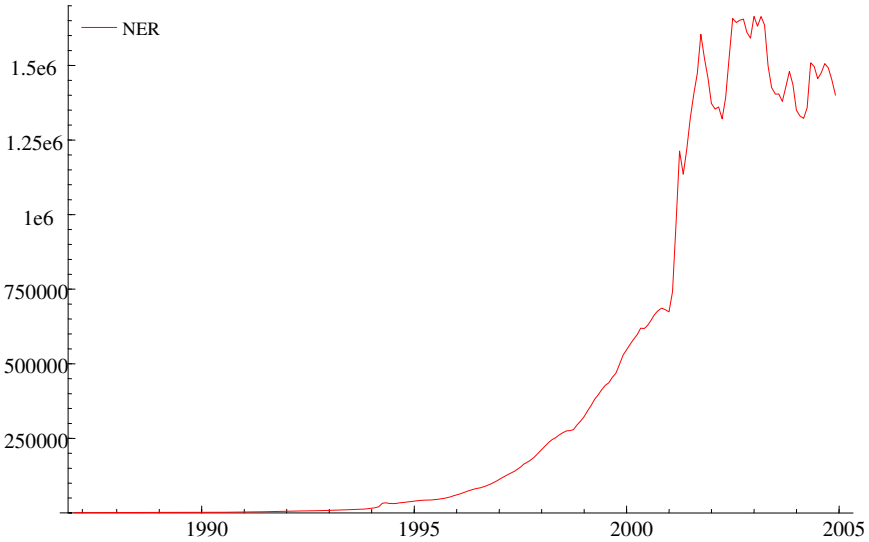


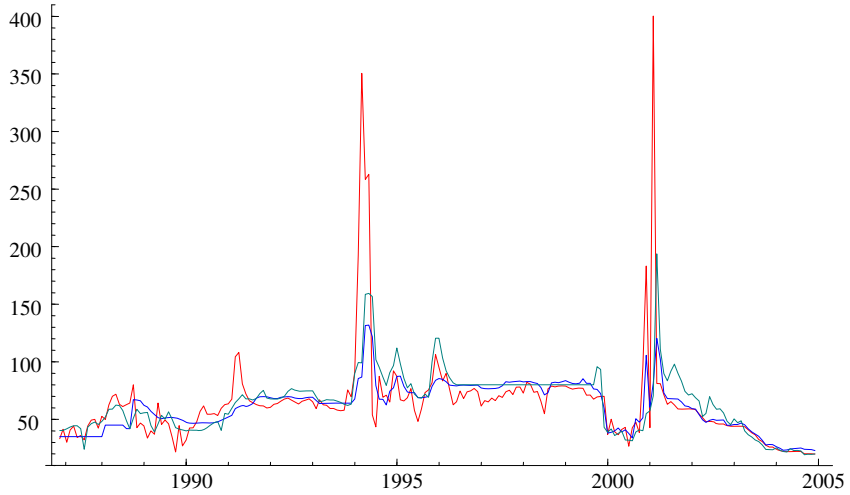
Figure 1: Nominal Exchange Rate

It was not the case of the Turkish banking sector which suffered some structural weaknesses in an unstable economic environment where the high rate of inflation (about 70% of annual average rate) and the fluctuations of the economic growth rate, by increasing uncertainties, contributed to the shortening of the maturities in the economy and to the increase of the interest rates (see Figure 2). In that environment, default risk was high for banks, because high interest rates deteriorated the non-financial institutions balance sheets, which degraded then the quality of banks loans.

The public sector's deficits were another handicap of the Turkish economy, because the financing of these deficits by the high real interest rates on the domestic money market incited banks to offset these deficits instead of granting credits to the private sector. In this context banks got into debt in foreign currency with the international financial markets in order to invest in the public sector securities in domestic currency, which generated a strong growth of the domestic banks short positions.

The great part of the State banks in the sector created negative effects on the entire system. The interventions of the political authorities in their management and the use of their assets to finance public deficits and doubtful projects of investors that were close to the political

authorities decreased their performances and deteriorated their balance sheets (duty losses of 21 billion USD at the end of 2000). Their massive borrowing requirement increased the instability of the financial system.



Ibank: Interbank interest rate
Ibond: Treasury bond rate
I3: Three-month interest rate

Figure 2: Interest Rates in the Turkish Economy (%)

In the context of full deposit insurance after the 1994 currency crisis, the moral hazard was inevitable, thus deteriorating the market discipline in the banking system. This structure encouraged banks and their depositors to take excessive risks in order to obtain higher profits. Furthermore, the lack of a Banking Regulation and Supervision Agency (BRSA) independent of the political authorities until September 2000 prevented an effective control on the banks operations and structures.

All these features led to a weak and fragile banking system in Turkey. Moreover, the implementation of the stabilization program at the beginning of 2000 emphasized these weaknesses. Like in the several emerging market crises, the excessive short-term capital inflows weakened first the Turkish financial system before being at the origin of the crisis when a reversal of capital flows occurred. In the context of excessive capital inflows, the Turkish economy had a credit boom, in particular to consumption, financed by domestic banks. However, this credit growth made them more vulnerable to credit risks by increasing the part of non-performing loans in their assets portfolios. Furthermore, in the context of the fixed exchange system, banks were encouraged to borrow in short-term foreign currency on the international financial markets in order to invest in long-term domestic securities, which

brought them higher profits. As Figure 3 shows, the banks short positions rose far during the year 2000[5].

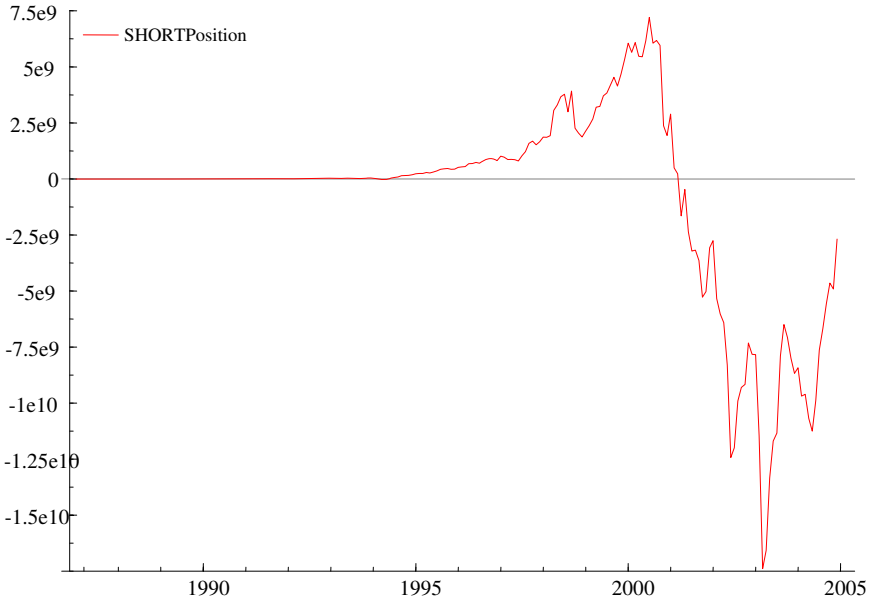


Figure 3: Short Position of the Turkish Banking System (millions $)

THE REVIEW OF THEORETICAL AND EMPIRICAL LITERATURE

As we stated above, the last decade of the 20th century and the beginning of the 2000s were marked by a new wave of international financial crises. In this context, the crisis literature has become considerable on the specification of theoretical crisis models on the one hand and on the econometric estimation of early warning signals on the other hand.

Following the first wave of currency crises, in particular those that came out in Latin America in the late 70s and early 80s, the first models of currency crises were developed by Krugman (1979) and Flood and Garber (1984). In the early crisis models, so-called first generation crisis models[6], currency crises are associated to persistent economic imbalances (large and growing fiscal deficits and/or gradual growth of domestic credit) that are in conflict with a fixed exchange rate system. The monetization of this persistent fiscal deficit leads to loss of foreign

[5] See Alper and Onis (2003), Banking Regulation and Supervision Agency (2002), and Banks Association of Turkey (2001) for an amplified analysis of the Turkish banking system.

[6] For a detailed analysis of the generation of currency crises, see Eichengreen et al. (1994 and 1995), and Flood and Marion (1998).

exchange reserves of the government in a fixed exchange rate regime. When the level of reserves reaches a critical threshold, operators anticipating that the exchange rate is no longer viable, withdraw from the domestic currency in order not to suffer losses of a possible devaluation. The deteriorated macroeconomic fundamentals resulting from the economic policy inconsistency with the fixed exchange rate regime lead to investors' generalized distrust towards the domestic currency and their "rational" reaction triggers a currency crisis. In that model, a speculative attack advances the date of onset of the crisis, but the crisis would outbreak even in its absence at a time of exhaustion of foreign exchange reserves of the government. Here, one suggests that some variables like large fiscal deficits, growth in domestic credit and depletion of reserves may be used as potential early warning indicators.

However, the first generation models remain insufficient in explaining the ERM crises in 1992-1993 and Mexico crisis in 1994. New models were created, in particular by Obstfeld (1994, 1997) so-called second generation models, where a crisis can be triggered without ex ante significant deterioration of macroeconomic fundamentals. Therefore, even if economic policies are consistent with the fixed exchange regime, a speculative attack may occur when a shift realizes in the operators' expectations whose herd behaviour leads to a currency crisis. Unlike the first generation models that describe a simple and mechanical behaviour of policymakers against a speculative attack, the optimizing behaviour of the latter is central to the process of crisis in the second generation models. Because, in these models economic policies are not predetermined, but respond to the problems of the economy that operators are aware of. So we are in a configuration of multiple equilibria in which the agents' expectations are not related to the macroeconomic fundamentals observed in period (t), but to the expected continuity of the government's policies in terms of the sustainability of the situation in (t+1) and of the loss function of government. Expectations are therefore based on the future direction of economic policy that is not predetermined but responds to the loss function of the government and to the future development of the economy. This circularity creates multiple equilibria which lead to the manifestation of self-fulfilling crises. In these models the exact timing of the crisis is unpredictable comparing to the first generation models. But even here we can identify if a country is in a zone of vulnerability, called later as "crisis zone" by Jeanne (1997), where some fundamentals are sufficiently weak that a shift in operators' expectations – generally triggered by sunspot dynamics – could bring a crisis.

The outbreak of the Asian financial crisis in 1997 led to a reorientation of the crisis modelling (third generation crisis models). Currency crises do not only result of an unsustainable macroeconomic situation and/or of self-fulfilling prophecies, but can also be associated to the fragility of the banking and financial system. Of course, before the

Asian crisis, a number of macroeconomic fundamentals had already weakened as the deterioration of the current account deficit, overvalued currencies in the region, slowing export revenues, however, as stated Krugman (1999), this situation was not new. So the fragility of the banking and financial system led to currency crises in Southeast Asia in a destabilized economic environment. We can also see the important impact of the Turkish banking fragility on the outbreak of the 2000-2001 Turkish crisis as we discussed in the previous section. We take into account that characteristic in making of our twin crisis index in the next section.

Beside the theoretical models that tended to explain crisis mechanism, several empirical studies have focused on the anticipation of the crises (early warning signals) that may give policymakers and investors alarms that a crisis is likely to occur. Four approaches have been adopted for creating early warning systems.

Kaminsky, Lizondo and Reinhart (1998) present a bivariate "signals" approach. They aim to monitor whether some "key" variables tend to behave unusually prior to the onset of a crisis. They define, albeit in an arbitrary method, an "optimal" threshold for each indicator which is calculated to minimize the noise-to-signal ratio; i.e. the ratio of false signals to good signals. Therefore, when an indicator crosses beyond a given threshold level, it issues a signal which is taken as a warning signal about a possible currency crisis within a specified period of time (24 moths). An indicator X_{jt} becomes a signal S_{jt} which defines the condition of the transition from a non-crisis state (0) to a crisis state (1) in a following manner:

$$S_{jt} = 1, \text{ if } X_{jt} \geq T_j$$
$$S_{jt} = 0, \text{ otherwise} \qquad (1)$$

Kaminsky et al. (1998) examine the performance of each individual indicator based on the following matrix.

	Crisis within 24 months	**No crisis within 24 months**
Signal was issued	A	B
No Signal was issued	C	D

Source: Kaminsky et al. 1998, 28.

Here, A represents the number of months in which an indicator issued a good signal, B represents the number of months in which an indicator signalled a crisis where there was no crisis in reality, C is the number of months in which an indicator failed to signal a crisis which actually occurred, and D is the number of months in which an indicator did not correctly issue any signal.

An important advantage of the signals approach is to give policymakers an easily interpretable picture of problems of the economy by showing clearly which indicators exceed the calculated threshold level. However, we lose some information when we set threshold levels. For example, an indicator does not give any signal even though it derives unusually from its trend, because it is just below the threshold. Or once an indicator crosses the threshold, we cannot observe how deteriorated an indicator is.

Frankel and Rose (1996) use a large multi-country sample composed of more than 100 developing countries. It consists in regressing a probit model in which the dependent variable is the crisis indicator based on the exchange market pressure index and the independent variables are economic and financial indicators, mostly the same as those used in Kaminsky et al.'s signal-based approach.

The probit or logit approach has been also used in Eichengreen, Rose and Wyplosz (1994). These two papers estimate the equation as

$$\text{prob}\left(\mathrm{C_t}\left|\Omega_{t-k}\right.\right) = F\left(X_{t-k}'\beta\right) \qquad (2)$$

where *F* is a cumulative distribution function, X_{t-k} is a vector of lagged early warning indicators, and *Ct* is a binary crisis variable defined as an index of speculative pressure (ISP) (Abiad, 1999). One suggests that a crisis occurs when ISP exceeds an arbitrary threshold T :

$$C_t = 1 \text{, if } ISP_t \geq T$$
$$C_t = 0 \text{, if } ISP_t < T \qquad (3)$$

This model has the advantage of measuring the direct effect of each variable on the crisis probability. In addition, it considers all variables together and looks only at the marginal contributions of each indicator. However, measures of statistical significance cannot distinguish if an indicator is good at signalling crises or sending false alarms (Abiad, 1999). Moreover, the use of annual data may restrict the applicability of this approach as an early warning system, while it allows the analysis of some variables available in this frequency, such as the composition of external debt (Berg & Pattillo, 1998).

Sachs, Tornell and Velasco (1996) define a "Cross-country" approach trying to explain the impact of the "tequila effect" following the Mexican crisis of December 1994. Their approach consists in finding the countries that will be most hit by a crisis appeared in a region. The method is based on a crisis indicator calculated over a stress period on the international markets. Therefore, they limit their cross-country sample to 20 countries which seem to have some similarities for one year period of 1995. Their approach differs then from the first two studies discussed above which integrate in their samples a large number of countries with different episodes of crises. We can claim the first two

approaches are based on an assumption that all crises can be explained in the same way while ignoring some geographic and local characteristics and also conjectural and periodical specificities. It should then lower the number of crises episodes to analyse over a shorter period of time with a smaller number of variables that Sachs et al. (1996) use as a method. However, their approach fails to shed light on the timing of the speculative attacks, but rather allows answering which countries are most likely to suffer a crisis due to an external shock.

Another method more contemporary at least in its use is to establish an early warning system by using Markov-switching models (Peria, 1999; Abiad, 1999, 2003). Abiad (1999, 2003) models a classic Y variable which measures the probability of transition from a non-crisis state in (t) to a crisis state in (t+1).

$$Y_t \left| s_t \overset{iid}{\square} N\left(\mu_{s_t}, \sigma^2_{s_t}\right)\right. \qquad (4)$$

This process follows a two-state Markov chain $\{s_t\}_{t=1}^{T}$ with $s_t = 1$ when crisis occurs and $s_t = 0$ otherwise.

This method is appropriate for modelling variables which present sudden, fluctuating and brutal behaviour, such as the dynamics of financial crises. Another advantage of these models lies on avoiding many ad hoc assumption used in early models like setting arbitrary thresholds for indicators or for the definition of crisis episodes. However, beside the technical difficulty of Markov-switching models with time-varying probabilities which are still not part of standard econometric software packages, these models present another difficulty in testing a null of no switching.

Our approach is to set an early warning system for the 2000-2001 Turkish crisis using dynamic OLS and logit models. Our contribution is to include a large number of indicators with monthly data and to model a binary endogenous variable, more sophisticated, which produces more accurate results than a study based on a classic ISP that we tested in a previous paper (Arı & Dağtekin, 2006). Our sample is composed of 215 monthly observations being spread out from January 1987 to December 2004. These data were collected from the IMF [International Financial Statistics, IFS (January 2006)], the World Bank [World Development Indicators, (2005)] and the Central Bank of Turkey[7].

Other empirical paper – as far as we know – that studied the case of the Turkish 2000-2001 crisis is that of Cepni and Kose (2006). They use dynamic logit and probit models for predicting currency crises probabilities by modelling a classic ISP a la Eichengreen, Rose, and Wyplosz (1995) of 4.04σ. They create a sample of 11 macroeconomic

[7] www.tcmb.gov.tr

variables in quarterly frequency that remain in our sense insufficient to explain the 2000-2001 Turkish crisis which presents a high vulnerability of the financial system in its occurrence as we displayed in the previous section.

THE MODELS

In order to explain our endogenous variable, we built a series of indicators taken from the financial literature to measure the vulnerability of an economy to speculative attacks. Following Eichengreen et al. (1995), Sachs et al. (1996), or Cartapanis, Dropsy and Mametz (1998, 2002), Dağtekin (2002a), Abiad (1999, 2003), and Arı and Dağtekin (2006, 2007), the first part of our crisis indicator is made of real exchange rate changes, international reserves changes and real interest rate changes.

This paper brings a double contribution. First, it implements an early warning signals approach for the 2000/2001 Turkish financial crisis. Secondly, it develops an original new generation crisis indicator that combines the macroeconomic and microeconomic dimensions of the crisis. Indeed, the third generation currency crises associate the weakness of economic fundamentals to the fragility of the financial system, in particular to the fragility of the banking sector. This is why the second part of our crisis indicator refers to three risk measures of the banking system that can easily be found in the literature under different forms, but also under an aggregated form in Kibritcioğlu (2002), defined as the banking sector fragility indicator.

Our crisis index appears then in the following way:

$$Itwin_t = \left(\frac{\log RER_t}{\sigma(\log RER_{t-1})} - \frac{\log RES_t}{\sigma(\log RES_{t-1})} + \frac{r_t}{r_{t-1}} \right) + \left(\frac{\log CPS_t}{\sigma(\log CPS_{t-1})} + \frac{\log FXLIAB_t}{\sigma(\log FXLIAB_{t-1})} - \frac{\log DEPO_t}{\sigma(\log DEPO_{t-1})} \right) + \varepsilon_t \quad (5)$$

where $RER = (NER \times P^*) / P$

RER = Real exchange rate (an increase corresponds to a real depreciation of the domestic currency)

NER = Nominal exchange rate (TL/USD)

P^* = Consumer prices index US (base 100 = 1995)

P = Consumer prices index Turkey (base 100 = 1995)

RES = International reserves – Gold (in USD)

r = real interest rate (deflated by the inflation rate to the consumption of the domestic country)

CPS = Claims on private sector (in TL)
$FXLIAB$ = Foreign exchange liabilities (in USD)
$DEPO$ = Total deposits (in TL)
σ = Standard deviation of the variables

The first part of the equation measures the market pressure or speculative pressure as defined by Eichengreen et al. (1995). The crisis indicator increases with a depreciation of the domestic exchange rate, with a significant fall of the Central Bank international reserves and with a considerable rise of the real interest rate. The second part of our equation measures the vulnerability of the domestic banking system. The crisis indicator increases with an increasing credit amount to the private sector granted by the banking sector, with a considerable rise of the banking system foreign exchange liabilities and with a significant fall of the banking system deposits.

Our indicator called *Itwin* (twin crisis indicator) can be debatable as for the economic acceptability to combine microeconomic and macroeconomic spheres. However, our choice is confirmed by the reality of the Turkish crisis, which would never have occurred if the banking system had not been weakened, because macroeconomic fundamentals were already deteriorated since 1999 in spite of the IMF strong backing. The Figure 4 can give an idea about the aspect of the crisis indicator. Thus, our analysis will be based and directed by this curve which enables to detect the peaks of crisis undergone by the Turkish economy.

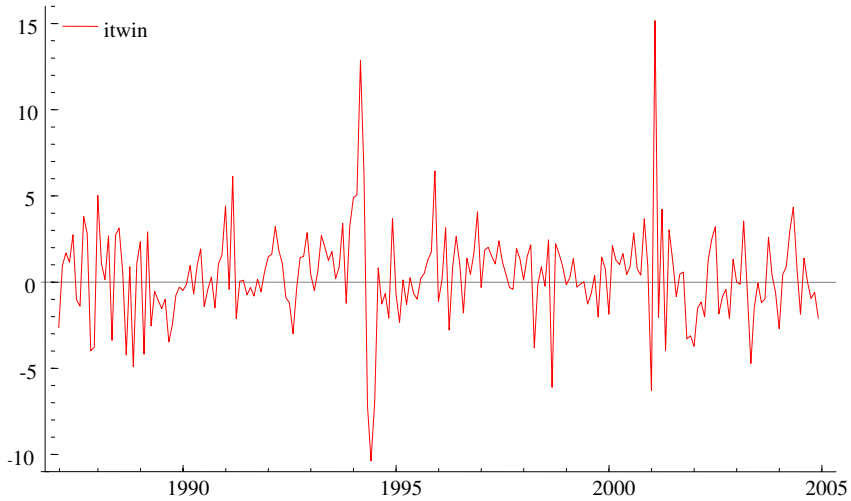


Figure 4: The Twin Crisis Indicator (*Itwin*)

The explanatory variables and the indicators used in the models are gathered in the below tables with their expected impacts on the crisis index.

Table 1: Variables of the Models

Variables	***Definitions***
CA	Current Account (in million TL)
TRADE	Trade Balance = EXPORT–IMPORT (in million TL)
EXPORT	Volume of Export (in million TL)
IMPORT	Volume of Import (in million TL)
GDP	Gross Domestic Product (in million TL)
RES	Total International Reserves–Gold (in million TL)
SHORTDEBT	Short-term Debt (in million TL)
EXDEBT	Foreign Debt (in million TL)
PORTEF	Portfolio Investments (in million TL)
ISE	Istanbul Stock Exchange Index
BUDG	Net Budgetary Position (in million TL)
PSBR	Public Sector Borrowing Requirement (in million TL)
CRED	Domestic Credit (in million TL)
M2	Monetary Aggregate = Money+Quasi-Money (in million TL)
OUVCOM	Degree of Opening to the International Trade [(EXPORT+IMPORT)/2]/GDP
TOT	Terms of Trade = Unit Value of Export/Unit Value of Import
IBANK	Interbank Interest Rate
BANKRES	Banking Sector Reserves Stock (in million TL)
BANKASSETS	Banking Sector Total Assets (in million TL)
BANKLIAB	Banking Sector Total Liabilities (in million TL)
BCCRED	Central Bank Credits to the Banking Sector (in million TL)

After defining the crisis index and the indicators of the models, we will present the development of the crisis models. Our objective consists first of all in testing the stationnarity of the variables. We assume that if we observe a mean reverting trend the so-called variables will be stationary. We make a unit root test (Augmented Dikkey Fuller) to judge the stationnarity of the variables. We can see that some variables are not stationary at all whereas others do not present any stationnarity at level, in which cases they will be excluded from the analysis.

Table 2: Early Warning Indicators and Their Awaited Impact on the Crisis Index

Early warning indicators	***Notations***	***Awaited impact on the crisis index***
Current imbalance	CA/GDP	A country which permanently records a current account deficit can only finance it with the capital inflows, in other words with operators' confidence towards the country. If the operators evaluate that the unsustainability of the current account deficit is high, the country becomes insolvent, which tends to increase the probability of a crisis.
Impact of financial liberalization	PORTEF/GDP ISE	An acceleration of the short-term capital inflows often under the form of portfolio investments makes the country vulnerable to shocks when a massive reversal of capitals occurs. An increase of this ratio can thus increase the crisis risks for the country if the operators lose their confidence towards domestic currency. -The collapse of the stock exchange index, which shows a massive withdrawal of capitals, can be perceived as a harbinger of the crisis.
Debt	SHORTDEBT/ RES	A high ratio of the short-term debt to the international reserves increases the risk of illiquidity and thus the vulnerability of a country to a speculative attack.
Budgetary imbalance	BUDG/GDP PSBR/GDP	The markets often consider a budgetary deficit as a source of imbalance as it reduces the available national savings and can lead to high inflation rates or to a rise of the interest rates. The crisis index should increase following a deterioration of the budgetary balance. A high public sector borrowing requirement can increase the interest rates in the domestic markets, thus the banking sector can choose to compensate for this excessive demand without any risk of return instead of granting credits to the private sector. This situation decreases investments in the domestic economy and leads to economic recession. The crisis index should react to the rise of this ratio.
Monetary imbalance	M2/RES CRED/GDP	An economy will be all the more vulnerable to a confidence crisis as the ratio of money supply to the international reserves is high. This ratio enables to measure the capacity for a central bank to face a collapse of the reserves in case of loss of the agents' confidence. A steady growth of the domestic credit higher than the economic growth can be considered as a sign of lax monetary policy, likely to lead to a speeding up of the inflation or a speculative bubble on the stock exchange securities. The crisis index should thus react to a rise of this ratio.

Table 2: Early Warning Indicators and Their Awaited Impact on the Crisis Index (continued)

Early warning indicators	***Notations***	***Awaited impact on the crisis index***
Degree of opening	OUVCOM	A high degree of commercial opening is generally perceived as a positive factor of long-term growth but increases the vulnerability of a country to an external imbalance.
International shocks	TOT	A country will be all the more vulnerable to a variation of its terms of trade as it is strongly open to international trade. For instance, an increase of the real oil price makes, theoretically, that the importing countries record a deterioration of their trade balance.
Financial fragility	IBANK BANKRES/ BANKASSETS BCCRED/ BANKLIAB	The sudden and/or continuous rise of the interbank interest rate gives an idea of the vulnerability of the banking sector. This ratio shows the ability of the banking system to face the bank runs. A fall of this ratio is perceived by the operators as a sign of weakness of the banking sector. This ratio presents the share of the central bank loans in the banking sector liabilities (bailing out by the central bank). An increase of this ratio represents the illiquidity of the banking system.

Source: Cartapanis et al. (1998, 2002), Abiad (2003), completed by the authors.

We undertake a stepwise regression which consists in integrating a maximum of variables in the analysis in order to extract firstly those having a colinearity with another variable, and secondly, those having a negligible significance. Some variables, being integral part of the analytical context of the crisis have not been integrated in the model, because they present multicolinierarity. Admittedly the principle of the forecasting models is that they analyze the crises case by case. Indeed, some variables can be significant for a country but not necessarily for another one, even if they are part of a homogeneous economic panel, which confirms in other sense our unique country approach applied here to the Turkish crisis came out in 2000-2001.

We successively estimate the equation systems with 4, 3, 2, 1 then 0 delays (respectively system 2, 3, 4, 5, 6) with the Johansen process (1995).

The AIC information criteria (Akaike criterion), HQ information criteria (Hannan-Quinn), and SC information criteria (Swartz criterion)[8] will enable us to distinguish the number of most significant delays according to the simplifications brought to the model. A decrease of the information criteria value corresponds to an improvement. According to the results, we can privilege the system 5 which corresponds to the model with one delay on the explanatory variables. In order to validate our model, we use other statistics of diagnostics such as the normality and the heteroscedasticity tests. We can find a more suitable description of the reference tests in Hendry and Doornik (1997). However we can affirm that our modelling is quite robust according to the Table 4.

Table 3: Descriptive Statistics of the Variables

Indicator	***Average***	***Sigma***
Itwin	0.33680	2.7377
EXPORT ; growth rate	0.0092144	0.15794
TRADE	-7.3219e+008	4.5530e+008
CA/GDP	89667	0.031787
PORTEF/GDP	-3.3825	6.5048
ISE ; growth rate	4504.8	6244.8
SHORTDEBT/RES ; level	0.55679	0.72352
SHORTDEBT/RES ; growth rate	0.027721	0.11590
EXTDEBT/EXPORT	44.172	8.0844
BUDG/GDP	-94.505	101.48
PSBR	0.040719	0.17147
PSBR/GDP	0.40715	0.19905
M2/RES ; level	2.2153	3.2447
M2/RES ; growth rate	0.031240	0.084872
CRED ; growth rate	4.0388e+010	6.6307e+010
CRED/GDP	1.1942	0.58830
GDP ; growth rate	2.1873e+010	3.4224e+010
INDUSTRIAL PRODUCTION ; growth rate	85.788	16.459
OUVCOM	18.037	33.239
TOT	0.65241	0.11599
IBANK	64.323	42.302
CPS/GDP	0.63467	0.17100
DEPO/M2 ; level	0.90595	0.032200
DEPO/M2 ; growth rate	0.00043620	0.010516
SHORTPOSITION	-8.0087e+008	4.2228e+009
CPS/DEPO	-0.0022773	0.042821

[8] $SC = \log(\sigma^2) + k\frac{\log(T)}{T}$, $HQ = \log(\sigma^2) + 2k\frac{\log(\log T)}{T}$

$FPE = \frac{(T+k)\sigma^2}{T-k}$, $AIC = \log(\sigma^2) + \frac{2k}{T}$

Table 3: Descriptive Statistics of the Variables (continued)

Indicator	***Average***	***Sigma***
BANKRES/BANKASSETS	0.049185	0.049185
BANKASSETS/GDP ; level	1.3256	0.50717
BANKASSETS/GDP ; growth rate	0.0017882	0.16141
BCCRED/BANKLIAB	0.033607	0.030709

After specifying a quite satisfying OLS model, we test our explanatory variables in a binary regression model (logit). The threshold to pass from the non-crisis state (0) to the crisis-state (1) from one period to another was chosen according to the crisis literature where the thresholds usually used go from 1.5 to 5 standard deviations. This method is completely arbitrary, but it also depends on the level of the indicators and thus on the volatility or fragility of a country to face external shocks. To understand the reality of the Turkish crisis, we tested the thresholds of 6, 7, 8, 9 and even 10 standard deviations as we can see in some empirical studies, in particular in Vlaar (2000). This solution was considered and tested but not adopted for an arbitrary rule which consists in placing the threshold in the state of crisis at the average of 2 standard deviations.

$$ITwin = 1 \text{ if } ITwin \geq 2\sigma$$
$$ITwin = 0 \text{ if } ITwin < 2\sigma \qquad (6)$$

Table 4: Tests

AIC	2.68675
HQ	2.92828
SC	3.28445
FPE	14.7399
AR 1-7 test	F(7,169) = 1.9416 [0.0659]
hetero test	F(74,101) = 1.3439 [0.0836]
log-likelihood	-249.483
Durbin Watson	2.19
Number of parameter	38
Number of observation	215

ESTIMATION RESULTS

According to the results of our regressions, we can see that our crisis indicator is rather faithful to reality and it confirms the occurrence of the crises in April 1994 and in February 2001 (see Figure 5 and Table 6). Our explanatory variables seem to be chosen in a satisfactory way. However some of our variables are seasonal (GDP) and would have biased our analysis if we had not created the time dummies.

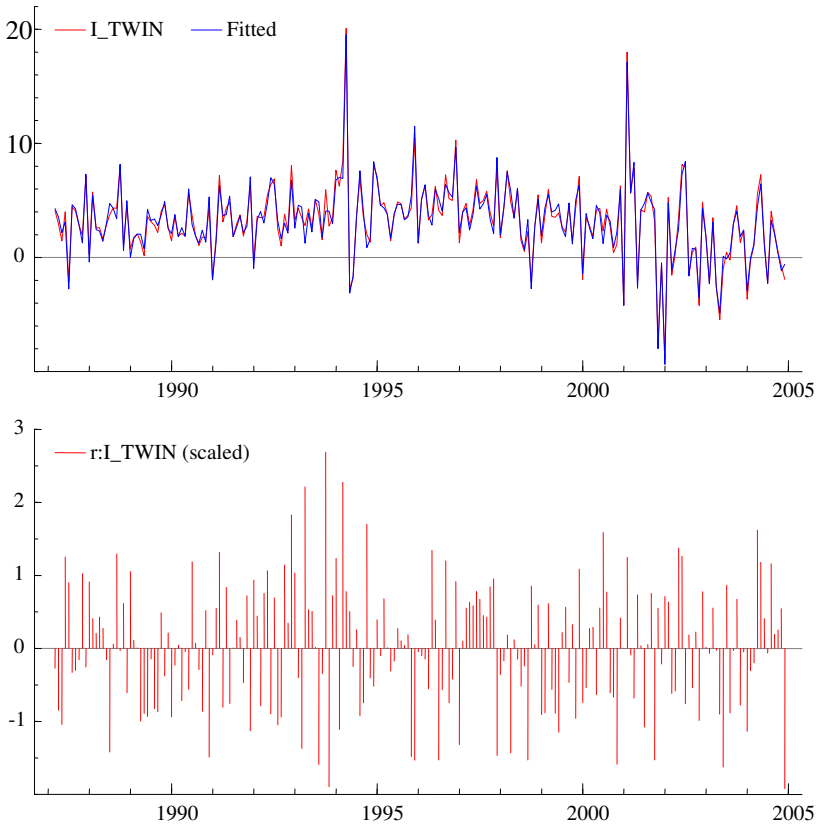


Figure 5: Crisis Indicator (*Itwin and Itwin fitted*)

Table 5: Twin Crisis Index Values

Period	Itwin Value	Period	Itwin Value	Period	Itwin Value	Period	Itwin Value
1987M1	-1,18	1991M6	4,49	1995M11	4,46	2000M4	1,83
1987M2	-1,18	1991M7	1,58	1995M12	10,04	2000M5	3,92
1987M3	3,78	1991M8	2,94	1996M1	1,32	2000M6	4,30
1987M4	2,72	1991M9	4,10	1996M2	4,81	2000M7	2,34
1987M5	1,18	1991M10	2,15	1996M3	6,12	2000M8	4,16
1987M6	3,55	1991M11	3,41	1996M4	3,23	2000M9	2,71
1987M7	-0,98	1991M12	6,49	1996M5	3,60	2000M10	0,54
1987M8	3,93	1992M1	0,22	1996M6	6,07	2000M11	1,57
1987M9	3,78	1992M2	3,43	1996M7	3,91	2000M12	6,55
1987M10	2,38	1992M3	3,19	1996M8	3,87	2001M1	-3,91

Table 5: Twin Crisis Index Values (continued)

Period	Itwin Value	Period	Itwin Value	Period	Itwin Value	Period	Itwin Value
1987M11	3,11	1992M4	3,47	1996M9	7,33	2001M2	17,09
1987M12	7,86	1992M5	4,93	1996M10	5,24	2001M3	3,15
1988M1	0,47	1992M6	6,03	1996M11	4,97	2001M4	6,30
1988M2	4,81	1992M7	6,78	1996M12	10,00	2001M5	-0,89
1988M3	3,08	1992M8	2,66	1997M1	1,09	2001M6	3,78
1988M4	2,15	1992M9	1,51	1997M2	3,94	2001M7	3,27
1988M5	2,00	1992M10	4,17	1997M3	4,80	2001M8	5,28
1988M6	2,32	1992M11	2,03	1997M4	3,04	2001M9	5,43
1988M7	3,19	1992M12	8,06	1997M5	4,13	2001M10	2,87
1988M8	3,59	1993M1	3,27	1997M6	6,54	2001M11	-6,43
1988M9	4,28	1993M2	4,19	1997M7	4,69	2001M12	0,33
1988M10	7,89	1993M3	3,54	1997M8	4,88	2002M1	-7,57
1988M11	1,71	1993M4	3,17	1997M9	6,07	2002M2	5,53
1988M12	4,08	1993M5	4,16	1997M10	4,35	2002M3	-1,55
1989M1	1,07	1993M6	2,14	1997M11	2,98	2002M4	0,72
1989M2	1,96	1993M7	4,98	1997M12	7,61	2002M5	2,86
1989M3	2,34	1993M8	3,56	1998M1	1,79	2002M6	7,06
1989M4	1,35	1993M9	1,99	1998M2	4,15	2002M7	7,02
1989M5	0,03	1993M10	6,06	1998M3	7,39	2002M8	-1,21
1989M6	3,76	1993M11	2,64	1998M4	4,76	2002M9	0,77
1989M7	3,46	1993M12	3,36	1998M5	3,58	2002M10	1,21
1989M8	2,52	1994M1	7,26	1998M6	5,80	2002M11	-3,55
1989M9	2,79	1994M2	5,17	1998M7	1,54	2002M12	5,22
1989M10	4,19	1994M3	7,44	1998M8	0,84	2003M1	1,78
1989M11	4,84	1994M4	17,31	1998M9	2,99	2003M2	-1,95
1989M12	3,14	1994M5	-2,30	1998M10	-1,58	2003M3	3,42
1990M1	1,62	1994M6	-1,06	1998M11	2,60	2003M4	-2,24
1990M2	3,70	1994M7	4,06	1998M12	5,38	2003M5	-4,28
1990M3	1,86	1994M8	6,80	1999M1	1,25	2003M6	-0,44
1990M4	2,63	1994M9	3,49	1999M2	3,37	2003M7	0,62
1990M5	1,96	1994M10	2,77	1999M3	5,70	2003M8	-0,27
1990M6	5,49	1994M11	1,76	1999M4	3,44	2003M9	3,19
1990M7	3,47	1994M12	8,13	1999M5	3,38	2003M10	4,25
1990M8	2,07	1995M1	6,88	1999M6	3,77	2003M11	1,09
1990M9	1,79	1995M2	4,70	1999M7	2,65	2003M12	2,75
1990M10	2,23	1995M3	5,04	1999M8	2,47	2004M1	-2,89
1990M11	2,12	1995M4	4,22	1999M9	4,59	2004M2	-0,09
1990M12	4,18	1995M5	1,61	1999M10	1,77	2004M3	1,13

Table 5: Twin Crisis Index Values (continued)

1991M1	-1,91	1995M6	3,92	1999M11	4,16	2004M4	5,21
1991M2	1,71	1995M7	4,82	1999M12	7,03	2004M5	5,98
1991M3	6,32	1995M8	4,57	2000M1	-1,80	2004M6	1,41
1991M4	3,15	1995M9	3,87	2000M2	3,42	2004M7	-1,86
1991M5	3,87	1995M10	3,82	2000M3	2,68	2004M8	3,95

The coefficients and their degrees of significance are gathered in the below tables. The mathematical complexity of the study leads us to reduce the number of variables so as not to alter accuracy of the coefficients elasticity and of course accuracy of the coefficients signs.

Table 6: Model I (OLS) Estimates

Indicator	***Coeff.***	***T-stat***
CA/GDP	6.93501***	1.29 (5.372)
PORTEF/GDP	0.0316210*	0.522 (0.06052)
ISE	0.000233172***	2.69 (8.676e-05)
SHORTDEBT/RES ; level	5.83497***	8.34 (0.6996)
BUDG/GDP	-0.00557158***	-2.89 (-2.89)
PSBR/GDP	8.24629**	2.12 (1.346)
M2/RES ; level	0.494364***	0.569 (0.3296)
CRED/GDP	-2.69920**	-1.27 (2.129)
OUVCOM	0.00651498*	0.694 (0.009387)
TOT	0.0040756*	1.68 (0.001694)
IBANK	0.330357***	19.8 (0.001667)
BANKRES/BANKASSETS	3.78043***	2.10 (1.797)
BCCRED/BANKLIAB	6.45613 **	3.52 (5.646)

* Threshold of 1%
** Threshold of 5%
*** Threshold of 10%

Table 7 : Model II (Logit) Estimates

Indicator	***Coeff.***	***T-stat***
CA/GDP; growth rate	30.4911	0.923 (33.03)
PORTEF/GDP; growth rate	6.15745e-005	3.26 (1836)
SHORTDEBT/RES ; growth rate	4.76282	1.45 (3.291)
PSBR/GDP; growth rate	56.6321	2.10 (27.00)
M2/RES ; growth rate	-20.9880	-8.04 (2.612)
CRED/GDP ; growth rate	15.9573	1.73 (9.237)
IBANK ; level	0.0673785	6.76 (0.02141)
BANKRES/BANKASSESTS ; growth rate	-35.6818	-2.21 (16.13)
BCCRED/BANKLIAB; growth rate	-84.4943	-155 (0.5434)

Our model foresees the occurrence of a crisis actually appeared in 40% of the cases. It also foresees the absence of a crisis in 97% of the cases whereas the failure reaches only 3% (occurrence of a signalled crisis which never occurred). But the forecast is limited because the model does not manage to signal 60% of the crises which occurred in the Turkish economy.

Table 8: Forecast Assessment according to Binary Regression Model

	Non-crisis foreseen by the model	**Crisis foreseen by the model**	**Total**
Non-crisis	96.744	3.256	100%
Crisis	60	40	100%
	Non-crisis foreseen by the model	**Crisis foreseen by the model**	**Total**
Non-crisis	208	2	210
Crisis	3	2	5

The liberalization of the Turkish economy plays a major role in the occurrence of the Turkish crisis; because the current imbalance indicator CA/GDP is quite significant. The indicator of crisis decreases when the current account deficits are financed by the capital inflows, but when the operators lose confidence towards the country, we observe an abrupt increase favourable for a crisis state. The trap of liberalization can only be avoided if a country has beforehand acquired stable economic fundamentals.

The financial liberalization, represented here by PORTEF/GDP and ISE, is another important factor in the outbreak of the crisis. The massive capital inflows and then their sudden withdrawal create an uncontrollable volatility. That situation generates a movement of widespread distrust which can lead to a panic and thus weaken the macroeconomic fundamentals whereas early warning signals are not so obvious. These misalignments lead to a self-fulfilling spiral which completes the sequence by an advanced crisis state. This is why our dependant variable is mainly explained by some basic variables as CA/GDP, SHORTDEBT/RES and M2/RES. Nevertheless, the Istanbul Stock Exchange index indicator ISE is not significant, whereas we observe a sharp fall on the Figure 6. So, the removal of that indicator from the analysis increases the robustness of the model.

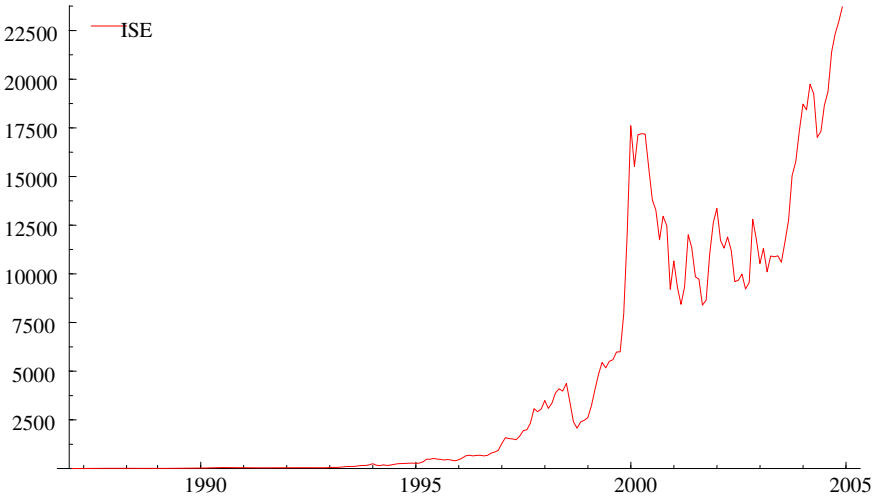


Figure 6: The Istanbul Stock Exchange Index

Our debt indicator SHORTDEBT/RES (short-term debt to international reserves) is also significant. This ratio that reaches more than 1.50 just before the crisis explains the important risk of a speculative attack and the increasing vulnerability of the country to a liquidity crisis.

However, the BUDG/GDP indicator, representing the net budgetary position of the country to the GDP, is not significant. It can be explained by implementation of the stabilization program at the beginning of 2000 which foresaw a restrictive budgetary policy in order to limit public expenditure and thus to decrease the inflation rate. Besides, the primary balance surplus reached approximately 6% at the end of the year 2000. Nonetheless, the PSBR/GDP indicator, which represents the public sector borrowing requirement to the GDP, is quite significant. That is due to the bailing out of the illiquid banks by the Treasury and the Central Bank of Turkey following the banking liquidity crisis of November 2000.

The M2/RES and CRED/GDP indicators, which represent the impact of monetary imbalance on the occurrence of the Turkish crisis, present an important aspect. The non-sterilization of the excessive capital inflows in the Turkish money market throughout the year 2000 by the monetary authorities involved a sharp rise of money supply and thus an increase of the domestic credit volume. The deterioration of the quality of the credit, which added to the loss of international reserves (struggle in order to maintain the parity of the fixed exchange rate), induced a negative effect on the crisis index. The explosion of credit also influenced in an indirect and negative way the disinflation policy by increasing domestic consumption and deteriorating trade balance. Because of that, this variable is one of the most influent on the crisis index in absolute value.

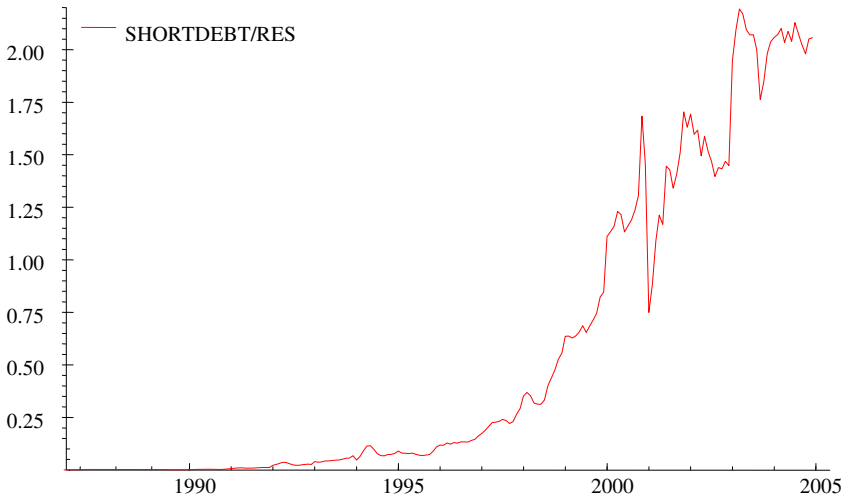


Figure 7: Short-term Debt to the International Reserves

The indicators OUVCOM (degree of opening to the international trade) and TOT (terms of trade) do not have a significant effect on the crisis index, which shows that the shock was not external, but internal due to the political instability and the fragility of the Turkish banking system.

As we show in Tables 5 and 6, all the indicators of the banking sector vulnerability, IBANK, BANKRES/BANKASSETS and BCCRED/BANKLIAB are significant. In particular the interbank interest rate which reaches more than 400% just before the crisis (see Figure 2) and the Central Bank credits to the banking system which records a sharp rise following the bailing out of the illiquid banks (see Figure 8) have a significant impact on the crisis index. The BANKRES/BANKASSETS indicator which shows the capital adequacy is also quite significant. The Turkish banking system which did not have an effective control mechanism until the establishment of the Banking Regulation and Supervision Agency in September 2000, did not respect the prudential ratios like the ratio Cooke.

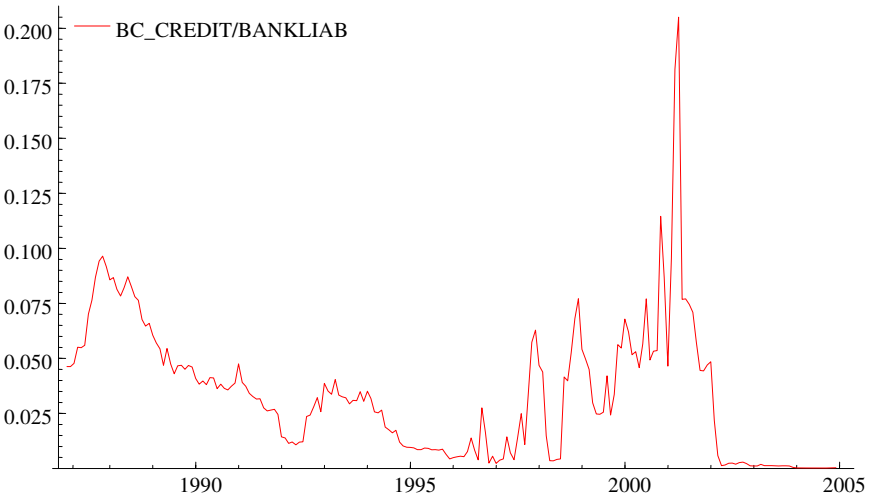


Figure 8: The Central Bank Credits in the Banks Liabilities

CONCLUSION

This paper aimed to examine the explanatory capacity of some variables to predict the 2000/2001 Turkish crisis. As we showed in the previous section, the models illustrate well the Turkish reality and the crisis periods. The variables seem also to be chosen in a satisfactory way. The 2000/2001 Turkish crisis was influenced especially by the banking sector fragility indicators and variables of the current and monetary imbalances.

We see that the characteristic of the 2000/2001 Turkish financial crisis is not only its violence but also its suddenness. We observe two rapid crisis sequences which are different from recent financial crisis examples where we could observe that the crisis countries did have peaks which remained in the crisis state (state 1) during several months; it was not valid for the Turkey which exited very fast from the crisis state. However, our analysis is a little biased by the IMF credit injections. It would be interesting to analyse the real impact of this crisis by withdrawing the IMF credits from the State's accounts. We can claim that the international lender of last resort fully functioned for the 2000/2001 Turkish crisis. Undoubtedly without IMF credits the negative effects of the crisis would be visible several months as we observed in the 2001 Argentinean crisis.

Why then did the crisis hit in February 2001 but not in another period? We explain it by the rumours of political instability that led to an excessive reaction of the operators and by the excessive risk taking of the banking sector. We thus claim that without the banking sector fragility, the 2001 Turkish crisis would never have occurred. In the Turkish financial crisis, the banking crisis and the currency crisis occurred

almost at the same time, with an interval of two months. The Turkish crisis is well a twin crisis a la Kaminsky and Reinhart where the banking crisis is followed by a currency crisis which, in its turn, deepened the banking crisis.

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