

Discussion Papers

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Berlin, February 2003



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[www.diw.de](http://www.diw.de)

ISSN 1619-4535

# Mis-Leading Indicators? The Argentinean Currency Crisis

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February 10, 2003

## **Abstract**

Despite the fact that Argentina has been suffering from recession for years the timing and severity of the recent currency crisis has surprised most observers. This paper analyzes whether the “early warning” or “signals” approach of Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999) could have predicted the Argentinean currency crisis at an earlier point in time. Using a broad set of indicators, it is shown that the forecasting quality of this approach was poor in the case of Argentina. (81 words)

*Keywords:* Currency Crisis, Early Warning Systems

*JEL classification:* F31, F47

# 1 Introduction

In economics as in medicine, prevention combined with early detection of emerging problems comprises the better part of the cure. In the case of economic crises, the question is whether these abnormalities can be detected soon enough to allow preemptive political measures.

One of the latest patients suffering from a far reaching currency crisis is Argentina. The collapse of the Argentinean peso in 2002 was followed by a deep economic recession, which then began to spread within Latin America. The new Argentinean crisis revived old debates about potential causes, symptoms and patterns of currency crises.

In general, economic theory proposes at least three answers to the question of how currency crises emerge. According to “first generation models” (Krugman (1979)) currency crises come about due to a run on the international reserves, as speculators understand that fiscal and monetary policy is inconsistent with the chosen pegged exchange rate. Thus, these models explain speculative attacks against a currency as a consequence of unsustainable developments in the “fundamentals” of an economy - such as rapidly growing budget deficits, high inflation, large and growing current account deficits, etc.

The “second generation models” of currency crises (Obstfeld (1986, 1996)) focus on expectations rather than on fundamentals and their developments. Unlike the first generation models, even

if fundamentals are not particularly unfavorable, a speculative attack may occur. The behavior of the domestic interest rate reflects the probability of a crisis. Since defending the exchange rate against an attack requires the authorities to raise interest rates relative to world levels, maintaining the fixed peg becomes costly for the policymakers. Thus, crises can be purely self-fulfilling events.

After the Asian crisis in 1997, a new generation of theoretical explanations evolved, linking currency crisis and financial sector fragility (Krugman (1998a,b), (1999) and Aghion, Bacchetta, Banerjee (2001)).<sup>1</sup> These models point out the role of financial intermediaries and asset prices concerning the emergence of a currency crisis.

In the case of the Argentinean crisis there is no consensus about the reasons for the emergence of the currency crisis- apart from the well-known and long-lasting foreign debt situation. According to Calvo, Izquierdo and Talvi (2002), the capital flow retrenchment after the Russian crisis of 1998 created a major real exchange rate misalignment and fiscal difficulties in Argentina. De la Torre, Levy Yeyati and Schmukler (2002) find that Argentina fell into a growth-debt trap after 1998. When economic activity did not increase and credit from abroad dried up, the crisis became unavoidable. Feldstein (2002) argues that the crisis was due to exchange rate overvaluation and to an extremely high amount of foreign debt. While we find numerous arguments for the potential emergence of a currency crisis in Argentina *ex post*, the concrete

timing of the Argentinean crisis was not predicted. It remains an open question whether the standard indicators gave hints for the evolution and timing of the currency crisis during the pre-crisis period.

To provide a substantial judgement concerning the usefulness of early warning indicators, our paper analyzes the economic development in Argentina between 1992 and 2002. We use the “early warning approach” developed by Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999). To our knowledge, an application of this analytical framework on Argentina does not exist at present. The “early-warning” system itself is based on “leading indicators” which are expected to send “signals” prior to a crisis. We show that in the case of Argentina these early warning indicators were widely misleading. Signals - if any - were sent very late. They came too late, for a crisis prevention, as effects of policy measures need time.

The remainder of the paper is organized as follows. Section 2 presents some stylized facts concerning the economic development in Argentina. In section 3, the signals approach developed by Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999) is briefly explained. Section 4 is a presentation of the findings obtained by using this methodology to explain the Argentinean crisis. Finally, section 5 concludes with a critical summary of the results.

## **2 Stylized facts - What went wrong in Argentina?**

In January 2002 the Argentinean currency board, which had started with overwhelming economic success (reflected in low inflation and high growth rates), came to a sudden, harsh and dramatic end. The time of a 1:1 peg between the US-dollar and the Argentinean peso was over and the peso depreciated dramatically.

The major aim of a currency board is to import price stability - in the case of Argentina from the USA. The introduction of such a fixed exchange rate regime is expected to make foreign investment more attractive and thus promote growth. However, the introduction of a currency board leads to the total abandonment of sovereign domestic monetary policy. Consequently, if such an exchange rate regime is to be sustainable, it requires not only the convergence of inflation rates between the developing country and the anchor-currency country, but also major institutional adjustments, especially within the financial sector. It also requires a strong fiscal discipline.

Indeed, after the introduction of the currency board in Argentina, growth rates increased tremendously; for the years 1991-1998 the gross domestic product increased on average around 5.8 percent (figure 1). Thus, Argentina outperformed most other countries in the region in terms of per capita growth until 1998. During the same period, inflation went down and remained be-

low one percent (figure 2). Furthermore, inflation in Argentina dropped below US rates; in real terms the Argentinean peso started to depreciate against the US-dollar (figure 3). Foreign direct investment into the Argentinean economy also increased enormously. However, a certain crowding out effect was observed against domestic investment activities: the investment ratio (around 19 percent) remained relatively stable over time.

The current account balance was negative during the whole period under consideration (figure 4). However, in comparison to other emerging economies its share of GDP remained low. Measured by traditional indicators, such as the share of exports to GDP, Argentina continued to be a relatively closed economy. While Argentina's exports were relatively low, the external debt was huge (figure 5). The first years of the currency board were accompanied by a relatively low budget deficit (figure 6).

### **Insert Figure 1 to 6 about here**

The initial macroeconomic difficulties occurred in the aftermath of the Mexican crisis of December 1994, but the Argentinean economy recovered relatively quickly; in 1996 positive growth rates were reported again.<sup>2</sup> After the Asian (1997) and Russian (1998) crises and the devaluation of the Brazilian real (1999) however, the Argentinean strategy for growth became more and more costly. Argentina was drawn into the swirls of the changing climate on the international financial markets. Argentinean policy makers faced a dilemma: an increase in interest rates was necessary to



make the country attractive for international investors. However, higher domestic interest rates lead to a profit squeeze and make any economic recovery more unlikely. Additionally, the appreciation of the US-dollar made the chosen exchange rate policy even more challenging, since Argentina began to lose competitiveness vis-à-vis its principal trade partners.

From 1999 onwards GDP decreased continually. But even though the economic weakness became more and more evident, many of the typical pre-currency crisis symptoms did not occur. Usually one of the main indicators of a currency crisis is a sizable current account deficit. The current account deficit in Argentina, in contrast, decreased since 1999. Furthermore, Argentina was suffering from deflation and the peso was depreciating in real terms against the US dollar. However, international debt measured in percent of exports remained very high (around 500 percent); possibly indicating the economy's vulnerability. In such an unclear setting, where some important crisis indicators might show the danger of the emergence of a currency crisis, but others don't, analytical approaches to evaluate the current situation are important.

### **3 The Signals Approach**

In this section, the "signals" approach developed by Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart

(1999) is described. They propose a specific early warning system for predicting currency crises. This warning system involves a range of macroeconomic and financial indicators that tend to exhibit an anomalous behavior in the periods preceding a currency crisis. Every time that an indicator deviates from its “normal” level beyond a determined critical threshold value, it is interpreted as issuing a warning signal about a possible currency crisis within the crisis window. This crisis window is set at 24 months, which means that within this period the indicators should be able to anticipate crises. Before describing the signals approach further, some terms have to be defined.

### **Identifying Crises**

A currency crisis is defined as a situation in which a currency gets under enormous pressure, leading either to a sharp depreciation and/or to a strong drop in international reserves. According to the existing literature, an “exchange market pressure index” is constructed, to identify currency crises. This index is usually calculated as a weighted average of monthly changes in exchange rates and international reserves.<sup>3</sup> Crises are then said to occur when the pressure index reaches “extreme” values. However, a major drawback of this approach is that the weights, as well as the threshold value used to identify the speculative attack, are somewhat arbitrary. To demonstrate, Kaminsky et. al. (1998) define crises as periods in which the exchange market pressure in-

dex is at least three standard deviations above the mean, while in Edison (2000), a crisis is called as soon as the index is above its mean by more than 2.5 standard deviations. However, the advantage of constructing this index is that both successful and unsuccessful attacks on a currency can be detected.

### **Choice of indicator variables**

In their studies, Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999) use the following variables as leading indicators:

- *Capital account indicators*: international reserves, ratio of broad money to gross international reserves, real interest differential, real interest rate of the USA, foreign debt, capital flight, short-term foreign debt.
- *Current account indicators*: exports, imports, terms of trade, real exchange rate.
- *Financial sector indicators*: stock of commercial bank deposits, ratio of domestic credit to GDP, money multiplier of M2, excess real M1 balances.
- *Real sector indicators*: an index of output, domestic real interest rate, ratio of lending to deposit rate, an index of equity prices.

Most of the variables (with the exception of interest rates, the “excess” of real M1 balances and the real exchange rate) are twelve-

month growth rates.<sup>4</sup>

### **Threshold values**

An indicator is interpreted as issuing a warning signal whenever it deviates from its “normal” level beyond a determined critical threshold value. The threshold values are set so as to maximize the signaling performance of each indicator. Thus, noise to signal ratios, defined as the ratio of bad signals to good signals, are estimated for a range of potential threshold values. “Bad” signals are those not followed by a crisis within the crisis window, while a signal followed by crisis is called a “good” signal. The value that minimizes the ratio of bad to good signals becomes the threshold chosen for that variable. However, it should be noted that the thresholds are defined in relation to percentiles of the frequency distribution of each indicator.

### **The signals of the leading indicators**

After having determined the optimal thresholds, the fragility of the economy can be analyzed by combining the information provided by all indicators. First of all, Kaminsky (1998) calculates the “index of fragility”. This index is calculated for each month by counting the number of indicators having crossed the threshold value in that month or in the eight preceding months.

Naturally, a desirable feature of the index of fragility is that the number of signals does not increase only in the months immedi-

ately preceding the crisis, as in that case an anomalous behavior of the indicators could not be detected sufficiently in advance to allow preemptive measures. Thus, the evolution of the index of fragility as the country approaches a crisis is examined.

However, by only counting the number of signals being issued, important information about the country's fragility may be lost. Therefore the following composite indicators, described in Kaminsky (1998), should be considered.<sup>5</sup>

The first of these indicators gives an idea about the strength of the signals. Signals are therefore classified into extreme and normal signals. In order to distinguish between them, a second threshold must be introduced. If an indicator crosses this second threshold, it is considered as issuing an extreme signal. The second threshold is defined as the half of the percentile of the frequency distribution, which corresponds to the first threshold. To demonstrate, if the critical region of the rate of growth of exports is 10 percent, it will be regarded as issuing an extrem signal when it lies in the 5th percentile of the distribution. Whereas it will be considered as issuing a mild signal when it falls in the interval between the 5th and the 10th percentile of the distribution.<sup>6</sup> The extreme signals enter into the first composite indicator double weighted and the mild signals, single weighted:

$$I_t^1 = \sum_{j=1}^n (MS_t^j + 2ES_t^j) \quad (1)$$

A second composite indicator considers the ongoing deterioration

in the fundamentals of an economy and is defined as follows:

$$I_t^2 = \sum_{j=1}^n S_{t-8,t}^j \quad (2)$$

where  $S_{t-8,t}^j$  is one if the variable  $j$  crosses the threshold value in  $t$  or in the previous eight periods, and zero otherwise.

The third composite indicator considers the different forecasting accuracy of each variable and weights signals more heavily when issued by indicators that already proved to have more reliable forecasting performance. In particular, the weights are given by the inverse noise-to-signal ratio. Thus, this composite indicator is defined as the sum of “weighted” signals being issued by each indicator in every month:

$$I_t^3 = \sum_{j=1}^n S_t^j / \delta^j \quad (3)$$

whereby  $S_t^j$  is one if the variable  $j$  crosses the threshold value in  $t$  and zero otherwise and  $\delta^j$  is the noise to signal ratio of the indicator  $j$ .

After having constructed these composite indicators, it is possible to calculate the conditional probabilities of a crisis. Following Kaminsky (1998) and Edison (2000) these probabilities are calculated as follows:

$$P(\text{crisis}_{t,t+24} | I_l \leq I_t < I_u) = \frac{\sum M^C \text{ with } I_l \leq I_t < I_u}{\sum M \text{ with } I_l \leq I_t < I_u}$$

where  $P$  is the probability,  $M$  stands for months and  $M^C$  for months which are followed by a crisis within 24 months.  $\text{Crisis}_{t,t+24}$

is the occurrence of a crisis within 24 months, given that the composite indicator  $I_t$  falls within the upper ( $I_u$ ) and the lower ( $I_l$ ) boundary.

## 4 Empirical results

In the following, we present empirical results obtained by using the signals approach just described for analyzing Argentina's vulnerability. The period under consideration runs from January 1992 to January 2002.<sup>7</sup> With the exception of the data for external debt, which are provided by the Ministry of Finance, all data are taken from the International Financial Statistics of the IMF. Monthly data are employed.

Our first step is to identify crises during this period. For this purpose, we construct an index of exchange market pressure (EMP) as a weighted average of monthly exchange rate changes ( $\Delta e$ ) and international reserve changes ( $\Delta R$ ):

$$EMP \equiv \eta(\Delta e) - \psi(\Delta R) \quad (4)$$

with  $\eta$  and  $\psi$  as weights.<sup>8</sup> Crises are then said to occur when the pressure index is at least 2 standard deviations above its mean.<sup>9</sup>

Using this index, only one crisis is identified: In January 2002 the pressure on the exchange rate became extremely high. Indeed, in January 2002 the currency board had to be abandoned and within a few days the Argentinean peso lost much of its value. Argentina was confronted with a far-reaching currency crisis.<sup>10</sup>

Could the indicators used by Kaminsky (1998), Kaminsky/ Lizondo/ Reinhart (1998) and Kaminsky/Reinhart (1999) have detected this currency crisis at its outset? To answer this question, we first construct the set of indicators discussed in the previous chapter. However, due to the lack of data, “excess real M1 balances”, “capital flight”, “short term foreign debt” , “terms of trade” and “the index of equity” cannot be considered for Argentina. The sample period runs from January 1992 to December 2001 - directly before the outbreak of the currency crisis. The frequency of the data is monthly.<sup>11</sup> According to Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999), the “crisis window” is set at 24 months.

Finally, the threshold values for the indicators have to be defined. We took these threshold values from Kaminsky and Reinhart (1999) and applied them to the distribution of the Argentinean indicators. Thus, if the optimal threshold for the rate of growth of exports is given as the 10th percentile in Kaminsky and Reinhart (1999), we have to determine the value of exports at the 10th percentile of its distribution for Argentina.

Did the indicators send any signals during the Argentinean pre-crisis period? If so, when did they start to send these signals? Was it early enough to prevent the emergence of a currency crisis by policy measures? Considering the 24 month crisis window, we see that two years prior to the crisis only one indicator was sending a warning signal: the output indicator. Hence, this time



can be considered as relatively tranquil. Eight months prior to the crisis, the picture looks only slightly different. At that time, five out of 14 signals were sending warning signals: the ratio of M2 to reserves, the reserves, the ratio of lending to deposit rate, the Argentinean real interest rate on deposits and the real interest differential between the Argentinean and the US-American interest rate. The output indicator had stopped sending signals. However, in the case of Argentina, history has shown that periods in which five of the given indicators were sending signals did not necessarily lead to a currency crisis. Even during tranquil times, there have been periods in which five indicators were sending signals.

It was only four months prior to the crisis when the number of signals increased dramatically. Nevertheless, it is extremely difficult to prevent currency crises within such a short period, as it takes time to put policy decisions into effect. To our surprise, in the month immediately before the crisis, the number of signals being issued actually decreased. Hence, the forecasting quality of this simple signal approach seems to be relatively low in the case of Argentina.

Calculating the “index of fragility” as Kaminsky (1998) has done leads to nearly the same result. Figure 8 shows the distribution of this index in times of crisis and in tranquil times. The mean number of signals being issued during the Argentinean pre-crisis period is only 23 percent higher than the mean number of signals in tranquil times. This finding is in contrast to the results pre-

sented by Kaminsky (1998), who analyzed a set of crisis countries and showed that the number of indicators sending signals during pre-crisis times is 70 percent higher than in non-crisis periods. Furthermore, the evolution of the index of fragility is illustrated in Figure 9. The number of signals decreases during the whole year 2000, suggesting a relaxation in the economic environment. Thus, the index of fragility does not appear to be a particularly good indicator for the Argentinean crisis.

**Insert Figure 8 to 9 about here**

In order to obtain more reliable information concerning the vulnerability of the Argentinean economy, the next step is to calculate the composite indicators. The first composite indicator makes it possible to take into account the severity of signals being issued by individual indicators (see Figure 10). However, at a glance, this indicator does not provide substantial information since the number of indicators sending signals increased only a few months prior to the crisis. Even more surprisingly, the indicators did not send more signals than in tranquil times, seven months before the crisis erupted. Again the trend of the indicator is not clear; only one month prior to the crisis, the indicator sends less signals than before.

The performance of the second composite indicator is even worse, as this indicator takes the highest values during non-crisis times (see Figure 11). According to this indicator, a crisis in Argentina was to be expected between 1995 and 1996. Like the other compos-

ite indicator, the second composite indicator starts sending more signals only a few months before the crisis.

Figure 12 shows the evolution of the third composite indicator. While it reflects the beginning of a potential crisis slightly earlier than the indicators mentioned above, it also begins to decrease only one month before the currency board had to be abandoned.

**Insert Figure 10 to 12 about here**

Using the composite indicators, it is possible to calculate the conditional probabilities of a currency crisis. Table 1 reports these probabilities associated with different values of the composite indicators. It should be noted that for a certain range of values there is an inverse relationship between the value of the composite indicators and the conditional probabilities. Only for a small range of values do the composite indicators suggest a rising probability of crisis as the indicator increases. It is particularly strange that in the case of the first composite indicator, the second highest conditional probability of a crisis is the one with the indicator taking the value zero. While in the case of the second composite indicator the probability of a crisis is the lowest one for this indicator taking the value 8 or higher. A possible explanation for this finding is that, as already mentioned, the indicators often issued signals without being followed by crises.

In summary, the fragility index as well as the different composite indicators do not appropriately reflect the tensions within the Argentinean economic system. The indicators started to send their

signals very late - too late to make a successful policy intervention possible. Furthermore, during the immediate pre-crisis period the power of explanation even decreased; the trend of many indicators is unclear and the development of the composite indicators in particular could be interpreted as the beginning of a relaxing process. Consequently, concerning the Argentinean crisis of 2002, Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999) indicators seem to be misleading on the whole.

## 5 Conclusions

After the emergence of the Argentinean currency crisis (2002) a magnitude of questions opened up. When did the ambitious currency board start to become unreliable? What was the initial spark that set off the crisis? Was there nothing that could have been done to prevent this disaster? What message were standard economic indicators giving during the pre-crisis period?

This paper analyzed the pre-crisis period in Argentina employing the “early warning system” developed by Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999). We found that this early warning system, which is based on a broad set of indicators, did not give enough indications for the emergence of a currency crisis. Neither the different indicators nor the fragility index was able to predict a currency crisis in the

given 24 month crisis window. Furthermore, some indicators even sent misleading information, especially during the immediate pre-crisis period. In addition, warning signals were sent very late - too late for any sufficient policy intervention.

Kaminsky (1998), Kaminsky/Lizondo/Reinhart (1998) and Kaminsky/Reinhart (1999) have shown that their indicators operated sufficiently in the case of many currency crises in many emerging economies. Why is Argentina different? To answer this question, further research is necessary. This should focus at least on two issues: First, expectations might have played a major role in the case of Argentina. Since the early warning system approach does not explicitly consider changes in expectations, the explanatory power of other methods might be more helpful. Second, other than macroeconomic factors, e.g. political turbulence and corruption, might be important to explain the crisis in Argentina.

## Notes

<sup>1</sup>In view of these models, “banking crises” are related to currency crises via a fragile financial sector within which both types of crises occur.

<sup>2</sup>In 1995 the authorities recognized the importance of a particularly resilient financial system and banking system reforms were introduced quickly.

<sup>3</sup>Eichengreen, Rose and Wyplosz (1994) also include the interest rate in the index of exchange market pressure, since the government can also boost the interest rate to defend the currency.

<sup>4</sup>In our study we apply this set of indicators with the exception of “excess real M1 balances”, “capital flight”, “short term foreign debt”, “terms of trade” and “the index of equity”. This is due to the lack of data.

<sup>5</sup>Composite indicators have been constructed in various studies, including Kaminsky (1998), Edison (2000) and Brüggeman and Linne(2002).

<sup>6</sup>If the critical region of the rate of growth of imports is 10 percent, the first indicator will be regarded as issuing an extrem signal when it lies in the 95th percentile of distribution, while it will be considered as issuing a mild signal when it falls in the interval between the 90th and the 95th percentile of the distribution.

<sup>7</sup>However, for a few indicators the period under consideration starts some months later. This is due to problems of data availability, but does not touch our results.

<sup>8</sup>The weights are calculated as the inverse of the series’ standard deviation in the past.

<sup>9</sup>We examined whether or not the results change if crises are defined as periods in which the index is at least 2.5 or 3 standard deviations above the mean. The results remain the same, however.

<sup>10</sup>To obtain an understanding of how the speculative pressure index works, see Figure 7, which displays this index for Argentina.

<sup>11</sup>Monthly rates for external debt and GDP are generated by interpolation from quarterly data. The variables (with the exception of interest rates and

the real exchange rate) are 12-month growth rates.

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Figure 1

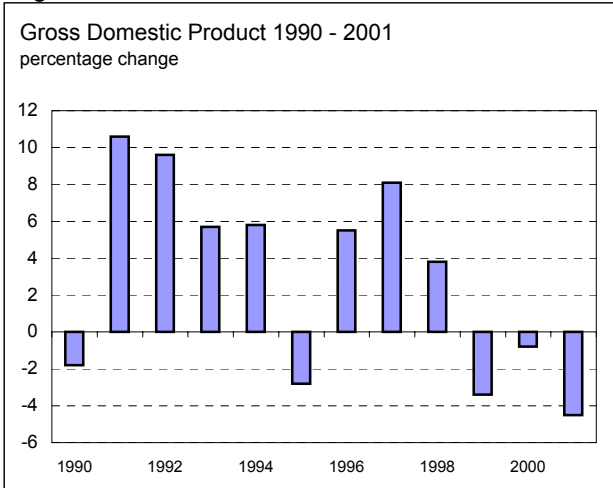


Figure 2

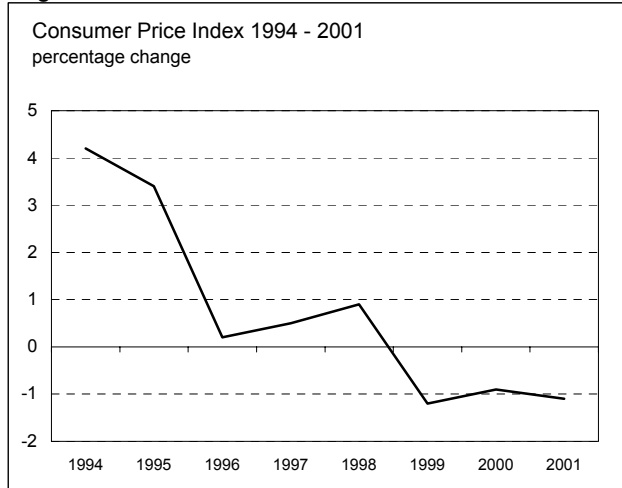


Figure 3

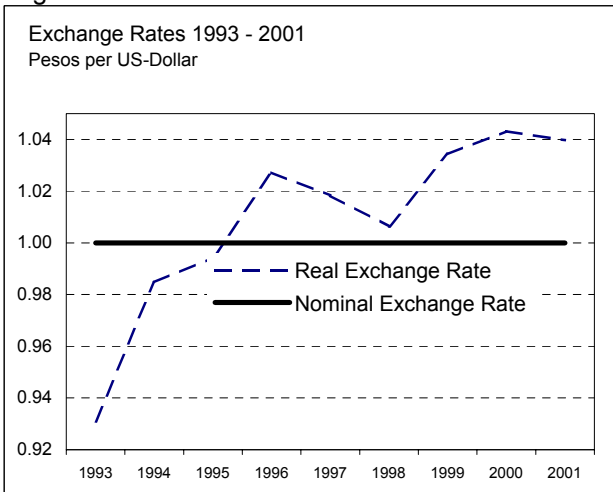


Figure 4

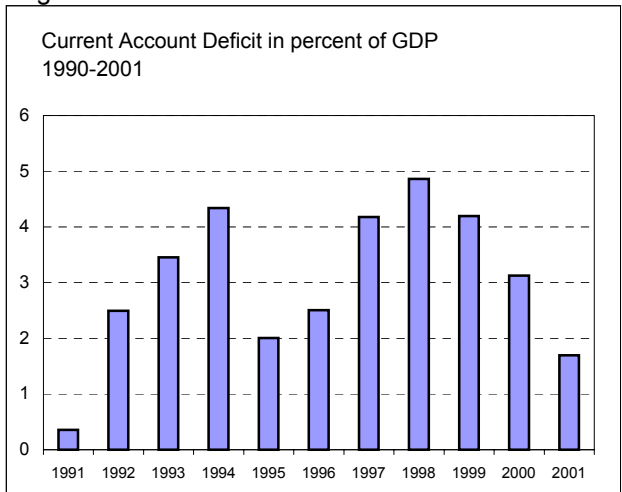


Figure 5

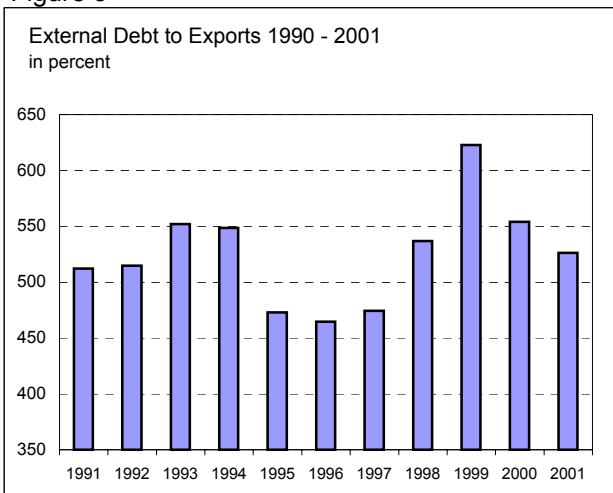


Figure 6

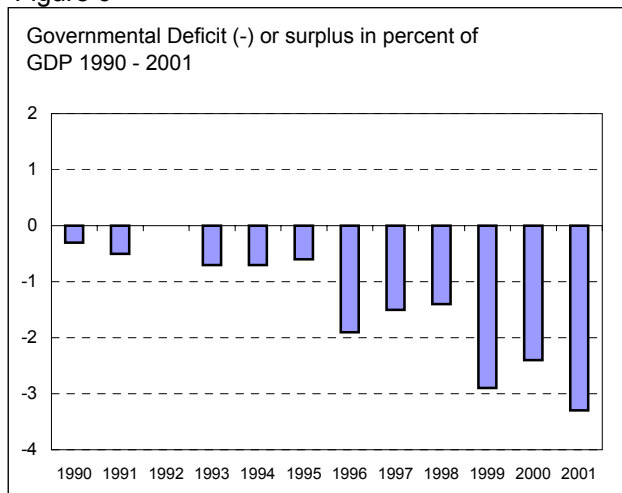


Figure 7

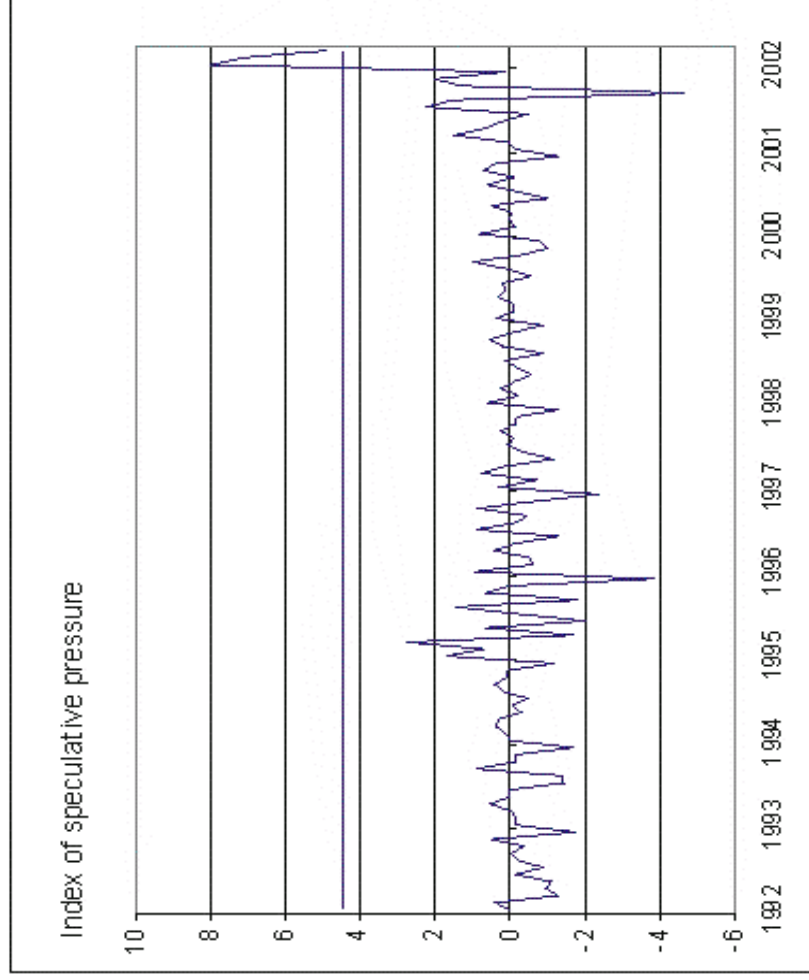


Figure 8

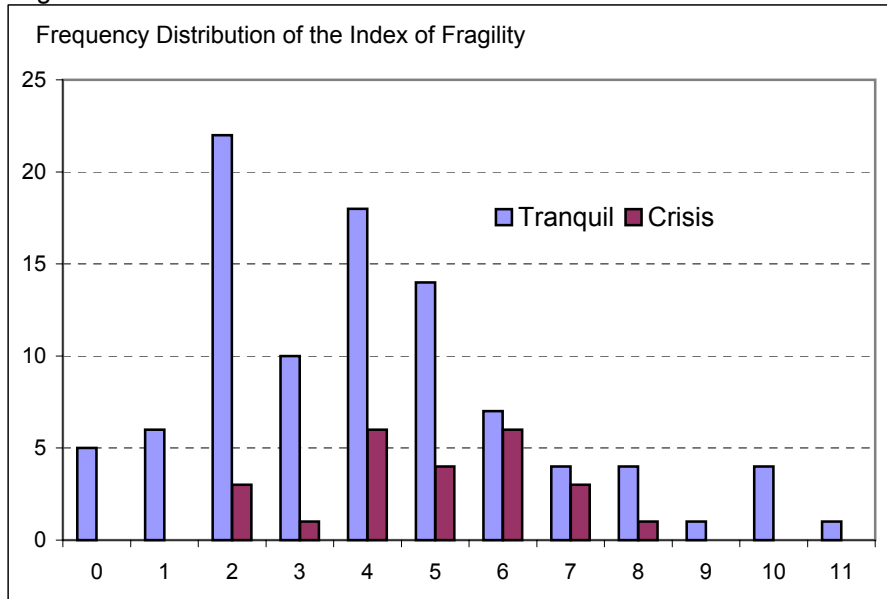


Figure 9

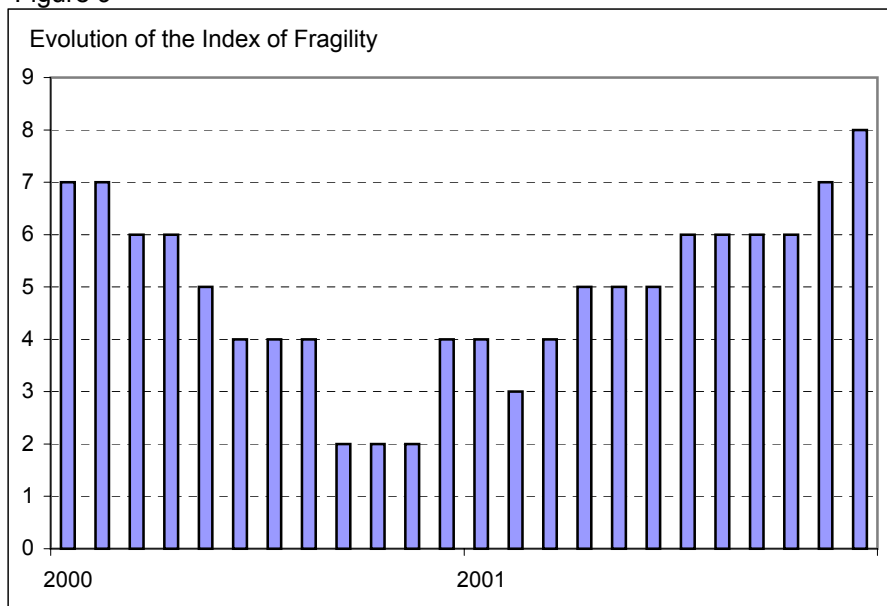


Figure 10

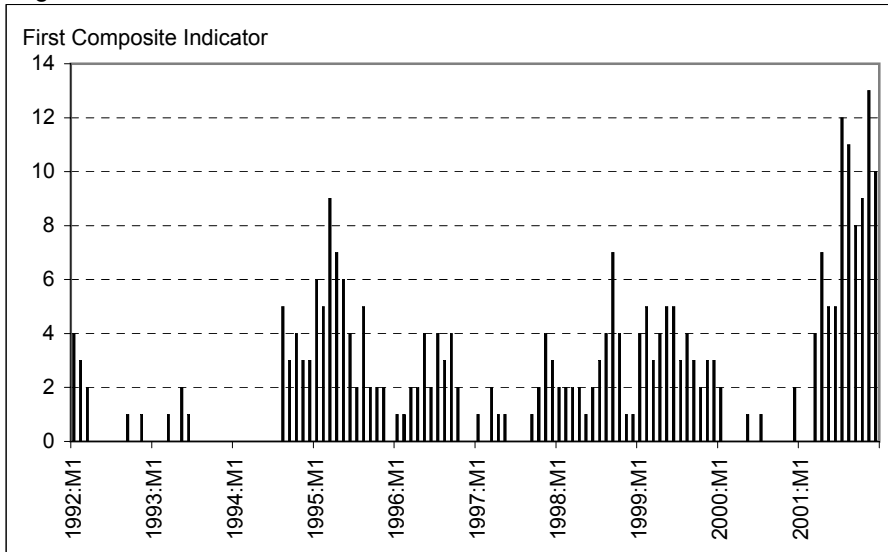


Figure 11

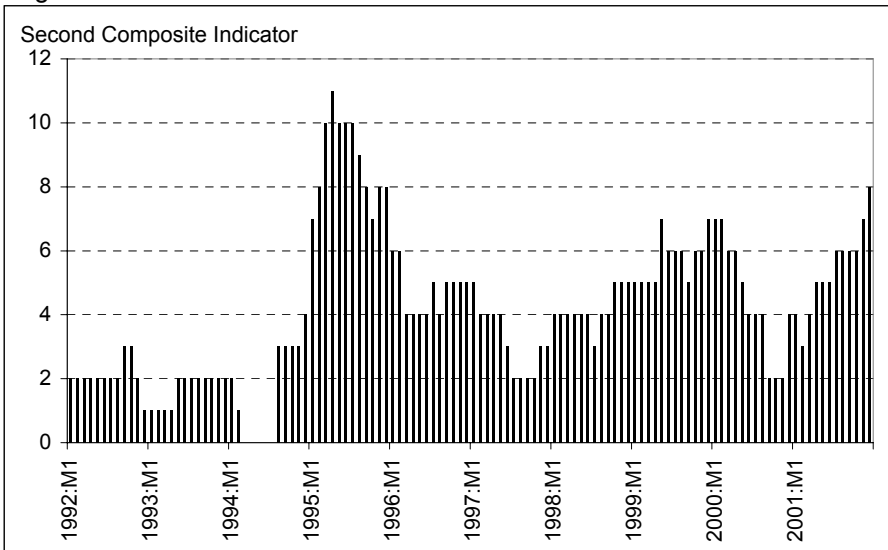


Figure 12

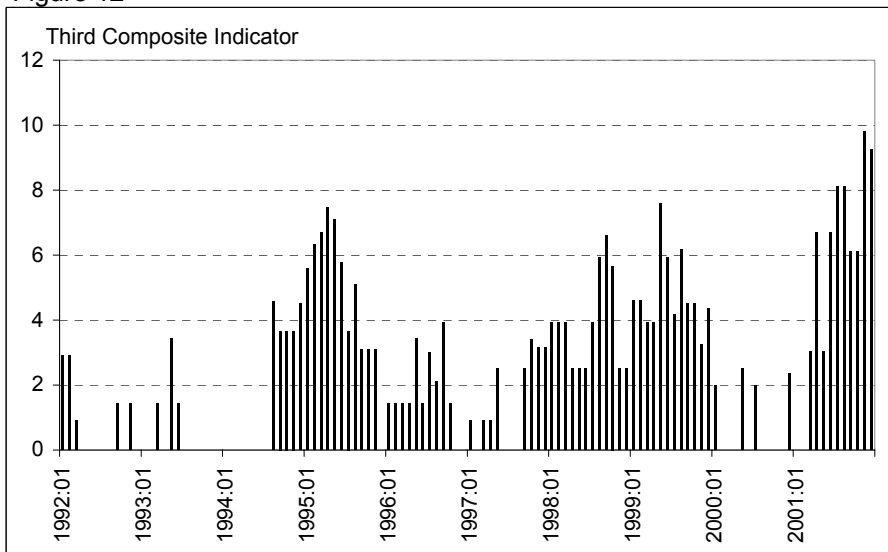
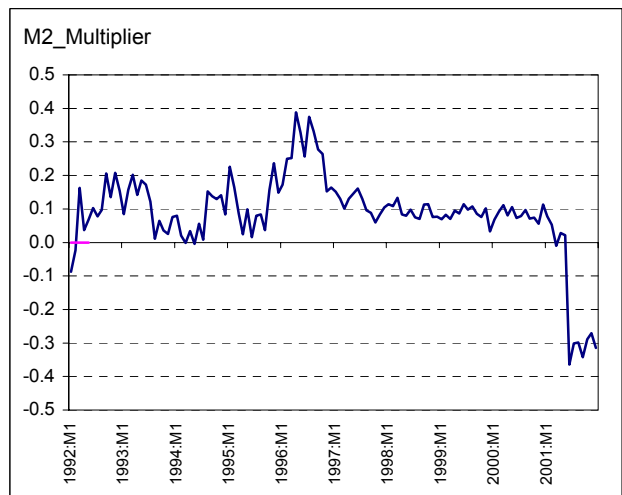
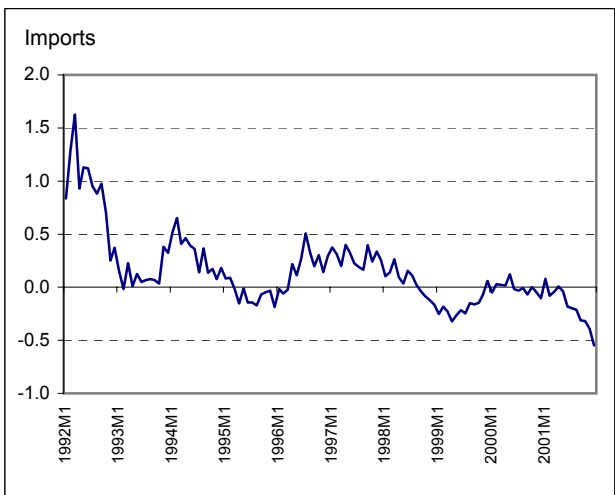
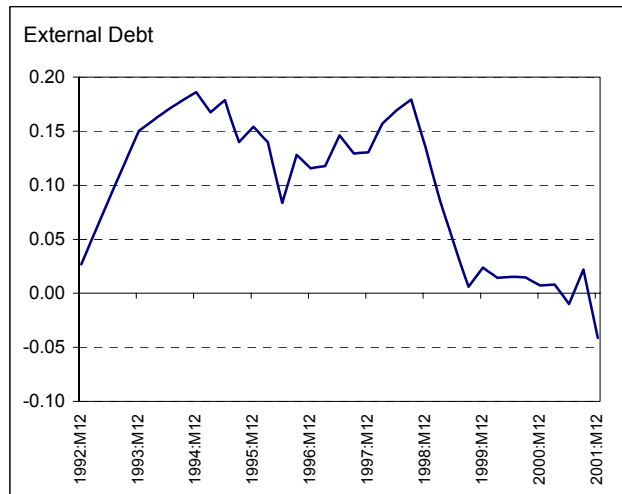
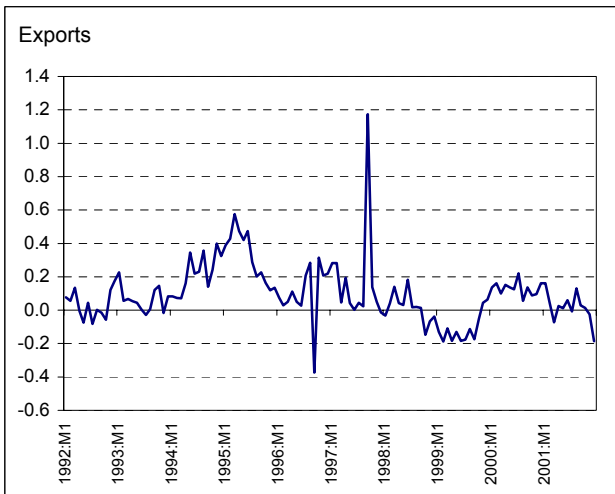
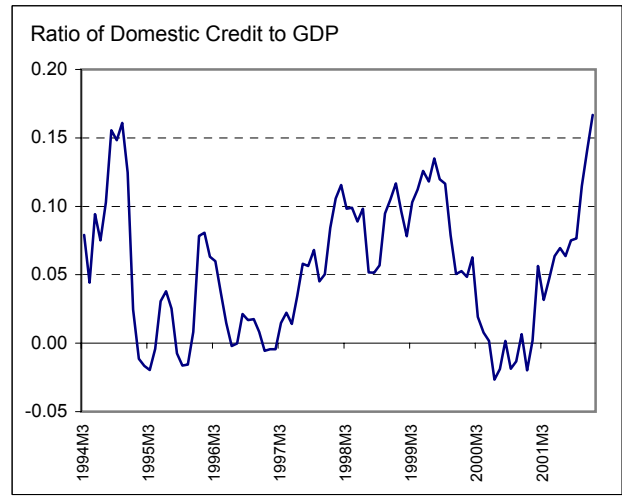
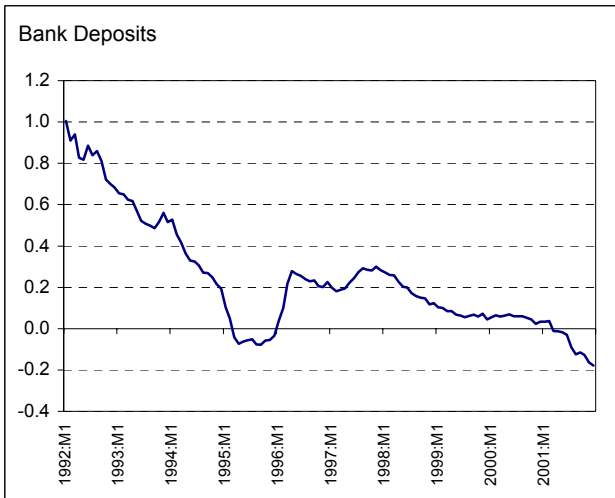
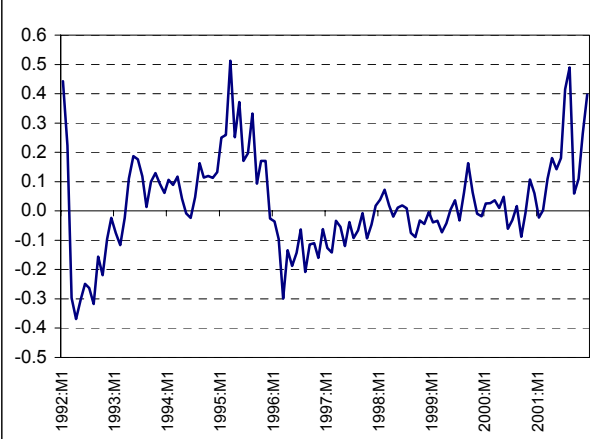


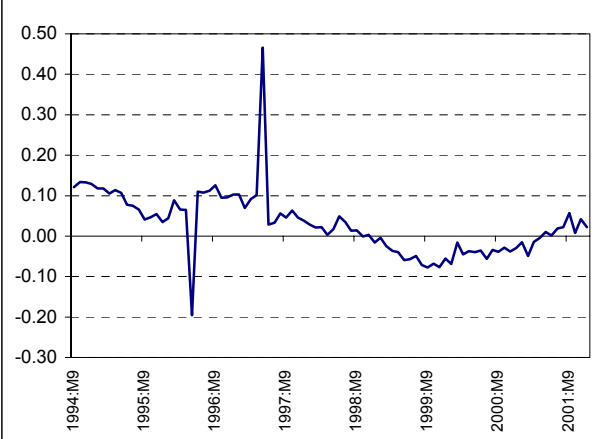
Figure 13  
Indicators (12-month-percentage change)



Ratio of M2 to Reserves



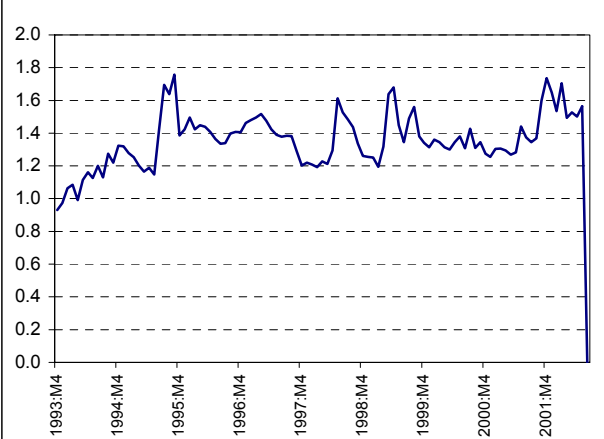
Output



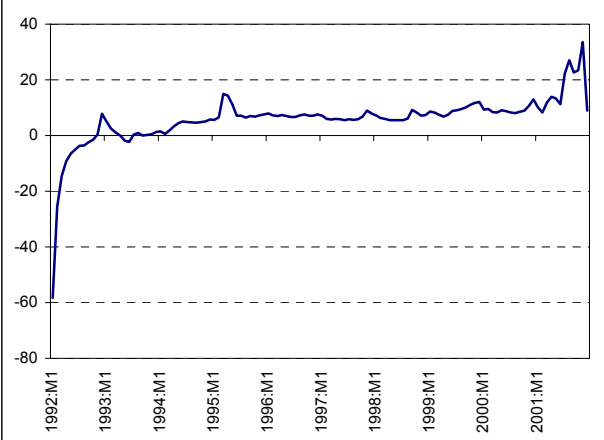
Reserves



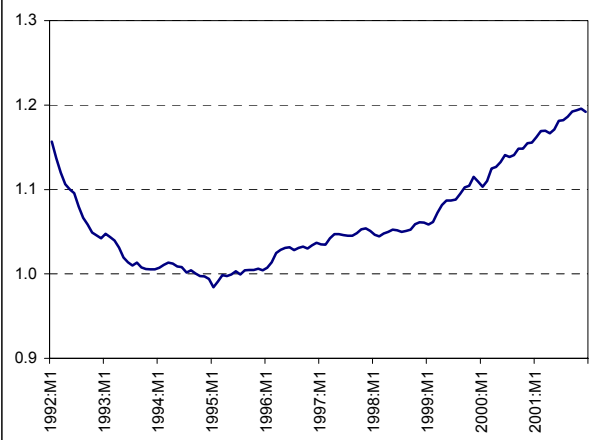
Ratio of Lending to Deposit Rate



Real Interest Rate

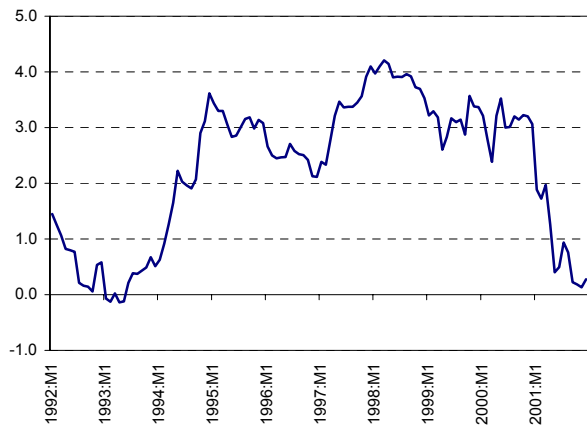


Real Exchange Rate





Real Interest Rate USA



Real Interest Differential

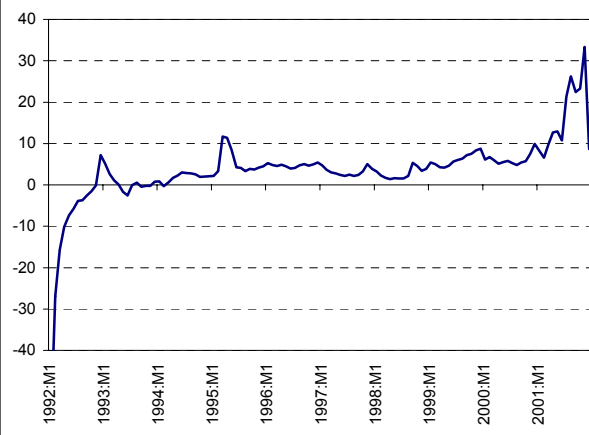


Table 1: Conditional Probabilities of the Currency Crisis

| Value of the composite indicators | Probability of a Crisis   |                            |                           |
|-----------------------------------|---------------------------|----------------------------|---------------------------|
|                                   | First Composite Indicator | Second Composite Indicator | Third Composite Indicator |
| 0-1                               | 0.25                      | 0.00                       | 0.23                      |
| 1-2                               | 0.13                      | 0.00                       | 0.00                      |
| 2-4                               | 0.06                      | 0.11                       | 0.16                      |
| 4-6                               | 0.14                      | 0.24                       | 0.00                      |
| 6-8                               | 0.20                      | 0.45                       | 0.36                      |
| > 8                               | 0.86                      | 0.09                       | 1.00                      |