MEASURING AND PREDICTING CURRENCY DISTURBANCES IN CROATIA: THE "SIGNALS" APPROACH*

Amina Ahec-Šonje** and Ante Babić***

Abstract

This paper examines the two currency disturbances that took place in Croatia, one at the beginning of 1999 and the other in the summer of 2001. The "signals" approach is used in constructing an effective system of early warning indicators heralding currency disturbances. This system monitors the behavior of various macroeconomic and financial variables that tend to exhibit an unusual behavior in the periods preceding a disturbance or crisis. The paper also proposes composite leading indicators comprising the best signal indicators. The performance of the indicators reveals that the two disturbances were different: the 1999 one came at the end of a banking crisis, while the 2001 disturbance was brought about by a combination of the domestic monetary relaxation and partial capital account liberalization. Since Croatia signed a Stabilization and Association Agreement with the EU that foresees further capital account liberalization, this system of early warning indicators can help the Croatian National Bank and other relevant policymakers along the way.

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** *Amina Ahec-Šonje, Institute of Economics, Zagreb.*

*** *Ante Babić, Croatian National Bank and Institute of Economics, Zagreb.*

1
INTRODUCTION

The overall financial flows in the international financial markets have accelerated enormously throughout 1990s, due to greater globalization, liberalization, interconnectedness of those financial markets, and quick development of information and telecommunications technologies. A rapid globalization process has put increasing limitations on national economic policies, especially in small open countries such as Croatia.

The Republic of Croatia embarked on a process of transition from a very liberal socialistic economic system (so-called "market socialism") towards a free market economy as soon as it declared independence in 1991. The process of transition, prolonged by a Serbo-Yugoslav aggression and war for independence, reached the trough around 1995, and has been accelerating since 2001. In that context, the EU recognized Croatian efforts in pursuing market reforms and finalized the talks on the Stability and Accession Agreement (SAA) with Croatia in 2001. Under the SAA, Croatia has to liberalize its capital account in the course of four years following the ratification of the SAA by the two parties to the agreement. The capital account liberalization, whereas globalization is already overwhelming, is likely to put more pressure on the policymaking in Croatia in the coming years until it eventually enters the EU - which represents the final goal on the road paved by the signing of the SAA.

The Croatian National Bank (CNB) gained its monetary independence by the end of 1991 without any international reserves (because they had been held by the National Bank of Yugoslavia before 1991, and were not transferred to the CNB afterwards). The financial system was underdeveloped at the beginning of 1990s - it comprised some 20 commercial banks and a few insurance companies, which had operated for 20-30 years under socialism. Banks inherited unindexed loan portfolios to the real sector, which had over time become bad loans and lost their real value. The old banks were re-capitalized through government bonds (so called "big bonds"), and new banks began to emerge due to very liberal census requirements.

On October 4th, 1993 the government of Croatia launched a successful anti-inflationary program. The aim of the program was to reduce inflation with the help of heterodox measures, using three nominal anchors: the exchange rate to the German mark, gross wages and salaries in the

government sector and the central bank discount rate.[1] The program almost immediately brought a halt to price rises, even causing deflation in the last two months of 1993, while it curbed inflation in 1994 to just 3.7 percent annually - among the lowest rates in transition countries. Croatia managed to keep inflation in the range of 3-5 percent in subsequent years. The overview of the Croatian macroeconomic indicators for 1991-2000 can be found in Table 1 in the Appendix I.

The exchange rate was allowed to float, and CNB introduced a new procedure of determining its official exchange rate: as an average of the exchange rates used in interbank trade among commercial banks for two previous days, thus reflecting market moves.

Thanks to a halt of hyperinflation and internal convertibility, as well as a restrictive monetary policy in 1994[2], the exchange rate was also kept stable (it appreciated 5-7 percent by 1996). The CNB did not intervene much to keep it stable, since Croatia had no access to the international financial markets until 1995/96. That was because it had not yet solved the issue of its share of the ex-Yugoslav debt by then.

Reconstruction began in 1995, led by government programs financed abroad - since credit rates in Croatia were at that point 10-15 percentage points higher than in Europe. Fiscal expansion soon resulted in accelerated growth of the external debt. Increased public expenditure was accompanied by rising personal consumption. All those developments resulted in the current account deficit (reaching as high as 11 percent of the GDP), as well as accumulation of foreign debt and appreciation pressures on the currency (the inflow part of the debt cycle).

Consumption was helped by banks, which started to extend more consumer and industrial loans. Some of the small and medium-sized banks offered double-digit interest rates on deposits in order to attract funds from households and give them away in the form of credits - and domestic credits grew 20 percent in 1997 and 1998. Since the CNB bank supervision was not formed until 1995, it was still in the process of training in 1997 and 1998 and was inexperienced and unable to cope with such a huge rise of credit activity or vulnerability of the banking sector. The end of 1998 saw some signs of the economic slowdown and credit defaults, while 10 fastest-growing small and medium-sized banks collapsed. Their vulnerability was emphasized through connected enterprises (group structure) that went bankrupt at the same time. As a result, bankruptcies were instigated at 16

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[1] *Anušić, Rohatinski and Šonje (1995).*

[2] *Babić (1998).*

small and medium-sized banks and led to their liquidation, which reduced the number of banks to 45 by the end of 2000.

The banking crisis eroded public trust in the banking sector and also eroded newly gained confidence in the local currency. The kuna depreciated almost 10 percent against the German mark at the beginning of 1999. Its depreciation was helped by the fact that the grace period for rescheduled Paris and London club (in 1995/96) debts expired, and the annual foreign debt service quota rose to more than 1 billion US dollars. From 1999, scheduled debt repayments stood at between 1 and 2 billion US dollars, causing pressure toward currency depreciation (the outflow part of the debt cycle). The depreciation was halted, however, through the CNB foreign exchange interventions.

Since confidence in the banking sector was restored (thanks also to a sale of the biggest banks to foreign strategic partners that increased foreign ownership to close to 90 percent of banking assets), deposits started flowing back into banks through 2000. The CNB launched a process of financial liberalization by cutting the mandatory reserve ratio for banks from 40 percent toward 15 percent in stages. Also at the beginning of 2001, it revised foreign exchange regulations allowing enterprises to operate their foreign exchange balances freely. The impact of the monetary relaxation on kuna liquidity helped bring domestic money market rates down to below European levels in mid-2001, and banks began to build up their foreign currency position. Amplified by first forward deals between banks and enterprises and speculative moves by some banks, these developments led to a sharp depreciation of the kuna by 5 percent to the German mark. The situation was brought under control by the most intense foreign exchange intervention of The Croatian National Bank since its independence.

The liberalization of some capital account transactions in 2001 brought about high volatility of the exchange rate, and heightened both the foreign exchange market and exchange rate vulnerability. Croatia still has to open its primary and secondary long-term securities and money markets to foreign (European) investors as part of the SAA obligations in the coming years. It means that the volatility of the exchange rate and the vulnerability of the kuna are poised to increase further. Therefore, in this paper we will try to develop a system of signaling indicators of currency crises for Croatia. We will be following the existent literature on the signal approach to predicting currency disturbances and implementing it with respect to Croatia. The application of the "signals" approach in transition countries is rare, to our knowledge, and this also will be a first attempt to implement signal approach to Croatia for 1995-2001 period.

2
BACKGROUND

Revival of the interest in the literature on financial crises came in the 1990s as costly financial crises struck both developed and developing countries.[3] A number of studies theoretically and empirically, found various causes of crises and thus enabled classifying the crisis episodes into three categories.[4]

The first generation models tried to explain currency and debt crisis episodes of the Latin-American developing countries in the late 1970s and early 1980s. The basic premise in those *traditional* models is the inconsistency with which the fundamental macroeconomic variable (loose monetary policy, monetization of fiscal deficit) expanded under the fixed exchange rate regime. The roots of these models can be found in Salant and Henderson (1978), who tried to model speculative attacks on the gold market. Krugman (1979) extends the Salant-Henderson model of speculative attack onto the fixed exchange rates. In his seminal paper, Krugman assumes that a rising fiscal deficit, financed by monetary expansion, leads to speculative attacks making devaluation inevitable - and the timing of the devaluation can be calculated exactly. Although Krugman's model was later revised and re-appraised, it represents the basis of the first generation models.[5]

Foreign exchange market developments and expectations are put forward in the *second generation models (speculative models)*.[6] The basic premise of those models is that currency crises can occur even when macroeconomic fundamentals are consistent, driven by self-fulfilling speculative attacks (Obstfeld 1984, 1986, 1994, 1996). A crisis occurs when expectations of the foreign exchange market participants are coherently turned in one direction. That cohering factor - *the trigger* - can be anything

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[3] *Chronologically, there was the ERM crisis, Mexican "tequila" crisis, Asian "flu" crisis, Russian crisis, Brazilian crisis, Turkish crisis, and Argentinean crisis, to name the most prominent.*

[4] *For a review of the literature see Blejer (1998), Flood and Marion (1998), and Jeanne (2000).*

[5] *Flood i Garber (1984) construct a linear simplification of Krugman's model within a stochastic framework, and Blanco and Garber (1986) extend it to a structural model for analyzing and predicting the exact timing of a devaluation of the Mexican peso in 1973-1982. The model showed that credit growth and main monetary aggregates are significant variables in determining the probability of the crisis. That model was extended by Goldberg (1993), and Cumby and Wijnbergen (1989) who showed that credit growth was a main cause of the speculative attacks in Argentina in early 1980s. Dornbusch (1987) re-appraises the differences between Krugman's deterministic and Flood-Garber stohastic model in the case of Argentina.*

[6] *Ozkan and Sutherland (1995), Obstfeld (1984, 1986, 1994, 1996), Gerlach and Smets (1994).*

from a political event, release of some data to a change of economic policy.[7] The very mechanism of coherence diffusion is also modeled as "rational" herd behavior of the foreign exchange market participants and foreign investors. International triggers are modeled through the contagion effects.[8]

The development of the *third generation models* of currency and financial crises intensified after the Asian crisis (1997/98). These models combine currency crises with the financial sector disturbances and weaknesses, emphasizing the effects of financial sector liberalization, weak supervision and regulation, as well as bad risk management and moral hazard of the financial institutions.[9] Most of the third generation models[10] emphasize the moral hazard problem and overlending by the financial institutions with implicit or explicit government guarantees, the creation of a speculative bubble and burst of the bubble when unfavorable fundamental developments cause the value of loans to exceed the guaranteed amount. One of the key factors related to financial and currency crises is the fact that financial institutions draw funds from abroad in order to start the overlending process. These models led to a development of the *twin crisis* concept.[11]

Based on above mentioned theoretical literature, various studies tried to explain the crises by using different empirical models in order to identify significant variables or even leading indicators. Within the existing empirical literature, we can separate two key approaches: *the traditional approach and the most recent signaling (nonparametric) approach*. The first approach generally tries to use econometric modeling.[12] Those studies that

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[7] *Some of the models do explore the self-fulfilling speculative attacks as a multiple equilibria phenomenon, which does not necessary have to end in a currency crisis - that outcome only arises when the economic agents stop believing in the government policies (Obstfeld, 1994).*

[8] *Allen and Gale (2000), Baig and Goldfajn (1998), Caramazza, Ricci, and Salgado (2000), Eichengreen, Rose and Wyplozs (1996), Gerlach and Smets (1994), Kruger, Osakwe, and Page (1998), Masson (1998).*

[9] *The initial attempt to connect financial sector weaknesses and the currency crises can be found in Diaz-Alejandro (1985).*

[10] *Corsetti, Pesenti and Roubini (1998b), Demirguc-Knut and Detragiache (1998), Dooley (2000), Eichengreen and Rose (1998), Glick and Hutchison (2000), Gruben and McComb (1997), Irwin and Vines (1999), Kaminsky (1998), Kaminsky and Reinhart (1999), Krugman (1998, 1999), McKinnon and Phill (1996).*

[11] *Pioneering empirical work on the twin crises was done by Kaminsky and Reinhart (1999). An earlier version of that research was published in Kaminsky and Reinhart (1996). Theoretical models of the connection of the currency and banking crises can be found in: Diaz-Alejandro (1985), Velasco (1987), Calvo (1995), Goldfajn and Valdes (1995), Miller (1998), and Chang and Velasco (1998).*

[12] *Regression and more classical econometric modelling can be found in: Frankel and Rose (1996), Eichengreen, Rose and Wyplosz (1996), Sachs, Tornell and Velasco (1996), Cumby and Wijnbergen (1989), Ötker and Pazarbasioglu (1994, 1995), Edin and Vredin (1993), Edwards (1989), Klein and Marion (1994), Kruger, Osakwe and Page (1998), Razin and Milesi-Ferritti*

provide qualitative description of pre-crisis events[13] can also be considered traditional. The traditional approach has an advantage in its simple interpretation. All information about a future crisis is contained in a single number. However, it seems that this advantage also represents a disadvantage of the method. This approach does not allow the researcher to rate indicators according to their relative predictive power. Either the variables are significant or they are not, and if they occasionally send incorrect signals, the methodology cannot detect this. This methodology can hardly be expected to tell us what "went wrong" in the global economic activity or how to reformulate the economic policy to avoid a crisis.

The *"signals" approach as a non-parametric method* attempts to overcome the difficulties and limitations faced by the traditional method in building a specific early warning system for crises. The starting point is that disturbances that may lead to a crisis do not happen accidentally, but are rather a result of the gradual deterioration in economic conditions. *This approach begins with a detailed analysis of the behavior of variables whose movements in the pre-crisis period differ substantially from their usual behavior in normal economic conditions.* The "signals" approach was established by Kaminsky, Lizondo and Reinhart (1997) as an alternative method to facilitate deeper understanding of the behavior of macroeconomic forces that pushed the country into the crisis. The idea of developing a system of economic indicators that can anticipate crises derives from the literature on business cycles and the methods used to forecast business cycle turning points.[14]

The implementation of the "signals" approach started only in the late 1990s, and could be very useful for multilateral financial institutions such as the IMF and World Bank (for monitoring purposes), as well as for the investment community. In the future, one can expect a more detailed empirical testing of the method's usefulness for analytical and

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(1997), Caramazza, Ricci and Salgado (2000), Corsetti, Pesenti and Roubini (1998a), and Eichengreen and Rose (1998). Probit/logit models were developed under the methodological influence of Blanco and Garber (1986), who used these methods in analyzing the Mexican crisis of the early 1980s.

[13] *See Dornbusch, Goldfajn and Valdes (1995), Kamin (1988), Edwards (1989), Eichengreen, Rose and Wyplosz (1995), Frankel and Rose (1996), Eichengreen and Rose (1998), Kaminsky and Reinhart (1999) Caramazza, Ricci and Salgado (2000), Aziz, Caramazza and Salgado (2000).*

[14] *This refers to a well-known barometric method which is used to monitor and forecast economic activity. In Croatia, the so-called CROLEI (CROatian Leading Economic Indicators) system has been developed since 1994 to monitor and forecast the overall economic activity (Ahec-Šonje, 2000).*

forecasting purposes.[15]

Why do we use the "signals" approach to identify a system of early warning indicators for currency crises in Croatia? Our motives for using it in determining the vulnerability of the Croatian foreign exchange market are as follows:

- The "signals" approach is a new analytical and forecasting method, and its improvement and increasing usage is expected;
- Croatia already has a similar nonparametric method in use for analyzing the cyclical behavior of the Croatian economy;[16]
- Perhaps the most important feature of this method is that it is applicable even in the situations where there are data problems (short series of reliable data, structural changes in the economy, frequent changes in the data methodology, a small number of crisis episodes), that are also evident in Croatia.

A more detailed description of how the "signals" approach functions is given in the following section, which shows an empirical test of the effectiveness of the method in predicting currency disturbances in Croatia. The ultimate goal of the exercise is to build an effective early warning system for currency crisis in Croatia.

3
THE EARLY WARNING INDICATORS FOR CROATIA

Defining crises and choices of potential indicators

Currency crises are defined as situations in which speculative attacks on the currency lead to a substantial depreciation, a substantial decrease in international reserves or a combination of one and the other. This approach rests on a broad definition that includes both successful

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[15] *Thus, it is not strange that several studies examining the possibilities of using this method to analyze currency or banking crises have already appeared. See, for example, Kaminsky, Lizondo and Reinhart (1997), Kaminsky (1998), Bruggemann and Linne (1999), Edison (2000), Goldstein, Kaminsky and Reinhart (2000), Nierhaus (2000), Glick and Hutchison (2000).*

[16] *Kindleberger (1996) warned long ago that financial crises could be associated with certain phases in the business cycle.*

and unsuccessful attacks on various exchange rate regimes. Currency crises are usually identified (ex-post) by the behavior of an *index of foreign exchange market pressure (FEMPI)*[17]. Because of the index's relative novelty, there is no consensus about a standard way of its calculation. It is usually calculated as a simple mean but more and more often as a weighted average, with standard deviations of the exchange rate and international reserves (because of different volatility of the exchange rate and international reserves) as weights. In a period of higher sensitivity and volatility in the foreign exchange market, the index usually exceeds two and even three standard deviations.[18]

The exchange market pressure index in Croatia is constructed by using the rates of change in the international reserves and the real bilateral exchange rate of the national currency against the euro.[19]

$$FEMPI_t = \Delta e_t - stdE/stdR * \Delta R_t$$

where e_t is the real bilateral HRK/EUR exchange rate, R_t gross international reserves, and (stdE/stdR) the ratio of standard deviations of the real exchange rate and international reserves. We do not include interest rate in the calculation because Croatia experienced periods of financial market deregulation, and because interest rates were never considered as a potent instrument of monetary policy.

The index is constructed in such a way that a depreciation of national currency and decreased international reserves work in the same direction, making the index grow and expressing stronger downward pressure on the currency. If we exclude 1994, as a year where some of the effects of a successful anti-inflation program were still present in the economy, the index reveals two currency disturbances in the 1995-2001 period (Figure 1).

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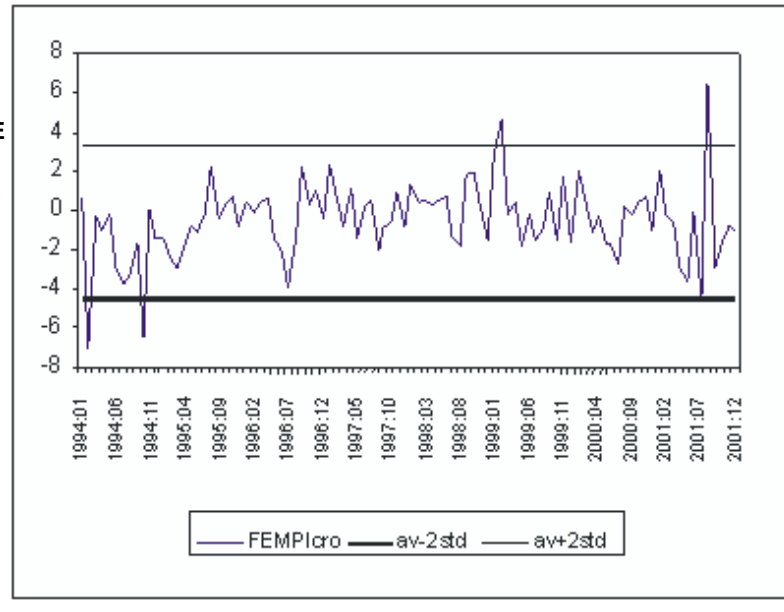
[17] *The index itself originates in the 1970s monetary approach to the balance of payments and exchange rate. By the end of 1970s, Girton and Roper (1977) formulated a monetary approach equation aimed at working regardless of the exchange rate regime. The idea of measuring the foreign exchange market pressure has been revived by Eichengreen, Rose and Wyplosz (1995) and later by Kaminsky, Lizondo and Reinhart (1997).*

[18] *That is why Kaminsky, Lizondo and Reinhart (1997) pronounce periods with FEMPI exceeding +/- 3 standard deviations as "turbulent", while Eichengreen, Rose and Wyplozs (1995) look for +/- 2 standard deviations violation.*

[19] *Real bilateral exchange rate equals $e_{HRK/EUR,t} = E_{HRK/EUR,t} * p_{EUR,t} / p_t$, where $p_{EUR,t}$ and p_t are HICP inflation in the eurozone, and CPI inflation in Croatia, respectively.*

Figure 1

INDEX OF FOREIGN EXCHANGE MARKET PRESSURE



Source: Calculations of the authors.

Currency disturbances in Croatia	
Jan/Feb 1999	**August 2001**
real exchange rate depreciated 3.3%	real exchange rate depreciated 5.9%
reserves shrank 15%	reserves shrank 1.8%

We will try to build a system of signal indicators based on those two turbulent episodes. The choice of indicators whose behavior in the pre-crisis period is to be tested is based on theory and on the availability of monthly data. The list of potential indicators of currency crises in Croatia is based on the Kaminsky-Lizondo-Reinhart list of 105 indicators, used by most studies on the signal approach as a starting point[20]. Based on the "early warning indicators" literature, the most important indicators that have been found to provide signals about upcoming currency crises are: international reserves, the real exchange rate, credit growth, inflation, fiscal deficit, real

[20] *The Kaminsky-Lizondo-Reinhart list was compiled by Kaminsky, Lizondo and Reinhart (1997) after reviewing the existing empirical literature. The authors found that as many as 43 indicators from the list were found significant in at least one of the reviewed 28 studies. Hawkins and Klau (2000) reviewed 30 more studies published since 1997, and conclude that most of the recent empirical studies base their research on the KLR list of indicators.*

GDP growth, credit to the public sector, M2/international reserves. The following table shows the total of 28 potential economic and financial indicators of currency disturbances in Croatia, with their expected signs in a pre-crisis period[21] (a description of data is shown in Appendix II).

Table 2

INDICATORS OF CURRENCY DISTURBANCES IN CROATIA

INDICATORS	expected sign in pre-crisis period
The real effective exchange rate; The real bilateral HRK/EUR exchange rate; International reserves, total; Net usable international reserves (NUIR); NUIR/broad money (M4); CNB foreign assets/M4; Bank deposits; Banks' reserves with CNB/total bank assets; Industrial production; Exports; Trade balance; Current account balance; Capital inflow	**negative**
M4 multiplier; M1 multiplier; Money supply (M1); Base money (M0); Domestic credit/output; Domestic credit, Ratio of bank claims to the public sector to total bank claims; Monetary institutions' claims to public sector (net); CNB claims on banks; Foreign liabilities of monetary institutions; Imports; Budget deficit as a share of GDP; Budget deficit less capital revenues as a share of GDP; Real money market interest rate; Lending/deposit interest rates ratio	**positive**

A brief summary of the stylized facts about their behavior before and during the crisis is given below.

- *In pre-crisis periods, the domestic currency is either heavily overvalued or else exposed to a strong pressure to appreciate. Therefore,* ***real effective and real bilateral HRK/EUR exchange rates*** *usually bear negative signs.*
- *We can also expect to see a reduction of* ***international reserves*** *(gross and net) due to moves to defend the proclaimed exchange rate parity.* ***The ratio of net usable reserves to M4 and the ratio of net foreign assets of the CNB to M4*** *are considered a good indicator of currency crises. Depositors, especially in developing and emerging markets, will take shelter in the currency they consider a safe haven for keeping their financial wealth as the government economic policies lose their credibility.*
- *In the case of* ***M2 and M1 multipliers****, we may expect a positive sign. An increase in the multiplier with an unchanged monetary base signals an expansionary monetary policy and likely pressure, leading to a deterioration of the domestic currency.*

[21] *Although foreign total and short-term debt shoud have been included, the figures were not available on a mothly basis before 2000 and there were significant methodological changes in 1999, making the data before and after 1998 not comparable.*

- *The **growth of M1 and M0** also means that the monetary policy is expansionary, causing pressure for the domestic currency to deteriorate, so we expect a positive sign.*
- ***Credit expansion** is considered a strong signal of currency and banking disturbances to come. It usually accompanies the phases of the "business cycle" and domestic financial liberalization. So **the ratio of credits to output**[22] and **growth of the bank credits to domestic sectors** are related positively to currency (and banking) disturbances.*
- *Out of the models of the twin crisis, we included the following indicators of banking sector vulnerability[23], which can also provoke currency disturbances: **total bank deposits** (expected to fall before/during the banking crisis, due to a run on banks), the **ratio of bank reserves with the CNB to total bank assets** (expected to fall because of the increase of bank assets - i.e. the credit boom), the **ratio of bank claims on the public sector to total claims**, and the **ratio of net claims of monetary institutions on the central government** (expected to grow in the pre-crisis period due to a monetization of the public deficit), **CNB credits to banks** (these grow as their liquidity shrinks), and **foreign liabilities of the monetary institutions** (increasing their external vulnerability).*
- ***Industrial output** (the base index of industrial output, 1995=100) and **exports** have negative expected signs in pre-crisis episodes (weak output and exports either weaken the exchange rate, or an overvalued exchange rate slows down exports and output).*
- *We except to see an **import** increase in the pre-crisis period (helped by an overvalued currency), which also worsens the **balance of trade** and **current account balance** (expected negative signs).*
- *A widening of the **budget deficit** usually causes monetary expansion, hence the currency crisis (as established in the first generation models).*
- ***Interest rates** are usually very weak indicators of the currency crises, while being better indicators of the banking crises. An increase of nominal (and real) interest rates could mean shrinking liquidity in the financial system, while high loan to deposit rate ratio can signal a risk increase and deterioration of the bank portfolio, as well as lack of competition and supervisory and regulatory weaknesses.*
- *Reduced **capital inflows** can be a sign of international financial markets disturbances, as well as of distrust in the local government's economic policy. This indicator can signal so-called "spill-over effects" within regions, as in 1998, when a currency crisis in one Asian country affected another, drying out capital inflows in the whole region. We have not included this indicator, however, because it is only available on a quarterly basis.*

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[22] *A ratio of bank credits to the domestic sector and the base industrial output index (1995=100).*

[23] *We include it because of the 1998 banking crisis, which brought about a currency disturbance at the beginning of 1999.*

The signal horizon, signals and critical values (thresholds)

The signal horizon is the period before a crisis during which the behavior of the indicators signals the upcoming crisis. We chose a horizon of 12 months before each disturbance.

The signal horizon	
Jan/Feb 1999	12 months (2/98 until 1/99)
August 2001	12 months (9/00 until 8/01)

A signal emitted within 12 months prior to the outbreak of currency disturbances (crisis) constitutes a good signal. A signal emitted before that date is correspondingly a bad or false signal. An indicator provides a warning signal within a 12-month window if it exceeds a critical value (threshold). The critical values are set to achieve a certain balance between the risk of having *false signals (noise)* and the risk of ignoring *good signals* of a crisis that is in fact impending. However, there are no general rules for determining the critical value. If the threshold is set very high, the indicator is likely to ignore all but the most severe crises. If the critical value is set very low, there is a risk of catching a number of false warning signals in tranquil times. We set the critical values k* in relation to percentiles of the distribution of observations of the indicator I_t, in order to discriminate between "normal" and "abnormal" behavior of an individual indicator. In most cases we used 25 percent percentile of the distribution (if the indicator falls prior to currency disturbances) or 75 percent percentile of the distribution (if the indicator rises prior to crisis).[24]

After determining the thresholds, we determine the total number of good and false signals in crisis and *tranquil times:*

a) for indicators with positive expected signs in pre-crisis period it holds:

$$S_t = 1, \text{ if } I_t > k, \quad \text{and} \quad S_t = 0, \text{ if } I_t \leq k$$

[24] *The threshold has been lowered to the 33.3 percent-th or the 66.67 percent-th percentile in individual cases, when previous analysis showed the quartils to be too high tresholds. For example, high interest rates in the first half of 1990s reflected existing structural problems in the banking sector and economy, as well as the lack of competition and a weak regulatory framework. As the situation in the financial sector improved, the interest rates started to decline.*

b) for indicators with negative expected signs in pre-crisis period it holds:

$S_t = 1$, if $I_t < k$, and $S_t = 0$, if $I_t \geq k$

S_t is a binary signal variable, constructed by virtue of the principle set above. An indicator sends a good signal if $S_t=1$ and a crisis occurs within the signal horizon or $S_t=0$ and no crisis occurs within a tranquil period. On the contrary, an indicator issues a false signal if $S_t=1$ and no crisis breaks out within a tranquil period or $S_t=0$ and a crisis breaks out within the signal horizon.

Performance of Individual Indicators

The most important criterion for assessing the effectiveness of indicators is the confirmation of their reliability in signaling a future crisis. The performance of each indicator can be estimated in terms of the following matrix (Table 3):

Table 3

MATRIX FOR ESTIMATING INDIVIDUAL CURRENCY CRISIS INDICATORS

	CRISIS within signal horizon	NO CRISIS tranquil times	TOTAL
signal was sent ($S_t = 1$)	A	B	A+B
no signal was sent ($S_t = 0$)	C	D	C+D
Total	A+C	B+D	A+B+C+D
good signals	A	D	A+D
good as % of total	A/(A+C)	D/(B+D)	(A+D)/(A+B+C+D)
false as % of total	C/(A+C)	B/(B+D)	(B+C)/(A+B+C+D)

Source: Kaminsky, Lizondo and Reinhart (1997), Nierhaus (2000).

In the above matrix, A is the number of months in which the indicator issued good signals of an upcoming crisis, B is the number of months with bad signals (noise), C is the number of months without a signal but that were followed by a crisis, and D is the number of months without a signal and no subsequent crisis. An ideal indicator is one that produces a signal in every month within the signal horizon, so that A>0 and C=0, or one which does not produce any signals in time horizon that is not to be followed by a crisis, so that D<0 and B=0. Based on this matrix and following the

method of KLR[25], it is possible to calculate measures that can help rank the indicators according to their predictive power. Information on the performance of 28 individual indicators of currency disturbances in Croatia is presented in Table 4.

For each indicator, the first column of Table 4 shows the number of good signals as a percentage of the number of months in which good signals could have been emitted. The maximum score (100 percent) would belong to an indicator that sent signals every month within the signal horizon before every observed crisis. According to this criterion, the best signal indicator is the real bilateral HRK/EUR exchange rate with 58 percent of good signals in the turbulent period, while exports have the smallest share of good signals (4 percent).

The second column of Table 4 shows the number of false signals as a percentage of the number of months in which false signals could have been. Obviously, the lower the number in the second column, the better the indicator. According to this criterion, the real bilateral exchange rate (HRK/EUR) shows the best performance (issuing only 7 percent of false signals in tranquil times), while the lending rate/deposit rate ratio shows the poorest performance (issuing 52 percent of possible false signals).

The key measure calculated on the basis of the matrix is *the adjusted noise-to-signal ratio* (the third column of Table 4). The ratio provides information on the ability of the indicator to produce correct signals and to avoid false signals. The lower this ratio comes in for an indicator, the more successful is the indicator in predicting currency disturbances. If an indicator issues signals at random times, the expected value of the ratio is equal to unity. Therefore, all those variables with noise-to-signal ratio equal to or higher than unity should be removed from the analysis. The third column of Table 4 shows which indicators had the best (lowest) noise-to-signal ratio: the real bilateral exchange rate (0.12), followed by the real effective exchange rate (0.21), the ratio of CNB foreign assets to broad money (0.28), CNB credits to domestic money banks (0.30), M1 multiplier (0.47).[26]

The choice of the best performing indicators should also depend on *the lead-time of the indicator*. It is necessary to establish how many months before the crisis a particular indicator produces its first warning signal. Usually, an average *lead-time* is calculated for all events of the crisis.

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[25] *See Kaminsky, Lizondo, Reinhart (1997).*

[26] *We have to mention that capital inflows and current account balance proved to be good signal indicators, according to the above mentioned criteria. But since they are only available on a quarterly basis, they are left out of the early warning system.*

Table 4

PERFORMANCE OF INDIVIDUAL INDICATORS FOR CURRENCY DISTURBANCES - CROATIA

INDICATORS	% good signals	% false signals	noise-to-signal ratio	"lead time"	P crisis/signal	P crisis/signal – P crisis
	A/(A+C)	B/(B+D)	B/(B+D) / A/(A+C)	before I and II disturbance	A/(A+B)	A/(A+B) – A+C/(A+B+C+D)
	(1)	(2)	(3)	(4)	(5)	(6)
1. The real effective exchange rate	0.43	0.09	0.21	13(I)	0.77	0.35
2. The real bilateral HRK/EUR exchange rate	0.58	0.07	0.12	13(I) and 14(II)	0.82	0.47
3. International reserves	0.21	0.41	1.95	11 (I)	0.22	-0.13
4. Net usable reserves (NUIR)	0.33	0.33	1.00	8 (I)	0.35	0.00
5. NUIR / M4	0.54	0.25	0.46	10(I) and 9(II)	0.48	0.18
6. CNB foreign assets / M4	0.50	0.14	0.28	17(I)	0.60	0.30
7. M4 multiplier	0.29	0.23	0.79	3(I) and 1(II)	0.41	0.06
8. M1 multiplier	0.38	0.18	0.47	14(II)	0.53	0.18
9. Growth of M1	0.25	0.25	1.00	9(II)	0.35	0.00
10. Growth of base money (M0)	0.13	0.32	2.46	5(II)	0.18	-0.17
11. Domestic credits / output	0.46	0.27	0.59	18(I)	0.48	0.13
12. Domestic credit	0.46	0.27	0.59	19(I) and 1(II)	0.48	0.13
13. Bank deposits	0.25	0.39	1.56	6(I)	0.26	-0.09
14. Bank reserves with CNB / bank assets	0.42	0.16	0.38	19(I) and 8(II)	0.59	0.24
15. Ratio of bank claims on the public sector to total bank claims	0.29	0.23	0.79	12(II)	0.41	0.06
16. Net claims of monetary institutions on public sector	0.25	0.24	0.96	8(II)	0.35	0.00
17. CNB credits to banks	0.46	0.14	0.30	11(I) and 1(II)	0.65	0.30
18. Foreign liabilities of monetary institutions	0.38	0.18	0.47	11(I) and 1(II)	0.53	0.18

Table 4 (continued)

INDICATORS	% good signals	% false signals	noise-to-signal ratio	"lead time"	P crisis/signal	P crisis/signal – P crisis
	A/(A+C)	B/(B+D)	B/(B+D) / A/(A+C)	before I and II disturbance	A/(A+B)	A/(A+B) – A+C/(A+B+C+D)
	(1)	(2)	(3)	(4)	(5)	(6)
19. Industrial output growth	0.33	0.20	0.61	4(I)	0.47	0.12
20. Exports	0.04	0.36	9.00	-	0.06	-0.29
21. Imports	0.21	0.27	1.29	8(II)	0.29	-0.06
22. Trade balance	0.25	0.25	1.00	9(II)	0.35	0.00
23. Budget deficit / GDP	0.29	0.22	0.76	2(I) and 11(II)	0.50	0.07
24. Budget deficit less capital revenues / GDP	0.29	0.22	0.76	2(I) and 11(II)	0.50	0.07
25. Real money market interest rate	0.38	0.32	0.84	9(I)	0.39	0.04
26. Ratio of lending to deposit interest rate	0.08	0.52	6.50	1(I)	0.08	-0.27
27. Current account balance, quarterly	0.50	0.28	0.56	5q(I) and 1q(II)	0.44	0.13
28. Capital inflows, quarterly	0.38	0.23	0.61	4q(I)	0.38	0.27

Source: Calculations of the authors.

However, since we here analyze only two identified turbulent events, we will analyze each of them separately. Out of all potential indicators, only six of them signaled both disturbances, with the rest signaling only one of them. The fourth column of the table above shows that, in case of the first currency disturbance, the longest lead-time of 19 months belongs to total credits to domestic sector, and to the ratio of banks reserves held at the CNB to total bank assets. The August 2001 disturbance was detected earliest by the real bilateral exchange rate (14 months) and by M1 multiplier (14 months). The *lead-time* of the indicators reveals the difference between the two disturbances. The first currency disturbance at the beginning of 1999 occurred at the peak of a banking crisis, and during a period of recession for the national economy. The macroeconomic situation and financial system soundness was very different in August 2001. That is why a number of indicators that detected the first disturbance are in fact *traditional* indicators of bank disturbances. If the first currency disturbance had grown into a full-blown crisis (with a strong loss of reserves, currency depreciation by more than 20 percent), then we could have spoken of twin crises. Indicators that anticipated the August 2001 disturbance are for the most part *traditional* currency crisis indicators.

The last measure of "noisiness" of the indicators is a comparison between the probability of a crisis conditional on a signal from the indicator and the unconditional probability of a crisis. For those indicators that have "predictive power", the conditional probability would be higher than the unconditional one (the fifth and the sixth column of Table 4). From these estimates it is obvious that the indicators whose conditional probability of a crisis is higher than the unconditional one, are the same ones whose adjusted noise-to-signal ratio is lower than unity. The real bilateral exchange rate shows the highest score, with an estimated conditional probability of a currency disturbance of 82 percent, followed by CNB credits to local banks (65 percent) and CNB foreign assets/broad money (60 percent).

The results of the "signals" approach used in this in-sample analysis serve as a basis for designing an early warning system for currency disturbances in Croatia (Table 5). The early warning system should consist of the indicators which detect the disturbance very early, and emit a persistent signal within the signal horizon.

Table 5

THE SET OF EARLY WARNING INDICATORS FOR CURRENCY DISTURBANCES - CROATIA

INDICATORS	noise to signal ratio
1. The real bilateral HRK/EUR exchange rate	0.12
2. CNB credits to banks	0.30
3. Bank reserves with CNB / bank assets	0.38
4. NIUR/M4	0.46
5. M1 multiplier	0.47
6. Foreign liabilities of monetary institutions	0.47
7. Domestic credit	0.59
8. Budget deficit / GDP	0.76
9. Ratio of bank claims to public sector to total bank claims	0.79

While choosing the indicators, we tried to pick those that either detect both disturbances or only the August 2001 disturbance. Figures in the Appendix III represent the behavior of nine early warning indicators for currency disturbances in Croatia.

The Composite Indicators of Currency Disturbances

In this section we will discuss two ways of combining the information provided by the set of early warning indicators in order to produce useful indices of vulnerability of the foreign exchange market. The idea is to construct the *composite indicator of currency disturbances* by weighting the signals of each individual indicator.

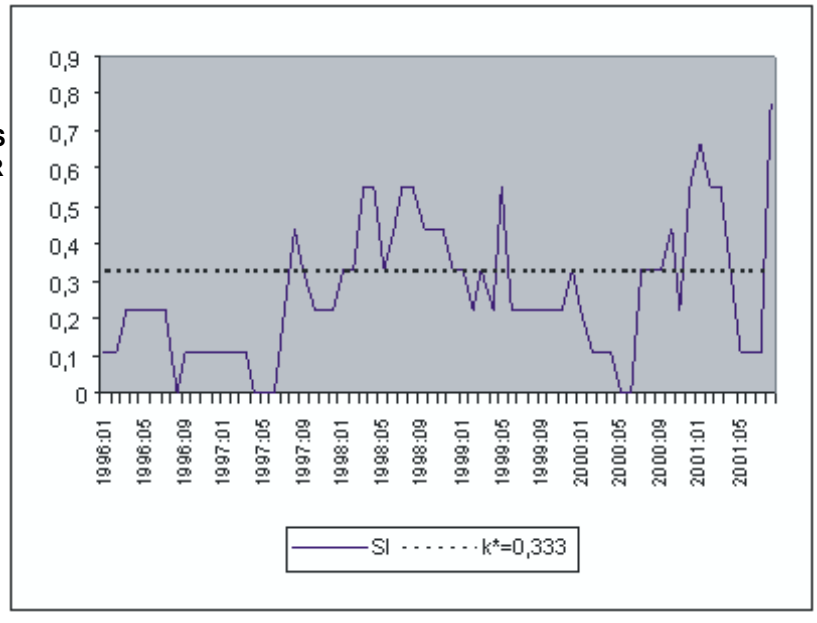
The first approach gives equal weights to all nine individual indicators from the early warning system:

$$SI_t = \Sigma_{r=1,..,9} S_{r,t} /9$$

where binary variable $S_{r,t}$ is equal to unity if the indicator ($I_{r,t}$) crosses the critical value k* in period t and zero otherwise. The next figure shows the performance of *unweighted* composite currency disturbances indicator.

Figure 2

COMPOSITE CURRENCY DISTURBANCES INDICATOR FOR CROATIA (UNWEIGHTED)



Source: Calculations of the authors.

The composite indicator SI_t can assume values between zero and unity ($SI_t \in [0.1]$). When each individual indicator ($I_{r,t}$) issues a signal of upcoming disturbances in period t, the composite indicator value is equal to unity ($SI_t=1$) and vice versa. Furthermore, the composite indicator issues a crisis warning signal if the critical value k* is exceeded. In order to set a critical value (threshold) for the composite indicator we used the 75 percent percentile of the distribution. This means that the composite indicator issues a warning signal if it exceeds k*=0.33. Figure 2 shows clearly that SI_t signaled both disturbances on the Croatian foreign exchange market almost 12 months ahead.

The second approach combines the information on the forecasting accuracy of nine signal indicators, which is better than not weighting them, because it puts better performing indicators forward. The composite early warning indicator SI_t^* is obtained by weighting the signals of individual signal indicators by an inverse of their noise-to-signal ratio.

$$SI_t^* = \Sigma_{r=1,..,9} S_{r,t} \omega_r$$

where $\omega_r=[(1/\delta_r)/\Sigma_{r=1,..,9}1/\delta_r]$, and δ_r is the noise-to-signal ratio of each individual indicator (r=1,..,9). As a result, the composite indicator SI_t^* gives more weight to the indicators that have a lower noise-to-signal ratios. The next table shows the weighting scheme for the composite indicator SI_t^*.

Table 6

THE WEIGHTING SCHEME FOR THE COMPOSITE INDICATOR SI_t^*

INDICATORS	**weights in %** $\omega_r=[(1/\delta_r)/\Sigma_{r=1,..,9}1/\delta_r]$
1. The real bilateral HRK/EUR exchange rate	33.3
2. CNB credits to banks	13.3
3. Bank reserves with CNB/ bank assets	10.5
4. NIUR/M4	8.7
5. M1 multiplier	8.5
6. Foreign liabilities of the monetary institutions	8.5
7. Domestic credits	6.8
8. Budget deficit / GDP	5.3
9. Ratio of bank claims on the public sector to total bank claims	5.1
TOTAL	100.0

Source: Calculation of the authors.

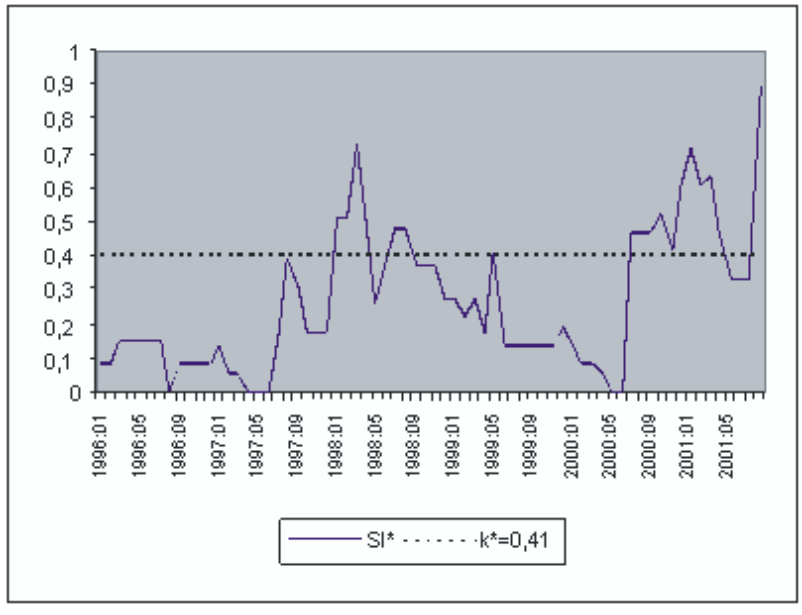
The highest weight is given to the best performing individual indicator - the real bilateral exchange rate. The next figure shows the behavior of the *weighted* composite indicator.

The composite indicator SI* anticipates a turbulence on the foreign exchange market if it exceeds the critical value k*=0.41, which is determined by the 75 percent percentile of the distribution. Figure clearly shows that during the signal horizon SI* sent fewer signals of the upcoming Jan/Feb 1999 disturbance than the unweighted indicator SI.

In Table 7 we compare the forecasting accuracy and quality of both composite indicators SI and SI*.

Figure 3

COMPOSITE CURRENCY DISTURBANCES INDICATOR (WEIGHTED)



Source: Calculations of the authors.

Table 7

PERFORMANCE OF THE COMPOSITE CURRENCY DISTURBANCE INDICATORS

	%good signals	% false signals	adjusted noise-to-signal ratio	P(crisis/signal)	P(crisis/signal)-P(crisis)
	A/(A+C)	B/(B+D)	B/(B+D) / A/(A+C)	A/(A+B)	A/(A+B) - A+C/(A+B+C+D)
SI (unweighted)	58	5	0.09	0.88	0.53
SI* (weighted)	58	7	0.12	0.82	0.47

Source: Calculations of the authors.

Obviously, both composite indicators anticipated the turbulent episodes in Croatia, determined by the index of foreign exchange market pressure. In both cases the adjusted noise-to-signal ratio are well below unity, as well as below the adjusted noise-to signal ratio of the best individual indicator - the real bilateral exchange rate. The composite indicator SI* has a slightly higher percentage of false signals in tranquil times leading to its higher noise-to-signal ratio (0.12), compared to the unweighted indicator SI (0.09). However, the estimated conditional probability of currency disturbances of both indicators is higher than 80 percent, which confirms their ability to anticipate the turbulence on the foreign exchange market.

4
CONCLUDING REMARKS

The set of early warning indicators, that proved useful and accurate in forecasting currency disturbances in Croatia, exceeded our expectations. Despite the fact that Croatia did not experience a true currency crisis resulting in a major devaluation or change in the exchange rate regime in the 1995-2001 period, the "signals" approach helped us to identify indicators that anticipate episodes of mild turbulence in Croatia in the period under observation. Also, it is quite encouraging that many of the variables that proved to be reliable warning indicators of currency disturbances are consistent with theoretical expectations and are supported by the empirical literature focusing on the causes of currency crises. However, one should have in mind the fact that there were too few disturbances during that period to formulate a stable early warning system.

The first currency disturbance happened at the beginning of 1999 after the peak of the banking crisis (1998/99). The CNB eased the depreciation pressures through foreign exchange interventions. Worsened liquidity of the banking and real sector limited the banks' ability to control their own liquidity, so they had no power to launch a coordinated speculative attack. Furthermore, the fact that the sale of domestic securities to foreigners was not yet liberalized and that the government financed itself largely in the international markets helped Croatia avoid a full-blown crisis. The second currency disturbance in August of 2001 came only after the CNB started a domestic financial liberalization by lowering the reserve ratio, and after it liberalized the foreign exchange regulations by allowing businesses to manage their foreign exchange balances starting from June 2001. Soon the yield on treasury and CNB bills dropped below European benchmarks and banks started to switch their foreign currency positions, building up foreign exchange assets. Those factors brought about depreciationary pressures that the CNB managed to quash through foreign exchange interventions with much more difficulty than ever before.

Apart from the real bilateral exchange rate, both disturbances were detected early enough by: a ratio of net usable international reserves to total liquid assets (M4), a ratio of bank reserves held at the CNB to total bank assets and the budget deficit. We included in the system the following series that signaled the 1998/99 currency and banking crisis, and came close to their thresholds before August 2001: CNB credits to banks, foreign liabilities of the monetary institutions and the growth of credits to

domestic sectors. We completed the system by including the two variables that reflect the impact of monetary and fiscal policy actions on the vulnerability of the foreign exchange market: M1 multiplier and claims on the government. Composite indicators reveal to us that the pressure on the domestic currency was higher in August 2001.

This paper represents the beginning of a serious empirical task whose final goal is to build an effective and reliable early warning system for currency disturbances in Croatia. The first step has been made to use a very new method, so the group of indicators analyzed here can be seen as a basis for further research. We saw that the domestic financial and very modest capital account liberalization in Croatia in 2001 brought about turbulence on the country's foreign exchange market, which were overcome with serious difficulties. The Stabilization and Accession Agreement Croatia signed with the EU obliges it to pursue further liberalization of its capital account. The ultimate goal is to find the most efficient warning information that may allow policymakers enough maneuvering space to avoid or at least minimize negative consequences of any future currency crisis in Croatia.

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APPENDIX I

Table 1

CROATIAN MACROECONOMIC INDICATORS

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
REAL SECTOR										
GDP, constant (1990) prices, mil. kuna	221.4	195.5	179.8	190.3	203.3	215.5	229.5	235.3	234.6	243.1
GDP, current prices, mil. kuna	441.2	2706.6	39003.2	87441.2	98382.0	107980.6	123812.0	137604.0	142700.0	157511.0
Consumption, private, curr. prices, mil. kuna	-	-	-	46574.9	60476.1	63299.4	77028.0	81067.0	81545.0	90025.0
Investment, current prices, mil. kuna	-	-	-	15191.3	17313.5	23749.2	29936.0	32066.0	32956.0	33091.0
Government cons., current prices, mil. kuna	-	-	-	25737.8	30455.7	30619.1	32183.0	36642.0	39637.0	41702.0
Exports, current prices, mil. kuna	-	-	-	40086.3	40606.2	45016.6	50873.0	54547.0	57902.0	70892.0
Imports, current prices, mil. kuna	-	-	-	40149.2	50469.5	55429.0	70351.0	67700.0	69731.0	79745.0
CPI base index (1995=100)	0.7	7.6	93.2	95.6	100.0	103.5	108.8	114.6	117.4	127.1
CPI chain index	-	1019.6	1225.1	102.5	104.6	103.5	105.1	105.4	102.4	108.3
Average monthly net wage, end of period, kuna		74.4	1073.2	1646.0	1883.0	2217.0	2544.0	2935.0	3262.0	3499.0

Table 1 (continued)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
MONETARY SECTOR										
Monetary base, mil. kuna	-	-	2248.9	4714.2	6744.1	8770.3	10346.1	9954.2	10310.0	11717.3
M1, millions of kuna	-	-	3134.4	6642.6	8234.9	11368.9	13731.4	13531.4	13858.9	18030.3
M4, millions of kuna	-	-	10061.1	17679.9	24623.0	36701.1	50742.0	57340.3	56698.6	73321.4
FC deposits, millions of kuna	-	-	5412.3	8783.3	14099.4	21817.5	31278.1	37970.9	36966.0	46901.6
Domestic credits, millions of kuna	-	-	39339.1	43280.5	47976.6	48464.9	56194.9	66923.1	65938.6	72080.3
Total assets of banking sector, mil. kuna	-	-	47332.4	54620.3	62653.6	67482.7	85309.3	93326.4	93251.5	109981.5
Number of banks	-	-	43	50	53	57	60	60	53	45
Daily money market rate	-	2182.3	86.9	17.8	27.2	10.4	9.4	15.8	12.7	4.5
Average bank loan rate	-	2332.9	59.0	12.4	22.3	18.5	14.1	16.1	13.5	10.5
Average bank deposit rate	-	434.5	27.4	5.0	6.1	4.2	4.4	4.1	4.3	3.4

Table 1 (continued)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
FISCAL SECTOR										
Consolidated government revenue, mil. kuna				36882.3	43283.1	48396.6	53345.3	65110.7	67541.0	66735.0
Consolidated govern. expenditure, mil. kuna				35469.3	44166.1	48874.0	54931.9	64228.6	70343.0	74432.3
Consolidated government balance, mil. kuna				1413.0	-883.0	-477.4	-1586.7	882.1	-2802.1	-7697.3
Internal government debt, mil. kuna			22865.2	18674.1	17741.2	17263.0	15538.4	15047.8	16754.6	21344.7
External government debt, mil. kuna			833.4	754.2	1279.6	13477.8	18314.9	21049.7	29962.5	38275.9
Total government debt, mil. kuna			23698.6	19428.3	19020.8	30740.9	33853.3	36097.5	46717.1	59620.6

Table 1 (continued)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
EXTERNAL SECTOR										
Current account balance, millions of dollars	-	-	623.0	853.4	-1441.5	-1091.3	-2325.1	-1530.6	-1390.4	-354.7
International reserves CNB, mil. dollars	-	166.8	616.2	1405.0	1895.2	2314.0	2539.0	2815.6	3025.0	3524.8
External debt, millions of dollars	-	-	2637.8	3019.8	3809.1	5307.6	7451.6	9588.2	9872.3	10840.1
NEER index (1995=100)	0.9	5.4	65.7	109.8	100.0	102.2	108.1	110.9	121.2	131.1
REER index (1995=100)	88.1	155.5	129.1	107.3	99.9	102.0	106.9	105.6	112.7	118.8
HRK/USD exchange rate, period average	-	0.2643	3.5774	5.9961	5.2300	5.4338	6.1571	6.3623	7.1124	8.2753
HRK/DEM exchange rate, period average	-	0.1710	2.1492	3.6920	3.6493	3.6141	3.5560	3.6193	3.8754	3.9038

Table 1 (continued)

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Memo:										
GDP, current prices, mil. dollars	-	10241.0	10902.6	14583.0	18811.2	19872.0	20109.0	21628.0	20063.4	19033.8
Average monthly net wage, end of period, USD	-	281.6	300.0	274.5	360.0	408.0	413.2	461.3	458.6	422.8
Total government debt, mil. dollars	-	-	6624.5	3240.1	3636.9	5657.3	5498.3	5673.6	6568.4	7204.6
Private consumption/GDP	-	-	-	53.3%	61.5%	58.6%	62.2%	58.9%	57.1%	57.2%
Investment/GDP	-	-	-	17.4%	17.6%	22.0%	24.2%	23.3%	23.1%	21.0%
Government consumption/GDP	-	-	-	29.4%	31.0%	28.4%	26.0%	26.6%	27.8%	26.5%
Consolidated gov.consumption/GDP	-	-	-	40.6%	44.9%	45.3%	44.4%	46.7%	49.3%	47.3%
Openness (EX+IMP/GDP)	-	-	-	91.8%	92.6%	93.0%	97.9%	88.8%	89.4%	95.6%
Financial development (M4/GDP)	-	-	25.8%	20.2%	25.0%	34.0%	41.0%	41.7%	39.7%	46.6%
Curr.account/GDP	-	-	5.7%	5.9%	-7.7%	-5.5%	-11.6%	-7.1%	-6.9%	-1.9%
Int.reserves/months of imports	-	-	-	251.8%	235.7%	272.2%	266.7%	317.5%	370.3%	438.9%
Ext.debt/GDP	-	-	24.2%	20.7%	20.2%	26.7%	37.1%	44.3%	49.2%	57.0%
Ext.debt/Exports	-	-	-	45.2%	49.1%	64.1%	90.2%	111.8%	121.3%	126.5%
Pub.ext.debt/Ext.debt	-	-	8.8%	4.2%	6.4%	46.7%	39.9%	34.5%	42.7%	42.7%

Source: Croatian national bank, Central Bureau of Statistics.

APPENDIX II

Data sources:
Bulletin, Croatian National Bank (CNB);
Monthly Statistical Report, Central Bureau of Statistics, Croatia;
Monthly Statistical Review, Ministry of Finance, Croatia.
The indicators are expressed as annual growth rates, with the exception of exchange rates, interest rates, budget deficit as a share of GDP, the ratio of CNB foreign assets to broad money, the ratio of net usable international reserves to broad money, capital account balance and capital inflow.

1. *The real effective exchange rate* - is a weighted geometric average of the index of bilateral exchange rates of the kuna against a basket of currencies (euro, US dollar, Swiss franc, British pound and Slovenian tolar) corrected for the relevant relative price indices (the ratio of price indices in partner countries and domestic prices), deflator is retail price index (CNB Table H10).
2. *The real bilateral exchange rate HRK/EUR* - is nominal bilateral exchange rate HRK/EUR (midpoint exchange rate of the CNB, end of period) multiplied by HICP inflation in Euro-zone and divided by CPI inflation in Croatia, (CNB Table H9).
3. *International reserves, total*, US$ (CNB Table H6).
4. *Net usable international reserves (NUIR)* in US$ - NUIR = international reserves - foreign liabilities - f/c denominated CNB bills - reserve requirement in f/c (Source: CNB).
5. *NUIR/broad money (M4)* - broad money comprises money (M1), savings and time deposits, foreign currency deposits as well as bonds and money market instruments (CNB Table B1).
6. *CNB foreign assets/broad money (M4)* - foreign assets of CNB include monetary gold, holdings of special drawing rights, foreign cash in vaults, reserve position in the IMF, current account balances with foreign banks, time deposits with foreign banks, foreign currency security investments and other claims (CNB Table C1).
7. *M4 multiplier* - M4/M0, M0 is base (reserve) money (CNB Table A1).
8. *M1 multiplier* - (M1/M0), (CNB Table A1).
9. *Money supply (M1)*, (CNB Table A1).
10. *Base money* (M0), (CNB Table A1).
11. *Domestic credit/output* - the index of kuna and foreign currency loans granted by domestic money banks to domestic sectors (1995=100); the measure for output is and index of industrial production (1995=100), (CNB Table D5; CBS).
12. *Domestic credit* - kuna and foreign currency loans granted by DMB's to domestic sectors (CNB Table D5).

13. *Bank deposits* - (calculated as broad money minus currency in circulation) (CNB Table A1, C1).
14. *Ratio of DMB's reserves with CNB to total DMB's assets* (CNB Table D1).
15. *Ratio of DMB's claims on central government and funds (net) to total DMB's claims* (CNB Table D1).
16. *Monetary institutions' claims on central government and funds (net)*, (CNB Table B1).
17. *CNB claims on DMBs* (CNB Table C1).
18. *Foreign liabilities of monetary institutions* (CNB and DMBs'), (CNB Tables C1 and D1).
19. *Growth of industrial production* - the index of total industrial production (1995=100), (CBS).
20. *Export growth*, (CBS).
21. *Import growth* (CBS).
22. *Trade balance* - is defined as the logarithm of exports divided by imports (CBS).
23. *Budget deficit as a share of GDP* - monthly nominal GDP was interpolated from quarterly data (CBS, Ministry of Finance).
24. *Budget deficit (less capital revenues) as a share of GDP*, (CBS, Ministry of Finance).
25. *Real money market interest rate* - nominal money market interest rate (in percent on annual basis) minus the annual rate of change of retail prices (CNB Table G1; CBS).
26. *Lending/deposit interest rates ratio* - nominal interest rates on kuna loans and deposits not indexed to foreign exchange (CNB Table G1 and G2).
27. *Current account balance* in USD, quarterly (CNB, Table H1).
28. *Capital inflow* in USD, quarterly (CNB Table H5).

APPENDIX III

Figure 1

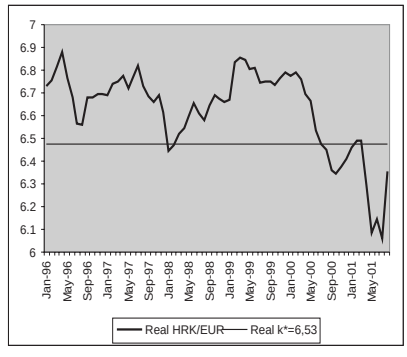

Figure 2

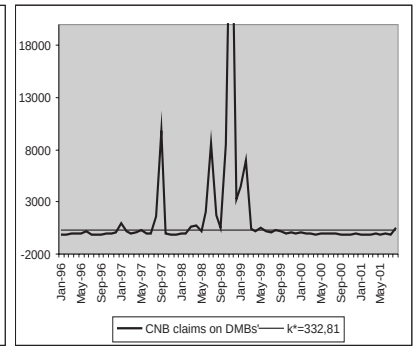

Figure 3

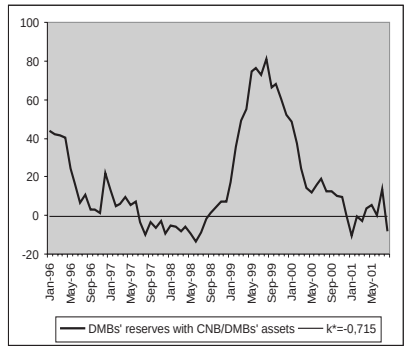

Figure 4

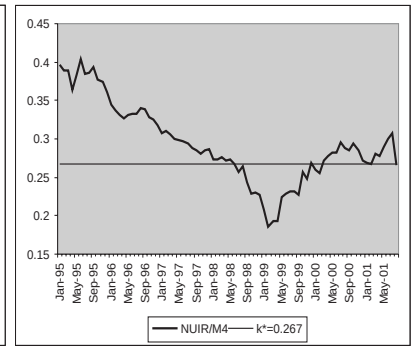

Figure 5

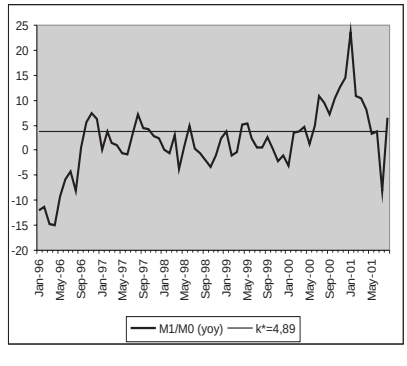

Figure 6

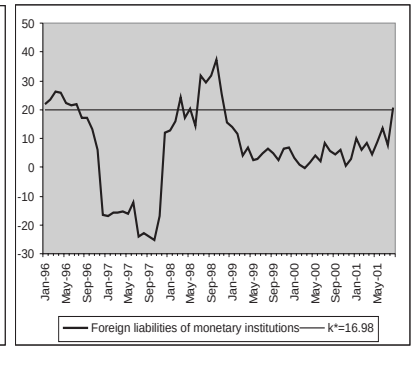

Figure 7

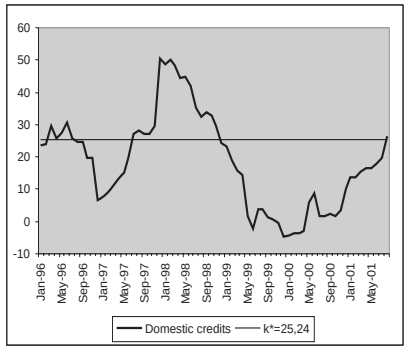

Figure 8

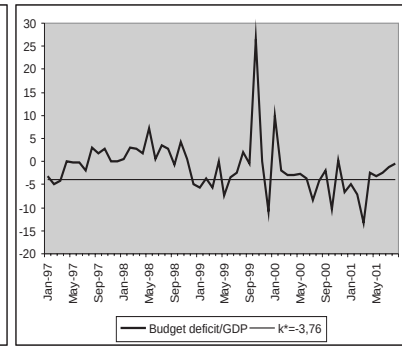

Figure 9