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This discussion paper presents results
from a research project on sustainable current
accounts and currency crises.

**How Good are Leading Indicators for Currency
and Banking Crises in Central and Eastern
Europe?
An Empirical Test**

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# Diskussionspapiere
*Discussion Papers*

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# 1.  Introduction

The 1990s were a decade of financial distress. The turbulences within the EMS were followed by the Mexico crisis and the Tequilla effect. After that the Asian crisis struck with its repercussions felt strongly in Russia and most recently in Brazil. Over time the nature of the crises seems to have shifted somewhat. While the earlier crises were confined to the currency markets, the crises that struck the Asian tigers were not only currency crises but also the result of inefficient banking systems.

Financial crises are usually quite expensive for the countries concerned. Just looking at the more recent ones, one is shaken by the numbers involved. The IMF has estimated that a typical currency crises causes output losses of about 4 – 7 percent of GDP and if currency crises occur together with banking crises this figures rises to 15 percent of GDP. (IMF, 1998a) The experience of the Asian countries points in similar direction. Their drops in GDP during 1998 were drastic with a reduction of 14 percent in Indonesia, 7 percent in Thailand and 6 percent in Korea and Malaysia. Except for Korea all countries are estimated to experience further contractions in 1999. The decline in Russian GDP is of similar magnitude, shrinking by over 5 percent in the course of 1998 and an estimated 8 percent in 1999. (IMF 1998b) Furthermore, the costs of restructuring the Thai banking sector have been estimated at 20% of GDP (Kaminsky and Reinhart 1998).

It is clearly worthwhile to study the causes of financial crises and to try to understand the factors responsible for the dramatic downturns that seem to strike out at times unpredictably. It has been argued that herding behavior and self fulfilling attacks were largely responsible for the crises (Wyplosz 1998). The theoretical and empirical literature has demonstrated that spillover effects and irrationalities indeed are among the factors that help explain the occurrence of currency crises (Eichengreen, Rose and Wypolsz (1996), Frankel and Rose (1996), Obstfeld (1994)).  Other recent empirical research that traces the evolution of different economic variables over time, indicates however that crisis do not just happen to countries, rather they are usually and foremost the result of unfavorable developments in the fundamentals of an economy. These deteriorating fundamentals typically "signal" long before the crisis that something is seriously amiss in the economic situation of a particular country. (Kaminsky and Reinhart (1996), Kaminsky (1998)) Furthermore, this research postulates that since financial liberalization has become more widespread a close link between balance of payments crises and banking crises - the so called twin crises - has developed. Thus knowledge about fragility in the banking sector can help to identify common causes and to prevent the outbreak of a balance of payments crisis.

This paper applies the signals approach developed by Kaminsky and Reinhart (1996)  for the first time to selected transition economies of Central and Eastern Europe. The countries which we focus on are Russia, the Czech Republic, Hungary, Bulgaria and Romania. For each of those countries it is possible to identify the occurrence of a balance of payments crisis and a banking crisis since the onset of transition. The aims of the paper are twofold. First, we study the behavior of the different variables leading up to the crises periods. This allows us to judge

whether the crises possessed a similar macroeconomic background and to identify the best leading indicators, which are of interest in assessing the development of economic variables in Central and Eastern Europe. Second, on a much more tentative note, we look at the individual countries and the evolution of the indicators before and after the time of crisis in order to highlight areas of concern for the countries involved. Our main results can be summarized as follows:

First, on a fundamental level, this approach can be sensibly applied to the transition economies in spite of their remaining singularities.

Second, all of the crises studied were characterized by a deterioration of economic fundamentals well ahead of the outbreak of the crises. Thus, spillovers and contagion seemed to have played a minor role at best.

Third, the best indicators for predicting a crisis were the exports, the real exchange rate and in contrast to other studies the budget deficit. Of little value were imports, capital flight and the domestic real interest rate.

The rest of the paper is organized as follows. Section two briefly reviews the empirical literature on currency and banking crises. Basically this involves a discussion of the more traditional approach of estimating the likelihood of a crisis taking place and the presentation of the signals approach. Section three applies the signals approach to the countries of Central and Eastern Europe and discusses the resulting fit of the indicators. Section four looks at the countries in more detail and discusses the evolution of the indicators after the passing of the crises. Section five concludes.

## 2. The empirical literature

### 2.1 Overview

Even though empirical studies on balance of payments problems have been conducted for a fairly long time, they have rose to prominence only since the mid-80s. Until today numerous studies have been carried out that seek to establish the influence of different economic variables on the outbreak and development of currency crises (e.g, Eichengreen, Rose and Wyplosz (1996), Frankel and Rose (1996)).[1] The possible interdependencies of currency and banking crises constitute a relatively new topic in this strand of literature, but one that has received heightened interest since the outbreak of the Asian crisis. Still, studies that deal with both balance of payments and banking crises are relatively rare yet.[2] The groundbreaking work was conducted by Kaminsky and Reinhart (1996), who asked themselves the question causality behind the two crises, i.e. if one of the crises causes the other or whether both crises have common causes and similar variables can be identified as being the driving forces. Their

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[1]  A good summary is found in Kaminsky, Lizondo and Reinhart (1997).

[2]  A little more has been written on the theoretical interactions between the crises, see e.g. Valesco (1987) Goldfajn and Valdez (1995) and Chang and Valesco (1998).

conclusion is that even though the two crises were unrelated until quite recently, they have tended to display a common background since capital controls have been abolished in earnest beginning in the early 1980s. Typically a banking crises will precede a balance of payments crisis, but will reach its climax only after the balance of payments crisis has erupted.

Studies dealing with the identification of early warning indicators differ widely in their scope, with some studies analyzing events over a time horizon of thirty years, while others focus on the events of one particular year. Similar disparity exist in view to the number of countries examined, sample groups of over 100 countries coexist with one country analysis. On the whole developing countries are included more often than industrialized countries. Data can be annual, quarterly or monthly.

Another important difference of the different studies lies in the definition of what actually constitutes a crisis. Balance of payments crises are usually associated with devaluations, but no accepted measure of the necessary size for a devaluation to constitute a crisis exists. (see e.g. Frankel and Rose (1996) Goldfajn and Valdez (1998) and JP Morgan (1998)). Building on Eichengreen, Rose and Wyplosz (1996) several recent studies also include changes in reserves and interest rates, as realignments or changes in the exchange rate regime capture attacks on a currency only imperfectly. To capture the occurrence of a crisis an index can be constructed which weighs changes in the three variables. In case of a successful attack the currency devalues, but in other cases typically interest rates will be raised and/or reserves be sold. According to this measure a crisis has taken place if the index takes on values lying a specified number of standard deviations above its mean, otherwise the period is identified as tranquil.

Banking crises are usually associated with events or states such as bank runs, closures, a certain share of non-performing loans or a recapitalization program. As they are usually much longer in duration than balance of payments crises two distinctions are made. The beginning of crisis is identified with a special occurrence like the closure of a bank or the granting of public financial assistance to the banking system. The climax of the crisis is that point in time when the largest number of bank are shut down or the government pledges its largest assistance – i.e. recapitalization – program.

The largest variance between studies occurs with respect to the variables used to monitor the development in the balance of payments or in the banking sector. Typically this choice is dictated by data availability. In their comprehensive overview Kaminsky, Lizondo and Reinhart (1997) identified 103 different variables used in studies, however many of these are transformations of the same basic variables.

## 2.2    The traditional approach: Estimating the probability of a crisis

Two alternative approaches exist for the systematic identification of early warning indicators. The first approach has traditionally focussed on balance of payments crises and tries to econometrically identify the roots and causes of currency crises. It was pioneered in a study dealing with Mexico by Blanco and Garber (1986). Following this approach Moreno (1995) conducted empirical test for several South-east Asian countries, Frankel and Rose (1996)

conducted a comprehensive study of 105 developing countries, while Eichengreen, Rose and Wyplosz (1995, 1996) analyzed spillover effects among 20 industrial countries and Sachs, Tornell and Valesco (1996) sought to explain the tequilla effect. More recently, Kruger, Osakwe and Page (1998) in a study comprised of 19 developing countries tried to determine whether currency crises are typically due to shifts in the fundamentals or the result of spillover among the countries. On the (even more) practical side JP Morgan (1998) used these models to construct the socalled Event Risk Indicator (ERI), which it uses to predict currency crises. Studies trying to identify early warning indicators for banking crises have been carried out by Hardy and Pazabasioglu (1998) as well as Demirgüç-Kunt and Detragiache (1998).

The methodology of these approaches is relatively uniform. For ease of exposition we will concentrate on the analysis of Eichengreen, Rose and Wyplosz (1995, 1996) and Kruger, Osakwe and Page (1998). Both analyzed which macroeconomic variables could be consistently linked to speculative attacks and whether after controlling for these influences, spillover effects are found to play a significant role in currency crises.

In both studies a crisis is identified with the help of the index for exchange market pressure, which evaluates changes in international reserves, the exchange rate and in interest rates. With the help of this index Eichengreen, Rose and Wyplosz identified during the period from 1959 until 1973 a total of 77 crises and 1179 periods of tranquility for their sample.

Concerning the variables Kruger, Osakwe and Page tested the behavior of the following indicators: a) ratio of foreign debts to GDP, b) international reserves, c) ratio of broad money to international reserves, d) real exchange rate, e)growth rate of domestic credit, f) inflation, g) ratio of budget deficit to GDP, h) claims of banks on the private sector, i) growth rate of GDP per capita and j) foreign interest rates.

Using a logit or probit model the hypothesis is tested that concurrent balance of payment crises in other parts of the world do not affect the likelihood of a crisis breaking out domestically. To this end the dependent variables are linked with the control variables via a maximum-likelihood estimate. Usually lagged variables are used under the assumption that a worsening of the fundamentals will take some time to feed itself through the system and culminate in a crisis. Additionally when using non-lagged variables it is hard to decide on the causality, i.e. whether the worsening fundamentals were responsible for the outbreak of the crisis or vice versa.

The main advantage of the probability approach lies in the fact that all information concerning the potential outbreak of a crisis is summarized in one number. Further, it allows to evaluate all variables simultaneously. But both strengths are likewise weaknesses. A main hindrance is the impossibility to rank the indicators according to their relative goodness in predicting crises. Under the probability approach a variable is either significant or not. While helpful in identifying highly explanatory variables, no information relating to the relative strength of a variable - i.e. to predict a large number of crises but to avoid emitting signals of crisis at non-crisis times - can be given. Similarly, from this analysis it is difficult to draw conclusions as to what went wrong in the macroeconomic sphere and where to correct economic policy in order to remedy the situation. A ranking of indicators according to their deviations from normal behavior would

be helpful for policy assessment. Lastly and related the probability approach is usually concerned with explaining crises that have happened. While JP Morgan undertakes out of sample predictions, these are of a short term nature, as with rising time horizon the predictive power is lost quickly. This restricts the usefulness of the probability approach for economic policy purposes, which needs to be able to implement measures - which only work with a certain time lag - in order to prevent a possible crisis.

## 2.3 The Signals approach

A different method that tries to overcome most of the above problems inherent in the probability approach is represented by the signal approach, which was formulated by Kaminsky and Reinhart (1996) as an alternative to identify early warning indicators for balance of payments and banking crises.[3] Other studies that have used this approach are Goldstein (1997), Kaminsky, Lizondo and Reinhart (1997) and Kaminsky (1998).

The basic idea behind the signal approach is that currency crises usually do not just happen, i.e. that pure self fulfilling attacks are rare, but that most crises are preceded by deteriorations in the economic fundamentals of an economy. While the approach does not claim to be able to accurately predict the outbreak of the next crises, it attempts to help in the construction of a warning system, which monitors the evolution of several variables over time. By identifying the relevant early warning indicators, deeper understanding of the precise macroeconomic forces that have driven the economy into the crisis can be gained. Furthermore, it is in principle possible to perform out of sample estimates about which countries are presently particularly prone to crisis.

To avoid duplication a more detailed description of the functioning of the signals approach is undertaken in the following section, which tries to determine whether a set of early warning indicators can be found that explain the experiences of the transition countries.

# 3. Applying the signals approach to Central and Eastern Europe

## 3.1 Size and scope of the sample

We study the evolution of five transition countries between 1991 and 1998. The countries in question are: the Czech Republic, Hungary, Romania, Russia and Bulgaria. The choice was dictated by the fact that each of them had experienced severe difficulties in the balance of payments and in the banking sector as well as by data availability. For both balance of payments and banking crises we focused on events – i.e. banking or balance of payments disruptions that would allow us enough data observations for a meaningful analysis - rather than employ the exchange market pressure index for currency crises.[4] Following Kaminsky

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[3] The idea behind the approach is not new however, but stems basically from the literature of trying to identify business cycles turning points.

[4] Not always to obtain time series covering the whole spectrum. Thus we did not include the Russian and Bulgarian currency troubles of 1994, which would otherwise have qualified as crises. The time series

(1998) our definition of banking crises is composed of two aspects, which arise from the fact that banking crises last longer and usually start earlier than currency crises. First, the start of a banking crisis is signaled either by a bank run, closures, mergers or a sizeable government assistance package and second the height of the banking crisis is assumed to happen considerably later.

This approach left us with the following events marking the beginning of a banking and/or currency crisis:[5]

- Czech Republic
    - Banking: August 1996, closure of Kreditni banka the sixth largest Czech Bank. Subsequently Agrobanka, the fifth largest bank was placed under forced administration and six smaller banks were closed.
    - Balance of payments: May 1997, after ten days of speculative attacks the fixed exchange rate regime is abandoned and the koruna left to float.

- Russia
    - Banking and balance of payments: August 1998, forced devaluation of the rouble, switch to a flexible exchange rate regime. A mounting interest burden due to several interest rate hikes and ensuing problems in rolling over short-term debt put the banking system in distress, with several closures in the following months.

- Bulgaria
    - Banking: March 1996, collapse of agricultural bank, starts a process that eventually wipes out half of the Bulgarian banks.
    - Balance of payment: January 1997, introduction of currency board after hyperinflation.

- Hungary
    - Banking: December 1993, net income before taxes of the banking sector turns negative to 5,2 percent of total assets. Bad debts rise to 18 percent of total loans.
    - Balance of Payments: December 1994, introduction of austerity package after current deficit has swollen to 9,4 percent of GDP.

- Romania
    - Banking: December 1996, bad debts reach 39 percent of total loans. This figures rises to 57 percent end of 1997.
    - Balance of payments: January 1997, the lei devalues 20 percent in the space of one week.

We study the evolution of 16 economic and financial variables[6]. The variables are mostly given in annual growth rates and on a monthly basis. An exception are the interest rate variables,

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that did cover the whole range were corrected for this fact in order to avoid a misinterpretation of the signals. Of course, this reduced the number of available observations.

[5] Naturally the fixing of dates is somewhat arbitrarily and often a matter of choice.

which are in levels. Below the variables are grouped in different categories. The plus or minus signs behind the variable name indicates the direction of the pre-crisis behavior a variable is assumed to exhibit. A brief summary of the economic rationale and stylized facts about their behavior in previous financial crises is given below:[7]

### a)     *Fiscal Policy*

- Ratio of government deficit to nominal GDP (+)

   This indicator corresponds to the classic Krugman-type explanation for currency crises. One would expect a steady rise before the eruption of a balance of payments crisis, while a priori there must not be a particular trend before a banking crisis. Afterwards an increase is to be expected due to the clean-up costs in the banking sector.

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[6]  The data is taken from the national statistics of the individual countries, the BIS and from the database of the Vienna Institute for Comparative International Economic Studies.

[7]  See also Kaminsky and Reinhart (1996) or Kaminsky (1998) for a theoretical underpinning of the variables.

**b)** **_Monetary Policy_**
- M2 multiplier (+)

Both banking and currency crises have been found to correlate closely with the emergence and rise of the domestic banking sector that accompanies financial liberalization. This usually entails e.g. reduction in the reserve requirements and thus a subsequent rise in the multiplier.

- Ratio of domestic credit to nominal GDP (+)

Again in the time leading to the two crises rapid credit expansion has been observed. The main reason for this lies in lending booms that can follow financial deregulation and the dismantling of capital controls or cyclical overheating. After the outbreak of a currency crisis a severe contraction of credit can be expected as banks are more judicious as the loan portfolio has deteriorated. Slowing economic activity and worsening portfolios.

**c)** **_Bank Runs_**
- Bank deposits (-)

Here we would expect a sharp drop before a banking crisis, as domestic residents who are better informed than foreigners slowly loose their faith in the banking systems ability to function efficiently. No particular reaction to currency crises is anticipated.

**d)** **_Current Account_**
- Exports (-)

Currency crises are closely linked to overvalued real exchange rates. Thus exports are expected to be depressed ahead of a crisis. Weak exports also add pressure on the banking sector as the reduced competitiveness will make business failures more likely and thus worsen the loan portfolio of the banking system.

- Imports (+)

The picture is less clear for imports, as the appreciation of the domestic currency should in principle foster imports. Should a weak export performance be also associated with lessening growth, negative income effects will compress import demand.

- Real exchange rate (-)

A financial crisis will go hand in hand with large appreciation of the real exchange rate from its trend value, worsening the competitiveness and increasing the interest burden of loans in foreign currencies.

*e)*    ***Capital Account***
- International reserves in US Dollars (-)

    The traditional measure of adequacy of foreign reserves to pay for imports. Reserves are expected to fall before a currency crises as they are spend on the defense of the exchange rate. A decrease can likewise be expected during banking crises.

- Ratio of M2 to reserves (+)

    This ratio is expected to increase as M2 will rise and reserves will fall before financial crises as domestic residents start converting domestic money into foreign exchange.

- Real interest rate differential (+)

    Real domestic interest rates will increase in banking crises as banks try to recapitalize themselves over a larger intermediation spreads. Also a sharp upswing is to be expected at the time of the currency crisis, as interest rates are used to stem capital outflows and for some time afterwards to prop up the new exchange rate.

- Foreign debt (+)

    Large foreign debts can turn the market sentiment against a country as it might be perceived to be unsustainable.

- Capital flight (+)

    The effects of capital flight are closely linked to shrinking bank deposits, as domestic residents will be the first to anticipate the crisis. Increasing capital flight can trigger a currency crises, which in turns may deepen an existing banking crisis.

- Short term foreign debt (+)

    An increase in short term foreign debt can be due to growing difficulties in rolling over foreign debt and the inability to obtain longer maturities due to the increased risk. This increases the susceptibility to financial crises, should the currency devalue, higher interest payments will increase the amount of domestic non-performing loans and the interest payments of the banking sector abroad.

*f)*    ***Growth***
- Output (-)

    An overvalued exchange rate and  the slowdown in exports will be reflected in a weakening economic activity both before balance of payments crises and banking crises. While the influence is quite direct for currency crises, the channel for banking crises runs from the overvalued exchange rate to sinking profit margins that cause the loan portfolio to worsen.

- Domestic real interest rate (+)

    High domestic interest rates may signal liquidity problems that in turn could cause banking sector problems as well as a general economic slowdown or contraction.

- Ratio of lending to deposit rates (+)

  The lead is historically taken here by the evolving banking crisis, as this variables captures a decreasing loan quality. With worsening credit portfolios, banks will become more hesitant to lend due to the associated adverse selection and moral hazard problems.

To determine whether the signal of a certain indicator heralds a crisis looming or whether it promises more settled times, it is necessary to determine a threshold value, which serves as a critical cutoff value that is the borderline between a sustainable and non-sustainable development. To find this critical threshold a balance has to be struck between setting it too high (should upward deviations indicate a worsening development) and thus potentially not classifying signals as worrying even though a crisis follows, or on the other hand to make the opposite mistake of setting the threshold not high enough, so that any slight deviation is considered a crisis signal, while the economy calmly trods on.

To solve the problem we followed Kaminsky and Reinhard (1996). For any indicator all observations from all countries were pooled. Iteratively this distribution was tested at varying cut-off points. For each cut-off point it is possible to compute a noise-to-signal ratio which is simply the ratio of bad signals to good signals. A bad signal is given when a signal is issued in non-crisis times or when no signal is issued during a crisis timeframe. A good signal conversely, remain silent in non-crisis periods and is observed prior to the outbreak of a crisis. For each indicator the cut-off value was selected that minimized the noise-to-signal ratio. Once having found the optimal cut-off point for all observations regarding a certain indicator, this value was applied to the individual distributions of that variable of a given country to determine the country specific threshold. If for example the value that minimized the noise-to signal ratio for all observations of current account deficits of the differing countries lay at 12 % , then all values greater than the value at the 12 % threshold were taken as a signal. Naturally, as the individual distributions between the countries differ, this produces very different results. To stick with the example, a current account deficit of 4 % might be troublesome in the Czech Republic but it might not be any problem at all for Hungary.

To differentiate between the signals and their "goodness" a time frame has to be defined within which the signals are evaluated. Due to the relatively short time period available for the transition countries an 18 month window was selected.[8] Specifically, for currency crises a signal emitted within 18 months prior to the outbreak of a crisis constitutes a good signal. A signal emitted before that date is correspondingly a bad signal. For banking crises the time frame was adjusted somewhat to take into account the different time structure of banking crises. Here the endpoint of the analysis is not the outbreak of the crisis, but several months afterwards in order to be able to take the worsening of the banking systems position into account. A signal is thus considered "good " if it was emitted in the 9 months preceding the crises or in the 9 months following the crises.

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[8]  The tests were also performed for a 24 month window yielding similar results.

To judge how effective an individual indicator is, it useful to consider the following matrix.

|  | crisis | no crisis |
|---|---|---|
| signal send | A | B |
| no signal send | C | D |

Source: Kaminsky, Lizondo and Reinhart (1997).

with :

A – number of months a god signal was send

B – number of months a bad signal was send

C – number of months no signal was send but a crisis followed

D – number of months no signal was send and no crisis followed

A good indicator will send primarily signals belonging in the quadrants A and D. To compute the noise-to signal ratio as an indicator of the quality of the individual early warning indicator one simply divides the tendency to send bad signals, i.e. the number of months where a bad signal was send divided by the number of months a bad signal could have been emitted (B / B+D) by the tendency to emit good signals (A / A+C). Defined like this values close to zero indicate that a variable is of high quality in predicting a crisis. If an indicator does not possess any information, i.e. if the signals it sends are arbitrary, it will take on the value 1. Indicators that show values of greater than 1 actually worsen the analysis and should be dropped from the list of indicators used for checking a country's vulnerability to either a currency crisis or an banking crisis.

## 3.2    The main results

Table (1) gives an overview over the performance of individual indicators in forecasting currency and banking crisis. For each indicator and type of crisis, the first column gives the critical region, which is the percentage of observations that are identified as signaling crises, the next two columns show the size of type I and type II errors, respectively, and the last column gives the a noise-to-signal ratio.

Table 1:
Characteristics of the Leading Indicators

| Indicator | Currency Crisis | | | | Banking Crisis | | | |
|---|---|---|---|---|---|---|---|---|
| | Critical Region | Type I Error (per cent) | Type II Error (per cent) | Noise-to-Signal Ratio | Critical Region | Type I Error (per cent) | Type II Error (per cent) | Noise-to-Signal Ratio |
| **Fiscal Policy** Gov. Deficit/GDP | 18 | 62 | 5 | 0.13 | 13 | 71 | 9 | 0.30 |
| **Monetary Policy** M2 Multiplier | 32 | 67 | 31 | 0.94 | 29 | 67 | 23 | 0.69 |
| Dom. Credit/ GDP | 14 | 77 | 8 | 0.36 | 10 | 81 | 6 | 0.30 |
| **Bank Runs** Bank Deposits | 8 | 84 | 4 | 0.25 | 16 | 39 | 7 | 0.12 |
| **Current Account** Exports | 10 | 80 | 2 | 0.12 | 7 | 85 | 4 | 0.24 |
| Imports | 18 | 88 | 21 | 1.70 | 32 | 86 | 39 | 2.77 |
| Real Exchange Rate | 28 | 48 | 19 | 0.37 | 7 | 89 | 6 | 0.53 |
| **Capital Account** Reserves | 18 | 72 | 9 | 0.31 | 7 | 78 | 5 | 0.24 |
| M2/Reserves | 9 | 88 | 4 | 0.33 | 26 | 50 | 18 | 0.35 |
| Real Interest Rate Diff. | 7 | 93 | 7 | 1.05 | 9 | 63 | 5 | 0.14 |
| World Real Interest Rate | 28 | 74 | 28 | 1.08 | 6 | 98 | 7 | 4.80 |
| Foreign Debt | 7 | 91 | 6 | 0.63 | 7 | 81 | 6 | 0.33 |
| Capital Flight | 12 | 90 | 13 | 1.26 | 6 | 92 | 8 | 0.95 |
| Short-term Foreign Debt | 10 | 82 | 4 | 0.24 | 9 | 71 | 5 | 0.16 |
| **Growth** Output | 28 | 64 | 24 | 0.69 | 18 | 54 | 13 | 0.28 |
| Domestic Real Interest Rate | 6 | 92 | 5 | 0.60 | 28 | 67 | 27 | 0.80 |
| Lending/Deposit RateRatio | 8 | 82 | 2 | 0.13 | 9 | 76 | 6 | 0.25 |

Like the findings of Kaminsky/Reinhart and Kaminsky (1998) the forecasting ability of the different indicators of our analysis vary widely. One of the best indicators are exports with a noise-to-signal ratio equal to 0.12 for currency crises and equal 0.24 for banking crises. The worst indicator are imports with a noise-to-signal ratio far greater than one; 1.7 for currency crises and 2.8 for banking crises - meaning that the indicator issues either false alarms or sends no signals at all. In sum, only five out of the eighteen indicators considered here should not be used for forecasting these types of crises.

Contrary to Kaminsky's findings, the world interest rate does not accentuate the vulnerability of the economies by triggering speculative attacks against the domestic currencies. The noise-to-signal ratio of this indicator is 1.1. An important result of Kaminsky's study (1998) is that the onset of a currency crisis is characterized by the coexistence of inverse capital flows. Her analysis suggests that during the period prior to the outbreak of a currency crisis, increasing foreign debt and positive capital flight can be observed. This seems to be only partially true for

the Central and East European countries – with a noise-to-signal ratio well below one for foreign debt and greater than one for capital flight. However, just like for the Asian crisis, liquidity problems have also been important during the East European currency crises. Liquidity problems are captured by the ratio of foreign debt with a one-year maturity or less to total foreign debt. Here the noise-to-signal ratio is 0.24.

Surprisingly, bank runs are an excellent predictor of banking crises. This result has not been found in previous studies for other countries. Apparently, the implicit and explicit deposit insurance guarantees are not very credible in the Central and East European countries. This result is even reinforced if domestic residents' assets overseas (capital flight) - with BIS reporting banks – is taken into account with a noise-to-signal ratio of below one (0.95) but greater than one for currency crises (1.26).

It is harder to anticipate banking crises than speculative attacks against the domestic currency. The average noise-to-signal ratio for all indicators is 0.75 for banking crises and 0.59 for currency crises. This confirms basically the findings of Kaminsky (1998) also for the Central and East European countries. However, in our analysis the bad average performance of the indicators in the case of banking crises is only due to the exceptionally bad forecasting abilities of two indicators; namely, imports with a noise-to-signal ratio of 2.8 and the world interest rate (4.8). All other indicators have noise-to-signal ratios below one. So, looking at the median of the noise-to-signal ratios of all indicators the performance in the case of banking crises is much better than in the case of currency crises. The median for currency crises and banking crises are 0.49 and 0.30, respectively. Some indicators are considerably more accurate in anticipating banking crises than currency crises. This is – like in Kaminsky's analysis- the case for indicators related to the domestic financial sector. In particular, the indicators that capture the boom-bust credit cycle: M2 multiplier and domestic credit/GDP.

## 3.3    A closer look at the individual countries

This section will take a look to see how the indicators fared in the individual crisis the countries and - except for Russia since its crisis is too recent - whether the indicators have emitted signals in concentrated form lately in order to gauge the soundness of recent economic developments. These comments should not be mistaken for a prognosis, rather they serve to highlight areas that could be but need not be of concern. The results of how the indicators performed regarding the actual crises are given in Table 2, with a plus or double plus indicating good explanatory power, 0 that no real inference could be made and a minus or double minus that the given indicator did not perform well.

The lead up to the **Czech** currency crisis was marked by an increasing number of indicators sending signals of distress. 82 percent of all indicators send signals at different points in time in the 18 months preceding the crises. Characteristic for the Czech case is a marked deterioration of most variables in this time period, without however always reaching the threshold. Consequently a staunching of signals only occurred in the last half year prior to the crisis with about 40 percent sending simultaneously 6 months ahead and 56 percent of all indicators blinking 4 months ahead. Only a few indicators – notably imports, foreign debt, the

domestic real interest rate and capital flight did not send any signals at all or did not convey any information about the impeding crisis. The evidence thus points overwhelmingly to a crisis that was caused by deteriorating fundamentals and not as sometimes asserted by contagion from East Asia. Since the crisis the economic performance as indicated by the variables has increased considerably with most indicators far from their threshold values. Exceptions are the banking deposits which have remained in the signal region, causing concern about the banking sector; the real exchange rate, showing that the koruna has become overvalued again and the government deficit which has lately started to emit signals again. Cause for concern are also the poor output figures realized in the last two quarter of 1998, which were not among the data set which we tested. All in all though the Czech Republic has mastered the crisis on the balance of payments front. The situation – as portrayed by the evolution of the indicators - is similarly stable for the banking sector. In light of the continuing problems with non-performing loans this comes as small surprise.

In **Bulgaria** the behavior of the indicators is influenced by the hyperinflation that preceded the introduction of the currency board. This affected the performance of certain indicators such as the real interest differential. On the whole, the performance of the indicators is weaker than for the Czech Republic with less indicators continuously rising above or below their respective thresholds. The best performing indicators were the ratio of the budget deficit to GDP, the growth rate of domestic credit and the changes in foreign exchange reserves. Like in the Czech Republic a deterioration could be observed over prolonged periods of time in almost all indicators, even if they did no always cross the threshold levels. Unlike the Czech Republic exports and the real exchange rate were not among the stronger indicators an variables related to the financial sector did  mostly better than those that can be grouped to the current account. Again no information could be gained from imports, the domestic real interest rate capital flight and the changes in foreign debt. Considerably more variables have started or continued to give signals after the end of the crisis than was the case for the Czech Republic with most of the variables only starting quite recently. The deterioration of export growth, output, and the rise in the spread between lending and deposit rates combined with a simultaneous expansion of domestic credit growth are particularly noteworthy, as each belonged to the better performing indicators in the sense of possessing low noise-to-signal ratios.

Table 2:
Summary of Results

| Country | Bulgaria | Czech Rep. | Hungary | Romania | Russia |
|---|---|---|---|---|---|
| **Indicator** | | | | | |
| **Fiscal Policy** | | | | | |
| Gov. eficit/GDP | ++ | + | + | ++ | ++ |
| **Monetary Policy** | | | | | |
| M2 Multiplier | 0 | + | 0 | + | + |
| Dom. Credit/ GDP | + | 0 | + | - | + |
| **Bank Runs** | | | | | |
| Bank Deposits | + | + | + | - | 0 |
| **Current Account** | | | | | |
| Exports | 0 | + | - | + | + |
| Imports | -- | -- | 0 | 0 | 0 |
| Real Exchange Rate | + | + | + | + | ++ |
| **Capital Account** | | | | | |
| Reserves | + | + | - | - | + |
| M2/Reserves | 0 | + | -- | n.a. | + |
| Real Interest Rate Diff. | - | 0 | + | -- | -- |
| World Real Interest Rate | | | | | |
| Foreign Debt | -- | -- | + | 0 | + |
| Capital Flight | -- | 0 | -- | -- | 0 |
| Short-term Foreign Debt | ++ | 0 | + | 0 | 0 |
| **Growth** | | | | | |
| Output | + | ++ | - | ++ | -- |
| Domestic Real Interest Rate | 0 | - | -- | 0 | -- |
| Lending/Deposit Rate Ratio | + | + | 0 | -- | + |

**Hungary** is after Romania the country with the least number of indicators issuing signals that indicated the outbreak of a crisis. Particularly interesting is the lack of influence of exports and only a subdued positive explanatory power of the real exchange rate. At the same time imports seemed to have played a role. This suggests that the ballooning current account deficit was driven by other forces than the current deficits experienced by other transition countries. Well on the other hand, performed the growth rate of domestic credit, the ratio of short term foreign debt to total foreign debt and to lesser degrees the real interest rate differential and bank deposits. Together these serve as an indication of sizable problems in the Hungarian banking sector, which at that time was severely undercapitalized and possessed a loan portfolio of poor quality. From the indicators that have given signals since the crisis have been overcome the real interest differential stands out as being steadily above the threshold since the time of the crisis. Yet, this does not indicate major problems down the road, as the ratio is well below that of other transition economies and Hungary has like other transition economies large capital needs. Similarly, the domestic credit variable has been above the threshold for the last 18

months, here more caution is called for as this could indicate the beginnings of a boom-bust cycle.

**Romania** is interesting insofar as it is the only country in the sample that has not fixed its exchange against another currency but rather has opted for a flexible exchange rate regime. It is also remarkable that only five out of the 16 indicators possess substantial explanatory power, the least number observed for a country in our sample. Yet, these proved themselves to be persistent in their emission of warning signs, with industrial output starting to send signals as early as 12 months prior to the outbreak of the currency crisis. Also of value were the deficit / GDP ratio, exports, the real exchange rate and the M2 multiplier. Unlike in other countries these were also exactly the same indicators that have signaled potential problems since the crisis. Even though he signals were not as intense as in the second half of 1996, clearly Romania could be heading for trouble again.

Finally, turning to the latest casualty of international financial markets in Central and Eastern Europe – **Russia** - the picture that emerges is similar to that of the Czech Republic. Nine indicators show good explanatory power, indicating that the crisis was certainly home made and not the result of Asian contagion. Especially well proved to be the real exchange rate, the deficit ratio, exports and domestic credit, as well as reserves and the ratio of M2 to reserves. All this mirrors the state of the Russian economy in the first nine months of 1998 rather well, with a sizable overvaluation of the rouble, a government deficit that could not be brought under control and dwindling reserves. Poor performance showed the growth indicators with the exception of the lending/ deposit rate, which had a mildly positive information impact.

## 4. Concluding remarks

The results of our empirical analysis are encouraging, since we were able to replicate the results of previous studies. It shows that the transformation countries – despite having special features – already share many common features with other countries. The main conclusion of our study selected Central and East European countries is that the crises that have taken place are baiscally homemade and not due to contagion effects.

The signal approach has certainly its limitations. Our sample consists only of five countries, thus, the results can be strongly influenced by outliers. which was apparent in some of the indicators. Furthermore, the country sample is quite heterogenous. And the classification of crises into pure currency or a pure banking crisis is frought with difficulties. While the Russian crisis contained strong elements of both, the Czech case was more representative of a currency crisis, and the Hungarian crisis leaned more towards a banking crisis.

Nonetheless, the signals approach certainly has its merits as a tool to assess the evolution of economic fundamentals within a particular country or region and to heighten the awareness of policymakers for potential imbalances. Due to the early warning character of the approach it provides policymakers with timely and ample opportunity to change course and to prevent subsequent eruptions. Yet, a blind following of a given set of indicators will almost surely be

misleading since crises usually exhibit individual characteristics that reflect special features germane to a country's history and unique economic circumstances prevailing at that moment. It is to be expected that the next crisis will contain new relevant factors which previously our profession had not considered. Still, while being imperfect in this sense the signals approach offers a host of information that can be put to profitable use by analysts and policymakers alike.

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