Predicting Currency Crises Using the Term Structure of Relative Interest Rates: Case Studies of the Czech Republic and Russia

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Among the plethora of early warning mechanisms for currency crises proposed in the literature, there is an approach which has received little attention so far. This rather simple early warning indicator relies on the term structure of relative interest rates, unlike the vast majority of such systems that are based on macroeconomic fundamentals to predict a crisis in a long- or medium-term horizon. It measures changes in market sentiment regarding the relative probability of a currency crisis to estimate the timing of a crisis within a very short time window. This indicator thus complements long-horizon models that have been widely used so far. We apply this method to currency crises in the Czech Republic in 1997 and in Russia in 1998 and find evidence that the indicator would have performed well as a real-time predictor in both episodes of currency distress.

1 Introduction

The last two decades have witnessed several and massive currency crises and speculative attacks. This is why researchers, politicians and central bankers have redoubled their efforts to better understand these dramatic events, which tend to be painful and costly shocks for the economy in question and usually also affect the population immediately, e.g. in the form of a massive contraction of GDP or growing poverty. Increasingly globalized capital markets imply growing volumes of and diminishing barriers to capital flows, principally reducing the potential risk of a sudden stop in capital inflows (see e.g. Goldstein, 2005, Roubini, 2006, and International Monetary Fund – IMF, 2006). Notwithstanding the relative tranquility of the past few years, there are certain countries whose fundamental macroeconomic and/or political conditions economists and politicians generally deem to be vulnerable to a balance-of-payments crisis. This holds particularly true for some emerging economies in Central and Eastern Europe (CEE), a key focus of this publication.

In both the theoretical and empirical literature, researchers have therefore paid attention to the phenomenon of currency crises. In the realm of theory, the so-called first generation model failed to provide satisfactory theoretical instruments to describe and explain the causes and frequency of crises in the 1990s, which led to the creation of the second and third generation of currency crisis models. Moreover, as some of the financial crises (e.g. in Mexico 1994 or in Asia 1997) took the international community rather by surprise, economists also started pondering ways to predict the timing of such events. Within just a few years, distinct forecasting models emerged with fair to middling predictive accuracy.

Among the abundance of models, one approach has received little attention so far. Unlike the vast majority of other early warning systems, this rather simple indicator does not rely on macroeconomic fundamentals to predict a

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crisis in a long- or medium-term horizon. Instead, it uses the term structure of relative interest rates to obtain estimates of changes in market participants' perception of the timing of a currency crisis in a very short time window. To our knowledge, only a handful of researchers have so far followed this approach, which is essentially based on the seminal work by Collins (1984).

The available evidence suggests a reasonable predictive power of the indicator. Compared with other models, this approach has several attractive advantages. First of all, it does not require a definition of what constitutes a crisis in terms of percentage depreciation, which tends to be rather arbitrary in the literature. Based on term structure data alone, this approach does not rely on estimating threshold values of fundamental variables (for a group of countries), but extracts expectations regarding the timing of a crisis from country-specific interest rates. Moreover, as this approach requires the use of country-specific data only (which are usually easily available), no pooling is necessary to obtain a sample of usable size. Most importantly, this indicator complements widely employed long-horizon models based on fundamentals, as it mirrors the very short-term sentiment on foreign exchange markets and thus focuses on predicting the imminent outbreak of a crisis.

Existing attempts to use early warning mechanisms in crises in emerging CEE economies have suggested that the predictive power of these models is rather poor, particularly out of sample. This may be attributable to too long forecasting horizons on the one hand and to limited data availability, especially in the early transition periods, on the other. Hence, the general advantages of the term-structure indicator sketched above are even more pronounced in this restricted environment. In this paper we would therefore like to complement the still rather patchy research by testing the term-structure indicator on crises in CEE. The general perception on currency crises in CEE during transition is concentrated on three events: Bulgaria in January 1997, the Czech Republic in May 1997 and Russia in August 1998.[3] As not even the basic data required for our indicator were available for the precrisis period in Bulgaria, we focus on the two other countries in this study.

The paper is structured as follows. In section 2 we give a brief overview of the theoretical and empirical literature on currency crises and early warning systems as well as their performance in CEE. In section 3 we develop the model framework for the indicator. In section 4 we provide empirical evidence of the indicator's performance as a real-time predictor prior to the crises in the Czech Republic in 1997 and in Russia in 1998. A detailed explanation of the reasons for the crises would go beyond the scope of this paper. However, we put the indicator in context by describing its performance against the background of the crises' most relevant milestones, and thus also briefly describe their evolution. Finally, section 5 concludes.

[3] *Depending on the definition of a crisis, some authors may interpret more episodes of currency weaknesses as crises.*

2 Brief Review of the Currency Crisis Literature

2.1 Theoretical Literature

Although this paper focuses on empirical early warning mechanisms for currency crises, we will also briefly look into the theoretical literature, as it set the stage for the (much younger) empirical models. The literature on currency and balance-of-payments crises looks back on a relatively long history. Its theoretical foundations were laid in the seminal work by Krugman (1979). In this paper and in others of the so-called first generation model (see e.g. Flood and Garber, 1984), speculative runs on currencies are explained by adverse developments of fundamental macroeconomic variables (particularly excessive fiscal and monetary expansion) that are incompatible with the sustainability of the fixed exchange rate arrangement. In Krugman's model, the monetization of fiscal deficits would eventually lead to a complete depletion of the central bank's foreign reserves, so that the bank would have to abandon the fixed exchange rate regime. However, as speculators anticipate this inevitable collapse, they lose confidence and start selling off domestic currency as soon as reserves drop to a certain level at which there are no longer any arbitrage opportunities. By selling currency, they accelerate the exhaustion of reserves and the ensuing devaluation of the exchange rate. According to first generation models, crises are thus homemade consequences of inadequate economic policy, and the outbreak of a crisis is entirely predictable.

As this theoretical approach was not really satisfactory in describing and explaining a series of speculative attacks in the European exchange rate mechanism (ERM) and in Mexico in the first half of the 1990s, when no critical development of macroeconomic fundamentals could be observed, a second generation of currency crises models emerged. These models, pioneered by Obstfeld (1994), describe crises as the consequence of self-fulfilling expectations of markets that are characterized by multiple equilibria. A speculative attack is regarded as a self-directed shift from one rational expectations equilibrium in which a fixed exchange rate regime is sustainable to another equilibrium in which it is not. The government abandons its exchange rate policy as soon as the costs that arise from maintaining the fixed regime exceed the total costs that stem from pursuing a floating regime on the one hand and from harmed credibility on the other. Obviously, the more the market is convinced that a central bank's resistance will eventually fail, the more expensive it becomes to defend a parity. The models of the second generation do not exactly specify how the switch from one equilibrium to another is initiated. The triggering factors might be, for instance, adverse political events, such as the outcome of the Danish referendum on the Maastricht Treaty in 1992, or a currency crisis in a neighboring country.

The third generation of models was developed when the existing approaches failed to provide a satisfactory explanation for the wave of currency crises in Asia in 1997. Krugman (1998), who was again one of the leading thinkers, came up with the idea of overinvestment. He explains the outbreak of a currency run as a symptom of, rather than the cause for, accumulated problems in the banking and financial sector. In concrete terms, the government issues implicit or explicit bailout guarantees to attract foreign banks and investment. Yet by guaranteeing bailouts for potential losses without improving and reinforcing regulation and control of the financial system, a moral hazard problem arises, and overinvestment occurs. Excessively risky credits that are issued by financial intermediaries and backed by government guarantees drive up asset prices. This leads to a bubble on the asset market that will eventually burst and thus fully reveal the insolvency of financial institutions. In contrast, Radelet and Sachs (1998) maintain that the shift from a "good" to a "bad" equilibrium was attributable to a combination of three factors: (1) a panic reaction on the part of the international investment community, (2) policy mistakes at the onset of the crisis by Asian governments, and (3) poorly designed international rescue programs that turned the withdrawal of foreign capital into a full-fledged financial panic. Dooley (2000) in a way links both approaches, arguing that a crisis will break out once a government's (limited) capacity for bailouts is exhausted.

2.2 The Empirical Literature on Currency Crises

The theoretical literature we have sketched so far aims at providing explanations for runs on currencies in afflicted countries. Babic and Zigman (2001) point out that more than ten crises since 1980 whose costs amounted to at least 10% of GDP have occurred since 1980. Given the strong impact and proliferation of financial crises over the last two decades,[4] researchers and policymakers have taken a strong interest in developing a mechanism for the early identification (and thus more likely prevention) of an approaching crisis. The first attempts to measure an economy's external vulnerability and the extent to which it is prone to crisis were made in the aftermath of the Tequila crisis in Mexico in 1994. The pioneering work on quantitative early warning systems for currency crises was the canonical indicator approach developed by Kaminsky, Lizondo and Reinhart (KLR) in a series of papers (see e.g. Kaminsky, Lizondo and Reinhart, 1998). The KLR approach is based on monitoring the evolution of a number of economic variables or indicators. The authors tested a total of more than 100 indicators, which were clustered into six generalized categories: the external, financial and real sectors, public finances, and institutional and political variables. When a variable deviates from its "normal" level beyond a certain threshold value, this variable is said to issue a signal. The threshold is chosen so as to minimize the noise-to-signal ratio of the data available. Then a composite indicator is constructed as an average of indicators weighted by the frequency of correct predictions. Some of the variables that perform best in this framework are output, exports, the deviation of the real exchange rate from trend, equity prices and the ratio of broad money to foreign reserves. One of the major points of criticism of the KLR approach is the inclusion or exclusion of variables which are only loosely related to the theoretical literature (see Blejer, 1998). Another point is the loss of information for independent variables, as the amount by which a threshold is surpassed makes no difference (see Bussière and Fratscher, 2006).

Following the KLR approach, a great number of forecasting models has emerged both in the academic literature as well as in the private sector. Unlike the indicator approach, most of them are based on the results of logit or probit

[4] *For a survey on recent crises and conclusions drawn from them, see e.g. Dornbusch (2001) or Feldstein (2002).*

regressions. It is noteworthy that these approaches, like the KLR model, tend to use as explanatory variables some fundamental data such as current account, exchange rate overvaluation or export growth data. The choice of variable is predominantly inspired by the three generations of theories on balance-of-payment crises, but tends to be limited by data availability. Whereas academic models usually use a long-term approach with forecasting horizons of up to two years, their private sector counterparts usually focus on a short time window of one to three months. Berg, Borensztein and Patillo (2005) give a very helpful overview of forecasting models which have either been directly implemented by the IMF or which have been developed by the private sector and have had their performance monitored by the IMF. Moreover, in their survey the authors address what may well be the most important question, namely whether early warning systems have any out-of-sample forecasting value added at all. In their assessment, they put a particular emphasis on the models' potential real-time performance. Unfortunately, their conclusions are rather disappointing: Only one of the long-horizon forecasts under consideration, the KLR model, provided better accuracy than pure guesswork and nonmodel-based predictions. The results for the other long-term models were not unambiguous, and the short-horizon private sector approaches performed rather poorly by and large. By contrast, when testing whether the KLR model would have been able to forecast the Thai crisis in 1997, Anzuini and Gandolfo (2003) conclude that the indicator approach has strong (ex post) explanatory power but quite limited predictive abilities.

Finally, several papers in the empirical literature employ Markov switching models to predict currency crises. In most cases, researchers only distinguish between two states (crisis or no crisis) and define two types of crisis regimes: one with a higher volatility (Abiad, 2003) and one with a higher mean (Cerra and Saxena, 2002). Chen (2005) introduced a third possibility in his model, defining an intermediate vulnerable state in addition to crisis and no crisis. This state is characterized by a higher mean than the whole sample but lower volatility than the high-volatility regime. He uses the Market Pressure Index (MPI) proposed in the KLR approach as the dependent variable, which reflects both the exchange rate and the change of foreign reserves. Chen shows that his approach is preferred to standard two-state models in six developing countries, in which the foreign exchange markets switched to either the vulnerable or the high-volatility regime prior to the crisis. In contrast, he finds that an alternative probit model does not issue any warning in three out of six cases. Moreover, in four of these six countries in question, the indicated probability falls as the crisis approaches. The Markov switching model thus outperforms the probit benchmark, particularly in the months immediately preceding the crisis.

Brüggemann and Linne (2002) were among the first to test an early warning mechanism on CEE data using the KLR methodology. Schardax (2002) studies the predictive power of macroeconomic fundamentals for crises in CEE using binary variable models after preselecting the variables by means of the signal approach. Bussière and Fratscher (2006) try to improve the forecasting abilities of binomial logit models by extending them to a multinomial model with three regimes of the dependent variable. In contrast, Kittelmann et al. (2006) apply the Markov switching approach put forward by Abiad

(2003) to economies in CEE and the Commonwealth of Independent States. Apart from the rather fair to moderate prediction results, particularly out of sample, all of these studies are characterized by a medium- to long-term forecasting horizon ranging between 12 and 24 months and the use of macroeconomic fundamentals as explanatory variables.

In contrast, only a handful of attempts have been made to use financial market information as a predictor of exchange rate developments. Malz (2000) investigates the predictive capacity of the implied volatilities of foreign exchange options, Cincibuch and Bouc (2001) do the same for the Czech koruna. In this paper, we propose an indicator which has enjoyed even less attention so far. It exploits the term structure of relative interest rates to estimate market participants' perception of the timing of a currency crisis in a very short time window. The seminal work on this method was done by Collins (1984), who applied her analysis to the March 1983 devaluation of the French franc relative to the Deutsche mark. The same approach was also used by Anzuini and Gandolfo (2003), who compare the predictive power of the fundamentals-driven indicator approach and of the term structure model for the crisis in Thailand in 1997. They conclude that the nonstructural approach used by Collins (1984) is well suited to forecasting, but does not provide an explanation of the events, while the opposite is true for the structural model. To our knowledge, the indicator has not been applied to CEE crises before and thus provides an innovative complement to the existing literature both in terms of methodology and the signaling horizon.

3 Using the Uncovered Interest Rate Parity to Predict Crises

The basic objective of our analysis is to examine the ability of foreign exchange markets to predict exceptional exchange rate devaluations. We rely on the model proposed by Collins (1984) to construct a leading indicator for currency crises (see also Anzuini and Gandolfo, 2003), which was designed to study the behavior of speculators prior to the French franc realignment in 1983. The indicator is anchored in the uncovered interest parity (UIP) and can be derived as follows.

Assuming perfect capital mobility, risk neutrality, a constant risk premium and arbitrage, the UIP can be written as follows

$$\frac{(1+i_{t,k})}{(1+i^*_{t,k})} = \frac{E(e_{t+k} \mid \Omega_t)}{e_t} + \rho_{t,k} \tag{1}$$

where e_t is the spot exchange rate at time t, defined as the price of foreign currency in domestic currency units.[5] $i_{t,k}$ and $i^*_{t,k}$ are the domestic and foreign interest rates at time t on deposits with maturity k. $E(e_{t+k} \mid \Omega_t)$ stands for the expected exchange rate in period $t+k$, given the information available at time t, and $\rho_{t,k}$ represents a premium for risks not immediately related to exchange rate movements (e.g. the country default risk) and is for the moment assumed to be constant. Equation (1) states that the relative yield on domestic deposits of a given maturity is equal to the expected exchange rate movement and a well-defined country risk premium. Equation (1) can be rewritten as

[5] *That is, an increase of e_t means a depreciation of the domestic currency.*

$$E(e_{t+k} \mid \Omega_t) = \left[\frac{(1+i_{t,k})}{(1+i^*_{t,k})} - \rho_{t,k} \right] e_t . \tag{2}$$

Let us assume that at time t, market agents form expectations on future exchange rate developments and assign a certain probability to the event that the exchange rate will remain stable. The complementary probability is assigned to the event of a crisis, meaning a one-time depreciation and a stable exchange rate afterwards.[6] Formally, this implies that

$$E(e_{t+k} \mid \Omega_t)) = (1-\pi_{t,k})e_t + \pi_{t,k} z_{t,k} \tag{3}$$

where $z_{t,k}$ is the exchange rate in the period $t+k$ in the case of devaluation, $z_{t,k} = \gamma_{t,k} e_t$, where $\gamma_{t,k} > 1$, and $e_{t,k}$ is the expected exchange rate assuming no devaluation (in other words, the exchange rate remains stable at the level observed at time t). The subjective probability of devaluation occurring after k periods is therefore $\pi_{t,k}$. In line with Collins (1984), we assume that the rate of depreciation does not depend on the temporal horizon, so that $\gamma_{t,k} = \gamma_t$. It follows that the link between the relative yields and the subjective probability of devaluation can be stated as

$$\alpha_{t,k} = 1 + (\gamma_t - 1)\pi_{t,k} + \rho_{t,k}, \tag{4}$$

where $\alpha_{t,k} = (1+i_{t,k})/(1+i^*_{t,k})$. The perceived probability of a devaluation between time t and $t+k$, $\pi_{t,k}$, can be written as $\pi_{t,k} = \sum_{i=1}^{k} r_{t,i}$, where $r_{t,i}$ is the probability of a devaluation happening between the periods $t+i-1$ and $t+i$, which refer to different deposit maturities. Assume that there are two maturities, $k=7$ and $k=30$ days (this will be the case in the empirical illustration in the following section). Then it can be easily shown that, assuming $\rho_{t,k} = 0$, that

$$r_{t,7} = \frac{\alpha_{t,7} - 1}{(\gamma_t - 1)}, \text{ and} \tag{5}$$

$$r_{t,30} = \frac{\alpha_{t,30} - \alpha_{t,7}}{(\gamma_t - 1)}. \tag{6}$$

The ratios (or log ratios) of the expressions above are independent of the assumed size of the devaluation, γ_t, and can thus be used to evaluate changes in the market participants' relative probabilistic assessment of crisis timing. Our basic indicator for the empirical analysis will be the log ratio of $r_{t,7}$ to $r_{t,30}$[7]

$$I_t = \ln\left(\frac{r_{t,7}}{r_{t,30}} \right) = \ln\left(\frac{\alpha_{t,7} - 1}{\alpha_{t,30} - \alpha_{t,7}} \right), \tag{7}$$

[6] *Constructing the indicator in this simplistic way rules out other possible expectations of the markets (e.g. expectations about developments of the exchange rate after the crisis, such as overshooting) which could otherwise (by different constructions) be reflected in the indicator's development. This construction also implies that the indicator cannot be interpreted in the same manner after the fixed exchange rate regime has been abandoned.*

[7] *As explained before, the indicator is meant to mirror short-term market sentiment, since we believe that market instruments are able to provide information on the markets' expectation only in the very short horizon. Indeed, although the results are similar to some extent if a short maturity (e.g. 7 or 30 days) is related to a longer maturity (e.g. 90 days), according to our expectations the indicator performs best if the two shortest maturities are used.*

so that increases in I_t imply an increase in the probability perceived by investors that a crisis will occur in the forthcoming week as compared to the crisis taking place in the period between day 8 and day 30.[8]

4 Applying the Model to Crises in CEE

In this section we will apply the indicator to data on two recent currency crises in CEE: the currency crisis in the Czech Republic in May 1997 and the one in Russia in 1998.[9] In both cases we will describe the economic framework in which the currency crises took place and present the real-time estimates of our indicator for both economies in the crisis period. Please note that the indicator proposed in this study does not have the typical properties of most crisis indicators in the literature – it does not send a binary signal of the type "crisis" versus "no crisis." This implies that the usual evaluation of crisis indicators in the light of type I and type II errors does not apply in our setting. Our indicator registers changes in investors' sentiment about the timing of the crisis, which means it is able to identify the initial stages of speculative attacks that may or may not cause currency crises.

4.1 Czech Republic, 1997

This crisis materialized when the peg of the Czech koruna to a Deutsche mark (65%) and U.S. dollar (35%) currency basket was replaced with a managed float regime on May 26, 1997. The reasons for the crisis given in the literature are manifold: The trade balance in the Czech Republic (which had been systematically positive after the breakup of Czechoslovakia) turned negative in 1996, and economic growth slowed down at the same time. Horváth (1999) interprets the current account deficit in the Czech Republic as reflecting an insufficiency of private savings, which – coupled with the Czech banking sector's institutional framework of that time – would make the deficit unsustainable. Furthermore, the real exchange rate appreciated persistently and continuously in the period from 1992 to 1997.[10]

Although trend appreciation is a common phenomenon in transition economies that can (at least partly) be explained by differential productivity increases, as outlined in the Balassa-Samuelson effect, Begg (1998) and Horváth (1999) argue that the real exchange rate dynamics nevertheless implied a loss of competitiveness of the Czech economy. The adverse macroeconomic conditions, together with an unstable political environment, led to a speculative attack on the koruna and to the consequent change in the exchange rate regime in May 1997.

We calculated the indicator given by (7) for the Czech koruna against both the Deutsche mark and the U.S. dollar for the period from January 1, 1997, to the time when the peg was abandoned on May 27, 1997. We used the daily interbank rates with a maturity of one week ($i_{t,7}$ and $i^*_{t,7}$) and one month ($i_{t,30}$ and $i^*_{t,30}$) for the Czech Republic and, alternatively, for Germany and the

[8] *For an understanding of the need for logarithmic transformation, see Collins (1984).*

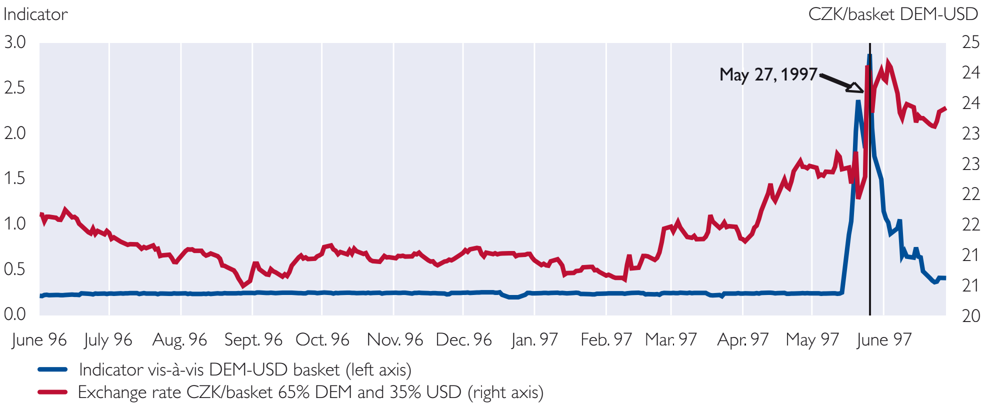
[9] *Our choice of these two crises was exclusively based on data availability.*

[10] *For an alternative description of the koruna exchange rate turbulence in 1997, see Šmídková (1998).*

U.S.A.[11] Given the disinflationary trend for the period studied, the yield curve implied by the term structure of interbank rates in the Czech Republic slopes downward for most of the sample, thus leading to negative values in the argument of the log ratio corresponding to $r_{t,30}$, since $\alpha_{t,30}$ tends to be systematically smaller than $\alpha_{t,7}$ for the sample at hand. We redesigned the log ratio of probabilities by adding a constant to the numerator and denominator of the argument of the log. In the light of the uncovered interest rate parity theory, this can be reconciled with the existence of a certain maturity structure in the risk premium coupled with appreciation expectations.[12] In chart 1 we show the resulting indicator vis-à-vis the currency basket (the results are identical to those using Germany or the U.S.A. as the foreign economy),[13] together with the exchange rate of the Czech koruna against the basket. It should be stressed that, as shown in chart 1, the exchange rate remained inside the ±7.5% band during the turmoil preceding the change in the exchange rate regime and depreciated strongly as soon as the managed float regime was in place. The fact that the monetary authorities were able to keep the koruna inside the fluctuation band was mainly ascribable to heavy central bank interventions in the week preceding the breakdown of the peg (see Horváth, 1999). Chart 2 presents the standardized changes in the indicator together with the 95% confidence interval for insignificant changes computed in real time using data back to January 1997.[14]

Chart 1

Exchange Rate against the Basket and Crisis Indicator – Czech Republic



Source: Datastream.

[11] *All data were obtained from Datastream (Datastream codes: PRIBK1W, PRIBK1M, ECUSD1W, ECUSD1M, ECWGM1W, ECWGM1M, CZECHC$, CZECHCM/DMARKER, RSUSDSP, ECUSD1W, RSIBK7D, ECUSD1M, RSIBK30).*

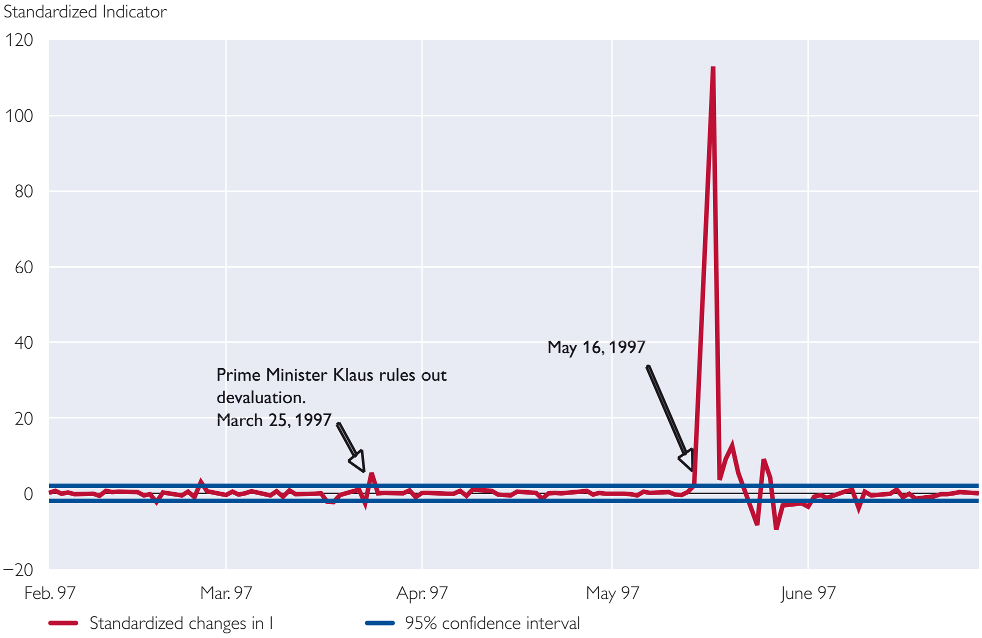
[12] *Admittedly, just adding a constant might appear fairly ad hoc here. Crespo Cuaresma and Slacik (2006) provide a more detailed justification for this approach as well as other methods for dealing with the negative term structure.*

[13] *The results are also similar if the indicator is constructed under the assumption that seven days are not the shortest maturity available, which would change the calculation of the index.*

[14] *The standardized indicator is defined as:* $\frac{I(1) - mean(I(1))}{SD(I(1))}$, *where* $SD(I(1))$ *stands for the standard deviation of the first difference of the indicator.*

Chart 2

Standardized Changes in the Crisis Indicator – Czech Republic



Source: Datastream.

Changes in the level indicator can be interpreted as changes in the perceived probability of a crisis occurring in the following week as compared to a crisis happening in the period between day 8 and day 30. The indicator level in chart 1 remains practically constant from January to mid-May and starts increasing dramatically on May 16, reflecting a strong change in investors' perceptions on the potential timing of a devaluation.[15] The increase is strong and sustained until May 28. After that, the indicator decreases slowly to a low level comparable with that of the precrisis period. However, chart 2 shows that apart from the ten-day window immediately prior to the crisis, the indicator issued a significant signal also on three days in the last week of March. March 25, the day on which the change in the indicator crosses the significance threshold, happens to coincide with the affirmation by Czech Prime Minister Klaus ruling out any devaluation on that day (see Horváth, 1999). Although the crisis broke out more than a month later and the signal thus has to be interpreted as a false one, this event suggests the beginning of mistrust in the markets.

Overall, the indicator performs extraordinarily well as a (very) short-term crisis indicator. It could be used ex post for dating the de facto occurrence of the crisis (de jure, the date of a crisis usually corresponds to the moment in which the fixed exchange rate regime is abandoned).

[15] *Horváth (1999) mentions that the media discussion on devaluation strengthened from mid-April onward.*

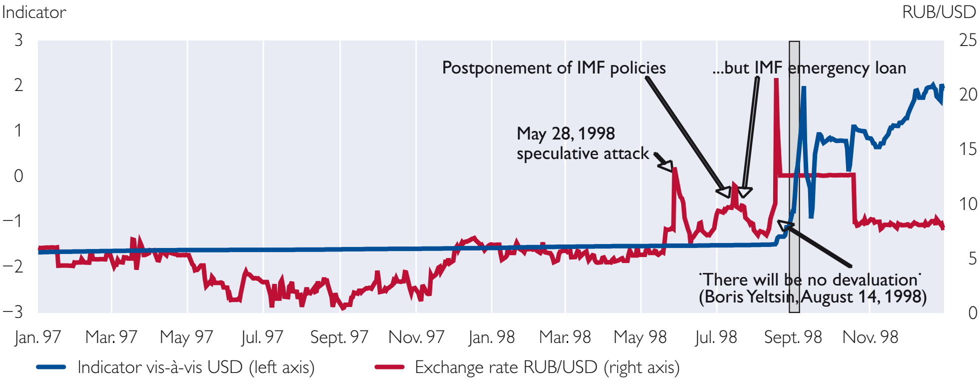
4.2 Russia, 1998

On August 17, 1998, after several months of financial instability, the Russian government announced a devaluation of the ruble against the U.S. dollar until the end of the year, defaulted on its government debt and declared a 90-day moratorium on foreign debt. On August 26, the Central Bank of Russia declared that the fixed exchange rate could not be supported any longer, and on September 2, 1998, the Russian ruble was floated.[16]

Using the corresponding interbank interest rate data for Russia and the U.S.A., we constructed the indicator for the dynamics of the relative probability of a crisis occurring within 7 days as compared to the interval between day 8 and day 30. Chart 3 presents the daily RUB/USD exchange rate together with the indicator I_t for the period from April to September 1998, adjusted to avoid negative probability values.

Chart 3

Exchange Rate against the U.S. Dollar and Crisis Indicator – Russia



Source: Datastream.

The first relevant feature of I_t is its positive trend in the period under study. This implies that investors systematically changed their expectations of the timing of an exchange rate crisis in the months preceding its actual occurrence: They tended to consider the crisis more imminent as it actually approached. Apart from this medium-term trend in I_t, the indicator shows relevant increases at end-May and mid-July as well as a global peak following the announcement of the devaluation (which preceded the change in the exchange rate regime by seven (working) days). The first peak took place on May 28, right after the Central Bank of Russia had increased the key interest rate to 150%. In the following days, the bank made several other interventions (using reserves to the tune of USD 1 billion) in a successful attempt to defend the ruble against speculative attacks (see e.g. Chiodo and Owyang, 2002). The indicator dropped in the following days and then resumed the positive trend that dominated the entire period.

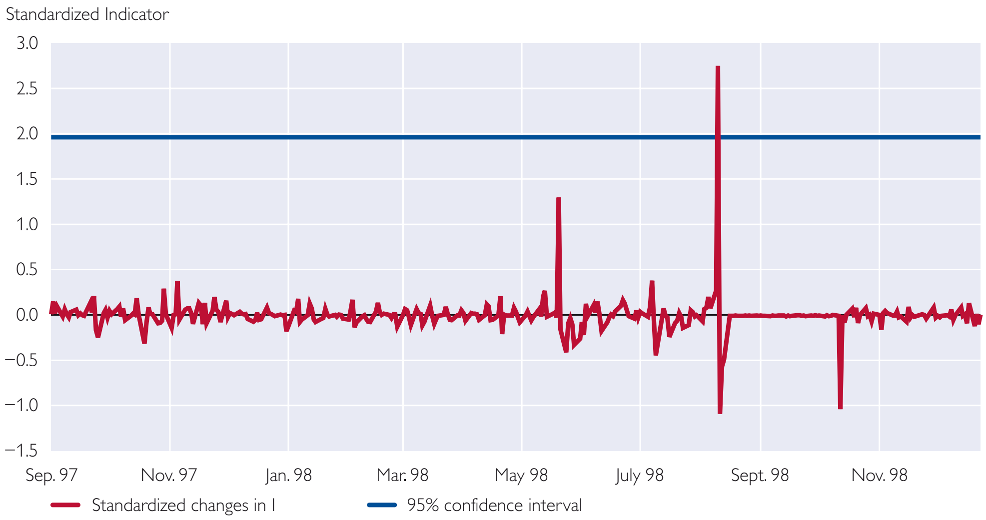
The second signal that investors expected an imminent devaluation was registered at the beginning of July. It coincided with a decision by the Russian parliament to postpone the policy reforms needed to qualify for IMF loans.

[16] *For an excellent account of the Russian crisis, see Kharas et al. (2001).*

The final approval of an IMF emergency loan to Russia in mid-July was given at the same time as investors' expectations of crisis timing shifted from the one-week period to the longer one. Finally, our indicator increased dramatically between August 10 and August 18, in parallel to the collapse of the stock and bond markets (on August 13) and in spite of Russian President Boris Yeltsin's affirmations that there would be no devaluation of the ruble after an emergency parliamentary session on August 14. Our indicator only stabilized on August 21, when the Russian crisis was already felt in the markets all around the world. Although the indicator peaked when the crisis was already felt, the increase in I_t was already strong up to seven days before the devaluation announcement. Chart 4 plots the standardized changes in the indicator, using data back to January 1997. As can be seen in the chart, the two increases in the indicator before the crisis do not represent significant crisis signals.

Chart 4

Standardized Changes in the Crisis Indicator – Russia



Source: Datastream.

To sum it up, our indicator is able (1) to identify speculative pressures that were successfully combated by the Central Bank of Russia in the precrisis period, and (2) to signal the crisis six days before the official announcement of the devaluation.

5 Conclusions

Given that numerous and massive currency crises have occurred in recent years, researchers in both public and private institutions have stepped up their efforts to develop early warning systems. The vast majority of approaches uses similar macroeconomic variables to forecast the timing of financial distress with a rather long signaling horizon. Fundamental data are perfectly suited to identifying potentially vulnerable countries well in advance and, possibly, to explaining the crises ex post.

However, we believe that a forecasting tool that is oriented on market sentiment should have better predictive power, as it is the participants in the foreign exchange markets who eventually trigger a crisis. Investor sentiment reacts much more strongly to short-term news and incoming signals than to the underlying long-term fundamentals. Along these lines, we employ a little-known early warning indicator based on a simple economic theory that uses the term structure of relative interest rates. It evaluates changes in market participants' perception of the relative probability of a crisis occurring in different time horizons. We applied the indicator to data on two of the most important recent currency crises in the Czech Republic, 1997, and Russia, 1998, and found that the indicator performs extraordinarily well as a (very) short-term crisis predictor in both cases.

Both case studies show that, even though the indicator may issue false alarms as in the Czech case or nonsignificant alarms as in the Russian case, signals from this indicator should always be taken seriously by central bankers and governments. Likening our indicator to a thermometer, a high body temperature does not necessarily imply a serious illness, but it is always a reason for vigilance. In that sense, our indicator is useful for economic policy institutions as an extra alarm bell that complements long-term oriented warning mechanisms.

References

Abiad, A. G. 2003. Early-warning systems: A survey and a regime-switching approach. IMF Working Paper 03/32.

Anzuini, A. and G. Gandolfo. 2003. Can currency crises be forecast? In: G. Gandolfo and F. Marzano (eds.). International Economic Flows, Currency Crises, Investment and Economic Development: Essays in Memory of Vittorio Marrama. Rome: EUROMA.

Babic, A. and A. Zigman. 2001. Currency Crises: Theoretical and Empirical Overview of the 1990s. Croatian National Bank Survey. October.

Begg, D. 1998. Pegging out: Lessons from the Czech exchange rate crisis. In: Journal of Comparative Economics 26. 669–690.

Berg, A., E. Borensztein and C. Patillo. 2005. Assessing Early Warning Systems: How Have They Worked in Practice? IMF Staff Papers 52. 462–502.

Blejer, M. I. 1998. The Economics of Currency Crises: Models, Indicators and Policy Responses. In: Zagreb Journal of Economics, Vol. 2, No. 2. Croatian Institute for Banking and Insurance. 55–70.

Bussière, M. and M. Fratscher 2006. Towards a New Early Warning System of Financial Crises. Journal of International Money and Finance. Vol. 25(6). 935–973.

Brüggemann, A. and T. Linne. 2002. Are the Central and Eastern European Transition Countries Still Vulnerable to a Financial Crisis? Results from the Signals Approach. In: IWH Discussion Papers 157. Halle Institute for Economic Research.

Calvo, G. and C. M. Reinhart. 2002. Fear of floating. In: Quarterly Journal of Economics, CXVII. 379–408.

Cerra, V. and S. Saxena. 2002. Contagion, Monsoons and Domestic Turmoil in Indonesia's Currency Crisis. In: Review of International Economics 10(1). 36–44.

Chen, C. 2005. How well can we predict currency crises? Evidence from a three-regime Markov-Switching model. Department of Economics. UC Davis. December.

Chiodo, A. J. and M. T. Owyang. 2002. A case study of a currency crisis: The Russian default of 1998. In: Federal Reserve of St. Louis Review. November/December. 7–18.

Cincibuch, M. and J. Podpiera. 2006. Beyond Balassa-Samuelson: Real appreciation in tradables. In: Economics of Transition Volume 14(3). 547–573.

Cincibuch, M. and P. Bouc. 2001. Interpretation of Czech FX Options. Ceská národní banka. Working Paper 36.

Collins, S. 1984. Exchange rate expectations and interest parity during credibility crises – The French franc March 1983. Harvard Institute of Economic Research. Discussion Paper 1080.

Crespo Cuaresma, J. and T. Slacik. 2006. An "almost-too-late" warning mechanism for currency crises. BOFIT DP 4/2007.

Dooley, M. P. 2000. Are Capital Inflows to Developing Countries a Vote for or against Economic Policy Reforms? In: P. R. Agenor, M. Miller, D. Vines and A. Weber (eds.). The Asian Financial Crisis: Causes, Contagion and Consequences. New York: Cambridge University Press.

Dooley, M. P., Folkerts-Landau, D. and P. Garber. 2004. The Revived Bretton Woods System: The Effect of Periphery Intervention and Reserve Management on Interest Rates and Exchange Rates in Center Countries. NBER Working Paper No. 10332.

Dornbusch, R. 2001. A Primer on Emerging Market Crises. NBER Working Paper No. 8326.

Diebold, F. X. and R. S. Mariano. 1995. Comparing Predictive Accuracy. In: Journal of Business and Economic Statistics 13. 253–263.

Eichengreen, B. 1994. International Monetary Arrangements for the 21st Century. Brookings Institution Press. Washington D.C.

Feldstein, M. 2002. Economic and Financial Crises in Emerging Market Economies: Overview of Prevention and Management. NBER Working Paper No. 8837.

Fischer, S. 2001. Exchange Rate Regimes: Is the Bipolar View Correct? In: Finance & Development 38. 1–8.

Flood, R. and P. Garber. 1984. Collapsing exchange rate regimes: some linear examples. In: Journal of International Economics 17. 1–13.

Goldstein, M. 2005. What Might the Next Emerging-Market Financial Crisis Look Like? Institute for International Economics. Working Papers 05–7.

Hausmann, R. and F. Sturzenegger. 2005. Global imbalances or bad accounting? The missing dark matter in the wealth of nations. Mimeo: Harvard University.

Horváth, J. 1999. Currency Crisis in the Czech Republic in May 1997. Post-Communist Economies 11. 277–298.

International Monetary Fund. 2006. Hungary – 2006 Article IV Consultation, Concluding Statement of the IMF Mission.

Kaminsky, G., S. Lizondo and C. M. Reinhart. 1998. Leading Indicators of Currency Crises. International Monetary Fund Staff Papers 45. 1–48.

Kittelmann, K., M. Tirpak, R. Schweickert and L. Vinhas de Souza. 2006. From Transition Crises to Macroeconomic Stability? Lessons from a Crises Early Warning System for Eastern European and CIS Countries. In: Comparative Economic Studies (forthcoming).

Kharas, H., B. Pinto, and S. Ulatov. 2001. An analysis of Russia's 1998 meltdown: Fundamentals and market signals. In: Brookings Papers on Economic Activity 1. 1–50.

Krugman, P. 1979. A Model of Balance-of-Payment Crisis. In: Journal of Money, Credit and Banking, Vol. 11, No. 3. August. 311–325.

Krugman, P. 1998. What Happened to Asia? Mimeo: MIT.

Malz, A. M. 2000. Do Implied Volatilities Provide Early Warning of Market Stress. The RiskMetrics Group. Working Paper No. 00–01.

Obstfeld, M. 1994. The logic of currency crises. In: Cahiers Économiques et Monétaires 43. 189–213.

Radelet, S. and J. Sachs. 1998. The Onset of the East Asian Crisis. NBER Working Paper No. W6680.

Roubini, N. 2006. Is Hungary at Risk of a Currency and Financial Crisis? Nouriel Roubini's Global Economics Blog. Retrieved on June 29, 2006. http://www.rgemonitor.com/blog/roubini/134057.

Roubini, N. and B. Setser 2005. Will the Bretton Woods 2 Regime Unravel Soon? The Risk of a Hard Landing in 2005–2006? Paper presented at the Symposium Revived Bretton Woods System: A New Paradigm for Asian Development? Symposium organized by the Federal Reserve Bank of San Francisco and UC Berkeley. San Francisco. February 4, 2005.

Schardax, F. 2002. An Early Warning Model for Currency Crises in Central and Eastern Europe. In: Focus on Transition 1/2002. Vienna: Oesterreichische Nationalbank. 108–125.

Šmídková, K. (ed.). 1998. Koruna Exchange Rate Turbulence in May 1997. Working Paper No. 2. Ceská národní banka.

Wolfers, J. and E. Zitzewitz. 2004. Prediction markets. NBER Working Paper No. 10504.