

**Assessing the likelihood of a twin crisis for new EU  
accession countries using a leading indicators approach.**



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## Abstract

The goal of this paper is to assess the likelihood of a twin crisis occurring in Bulgaria, Hungary, Romania and Slovakia by applying a leading indicator model. Specifically the model from Reinhart and Kaminsky (1999) is used. When the model is applied to transition economies, there can be some difficulties. The leading indicator model relies on data from a tranquil period, which for transitional economies can be quite volatile and thus problematic. The particular application of this model shows that it would be more likely that a crisis would occur in Romania or Slovakia, now an EMU member, than that a crisis would occur in Bulgaria or Hungary.

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## 1. Introduction

In the last twenty five years there have been relatively many economic crises, from the EMS crisis to the Tequila crisis, from the Asian crisis to the Brazilian and Russian crises.

Research by Bordo et al. (2000, p. 27) indicates that the frequency of such crises has been increasing. It is not just economic crises in general that have been occurring more frequently, but mainly the *twin crises* that have been more prevalent in the last quarter of the 20<sup>th</sup> century. These so called twin crises are characterized by a crisis in the financial sector and a consecutive crisis in the currency market. Twin crises are also found to be more disruptive for the economy, both in economic output and restructuring costs. This has been pointed out by Bordo et al. (2000, pp. 27-28) and Kaminsky and Reinhart (1999, p. 480).

Both in the light of an individual country and in the light of the current expansion of the Economic and Monetary Union (EMU) of the European Union (EU) it is interesting to assess the likelihood of such a twin crisis happening in new EU accession countries. As has been pointed out, for the individual countries such a crisis has a detrimental effect on their economy, whereas in the EMU context it might affect their possibilities for further integration, for example with regard to the Maastricht criteria. The focus of this paper will be to analyze the likelihood of such a crisis happening in some of the EU accession countries.

The countries analyzed are Bulgaria, Hungary, Romania, and Slovakia. All four have experienced crises in the recent past (Brüggeman and Linne, 1999; Krkoska, 2000) and can be considered to be transition economies, changing their economies from a centrally planned structure to a free market based structure. Bulgaria experienced a twin crisis in 1996-1997 and became an EU member in 2007. Romania became an EU member in 2007 and experienced a twin crisis in 1996-1997. Hungary, member of the Organisation for Economic Co-operation and Development (OECD), and EU member since 2004,

experienced a twin crisis in 1993-1995. Finally, Slovakia experienced a twin crisis in 1998 and became an EU member in 2004. Slovakia is also an OECD member and will join EMU on the 1<sup>st</sup> of January 2009<sup>1</sup>.

The structure of the paper is as follows. First the literature regarding the leading indicator approach will be discussed. In the next section the model itself is explained. In the section after that the leading indicator model will be applied to the four countries in question. The last section will discuss the results and draw conclusions.

## 2. Literature discussion

Throughout the history of economic crises a range of models have been used to explain past and to predict future crises. Theoretical models, like Krugman's (1979) model on currency crises, and more empirical models such as Eichengreen et al. (1996). Brüggemann and Linne (2002) identify two main areas of empirical research in this field of economic crises. A qualitative approach, using logit or probit regression analysis, and the signaling approach, which is based on comparative analysis of economic indicators during tranquil and crisis times. This signaling approach, also called leading indicator approach, will be the focus of this paper.

Kaminsky and Reinhart (1996) and Kaminsky et al. (1998) introduced the leading indicator approach with respect to currency crises. One year later this approach was extended to the analysis of twin crises (Kaminsky and Reinhart, 1999), which further analyzed the link between banking and currency crises. This leading indicator model is partly build on theoretical foundations (to identify potential interesting indicators) and tries to explain the causes of both currency and banking crisis and the linkages between them. It

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1 Announcement of Slovakian accession to EMU, Communiqué of the European Central Bank and Národná banka Slovenska, <http://www.ecb.int/press/pr/date/2008/html/pr080708.en.html>, accessed 25<sup>th</sup> of December 2008.

further identifies empirical regularities in the period leading up to twin crises.

The idea behind this approach is to identify different indicators that might signal a crisis. The indicators are identified by looking at the behaviour of different indicators with respect to past crises. These indicators include, but are not limited to the *real interest rate*, the *M2/reserves* ratio, the *reserves*, the *M2 multiplier*, the *output* and the *exports* of a particular country. The behaviour of all these economic variables might be capable of signalling a crisis; however, not every worsening of these variables necessarily triggers a crisis. A signal will only be recorded when a variable reaches a certain threshold level. This raises the question at what level, the threshold, an indicator should signal a crisis. A generic threshold for each indicator is determined by calculating the value that minimizes the noise-to-signal ratio<sup>2</sup>. In this way the statistical Type-1 and Type-2 errors are minimized, resulting in an optimal threshold expressed as a percentile of the distribution. Applying this generic threshold to the data of each individual country results in a specific critical value for each indicator specific to that country. Kaminsky et al. (1998, p.14) compare the leading indicator approach with the logit and probit approach and find that it has some advantages over the logit and probit approach.

An advantage of the leading indicator approach is that for each indicator it is possible to determine the ability to accurately give correct signals and to avoid false signals. This can then be used to determine how much an indicator contributes to the estimation of the likelihood of a crisis occurring; the better the noise-to-signal ratio, the more a signal contributes. Another benefit is that because this method compares different indicators, it is possible to see how widespread economic problems are: the more indicators signaling a problem, the wider the economics problems. This can also give information on the source of these problems (Kaminsky et al., pp. 14-15).

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2 The noise-to-signal ratio: 'The ratio of a false signal to all possible bad signals, divided by the ratio of a good signal to all possible good signals' (Kaminsky and Reinhart, 1999, p. 488).

Their main criticism on the logit and probit approach is that although the explanatory variables in a regression can be quite varied, the estimation technique in a logit and probit approach is considered to be uniform. In logit and probit estimation the variables are either significant or not, if they do not contribute to the existing information they are dropped. The leading indicator approach compares the behaviour of the selected variables before a crisis with a tranquil period in order to see if this behaviour can be used to assess the likelihood of a crisis. An indicator that gives the same information as another is thus not left out. The advantage of the logit and probit approach is that it results in a single number that reflects the likelihood of a currency crisis, whereas the leading indicator approach shows the behaviour of different indicators. This latter problem can be solved by constructing a composite indicator, which weighs the different indicators according to different criteria.

There is also criticism on the leading indicator approach. For example, Brüggeman and Linne (2002, p. 13) note that the “forecasting capabilities of the leading indicators approach should not be overstated.” According to their research, which applies the leading indicator model to Eastern and Central European countries, the model does indeed help to identify potential weak countries. It can give an indication what the weaknesses within the economies are, but in order to better understand the problems, a “policy oriented analysis” should be undertaken. If policies are changed and a crisis is averted, a crisis would not follow on the signals. In other words, the Lucas critique can also apply to the leading indicator model.

### 3. The leading indicator model

In the following sections the applied leading indicator model will be further explained. The first section deals with the economic intuition behind the indicators. The section after that shows how country and indicator specific critical values are constructed from generic thresholds. The time horizon over which the countries will be estimated will be constructed after this. Then the construction of a composite indicator is explained and finally the

problems with assessing the likelihood will be discussed.

### *3.1 Indicators*

The concept of the word leading in 'leading indicators' is that you are able to use these indicators to assess the likelihood of future events. Some of these indicators result from economic theory, others from empirical research. From the results of Kaminsky and Reinhart (1999, p. 490), which investigated 76 currency and 26 banking crises in 20 countries in the period of 1970-1995, the most accurate indicators are taken. The chosen indicators have historically predicted twin crises with an accuracy of over 75 percent. This means that in all the cases in which a twin crisis was signaled by these indicators, the currency crisis actually followed in 75 percent of the time within 24 months (and for banking crises within 12 months) (Kaminsky and Reinhart, p. 487). Because a twin crisis consists of both a currency and a banking crisis, the likelihood for the occurrence of a twin crisis thus increases when both a signal for a banking crisis and a signal for a currency crisis are given.

One indicator that can be used to forecast twin crises is the *real interest rate*. Its level of accurately signaling twin crises in the Kaminsky and Reinhart model was estimated to be at 94 percent. Kaminsky and Reinhart (1999, p. 484) found based on their research that it on average signals a banking twin crisis when it is 1 to 2 percentage points higher than the average in tranquil times. This can have different causes. High real interest rates can reflect excessive risk taking by banks, but they can also be a product of tight monetary policy. The value of the indicator in the case of a currency crisis alone is less clear. It can be either a relatively low real interest rate reflecting lax monetary policy or relatively a high real interest rate reflecting a higher risk premium. A relatively high real interest rate was determined to give a better noise-to-signal ratio.

The growth of *M2/reserves* indicator preceding a twin crisis tends to be above the

growth in tranquil times. The indicator is defined here as the 12 month change in M2/reserves, expressed as a percentage. In the case of a crisis a large positive growth rate often reflects both a large expansion in M2, which can signal a reduction in reserve requirement which in turn can make banks more vulnerable to a bank run, and a decline in reserves, which can be important to defend an exchange rate. The importance of the indicator is that the relatively liquid M2 can be exchanged for foreign currencies, for which the foreign reserves will have to be used. The higher the ratio is, the less likely a country is able to facilitate these exchanges, which increases the likelihood of a speculative attack taking place. The growth in M2 can also be witnessed by the M2 multiplier.

The *M2 multiplier* is defined as the ratio of M2 over base money. Here the 12 month growth in the M2 multiplier is used as the indicator. In the case of a currency crisis the growth in the M2 multiplier generally is above the average in tranquil times nine months before a crisis, and then it starts to drop until the crisis. A reason for this drop can be capital flight, the currency can already be seen as weak and the capital flight will thus put more pressure on the exchange rate. For banking crises it generally stays above average in the 18 months preceding a crisis. A part of the explanation of the growth in the M2 multiplier can be the reduction in reserve requirements for the financial sector. This again can indicate higher inflation in the future, which in turn can cause appreciation of the real exchange rate. If a currency is pegged to another, this can put pressure on the peg.

The growth in *reserves* is valuable as an indicator with an accuracy between 70 and 80 percent. Whereas the M2/reserves indicator captures both the effects of M2 and the reserves and their ratio, the reserves alone provides valuable information as well. The growth in the reserves tends to drop in the months before both a currency and a banking crisis. With currency crises, on average the growth in reserves was about 20 percent below the growth in tranquil times (Kaminsky and Reinhart, 1999, p. 485). This decline in reserves can be connected with the defense of the exchange rate, as for example in Krugman (1979).

The previous four indicators mainly dealt with the financial aspects, the next two

indicators give an indication on economic activity in the real sector. The first indicators are the *exports* of a country. The worsening terms of trade in the prelude of a crisis, for example due to an overvalued currency, affects exports. The growth in exports indicator generally is lower (relative to tranquil times) in the one and a half year before a currency and banking crisis. Estimation by Kaminsky and Reinhart (1999, p. 485) shows that in the case of a currency crisis on average the growth in exports was 20% below the average growth in tranquil times. In the case of a twin crisis the average export growth was even lower.

The 12 month growth in *output* is the second indicator dealing with the real sector. The output is affected by the exports. If exports drop, the output will drop as well. This of course depends on the structure of the economy. It is also a more generic indicator for the state of an economy. If companies cut their output, this can be a signal that there is less demand. It also can have an effect on the employment in a country, less labor will be required to produce goods. In the case of a currency crisis the average growth in output was 2 to 6 percent lower on average than during tranquil times (Kaminsky and Reinhart, p. 486). During twin crises the growth was even lower.

Now that we have an idea how indicators behave in a certain way before crises, we have to determine at what value an indicator issues a signal that might indicate a crisis, or in other words, determine a critical value from a threshold.

### *3.2 Thresholds*

The threshold is the percentile where the critical part of the distribution of an indicator in the tranquil state starts. In the application of the leading indicator model the generic threshold is then applied to the distribution of the indicator of an individual country to determine a specific critical value. This means that the critical value is different for a country with an indicator that fluctuates between 5 and 10 percent and a country with an indicator that fluctuates between 1 and 3 percent.

The critical value is the value of the indicator above (or below) which a signal is given. Thresholds are determined by finding the optimal level at which an indicator gives a signal, while weighing the possibilities between both statistical Type 1 and Type 2 errors. In this case the null hypothesis is being in a tranquil state. Here a Type 1 error would thus be to falsely reject the null hypothesis of being in a tranquil state. A Type 2 error would be to accept the null hypothesis of being in a tranquil state, while in reality there is a crisis. The value of the threshold for every individual indicator that minimizes the noise-to-signal ratio is then chosen as the preferred threshold. These generic thresholds can then be applied to the distribution of the indicators of the specific countries, to find a critical value specific for that indicator in that country.

In this case the thresholds calculated by Kaminsky and Reinhart (1999, p. 489) will be used (Table 2). The large sample to calculate the respective thresholds gives a good basis to apply them to the four countries. While it is possible to calculate these thresholds for a particular country purely based on a past crisis of a country, the problem is that if a crisis happened in the past, this crisis alone might not give enough information to assess the likelihood on the occurrence of a new crisis. A new crisis might unfold in a different way, triggering different indicators. A more practical problem is that in the case of a single country there is only a certain amount of past crises to calculate the noise-to-signal ratio, which may not be sufficient to reliably determine a threshold. Calculating the noise-to-signal ratio from a larger sample does not have this problem. These more generic thresholds can then be applied to the tranquil data of an individual country to calculate a country-specific critical value. These noise-to-signal ratios can be found in Table 1 and will further be used to calculate a composite indicator for each country.

Noise-to-signal ratio	Currency crises	Banking crises
M2 multiplier	0.7	0.5
Real interest rate	0.8	0.5
M2/reserves	0.5	0.7
Exports	0.4	0.6
Reserves	0.6	0.7
Output	0.5	0.5

Table 1: Noise-to-signal ratios. Source: Kaminsky (1997, p. 16).

The thresholds of Kaminsky and Reinhart (1999) are shown in Table 2 and correspond with the noise-to-signal ratios listed in Table 1. The value of the respective threshold, expressed as a percentile, is the start of the critical part of the distribution of the indicator. The sign in front of the value indicates on what side of the threshold the critical part of the distribution lies. An explanation on the characteristics of the sign (why it is on the upper side or lower side of the distribution) can be found in the previous section.

Indicator	Currency crises	Banking crises
M2 multiplier	> 0.86	> 0.90
Real interest rate	> 0.88	> 0.80
M2/reserves	> 0.87	> 0.90
Exports	< 0.10	< 0.10
Reserves	< 0.15	< 0.28
Output	< 0.11	< 0.14

Table 2: Threshold values. Source: Kaminsky and Reinhart (1999, p. 489).

For transition countries there can be a problem to determine a proper critical value. When we apply the generic thresholds to calculate the critical value, the critical value might be too large (or too small). Thus, in times of a real crisis, the indicator might not cross the critical value or due to the volatility of the indicator cross the value too often. The reason for this is the relative small size of the sample which can be considered tranquil data. Considering that most transition countries only started their transition after 1990, these countries have relatively small time series of macroeconomic variables which we can consider to be tranquil. This problem was also described by Brüggeman and Linne (2002, p. 14).

### *3.3 Time horizon*

In applying the model time horizons for both the period in which the indicators will be investigated and the period which is considered to be tranquil have to be specified. The minimum period that is investigated is determined by the interval between the signal and the occurrence of a crisis.

The first part is then to establish this period. Following Kaminsky and Reinhart (1999, p. 487) the interval for currency crises is defined to be 24 months and in the case of a banking crisis 12 months. If a signal is given and 12 or 24 months afterwards no crisis takes place, this can be considered to have been a false signal. To assess both types of crises the minimum period of 24 months is used for which the behavior of the indicators is compared with their respective behavior in tranquil times. In the application of the model the period of June 2006 to June 2008 is used.

The second part is to define the period which can be considered to be tranquil. As in this application of the model the tranquil period is different from the analyzed period. The end of the tranquil period is in May 2006.<sup>3</sup> As some of the analyzed countries suffered from

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3 For this specific application of the leading indicator model the choice is made to

one or more crises in the past, another condition to define a tranquil period is that it has to be sufficiently before or after a previous crisis. The question then is how long after a crisis can we consider the economy (and hence the data for the indicators) to be in a tranquil state. We can see from Kaminsky and Reinhart (1999, pp. 481-483) that 18 months after the crisis the indicators tend to revert to their mean, or in other words, go back to their tranquil state. Adding 6 months to this might strike a balance between realizing a sample that is large enough and data that is tranquil enough. 24 months after a crisis can be considered to be a reasonable starting point of the tranquil period.

In Section 4 the leading indicator model will be applied on four countries and the behavior of the indicators will be investigated for the period of June 2006 to June 2008 in order to determine the likelihood of the occurrence of a twin crisis happening after June 2008. This leads us to the question on how we can assess the signals from these different indicators and how they can be compared between different countries.

### *3.4 Composite indicator*

For an individual country the signal of just one indicator might not be really alarming. The idea of using the distribution of the tranquil state implies that a signal will be given during the tranquil period as well. Multiple indicators signaling at the same time is less likely to occur and thus will be more alarming. How should these different indicators be assessed? Which one is more important and how can these different indicators be compared between different countries?

These two problems can be solved by including the individual signals in a composite indicator, and giving weights to the signals of the different indicators. In this way we can

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separate the tranquil period and the period in which the indicators are investigated. The reason is that it is not sure whether the last 24 months were indeed a tranquil period or already part of the beginning of a crisis. If this is the case, then the critical values might be higher and signals will be missed.

give indicators that have a lower noise-to-signal ratio more weight and compare different countries with each other. Even though in this paper relatively few indicators have been used, constructing such an indicator will make the assessment easier. The next step is to construct such an indicator. As has been noted above, different weights can be attached to the signals from different indicators to indicate their relative importance. The weights could for example be based on how long ago a signal was given, how consistent these signals were, or how accurate the indicator is (as measured by its noise-to-signal ratio). In this case a composite indicator constructed by Kaminsky (1999, p. 23) will be used. The idea is to weigh the respective signals by the inverse of their noise-to-signal ratio, a lower noise-to-signal ratio is considered to be better. How the composite indicator is constructed can be seen below.

$$I_t = \sum_{j=1}^m \frac{S_t^j}{\omega^j}$$

In the composite indicator  $j$  is the number of the respective indicator,  $t$  is the respective period in which the signal is given,  $S$  is 1 for a positive signal, 0 otherwise and  $\omega$  the noise-to-signal ratio (see Table 1). This kind of composite indicator performed best in the case of currency and banking crises (Kaminsky, 1999, p. 27).

### *3.5 Likelihood*

Kaminsky (1999, p. 24) and Brüggeman and Linne (2002, p. 9) calculate conditional probabilities to assess the likelihood of a crisis. This would be the preferred way to give an answer to the question on how likely it is that a crisis might occur in a certain country. Due to the lack of data on the historic behavior of the composite indicator based solely on the six indicators as mentioned above, calculating such a probability is in this case not possible.

Instead the assessment of the likelihood will be done by looking at the absolute value of the composite indicator, both for the country itself and as a way to compare countries

with each other. The intuition here is that a higher composite indicator indicates a higher likelihood that a crisis can occur. The more indicators that give a signal, the higher the composite indicator will be. The second way of assessment will be to look at the behavior of the composite indicator over time. A rise in the composite indicator indicates that more indicators are starting to signal a crisis. If for both a banking and a currency crisis the composite indicator is higher, it is thus more likely that a twin crisis will occur. Now that the indicators have been discussed, the critical values can be determined, the time horizon is established, a composite indicator can be constructed and the likelihood can be assessed, it is possible to apply the model. This is discussed in the next section.

#### 4. Application of the model

The countries that will be assessed are Bulgaria with the lev, Hungary with the forint, Romania with the leu and Slovakia with the koruna. Slovakia is included because it is a new EU member, meeting the criteria for EMU membership and hence could be considered to have better fundamentals. As Slovakia's fundamentals are expected to be different, it can be a good country for comparison. The data from all the countries is acquired through the IFS (International Financial Statistics) from the IMF. What has to be kept in mind is that some of the data was still under revision, especially the most recent data. This can affect the reliability of the outcomes. For each country the critical values are calculated based on historical data from a period considered to be tranquil. In the next sections some light is shed on the past crisis or crises of the country, after which the results of the application of the leading indicator model will be discussed. The graphs for all the indicators of the four different countries and their composite indicators can be found in the Appendix.

##### *4.1 Bulgaria*

After the end of the cold war, Bulgaria went through a transition period in which both

political and economic transformations took place. In 1996 Bulgaria encountered a severe crisis; problems in the financial sector destroyed the banking system. As described by Dobrinsky (2002, p. 581), the crisis had a severe impact on the public finances, interest payments alone accounted for 17 percent of GDP in 1996. From 1996 to 1997, GDP also dropped over 18 percent and in the beginning of 1997 Bulgaria even experienced hyperinflation. The change in the exchange rate of the lev with regard to the US dollar amounted to 1682 percent from 1996 to 1997 (Dobrinsky, 2000, p. 584). To stabilize the currency, a currency board was introduced in February 1997. After the election of a new government in April 1997 and the adoption of IMF policies, the economy began to stabilize.

When February 1997 is considered to be the end of the crisis, the tranquil period according to our assumptions then starts 24 months after February 1997, in February 1999. May 2006 is taken as the end of the tranquil period. The data from June 2006 to June 2008 will be used to assess the likelihood of the occurrence of a crisis after June 2008. We will first look at Figure 5, which shows the results of the model applied to Bulgaria, as expressed by the composite indicator. In the period June 2006 to June 2008 there have indeed been a couple of signals, with a peak signaling a potential banking crisis in May 2007. The values of the composite indicators have been lower than the values in other countries. This implies that there have not been many signals at the same time. Where did these signals come from?

In 2007 the real interest rate, though still negative, rose above the threshold value for banking crises as can be seen in Figure 1. The critical value, as calculated for Bulgaria was - 0.61 percent. The nominal interest rate in this period was relatively stable, though rising from 3.15 percent in June 2006 to 4.19 percent in June 2008. The explanation for the signal mainly lies in the drop in inflation from 8.24 percent in June 2006 to 4.18 percent during the time that the signals were given. Afterwards the inflation rose again to 15.28 percent in June 2008 and no more signals were given. The M2/reserves indicator issued a signal for both a banking and a currency crisis in June 2006 after a period of relative high growth in 2006. Afterwards it did not issue any signals. We can now say that the signal has been incorrect, a

crisis did not occur in the 12 and even 24 months afterwards. The growth of M2/reserves slowed down and even became negative. By looking at both the M2 and the reserves indicator we might be able to find a cause for this behavior.

The M2 multiplier did issue signals during 2007 for both a banking and a currency crisis. With a critical value for banking crises at 10.92 percent growth and for currency crises at 8.29 percent growth, the growth of 23.51 percent in May 2007 and afterwards was clearly higher. The growth in reserves in Bulgaria has, on average, been rising from 2006 to 2008. In the middle of 2007, during the time the M2 multiplier issued signals, the growth in reserves dropped, but not enough to cross the critical values of 6.35 percent (banking crisis) and 3.43 percent (currency crisis).

With respect to the real sector, average growth in output gave a signal in December 2006 (1.17 percent) and in March 2008 (0.22 percent) for both a banking (critical value 1.96 percent) and a currency (critical value 1.54 percent) crisis. The growth in exports indicator did not signal a crisis.

The period on which the tranquil data is based could be too short to calculate accurate critical values, especially since Bulgaria can be considered to be a transitional economy. Some false signals have been given, which can indeed be the result of the short tranquil period, which can also explain the behavior of the composite indicator. In May 2007 the composite indicator reached its highest value for Bulgaria, which we can now say was not followed by a banking crisis within 12 months. Afterwards the indicator declined again, not to reach previous levels. The convergence towards EMU criteria<sup>4</sup>, especially with respect to inflation can have increased the real interest rate, showing that there is indeed a change in the economy, but not necessarily increases the likelihood of a crisis.<sup>5</sup> A decline in

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4 The average inflation rate should not exceed the best three performing EMU countries by more than 1.5 percentage points.

5 Bulgaria's commitment of convergence to EMU criteria was for example, expressed in 2005 by the Bulgarian National Bank,

output and a rise in the M2 multiplier can be considered to be a sign for both a banking and a currency (and thus twin) crisis.

#### *4.2 Hungary*

Hungary is like Bulgaria an economy in transition. In 1993 Hungary experienced a banking crisis, with bad debt rising (18% of the total loans) and net income before taxes turning negative. This is followed by a currency problem in 1994, with a current account deficit of 9.4% of GDP (Brüggeman and Linne, 1999). In March 1995 the currency devalued due to excessive external debt and twin deficits (Krkoska, 2000, p. 6). As start of the tranquil period March 1997 is taken and as end May 2006.

The composite indicator for Hungary in Figure 5 shows no signals, except for June 2008. Here both signals for a banking and a currency crisis are given. Especially looking at the past behavior of the composite indicator can be alarming. The rising growth of the M2 multiplier and the decline in the growth in output are the signaling indicators as can be seen in Figure 2. The M2 multiplier grew 17.61 percent, where the critical value for a banking crisis was estimated to be 16.76 percent and for a currency crisis 14.63 percent. This could indicate a reduction in reserve requirements. The growth in output in June 2008 was -0.25 percent, with critical values of 1.99 for a banking crisis and 1.37 for a currency crisis. It can be seen as a clear signal of problems in the real sector, especially with an average growth in tranquil times of around 8 percent.

The M2/reserves indicator has been growing since June 2006, but has been relatively steady around its tranquil average. Hungary's reserves, with a lower growth in the beginning of 2007, grew above its tranquil average in 2008. The real interest rate has been lower than its tranquil average and in June 2008 it still was around 1 percent. There has been a decline in the growth of exports, but not as much as in output. For the largest part of 2007 and 2008

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[http://www.bnbank.org/bnb/home.nsf/vPages/Manchev-speech-CEE-Frankfurt/\\$FILE/Eurofinancialweek11112005.pdf](http://www.bnbank.org/bnb/home.nsf/vPages/Manchev-speech-CEE-Frankfurt/$FILE/Eurofinancialweek11112005.pdf), accessed on December 25 2008.

the growth in exports has been beneath its tranquil average.

From the four countries, Hungary has the longest period that is considered to be tranquil. This could make the critical values a bit more accurate than for other countries. The fact that no signals have been given before June 2008 could be a consequence of this. The decline in output and rise in M2 multiplier can give rise to concern. It is however possible that the data will be revised later. Considering that there are only two indicators signaling, such a revision could yield a different conclusion.

#### *4.3 Romania*

Romania is like Bulgaria and Hungary a country with a transition economy. It also shares a crisis in its history. For Romania this crisis took place in 1997. The amount of bad debt rose from 39 percent of total loans in the banking sector to 59 percent in 1997 (Brüggeman and Linne, 1999). In February 1997, Romania experienced a currency crisis. According to Brüggeman and Linne (2002, p. 5) “large external imbalances, declining output and investment, and structural weaknesses in the banking and enterprise sectors led to a decline of the Leu by nearly 20% against the US-Dollar within two weeks.” The start of the tranquil period is 24 months later, February 1999. The end of the tranquil period is May 2006.

Figure 5 shows the composite indicator for Romania. As can be seen, quite some crises have been signaled in the past. Especially for banking crises we can, with the benefit of hindsight, say that some of these signals were not followed by a crisis in the banking sector within 12 months. In April 2007 there was a combination of signals, as well as in December 2007. Although some of these signals have not been correct, it can still be worth to look at the individual indicators.

The real interest rate and the M2/reserves triggered the most signals, as can be seen in Figure 3. For the real interest rate critical values of -3.42 for a banking crisis and -0.72

for a currency crisis have been calculated. These negative numbers mainly reflect Romania's history of relatively high inflation and low nominal interest rates<sup>6</sup>. In the light of the EMU accession criteria, a decline in inflation would, with a smaller decline in nominal interest rates, lead to a higher real interest rate. A higher real interest rate for Romania in this context does not have to be that alarming.

The M2/reserves indicator signaled both currency and banking crises. The critical value was calculated to be at 3.52 percent for banking crises and 0.16 percent in currency crises. As an indication the average growth was -12.43 percent in tranquil times. A small growth in M2/reserves would thus already give a signal. In November 2007 and May 2008 the growth was above 10 percent, well above the critical value. The growth in the M2 multiplier did not signal a crisis, the reserves however did. In 2006 and 2007 it gave signals for a banking crisis. The critical value for this was calculated to be at 27.7 percent. The critical value for a currency crisis was estimated to be at -18.83. The critical value for the banking crisis can be considered to be quite high in absolute terms, especially considering the difference with the critical value for the currency crisis. Output gave two signals for both banking and currency crises, one in April 2007 of -5.24 percent and one in December 2007 of -9.44 percent. The critical value for banking crises is -1.47 and -2.95 for currency crises. A negative growth in output can indeed be an alarming signal. Next to these signals, the growth has been relatively equal to its average in tranquil times. Exports did not give a signal and have seen considerable growth in the period 2006-2008.

Assessing the indicators with respect to Romania has the same drawbacks as the other assessed countries. Romania is undergoing an economic transition, which can result in a volatile tranquil period. The period in which Romania is considered to be in a tranquil state is also relatively short, from February 1999 to May 2006. This has an influence on the

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<sup>6</sup> Based on the IFS data the average inflation in the tranquil period February 1999 – May 2006 was 25.3 percent. The nominal interest in the same period was 20.78 percent.

distribution of the data of the indicators, as can be seen with the critical values of the reserves, which in turn can cause Type-1 or Type-2 errors. Nonetheless, the rise in the real interest rate, the decline in output and the growth in the M2/reserves can give rise to concern.

#### *4.4 Slovakia*

Slovakia is currently one of the leading transition economies from Eastern Europe. According to the OECD it will continue to be the OECD member with the highest growth.<sup>7</sup> As an EU member since 2004, it is the first of the four analyzed countries to adopt the Euro as its national currency. The transition process has not been without difficulties. According to Krkoska (2000, p. 6) external imbalances emerged in 1997 and Slovakia suffered from contagion effects from the Czech crisis. This was combined with large external debt and twin deficits. The total external debt rose from 32.7 percent in 1995 to 58.5 percent in 1998. The general government deficit rose from -0.2 percent in 1995 to 5.8 percent in 1998 (Krkoska, 2000, p. 12). From August to October 1998 the result was a devaluation of the Slovak koruna. The fixed exchange rate was abandoned and a floating rate was introduced.

The start of the tranquil state is then taken in October 2000 and the end in May 2006. In Figure 5 the results can be seen. The composite indicator had relatively high values (the composite indicator showed values of over 6) until the third quarter of 2007 for both banking and currency crises. After this period it started to decline. The main indicators signaling a crisis, as can be seen in Figure 4, were the real interest rate, the growth in M2/reserves, the growth in reserves and the growth in M2.

The real interest rate in tranquil times is negative with on average -2.71 percent and the critical values for a banking crisis are estimated to be at -0.09 and 0.23 for a currency

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<sup>7</sup> OECD economic outlook preliminary report, <http://www.oecd.org/dataoecd/45/46/20434938.pdf>, accessed December 25<sup>th</sup> 2008.

crisis. From October 2006 to January 2008 signals were given for both a banking and a currency crisis, mainly due to the fact that the real interest rate became slightly positive. In the light of the EMU criteria this is not surprising. Compared to the tranquil period the inflation has indeed gone down, being a possible explanation for the rise in the real interest rate.<sup>8</sup>

The M2/reserves between June 2006 and June 2007 gave signals for both a banking and a currency crisis. In tranquil times the average growth was -9.11 percent. The critical values are estimated to be at 12.85 percent for a banking crisis and 11.77 percent for a currency crisis. In some cases the growth was over 60 percent, being a clear signal. In the same period the growth in reserves declined significantly as well. Where the average growth in tranquil times is calculated to be 33.67 percent and the critical values for a banking crisis at 11.54 percent and for a currency at 1.4 percent, the signals were given at even lower values of the growth. In some cases the growth was below -18 percent. The M2 multiplier has given signals for both a banking and a currency crisis. With a growth of over 20, 50 and even one instance of 100 percent growth it is clear that the critical values were exceeded. Considering that this last signal was in March 2008, there is a possibility that this data could still be revised. The indicators for the real sector, output and exports did not issue any signals. Because the growth in both has been declining, a continuing trend could generate signals in the future months.

For Slovakia we have to keep in mind that the period on which the tranquil data is based is the shortest of the four countries (October 2000 to May 2006) and that its conversion towards the EMU criterion of low inflation could be a source of the signals from the real interest rate indicator. The composite indicator has been declining in the period since June 2007, but has shown some increase since March 2008. The behavior of the M2/reserves, the M2 multiplier and the reserves could be sign of alarm, considering not

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<sup>8</sup> Based on the IFS data the average inflation rate in the period October 2000 – May 2006 was 5.91 percent and the average nominal interest rate was 2.98 percent.

just the fact that the critical value was exceeded but also the size of the growth or decline. As can be seen in Figure 5, the composite indicator for Slovakia reached the highest level of all the four countries.

## 5. Conclusions

In the previous sections we have seen a description of the literature on the leading indicator model from Kaminsky and Reinhart applied to twin crises. The benefits are that application of it can tell us a bit more on the sources of the crisis, by looking at the indicators that give a positive signal. Applying this model to transition countries, or countries with a transition in their recent histories, shows that there can be some difficulties. The idea is to use data while the economy is in a tranquil state and if indicators cross a certain threshold in the distribution of the tranquil data, a signal is given. It can be difficult to determine a tranquil period for these transition countries, resulting in a period that can be too short and not tranquil enough.

Knowing this, the model can still be applied, but for the interpretation of the results we have to keep in mind that the outcomes might be less certain than when the model was applied to a non-transitory economy. This might be a reason for the results found for the four different countries. In levels of the composite indicators Bulgaria and Hungary scored lower both in terms of banking and currency crises signals. In the case of Bulgaria we can now say that the signals for a banking crisis might have been incorrect. Romania and Slovakia had higher values of the composite indicator for both banking and currency crises. In this sense Romania and Slovakia would have a higher likelihood to be hit by a banking, currency or twin crisis.

This is not the result that might be expected, Slovakia is the only country of the four that is certain to become an EMU member. One of the reasons, especially with respect to the real interest indicator, is that convergence to EMU criteria itself can give rise to a

higher real interest rate and thus to values crossing the critical value. The critique of Brüggeman and Linne (2002) might be applicable here; in order to understand the problems better, a policy oriented analysis should be undertaken. Although the tranquil period to determine the critical values from for each country has been relatively small, with Slovakia's period being the smallest, this application of the model shows that it is more likely for a twin crisis to occur in Romania and Slovakia than in Bulgaria and Hungary.

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# Appendix

## Bulgaria

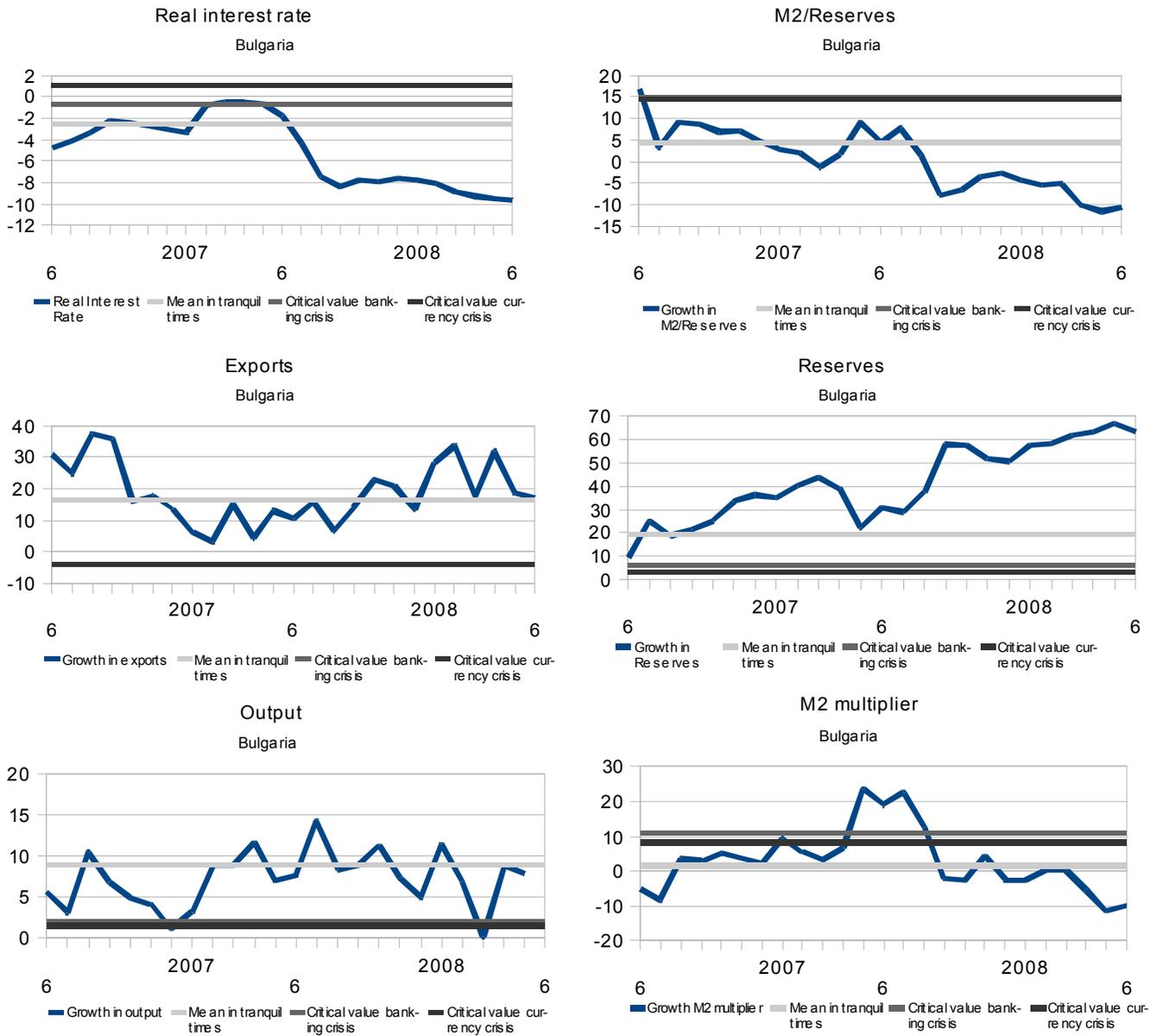


Figure 1: Indicators for Bulgaria, expressed in 12 month percentage change from Juli 2006 to June 2008.

## Hungary

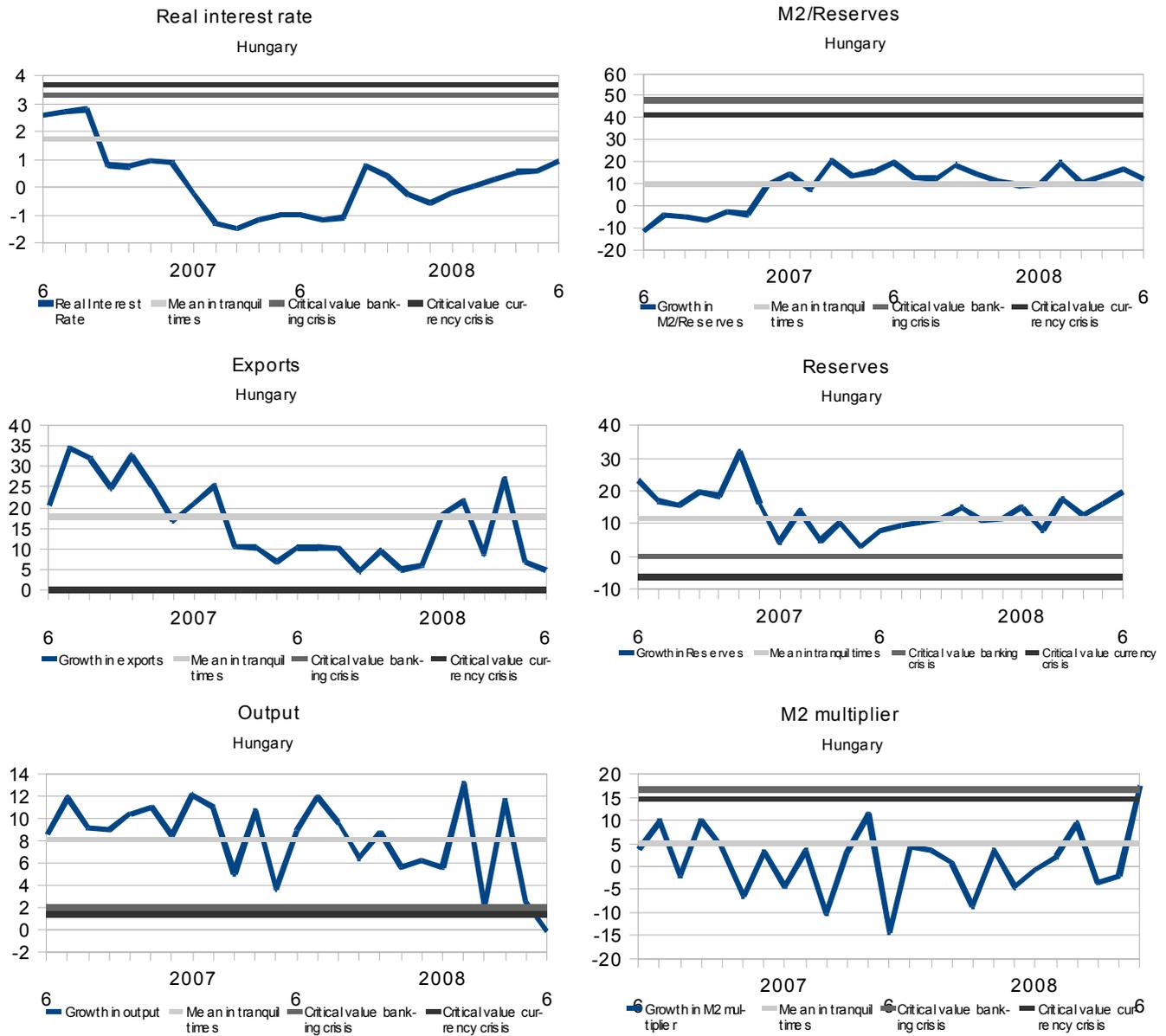


Figure 2: Indicators for Hungary, expressed in 12 month percentage change from Juli 2006 to June 2008.

## Romania

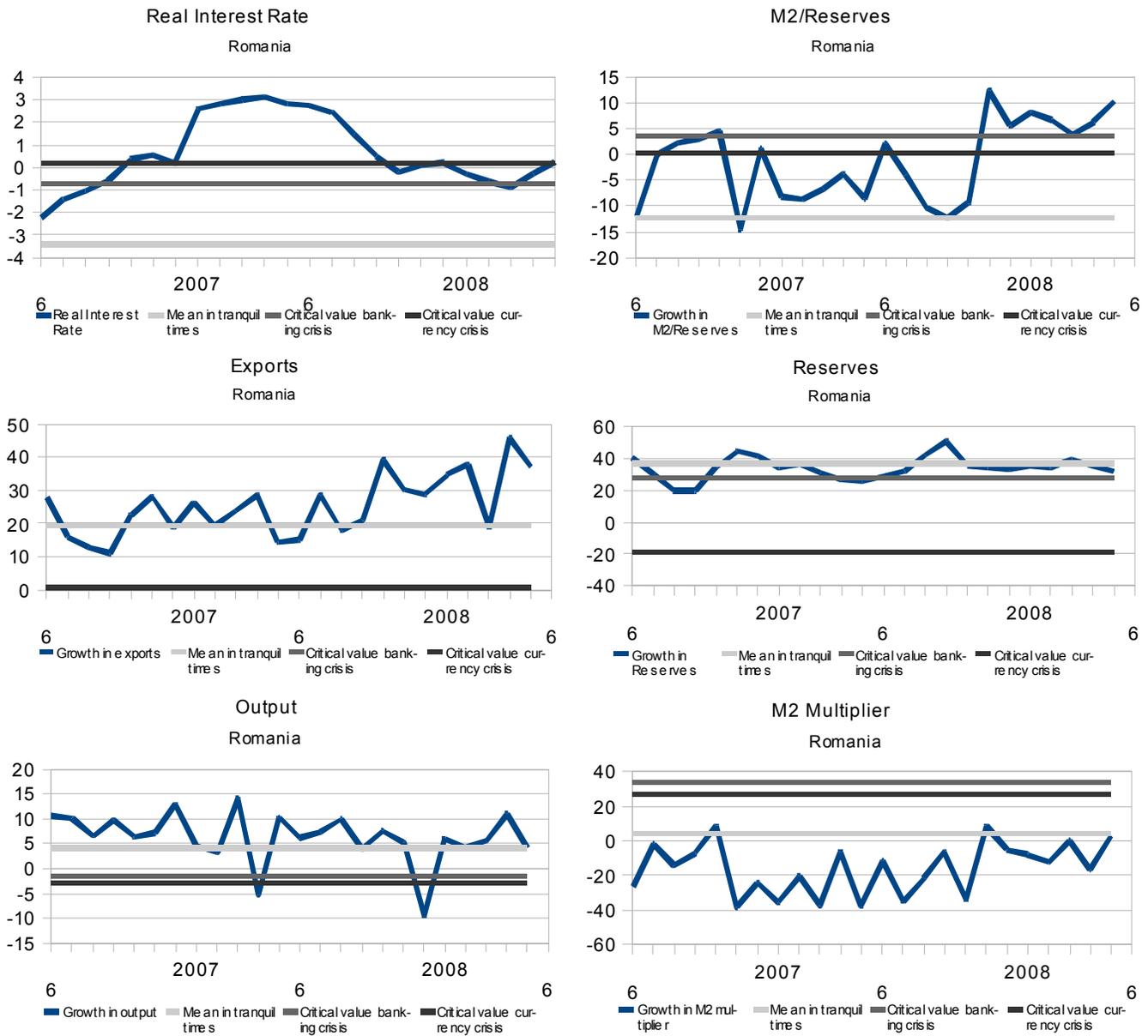


Figure 3: Indicators for Romania, expressed in 12 month percentage change from Juli 2006 to May 2008.

## Slovakia

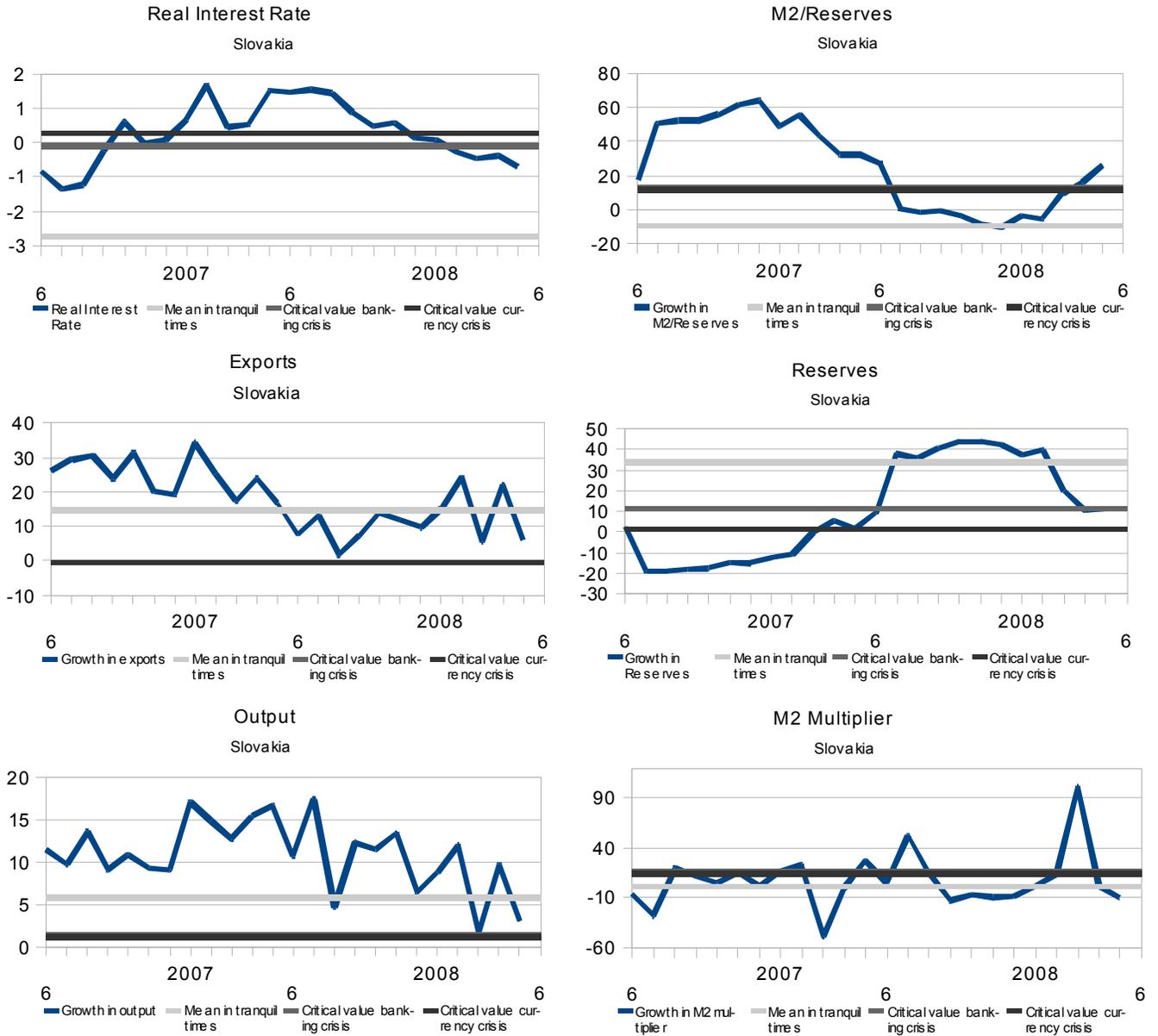


Figure 4: Indicators for Slovakia, expressed in 12 month percentage change from Juli 2006 tot May 2008.

## *Composite Indicators*

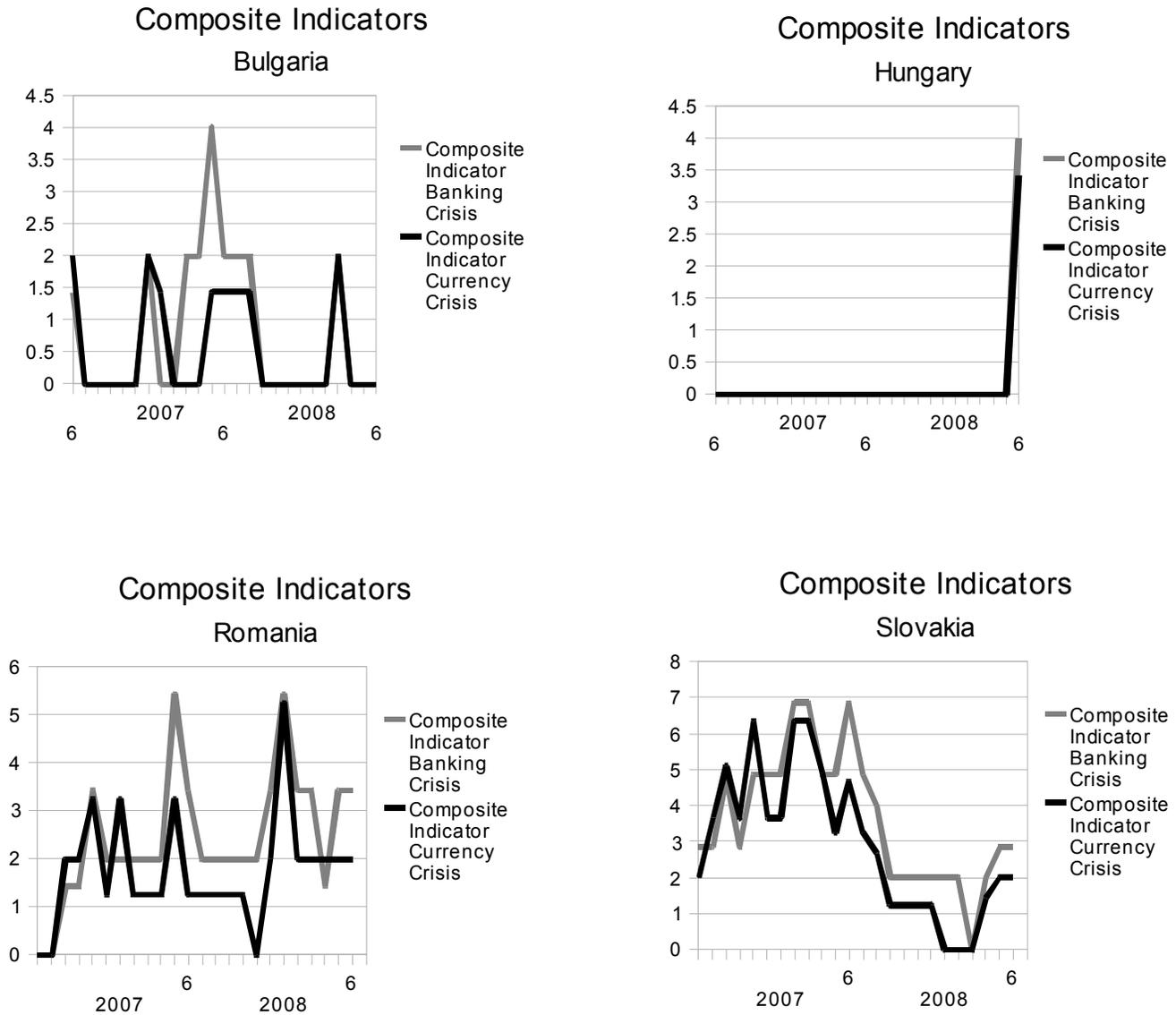


Figure 5: Composite indicators for Bulgaria, Hungary, Romania and Slovakia.