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An analysis of financial crisis by an early warning system model: The case of the EU candidate countries

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The objective of this paper is to estimate the relative contribution of a wide array of determinants to outbreak of financial crises in the EU candidate countries (Croatia, Macedonia and Turkey) and to identify the best-performing early warning indicators of financial crises. We have estimated a binomial logit model of the three EU candidate countries for the period 2005Q1 to 2009Q4 using actual quarterly data. It has been found that the capital account indicators (gross external debt relative to export) and the financial sector variables (the domestic loans and the total bank deposits in relation to GDP) have the highest contribution of all early warning indicators, which is in line with the previous studies of financial shocks in emerging markets. The obtained empirical results give support to the thesis that financial crises in the EU candidate countries can not be solely explained and predicted by only one group of variables, but by a number of different types of indicators. Based on our empirical findings, the EU candidate countries are strongly suggested to decrease their stock of external debt to GNP and to continually analyze and close monitor the financial deepening processes in their countries.

JEL Classifications: C13, C25, C51, C53, E44, G01

Keywords: Financial crisis, early warning system model, logit model, the EU candidate countries.

Introduction

The global financial and economic crisis of 2008, the severest one since the chronic days of the Great Depression and with worldwide simultaneous devastating economic, social and political impact has rekindled the interest of economists and policymakers in early warning system (EWS) models for explaining and predicting financial crises. The importance of understanding the causes of the financial crises and predicting them early on is especially true with the EU candidate countries that as a consequence of the recent global financial and economic crisis, have been forced to deal with multiple exogenous shocks simultaneously. In order to mitigate the severe consequences of the global financial and economic crisis (reduction in trade, capital inflows and foreign assistance), these countries have turned to international financial institutions asking for a substantial financial aid. On the other hand, the convergence towards the EU (the ongoing capital account liberalization towards its full liberalization by the time of the EU accession at the latest) could create additional problems regarding the macroeconomic stability of the EU candidate countries.

Against this background, the purpose of our paper is to assess the relative contribution of a wide array of determinants of financial crises for the group of EU candidate countries and to build an econometric EWS model of the 2008 global financial and economic crisis which will serve as a tool for predicting future financial crises in the EU candidate countries (Croatia, Macedonia and Turkey). The ultimate objective is to help governments of these countries, but also public and private companies in these countries to recognize vulnerability to financial crises at an earlier stage and create corrective policy actions that would mitigate the crisis impacts or prevent such crises from actually taking place.

Although there are a number of empirical studies of early warning indicators of financial crises (Demirguc-Kunt and Detragiache, 1998; Eichengreen et al., 1996; Furnam and

Stiglitz, 1998; Honohan, 1997; Gavin and Hausman, 1996; Goldstein et al., 2000; Kaminsky and Reinhart, 1996; Rojas-Suarez and Weisbrod, 1996; Sundararijan and Balino, 1991), to this point, most of them relate exclusively to determinants of currency crises or "twin" crises. However, the joint occurrence of banking, currency and debt crises associated with the global financial crisis of 2008 has motivated the interest in studying the determinants of the "crisis of the triad"[1] (banking, debt and currency crisis). The main theoretical contribution of this paper to the existing literature on financial crises is that it analyses the determinants of the financial crisis of the triad in a constrained sample of economies (the EU candidate countries) and considers the crisis to have continued until the end of 2009, unlike the previous empirical studies (Obstfeld et al., 2009; Rose and Spiegel, 2009; Berkmen, 2010) which analyzed the recent crisis as it has ended in 2008.

The rest of the paper is structured as follows. Next section gives a brief overview of the theoretical and empirical literature on the early warning models of financial crises. Then, the paper describes the methodology and the tested variables. The estimation of the binomial logit model, the obtained results as and a few policy recommendations derived from these results are presented in further analysis. The final section draws some conclusions and considers the prospects for future research.

Literature review

Although this paper has an empirical focus, before reviewing the relevant empirical studies on this topic, first I will briefly review the theoretical literature, as it makes some important predictions regarding the ability of empirical models to predict financial crises correctly.

The historical development of the theoretical literature can be grouped into three generations of models which will be discussed below.

Initiated by the Latin American debt crisis at the beginning of 1980s and pioneered by Krugman (1979), the first generation of theoretical models of crisis focus on the role of the weak economic and financial fundamentals such as, the gradual decline in international reserves, growing budget and current account deficits, domestic credit growth, and gradual exchange rate overvaluation as potential early warning indicators of currency crisis. However, the ERM crisis 1992-93 in Western Europe proved that sound fundamentals (adequate international reserves, manageable domestic credit growth and non-monetized fiscal deficits) and good economic policies were not enough to protect some countries (UK and Spain) from speculative attacks. Motivated by these counter-examples, Obstfeld (1996) developed the so called second generation of models, by adding features of self-fulfilling prophecies to currency crises. The main innovation of these models lies in identifying the role that the 'expectations' of the economic agents (investors) may play in precipitating currency crises. After the Asian and the Latin American crisis during the mid 1990s, when the economic fundamentals of the affected countries were found to be rather sound before the outbreak of the crisis, it was found that problems in the financial sector trigger the financial crises. Therefore the new, third generation of theoretical models additionally included the financial sector indicators derived from aggregate balance sheets of banks. According to Krznar (2004) the three generations of models, developed over the last two decades, do not offer consensus on the causes of financial crises since they identify different determinants of a crisis.

Based on the identified determinants of financial crises, different empirical studies were undertaken to predict future financial crises. There are essentially two main approaches which have been used for developing of early warning models: the econometric approach (discrete-dependent-variable approach) and the "signals" approach.

[1] The term "crisis of the triad" was introduced by Willem Buiter, Professor of European Political Economy at London School of Economics and Political Science.

In the empirical literature, there are essentially two main approaches for constructing EWS models: the econometric and the "signals" approach.

The first approach, the econometric approach estimates limited dependent variable probability models (a probit or a logit model) for prediction of the outbreak of a financial crisis.[1] These models estimate a probability relationship with a discrete dependent variable (one or zero, or a crisis happens or does not happen). They can tell us which of the explanatory variables included in the model has a predictive power and can also show the probability of a future crisis. The main difference between them is that the probit model is based on the standard normal probability density function, whereas the logit model uses an S-shaped logistic function to constrain the probabilities to the [0, 1] interval. Predicated probabilities calculated by these models differ only slightly in practice.

Eichengreen et al. (1996), who were among the first to adopt a probit model for prediction of currency crisis, found that speculative attacks on fixed exchange rates played a significant role in predicting the incidence of currency crises. Demirguc-Kunt and Detragiache (1998) relate a banking crisis to low economic growth, high inflation and high real interest rate. By estimating panel and logit regressions, Cartapanis et al. (2002), found that both currency overvaluation and pure contagion effects were the leading indicators of the Asian crisis. Rossi (1999) found that a higher probability of a banking crisis is related to slow economic growth and rapid bank credit expansion, and the occurrence of a currency crisis is highly related to a change in terms of trade, economic growth and the occurrence of banking distress. After controlling for the influence of a set of macro variables, Glick and Hutchison (2000) found a significant contemporaneous effect of the currency crisis in the banking distress equation, and significant contemporaneous and lagged effect of banking crisis in the currency pressure equation in the emerging economies sub-sample. However, the causal relationship between banking and currency crises disappeared after including the developed economies.

More recently, Falcetti and Tudela (2006) studied the determinants of twin crises in emerging economies. Their results showed that banking and currency crises had become closely intertwined and driven by common fundamentals.

Instead of summarizing the probability of crisis in one number between zero and one, the "signals" approach uses a completely different method - a non-parametric method to ascertain the risk of financial crisis. A variable is considered to be issuing a warning signal if it goes beyond a certain "threshold" level in the bad direction. The "signals" approach was pioneered by Kaminsky and Reinhart (1996) who studied the casual linkages between crises in order to identify the behaviour of macroeconomic fundamentals on a sample of 20 economies in the period from 1970 to 1995. A set of 16 indicators were selected, measuring the degree of financial openness, balance-of-payment conditions, and real and fiscal sector conditions. It was concluded that when a few indicators exceed certain threshold values, a crisis or an occurrence of a distress is expected in the following twenty-four months.

Methodology and data

In our paper we decided to employ the probability model over the "signals" approach due to the following advantages of the logit/probit model:

1. It provides a framework for statistical testing of the magnitude and statistical significance of each of the individual explanatory variables on the onset of a crisis (Berg and Pattillo, 1998);
2. It takes into account correlation between regressors and combines information from various crisis indicators into a single composite indicator of crisis (Berg and Pattillo, 1998);

[1] There are also econometric studies employing ordinary least squares and vector auto regression, but probit and logit models are the pillars of econometric studies of financial crises.

3. It also allows estimation of the probability of occurrence of a crisis in the future given projected values of the explanatory variables and
4. It allows introduction of various functional forms between the binomial dependent variable and the set of different explanatory variables.

To these advantages we should also add the important advantage of the probability over the linear model, namely, the fact that the probability model does not require strict assumptions which makes this model wider used than the linear equations.

The above described advantages of probability models make them appropriate for the purpose of our study - to estimate the relative magnitude and to test the statistical significance of a wide array of determinants of financial crises in order to identify which of them are the best-performing early warning indicators of crises in the EU accession countries.

In this paper, we opt for the logit model, since it is easier to use computationally than the probit model. We estimate a binomial logit model using a richer set of determinants of crisis in order to answer the question of what probability different indicators have assigned to the outbreak of the current global financial crisis in the three EU candidate countries, given the information set in the period 2005:Q1-2009:Q4.

The big challenge to undertaking the estimation is the definition of the dependent variable - the financial crisis. In our logit framework we define the binary dependent variable using the common for empirical studies method of identifying episodes of financial crises, namely, exchange market pressure index (EMPIit).[1] Following the model-independent approach originally developed by Eichengreen et al. (1995), we construct the EMP index as a weighted average of the percentage change in the nominal foreign exchange rate of the national currency against the Euro, percentage change in the nominal gross foreign exchange reserves expressed in Euro and the interest rate differential between the nominal short-term interest rate of the relevant EU candidate country and the short-term interest rate of Germany, as the biggest trading and investment partner of the three analyzed countries (Croatia, Macedonia and Turkey):

$$EMPI_{it} = \Delta e_t - \beta \Delta r_t + yidif_t \qquad (1)$$

where, e_t - the nominal exchange rate of the national currency against the Euro in period of time t; r_t - the nominal international reserves expressed in Euro; i_t - the difference between the nominal short-term interest rates of the relevant EU candidate country and Germany. The second and the third additives are weighted by the ratio of the standard error of the percentage change of the exchange rate over the standard error of the percentage change of reserves and the interest rate differential, respectively (β, y), which gives a larger weight to a component with smaller variance and equalizes conditional volatility.

The EMP index signals a financial crisis episode (ex post) when its value exceeds a given threshold level. One limitation of this "conversion" rule of the EMP index into a binary variable is the arbitrariness of the choice of the threshold. In our paper we apply a criterion of 1.5 standard deviations above the mean of the country-specific EMP index (Girton and Roper, 1977), which identifies the highest index values in the sample EMP index, in order to define the threshold of a crisis in the exchange market

Following this definition of the threshold value, a financial crisis is defined as a binary dependent variable as follows:

[1] The seminal paper on the exchange market pressure index is Girton and Roper (1977).

$$\begin{aligned} \textit{Financial crisis } (Y_{it}) &= 1 \textit{ if } EMP_t > \mu_{EMP} + 1.5 \times \sigma_{EMP} \\ &\quad (\textit{and three quarters before the onset of the crisis}) \qquad (2) \\ &= 0 \textit{ in any other case} \end{aligned}$$

where σ_{EMP} - the standard deviation of the exchange market pressure index and μ_{EMP} - the index arithmetic mean.

In addition to the clear definition of crisis, it is also important to define the required output of the model: predicting the exact timing of a financial crisis or merely its occurrence in a specified time horizon. Our objective is to predict the occurrence of a financial crisis in a cluster of countries (the EU candidate countries) within a particular period of time, and not to predict the exact timing of a crisis.

Since a crisis often culminates in the deterioration of macroeconomic indicators well before an actual financial crisis occurs, the value of 1 is assigned to the crisis variable Y_{it} not only in the quarter when the EMP index exceeds the threshold, but also three quarters before that. Because of the short time series, it was decided that the pre-crisis period lasts three quarters (before the moment of the onset of a financial crisis), the time interval when various signalling indicators of a financial crisis should signal the outbreak of a financial crisis in the sample. On the other hand, the four-quarters inclusion window is justified by the fact that the focus of this paper is on the period leading up to the crisis, rather than the crisis itself. Therefore, as shown in equation (2), the binary dependent variable (Y_{it}) is assumed to be one if the index is above the threshold any time within a four-quarters crisis window. This approach allows for the crises probability to occur any time within a crisis window of twelve months. Such a crisis window should provide a good trade-off between two important countervailing effects (Fratzscher and Bussiere, 2002). On the one hand, economic variables show deterioration 12-19 months before a crisis (Kaminsky et al., 1998) and on the other hand, the earlier it is possible to identify signs of vulnerability, the more time there is for policy makers to take effective corrective actions.

The next step in construction of an EWS model is selecting the explanatory variables i.e. the indicators of a financial crisis.

The choice of the explanatory variables which enter our logit model is based on the previous literature on financial crises, the circumstances specific to the economic systems of the group of EU candidate countries and is also subject to the data availability. Our approach was to include a relatively wide array of potential early warning indicators. Translated in operational terms, this means that the vector of explanatory variables in our logit model consists of set of 11 explanatory variables that are commonly used in empirical modelling of financial crisis. These variables can be grouped into the following groups of variables:

1. Fiscal variables

- *Government budget balance as a percentage of GDP* (BUDGET) - A rise in a budget surplus could lead to a more expansionary contemporaneous fiscal policy and hence a rise in output growth. On the other hand, a steady rise of a budget deficit can be expected before the eruption of a crisis as the higher deficit will impair the government's willingness to service its debt (Krugman, 1979).

2. Financial sector variables

- *Ratio of domestic bank loans to GDP*, nominal (LOANS) - Credit expansion follows financial deregulation and cyclical "overheating". The ratio of domestic bank loans to GDP usually rises in the months preceding a banking crisis or in the early phase of a banking crisis. As the crisis unfolds, banks' credit activity decreases sharply, banks become more cautious, and total economic growth slows.

- *Decline in total bank deposits to GDP*, nominal (DEPOSITS) - When a banking crisis is looming, domestic residents, who are usually better informed than foreigners, slowly loose faith in the stability of the banking sector and begin to withdraw their savings. Therefore, a drop in bank deposits can be expected before a crisis (Demirguc-Kunt and Detragiache, 1999).

3. External sector (current account) variables

- *Trade deficit as a percentage of GDP* (TRBALANCE) - According to the first generation models, higher trade deficit signals appreciating foreign exchange rate and makes current account deficits less sustainable (Roubini and Wachtel, 1998).
- *Current account deficit as a percentage of GDP* (CURACC) - Large current account deficits are likely to be associated with a higher degree of vulnerability. Above a certain level, market participants may judge that the deficit is unsustainable and expect currency devaluation.
- *Growth rate of exports* (EXPORT) - Reduced exports inhibit a country's ability to earn foreign exchange to finance an existing current account deficit. Thus, falling exports add to the crisis potential.
- *Real effective exchange rate as a deviation from HP* trend (REER) - This variable is used as a proxy for currency appreciation or depreciation. If the real exchange rate appreciation is a reflection of upward misalignment of currency value, it will cause more pressure on currency devaluation. Usually, financial crises are closely linked to strong appreciation that hinders competitiveness in the external market, deteriorates the current account and ultimately negatively affects a country's ability to service its debt. In our model an appreciation (overvaluation) of the real exchange rate is defined as a negative deviation of the real exchange rate from the long term HP trend. Conversely, a depreciation (undervaluation) is a positive deviation from HP trend (Kaminsky et al., 1998).

4. External sector (capital account) variables

- *Real interest rate differential, as a difference between domestic and foreign short-term interest rate* (REALINRATEDIF) - Theoretical presumptions are not entirely clear (sometimes contradictory) in this area. Domestic short-term real interest rates can be increased in order to fend off a speculative attack. Increased real short-term domestic interest rates could prevent a possible capital flight from the analyzed country and avoid a pressure on the foreign exchange rate. On the other hand, higher domestic interest rates could also signal a liquidity crunch and outbreak of a financial crisis.
- *Capital flight* (PORTFOLICHANGE) - Capital flight, identified as one or more categories of short-term capital outflows, intensifies a currency crisis, and can further deepen a banking crisis due to devaluation expectations (Brüggemann and Linne, 2003). As a proxy for the amount of flight capital we use the portfolio investment decline rate. Portfolio outflows induce vulnerability to sudden stops which is in accordance with the second and third generation models (Radelet and Sachs, 1998a).
- *Ratio of gross external debt to export* (DEBT) - According to Kaminsky (2006) this indicator measures international liquidity and reserve adequacy. Following financial liberalization, massive inflows of foreign capital often create macroeconomic imbalances that ultimately prove unsustainable (McKinnon and Pill, 1999). An increase especially in short - term debt points to rising difficulties in rolling over foreign debt due to the increased risk; excessive exposure to financial markets leads to an increased vulnerability of macroeconomic situation.

Foreign exchange reserves are not included in the baseline indicators because of two main reasons (Frankel and Saravelos, 2010). First, during the current financial crisis the level of reserves increase as a result of credits drawn under IMF programs. Even if the currency reserves record a decline, that decline is a biased measure of crisis incidence, as their level would have likely been much lower in the absence of an IMF credit. Second, movements

in exchange rates cause not only a volume loss in reserves, but also a paper loss on their value.

5. Domestic real sector variables

- *Real GDP growth rate* - Lower GDP growth is likely to increase the vulnerability of the economy to a financial crisis which is usually preceded by a recession (Peltonen, 2006).

Some of the above mentioned indicators are exclusive for currency crises, banking crises or debt crises, and others are multiple crises indicators in the sense that the same indicator causes more than one type of financial crises. However, it is not sure whether such a multiple crisis indicators affects the probability of two or more types of financial crises simultaneously, or whether it causes only one type of crisis which in turn leads to outbreak of a second type of crisis, and a third. For instance, an overvaluation of the domestic currency could cause a currency crisis as a result of which a banking crisis occurs. In our logit model we take the approach developed by Lestano and Kuper (2003) which allows for one explanatory variable to affect two or more types of crises, without capturing explicitly the rollover effect.

The panel dataset covers the cluster of the three EU candidate countries (Croatia, Macedonia and Turkey). Our empirical analysis is based on actual quarterly data collected in the sample period from 2005 Q1 to 2009 Q4 with at most 20 observations for each country. In absence of actual monthly data for most of the explanatory variables for the sample countries, we have decided to use actual quarterly data, as has been the case in many recent papers investigating the determinants and/or predictability of the emerging markets financial crisis, where the frequency of data was chosen to be quarterly, and not monthly.

We have avoided interpolating the actual quarterly data into monthly data due to some econometric issues. Namely, the greatest difficulty of using interpolated series is that by doing so one uses information about future economic conditions that was not available to economic agents at the time. They are forced to use forecasts of the key economic variables when they make their investment decisions simply because the actual information is not available.

The timing of the crisis was identified on the basis of the country specific EMP index as described before: Croatia: 2009Q2; Macedonia: 2009Q2 and Turkey: 2009Q1. The reliability of this statistics-based crisis dating system is confirmed by the actual occurrence of financial crisis in these countries. The majority of the data are taken from the central banks and the state statistical offices of the EU candidate countries.

Estimation results

To identify the determinants of financial crises in the economies of the EU candidate countries, the broad logit regression estimates a large number of explanatory variables suggested by the prior theoretical and empirical analyses of financial crises, with 6 statistically significant indicators from the initial set of 11 variables. A large number of insignificant regressors may introduce some noise into estimations; therefore, using a general-to-specific approach, variables that are not statistically and economically significant are manually stepwise deleted.

The degree of statistical significance of each specification is assessed with several tests. The null that each single indicator is zero is tested with a z-test on each parameter. Then, the joint hypothesis that all the coefficients are zero is examined using a chi squared test. In order to approximate the explanatory power of the model, the value of McFadden R-squared and LR statistic are computed. Testing the expected sign and the statistical significance of each coefficient in the model has lead to elimination of insignificant variables and those with wrong signs and specification of final reduced model.

TABLE 1. ESTIMATION OF THE BROAD LOGIT REGRESSION MODEL

Dependent Variable: CRISIS				
Method: ML - Binary Logit (Quadratic hill climbing)				
Sample (adjusted): 2005Q1 2009Q3				
Included observations: 52 after adjustments				
Convergence achieved after 8 iterations				
Covariance matrix computed using second derivatives				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-72.11048	45.91135	-1.570646	0.1163
BUDGET	-0.850055	0.491359	-1.730009	0.0836
REER	1.217805	0.727713	1.673468	0.0942
CURACC	0.573631	0.354755	1.616981	0.1059
LOANS	0.161044	0.097854	1.645762	0.0998
DEPOSITS	0.335684	0.208036	1.613583	0.1066
PORTFOLICHANGE	0.022237	0.015236	1.459521	0.1444
EXPORT	-0.038919	0.081141	-0.479652	0.6315
DEBT	0.007910	0.005889	1.343035	0.1793
GDPCHANGE	0.715186	0.618012	1.157237	0.2472
TRBALANCE	0.316865	0.437114	0.724902	0.4685
REALINRATEDIF	-0.089269	0.285665	-0.312496	0.7547

Mcfadden R-squared	0.668157	Mean dependent var	0.250000
S.D. dependent var	0.437237	S.E. of regression	0.266577
Akaike info criterion	0.834752	Sum squared resid	2.842523
Schwarz criterion	1.285039	Log likelihood	-9.703561
Hannan-Quinn criter.	1.007382	Restr. log likelihood	-29.24143
LR statistic	39.07573	Avg. log likelihood	-0.186607
Prob(LR statistic)	0.000051		
Obs with Dep=0	39	Total obs	52
Obs with Dep=1	13		

The final bivariate logit model was estimated following the previous criteria of the expected sign and statistical significance of each of the indicators. The statistical characteristics of the final model are favourable. Namely, the resultant reduced regression contains seven variables, all except one with expected sign. The variable DEBT is highly significant at level of 1% significance and the other variables are statistically significant at level of significance of 5%, except variable PORTFOLICHANGE which is significant at 10% level. On the contrary, the real interest rate spread between the analyzed country and Germany, the growth of export and the trade balance as a percentage of GDP have not proved to be statistically significant in different specifications and, thus, are excluded from the final model. The indicator of economic growth, GDP growth rate, has, unexpectedly,"+" sign. This can be explained with the fact that higher past GDP growth is associated with larger output drops during the current crisis, as well as a higher probability of recourse to the IMF. This appears somewhat counterintuitive, but may be attributable to a positive link between higher GDP growth rates and asset market bubbles and credit or commodity export booms (Frankel and Saravelos, 2010).

The LR statistic which tests the joint null hypothesis that all slope coefficients except the constant are zero is rejected at level of significance of 0%, and McFadden R2 indicates relatively good goodness-of-fit of the model. The probability of a financial crisis incidence in the EU candidate countries increases when the ratio of budget surplus to GDP is decreasing, the real effective exchange rate is appreciating below the trend, the current account deficit is worsening, the share of domestic loans in GDP is growing, total bank

deposits are declining, portfolio outflows are increasing and the gross external debt relative to export is rising.

TABLE 2. ESTIMATION OF THE REDUCED LOGIT MODEL

Dependent Variable: KRIZATOCNA				
Method: ML - Binary Logit (Quadratic hill climbing)				
Date: 07/27/10 Time: 18:56				
Sample (adjusted): 2005Q1 2009Q3				
Included observations: 52 after adjustments				
Convergence achieved after 6 iterations				
Covariance matrix computed using second derivatives				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-36.40388	13.93760	-2.611920	0.0090
BUDGET	-0.390990	0.176389	-2.216629	0.0266
REERRAZLIKA	0.684903	0.294987	2.321805	0.0202
CURACC	0.291911	0.130563	2.235790	0.0254
LOANSTOCNI	0.075607	0.030609	2.470107	0.0135
DEPOSITSTOCNI1	0.158546	0.062936	2.519148	0.0118
PORTFOLICHANGE	0.009865	0.005551	1.776989	0.0756
DEBT	0.003698	0.001406	2.630040	0.0085

Mcfadden R-squared	0.622104	Mean dependent var	0.250000
S.D. dependent var	0.437237	S.E. of regression	0.255607
Akaike info criterion	0.732700	Sum squared resid	2.874744
Schwarz criterion	1.032892	Log likelihood	-11.05021
Hannan-Quinn criter.	0.847787	Restr. log likelihood	-29.24143
LR statistic	36.38244	Avg. log likelihood	-0.212504
Prob(LR statistic)	0.000006		
Obs with Dep=0	39	Total obs	52
Obs with Dep=1	13		

What do these estimates mean? If we divide all of the estimates by 4, we can see that if the budget balance increases for 1% the estimated probability that crisis will occur decreases by almost 0.10 keeping all other variables constant. The parameter of REER is showing that if REER increases for 1%, the estimated probability of crisis goes up by 0.17 if all other variables stay constant. A one point increase in CURACC leads to probability increase by 0.07, 1% increase of LOANS cause the estimated probability to increase by 0.02, of PORTFOLICHANGE by 0.002 and the increase of DEBT for 1 point will increase the probability that crisis will outbreak by 0,001, holding constant the remaining five variables. A one point increase in DEPOSITS will cause a fall in estimated probability of crisis occurring by 0.04 when all other variables remain unchanged.

Turning to the economic interpretation of our results, the estimates from the specification in above table give a sense of the relative strong impact of the gross external debt relative to export, domestic loans and bank deposits relative to GDP in predicting the incidence of a financial crisis in the EU candidate countries. Our findings are in line with the previous empirical studies of financial shocks in emerging markets, where wrecked banking systems and foreign capital flows played a crucial role. These indicators actually belong to the third generation models in which domestic banking sector weaknesses, high external indebtedness and poor quality loans are the key determinants of financial crises.

The ratio of gross external debt to export is found to be the most significant early warning indicator of financial crisis in the EU candidate countries. This result is in line with the very high and unsustainable foreign debt burden of the EU candidate countries as a result

of over-borrowing from abroad. Namely, in the first quarter of 2010 Croatia's total gross external debt amounted to 95% of GDP, 57% of Macedonia's GDP and 43% of Turkey's GDP. Given that a substantial portion of the external debt is held by the private sector, increased costs for its servicing will require higher borrowing by the governments of the EU candidate countries, and thus to higher fiscal deficits and to growth of public debt.

Though not figuring prominently in the earlier empirical research, the very high statistical significance of the indicators relating to financial market development in the EU candidate countries, namely, the ratio of domestic bank loans to GDP and ratio of bank deposits to GDP is particularly relevant given the origins of the global financial crisis of 2008. Our result is in line with Berkman et al. (2009) and Frankel and Saravelos (2010) who have found out that countries with a more leveraged financial system and higher credit growth suffered more during the crisis.

The real effective exchange rate overvaluation and the level of the current account deficit are also found to be statistically significant indicators for predicting financial crisis incidence in the EU candidate countries.

The same refers to the ratio of budget balance to GDP. This result is in line with the persistent fiscal deficits in the three analysed EU candidate countries (Croatia, Macedonia and Turkey). A relatively high fiscal deficit could easily tilt the market sentiment against the domestic currency.

TABLE 3. PREDICTION ABILITY OF THE MODEL

Expectation-Prediction Evaluation for Binary Specification						
Equation: Kraenreduciran						
Date: 01/26/11 Time: 07:28						
Success cutoff: C = 0.5						
	Estimated Dep=0	Equation Dep=1	Total	Constant Dep=0	Probability Dep=1	Total
P(Dep=1)<=C	37	2	39	39	13	52
P(Dep=1)>C	2	11	13	0	0	0
Total	39	13	52	39	13	52
Correct	37	11	48	39	0	39
% Correct	94.87	84.62	92.31	100.00	0.00	75.00
% Incorrect	5.13	15.38	7.69	0.00	100.00	25.00
Total Gain*	-5.13	84.62	17.31			
Percent Gain**	NA	84.62	69.23			
	Estimated Dep=0	Equation Dep=1	Total	Constant Dep=0	Probability Dep=1	Total
E(# of Dep=0)	35.90	3.10	39.00	29.25	9.75	39.00
E(# of Dep=1)	3.10	9.90	13.00	9.75	3.25	13.00
Total	39.00	13.00	52.00	39.00	13.00	52.00
Correct	35.90	9.90	45.79	29.25	3.25	32.50
% Correct	92.04	76.13	88.06	75.00	25.00	62.50
% Incorrect	7.96	23.87	11.94	25.00	75.00	37.50
Total Gain*	17.04	51.13	25.56			
Percent Gain**	68.17	68.17	68.17			

Note: *Change in "% Correct" from default (constant probability) specification; **Percent of incorrect (default) prediction corrected by equation.

Also, capital flight does quite well in explaining the outbreak of financial crises within the EU candidate countries. As in the other developing countries, capital flight can cause serious economic difficulties for the EU candidate countries: Khan and Haque (1985) spoke of erosion of the tax base and a reduction in domestic investment. Since capital

flight leads to a build-up of gross foreign debt, it can cause a financial crisis as foreign investors become doubtful about the ability and the will of these countries to pay back.

To use the estimated logit model as a forecasting model of a financial crisis, it is necessary to evaluate its predictive power. Since the within-sample and out-of-sample performance is strongly related, it is sufficient to test only the within-sample performance. The ability of all estimated models to predict financial crises was evaluated using cross tabulations of correct specifications. The cutoff value which separates the pre-crisis period from the tranquil period was set at 0.5. The model correctly calls about 92% of the observations at the selected cut-off value. The model accurately predicted a crisis in as many as 84.62% of cases (quarters) and accurately predicted a tranquil period in 94.87%. Tranquil periods are those which are not followed by a crisis within 4 quarters. The measures of expectation-prediction table show that the model has considerable potential to predict in sample financial crisis. The model was unsuccessful in predicting crisis in only 7.69%.

After we have statistically confirmed the predictive power of the logit model specifications, we employ a χ^2 test of independence to check if there is a systematic relationship between the forecasts and the realisations. The null hypothesis assumes that the forecasts for a binary event (in this case crisis and tranquil periods) are independent from the actual outcomes. The results of the χ^2 test show that the null hypothesis is strongly rejected.

TABLE 4. χ^2 TEST

Goodness-of-Fit Evaluation for Binary Specification								
Andrews Test								
Equation: Kraenreduciran								
Date: 07/27/10 Time: 18:58								
Grouping based upon Krizatocna (randomize ties)								
	Quantile Low	High	Dep=0 Actual	Expect	Dep=1 Actual	Expect	Total Obs	
1	0.0000	0.0000	5	4.32550	0	0.67450	5	
2	0.0000	0.0000	5	4.92828	0	0.07172	5	
3	0.0000	0.0000	5	4.30003	0	0.69997	5	
4	0.0000	0.0000	5	4.38971	0	0.61029	5	
5	0.0000	0.0000	6	5.90503	0	0.09497	6	
6	0.0000	0.0000	5	4.37242	0	0.62758	5	
7	0.0000	0.0000	5	4.68166	0	0.31834	5	
8	0.0000	1.0000	3	3.52396	2	1.47604	5	
9	1.0000	1.0000	0	1.34433	5	3.65567	5	
10	1.0000	1.0000	0	1.22907	6	4.77093	6	
		Total	39	39.0000	13	13.0000	52	7.16394
Andrews Statistic			27.7199		Prob. Chi-Sq(10)			0.0020

From the above analysis, the following two key policy implications can be derived:

1. First, the EU candidate countries are strongly suggested to decrease their current external indebtedness which is unsustainable and unaffordable even for developed economies. According to Reinhart et al. (2003) in most emerging market economies the external debt to GNP ratio needs to be lower than 35% (and even lower if a country has a long history of crises or defaults) to be regarded as "safe". This is because these economies unlike the advanced economies have a weaker fiscal structure, less developed financial systems and a worse record of macroeconomic management and inflation than more advanced economies. Therefore, they are felt as less able to tolerate high levels of indebtedness. The appropriate policy would be to correct the exchange rate where this is possible in order to support improvements in

the current account and boost private savings. Once the current account improves through growth of exports and interest rates decline due to decreased private sector refinancing requirements (the result of debt restructuring), fiscal consolidation becomes easier. This is the way countries have grown out of crisis in a number of previous instances (e.g. in the case of the Asian crisis in the late 1990s). This strategy may not be possible if additional public borrowing is not available to some countries because of increased risk. This is where the support from the multilaterals (IMF and the World Bank) and the EU and the ECB should come in (Gligorov and Landesmann, 2010).

2. Second, since the financial deepening process in the EU candidate countries (which is a natural EU catching up phenomenon) is also associated with enhanced vulnerability to financial crises, healthy financial deepening is one of the main policy challenges ahead in these countries. Allowing for the rapid development of fully-fledged credit and deposit markets, without excessive risk-taking and without an excessive build-up of external vulnerabilities, will remain a difficult balancing act for policy-makers, requiring careful judgment, deep analysis and close monitoring (European Central Bank, 2008).

Limitations of the study

However, there are several limitations of our study. First, the designed logit model defines the financial crisis as a specific event in time, ignoring the independence of crisis occurrence from period to period (except indirectly through serial correlations among the explanatory variables). Second, the logit model coefficients are not intuitive to interpret and they do not reflect the threshold effects that may be simultaneously exerted by other variables. Third, the constructed EWS model suffers from temporal instability of the model parameters as well as of the selection of explanatory variables. Fourth, the model does not provide a direct measure of the intensity or weakness of the signal of each explanatory variable regarding the onset of a crisis. In addition, our EWS model does not include any variables of political and institutional nature that very often have a significant impact on the timing of a financial crisis. In spite of the above limitations, we contend that our logit model performs very well in predicting the occurrence of financial crisis in the EU candidate countries and as such provides a very promising step towards developing a more comprehensive EWS model which will capture more variables especially variables of political and institutional nature.

Conclusion

Our econometric analysis of the early warning indicators of financial crisis incidence based on a binomial logit model on a panel of the three EU candidate countries allows the general conclusion that indicators of financial crisis do work, at least in our EWS model of the EU candidate countries. The estimation results of our model have identified the capital account indicators (gross external debt relative to export) and the financial sector variables (the domestic loans and the bank deposits in relation to GDP) as the top three early warning indicators of financial crises incidence in the EU candidate countries (Croatia, Macedonia and Turkey). These findings are in line with the previous empirical studies of financial shocks in emerging markets, where wrecked banking systems and foreign capital flows played a crucial role. The other four identified highly statistically significant determinants of financial crisis in the EU candidate countries are the overvaluation of the real effective exchange rate, the level of the current account deficit, the fiscal deficit and the capital flight. These empirical results provide an evidence in support of the thesis that indicators of financial crises in the EU candidate countries can not be attributed to only one generation of models of financial crises.

From a policy perspective, two policy recommendations can be derived from the obtained empirical results: 1. The EU candidate countries are strongly suggested to decrease their

stock of external debt in relation to GNP; and 2. They should continually analyze and close monitor the financial deepening process since financial liberalization and elimination of capital account restrictions could fuel the outbreak of financial crises in these countries.

The constructed EWS model in this paper is only a first step towards developing a more comprehensive EWS model. However, it should be noted that even a perfectly designed EWS model may not and cannot be a substitute for sound judgment of policy makers, but only a complement to the arsenal of macroeconomic policy tools in guiding economic policy.

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