# Measuring Financial (In)Stability in Emerging Europe: A New Index-Based Approach

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*The importance of assessing financial stability in emerging Europe has increased rapidly since the recent financial crisis. Against this background, in the present paper we contribute to the existing literature in a twofold way: First, by using a broad range of indicators from money, bond, equity and foreign exchange markets, we develop a comprehensive financial instability index (FII) that gauges the level of financial market stress in some key Central, Eastern and Southeastern European (CESEE) countries. In a second step, we perform a panel estimation to investigate which macroprudential indicators that cover both internal and external imbalances explain the evolution of our FII over the past more than 15 years. Our analysis suggests that both the levels and changes of some indicators (such as credit growth and the level of private sector indebtedness) play an important role for financial stability. Moreover, we find that the impact of some key indicators on financial (in)stability is nonlinear and varies over time depending on market sentiment.*

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Financial stability has again shifted into the center of attention, especially since the beginning of the recent global financial crisis. To be able to detect potential threats to financial stability and take appropriate macroprudential measures early on, policymakers not only need to monitor and assess financial stability but also to project its likely future development. One of the lessons to be learned from the recent financial and economic crisis is that a very broad range of indicators must be monitored to be able to assess overall financial stability in a reliable manner. This is because globalization, financial innovations and technological progress have accelerated many financial processes and have brought forth many new and more complicated transmission channels. As a consequence, financial stability assessment has become more challenging.

Several techniques are employed to assess financial stability, and each has its advantages, disadvantages and limitations. Among the commonly used quantitative methods for financial stability assessment are

- early warning systems,
- macro-stress testing, and
- financial stability indices.

Early warning systems are constructed from potential leading indicators to predict the probability of a financial crisis. They use a discrete representation of the dependent variable and the signaling approach to evaluate indicators by minimizing either their noise-to-signal ratio (Kaminski, 1999) or some type of loss function (Bussière and Fratzscher, 2008; Alessi and Detken, 2009).[2] Even though early warning systems may differ substantially as regards the definition of the dependent variable,

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[2] *See Babecký et al. (2011) for a detailed literature survey on early warning systems.*

the projection horizon, choice of regressors and, of course, their econometric approach, in general they aim to predict the outbreak of potential financial crises. However, early warning systems should only be used as a starting point, or a complementary instrument, while more detailed financial stability analyses should follow to carefully assess all the risks the financial system is exposed to and to obtain some information on the respective economy's risk absorption capacity.

Stress testing offers a more precise analysis, which can estimate financial system resistance to adverse macroeconomic scenarios. Stress tests can detect the source of risks and vulnerabilities of the investigated banking sector or, more broadly, the financial sector (see e.g. Čihák, 2007; Schmieder et al., 2011; Buncic and Melecký, 2012; Jakubík and Sutton, 2012).

Apart from early warning systems and stress testing, aggregate financial stability indices represent another quantitative method for measuring the stability of a financial system. Country-specific financial stability indexes have been constructed e.g. by Sales, Areosa and Areosa (2012) for Brazil, by Brave and Butters (2011) for the United States or by Illing and Liu (2003) for Canada. Geršl and Heřmánek (2008) discuss the methodology of selected financial soundness and financial stability indicators. Furthermore, they construct a composite indicator for the stability of the Czech banking system using equal weights for all included components. They point out, however, that constructing a single aggregate measure of financial stability is a difficult task given the complex nature of the financial system and the existence of complex links between various financial market sectors. Gadanecz and Jayaram (2006) provide a review of financial stability measures along with indicators that are commonly used as explanatory variables for financial stability. While they compute single aggregate measures of financial stability, they conclude that such measures should not be employed for financial stability assessment in isolation, but should be combined with other quantitative and qualitative instruments.

Against this background, the present paper contributes to the existing literature in two ways: First, by using a broad range of indicators from money, bond, equity and foreign exchange markets, we develop a comprehensive financial instability index (FII) that gauges the level of financial market stress in selected Central, Eastern and Southeastern European (CESEE) countries. Not only is this, to our best knowledge, the first attempt at developing such an index for the CESEE region but, more importantly and in contrast to the existing literature, we carefully handpicked the index components to capture all relevant market segments in the countries included in the panel and thereby created a really comprehensive "thermometer" to measure the temperature or, as it might be, the "fever" in CESEE financial markets. Having constructed our financial stress measure, in a second step we perform a panel estimation to investigate which macroprudential indicators that cover both internal and external imbalances explain the evolution of our FII over the past 10 to 16 years.

The remainder of the paper is structured as follows. In the first section, we develop a new composite indicator of financial instability for nine CESEE countries under observation. The section provides a detailed description of the construction of the indicator and all its subindices as well as a discussion of striking episodes of elevated financial

instability in the CESEE region in the period under observation. Section 2 focuses on the key macroeconomic indicators that explain periods of financial stress. We present an empirical analysis based on a panel regression and discuss the data employed. Section 3 examines policy implications and provides some financial instability projections based on the estimated model. Finally, the last section summarizes the results and concludes.

## 1 Financial Instability Index

Compared with the objective of price stability, which can be clearly defined (typically primarily by inflation), financial stability is more difficult to grasp and to measure. As stated in the OeNB's Financial Stability Reports, financial stability can be defined as a situation in which "(…) the financial system (…) is capable of ensuring the efficient allocation of financial resources and fulfilling its key macroeconomic functions even if financial imbalances and shocks occur. Under conditions of financial stability, economic agents have confidence in the banking system and have ready access to financial services (…)." (OeNB, 2012).

### 1.1 Definition and Construction

In order to investigate the key fundamentals that might explain future financial instability, we must start by defining periods of financial stress. Approaches found in the literature typically use some sort of composite index of financial (in)stability. To ensure the comparability and compatibility of the time series employed, each individual component of the overall index has to be normalized. There are a number of popular normalization methods that are commonly used in the literature (see e.g. Hallo et al., 2012). One widely used approach transforms all time series' values into their distance from the mean, expressed in standard deviation units. Alternatively, an empirical or mathematical normalization can be applied, transforming each indicator into a number between a defined lower and upper limit, e.g. 0 and 1 (Albulescu, 2010). Another possibility is to map each indicator into quantiles by using the indicator's sample cumulative distribution function (Lo Duca and Peltonen, 2012, or Jakubík and Teplý, 2011). We opt for this latter method in the present study as it reduces the impact of outliers, which are relatively frequent in time series for emerging European countries and can substantially influence the results under other normalization approaches.

Subsequently, to construct an overall financial (in)stability index, some weights need to be assigned to individual indicators after the applied quantile transformation. The most simplistic approach mentioned in the literature is to apply equal weights to all indicators that make up the aggregate index (see e.g. Albulescu, 2010). Alternatively, weights can be set up according to credit aggregate weights or factor analysis (see e.g. Illing and Liu, 2003). Another approach was introduced by van den End (2006). According to this approach, fundamental indicators that enter the financial (in)stability index are assigned weights that correspond to their contribution to GDP growth. This approach is based on the idea that financial instability negatively affects economic output and that the relative importance of the determinants of financial instability corresponds to the relative importance of drivers of GDP growth. In contrast to the latter study, which defines financial instability on the basis of macroeconomic fundamentals in line with findings in the literature, we believe that a more appropriate measure can

be retrieved from financial market data themselves. For instance, Crespo Cuaresma and Slačík (2009), who develop an early warning mechanism for currency crises based on financial market data, argue that recent research on the predictive power of markets suggests that markets can aggregate disperse information and that market-based forecasts of uncertain events are usually fairly accurate. Moreover, as Wolfers and Zitzewitz (2004) document, such forecasts typically outperform alternative forecasting tools, including highly sophisticated forecasting models, polls or expert surveys.

This is why we follow a similar approach as in Lo Duca and Peltonen (2012) in constructing a financial stress indicator as a composite index that captures risks in money, foreign exchange, equity and bond markets. Yet in contrast to Lo Duca and Peltonen (2012), who use five equally weighted subindices without elaborating on their selection,[3] we try to select and define all subindices in a way which in our view better captures the relative importance of the financial market segments relevant for the respective countries in our panel. As in Lo Duca and Peltonen (2012), all of our subindices are, in principle, weighted equally. However, to increase the weight of the money market for reasons specified below, we construct two subindices for the money market and one index each for the foreign exchange, equity and bond markets. In this way, the money market receives a double weight (40%) compared to other subindices (20% each) in the composite FII. As some of the four markets in question have a very short history in the countries considered, in case the values for some indicators are missing, we distribute the weights equally among the remaining available subindices subject to the restriction of double-weighting for the money market.[4] For example, if bond market data are not available for a country, the weight of its money market is assigned 50%, and weights for foreign exchange and equity markets are both assigned 25%.

The idea behind applying a double weight to the money market is that security and stock markets in CESEE are rather underdeveloped, which makes bank financing the prevailing external source of funding. Moreover, historical evidence shows that all economic crises that occurred in CESEE during the transition period unfolded in the banking sector. Hence, the banking sector plays a key funding and financial stability role for the economies in the region. At the same time, in contrast to other market segments banks are by far the most dominant players in the CESEE money market. Therefore, money market-based indicators provide the closest and most informative signal about the banking sector situation as the crucial financial stability factor in the region.

All subindices – money, foreign exchange, equity and bond markets – are constructed in the same manner, combining annual growth and volatility. The only exception is the overall bond market subindex: In this case, we include the ten-year government bond

[3] *Lo Duca and Peltonen (2012) use two subindices for the equity market and one index for each of the remaining markets. In this way, they implicitly assign a 40% weight to the equity market and a 20% weight to the money, foreign exchange and bond markets, respectively. We think that this construction, whose motivation is not explained in the paper, does not properly reflect the relative importance of financial market segments in the CESEE countries as, typically, the CESEE equity market is still rather underdeveloped.*

[4] *Bond market data are not available for the Czech Republic (until 2000), Hungary (until 1998), Poland (until 1996), Romania (until 2000 and since 2011) and Slovakia (until 2002).*

yield in index construction because, in addition to annual growth and volatility, the yield level itself might be relevant for financial stability. In addition, for the construction of the overall money and bond market subindices we use, respectively, the spread vis-à-vis German sovereign bonds and the country-specific EMBI Global – two widely employed indicators capturing the riskiness of these market segments. Table 1 summarizes the composition of the FII.[5]

### 1.2 Financial Stability Developments in Emerging Europe

Chart 1 shows the development of the FII for the nine CESEE countries under observation – Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Ukraine – between 1996 (or later, depending on data availability) and 2012, based on quarterly market data. While interpreting the paths of financial distress, some key features of the FII have to be borne in mind. First, as the FII is standardized by means of percentile mapping as described above, it is normalized between 0 and 1, which means values above the threshold value of 0.5 indicate periods of elevated financial instability. Second, and more importantly, since the FII is normalized individually for each country, comparing index values across countries does not yield entirely meaningful results. Hence, while it is sensible to compare the FII values for one country over time, the informative value of cross-country FII comparisons at a given point in time is limited.[6]

Table 1

**Financial Instability Index (FII)**

| Markets | Weights | Subindices | Subweights |
|---|---|---|---|
| | % | | |
| Money market | 40 | Overall money market development[1] | 50 |
| | | Money market year-on-year change[1] | 25 |
| | | Money market volatility[1] | 25 |
| | | Spread between domestic and German interbank offered rates | 50 |
| Foreign exchange market | 20 | Exchange rate[2] year-on-year change | 50 |
| | | Exchange rate[2] volatility | 50 |
| Equity market | 20 | Stock index year-on-year change | 50 |
| | | Stock index volatility | 50 |
| Bond market | 20 | Overall bond market development | 50 |
| | | Ten-year government bond yield | 33 |
| | | Ten-year government bond yield – year-on-year change | 33 |
| | | Ten-year government bond yield – volatility | 33 |
| | | Composite EMBI Global | 50 |

*Source: Bloomberg, Eurostat, NCBs.*

*[1] Three-month interbank offered rates.*

*[2] Local currency per EUR 1.*

*Note: Our data sample covers Bulgaria (2004–2011), Croatia (1999–2011), the Czech Republic (1996–2011), Hungary (1997–2011), Poland (1996–2011), Romania (1999–2011), Russia (2002–2011), Slovakia (1996–2011) and Ukraine (2003–2011).*

[5] *It goes without saying that the exact composition of the FII is to some extent arbitrary. However, in contrast to the bulk of the literature featuring apparently rather ad-hoc methods in the construction of similar indices we exercised great care in selecting and weighting the indicators that enter our indices. We experimented with many different specifications of the FII. While all of them delivered a similar FII path, we eventually opted for a variant which, in our view, provides the results best in line with economic intuition and financial stability developments in the considered countries.*

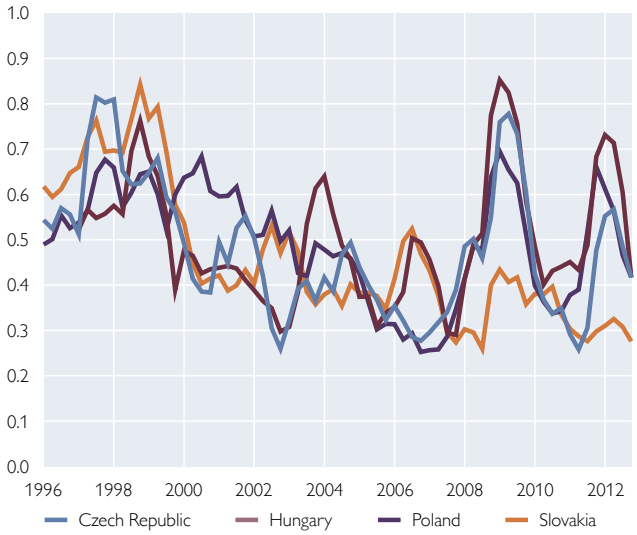
[6] *For example, if the FII amounts to 0.8 in country A and to 0.6 in country B, this does not necessarily imply that the absolute values of the financial instability subindices (raw data before percentile transformation) in country A are worse than those in country B. What it does imply, however, is that historically, the parameter values in country A have led to higher financial stress than those in country B.*

Chart 1

## Development of Financial Instability in Selected CESEE Countries

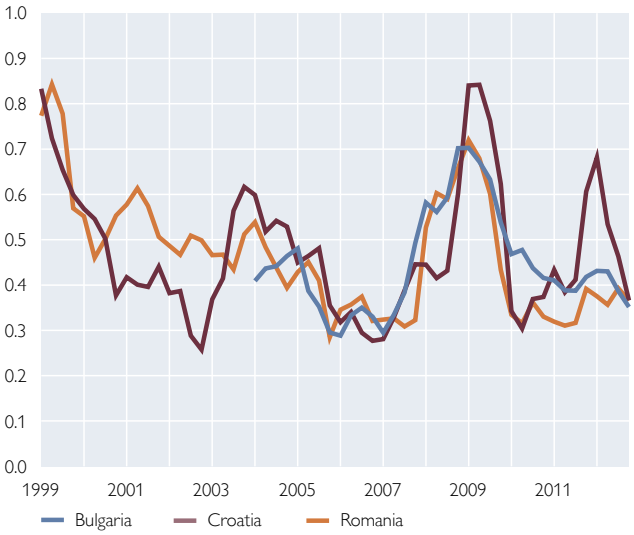
**Selected CEE Countries**

*Financial instability index (FII)*



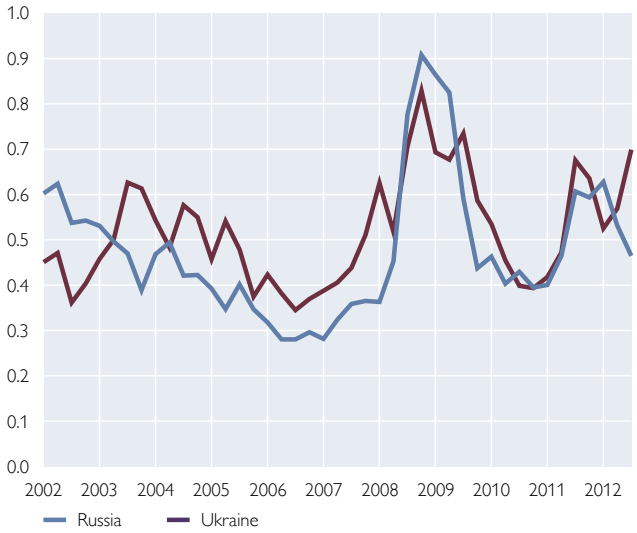

**Selected Balkan Countries**

*Financial instability index (FII)*




**Selected CIS Countries**

*Financial instability index (FII)*




*Source: Authors' calculations.*

*Note: Based on quarterly data. Since the FII is normalized by applying the quantiles approach to each country individually, the comparability of index values across countries is limited.*

The three panels of chart 1 depict FII developments in the four Central and Eastern European (CEE) countries (panel A), three Balkan countries (panel B) and two CIS countries (panel C) in our sample. When taking a look at the FII paths over time, some peculiarities catch the eye. In the Czech Republic, financial distress reached the highest level so far in 1997 – which comes as no surprise as this was the year of the currency crisis – and declined noticeably thereafter. In other countries in the CEE region, by contrast, financial instability rose substantially in 1998, probably in the wake of

the currency and financial crisis in Southeast Asia and Russia. The economic crisis we have been facing since 2008 has, at least at some point, brought about elevated financial stress levels in all countries under observation but Slovakia. Slovakia is the only country in our panel for which the FII has not risen to worrisome levels in the course of the current crisis and has remained well below the 0.5 threshold. However, it is interesting to note that the different phases of the current crisis – ranging from the subprime mortgage crisis at the very beginning to the recent sovereign debt crisis in parts of the euro area – had a different impact on financial instability in the CESEE countries in question. Notably, in all countries under observation the first two crisis years impaired financial stability more than the subsequent sovereign debt and euro crises. In Poland, Bulgaria and Romania financial instability peaked in 2008, suggesting that the very first phase of the crisis was transmitted particularly through short-term channels such as stock or currency markets. By contrast, in the remaining countries financial stress reached the highest levels with a one-year lag in 2009, reflecting markets' uncertainty about longer-term fundamental and real economy issues (e.g. fiscal deficits, low growth), which took some time to feed through into some of the financial stability components of the FII. Moreover, some countries in our sample feature a rather significant rise in the FII between 2008 and 2009. For the Czech Republic, for instance, the FII went up by more than 20% within that one year, peaking just below the levels that had been reached during the currency crisis in 1997. This development indicates that the first subprime phase of the current crisis did not cause much harm in the CESEE region in terms of financial instability.

## 2 Key Driving Factors of Financial Instability

As described above, we defined the FII as a measure for financial markets' assessment of the current level of financial stress. While the FII is based purely on financial market data, we conjecture that periods of financial instability are at least in part driven by fundamental developments that reflect internal and external imbalances which accumulated in the economy in the past. Hence, we now proceed to find an annual model capable of explaining financial stress by past developments of economic fundamentals. In contrast to the literature on early warning systems we do not aim to predict the probability of financial crises but rather to eventually project the future level of financial (in)stability in real time. We therefore do not face the key problem of this literature strand, which is to define crisis periods and which typically has a substantial effect on the results of early warning models.

### 2.1 Data and Regressor Selection

In order to econometrically establish the key driving forces of the FII, we collect a wide range of so-called macroprudential indicators, capturing internal as well as external imbalances and potential vulnerabilities and thus determining the (in)stability of a country's financial sector. Table 2 lists the set of potential explanatory variables for our model, clustered in five categories (sovereign risk, banking sector, contagion risk, real sector and macroeconomy), as well as the sources they have been obtained from. While our indicator selection is not exhaustive and one could certainly think of other potentially relevant drivers of financial

(in)stability[7], it covers all financial market segments. However, as the set of potential explanatory variables is too large given the limited length of our panel, we use univariate regression analyses to eliminate insignificant and improbable regressors. In addition, we consider model specifications that represent each of the key categories important for financial stability, covering

Table 2

**Set of Potential Explanatory Variables for the Panel Estimation Model**

| Category | Indicator | Unit | Time reference | Adjustment | Source |
|---|---|---|---|---|---|
| Sovereign risk | Public debt | % of GDP | End of period | | AMECO |
| | Fiscal deficit (surplus) | % of GDP | Sum over period | | AMECO |
| | Real credit growth (HICP-deflated) | % | End of period | | IMF, NCBs |
| | Credit to private sector | % of (nominal) GDP | End of period | | IMF, NCBs |
| | Current account deficit (surplus) | % of GDP | Sum over period | | IMF, NCBs |
| | Foreign reserves | Import months of goods and services | End of period | | IMF, NCBs |
| | External debt | % of GDP | End of period | | IMF, NCBs |
| Banking sector | Capital adequacy ratio (CAR) | % | End of period | | NCBs |
| | CAR, tier 1 | % | End of period | | NCBs |
| | Nonperforming loans | % of total loans | End of period | | NCBs |
| | After-tax profit | % of average assets | Cumulative sum since year-start | | NCBs |
| | After-tax profit | % of average equity | Cumulative sum since year-start | | NCBs |
| | Foreign currency loans | % of total lonas | End of period | | NCBs |
| | Foreign currency loans and deposits | % of foreign currency deposits (nongovernment and nonbank) | End of period | | NCBs |
| | Loan-to-deposit ratio | % | End of period | | NCBs |
| | Pre-tax profit | % of average equity | Cumulative sum since year-start | | NCBs |
| Contagion risk | Cross-border exposures | % of total assets | End of period | | IMF, NCBs |
| | Exports to EU countries | % of total exports | Sum over period | | wiiw |
| | VIX | % per annum | Average over period | | Thomson Reuters Datastream |
| | EMBI Global | Basis points | Average over period | | Bloomberg |
| Real sector | Corporate sector indebtedness | % of GDP | End of period | | IMF, NCBs |
| | Household sector indebtedness | % of GDP | End of period | | IMF, NCBs |
| Macroeconomic indicators | Real GDP growth | Percentage change period on period | | Seasonally and working-day adjusted | Eurostat |
| | Real industrial production growth | % | | Working-day adjusted | Eurostat |
| | HICP inflation | Percentage change year on year | Average over period | | Eurostat |
| | Central bank policy rate | % per annum | Average over period | | Bloomberg |
| | Real effective exchange rate (CPI-based) | Index, 2005 = 100.0 | Average over period | Seasonally adjusted | IMF |

*Source: Authors' compilation.*

[7] *We did indeed experiment with additional variables such as sovereign debt ratings or indicators capturing political risks (e.g. corruption perception indices, rule of law, government effectiveness, etc.) but eventually decided not to use them given the limited data availability for our country sample, methodological problems with some types of data (e.g. step function-like sovereign debt ratings) and/or the subjective character of soft indicators whose explanatory and, even more so, predictive power may well be questionable.*

internal as well as external imbalances by at least one indicator.

In line with findings in the literature (e.g. Crespo Cuaresma and Slačík, 2009, and Crespo Cuaresma and Slačík, 2008), we hypothesize that factors driving financial distress as well as their relative importance as perceived by the markets change over time, particularly depending on the overall sentiment and risk appetite prevailing in the markets. To capture this phenomenon, we employ the J.P. Morgan Emerging Market Bond Index Global (EMBI Global) and the Chicago Board Options Exchange (CBOE) Volatility Index (VIX, also dubbed the "fear index").[8] In order to capture the possibly time-varying weights markets assign to fundamentals, we interact the two sentiment measures with those variables that do not contribute significantly to the model's explanatory power on their own but should be important for financial stability according to economic theory.

Our raw annual data set consists of a panel of nine CESEE countries and covers, subject to – in some cases rather patchy – data availability, a time span from 1996 to 2012. However, we excluded all Slovak data as of mid-2008, by which time Slovakia's euro area entry was fixed and therefore some of the data employed in the model (money and foreign exchange markets) would bias the results. The poolability test carried out to ensure that the data are sufficiently homogeneous suggests that none of the countries should be eliminated from the panel. After performing the quantile transformation of the raw data and taking into account data gaps, we end up with an unbalanced panel of 74 observations covering the period between 1999 and 2011 to use in our econometric estimations.

### 2.2 Empirical Model

Before estimating a linear panel data model, we first check the stationarity of all considered indicators and we reject the null hypothesis of a common unit root process for all countries as well as the hypothesis of unit root processes for individual countries. As the time series is rather short, we apply the feasible general least squares (GLS) method with cross-section weights instead of the Generalized Method of Moments (GMM), which is better suited for longer samples. The applied cross-section weights allow us to control for the presence of cross-section heteroskedasticity. We test the model for fixed effects. However, as each indicator is transformed into percentiles for all countries, i.e. into a number between 0 and 1, with the median amounting to 0.5 for all countries, tests confirm that fixed effects are not present in the panel. As the time series is rather short, we restrain the number of possible lags to two. Moreover, as we are looking for leading indicators which would enable a projection of financial (in)stability over a one-year horizon, we do not consider current independent variables.

Having explored all economically meaningful combinations of our potential regressors, we find that the best statistical performance (based on the

[8] *Although bond indices and stock market volatilities are used on both sides of the equation, endogeneity concerns are limited as the indicators contained in the dependent variable, for several reasons, are only very loosely related to the regressors: a) the dependent FII contains country-specific EMBI Global and national stock market data while global variables (composite EMBI Global and VIX) are employed on the right-hand side; b) VIX is a measure of the implied volatility of the S&P 500 Index options while the FII contains a measure of the actual volatility of national stock markets; c) the regressors EMBI Global and VIX are lagged. We also conducted formal robustness checks suggesting that endogeneity is not an issue (see below in this section).*

high value of R-squared adjusted and autocorrelation diagnostics) is obtained when specifying a model that explains the FII by public debt combined with fiscal deficit and risk attitude toward emerging markets $(X_1)$, real credit growth combined with the level of credit to the private sector $(X_2)$, risk appetite in advanced economies $(X_3)$, the growth rate of the nonperforming loans-to-total loans ratio combined with the level of the nonperforming loan (NPL) ratio $(X_4)$, the external debt growth rate $(X_5)$, the capital adequacy ratio in the banking sector $(X_6)$ and official foreign reserves $(X_7)$:

$$FII_{i,t} = \sum_{j=1}^{7} b_j X_{j,i,t-l} \qquad (1)$$

where $X_{j,i,t-l}$ is the $j^{th}$ indicator for country $i$ and time $t–l$, $l=\{1,2\}$. Table 3 reports the results of the best-performing model with explanatory variables significant at the 1% level. The number in parentheses indicates the number of lags $(l)$ in years for each indicator. Moreover, it has to be borne in mind that we construct all indicators in such a way that a value closer to 1 corresponds to higher risk. Therefore, the indicators for foreign reserves and regulatory capital were inverted by subtracting the original indicator from 1.

Due to the applied transformation, all variables range between 0 and 1. Hence, the magnitudes of the estimated coefficients represent the relative importance of each variable in explaining financial instability. Our model suggests that public debt combined with budget deficit data, the risk attitude toward emerging markets $(X_1)$ and real credit growth combined with the level of credit to the private sector $(X_2)$ are the most important indicators explaining the FII. We find that each of these indicators contributes roughly three times more to explaining the FII than foreign reserves $(X_7)$ or the capital adequacy ratio $(X_6)$, or has roughly twice the explanatory power of external debt growth $(X_5)$. The third and fourth most important indicators in the model – the NPL ratio growth rate combined with the NPL ratio level $(X_4)$ and the indicator of risk appetite in advanced economies $(X_3)$ – make closely similar contributions to explaining FII development (0.25 and 0.21, respectively). Apart from this static model, we also tried to estimate a

Table 3

**Panel Estimation with FII as Dependent Variable**

| Variable | Coefficient | Coefficient value | Standard error | t-statistic | Probability |
|---|---|---|---|---|---|
| PUBLIC_DEBT(-2)*FISCAL_DEFICIT(-2)*EMBIG(-1) | $b_1$ | 0.2968 | 0.0801 | 3.7037 | 0.0004 |
| CREDIT_GROWTH_REAL_ALT(-1)*CREDIT_TO_PRIVATE_ALT(-1) | $b_2$ | 0.2829 | 0.0433 | 6.5280 | 0.0000 |
| VIX(-1) | $b_3$ | 0.2511 | 0.0201 | 12.4878 | 0.0000 |
| NPL_GROWTH(-1)*NPL(-1) | $b_4$ | 0.2053 | 0.0451 | 4.5493 | 0.0000 |
| EXTERNAL_DEBT_GROWTH(-2) | $b_5$ | 0.1469 | 0.0224 | 6.5655 | 0.0000 |
| 1-REGULATORY_CAPITAL(-1) | $b_6$ | 0.1037 | 0.0367 | 2.8213 | 0.0063 |
| 1-FOREIGN_RESERVES(-1) | $b_7$ | 0.0941 | 0.0304 | 3.0981 | 0.0028 |

| Goodness-of-fit indicators | Indicator values |
|---|---|
| R-square | 0.6885 |
| Adjusted R-square | 0.6606 |
| Durbin-Watson statistic | 2.0446 |
| Mean dependent variable | 0.5069 |

*Source: Authors' calculations.*

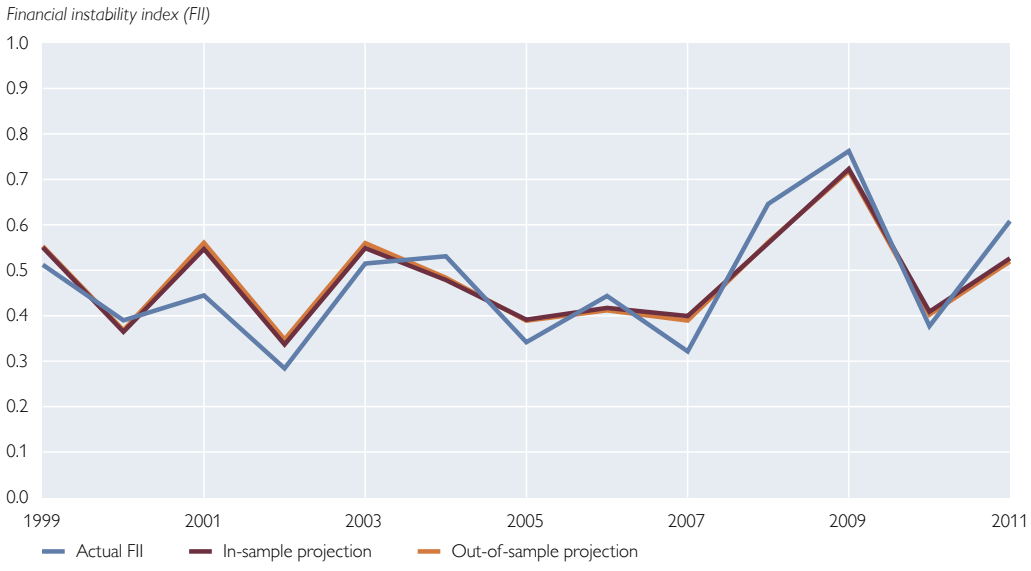
dynamic version, but the lagged FII did not turn out to be significant so that for annual data a static model has better explanatory power.

Moreover, to ensure the robustness of our findings we checked for endogeneity. We estimated model (1) using GMM and including all regressors as instrumental variables. The model's coefficients hardly changed, which suggests that the endogeneity problem is not a major issue in our model. Furthermore, the correlation matrix suggests no presence of multicollinearity among the regressors. The only variables with a correlation of slightly above 0.6 are real credit growth combined with the level of credit to the private sector $(X_2)$ and the capital adequacy ratio in the banking sector $(X_6)$. However, excluding the capital adequacy ratio in the banking sector from the model hardly changes the coefficients of the remaining variables. We therefore decided to keep this indicator $(X_6)$ in the model, given the importance of banking capital for financial stability. The correlations among the other variables were rather low.

As an additional robustness check, we tested the model's out-of-sample fit. As the time series included in our panel is rather short, we were not able to perform a standard out-of-sample test. Instead, we sequentially excluded one country after the other from the sample and each time re-estimated the panel regression with the remaining countries in the panel. Then we used the excluded country to test the performance of the new model by comparing fitted values with the actual (ex-post) path of the FII. This procedure, i.e. the successive exclusion of countries from the sample, did not change the model's estimated coefficients significantly, which suggests that they are relatively stable and thus implies a very high correlation between in- and out-of-sample fitted values. For the sake of illustration, chart 2 shows the in- and out-of-sample fitted values in comparison with the actual (ex-post) FII for Hungary.

Chart 2

**In-Sample and Out-of-Sample Projection for Hungary**




*Source: Authors' calculations.*

## 3 Discussion of Results and Policy Implications

The estimated model suggests which indicators should be carefully followed to assess risks and to detect accumulated imbalances that could threaten financial stability. Our analysis indicates that credit growth combined with the level of credit to the private sector is a particularly good leading indicator for financial instability. Until 2007–2008, many emerging European countries experienced high credit growth, which was driven by softening credit standards and high domestic demand. It was a period when credit risk was accumulated and internal as well as external imbalances were built up. Our results show that not only credit growth but also the level of private sector indebtedness might play an important role in risks accumulation. Based on our empirical analysis, the lag between the building-up of imbalances and their materialization, as reflected in financial stress in the markets, is about one year.

Another key indicator according to our model is public debt combined with the budget deficit and the risk attitude toward emerging markets (as measured by the composite EMBI Global). The model suggests that financial markets perceive lax fiscal policies negatively. However, since the fiscal variables turn out to be significant only in combination with the composite EMBI Global, the proxy for risk appetite, it seems that there is no level of public debt or fiscal deficit that would be perceived as critical per se. Our findings suggest that the impact of public finance indicators on financial instability might depend on market sentiment.[9] This means that public indebtedness and high fiscal deficits hamper financial stability only in times of global distress, when financial markets are typically more sensitive. Moreover, our results suggest that there is a lag of about two years for those risks to materialize and that their materialization is triggered by negative global market sentiment toward emerging markets.

Our analysis also confirms that risks in emerging European countries – mostly small open economies – strongly depend on the risk appetite prevailing in advanced economies (as measured by the VIX). The results indicate that the current risk appetite in advanced economies impacts financial stability in European emerging markets over a one-year horizon.

Furthermore, given the crucial role of the banking sector, which applies a traditional commercial banking model, credit risk is a key risk in emerging Europe. This is in line with the estimated econometric model that ranks the indicator combining the NPL ratio growth rate and the NPL ratio level among the most important drivers of financial stress. This finding suggests that increasing credit risk and/or a high level of NPL stock reduce the banking sector's capacity to support economic growth and thus impose a significant risk for financial stability over a one-year horizon.

In the model, the external imbalances represented by external debt growth affect financial instability within two years. A higher level of foreign reserves decreases a country's financial vulnerabilities. Finally, banks' regulatory capital serves as a buffer against banks' potential losses.

Our empirical analysis shows which indicators may serve as powerful leading indicators for financial (in)stability in

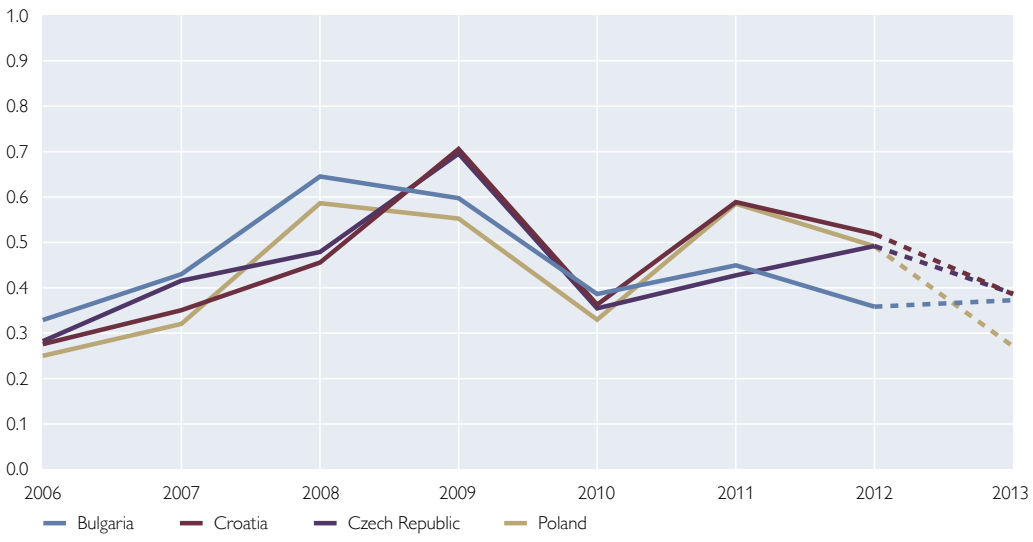
[9] *See e.g. Minea and Parent (2012) for evidence on the nonlinear effect of public debt on economic growth and Cohen and Villemot (2011) on the endogenous (self-fulfilling) character of debt crises.*

the future and which should therefore be carefully assessed and monitored, alongside with other measures of financial stability. Indeed, when developing the FII and deriving its explanatory factors, we aimed to eventually use the FII as a possible real-time financial stability monitoring tool for the CESEE region. Therefore, all variables in the model are lagged so that projections of future financial stability development can be made in real time. To demonstrate this option, chart 3 presents a projection of the FII for 2013 for selected CESEE countries based on the latest information available.[10]

Based on data for the first half of 2012, our calculations suggest that financial instability risk should not substantially increase in any of the countries considered and should stay, or drop, well below the median financial instability value of 0.5 in all countries included in our projection. The easing of financial stress in the region mainly relies on a decline in external risks in 2012 compared to 2011, which reduces the financial stress expected for 2013. Most of the other indicators included in the FII have stabilized or slightly improved in all countries under observation. Credit risk has substantially increased in year-on-year terms in Croatia and only slightly risen – while still remaining at very low levels – in Poland in 2012. Based on our FII projections, financial stability risk in 2013 should be only slightly higher than in 2006, the last non-crisis year, in all countries considered. The key drivers of potential financial instability, however, have changed dramatically. While

Chart 3

**Projections for Selected Countries**




*Source: Authors' calculations.*

*Note: Since the FII is normalized by applying the quantiles approach to each country individually, the comparability of index values across countries is limited.*

[10] *Our projection is confined to Bulgaria, Croatia, the Czech Republic and Poland as data on these countries are available at least until mid-2012, which means they can reasonably be annualized for 2012 as a whole. Hungary was not included in the projection as, in this case, the observable headline data required for the FII have been partially obtained through temporary or unsustainable measures and would thus bias the forecast.*

risks in 2006 were driven mainly by increasing external as well as internal imbalances, the current threats for financial instability emerge from the potential deterioration of the external environment and a higher level of public debt.

## Conclusion

Financial stability has become an important issue especially since the beginning of the recent global financial crisis. Unlike monetary policy with its clearly defined objectives, financial stability is more difficult to measure. Moreover, policymakers need not only monitor and assess financial stability but also project its future development to detect potential threats to financial stability and take appropriate macroprudential measures early on.

Against this background, the present study contributes to this goal and to the existing literature in two ways. Using a broad range of indicators, we first construct a comprehensive financial instability index (FII), which gauges the level of financial market stress in some key Central, Eastern and Southeastern European (CESEE) countries. The FII captures developments in money, foreign exchange, equity and bond markets and thus reflects sentiments in all relevant financial market segments in the countries considered.

In a second step, we perform a panel estimation to investigate which macroprudential indicators covering all important segments of the economy explain the evolution of the FII over the past more than 15 years. To reduce the impact that the relatively frequent outliers in the data have on the results, we use a rather novel approach to normalization by transforming the time series into quantiles of the sample distribution for each individual country. Contrary to other studies, we interact stock and flow variables to construct explanatory variables. Despite the fact that all selected raw variables can be found in the existing literature, this is – to our best knowledge – the first study that shows that the appropriate interaction of these variables might substantially increase the model's explanatory power. We consider indicators that capture sovereign and contagion risk, the macroeconomic environment as well as vulnerabilities in the real economy and the banking sector. This means that our set of potential explanatory variables covers external as well as internal imbalances.

Our analysis suggests that what matters for financial stability are not only the levels and changes of some macroprudential indicators but also the interaction of individual factors with each other as well as with the overall market sentiment toward emerging markets. In concrete terms, credit growth combined with the level of credit to the private sector is a particularly good leading indicator for financial instability. Another key indicator emerging from our model is public debt combined with fiscal deficit and the risk attitude toward emerging markets. Moreover, risks in – mostly small open – emerging European countries strongly depend on the overall risk appetite in advanced economies. In line with the crucial role of the banking sector, which applies a traditional commercial banking model, the interaction of the NPL ratio growth rate with the NPL ratio level also ranks among the most important drivers of financial stress. Other but significantly less important determinants of financial (in)stability are external debt growth, the level of foreign reserves and regulatory bank capital.

Last but not least, we wrap up by showing that because of its specific structure, our econometric model can

also be used for projections of future financial stability developments in real time. Moreover, it can be used as a simulation tool to detect potential imbalances which might emerge under different scenarios. To fully exploit this potential, the model's natural extension – and thus our next avenue of research – will be to cast it in quarterly data.

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