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Measuring financial stress in transition economies

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ABSTRACT

This study constructs a financial stress index for Bulgaria, the Czech Republic, Hungary, Poland, and Russia and examines the relationship between financial stress and economic activity. The financial stress index incorporates banking sector fragility, time varying stock market return volatility, sovereign debt spreads, an exchange market pressure index, and trade credit. These variables seem to capture key aspects of financial stress in sample countries as the index peaks at known financial crises in these countries. We then examine the relationship between financial stress and economic activity. Impulse response functions based on bivariate VARs show a significant relationship between financial stress and some measures of economic activity. Overall, the constructed financial stress index provides valuable information on the state of the economy and economic activity.

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1. Introduction

The recent global financial crisis highlighted the importance of measuring financial stress. Even before the crisis, there was an emerging literature that tried to measure financial stress and its impact on the economy. In the case of advanced economies, Hanschel and Monnin (2005) developed an index to measure the degree of stress for the Swiss banking system. Illing and Liu (2006) proposed a financial stress index for the Canadian financial system while Misina and Tkacz (2009) examined the impact of credit and asset price movements on financial stress in Canada. Hakkio and Keeton (2009) studied episodes of financial stress in the U.S. and developed a comprehensive financial stress index. Melvin and Taylor (2009) examined the relationship between financial stress index and carry trade for advanced economies. Cardarelli et al. (2011) constructed a financial stress index for 17 advanced economies and Cardarelli et al. (2011) examined the link between financial stress and economic downturns. Balakrishnan et al. (2011) proposed a financial stress index for developing countries and examined the transmission channels of financial stress between advanced and developing countries.

The Russian financial crisis had a strong impact on Central and Eastern European countries and other transition economies through contagion effects (e.g., Gelos and Sahay, 2001; Pastor and Damjanovic, 2003; Taylor, 2007). Brüggeman and Linne (1999) focused on predicting financial crises in the Czech Republic, Bulgaria, Hungary, Romania, and Russia via a signal approach. Schardax (2002) developed an early warning model for 12 Central and Eastern European countries. Karfakis and Moschos (2004) investigated the fundamentals of speculative attacks in the Czech Republic and Poland during 1990s. Kittelman et al. (2006) examined the determinants of a financial crisis for the Czech Republic, Hungary, Russia, Slovak Republic, and Ukraine by means of a Markov regime switching model. Zinkovskaya (2008) investigated the relative contributions of different vulnerability factors to the crises in Russia and Central and Eastern European economies by employing a probit model.

Lo Duca and Peltonen (2011) constructed financial stress indexes for several advanced and emerging economies by taking the arithmetic average of five raw stress indicators by transforming them on the basis of their quartiles derived from the empirical

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Cumulative Distribution Function. Hollo et al. (2012) constructed an index of contemporaneous stress in the financial system named Composite Indicator of Systemic Stress (CISS). Accordingly, CISS is designed to monitor current level of systemic risk in financial markets by aggregating measures of risk from five financial market segments and their sub components. The main feature of CISS is that systemic risk increases in times of high correlation of the subindices where it becomes difficult to diversify and hedge portfolios since market segments are nearly perfectly correlated.

Even though many studies focused on determinants of crises and contagion associated with such crises, scant attention has been paid to measuring financial stress in Russia and Central and Eastern European economies. The main objective of this study is to develop a financial stress index to determine episodes of elevated financial stress for Bulgaria, Czech Republic, Hungary, Poland, and Russia in the post transition period. We also examine the relationship between financial stress and economic activity for the sample countries. Our sample countries were chosen based on data availability, which precluded us from including other Central and Eastern European countries.[1] A financial stress index would provide valuable information as a heightened index helps fine tune economic policy. For example, Baxa et al. (2011) and Martin and Milas (2010) show that monetary policy authorities in developed economies respond to financial stress. Our focus is on the former transition economies and is motivated by several additional reasons. First, our sample consists of mostly small open market economies with relatively little experience in dealing with financial crises unlike some countries in Asia and Latin America. Second, save Russia, these countries are part of the European Union and are subject to shocks emanating from the euro zone and elsewhere. A recent good example is the European debt crisis. In that regard, advance warning systems such as a financial stress index would provide valuable time for policymakers in these countries to fine tune policy.

We modify and extend the index proposed by Balakrishnan et al. (2011) for developing countries with specific considerations for Bulgaria, the Czech Republic, Hungary, Poland, and Russia. Section 2 explains the components of the financial stress index. Section 3 elaborates on the construction of the index and shows our indicators capture key aspects of financial stress. Section 4 examines the relationship between financial stress and economic activity and shows how an elevated index tended to coincide with known crisis episodes. Finally, we show the constructed index provides valuable information on economic activity.

2. Construction of a financial stress index

Episodes of financial stress are described in various ways in the literature. For example, Illing and Liu (2006) defined financial stress as the force exerted on economic agents by uncertainty and changing expectations of losses in financial markets and institutions. Hakkio and Keeton (2009) describe financial stress as an interruption to the normal functioning of financial markets. According to Balakrishnan et al. (2011), financial stress tends to be associated with at least four fundamental characteristics: large shifts in asset prices, an abrupt increase in risk and/or uncertainty, liquidity droughts, and concerns about the health of the banking system. Similarly, Hakkio and Keeton (2009) argue that episodes of financial stress must involve at least one of the following: (i) increased uncertainty about fundamental value of assets, (ii) increased asymmetry of information, (iii) decreased willingness to hold risky assets, and (iv) decreased willingness to hold illiquid assets.

As for specific variables that measure financial stress, Balakrishnan et al. (2011) emphasize five essential components to gauge financial stress for developing countries: banking sector beta, stock market returns, time varying stock market return volatility, sovereign debt spreads, and an exchange market pressure index (EMPI). Similarly, Hollo et al. (2012) and Lo Duca and Peltonen (2011) focus on the financial intermediaries sector, money markets, equity markets, bond markets, and foreign exchange markets. However, focusing on financial markets or asset prices to gauge financial stress in emerging markets may be inadequate as there are additional sources of financial stress such as external debt and sovereign risk. Moreover, Rey (2009) suggested that a financial stress index for emerging markets and developing countries should include a "trade credit" component.

The latter is particularly becoming more relevant for our sample countries because small and medium size companies in these countries are growing due to reforms and liberalization measures taken, including opening up of markets to global competition. Producers in these countries also tend to sell a relatively large amount of their goods on trade credit due to competition and strong market power of buyers. Using firm level data from 20 countries in Eastern Europe and Central Asia, Van Horen (2007), for example, found that customers indeed take advantage of their market power to purchase goods on credit. While the literature focuses on financial market risks in measuring financial stress, we augment these factors with measures of external debt, trade finance, as well as specific measures of sovereign risk to specifically address different aspects of financial stress in Central and Eastern European economies. In light of these considerations, our financial stress index is made up of six economic and financial components as discussed below separately.

2.1. Riskiness of the banking sector

The soundness of banking system is important for financial stability and a large numbers of studies consider riskiness of the banking sector in measuring financial stress. While studies in the literature use a standard Capital Asset Pricing Model (CAPM) or the conditional variance of the banking sector stock market index to measure riskiness of the banking sector, we use the banking sector fragility index proposed by Kibritçioğlu (2003) due to the lack of appropriate banking sector stock market data in these countries.[2]

The banking sector fragility (BSF) index is based on assets and liabilities of the banking sector and hence the index can be used to assess banking sector fragility.[3] The BSF index takes into account real deposits (DEP) of banks, real claims on the domestic private sector (CPS) and the real foreign liabilities of banks (FL) as follows[4]:

$$BSF_t = \frac{[(\Delta DEP_t - \mu_{\Delta DEP})/\sigma_{\Delta DEP}] + [(\Delta CPS_t - \mu_{\Delta CPS})/\sigma_{\Delta CPS}] + [(\Delta \mathrm{FL}_t - \mu_{\Delta FL}/\sigma_{\Delta FL})]}{3} \quad (1)$$

[1] Romania was excluded due to lack of domestic debt data for 1995–2010. We omitted other Central and Eastern European countries, such as Slovakia, Slovenia, Latvia and Lithuania due to lack of stock market data for 1995–2010.

[2] Another approach to measure riskiness of banking sector is to calculate the Altman *z*-score. However, the *z*-score method is based on detailed balance sheet of the banking sector which is unavailable for these countries.

[3] Shen and Chen (2008) used the BSF index to determine the causal link between currency and banking crisis and found the presence of bidirectional causality between banking sector and currency fragility.

[4] The consumer price index is used to calculate real variables.

where Δ indicates changes in variables over a period of 12-month,[5] and μ and σ denote the mean and standard deviation of the respective variables.

The BFS index represents the fluctuations in domestic banking sector and a decrease in the index indicates an increase in the fragility of banking system. This can be due to a decline in bank deposits (due to bank withdrawals), a higher level of claims on the private sector (due to the rise in non-performing loans) and an increase in foreign liabilities (due to an actual or potential depreciation in the domestic currency).[6] Even though these are factors that contribute to banking sector fragility, additional factors such as discontinuation of foreign credit lines can worsen banks' balance sheets.

2.2. Security market risk

Another important component of financial stress is securities market risk. It is expected that the securities market becomes more volatile in periods of high financial stress. The conditional variance of financial time series such as stock market returns is essential for pricing derivatives, calculating measures of risk, and hedging and hence a large number of studies employ GARCH models to forecast volatility in the stock market following: Engle (1982) and Bollerslev (1986). Although several volatility models are proposed in the literature in order to account for different specifications in asset returns, Andersen and Bollerslev (1998) found that GARCH(1,1) and stochastic volatility models provide good volatility forecasts particularly in high frequency data. Similarly, Gokcan (2000) compared GARCH and EGARCH models in terms of their ability to forecast the conditional variance for emerging markets and found evidence in favor of a GARCH(1,1) model. Therefore a GARCH(1,1) model proposed by Bollerslev (1986) can be employed to measure stock market volatility as follows:

$$\begin{aligned} r_t &= X_t'\theta + \varepsilon_t \\ \sigma_t^2 &= \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \end{aligned} \tag{2}$$

where r_t indicates stock market index returns, X_t' includes a constant and autoregressive terms of stock market returns, ε_t is an error and σ_t is conditional standard deviation of stock returns.[7]

We also employ a stochastic volatility model to measure volatility in the stock market. A simple stationary stochastic volatility model is given by

$$\begin{aligned} r_t &= \varepsilon_t \exp\{h_t/2\} \\ h_t &= \gamma + \phi h_{t-1} + \eta_t \end{aligned} \tag{3}$$

where $\eta_t \sim NID\left(0, \sigma_\eta^2\right)$, $h_t = \ln\left(\sigma_t^2\right)$ and working with logarithms ensure that volatility is always positive. ε_t is a white noise process with unit variance, generated independently of η_t and $|\phi| < 1$. Transforming r_t by taking logarithms of the squares, we specify following linear state space model:

$$\begin{aligned} \ln\left(r_t^2\right) &= E\left(\ln\left(\varepsilon_t^2\right)\right) + h_t + \xi_t \\ h_t &= \gamma + \phi h_{t-1} + \eta_t \end{aligned} \tag{4}$$

where $\xi_t = \ln\left(\varepsilon_t^2\right) - E\left(\ln\left(\varepsilon_t^2\right)\right)$. ξ_t is a non-Gausssian zero mean, white noise, and its statistical properties depend on the distribution of ε_t. While there are a number of estimation issues to be addressed, stochastic volatility of stock return series can be estimated by using the quasi-maximum likelihood (QML) method based on the Kalman filter as discussed in detail in Nelson (1988) and Harvey et al. (1992)).

2.3. Currency risk

Currency risk is another important component of financial stress for transition economies. The simplest method for measuring the degree of pressure on the exchange rate is to calculate Exchange Market Pressure Index (EMPI) proposed by Girton and Roper (1977). The index contains a simple average of exchange rate and foreign reserve changes and a large numbers of studies in the literature use a variant of it. Although different versions of EMPI in the literature fail to successfully identify currency crises, Bussiere and Fratzscher (2006) defend EMPI based on its ability to capture both successful and unsuccessful speculative attacks. In this study, we construct the EMPI by combining exchange rate movements, changes in international reserves, and changes in the overnight interest rate relative to the US as follows:

$$EMPI_t = \frac{\Delta e_t}{\sigma_{\Delta e}} - \frac{\Delta Res_t}{\sigma_{\Delta Res}} + \frac{\Delta(i_t - i_{US,t})}{\sigma_{\Delta(i_t - i_{US,t})}} \tag{5}$$

where Δe_t and ΔRes_t are 12-month percent changes in the exchange rate and total foreign international reserves minus gold, and i_t and i_{US} represent the overnight interest rate for the home country and the US, respectively. Similarly σ_x denotes the standard deviation of variable x (x = the changes in the exchange rate, total reserves, and overnight interest rate).

2.4. External debt

External debt is important for sustainable economic growth in emerging economies. Since short term external debt played a significant role in the Asian and Russian crises, excessive increase in the external debt can cast a doubt on sustainability of such debt. In the literature external debt is considered as a potential leading indicator of financial crises for developing countries (see Sachs et al., 1996; Kruger et al., 1998; Kaminsky, 1998; Abiad, 2003; Bussiere and Fratzscher, 2006). Moreover, Aizenman and Pasricha (2012) consider total external debt as a component of their financial stress index. Therefore external we include the growth rate of total external debt as a component of our financial stress index.[8,9]

Although the relationship between external debt and economic growth is widely examined for developing countries in the literature, there is no consensus view on the effects of external debt. For example, Bellas et al. (2010) found that an increase in the short term debt/reserves ratio causes a decrease in sovereign bond spreads in short run with no statistically significant impact in the long run. If we consider increases in the external debt as an indicator of creditworthiness of debtor countries, we can expect an increase in the

[5] Kibritçioğlu (2003) proposed changes over 12 months as opposed to monthly changes to avoid any seasonality. Moreover, he argued that one month is too short to capture changes in banking sector fragility.

[6] We multiply the BSF by −1 to simplify the interpretation of model results. So, an increase in the BSF implies a rise in the fragility of the banking sector.

[7] We consider other types of GARCH specifications such as the EGARCH proposed by Nelson, but the GARCH (1,1) model has a better fit according to the Schwarz Bayesian Information Criterion.

[8] As external debt is measured quarterly in these countries, we use the cubic spline method to obtain monthly external debt series. Even though there are several methods to interpolate data in the literature, we use the cubic spline method because it is simple, fast, efficient and stable; see Avarmaa et al. (2011), Valenzuela and Pasadas (2011) and Grigorenko and Efimova (2008).

[9] Note that we also consider the level of total external debt in the principal component analysis. However the growth rate of total external debt explains a higher proportion of variance in the principal component analysis as compared to level of total external debt.

Table 1
The balance sheet of a Sovereign country.

Assets	Liabilities
International Reserves	External Debt
Net Financial Assets (Discounted Value of Primary Fiscal Surpluses)	**Equity**
Value of Monopoly over Issue of Money	Domestic Debt
Other Assets less Guarantees	Base money

external debt to decrease financial stress. On the other hand, perhaps after a threshold level, an increase in external debt may raise questions about the sustainability of the debt and ultimately affect solvency.

2.5. Sovereign risk

Changes in investors' risk perceptions which drive short term capital flows are useful indicators of financial stress in transition economies (Garibaldi et al., 2001). Because interest rate spreads between home country and the US can be used as an indicator of risk perception in the home country, we use sovereign bond spreads (the difference between home country's Emerging Market Bond Index (EMBI) and 10 year US Treasury yield) in constructing the financial stress index. Due to EMBI spreads data unavailability for the Czech Republic and Hungary, we employ the so called Contingent Claim Analysis (CCA) to compute sovereign risk for the countries in question.[10]

The CCA is a framework that combines balance sheet information with commonly used risk measurement tools to construct a marked-to-market balance sheet to identify and quantify risks. In essence, the CCA approach models firm equity as a contingent claim on a firm's assets. It is a contingent claim because the value of firm equity depends on the value of the firm's assets and the default-free value of the firm's liability at a particular point in time (Geuorguiev et al., 2009). The firm equity can be written as a call option as follows:

$$E = \max[A - DB, 0] \tag{6}$$

where A is firm assets and DB is the default barrier. In Eq. (6), when the firm can generate enough cash to cover its current debt obligations ($A \geq DB$), the value of firm's equity is equal to difference between the value of firm's assets (A) and the current debt obligations of the firm or default barrier (DB). On the other hand, when the firm's assets do not cover the current debt obligations ($A \leq DB$), firm equity equals zero.

While the CCA analysis is commonly used to calculate default probability of firms in the finance literature, there have been studies that measure the sovereign risk profile of countries based on the CCA approach. For instance, Gapen et al. (2008) employed the CCA analysis to determine the sovereign risk profile for 12 developing economies. They showed that the CCA generates similar results to EMBI and CDS spreads. Also Keller et al. (2007) examined changes in Turkey's sovereign risk profile by using the CCA and found a strong correlation between sovereign risk indicators based on the CCA and EMBI spreads.

According to Gapen et al. (2008) and Keller et al. (2007), the sovereign balance sheet of a country can be represented as in Table 1.

In order to derive default probabilities, some assumptions must be made about the seniority structure of a sovereign country's liabilities. To derive external default probabilities, external debt is assumed to be the more senior liability,[11] whereas domestic debt and base money are assumed to represent the equity portion of the sovereign balance sheet and thus can be viewed as a contingent claim on the residual value of sovereign assets. The sovereign is assumed to default whenever the value of its implied assets falls below a distress barrier. The difference between the asset value and the distress barrier, scaled by the asset volatility, is referred to as the distance-to-distress, while the area of the distribution that falls below the distress barrier represents the sovereign's default probability (Keller et al., 2007).

In this context the market value of equity can be modeled by using Black and Scholes (1973) and Merton (1974) formula for call options:

$$E = AN(d_1) - DBe^{-rt}N(d_2) \tag{7}$$

where A is the assets, DB, the default barrier, is equal to the sum of short term and half of long term external debt,[12] $d_1 = \left[\ln(A/DB) + \left(r + 0.5 \times \sigma_A^2\right) T\right] / \sigma_A\sqrt{T}$, $d_2 = d_1 - \sigma_A\sqrt{T}$, r is the risk free interest rate,[13] T is the time to maturity of the default barrier,[14] $N(d)$ is a cumulative probability distribution function for a standard normal variable, and σ_A is the standard deviation of assets. Under the Merton (1974) bond pricing model's assumptions, the volatility of the equity is

$$\sigma_E = \frac{A\sigma_A N(d_1)}{E} \tag{8}$$

Distance to default (DD) can be written as

$$DD = \frac{\ln(A/DB) + \left(r - 0.5 \times \sigma_A^2\right) T}{\sigma_A\sqrt{T}} \tag{9}$$

Under the normal distribution which is implied by Merton (1974), the default probability or the risk-neutral default probability (RNDP) can be calculated as $N(-DD)$.

Although Eqs. (7) and (8) can be solved simultaneously, Crosbie and Bohn (2003) argue that market leverage moves around far too much for Eq. (8) to provide reasonable results. In order to overcome this problem we used an iterative procedure. First, we set an initial value of $A = E + DB$ and compute the standard deviation of the log asset returns. Then we insert A and σ_A into Eq. (7) and compute new values of A and σ_A. The procedure is repeated until convergence where the sum of squared differences between consecutive asset values is less than 10^{-10}.

2.6. Trade finance

Rey (2009) argued that financing of trade is important for developing countries and emerging markets and trade finance must be considered as a component of financial stress. Since trade finance cannot be measured directly, some proxy variables are used in the literature. For instance, Ronci (2004) used changes in outstanding short-term credit whereas Thomas (2009) used net financial flows as a proxy variable for the trade financing flows. Following Ronci

[10] The EMBI spreads data are available for 1999M1–2010M6 for Hungary. The correlation coefficient between EMBI spread and our sovereign risk measure based on the CCA for this period is 0.85 which is supportive of the CCA measure.

[11] Since external debt is assumed to be the more senior liability in the CCA approach, high correlation between sovereign risk and external debt can be expected a priori. On the other hand, the correlation coefficients between sovereign risk and external debt are −0.008 and −0.237 for the Czech Republic and Hungary, respectively.

[12] External debt that matures within one year is defined as short term with any other liability deemed long term.

[13] The one year US Treasury Bill rate is taken to be the risk free interest rate.

[14] Although the time horizon of the estimate of default risk can vary in the literature, Gapen et al. (2008) and Keller et al. (2007) considered one year as the time horizon. Therefore we use $t = 1$ in the model estimation.

(2004), we use the first-difference of the log of the outstanding external short-term debt as a proxy variable for trade finance.[15] However, as Ronci (2004) has emphasized, using short-term credit as a proxy for trade finance excludes trade finance associated with intra-firm trade by multinational corporations, and trade related to foreign direct investment. As an alternative we use financial flows as a proxy to assess the usefulness of the alternative proxies.

3. Empirical results

3.1. Data

In order to examine the degree of the financial stress in Bulgaria, Czech Republic, Hungary, Poland, and Russia, we construct a monthly financial stress index for February 1995 through June 2010. Data on overnight interest rate, banking sector, and base money were taken from the IMF-IFS CD-ROM. Data on the stock market index, the foreign exchange rate, international reserves, sovereign bond spreads, and real GDP were obtained from World Bank-GEM database. External debt data were taken from BIS-JEDH database. Finally, data on domestic currency debt for Czech Republic and Hungary were obtained from national central banks. Before the aggregation of the components, all of the components are standardized by subtracting their means and dividing by their standard deviations.

3.2. Aggregation of the components

There are various methods to aggregate the variables in constructing a financial stress index in the literature. Illing and Liu (2006) use different weighting schemes, such as factor analysis, equal weights, economic weights, and cumulative distribution functions. Cardarelli et al. (2011) and Balakrishnan et al. (2011) prefer a variance equal weighting procedure. Hakkio and Keeton (2009) use a principal component analysis and both the Federal Reserve Bank of Kansas City and the Federal Reserve Bank of St. Louis employ the principal component analysis to calculate their respective financial stress indexes. We follow suit and use the principal component analysis to aggregate the components.

As a statistical technique, the principal component method transforms a number of possibly correlated variables into a smaller number of components. It is presumed that each of the variables above captures some aspect of financial stress and hence all variables are likely to move together according to the level of financial stress in the economy. If financial stress is the factor most responsible for the observed correlations among the indicators mentioned above, it can be identified by the first principal component of the correlation matrix computed for the standardized indicators. The weights of individual indicators in the composite FSI are computed from the indicators' loadings to the first principal component (the first eigenvector of the correlation matrix). In periods of high financial stress the pressure on the value of local currencies and the banking sector increase, stock market becomes more volatile and sovereign risks rise. Therefore we expect that an increase in the EMPI, stock market volatility, banking sector fragility, and bond spreads raise financial stress. On the other hand, the relation between external debt and financial stress is ambiguous.

3.3. Principal component analysis results

The principal component analysis results for Bulgaria,[16] the Czech Republic, Hungary, Poland and Russia are given in Table 2. Volatility of the stock market is measured via a GARCH (1,1) model for all countries except for Bulgaria and Russia where it is measured by a stochastic volatility model.[17] According to the signs of the coefficients, increases in the EMPI, stock market volatility, and bond spreads act to raise financial stress in all countries. Note that by construction, banking sector fragility is multiplied by (−1) in the principal component analysis and it is expected that it will contribute to the financial stress index positively. Banking sector fragility raises financial stress in all countries except for Poland. The anomaly may be explained by examining the individual components of the banking fragility index to see whether it is mostly driven by a certain component. Again, the index takes into account real deposits of banks, real claims on the domestic private sector and the real foreign liabilities of banks. In the case of Poland, the index is dominated by developments in the real foreign liabilities of banks, which is likely to be viewed sustainable by investors below a threshold level of concern, resulting in less financial stress. On the other hand, increases in trade finance ease financial stress and these results are consistent with a priori expectations.[18] As for external debt, an increase in external debt also eases financial stress which implies market participants have little concern about debt sustainability.

Since variables are standardized, each coefficient represents the effect of one-standard-deviation change in the respective variable on the index. The magnitude of coefficients in Table 2 indicates that a one-standard-deviation increase in EMPI has similar effects on financial stress in all countries except for Hungary, where the effect seems to be modest. On the other hand, stock market volatility has quantitatively similar effects on financial stress in all countries in our sample. Banking sector fragility seems to be an important source of financial stress in Bulgaria and Russia and to a less extent in the Czech Republic and Hungary. Not surprisingly, sovereign risk seems to figure prominently in financial stress in Russia followed by Bulgaria, Poland, Hungary and the Czech Republic. Perhaps the most diverse sources of financial stress across countries are trade finance and external debt. Recall that we proxy trade finance by short term external debt. This diversity is partially attributable to the various indebtedness indicators of the countries and perhaps the perceived sustainability of external debt. For example, the mean of short term debt GDP ratio ranges from 22% for Poland to 70% for Bulgaria (24% for Russia, 30% for Czech Republic and 64% for Hungary) over the sample period.

The last row in Table 2 shows that between 34% and 58% of the total variation in the six variables over the sample is explained by the financial stress index. Since this variation measures the tendency of the six variables to move together, a higher number implies financial stress is a key element in the comovements of the variables. Ultimately the performance of a FSI is its ability to

[15] The outstanding external short-term debt is available at quarterly frequencies for these countries; as such, we use the cubic spline method to obtain monthly data.

[16] Bulgaria experienced high inflation during 1996 and 1997 where the annual inflation rate reached 2000% in the first quarter of 1997. Kaminsky et al. (1998) argued that historic mean and variance of series could be distorted by high inflation periods. In order to avoid this problem in Bulgaria, we divided the sample according to whether inflation in the previous six months was higher than 150%. Therefore we standardized the EMPI into two periods in which the first sample period is 1995:01–1997:08 and second sample period is 1997:09–2009:12.

[17] For Bulgaria and Russia, using the stochastic volatility model explains a higher proportion of variance in the principal component analysis as compared to a GARCH (1,1) model.

[18] As an alternative measure of trade finance, we use financial flows as a proxy and find similar results.

Table 2
Principal component analysis results.

Variables	Bulgaria	Czech Republic	Hungary	Poland	Russia
EMPI	0.742	0.638	0.237	0.637	0.644
Stock market volatility[a]	0.718	0.726	0.834	0.803	0.812
Banking Sector Fragility	0.750	0.669	0.530	−0.593	0.811
Bond spreads	0.843	0.376	0.428	0.760	0.874
Trade finance	−0.210	−0.469	−0.468	−0.157	−0.657
Growth rate of total external debt	−0.729	−0.831	−0.758	−0.248	−0.731
Total variance explained (%)	52	41	34	36	58

[a] Volatility of the stock market is measured via a GARCH (1,1) model for all countries except for Bulgaria and Russia where it is measured by a stochastic volatility model.

identify known episodes of financial stress and its relationship to economic activity, which we address in the remainder of the paper.

3.4. The evolution of financial stress in the post transition period

In this section, we investigate the evolution of financial stress in the post transition period. We are particularly interested in whether heightened episodes of financial stress correspond to known episodes turmoil in the real economy and the behavior of financial stress over the business cycle. The behavior of financial stress in the sample countries is given in Fig. 1 where the shaded areas correspond to recessions. We date recessions using the Harding and Pagan (2002) algorithm which involves the following three steps: (1) determination of a potential set of turning points (i.e., the peaks and troughs in a series), (2) a procedure for ensuring that peaks and troughs alternate, (3) using a set of censoring rules to restrict the minimum length of a phase or complete cycle. Let y_t = log real GDP. Harding and Pagan (2002) argued that the most important point in the first step is a definition of a local peak (through) as occurring at time t whenever $\{\Delta y_t > (<)\Delta y_{t\pm k}\}$, $k = 1,\ldots, 5$. The main criteria for the third step are that a phase must last at least 6 months (or 2 quarters) and a complete cycle should have a minimum duration of 15 months (or nearly 4 quarters). In addition, a local peak occurs at time t when $\{\Delta_2 y_t > 0,\ \Delta y_t > 0,\ \Delta y_{t+1} < 0,\ \Delta_2 y_{t+2} < 0\}$, which makes y_t a local maximum relative to two quarters on either side of y_t. Applying this method of dating business cycles finds recessions in all countries except for Poland in our sample.

Panel (a) of Fig. 1 indicates that the Bulgarian Financial Stress Index (B-FSI) tracks recessions closely in the sample.[19] Specifically the B-FSI increased at the beginning of the sample and remained above zero until the end of 1997. The index reached its highest level in March 1997. This happened in the aftermath of the collapse of the agricultural bank in March 1996 which precipitated a banking crisis that wiped out half of the Bulgarian banks (Brüggeman and Linne, 1999, p. 9). Due to the banking crisis in Bulgaria, the exchange rate vis-a-vis the US dollar went up from 487 to 1588 and the annual inflation rate reached 2000% in the first quarter of 1997. After the Bulgarian government announced a stand-by agreement with IMF, the financial stress index started to decrease.

During the Russian crisis, even countries that had little direct trade with Russia were affected as international investors liquidated some positions to cover losses elsewhere. Temporarily, sovereign risk premiums rose, exchange rates came under pressure, and banking systems were subjected to severe stress, reflecting these countries' vulnerability to external shocks (Nord, 2000).

The Russian crisis in 1998 caused a small spike in financial stress in Bulgaria. During the 1998–2002 period, because of several financial and economic crises in the world (such as the Russian crisis, the Long Term Capital Management Collapse in the US in 1998, the stock market crash in 2000, the Turkish crisis in 2001, the Argentina crisis in 2002, Enron scandal and 9/11 attacks in 2001), the financial stress index remained above zero until the first half of 2002. Then the B-FSI decreased and remained under zero. Finally, financial stress started to rise again in the middle of 2008 with the start of the global financial crisis.

The Czech Republic Financial Stress Index (CR-FSI) is plotted in Panel b of Fig. 1. As seen in the figure, the CR-FSI captures all periods of recessions in the Czech Republic. Although financial stress started to increase beginning of the 1995 in Czech Republic, it remained under zero until the beginning of the 1997. Despite disinflationary policies in the 1990s, the annual inflation rate in the Czech Republic continued to exceed inflation rates of its main trading partners. This led to a real appreciation of the koruna and an increase in the trade deficit in the Czech Republic. As a result, in May 1997, after a speculative attack on the koruna, the currency was left to float by the government (Karfakis and Moschos, 2004). Our results show that due to the balance of payment crisis in May 1997, financial stress increased sharply in 1997. Between 1998 and 2001, the CR-FSI remained above zero as a result of crises in developed and developing economies. Starting in 2002, financial stress in the Czech Republic started to decrease and then the CR-FSI was below zero until the first half of 2008. As in other economies, the global financial crisis has led to a major increase in financial stress in the Czech Republic and the index has reached its highest value in April 2009.

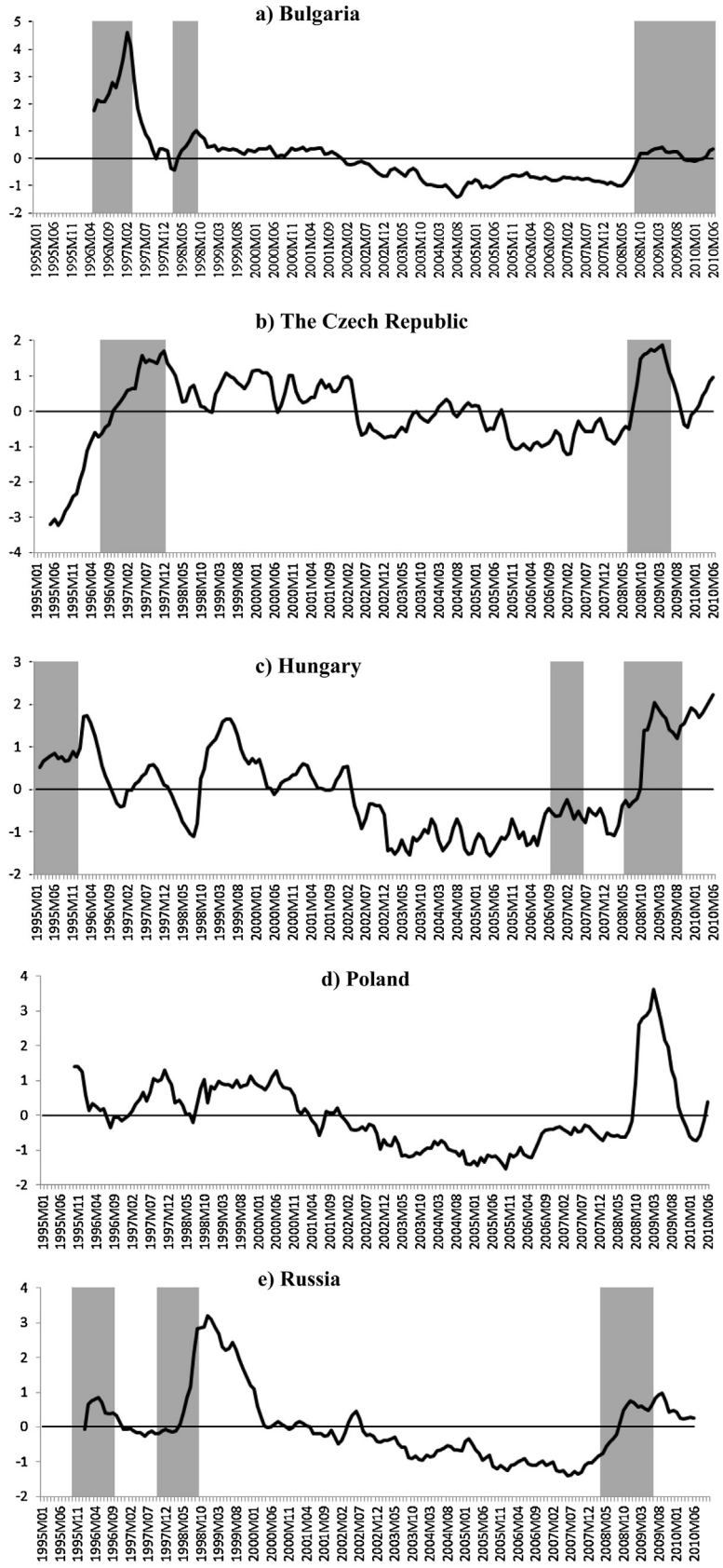
According to Panel c of Fig. 1, financial stress in Hungary started to rise at the beginning of the 1996 and it remained above zero until the end of 2001 except for the 1996 and the middle of 1998. Like the other transition economies, the Russian crisis in 1998 led to an increase in financial stress. Although financial stress was below zero between 2002 and 2008, it increased sharply at the end of 2008 due to the global financial crisis reaching its highest value at the beginning of 1998.

The Polish Financial Stress Index (P-FSI)[20] remained above zero between 1996 and 2000 except for the middle of 1996 and 1998. The Russian crisis and an economic slowdown in the European Union (EU) dampened demand for Polish exports in 1999 and contributed to the growth of Poland's current account deficit (Balcerowicz, 2000). An economic contraction and an increase in the current account deficit in the first quarter of 1999 led to an increase in financial stress in Poland. Then financial stress decreased in Poland until beginning of the global financial crisis. The P-FSI increased sharply in August 2008 and the index has reached highest value in March 2009.[21]

[19] Due to stock market index data availability, the Bulgarian Financial Stress Index starts from February 1996.

[20] Due to sovereign bond spreads data unavailability, financial stress index starts from October 1995.

[21] Poland did not have a recession in the sample according to Harding and Pagan (2002) definition.



Note: Shaded areas are recessions.

Fig. 1. Financial stress in the post transition period. *Note*: Shaded areas are recessions.

Table 3
The cross correlogram of high episodes of financial stress and recessions.

Bulgaria		Czech Republic		Hungary		Russia	
Recessions ($-i$)	Recessions ($+i$)	Recessions ($-i$)	Recessions ($+i$)	Recessions ($-i$)	Recessions ($+i$)	Recessions ($-i$)	Recessions ($+i$)
Threshold = 0.5 Std. Deviations							
0.382**	0.382**	0.357**	0.357**	0.199**	0.199*	0.289**	0.289**
0.438**	0.302**	0.418**	0.297**	0.205**	0.175**	0.357**	0.226**
0.494**	0.221**	0.448**	0.237**	0.275**	0.152**	0.398**	0.197**
0.508**	0.141	0.447**	0.178**	0.345**	0.128	0.438**	0.134
0.522**	0.103	0.445**	0.113	0.415**	0.105	0.478**	0.035
0.493**	0.065	0.412**	0.048	0.485**	0.081	0.484**	−0.028
0.423**	0.026	0.378**	−0.017	0.484**	0.057	0.489**	−0.092
0.353**	0.030	0.377**	−0.082	0.483**	0.034	0.523**	−0.155**
0.282**	0.034	0.343**	−0.147	0.481**	0.010	0.521**	−0.219**
0.212**	0.038	0.278**	−0.212**	0.480**	−0.014	0.485**	−0.206**
0.184**	0.042	0.245**	−0.277**	0.450**	−0.037	0.449**	−0.200**
0.155**	0.046	0.212**	−0.311**	0.419**	−0.096	0.413**	−0.194**
0.127	0.087	0.178**	−0.307**	0.389**	−0.091	0.376**	−0.189**
Threshold = 1 Std. Deviation							
0.414**	0.414**	0.616**	0.616**	0.172**	0.172**	−0.042	−0.042
0.429**	0.320**	0.587**	0.614**	0.207**	0.148**	0.002	−0.084
0.444**	0.274**	0.525**	0.482**	0.278**	0.124	0.047	−0.126
0.459**	0.229**	0.463**	0.351**	0.349**	0.100	0.091	−0.167**
0.425**	0.183**	0.396**	0.284**	0.420**	0.076	0.136	−0.163**
0.390**	0.137	0.362**	0.217**	0.491**	0.052	0.180**	−0.159**
0.356**	0.092	0.328**	0.150**	0.490**	0.028	0.224**	−0.155**
0.273**	0.046	0.261**	0.149**	0.489**	0.004	0.269**	−0.151**
0.239**	0.001	0.195**	0.147	0.488**	−0.020	0.313**	−0.147
0.205**	0.004	0.161**	0.081	0.486**	−0.044	0.358**	−0.143
0.171**	0.007	0.061	0.046	0.455**	−0.068	0.357**	−0.144
0.137	0.010	−0.038	0.012	0.424**	−0.092	0.356**	−0.145
0.103	0.058	−0.100	0.011	0.393**	−0.086	0.355**	−0.146
Threshold = 1.5 Std. Deviations							
0.414**	0.414**	0.513**	0.513**	0.039	0.039	−0.056	−0.056
0.430**	0.365**	0.513**	0.445**	0.081	0.052	−0.006	−0.103
0.445**	0.316**	0.512**	0.376**	0.167**	0.064	0.044	−0.150**
0.408**	0.267**	0.512**	0.307**	0.252**	0.076	0.093	−0.147**
0.371**	0.218**	0.511**	0.238**	0.337**	0.089	0.143	−0.143
0.335**	0.169**	0.442**	0.169**	0.379**	0.058	0.193**	−0.140
0.298**	0.120	0.374**	0.100	0.421**	0.027	0.242**	−0.136
0.261**	0.071	0.305**	−0.037	0.463**	−0.004	0.292**	−0.133
0.224**	0.021	0.236**	−0.106	0.462**	−0.034	0.341**	−0.129
0.187**	−0.028	0.167**	−0.106	0.461**	−0.065	0.391**	−0.126
0.150**	−0.025	0.098	−0.107	0.422**	−0.061	0.441**	−0.127
0.113	−0.022	0.098	−0.108	0.383**	−0.057	0.440**	−0.128
0.077	0.030	0.029	−0.108	0.344**	−0.058	0.439**	−0.129

Note: Recessions ($-i$) give the correlation coefficient between lags of recessions and high episodes of financial stress and recessions ($+i$) give the correlation coefficients between leads of recessions and high episodes of financial stress. ** indicates a significant correlation at 5% level.

Table 4
The cross correlogram of the financial stress index and composite leading indicators.

i	Czech Republic		Hungary		Poland		Russia	
	CR-CLI ($-i$)	CR-CLI ($+i$)	H-CLI ($-i$)	H-CLI ($+i$)	P-CLI ($-i$)	P-CLI ($+i$)	R-CLI ($-i$)	R-CLI ($+i$)
0	−0.021	−0.021	−0.277**	−0.277**	−0.326**	−0.326**	−0.456**	−0.456**
1	0.003	−0.038	−0.300**	−0.251**	−0.318**	−0.343**	−0.499**	−0.404**
2	0.023	−0.066	−0.312**	−0.218**	−0.312**	−0.360**	−0.527**	−0.343**
3	0.043	−0.101	−0.314**	−0.181**	−0.308**	−0.374**	−0.541**	−0.276**
4	0.062	−0.14	−0.305**	−0.143	−0.302**	−0.387**	−0.543**	−0.207**
5	0.08	−0.182**	−0.287**	−0.106	−0.293**	−0.396**	−0.532**	−0.137
6	0.097	−0.227**	−0.261**	−0.074	−0.283**	−0.400**	−0.510**	−0.071
7	0.112	−0.273**	−0.228**	−0.047	−0.268**	−0.401**	−0.479**	−0.008
8	0.125	−0.321**	−0.188**	−0.026	−0.248**	−0.395**	−0.439**	0.05
9	0.133	−0.366**	−0.143	−0.01	−0.224**	−0.385**	−0.390**	0.101
10	0.136	−0.406**	−0.093	−0.002	−0.192**	−0.371**	−0.334**	0.144
11	0.136	−0.440**	−0.04	0.001	−0.155**	−0.355**	−0.273**	0.181**
12	0.133	−0.467**	0.016	−0.001	−0.115	−0.338**	−0.210**	0.210**

Note: CLI ($-i$) gives the correlation coefficients between lags of the composite leading indicator and the financial stress index and CLI ($+i$) give the correlation coefficients between leads of the composite leading indicator and the financial stress index. ** indicates a significant correlation at 5% level.

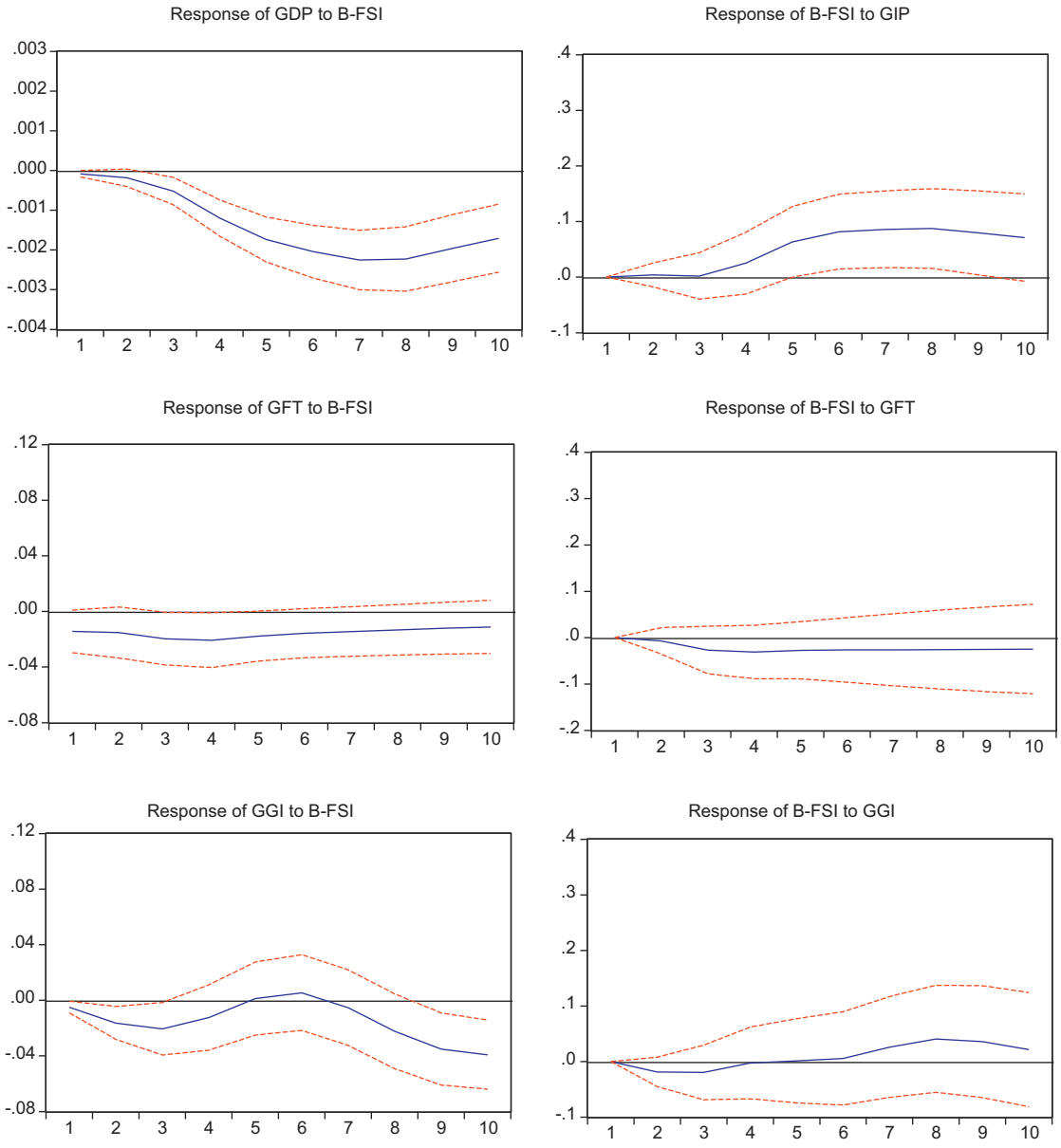


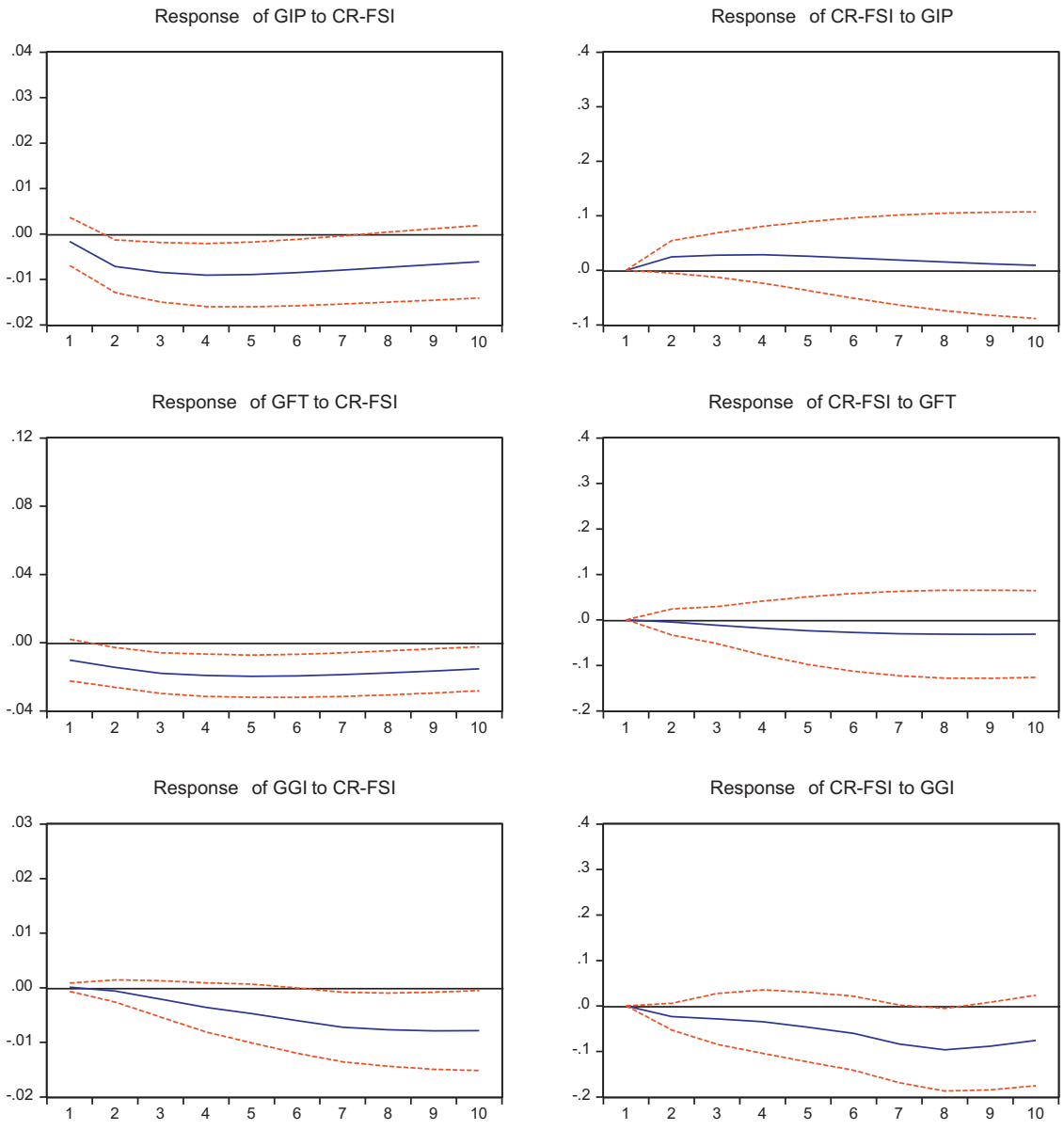
Fig. 2. Impulse response functions: Bulgaria. *Note*: Dashed lines indicate 98% confidence interval.

The Russian Financial Stress Index (R-FSI) is plotted in panel e of Fig. 5. The Asian crisis in 1997 had a significant impact on emerging markets. Therefore economic activity slowed down and financial stress rose in Russia during the Asian crisis. This external shock decreased investors' confidence in Russia and caused capital outflows, forcing the Bank of Russia to defend the exchange rate band. During the exchange market interventions in November 1997, the Bank of Russia lost over USD 6 billions of its liquid reserves. Nevertheless, after renewed attacks in the run up to August 1998, the government was forced to default on its domestic debt obligations (Kittelman et al., 2006). Consequently, in 1998 the financial stress index has reached its highest value in the sample. After the crisis, financial stress started to decrease and the index remained under zero until the second half of 2008. The global financial crisis that engulfed the US and other economies led to a rise in financial stress in Russia as well.

3.5. *The relationship between financial stress and the business cycle*

As emphasized by Hakkio and Keeton (2009), casually determining episodes of financial stress is difficult and hence a threshold is called for. Moreover, the length of time over which the index remains at or above the threshold level is as important as episodes of financial stress. In this context, Balakrishnan et al. (2011) used 1.5 standard deviations of the detrended financial stress index as a threshold. However, Illing and Liu (2006) and Cardarelli et al. (2011) classify episodes of heightened financial stress by using a threshold level that is one standard deviation from the index.

In this paper, we consider 0.5, 1 and 1.5 standard deviations from the mean of the financial stress index as threshold values for high episodes of financial stress and construct binary 0, 1 series based on whether the financial stress index exceeds the threshold. We then



Note: Dashed lines indicate %98 confidence interval.

Fig. 3. Impulse response functions: The Czech Republic. *Note*: Dashed lines indicate 98% confidence interval.

compute cross correlograms to examine the relationship between high episodes of financial stress and recessions. The results are presented in Table 3. In general, there are significant correlations between high financial stress and recessions at some leads and lags for all countries regardless of financial stress threshold levels. This indicates significant correlations between high episodes of financial stress and recessions in our sample countries.

Another way to analyze the relationship between financial stress and the business cycle is to examine the dynamic correlations of Composite Leading Indicators (CLI) of economic activity and the financial stress index. The CLI index series were obtained from the OECD for all countries except for Bulgaria where such data are unavailable. The OECD constructs CLI indexes from economic time series which exhibit leading relationship to the business cycle at the turning points. The number of series in the CLI index is typically between 5 and 10 series and the selection depends on economic significance, cyclical correspondence and data quality. We compute cross correlograms between the composite leading indicator index and the level of the financial stress index and the results are presented in Table 4. There seems to be no statistically significant correlations between the financial stress index and lags of the composite leading indicators in the Czech Republic. However, there is a significant negative relation between the financial stress index and the composite leading indicators after four leads. On the other hand, the financial stress index in Hungary is negatively correlated with up to 9 month lags and up to 4 month leads of the CLI. Moreover the results for Poland also indicate negative and statistically significant correlations between the financial stress index and the composite leading indicators over the sample period at various leads and lags. Finally, the Russian financial stress index is correlated significantly with the composite leading indicators at all lags and up to 4 leads. Note that in almost all cases where cross correlations are

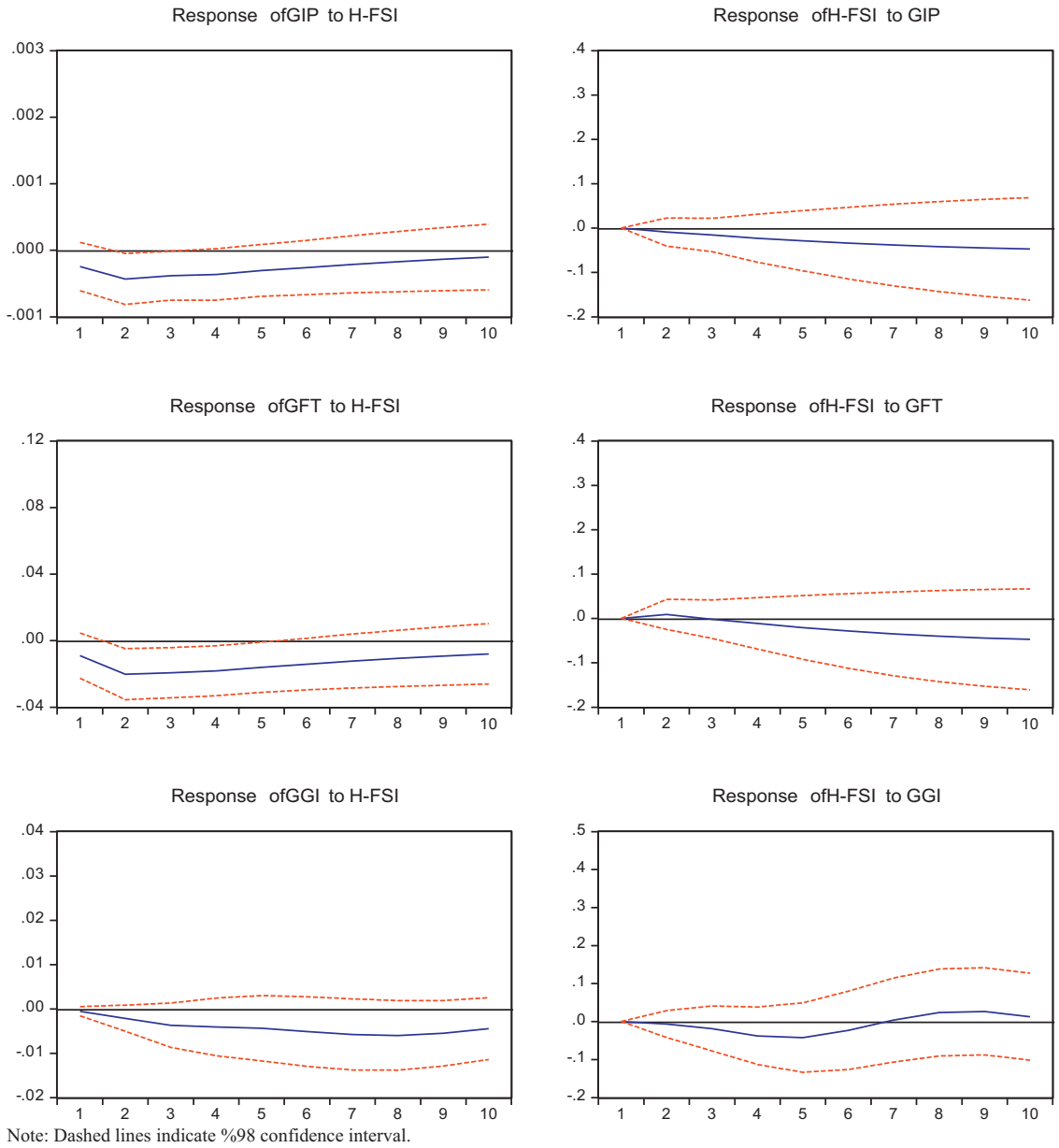


Fig. 4. Impulse response functions: Hungary. *Note*: Dashed lines indicate 98% confidence interval.

significant, the financial stress index is correlated negatively with the index of composite leading indicators indicating financial stress is associated with slack economic activity.

4. The relationship between financial stress and economic activity

The links between financial variables and the real sector along with transmission channels have been extensively discussed in the literature (Jacobson et al., 2005; Albertazzi and Gambacorta, 2009; Male, 2011). Some studies emphasize the role of financial leverage. According to this view, the increase in the value of borrowers' collateral that provides credit to the economy tends to stimulate the effects of financial cycles on the real economy. Another effect of financial variables on the real economy is the so called bank capital channel. In high episodes of financial stress, bank capital is eroded which forces banks to deleverage and banks become unwilling to lend to businesses. Contraction of credit due to strict credit standards can also affect output.[22] Moreover, as emphasized by Hakkio and Keeton (2009), an increase in uncertainty about the price of financial assets and the economic outlook in general tend to decrease economic activity.

Some studies have empirically examined the relationship between financial stress and economic activity. For instance, Li and St-Amant (2007) investigated the relationship between monetary policy and economic activity during the high and low financial stress episodes. They concluded that effects of monetary shocks on the economic activity are different in the low and high financial stress periods. Claessens et al. (2008) examined link between macroeconomic and financial variables during recessions and episodes of financial stress for 21 OECD economies. They found that recessions after the high financial stress periods are longer and

[22] For the collateral effect and bank capital channel, see Cardarelli et al. (2011) and the references cited therein.

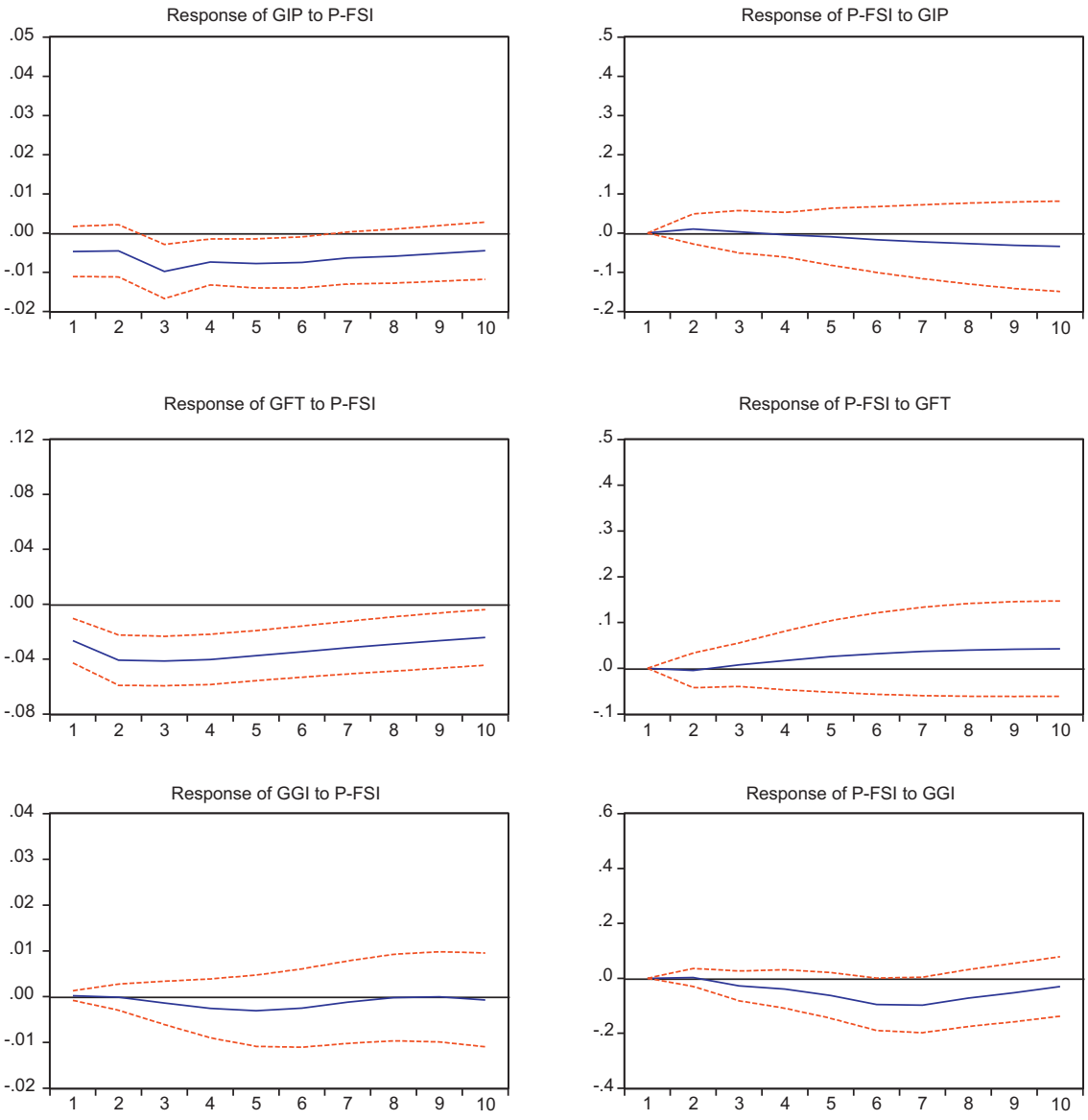


Fig. 5. Impulse response functions: Poland. *Note*: Dashed lines indicate 98% confidence interval.

deeper than other recessions. Hakkio and Keeton (2009) showed that an increase in financial stress leads to tightening of credit standards and decreases in economic activity in the US. Cardarelli et al. (2011) found that financial stress is often but not always a precursor to an economic slowdown in the 17 advanced economies. Davig and Hakkio (2010) investigated regime dependent relations between financial stress and economic activity and concluded that increases in financial stress have had a much stronger effect on the real economy when the economy is in a distressed state.

Following Hakkio and Keeton (2009), we examine the relationship between the constructed financial stress indexes for transition economies and economic activity using a bivariate vector autoregression (VAR) model. Although we employ a bivariate model, our approach captures multiple variables as the financial stress index is based on six economic and financial variables. Using a multivariate VAR model would likely be biased if other variables are used that are already incorporated into the financial stress index. Our measures of economic activity are the yearly *growth rate* of the industrial production index (GIP), the yearly *growth rate* of foreign trade (sum of merchandize exports and imports-GFT) and the yearly *growth rate* of gross fixed capital formation (with constant prices-GGI) in Bulgaria, Czech Republic, Hungary, Poland and Russia. The monthly data set runs from 1995:01 through 2010:06 for industrial production, trade, and the gross fixed capital formation.[23] Data on industrial production and gross fixed capital formation data are obtained from IFS CD-ROM for all countries.[24] Export and import data are collected from GEM database for all countries except for Bulgaria where the latter are obtained from the Bulgarian National Bank. Since variables in the VAR model must be stationary, we pretest stationarity of GIP, GFT and GGI series via ADF unit root test proposed by Dickey and Fuller (1979) and PP unit root test proposed by Phillips and Perron (1988). According to both unit root test results in Table 5, we reject the null hypothesis of a unit root for industrial production growth,

[23] Due to industrial production index data unavailability, we use real GDP for Bulgaria and obtain monthly GDP data using the cubic spline method.

[24] Since gross fixed capital investment is measured quarterly, we use the cubic spline method to obtain monthly capital investment.

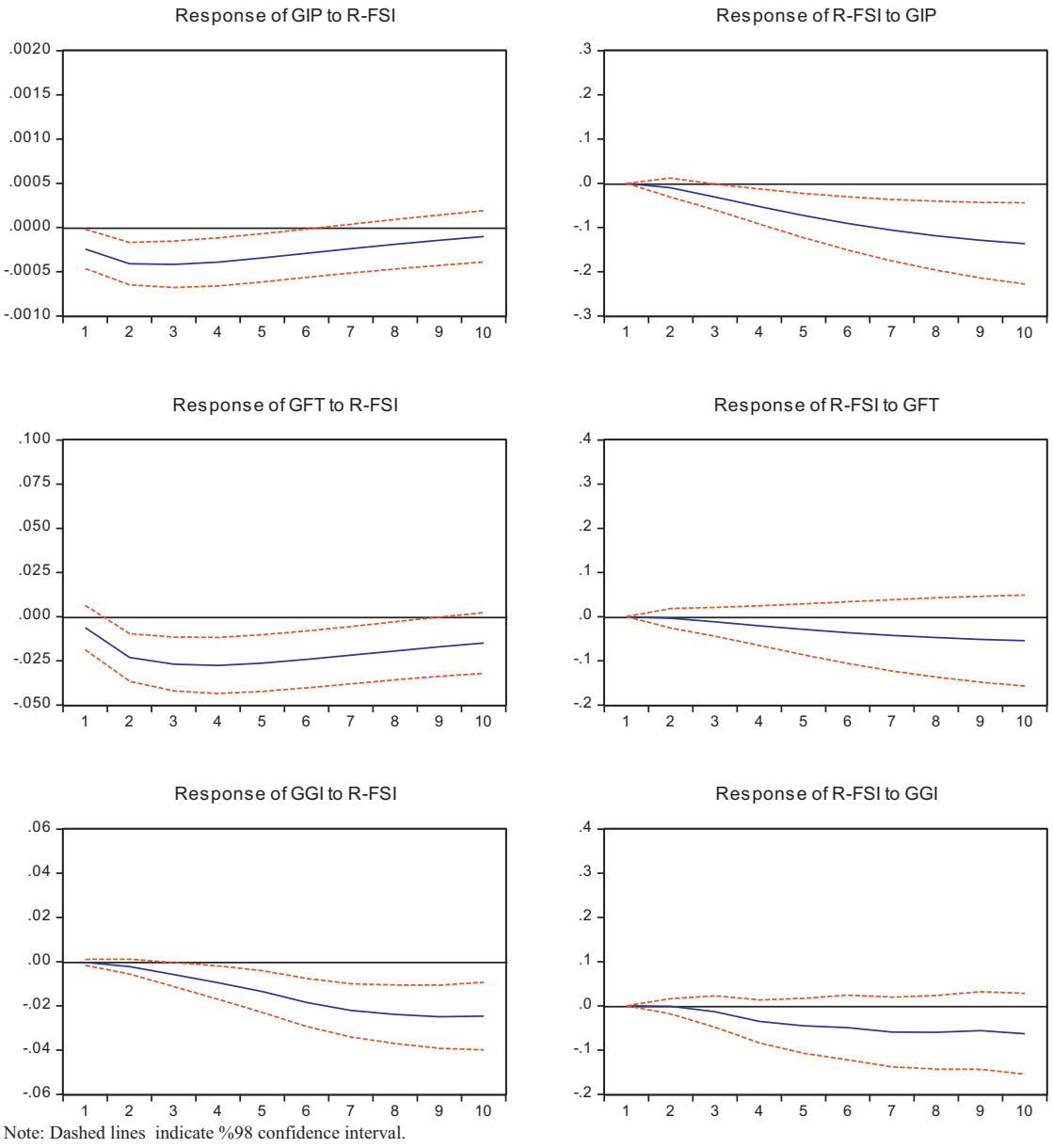


Fig. 6. Impulse response functions: Russia. *Note*: Dashed lines indicate 98% confidence interval.

investment growth, and trade growth at the 5% significance level. In what follows, we estimate bivariate VAR models to examine the dynamic interactions between financial stress and economic activity. In all cases the lag length is determined by the Schwarz Bayesian Information Criterion (BIC). We orthogonolize the innovations using a Cholesky decomposition where the financial stress shock is ranked first: it is assumed that real economic activity shocks have no contemporaneous effects on financial stress shock and they may affect financial stress after a month. This orthogonalization of the shocks is commonly used in the literature, see e.g., Bloom (2009), Hollo et al. (2012), Van Roye (2012) and the references cited therein. Such ordering can be justified by information lags. Namely, measures of economic activity cannot be directly observed by financial market participants in real time and thus cannot properly be reflected in contemporaneous asset prices.[25]

4.1. Relationship between financial stress and economic activity in Bulgaria

First, we estimate a bivariate VAR models with the B-FSI and each measure of real economic activity (growth rate of the industrial production index, GIP; the growth rate of foreign trade, GFT; and the growth rate of gross investment, GGI). The impulse response functions for the B-FSI and economic activity variables are shown in Fig. 2. Although the responses of the GIP to a B-FSI shock are negative and significant, the responses of the B-FSI to a GIP shock are only statistically significant between the sixth and ninth lags. Note that a financial stress shock decreases output in Bulgaria. According to the results in the middle panel, neither the response of the GFT to a B-FSI shock nor the response of the B-FSI to a GFT shock is statistically significant. Finally, the bottom panel shows that financial stress affects investment negatively affected and the responses are only significant at second, third, ninth and tenth lags. Overall, financial stress causes significant economic slowdowns in Bulgaria particularly in aggregate output.

[25] See Hollo et al. (2012) and Van Roye (2012) for a discussion.

Table 5
Unit root test results for level of series.

	ADF	PP	Deterministic component
Bulgaria			
GIP	−1.692*	−2.773***	None
GFT	−3.354**	−3.987***	Intercept
GGI	−4.015***	−3.633***	Intercept
Czech Republic			
GIP	−2.368**	−3.203***	None
GFT	−3.983***	−4.608***	Intercept
GGI	−3.486***	−6.942***	None
Hungary			
GIP	−3.862**	−5.282***	Trend and intercept
GFT	−4.617***	−4.808***	Trend and intercept
GGI	−5.199***	−3.478**	Trend and intercept
Poland			
GIP	−2.913**	−6.561***	Intercept
GFT	−3.249**	−4.459***	Intercept
GGI	−2.751***	−1.837*	None
Russia			
GIP	−2.447**	−3.315***	None
GFT	−1.981**	−3.378***	None
GGI	−2.238**	−2.211**	None

Note: ***, ** and * indicates the null hypothesis of a unit root can be rejected at 1%, 5% and 10% levels. Lag lengths are selected by Schwarz Bayesian information criterion.

4.2. Relationship between financial stress and economic activity in the Czech Republic

The impulse response functions of financial stress and economic activity for the Czech Republic are given in Fig. 3. Results in the upper panel indicate that the response of GIP to a CR-FSI shock is negative and statistically significant after the first lag. However, the response of the CR-FSI to a GIP shock is not statistically significant. In the middle panel, although the response of the GFT to a CR-FSI shock is negative and statistically significant, the response of the CR-FSI to a GFT shock is not statistically significant. Finally, as seen in the bottom panel, the response of the GGI to a CR-FSI shock is negative and significant after the sixth lag.

4.3. The relationship between financial stress and economic activity in Hungary

Fig. 4 shows the impulse response functions for Hungary. Results in the upper and middle panel indicate that the response of the GIP to an H-FSI shock is negative but only significant at the second lag. The response of foreign trade to financial stress is negative and significant between the second and sixth lags. Even though, gross investment responds negatively to financial stress, the responses are not statistically significant. Finally financial stress does not respond significantly to economic activity variables in Hungary.

4.4. Relationship between financial stress and economic activity in Poland

Fig. 5 gives the impulse response functions for Poland. The response of the GIP and GFT to a P-FSI shock is negative and statistically significant. However gross investment responses to financial stress are not significant. Finally, real variables such as foreign trade, investment, and industrial production have no significant bearing on financial stress in Poland.

4.5. Relationship between financial stress and economic activity in Russia

Finally, we estimate a bivariate VAR model to determine dynamic relationship between financial stress and economic activity in Russia. Fig. 6 shows the impulse response functions for Russia. The responses of the GIP, GFT and GGI to a financial stress shock are negative and significant. Note that industrial production growth seems to ease financial stress in Russia as the response of financial stress to a GIP shock is negative and significant. On the other hand the response of the financial stress to a GFT and GGI shock is not significant. Overall these results show that an increase in the financial stress causes a significant economic slowdown in Russia.[26]

5. Conclusions

The global financial crisis of 2007–2009 highlighted the importance of troubles originating in financial markets and their implications for real economic activity. Even though the literature is replete with work on financial stress in advanced economies, few studies have focused on former socialist economies in Eastern Europe. This study constructs a financial stress index for Bulgaria, the Czech Republic, Hungary, Poland, and Russia and examines the relationship between financial stress and economic activity. As these countries are emerging market economies with relatively less experience dealing with financial crises and most of them are part of the enlarged European Union with plans to enter the euro zone area eventually, developing a financial stress index for these countries is particularly relevant, given the ongoing financial stress in the European Union due to the debt crisis.

The link between financial stress and the real sector is an important one. An increase in financial stress can potentially produce substantial spillovers and systemic risks that impact the real sector adversely. From an economic policy standpoint, financial stress calls for vigilance and policymakers have to go beyond the usual policy prescriptions such as aggregate demand management for price stability and full employment. In emerging markets, in times financial stress specific policy actions depend on the source of stress. If financial stress is due to banking sector problems, policy actions need to focus on strengthening the banking sector. However if the source of financial stress is an external one, such as contagion from other countries, international policy coordination and contingency funding facilities of international financial institutions may become important in dealing with financial stress. Measuring financial stress not only provides a quantitative benchmark to assess the intensity of stress, but also gives an idea about the relative contribution of each financial indicator to the overall measure of stress and hence helps in formulating the appropriate policy response.

Our financial stress index incorporates banking sector fragility, time varying stock market return volatility, sovereign debt spreads, an exchange market pressure index, and trade credit. Our results show that these variables capture key aspects of financial stress in sample countries as the index peaks at known financial crises in these countries. We then examine the relationship between financial stress and economic activity (the latter being measured by industrial production, aggregate investment, and foreign trade). Impulse response functions based on bivariate VARs show some significant relationships between financial stress and most

[26] We also derive impulse response functions with the order of the shocks reversed for all countries and get qualitatively similar results. These are available upon request.

measures of economic activity. Overall, the constructed financial stress index provides valuable information on economic activity

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References

Abiad, A., 2003. Early warning systems: a survey and regime switching approach. IMF Working Paper No. 03/32.
Aizenman, J., Pasricha, G.K., 2012. Determinants of financial stress and recovery during the great recession. International Journal of Finance and Economics 17 (4), 347–372.
Albertazzi, U., Gambacorta, L., 2009. Bank profitability and the business cycle. Journal of Financial Stability 5 (4), 393–409.
Andersen, T.G., Bollerslev, T., 1998. Answering the skeptics: yes, standard volatility models do provide accurate forecasts. International Economic Review 39 (14), 885–905.
Avarmaa, M., Hazak, A., Mannasoo, K., 2011. Capital structure formation in multinational and local companies in the Baltic States. Baltic Journal of Economics 11 (1), 125–145.
Balakrishnan, R., Danninger, S., Elekdag, S., Tytell, R., 2011. The transmission of financial stress from advanced to emerging economies. Emerging Markets Finance and Trade 47 (Suppl. 2), 40–68.
Balcerowicz, L., 2000. Poland's transformation. IMF Finance and Development 37 (3) http://www.imf.org/external/pubs/ft/fandd/2000/09/balcerow.htm
Baxa, J., Horvath, R., Vasicek, B., 2011. Time-varying monetary-policy rules and financial stress: does financial instability matter for monetary policy? Journal of Financial Stability, http://dx.doi.org/10.1016/j.jfs.2011.10.002.
Bellas, D., Papaioannou, M.G., Petrova, I., 2010. Determinants of emerging market sovereign bond spreads: fundamentals vs. financial stress. IMF Working Paper No. 10/281.
Black, F., Scholes, M., 1973. The pricing of options and corporate liabilities. Journal of Political Economy 81, 637–659.
Bloom, N., 2009. The impact of uncertainty shocks. Econometrica 77, 623–685.
Bollerslev, T., 1986. Generalized Autoregressive Conditional Heteroskedasticity. Journal of Econometrics 31, 307–327.
Brüggeman, A., Linne, T., 1999. How good are leading indicators for currency and banking crises in central and eastern Europe? An empirical test. Discussion Paper. Halle Institute for Economic Research, pp. 95–99.
Bussiere, M., Fratzscher, M., 2006. Towards a new early warning system of financial crises. Journal of International Money and Finance 25, 953–973.
Cardarelli, R., Elekdag, S., Lall, S., 2011. Financial stress and economic contractions. Journal of Financial Stability 7 (2), 78–97.
Claessens, S., Köse, M.A., Terrones, M.E., 2008. Financial stress and economic activity. Journal of BRSA Banking and Financial Markets 2, 11–24.
Crosbie, P., Bohn, J., 2003. Modeling Default Risk. http://www.ma.hw.ac.uk/~mcneil/F79CR/Crosbie_Bohn.pdf
Davig, T., Hakkio, C., 2010. What is the effect of financial stress on economic activity. Federal Reserve Bank of Kansas City Economic Review, Second Quarter, 35–62.
Dickey, D.A., Fuller, W.A., 1979. Distribution of the estimators for autoregressive time series with a unit root. Journal of the American Statistical Association 74, 427–431.
Engle, R.F., 1982. Autoregressive conditional heteroscedasticity with estimates of variance of United Kingdom inflation. Econometrica 50, 987–1008.
Gapen, M.T., Gray, D.F., Lim, C.H., Xiao, Y., 2008. Measuring and analyzing sovereign risk with contingent claims. IMF Staff Papers 55 (1), 109–148.
Garibaldi, P., Mora, N., Sahay, R., Zettelmeyer, J., 2001. What moves capital to transition economies? IMF Staff Papers 48, 109–145.
Gelos, G.R., Sahay, R., 2001. Financial market spillovers in transition economies. Economics of Transition 9 (1), 53–86.
Geuorguiev, N., Ramcharan, R., Stuart, A., Aydin, B., 2009. South Africa: selected issues. IMF Country Report No. 09/276.
Girton, L., Roper, D.E., 1977. A monetary model of exchange market pressure applied to the postwar Canadian experience. American Economic Review 67, 537–548.
Gokcan, S., 2000. Forecasting volatility of emerging stock markets: linear versus non-linear GARCH models. Journal of Forecasting 19 (6), 499–504.
Grigorenko, A.Y., Efimova, T.L., 2008. Using spline-approximation to solve problems of axisymmetric free vibration of thick-walled orthotropic cylinders. International Applied Mechanics 44 (10), 1137–1147.
Hakkio, S.C., Keeton, W.R., 2009. Financial stress: what is it, how can it be measured, and why does it matter? Federal Reserve Bank of Kansas City Economic Review, Second Quarter, 5–50.
Hanschel, E., Monnin, P., 2005. Measuring and forecasting stress in the banking sector: evidence from Switzerland. BIS Working Paper No. 22.
Harding, D., Pagan, A., 2002. Dissecting the cycle: a methodological investigation. Journal of Monetary Economics 49, 365–381.
Harvey, A.C., Ruiz, E., Shephard, N.G., 1992. Multivariate stochastic variance model. Financial Markets Group Discussion Paper. London School of Economics.
Hollo, D., Manfred, K., Duca, M.L., 2012. CISS – a composite indicator of systemic stress in the financial System. Working Paper Series No. 1426. European Central Bank.
Illing, M., Liu, Y., 2006. Measuring financial stress in a developed country: an application to Canada. Journal of Financial Stability 2, 243–265.
Jacobson, T., Linde, J., Roszbach, K., 2005. Exploring interactions between real activity and the financial stance. Journal of Financial Stability 1 (3), 308–341.
Kaminsky, G.A., 1998. Currency and banking crises: the early warning distress. IFDP Working Paper No. 629.
Kaminsky, G.A., Lizondo, S., Reinhart, C.M., 1998. Leading indicators of currency crises. IMF Staff Papers 45 (1), 1–48.
Karfakis, C., Moschos, D., 2004. Predicting currency crises: evidence from two transition economies. Emerging Markets Finance and Trade 40, 95–103.
Keller, C., Kunzel, P., Souto, M., 2007. Measuring sovereign risk in Turkey: an application of the contingent claims approach. IMF Working Paper No. 07/233.
Kibritçioğlu, A., 2003. Monitoring banking sector fragility. The Arab Bank Review 5 (2), 51–66.
Kittelman, K., Tirpak, M., Schweickert, R., De Souza, L.V., 2006. From transition crises to macroeconomic stability? Lessons from a crises early warning system for eastern European and CIS countries. Comparative Economic Studies 48, 410–434.
Kruger, M., Osakwe, P., Page, J., 1998. Fundamentals, contagion and currency crisis: an empirical analysis. Bank of Canada Working Paper No. 10.
Li, F., St-Amant, P., 2007. Financial stress, monetary policy, and economic activity. In: 42nd Annual Meeting of the Canadian Economics Association, Vancouver, BC.
Lo Duca, Peltonen, T., 2011. Macro-financial vulnerabilities and future financial stress – assessing systemic risks and predicting systemic events. Working Paper Series No. 1311. European Central Bank.
Male, R., 2011. Developing country business cycles: characterizing the cycle. Emerging Markets Finance and Trade 47 (Suppl. 2), 20–39.
Martin, C., Milas, C., 2010. Financial crises and monetary policy: evidence from the UK. Journal of Financial Stability, http://dx.doi.org/10.1016/j.jfs.2012.08.002.
Melvin, M., Taylor, M.P., 2009. The crisis in the foreign exchange market. Journal of International Money and Finance 28, 1317–1330.
Merton, R.C., 1974. On the pricing of corporate debt: the risk structure of interest rates. Journal of Finance 29, 449–470.
Misina, M., Tkacz, G., 2009. Credit, asset prices, and financial stress. International Journal of Central Banking, 95–122.
Nelson, D.B., 1988 The time series behavior of stock market volatility and returns. Unpublished Ph.D. Dissertation, Massachusetts Institute of Technology, Cambridge, MA.
Nord, R., 2000. Central and eastern Europe and the new financial architecture. IMF Finance and Development 37 (3) http://www.imf.org/external/pubs/ft/fandd/2000/09/nord.htm
Pastor, G., Damjanovic, T., 2003. The Russian financial crisis and its consequences for central Asia. Emerging Markets Finance and Trade 39 (3), 79–104.
Phillips, P.C., Perron, P., 1988. Testing for a unit root in time series regressions. Biometrika 75, 335–346.
Rey, H., 2009. Discussion of How Linkages Fuel the Fire. http://www.internationalgrowthcentre.org/index.php?q=node/376
Ronci, M., 2004. Trade finance and trade flows: panel data evidence from 10 crises. IMF Working Paper No. 04/225.
Sachs, J., Tornell, A., Velasco, A., 1996. Financial crises in emerging Markets: the Lesson from 1995. NBER Working Paper No. W5576, pp. 147–198.
Schardax, F., 2002. An early warning model for currency crises in central and eastern Europe. Focus on Transition 1, 108–124.
Shen, C.-H., Chen, C.-F., 2008. Causality between banking and currency fragilities: a dynamic panel model. Global Finance Journal 19, 85–101.
Taylor, J.B., 2007. Lessons of the financial crisis for the design of the new international financial architecture. In: Conference on the 2002 Uruguayan Financial Crisis and its Aftermath, Montevideo, 29 May 2007.
Thomas, A., 2009. Financial crises and emerging market trade. IMF Staff Position Note No. 09/04.
Valenzuela, O., Pasadas, M., 2011. Fuzzy data approximation using smoothing cubic splines: similarity and error analysis. Applied Mathematical Modelling 35 (5), 2122–2144.
Van Horen, N., 2007. Customer market power and the provision of trade credit: evidence from eastern Europe and central Asia. Policy Research Working Paper Series 4284. The World Bank.
Van Roye, B., 2012. Financial stress and economic activity in Germany. Working Paper. The Kiel Institute for the World Economy.
Zinkovskaya, E., 2008. Determinants of financial crises in Russia and other transition economies: an empirical test. Japanese Journal of Comparative Economies 45, 1–18.