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# Measuring financial stress in Turkey

Emrah Ismail Cevik [a], Sel Dibooglu [b,*,1], Turalay Kenc [c]

[a] *Bulent Ecevit University, Zonguldak, Turkey*
[b] *University of Missouri St. Louis, USA*
[c] *Central Bank of the Republic of Turkey, Ankara, Turkey*

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**Abstract**

This study examines episodes of financial stress and develops a financial stress index for the Turkish economy for the 1997–2010 period. We consider various variables that summarize different aspects of financial conditions in the economy to gauge financial stress. We construct the index and show that financial stress affects economic activity significantly. Specifically, the index is a leading indicator of economic activity in Turkey. We then discuss how information provided by the financial stress index can be used to fine tune macroeconomic policy.


*JEL classification:* G01; E32; C43

*Keywords:* Financial crises; Financial pressure; Economic indicators; Business cycles

## 1. Introduction

In the past 30 years, the Turkish economy experienced several episodes of financial stress and two major economic crises in 1994 and 2001. After the 2001 economic crisis, the economy recovered and the Turkish economy achieved respectable economic growth until the global financial

* Corresponding author at: Department of Economics, University of Missouri St. Louis, One University Blvd., St. Louis, MO 63121, USA. Tel.: +1 314 516 5530; fax: +1 314 516 5352.
*E-mail address:* dibooglus@umsl.edu (S. Dibooglu).

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crisis of 2008. The financial crisis that started in the US has increased financial stress in advanced and developing economies alike. Despite a lack of serious economic and financial imbalances in Turkey in early 2008, increasing uncertainty in global financial markets and banking systems lead to an increase in financial stress in Turkey.

There are numerous studies on the determinants and episodes of currency, banking, and debt crises (Davis & Karim, 2008; Demirgüç-Kunt & Detragiache, 1998; Hardy & Pazarbasioglu, 1999; Kaminsky et al., 1998). However, Balakrishnan, Danninger, Elekdag, and Tytell (2009) argued that these studies are not appropriate to study episodes of financial stress for two reasons. First, past econometric work often uses zero-one binary variables: either no crisis or crisis. Such variables do not provide a measure of the intensity of stress and ignore the ambiguity of "near-miss" events. Even if a country does not experience a crisis, it does not mean financial stress is low in that country. Second, even the most comprehensive databases focus on banking, currency and debt crises, and pays little attention to securities-market stress.

There have been a limited number of studies focusing on constructing a financial stress index in the literature and those that exist are fairly recent. Hanschel and Monnin (2005) derived a stress index for the Swiss banking system. Illing and Liu (2006) developed an index to measure the degree of financial stress for the Canadian financial system. Balakrishnan et al. (2009) developed a financial stress index for developing countries and investigated the transmission channels of financial stress between advanced and developing countries. Hakkio and Keeton (2009) studied episodes of financial stress in US and developed a comprehensive financial stress index. Finally, Melvin and Taylor (2009) developed a financial stress index for advanced economies and examined relationship between financial stress index and carry trade.

The principal objective of this paper is to construct a comprehensive index of financial stress for Turkey. We modify and extend the index proposed by Balakrishnan et al. (2009) for developing countries with specific considerations for the Turkish economy. Such an index would provide valuable information for policymakers particularly as a heightened index warrants special attention as described in Section 2. In Section 2 we motivate the construction of a financial stress index for an emerging market economy by highlighting the link between financial stress and macroeconomic policy and managing macroeconomic risks. Section 3 describes the components of the Turkish Financial Stress Index and its construction. Section 4 elaborates on the construction of the index and how the variables considered capture key aspects of financial stress. Section 5 considers the relationship of the index with economic activity and shows that high values of the index have tended to coincide with known periods of financial stress and the index provides valuable information about future economic growth.

## 2. Financial stress and macroeconomic policy

The onslaught of the financial crisis of 2007–2008 and the economic downturn that followed highlighted the importance of the link between the financial sector and real economic activity in an interconnected world. The stress in the financial sector has ripple effects as problems in the financial sector have a negative effect on international trade and asset flows exacerbating the problems of an already constrained aggregate demand. Moreover, there is evidence that economic crises associated with credit crunches and busts are worse than others as they tend to be longer on average and have much larger output losses than others (Claessens, Köse, & Terrones, 2008). In this regard, it is very important to measure financial stress in the economy by extracting signals from variables that that are thought to capture some aspect of financial stress. This approach is becoming a common method of measuring financial sector conditions and several institutions

are regularly reporting such indexes. These include the St. Louis Fed's Financial Stress Index (STLFSI), Kansas City Fed's Financial Stress Index (KSFCI), and Bank of America's Global Financial Stress Index (GFSI), which was introduced in late 2010 to gauge the global cross-market risk, hedging demand and investment flows. What is less common is the regular reporting of such financial stress indicators for emerging markets. The financial stress index for the Turkish economy is important in that regard and is intended to fill a void in the literature.

Given the sovereign debt burden of some advanced economies, a significant policy stimulus in advanced economies is unlikely. Whether emerging markets can implement monetary and fiscal policy measures to reinvigorate global growth outlook critically depends on the health of their financial sectors, their fiscal capacity to undertake such measures, and proper design of macroeconomic policies. How can measuring and monitoring financial stress contribute to the design and implementation of proper macroeconomic policies? While in normal times, the standard evaluation of macroeconomic prospects (maintaining full employment and price stability) is adequate and there are useful policy benchmark rules (such as the Taylor rule), heightened periods of financial stress may call for policy responses that are different than the usual prescriptions. That is because a period of excessive financial stress may produce substantial spillovers that constrain the credit intermediation capacity of the financial sector and hence require policy to be recalibrated. A financial stress index not only is useful in evaluating macroeconomic prospects and designing monetary and fiscal policy measures, it is also useful in assessing financial conditions and fragility of the financial sector. Doing so contributes to a smoothly functioning financial system. For example, in periods of heightened financial stress it may not be sufficient to adjust short term interest rates. When markets suffer from illiquidity, there is increased uncertainty about asset values and lenders are unwilling to accept these assets as collateral; as such, credit intermediation declines and real economic activity is adversely affected. Under these circumstances, policymakers may have to resort to unconventional policy measures to deal with liquidity problems. Therefore measuring financial stress not only is important from the design and implementation of macroeconomic policy but also contributes indirectly to a smooth, robust and more resilient financial system.

## 3. Construction of a financial stress index

In this paper the Turkish Financial Stress Index (TFSI) is constructed using variables that capture some aspect of financial stress. In addition to those used in the literature (e.g., banking sector beta, stock market returns, time varying stock market return volatility, sovereign debt spreads, and an exchange market pressure index) we include proxies for "trade credit", "credit stress" and variables that proxy liquidity in financial markets. Therefore the Turkish Financial Stress Index (TFSI) includes the following economic and financial components.

### *3.1. Riskiness of the banking sector*

The soundness of the banking system is of paramount importance for developing countries in terms of sustainable economic development. Therefore we include the riskiness of the banking sector as a component of TFSI. In this context we measure the default probability of the banking sector via contingent claims analysis.

The contingent claim analysis (CCA) models bank equity as a contingent claim on bank assets. It is a contingent claim because the value of bank equity depends on the value of bank assets and

the default-free value of bank liability at a particular point in time (Geuorguiev, Ramcharan, Stuart, & Aydin, 2009). The bank equity can be written as a call option as follows:

$$E = \max\ [A - DB, 0] \tag{1}$$

where $A$ is banks assets and $DB$ is the default barrier. In Eq. (1), when the bank can generate enough cash to cover its current debt obligations ($A \geq DB$), the value of bank's equity is equal to difference between the value of bank's assets ($A$) and the current debt obligations of the bank or default barrier ($DB$).[2] On the other hand, when the bank's assets do not cover the current debt obligations ($A \leq DB$), bank equity equals zero. The market value of bank's equity can be modeled by using Black and Scholes (1973) and Merton (1974) valuation for call options:

$$E = AN(d_1) - DBe^{-rt}N(d_2) \tag{2}$$

where $d_1 = [\ln(A/DB) + (r + 0.5 \times \sigma_A^2 T]/\sigma_A\sqrt{T}$, $d_2 = d_1 - \sigma_A\sqrt{T}$, $r$ is the risk free interest rate,[3] $T$ is the time to maturity of the default barrier, $N(d)$ is a cumulative probability distribution function for a standard normal variable, and $\sigma_A$ is the standard deviation of bank's assets. Using Merton (1974) bond pricing assumptions, the volatility of the banking sector equity is:

$$\sigma_E = \frac{A\sigma_A N(d_1)}{E} \tag{3}$$

Distance to default (DD) of the banking sector can be written as:

$$\mathrm{DD} = \frac{\ln\ (A/DB) + (r - 0.5 \times \sigma_A^2)T}{\sigma_A\sqrt{T}} \tag{4}$$

Under the normal distribution, the default probability of the banking sector can be calculated as $N(-\mathrm{DD})$.

In order to solve the system in Eqs. (2) and (4), we use 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 $\sigma_A$ into Eq. (2) and compute new values of $A$ and $\sigma_A$. The procedure is repeated until convergence where the sum of squared differences between consecutive asset values is less than $10^{-3}$.

### 3.2. Securities market risk

Another component of financial stress in developing countries is securities market risk. One way to measure securities market risk is to use country beta from the standard CAPM:

$$\beta_C = \frac{Cov(r_t^W, r_t^C)}{Var(r_t^W)} \tag{5}$$

where $r^W$ and $r^C$ indicate excess MSCI-Barra World Index (WI) and Istanbul Stock Exchange 100 index (ISE 100) returns. As is common in the literature, the beta is computed over a 12-month rolling window.

[2] We assume that default barrier of the banking sector is equal to the sum of short term and half of long term liabilities. Therefore, liabilities that mature in six months are defined as short term with any other liability is deemed long term.

[3] The overnight interest rate is taken to be the risk free interest rate.

Estrada (2007) questions the use of standard CAPM because it assumes the underlying distribution of returns is symmetric and normal. As such, the downside beta is a more appropriate measure of risk because it can account for asymmetry and non-normality of returns. This is important because investors evaluate upside volatility differently than downside volatility. Second, the semi variance is a more useful measure than variance when the underlying distribution of returns is asymmetric. Third, the downside beta combines into one measure when the information is provided by two statistics, variance and skewness, thus making it possible to use a one-factor model to estimate the required return. Following these arguments, we consider downside beta as an alternative measure of securities market risk. The downside beta is computed as:

$$\beta_C^d = \frac{Cov(r_t^W, r_t^C)}{Var(r_t^W)} \tag{6}$$

where $r_t^W = Min\,[(r_t^W - \mu_W), 0]$, $r_t^C = Min\,[(r_t^C - \mu_C), 0]$ and $\mu_W$ and $\mu_C$ are mean of excess WI and ISE100 returns.

Finally, we use time varying volatility of stock returns obtained from a GARCH (1, 1) model as an alternative measure of securities market risk.

### 3.3. Currency risk

Another factor important in measuring financial stress in developing countries is currency risk. Various works in this area follow Girton and Roper (1977) who introduced an Exchange Market Pressure Index (EMPI) to ascertain the degree of pressure on the exchange rate. The index uses a simple average of exchange rate and foreign reserve changes and most studies in the literature use a variant of it. Although variants of EMPI used 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. As is common in the literature, we construct the EMPI by using exchange rate movements and changes in international reserves as follows:

$$EMPI_t = \frac{\Delta e_t - \mu_{\Delta e}}{\sigma_{\Delta e}} - \frac{\Delta RES_t - \mu_{\Delta RES}}{\sigma_{\Delta RES}} \tag{7}$$

where $\Delta e_t$ and $\Delta RES_t$ are the 12-month changes in the exchange rate and total reserves minus gold and $\mu$ and $\sigma$ denote the mean and standard deviation of the exchange rate and total international reserves respectively. Even though the link between foreign exchange market pressure and the probability of a crisis is well known, recent work by Alper and Civcir (2012) shows that persistent overvaluation in excess of 7% in three consecutive years or more can serve as an early warning indicator for potential crises in Turkey.

### 3.4. External debt

Although external debt plays a key role in economic growth in developing countries, excessive increase in the external debt casts a doubt on sustainability of external debt. Since short term external debt played a prominent role in the Asian and Russian crises, it has to be part of any financial stress index for developing countries. There are several direct and indirect channels where foreign debt affects economic activity. Faced with excessive foreign debt, a country will experience reduced incentives to invest, high domestic real interest rates due to the impaired access to international credit, and a decrease in public investment. This is known as the “debt overhang

effect". As Erbil and Salman (2006) emphasized, debt overhang implies the accumulated debt, acting as a tax on future output, discourages productive private sector investments and puts severe constraints on the adjustment efforts of governments. To that end, we include the 12-month growth rate of short term external debt and total external debt as parts of TFSI.[4]

### 3.5. Sovereign risk

Changes in investors' risk perceptions which drive short term capital flows are useful indicators of financial stress in developing countries. Because interest rate spreads between Turkey and US can be used an indicator of risk perception in Turkey, we use sovereign bond spreads (the difference between Turkey's Emerging Market Bond Index and 10-year US Treasury yield) in constructing the TFSI.

### 3.6. Trade finance

Rey (2009) suggested trade finance as another important component of financial stress in developing countries. Since trade finance cannot be measured directly, there are numerous proxy variables used in the literature. Ronci (2004) used changes in outstanding short-term credit in US as a proxy variable for the trade financing flows. Thomas (2009) used net financial flows as a proxy variable for the trade finance. In this study we use the financial account balance in the balance of payments as a proxy for trade finance.

### 3.7. Credit stress

Rey (2009) also argued that a financial stress index should include credit stress, which is not directly measurable. In this paper, we use the growth rate of the claims on the private sector as a proxy for credit stress.

### 3.8. Money market spreads

Spreads in the money market are indicators of liquidity and the absence of liquidity leads to a deterioration of the financial system since the money market is an important source of short-term funds for banks. It is well known that the money market is illiquid when financial stress increases; therefore we consider money market spreads as a component of financial stress. We include bid–ask spreads in the overnight interest rate and the foreign exchange market in constructing the financial stress index.

In order to proxy illiquidity in the market, we calculate bid–ask spread as follows:

$$S = \left\{ \frac{[\mathrm{AP} - \mathrm{BP}]}{[(\mathrm{AP} + \mathrm{BP})/2]} \right\} \times 100 \tag{8}$$

where $S$ is spread, AP is the ask price and BP is the bid price. Because bid and ask prices for the overnight interest rate are not available, we used highest and lowest price in the money market as a proxy for bid and ask prices.

[4] As external debt is measured on a quarterly basis in Turkey, we use the Chow-Lin procedure (reserves being the indicator variable) to obtain monthly external debt figures.

### 3.9. Spreads in the stock market

Another measure of liquidity is the bid–ask–spreads in the stock market; as such, following Hakkio and Keeton (2009) we use bid ask spreads in the stock market as a component of financial stress in Turkey. Again due to data availability, we use the highest and lowest prices in the stock market as a proxy for bid and ask prices.

## 4. Aggregation of components

There are various methods in aggregating the components of 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, Eledag, and Lall (2011) and Balakrishnan et al. (2009) prefer a variance equal weighting procedure. As in Hakkio and Keeton (2009), we use principal components analysis to aggregate the variables and construct the financial stress index.

## 5. A financial stress index for the Turkish economy

In order to examine the degree of the financial stress in the Turkish economy, we construct a monthly financial stress index for January 1997 through March 2010. Data were collected from Central Bank of the Republic of Turkey (CBRT), World Bank Global Economic Monitor (WBGEM) database, the Istanbul Stock Exchange (ISE), and MSCI-Barra's official website. Data on external debt, the money market rate, the foreign exchange rate, international reserves, claims on the private sector, banking sector liabilities, and the financial account balance were taken from CBRT; the ISE 100 and banking sector index were taken from ISE. Sovereign bond spreads and MSCI-Barra World Index data were obtained from WBGEM and MSCI-Barra's official website[5] respectively. Before the aggregation of components, all of the variables were standardized by subtracting their means and dividing by their standard deviations. The correlation coefficients among the components vary between −0.76 and 0.76 and correlation coefficients computed by using time varying volatility for the stock market are found to be higher than correlation coefficients computed by using beta and downside beta and therefore time varying volatility seems to be a more suitable measure of stock market risk.[6]

In constructing the index, variables used and their respective weights in the principal component analysis are given in Table 1. We use different combinations of the variables in principal component analysis with various groupings of the data to obtain an index that explains a large proportion of the total variance. Our final model includes six variables which explain 59% of total variance.[7] As shown in Table 1, the weights of individual variables such as stock market volatility, EMPI, bond spreads and default probability of banking sector raise financial stress in Turkey. However, increases in trade finance, and growth rate of short term external debt decrease financial stress. Although most of these results are consistent with a priori expectations, some warrant additional comments.

Although the relationship between external debt and economic growth is widely examined for the developing countries in the literature, there is no consensus view on the effects of external

[5] http://www.mscibarra.com/products/indices/stdindex/performance.html.
[6] These results are omitted for brevity.
[7] Results from alternative models are available upon request.

Table 1
Principal component analysis results.

| Variables | Weight |
|---|---|
| Stock market volatility | 0.897 |
| EMPI | 0.768 |
| Bond spreads | 0.730 |
| Default probability of banking sector | 0.668 |
| Trade finance | −0.829 |
| Growth rate of short term external debt | −0.549 |
| Total variance explained | 59% |

debt. For example, Bellas, Papaioannou, and Petrova (2010) found that an increase in the short term debt/reserves ratio causes a decrease in sovereign bond spreads in the short run and has no statistically significant impact in the long run. If we consider increases in the short term external debt as an indicator of creditworthiness of debtor countries, we can expect an increase in the short term external debt to decrease financial stress. On the other hand, perhaps after a threshold, an increase in debt may raise questions about the sustainability of debt and ultimately affect solvency.

Table 1 indicates that financial inflows contribute negatively to financial stress in Turkey. This result is consistent with expectations because financial flows play an important role in economic growth in developing countries. In this context, Kose, Prasad, and Terrones (2009) examine the impact of financial openness on output growth and conclude that financial flows have a positive effect on total factor productivity. Also, Thomas (2009) found that capital flows have positive effect on external trade.

The behavior of financial stress index over the business cycle can be informative. This is important because a well defined financial stress index must correlate with and ideally be a leading indicator of recessions. Fig. 1 indicates that the TFSI captures all recessions in Turkey in the sample. Notice that all recessions follow high episodes of financial stress which point to TSFI being a leading indicator of aggregate economic activity in Turkey. According to the plot of

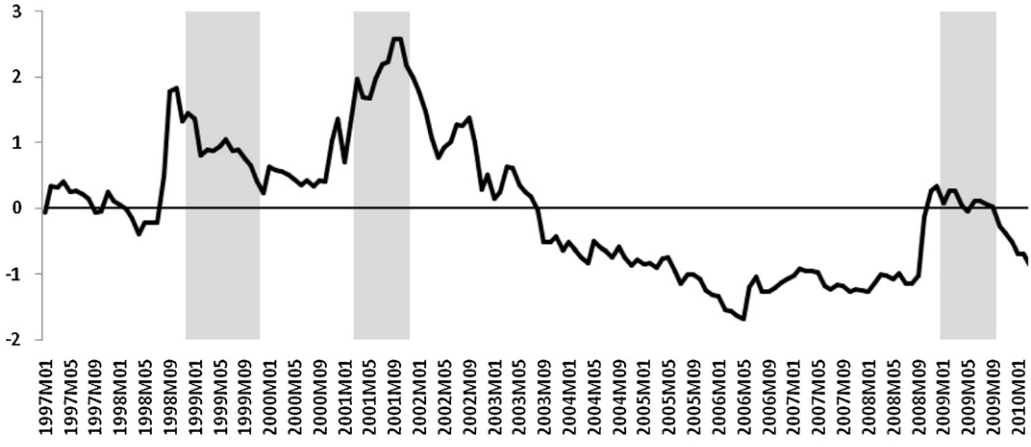



Fig. 1. The Turkish Financial Stress Index. *Note*: Shaded areas are recessions.

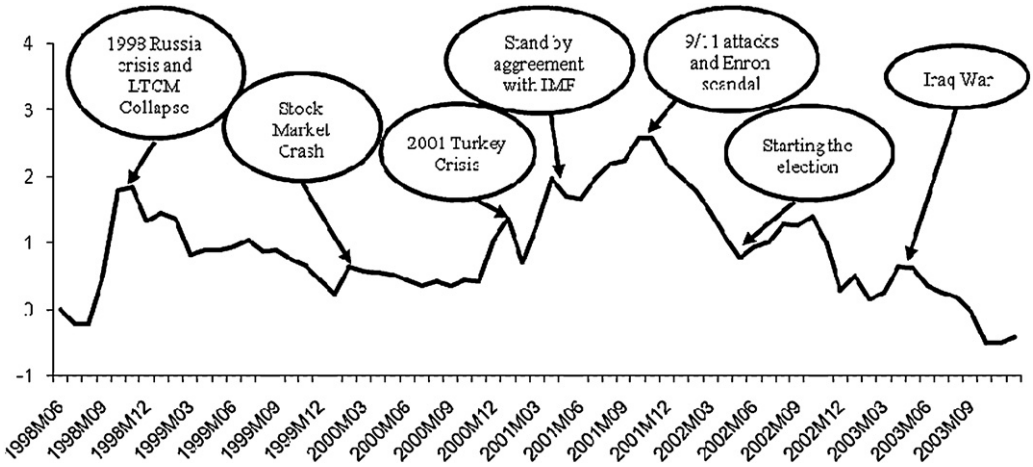


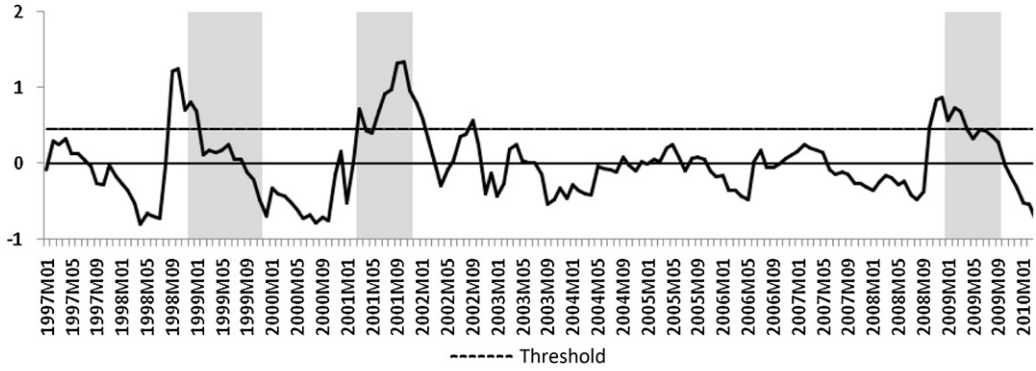

Fig. 2. Financial stress in Turkey in 1998–2003.

TFSI in Fig. 1, financial stress in Turkey increased at the beginning of 1998 and remained above zero until the end of 2003. Then financial stress decreased and remained below zero from 2003 through 2007. With the start of the global financial crisis, TFSI started to increase again. Because the financial stress index has several peaks from 1998 to 2003, this period is examined in detail in Fig. 2.[8]

In Fig. 2, first peak of the TFSI occurred at the end of 1998. This peak corresponds to the Russian crisis and the collapse of Long Term Capital Management (LTCM). The second peak in the TFSI appears at the beginning of 2000 around the deflation of the so called technology bubble of the 1990s. The third peak occurs in the 2001 Turkish crisis. Notice that after the Turkish government announced a standby agreement with IMF after the crisis, the TFSI started to decrease. The highest value of the TFSI corresponds to the aftermath of the 9/11 terrorist attacks in October 2001. Thereafter we observe peaks in the TFSI corresponding to the start of an election cycle in Turkey, and the Iraq war. Overall, the TFSI provides valuable information regarding important developments that affect the economy.

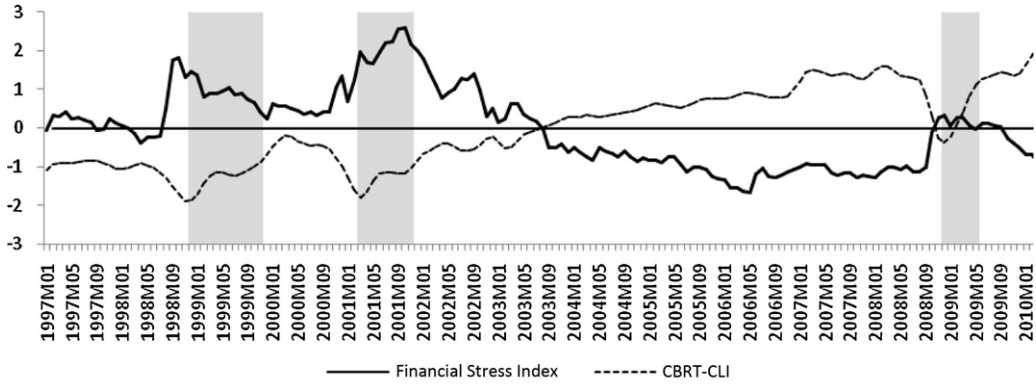
As emphasized by Hakkio and Keeton (2009), casually determining episodes of financial stress is difficult hence a threshold is called for. Moreover, the length of time over which the index remains at or above threshold level is as important as episodes of financial stress. Illing and Liu (2006) and Cardarelli et al. (2011) classify episodes of heightened financial stress by using a threshold level that is one standard deviation from the index trend level. Following the same approach, high financial stress is defined as periods where the index is more than one standard deviation above its trend level in this study. The trend of TFSI is derived by means of a Hodrick–Prescott (HP) filter. TFSI is detrended to determine its standard deviation. The TFSI relative to its one standard deviation threshold value and high episodes of financial stress in Turkey are plotted in Fig. 3. Again, high episodes of financial stress precede all recessions in Turkey. Specifically the financial stress caused by the 2007–2009 global financial crisis in Turkey is similar to that observed in 1998 and in 2001.

[8] Recessions are dated casually as two successive declines in real GDP.




Note: Shaded areas are recessions.

Fig. 3. High episodes of financial stress in Turkey. *Note*: Shaded areas are recessions.




Note: Shaded areas are recessions.

Fig. 4. Composite leading indicators index and TFSI. *Note*: Shaded areas are recessions.

Next we compare TFSI to a composite leading indicator (CLI) index constructed by the Central Bank of the Republic of Turkey (CBRT). Fig. 4 plots TFSI against CLI constructed by the CBRT.[9] The CLI was constructed by the CBRT as a leading indicator of the business cycle since 1987. The CBRT considered 18 potential series and found only 7 to be statistically significant. These series are Production of Electricity, Discounted Treasury Auction Interest Rate Weighted by the Amount Sold, Imports of Intermediate Goods, CBRT Business Tendency Survey Related to the Stocks of Finished Goods, CBRT Business Tendency Survey Related to New Orders Received from the Domestic Market, CBRT Business Tendency Survey Related to Export Possibilities, and CBRT Business Tendency Survey Related to Employment. Typical of any leading indicator index, any decrease in CLI is a precursor to a significant slowdown in economic activity in the following months. As shown in Fig. 4, our financial stress index tracks CLI quite well and can serve as a leading indicator. One can argue TFSI has some advantages over the CLI of the CBRT. First, most components of TFSI are time series that are readily available. Second, although CLI includes

[9] To make CLI and TFSI comparable, we standardized CLI by subtracting its mean and dividing by its standard deviation.

Table 2
Granger causality between economic activity and TFSI.

| Null hypothesis | *F*-statistic | Prob. |
|---|---|---|
| TFSI does not Granger cause GIP | 3.244 | 0.005 |
| G IP does not Granger cause TFSI | 0.901 | 0.495 |
| TFSI does not Granger cause GFT | 4.217 | 0.001 |
| GFT does not Granger cause TFSI | 0.241 | 0.943 |
| TFSI does not Granger cause GGI | 4.383 | 0.000 |
| GGI does not Granger cause TFSI | 1.627 | 0.143 |

only internal variables, TFSI considers external variables such as bond spreads, external debt, and financial inflows. Finally, our TFSI almost exclusively considers financial variables some of which are available in high frequency.

## 6. The relationship between financial stress and economic activity

The link between financial variables and the real sector has been extensively analyzed in the literature and sources of possible links have also been discussed. Some studies have emphasized 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. In other words, shocks which affect the creditworthiness lead to increased swings in output. Another effect of financial variables on the real economy is the so called bank capital channel. In 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. Moreover, as emphasized by Hakkio and Keeton (2009), an increase in uncertainty about the price of financial assets and the economic outlook in general lead to decreases in economic activity.

Some studies have empirically examined the relationship between financial stress and economic activity. 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 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 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.

In this section, the dynamic relationships between TFSI and measures of economic activity are examined by means of unrestricted vector autoregression (VAR) models. Our measures of economic activity are the 12-month growth rate of the industrial production index (GIP), the 12-month growth rate of foreign trade (sum of merchandise exports and imports-GFT) and 12-month growth rate of gross fixed capital formation (with constant prices-GGI) in Turkey. Data for 1997:01–2010:03 on industrial production, trade, and gross fixed capital formation were obtained from the CBRT.[10]

[10] Since variables in the VAR model must be stationary, we test stationarity of GIP, GFT and DI series via augmented Dickey Fuller and KPSS unit root tests. The test results indicate stationarity and are available upon request.

First, we present evidence regarding Granger-causality between the TFSI and measures of economic activity and the results are presented in Table 2. Lag lengths in the bivariate VARs are determined via Akaike information criterion. Granger causality tests indicate that the null hypothesis that TFSI does not Granger-cause each economic activity variable is soundly rejected

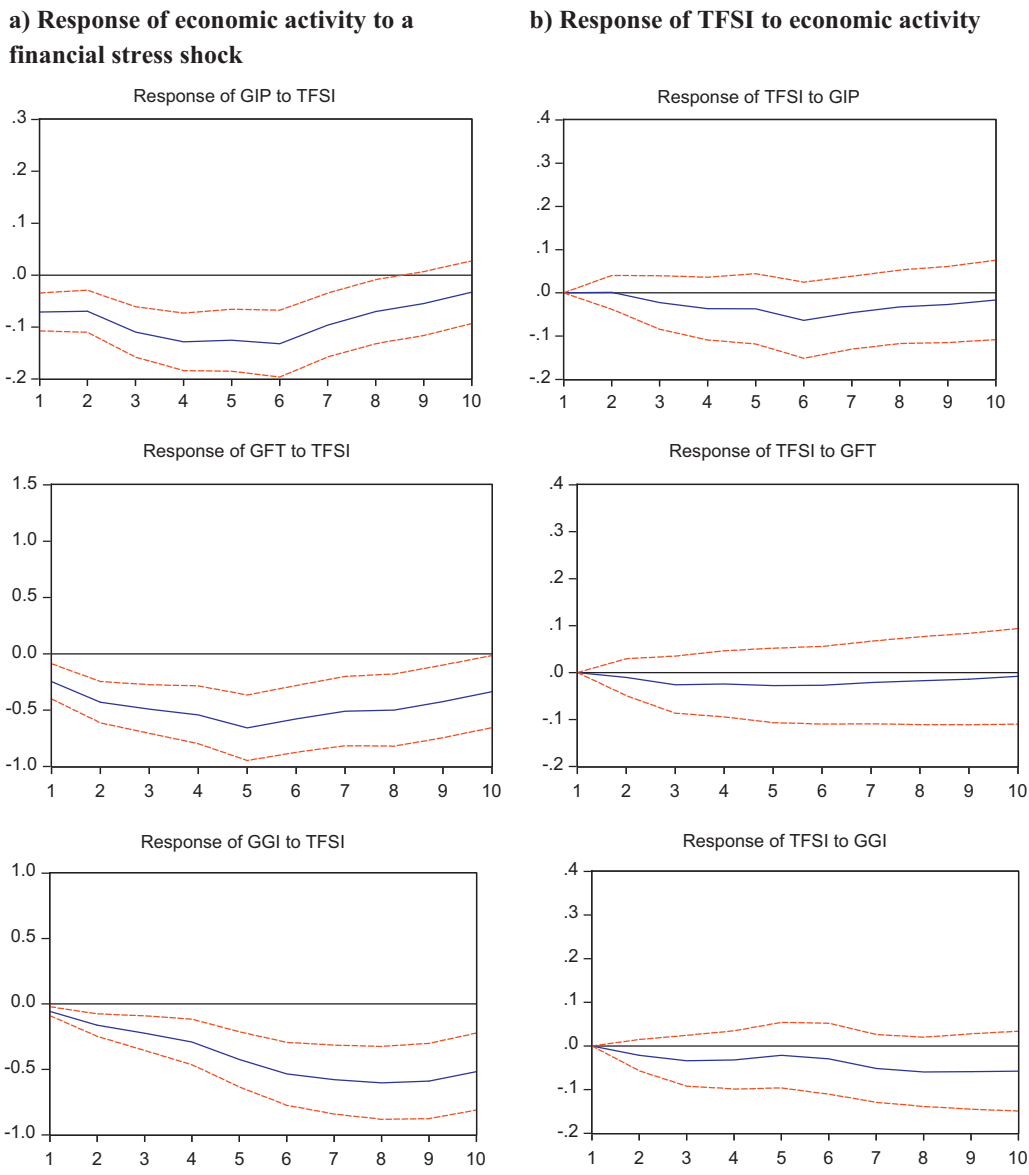



Fig. 5. Impulses responses functions from bivariate unrestricted VARs.
(a) Response of economic activity to a financial stress shock.
(b) Response of TFSI to economic activity.
*Note*: Dashed lines indicate a 98% confidence interval.

at conventional significant levels. This indicates that movements in the TFSI affect industrial production, foreign trade, and aggregate investment significantly. Note that test statistics presented in Table 2 indicate that measures of economic activity such as industrial production, foreign trade, and aggregate investment fail to Granger cause the TFSI at conventional significance levels.

In order to examine the dynamic interactions between financial stress and economic activity, we present impulse response functions from unrestricted bivariate VARs of TFSI and each economic activity variable. We orthogonolize the innovations using the Choleski decomposition where we order the financial stress shock first. Fig. 5 presents the impulse response functions. Column (a) in the figure presents the response of economic activity to a financial stress shock. Note that in responses to an increase in financial stress, all measures of economic activity (industrial production, foreign trade, and aggregate investment) fall and all responses are significant. On the other hand, column (b) of Fig. 5 indicates that none of the responses of TFSI to any measure of economic activity is statistically significant.

## 7. Summary and concluding discussion

The global financial crisis that had started in US has affected advanced and developing economies alike. Financial stress that started in advance economies passed strongly and rapidly to developing economies. The Turkish economy has been affected by the global financial crisis just like many other developing economies. In the last 30 years, Turkey's economy has experienced several episodes of financial stress. In this study we examined episodes of financial stress in Turkey in the 1997–2010 period. To that end, we considered various variables that capture different aspects of financial sector to construct a financial stress index for Turkey. Using principal component analysis, we aggregated EMPI, stock market volatility, bond spreads, default probability of banking sector, trade finance and growth rate of short term external debt into an index of financial stress. Empirical results show that our financial stress index is quite successful in acting as a leading indicator of aggregate economic activity and capturing all recessions in Turkey. We then examined the links between financial stress and economic activity by means of a bivariate VAR model. Granger causality tests and impulse response functions indicated that our financial stress index is significant in affecting economic activity.

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 constrain the credit intermediation capacity of the financial sector. In times of heightened financial stress, distressed asset values decrease the collateral that provides credit to the economy. At the same time, capital of banks is eroded which forces banks to deleverage and banks become unwilling to lend to businesses. Contraction of credit due to strict credit standards and a general negative outlook can also affect economic activity adversely. From an economic policy standpoint all of these developments call for vigilance and policymakers have to go beyond the usual policy prescriptions such as aggregate demand management for price stability and full employment. As the recent financial crisis has shown, when credit markets are frozen and trade in certain assets come to a halt, policymakers may need to engage in policy innovations such as the US Federal Reserve System's Term Auction Facility, Term Securities Lending Facility, and foreign exchange swap lines. In an emerging market, 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, access to currency swap lines, and contingency funding facilities such as Contingent Credit Lines of the

IMF become very 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 policy response.

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