Financial Stress and Effect on Real Economy: The Turkish Experience

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Abstract

In this paper, we aim to analyze empirically how economic activity reacts to the financial stress shocks depending on the stress regime in Turkey. Using quarterly data, the effect of financial stress is examined using two threshold vector autoregression model (TVAR) for consumption, investment and real GDP by using financial stress index, credit growth and inflation rate as endogenous variables. The paper proposes local projection approach for estimating threshold VAR model as robustness check to overcome the data limitations. The main result of this paper is that the effect of financial stress on consumption, investment, and real GDP, such as magnitude and significance, vary greatly depending on the financial stress regime. The paper finds that financial stress is found to affect economic growth when the stress level is already high. This corroborates with the effectiveness of credit channel in the financial friction mechanism. On the contrary, the financial stress does not affect real economic activities to significantly during low stress regime. The effect of financial stress impairs consumption and investment growth during high stress regime which leads to slow down of economic activities.

Keywords:Financial stress index, Threshold VAR model, Markov Switching Model, Local Projection, Forecast Error Variance Decomposition

JEL Classification: C01, C32, G01

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1 Introduction

The Global Financial crisis earmarked a new era of banking supervision in recent times. It underlined the greater role of financial risk on real economy. The crisis started from the mortgage market of the United States and translated into a full blown financial market collapse by September 2008. With the collapse of Lehman Brothers, the stock market plummeted drastically and US economy slipped into an economic depression. Unemployment level reached a record level and US households suffered a drastic loss of their wealth as asset price crashed. In short, the Global Financial Crisis underlined the rippling effect of financial stress on real economic activities. Following the collapse of global financial market during the global financial crisis, macro-financial linkage became a major area of analysis and understanding the role of financial stress on real economic activities captured the headline of central bank research. Turkey's experience was no exception. In this paper, we analyze the impact of financial stress on real economic activities through the lens of Turkish economy using threshold vector auto regression model and Markov Switching Model.

This paper evaluates the role of financial stress on real economic activities and thereby contributes to broadly three strands of literature. The primary contribution of the paper is focused on empirical evaluation of the relationship between financial stress and real economy. We used a noble financial institution stress index (following Yildirim (2021)) to quantify the historical stress levels in financial sector. The spillover analysis of financial stress are motivated by the financial friction literature. The paper analyzes the economic impact of financial friction through GDP, consumption, and investment growth. The empirical framework uses threshold vector autoregression model (TVAR) highlighting the role of non-linearity in spillover of financial shock. Such non-linear trade-off emphasises the importance of non-linearity in financial friction mechanism. For that, the existence of threshold is established and threshold VAR model is used to model the impact of financial stress under low stress and high stress regimes. The VAR model uses quarterly data since 2002 onwards. The impact of financial stress is visualized using impulse response function under both regimes. However the robustness of threshold VAR models can be compromised due to lack of data availability. Hence we introduce linear projection estimation methodology for checking the robustness of the findings. The local projection estimation approach in TVAR model is relatively new. We use the local projection approach of Miranda Agrippino in the TVAR model. The threshold estimate is carried out using Markov Switching model on financial stress index following Hamilton (1989). Following the literature of financial friction, this paper analyzes the impact of financial stress on real GDP and Consumption for Turkey. The paper observes asymmetric effect of financial stress on overall growth and domestic demand. Financial stress is found to impart significant moderation of consumption and real GDP growth when the stress level is already high. The effect is found to be muted in lower stress regime. This observation follows the financial friction models. Further, the forecast error decomposition reveals that the forecast error of GDP growth is contributed by the financial stress during high stress regime.

The relation between financial sector stress and economic activities can be explained using three broad channels namely borrower financial conditions, banks' balance sheet position and liquidity channel. The importance of these channels are aptly described under financial friction theory. As the financial stress builds up, the cost of borrowing exerts bindings impact on real economic activities. The financial accelerator theory thereby combines the higher cost of borrowing with lesser investment and hurting growth potential. On the contrary, the economic activities are not impacted by financial sector stress when the level of stress is benign. Bernanke et al. (1998) (*hereafter referred as BGG model*), Carlstrom and Fuerst (1997) proposed the workhorse model of financial friction where the firms with higher debt pays premium while borrowing for fresh investment under stress scenario. The borrowing constraint which creates the wedge between highly leveraged and low leveraged firms, binds only when the financial institutions face stress. Using asset value as collateral, Kiyotaki and Moore (1997) (*hereafter referred as KM model*) explained the relationship between credit constraint and economic growth in financial friction. They highlighted the role of collateral in accessing credits. The collateral constraint is amplified during recession as value of collateral depreciates. The importance of bank lending channel was highlighted in financial accelerator model of Holmström and Tirole (1997). Stein (1998) and Van den Heuvel (2002) provided insight about the role of bank's financial condition in overall credit supply. Another aspect of bank lending channel may arise due to the monetary and macro prudential policy. Lowe and Borio (2004), Goodhart et al. (2004) showed the importance of bank's balance sheet impact due to such policies. Finally, Fisher (1933) described the transmission of bad asset sales and its impact on overall credit supply using liquidity channel. Other noted work on this topic are Diamond and Dybvig (1983) model where he highlighted bank run as a possible mechanism under liquidity channel, impairing the overall credit conditions. Diamond and Rajan (2005) magnified the interaction between bank's health and solvency problem. In this paper, we consider all these three channels towards possible transmission mechanism of financial stress shock. However no conscious is made to disentangle the relative importance of these channels.

This paper also contributed to the empirical literature on financial stress and real economic activities. Empirical evidences of financial shocks impacting real economic activities are also vastly available across literature. Sufi (2005) observed bank's line of credit as significant source of debt financing for the firms. Gan (2007) established the impact of real estate sector stress on the health of domestic banks in Japan. Almeida et al. (2009) analyzed the effect of financial contracting on the behaviour of firm investment during global crisis for the leveraged firms using COMPUSTAT data. Sufi (2009) observed significant moderation of credit line access when the firms' profitability are hit adversely. Ivashina and Scharfstein (2010) found increasing reliance on firm's line of credit at the time of global financial crisis. Paravisini et al. (2011) observed impact of financial crisis on working capital finance. Extending the analysis beyond investments, Benmelech et al. (2011) observed significant impact of liquidity shocks on employment decisions. Acharya et al. (2013) observed that firms facing exogenous liquidity shocks often move out of credit lines at the instance of downgrade.

The third strand of literature where this paper fits in, is financial stress index and its importance in policy making. Drawing experience from the recent financial crisis, the central banks around world started developing financial stress index for assessing the financial market conditions. These financial stress indices were found to have feedback mechanism with real economic activities like GDP growth (Hakkio and Keeton, 2009). The nexus between financial stress and monetary stability is found to be influencing growth prospects (Granville and Mallick, 2009; Sousa, 2010). Castro (2011) observed that financial stress modulates the domestic demand during different phases of business cycle. Highlighting the importance of credit condition, Jermann and Quadrini (2012) observed that the financial stress led to economic downturn due to constrained credit condition.

The remaining of the paper is organized as follows - Section 2 briefly describes the relevant literature, section 3 documents the transmission mechanism and empirical framework. Section 4 focus on data description and stylized facts. The empirical findings are listed in Section 5, followed by concluding remarks in Section 6.

2 Literature Review

In this section, we briefly review the economic literature on this topic, focusing on studies that allow for linear and non-linear relationships between financial stress and the real economy. Illing and Liu (2006), who are among the main studies examining the relationship between financial stress and economic activity, statistically demonstrates that financial stress has devastating effects on economic activity if financial stress deviates by one or two standard errors from its historical average. Although the method used in the study provides the opportunity to compare the current financial stress level and its effects on economic activity with a historical perspective, it has some disadvantages. While standardizing the variables, it is accepted that the financial stress index has a normal distribution and the change in the sample mean and standard deviation with each stress period added to the sample causes the reclassification problem. Another criticism of the method is that the method ignores the specific characteristics and effects of stress events, in other words, assumes all stress events as the same.

As an alternative to this method, the studies utilize the empirical models that examine the relationship between financial stress periods and economic activity. Claessens et al. (2008) examined the relationship between macroeconomics and financial variables during periods of financial stress and economic recession on 21 OECD countries. Their results indicate that economic contractions experienced after high financial stress periods are longer and deeper than those experienced after low stress periods. Hakkio and Keeton (2009) argued that there is a negative relationship between industrial production and financial stress for the US economy and concluded that the negative correlation between the two variables increased in the post-crisis period compared to the pre-crisis period. Davig and Hakkio (2010) examined the interaction between financial stress and the real economy depending on the stress regime in their studies and concluded that the contraction in the real economy is more severe in times of high stress. Elekdağ et al. (2010) examined the relationship between financial stress and economic activity from the perspective of developing countries and revealed the negative effects of financial stress on economic activity as a result of the VAR analysis they applied.

When we look at the studies done specific for Turkey, Çevik et al. (2013) comes into prominence. By using the financial stress index created for Turkey, they look at the relationship between financial stress and economic activity through unrestricted VAR analysis and stated that economic activity displays statistically significant negative responses to financial stress shocks.

In addition to these empirical studies, the number of studies examining the relationship between financial stress and economic activity with nonlinear models has increased in recent years. The basic idea behind this approach is to model the interaction of financial system dynamics with the real economy in multiple equilibrium conditions, depending on the stress regime the economy is in. Hubrich and Tetlow (2012) analyzed the interaction of economic activity with the financial sector through the markov regime switching vector autoregression (MSVAR) model and revealed the sensitivity of economic activity to the change in the financial stress regime. Afonso et al. (2011) examined the relationship between financial stress and macroeconomics through threshold VAR (TVAR) model and concluded that there is a non-linear relationship between economic activity and financial stress and that economic contraction is relatively stronger in high stress periods. Hollo et al. (2012) also come up with different stress regimes for the Eurozone countries with the stress threshold calculated internally by the means of TVAR model.

3 Transmission Mechanism and Empirical Framework

The link between financial stress and real sector of economy can be examined by the macro-financial linkages. The relation between real and financial sector can be drawn from real business cycle models (RBC). As the macroeconomic condition deteriorates due to productivity shock, the household savings are affected adversely resulting in low savings and low investment. Further as economic downturn set pace, the households and firms default leading to Bank's asset-liability mismatch and bank run happens. Hence the financial sector suffers as a result of macroeconomic downturn. Following RBC models, the linkage between financial sector and real sector is, therefore, one-directional. The implications of financial shocks on real sector is drawn from financial friction model. Following the friction literature, any financial shock can impact real economic activities through two major channels - (i) balance sheet effect of borrower and (ii) balance sheet effect of banks and other financial institutions. Apart from these two channels, liquidity channel is another major channel which creates a wedge between credit supply to different firms and households.

Financial friction literature came into prominence by the works of BGG and KM around 1997. These models established significant influence of firm's financing decision, contrary to the view proposed by Modigliani-Miller. The balance sheet effect of the firms and the banks were found to amplify the financial shocks as credit condition worsens. The borrower balance sheet effect is likely to hurt households and firms due to lender's inability to screen borrower's profile, their investment pattern and inability to enforce repayment of debt fully. BGG model proposed costly state verification in RBC model which resulted in borrower's paying higher risk premium at the time of borrowing. The risk premium which varies inversely with the networth of the borrower, provides incentive to the borrowers to undertake risky propositions. In this mechanism, the financial stress will result in devaluation of borrower's networth and thereby restricts credit supply. Another strand of models which deals with the financial linkages with real sector, is Kiyotaki and Moore (1997) model *(hereafter referred as KM model).* Unlike risk premium, KM's model links the borrowing limit with the asset value as collateral. The lenders, in this model, can force the borrower to repay by enforcing a limit to borrowing and that limit is determined by the underlying value of the asset. In case of any adverse shock, the collateral loses value leading to strict borrowing constraint. As credit constraint binds, the borrowers faces lack of credit supply and investment goes down. The feedback mechanism between financial sector and real sector of the economy set pace.

The bank balance sheet channel, on the other hand, focus on the importance of financial health of banks and financial institutions. There are two broad sub-components which can trigger bank balance sheet effect - (i) bank lending channel and (ii) bank capital channel. The traditional bank lending channel links the domino effect of any shock on the liability side and the asset side of the banks. Following Bernanke and Blinder (1988), the bank lending channel can invoke as contractionary monetary policy affect bank's balance sheet from asset and liability side. The bank balance sheet effect can also emerge in case of bank's capital loss. Holmström and Tirole (1997) showed the impact of bank capital on amplification of the effectiveness of bank lending channel as banks use their own capital to finance credit supply. Any credit crunch, therefore, leads to lack of credit supply and as credit supply moderates, the aggregate demand also moderates. Following Stein (1988), capital rich banks takes due diligence to underwrite the borrowers and monitor their loans. Hence the capitalized banks will be able to raise non-deposit funds at relatively lower cost.

Finally, the liquidity channel concentrates on the banks' liquidity condition in addressing credit demand. Following seminal work of Fisher (1933), the banks opt for fire sale of their assets in case of any solvency shocks. The fire sale reduces the asset price which further shrinks banks' assets leading the banks to more asset sales. The bank run model proposed by Diamond and Dybvig (1983), leads to the liquidity channel impact at the event of bank run. On similar lines, Diamond and Rajan (2005) proposed the interaction of liquidity shortage and solvency in case the depositors start asking for deposits back from the banks. Following Brunnermeier and Pedersen (2009), The liquidity channel can be further segregated into funding liquidity and market liquidity components. The funding liquidity impacts the liability side of banks' balance sheet and it depends upon bank's ability to raise new funds by asset sales and net borrowing. The market liquidity component addresses the ease of trading any asset and thereby links the asset side of bank balance sheet.

We combine these three channels of transmission to assess the impact of financial stress using financial stress index, credit supply and real GDP/ consumption growth as endogenous variables. The other endogenous variable is domestic inflation which contains direct impact of financial stress on domestic price movements and indirect proxy of asset prices. The price impact of financial stress can be linked with asset price channel. Elevation in financial stress leads to asset price movements. Baker and Wurgler (2006) observed significant movement in stock prices due to investors' sentiment which are often linked to financial stress. Following long run risk (LRR) framework proposed by Bansal and Yaron (2004), He and Zong (2021) observed financial stress influencing asset prices by inducing consumption volatility and market volatility. While the causality between asset prices and financial stress can be bi-directional in nature, Hakkio and Keeton (2009) observed that financial stress impacts fundamentals of asset prices in statistically significant manner. As the asset price changes in response to the financial stress level, the size of balance sheet changes for the borrowers and lenders. The impact of high financial stress, thereby, is expected to translate into moderation of growth following financial friction mechanism. Further the asset price movements can become inflation in the presence of nominal rigidity. Following Assenza et al. (2010), the cost channel of monetary policy augments the Phillips Curve with asset price. In view of the above mechanisms, we postulate a four variable vector auto-regression model with financial stress, credit supply, inflation and real economic activity to assess the impact of financial stress.

3.1 Threshold VAR Model

Following the financial friction literature, the financial frictions amplifies the economic downturn when the borrowing constraint binds. Higher financial stress is expected to amplify the asset price movements and thereby may result into balance sheet impact. However the same mechanism may not be true for regimes with low financial stress. In particular, low financial stress may not evoke the adverse asset price movements and thereby the financial friction mechanism is likely to be absent. With this background, we rule out the linearity assumption for assessing the impact of financial stress and introduce non-linearity in VAR model. The simplistic VAR model with non-linear trade-off can be achieved using threshold VAR model. The threshold VAR model inhibits multiple different VAR models depending upon the regimes. In a two regime model, the regimes are defined in terms of a threshold variable. When the threshold variable crosses a particular threshold, then the data generating process moves into high regime and VAR model from high regime is used to explain the endogenous interactions among variables. The threshold variable can be endogenous or exogenous in nature. In this paper, we propose to use the level of financial institution stress to determine the regimes. This assumption helps to make intuitive interpretation about the regimes.

Further to the threshold variable, the subjectivity lies with the choice of optimal number of regimes. We follows the extension proposed by Lo and Zivot based on Hansen (1996) approach to determine the optimal number of regimes from the data. We test for linearity vs 2 regimes and linearity vs 3 regimes with optimal lag length of 1 quarter [1]. The optimal number of regimes is found to be 2 from our data. Following the choice of number of regimes, the threshold VAR model for consumption, investment, and real GDP growth can be written in following way where Δ stands for quarter-on-quarter growth.

[1] We consider lag length of 1 following quarterly frequency of our data and to accommodate higher number of regimes

$$\begin{bmatrix} \Delta FISI_t \\ \Delta Credit_t \\ \pi_t \\ \Delta C_t \end{bmatrix} = \begin{cases} \phi_0^L + \Phi_1^L \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta C_{t-1} \end{bmatrix} + \epsilon_t^L & \text{if } FISI_{t-1} < F\bar{I}SI \\ \phi_0^H + \Phi_1^H \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta C_{t-1} \end{bmatrix} + \epsilon_t^H & \text{if } FISI_{t-1} \geq F\bar{I}SI \end{cases}$$

$$\begin{bmatrix} \Delta FISI_t \\ \Delta Credit_t \\ \pi_t \\ \Delta Y_t \end{bmatrix} = \begin{cases} \phi_0^L + \Phi_1^L \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta Y_{t-1} \end{bmatrix} + \epsilon_t^L & \text{if } FISI_{t-1} < F\bar{I}SI \\ \phi_0^H + \Phi_1^H \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta Y_{t-1} \end{bmatrix} + \epsilon_t^H & \text{if } FISI_{t-1} \geq F\bar{I}SI \end{cases}$$

$$\begin{bmatrix} \Delta FISI_t \\ \Delta Credit_t \\ \pi_t \\ \Delta I_t \end{bmatrix} = \begin{cases} \phi_0^L + \Phi_1^L \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta I_{t-1} \end{bmatrix} + \epsilon_t^L & \text{if } FISI_{t-1} < F\bar{I}SI \\ \phi_0^H + \Phi_1^H \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta I_{t-1} \end{bmatrix} + \epsilon_t^H & \text{if } FISI_{t-1} \geq F\bar{I}SI \end{cases}$$

where $FISI_t$ is the financial stress index from Yildirim (2021); $Credit_t$ represents total credit supply to commercial sector; π_t is the consumer inflation proxy by GDP deflator; C_t is the consumption at time t, I_t is the real investment at time t, and Y_t is the real GDP at time t. The threshold VAR model is estimated using conditional least square approach.

As indicated previously, the impact of financial stress is examined using impulse response function. Impulse response analysis in VAR models calculates the expected values of the variables defined in the system in the face of an external shock. In order to describe the effect of shocks, the system must be defined as a vector moving average (VMA) model.

$$Y_t = \mu + \varepsilon_t + \sum_{i=1}^{\infty} \Psi_i(L)\epsilon_{t-i}$$

However, under the regime change, the VMA model cannot be modeled linearly in terms of shocks. Therefore, impulse response analysis should be calculated with the magnitude and direction (whether they are positive or negative) of the shocks as well as the initial period information set. The impulse response function for the non-linear model is conditional on the entire past history of the variables and the size and direction of the shock. To that end, we decide to use the method developed by Balke (2000) that calculates nonlinear generalized impulse-response functions under alternative regimes using bootstrap simulations.

$$IRF_k = E\left[Y_{t+k} \mid \Omega_{t-1}, e_t\right] - E\left[Y_{t+k} \mid \Omega_{t-1}\right]$$

Here, Y_{t+k} is the vector of endogenous variables in the period k and Ω_{t-1} is the information set before the period when the t shock is applied. The formula indicates that the impulse response function depends on the initial conditions and there is no limit on the symmetry of shocks.

3.2 TVAR with Local Projection

One of the major disadvantages of threshold VAR model is that the model parameters increase exponentially as regimes increase. Hence it requires longer history of variables to obtain robust estimate of the parameters. In view of the lack of quarterly data for our analysis, we use local projection approach to estimate the threshold VAR model at different horizons. The local projection estimation of threshold VAR model is done using ordinary least squares for each horizon. An example of TVAR with local projection for consumption is presented in Eq. 1.

$$
\begin{aligned}
\begin{bmatrix} \Delta FISI_{t+k} \\ \Delta Credit_{t+k} \\ \pi_{t+k} \\ \Delta C_{t+k} \end{bmatrix} &= \phi_0^L \mathbf{1}_{FISI<\bar{FSI}} + \phi_1^L \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta C_{t-1} \end{bmatrix} \mathbf{1}_{FISI<\bar{FSI}} \\
&+ \phi_0^H \mathbf{1}_{FISI\geq\bar{FSI}} + \phi_1^H \begin{bmatrix} \Delta FISI_{t-1} \\ \Delta Credit_{t-1} \\ \pi_{t-1} \\ \Delta C_{t-1} \end{bmatrix} \mathbf{1}_{FISI\geq\bar{FSI}} + \epsilon_t \; \forall k = 0, 1, 2, ...H
\end{aligned} \tag{1}
$$

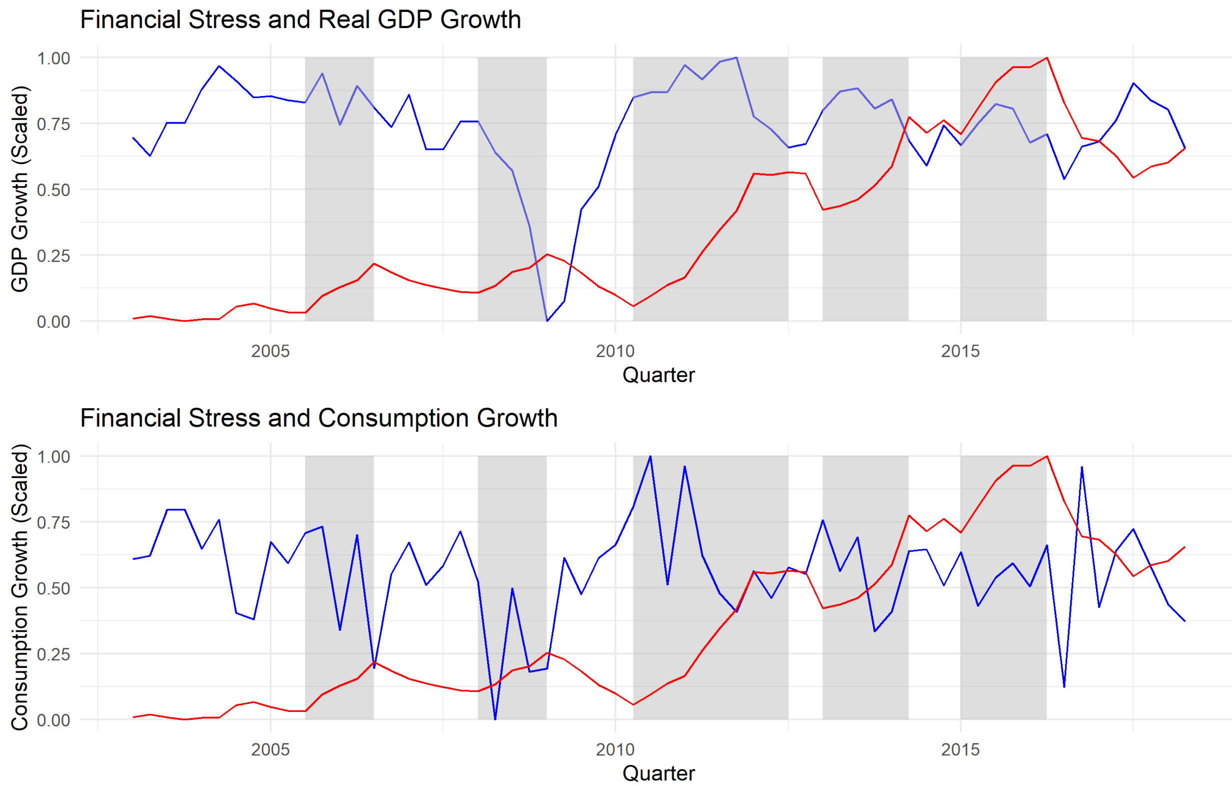
Eq. **??** is estimated for every horizon k (k=0,1,,,,H). In view of the quarterly frequency of our data, we restrict H to 8 quarters.

4 Data and Stylized Facts

We take consumption and real GDP as a measure of economic activity. We obtained the data from Turkish Statistical Institute (TUIK) for the period of 2002:12–2018:03 in quarterly frequency. To measure the financial stress, we use the stress index which we develop by using the Portfolio Theory. The main characteristic of this method that it takes into account the systemic component of stress. The index has a structure that gives more weight to the financial stress that occurs in several sub-markets at the same time as a result of taking time dependent cross-correlations between sub-indices into account when aggregating sub-indices. We also use the credit growth and inflation rate to provide a plausible linkage between the financial stress and economic activity.

The effect of financial stress is visualized on the consumption growth and real GDP growth. Due to possible non-linearity in the trade-off between financial stress and real economy, we analyze the growth pattern different phases of financial stress. The turn around points of financial stress is identified using Harding-Pagan approach for quarterly data. The growth patterns are then analyzed for the phases when financial stress moved from peak to trough and trough to peak. The shaded regions in Figure 1 represents the trough to peak transition of financial stress i.e. these episodes signify the period when financial stress moved from low stress to high stress regimes. The movement in financial stress is represented by red line and the real economy is represented by blue line. The top panel represent GDP growth during these episodes and the bottom panel represents the consumption growth during same episodes. As the stress moved from low to higher level, both GDP growth and consumption growth moderated visibly. This supports our hypothesis of possible non-linearity in the trade-off between financial stress and economic activities. In the next section, we try to establish the differential impact of financial stress on GDP growth and consumption growth using econometric models.

Figure 1: GDP and Consumption growth during financial stress cycle [2]



5 Findings

We use the threshold VAR model on the quarterly data to assess the impact of financial stress on real economy using quarterly data since 2003. For that, the optimal number of thresholds is determined using Hansen test. The threshold variable is considered as level of financial stress with delay of 1 quarter. We built three different models for financial stress impact on real GDP growth, consumption growth, and investment growth. For that, we compare the linear model vs two thresholds and three thresholds for VAR models with lag of 1 and 2 quarters. We restrict our model selection with minimum lag length and minimum number of regimes to ensure robustness in the estimates [3]. Following table 1, we confine our model with 2 regimes and 1 quarter lag value.

[2]The red line represents financial stress level and blue line is consumption growth and real GDP growth. The shaded area denotes turn around point of financial stress.

[3]The parameter space explodes as number of lags and number of regimes increase in a threshold VAR model, resulting in loss of degrees of freedom

Table 1: Threshold determination using LR test

	linear vs 2 regimes	**Linear vs 3 regimes**
	Lag length of 1 quarter	
Test Statistic	71.24*	4215.77***
p-value	(0.08)	(0.00)
	Lag length of 2 quarter	
Test Statistic	108.28***	4178.01***
p-value	(0.00)	(0.00)

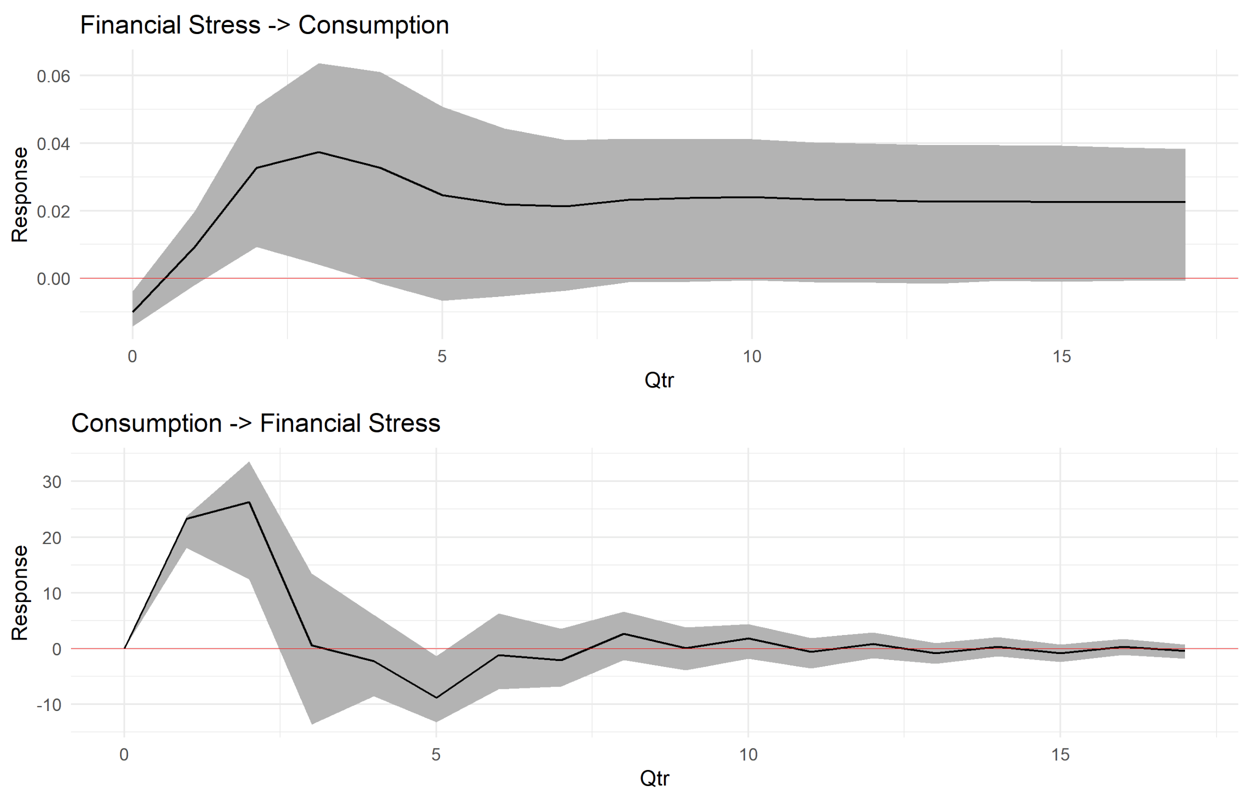
With the model selection, the parameters of endogenous variables were estimated for the two regimes (*We call these two regimes as high and low regime*). The threshold value of financial stress level was found to be 0.03 [4]. We start with the consumption and investment impact first since the friction channel of financial stress impacts the real economy through consumption and investment growth. Towards the end of the findings, we also focus on the overall impact of financial stress on real GDP growth.

To understand the impact of the financial stress, we analyze the impulse responses by giving one standard deviation shock on the change of financial stress and consumption growth in high stress and low stress regimes. The first set of responses, drawn on consumption growth and financial stress growth, reveals the dynamics between economic growth and stress in low stress regimes. Figure 2 illustrates the response of consumption growth and financial stress on each other in a low stress regime. This response functions provide us insight about the possible feedback mechanism happening between financial;l stress and consumption growth. When the overall stress level is low, the consumption growth appears to increase as financial stress increases and the effect is found to be statistically significant at 95% confidence. On

[4] The threshold of financial stress index corresponds to scaled value of financial stress index. The scaling of financial stress index is done using Z-score of FISI index value over time

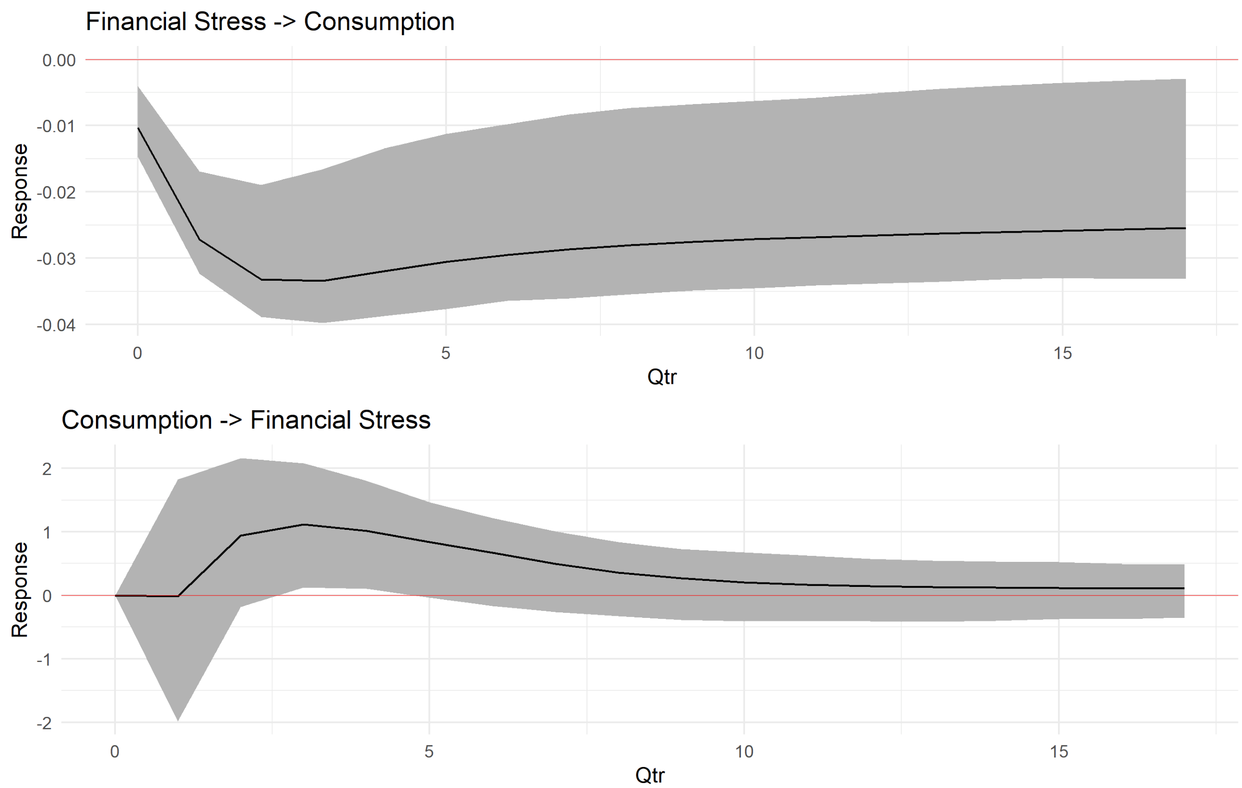
the other hand, increase in consumption growth appears to be elevating the stress level. The effect of financial stress shock influences consumption growth for at least 5 quarters whereas the effect of consumption growth is much short lived. This phenomenon follows a typical business cycle model where higher financial stress does not impede real economic activities as the overall stress level remains low. The financial friction mechanism remains absent in this process as the borrowing constraint does not bind.

Figure 2: Impulse response from TVAR for lower regime



Contrary to low stress regime, the impact of financial stress on higher regime imparts contractionary effect on consumption growth and the effect stays for longer period of time. When the consumption shock is applied during high stress regime, the financial stress elevates further and the effect is statistically significant after 3 quarters of lag (refer to Figure 3). The contraction in consumption due to high financial stress is justified through the lens of financial friction models when the stress level is already high. Higher financial stress indices the financial institutions to provide strict borrowing constraint. As the borrowing constraint binds, the financial friction kicks in, moderating the consumption growth.

Figure 3: Impulse response from TVAR for upper regime



Next, we move to the forecast error variance decomposition in the high stress and low stress regime for consumption growth and financial stress. The forecast error of consumption growth is contributed by the financial stress significant extent over different forecast horizons when the stress level is already high. In fact, the contribution of financial stress outpaces the contribution of credit growth and inflation, implying the dominant effect of binding constraint during the high stress regime (refer to Figure 4) [5]. On the contrary, the dominance of financial stress on consumption growth is lost when the financial stress level is relatively lower. Credit supply appears to be the dominant factor contributing to higher stress level during low stress regime. Shifting to forecast error variance of financial stress, the effects of consumption growth and credit growth is noticeable when the stress level is higher. Similar phenomenon is absent when the stress is lower. This findings corroborates with the credit channel effect of financial friction models (refer to Figure 5). The lingering effect of financial stress on consumption growth implies that binding nature of the borrowing constraint remains effective as higher stress forces financial institutions to maintain strict borrowing constraint.

[5]Here we focus on the contribution of the endogenous variables excluding self impact of consumption lags

Figure 4: Forecast Error Variance Decomposition of Consumption Growth

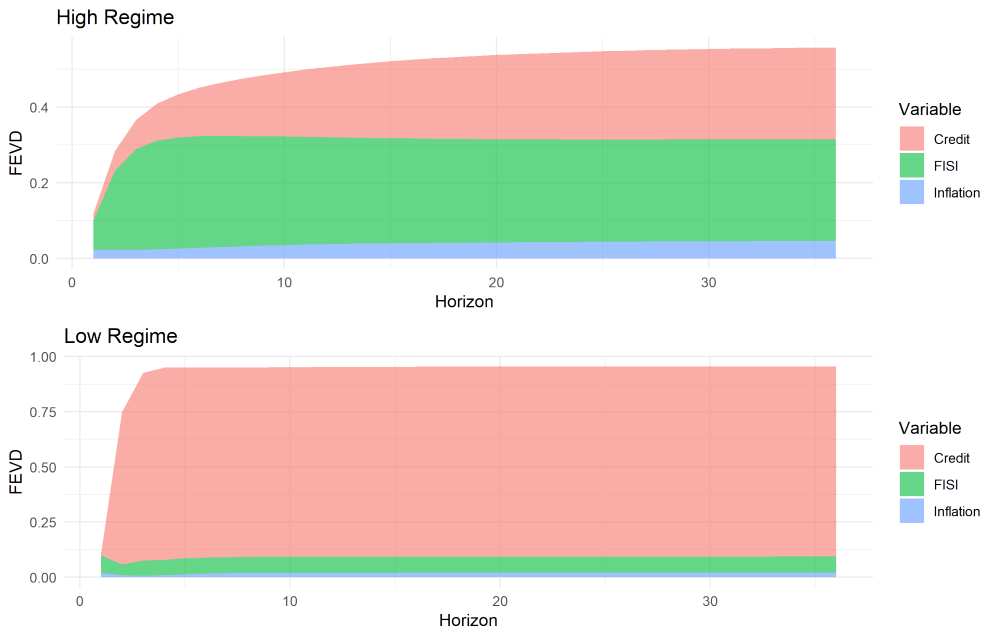
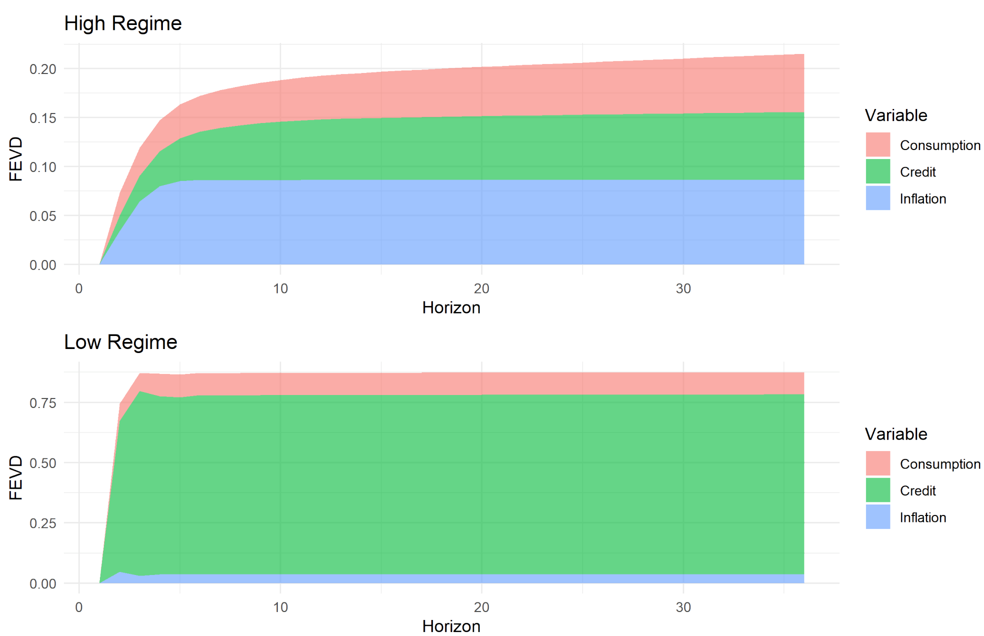


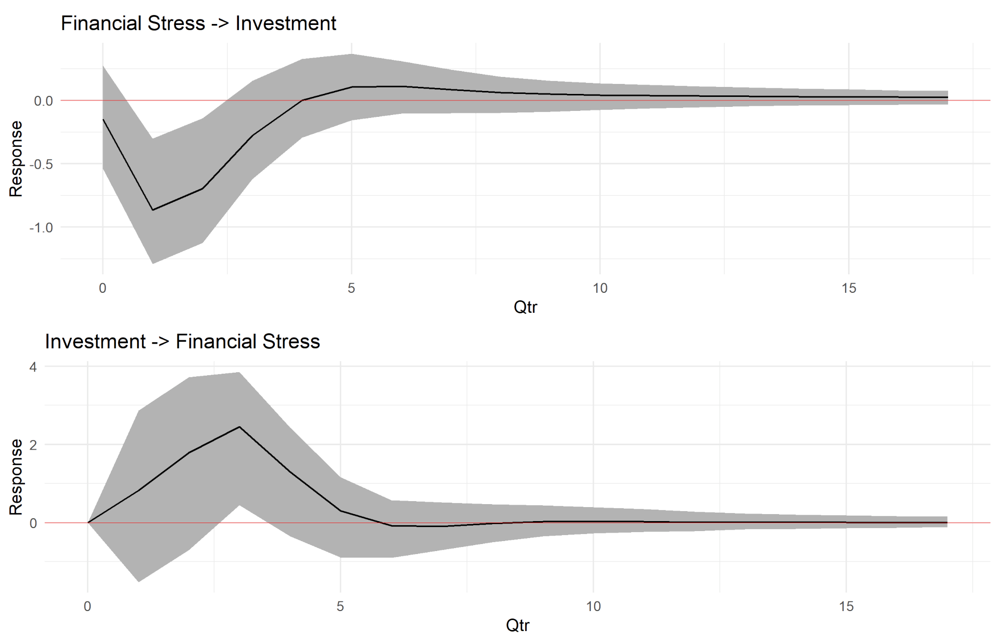
Figure 5: Forecast Error Variance Decomposition of Financial Stress



We conduct similar analysis on investment growth also. The model selection criteria remains same as before. The impact of financial stress is analyzed using impulse response function analysis and forecast error variance decomposition. As indicated previously, the impulse response plots (refer to Figure 6 for lower regime and Figure 7 for higher regime) represent the response of investment growth and change in Financial stress in response to one standard deviation shock on financial stress and investment growth respectively. The impact of financial stress hurts investment growth adversely when the financial stress level is already high. On the other hand, the impact of higher investment growth increases financial stress further but with a lag of 3-4 quarters during high stress regime.

Figure 6: Impulse response from TVAR for lower regime

Figure 7: Impulse response from TVAR for upper regime



The forecast error variance decomposition of investment growth displays similar pattern like consumption growth. The contribution of financial stress is found to be significantly higher in high stress regime. On the other hand, credit growth dominates the forecast error of investment growth during lower stress regime (refer to Figure 8). Similar pattern is also observed in financial stress index (refer to Figure 9).

Figure 8: Forecast Error Variance Decomposition of Investment Growth

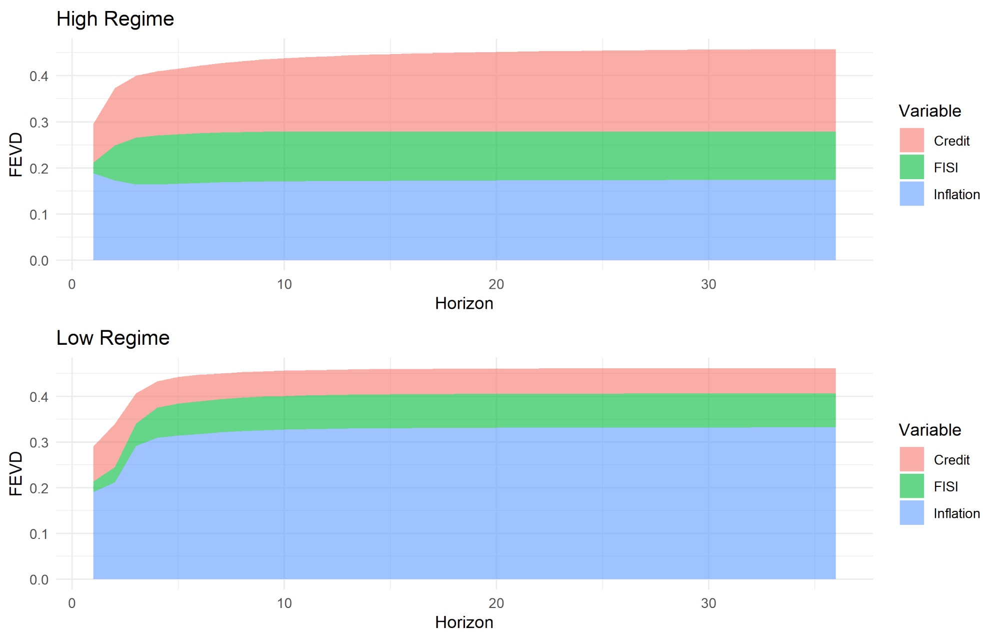
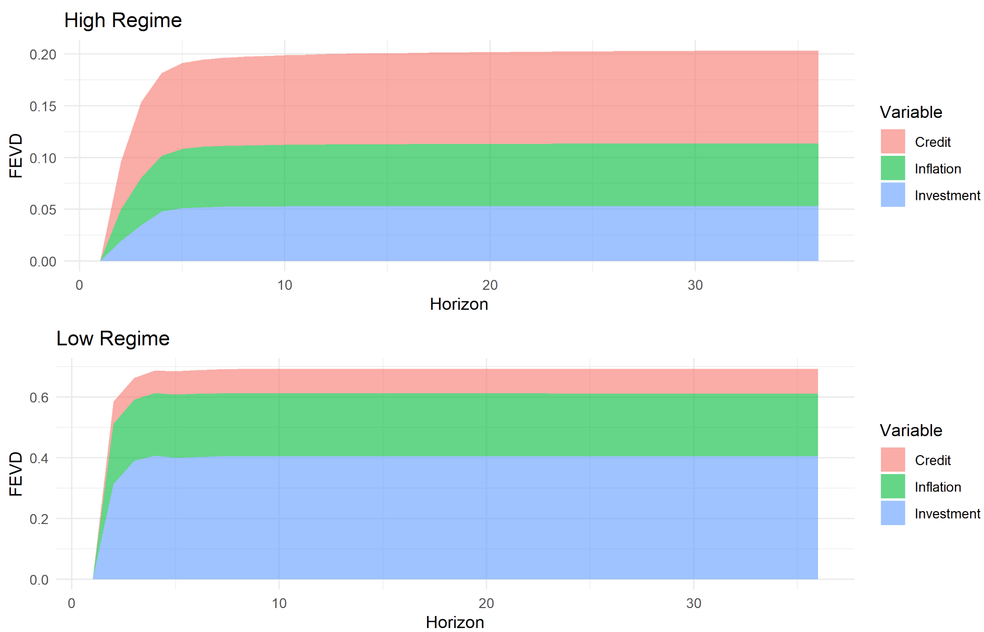


Figure 9: Forecast Error Variance Decomposition of Financial Stress



Lastly, we analyze the effect of financial stress on real GDP growth. The VAR structure remains same as before, we only replace the consumption growth by real GDP growth. The threshold level is determined and the impulse responses are derived for low and high financial stress regimes (refer to Figure 10 for low regime and Figure 11 for high stress regime). Real GDP growth is found to be impacted positively in response of increase in financial stress level during low financial stress regime. The opposite happens during the high stress regime when the GDP growth contracts in response of higher financial stress. The explanation of GDP growth response highlights the importance of financial friction during the high stress regime. The effect of GDP growth increases financial stress in low and high risk regimes.

Figure 10: Impulse response from TVAR for lower regime

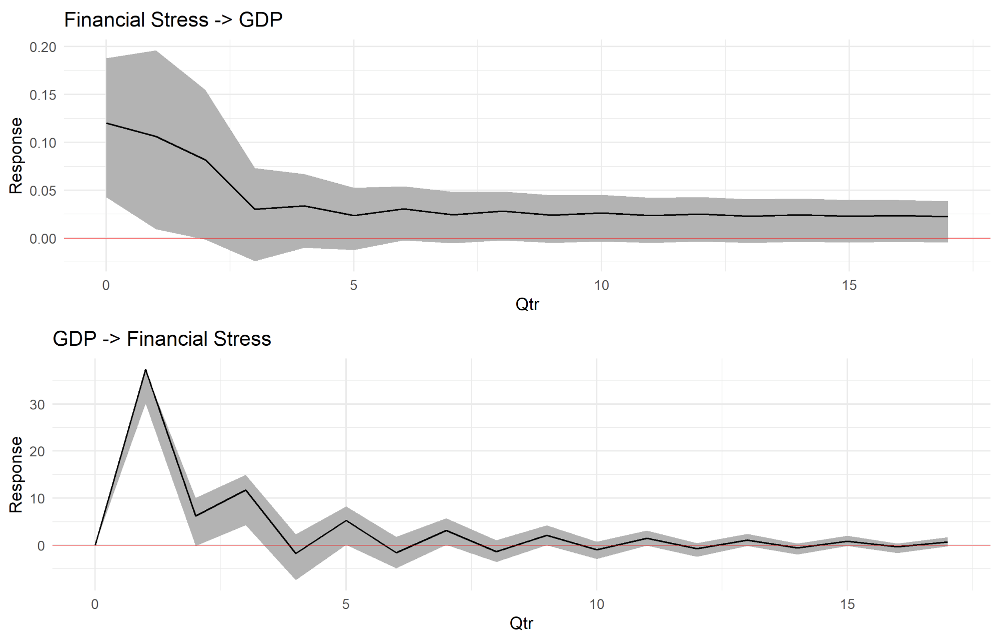
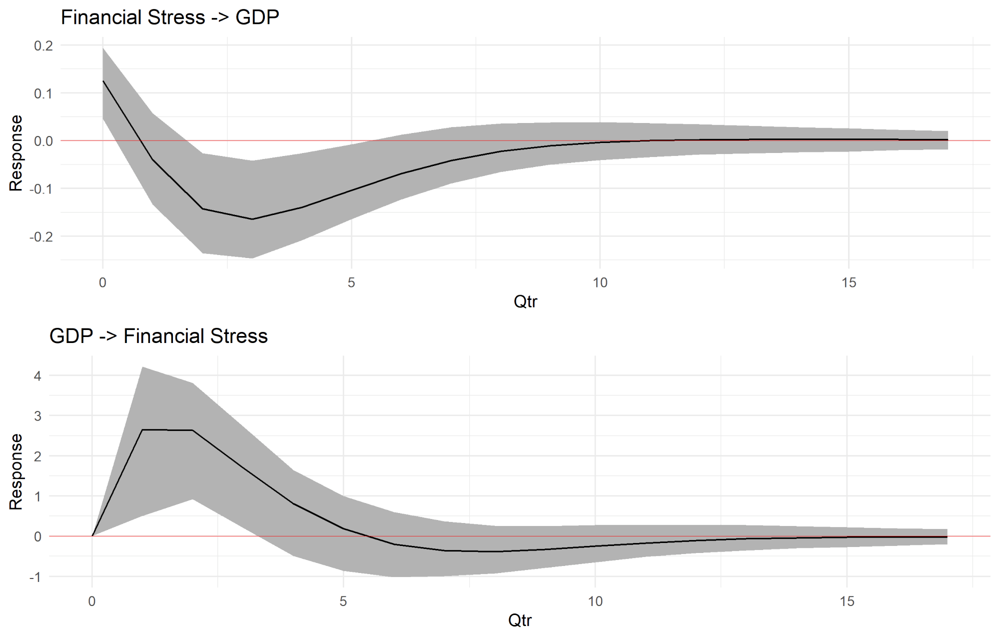


Figure 11: Impulse response from TVAR for upper regime



The forecast error decomposition of real GDP growth underlines the impact of financial stress on real growth of economy but the effect is more dominant during higher stress regime. Following the impact of financial stress on consumption and investment growth, the pattern appears to be self-explanatory. However unlike other components of GDP, the contribution of domestic inflation also remains dominant on GDP growth during higher stress regime (refer to Figure 12). On the other hand, forecast error of financial stress is contributed by GDP growth, credit supply and inflation over longer horizon when the stress is already at elevated level. On the other hand, real GDP growth dominates the movement of financial stress during low stress regime (refer to Figure 13).

Figure 12: Forecast Error Variance Decomposition of GDP Growth

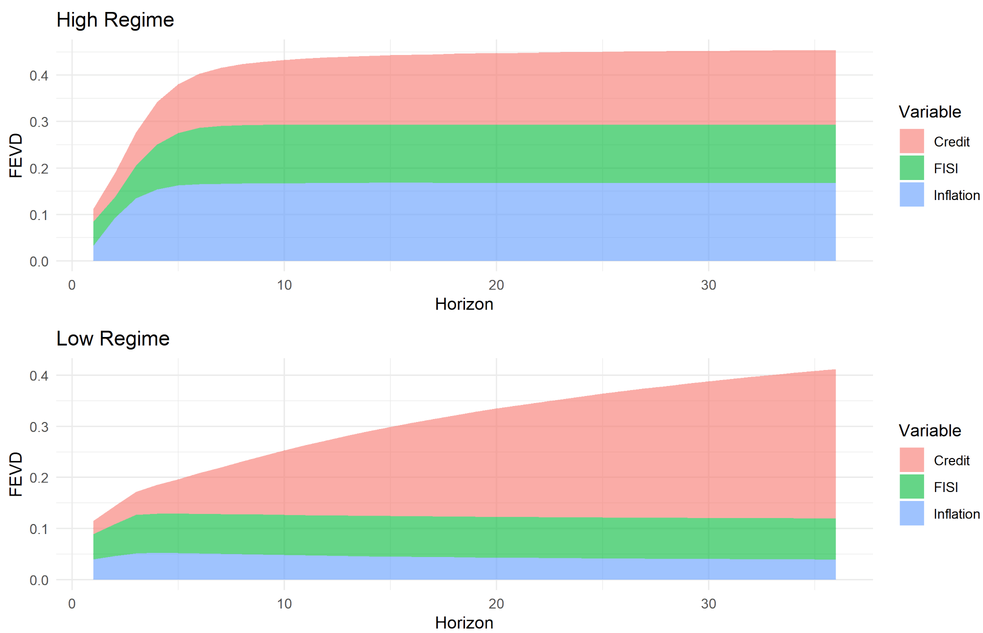
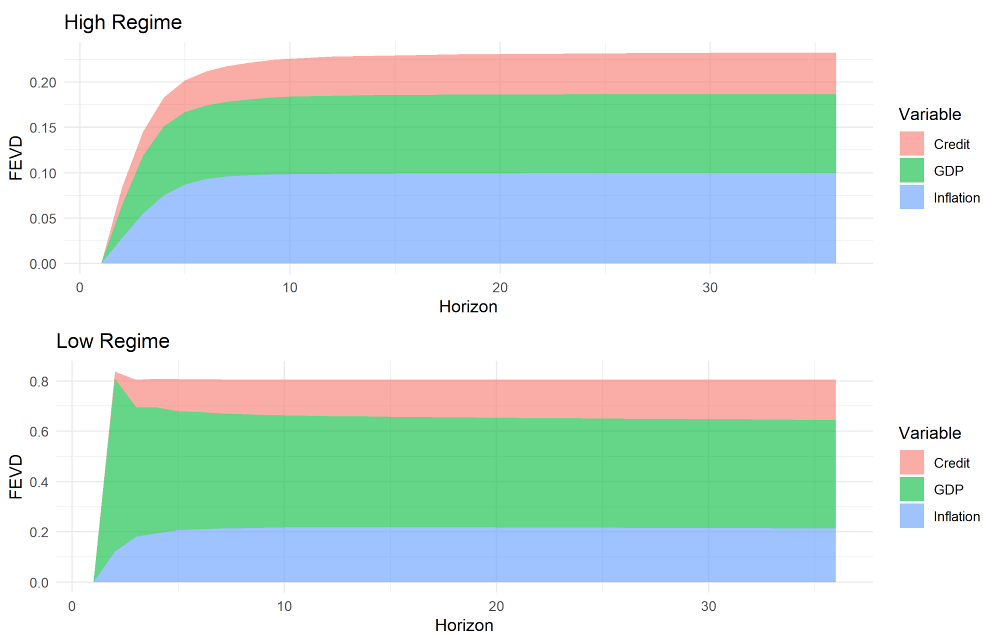


Figure 13: Forecast Error Variance Decomposition of Financial Stress



6 Robustness

In this section, we present the findings of threshold VAR estimates using local projection method. We estimate threshold level using Markov Switching model on financial stress and apply local projection method on threshold estimates. The estimation code of threshold VAR using the local projection (LP) method broadly follows Stock and Watson (2018) as well as Miranda and Agrippino (2021) using the threshold value from the Markov switching model. The basic idea behind local projections, as proposed by Jordà (2005), is to estimate the impulse responses separately at each horizon by a direct regression of the future outcome on current covariates opposite to the standard VAR models which estimates the impulse responses with respect to the a recursive orthogonalization of the reduced-form forecast errors. The benefit of using LP method is that it does not assume any structural assumption among the endogenous variables. However one of the major disadvantages of LP approach is that different parameter estimates for different horizons are based on the different number of data points. The impulse responses are derived from LP estimates for values above and below threshold. Here we present the parametric impulse responses for both regime in the case of consumption and real GDP [6].

The impulse response of LP estimates corroborates with the classical estimation. These impulse responses corresponds to 1 unit of positive shock on financial stress (compared to 1 standard deviation shock in previous analysis). Following Figure 14 for consumption effect, we observe that the consumption growth increases as financial stress remains low. The effect is contractionary in high stress regimes. Further the effect of financial stress appears to drag consumption growth till 4 quarters in higher stress regime. Similarly, the effect of financial stress on real GDP growth is found to be negative in high stress regime as seen in the threshold VAR model.

[6] We applied the non-parametric approach for estimating the impulse response function using wild bootstrap of residuals and the results are found to be in similar lines

Figure 14: Impulse response from TVAR for consumption

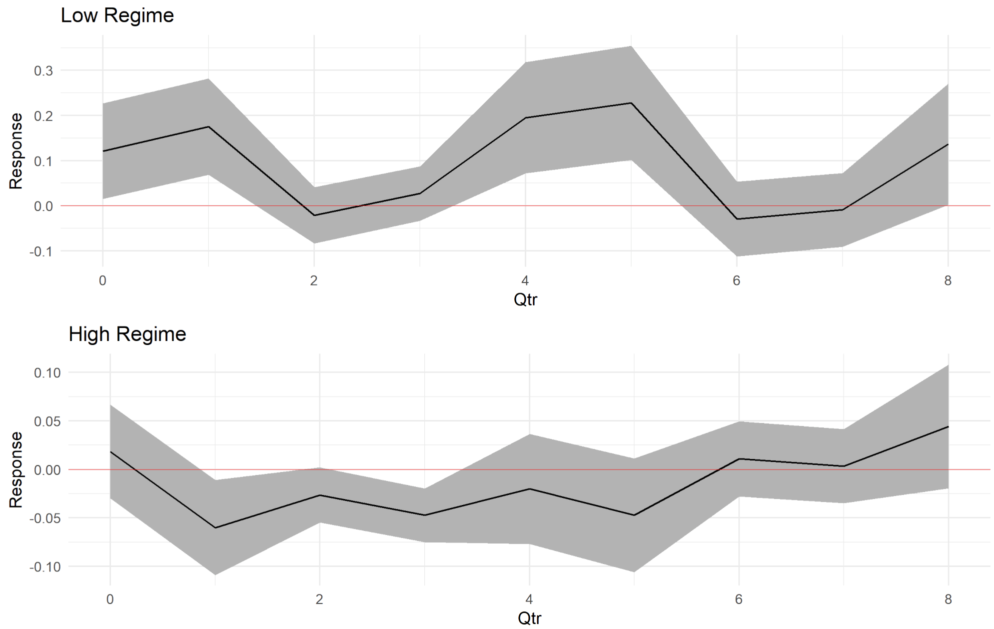
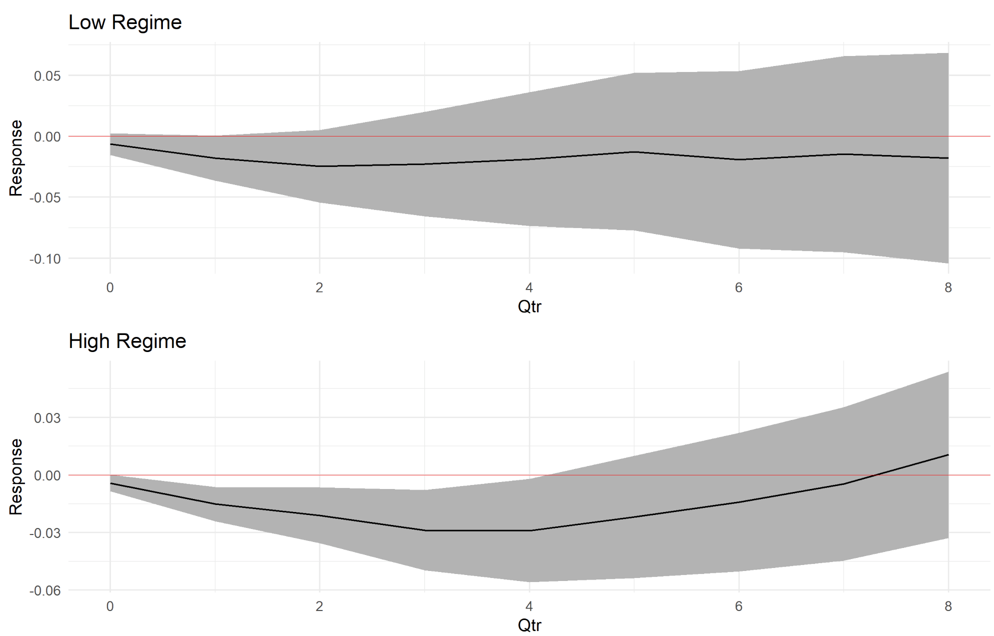


Figure 15: Impulse response from TVAR for real GDP



7 Concluding Remarks

The financial crisis, which emerged in the economies of developed countries in 2008 and spread to developing countries, once again proved the depth of the relationship between the financial sector and real economy. Therefore, we investigate the nonlinear impact of financial stress on economic activity by looking at consumption, investment, and real GDP responses to the financial stress shocks.

To that end, we start with the assumption that the effects of exogenous shocks on economic activity in upper stress periods may be reverse and significant relative to the lower stress periods. For this purpose, we utilize TVAR estimation which was developed to examine non-linear relationships, including regime changes, multiple equilibria, and asymmetric responses to shocks.

In the first stage of the TVAR estimation, we test whether there is a threshold effect in the relationship between financial stress and economic activity. After finding the presence of the threshold effect, the TVAR method calculates the threshold stress value internally. Then, we present the nonlinear impulse-response functions of consumption and real GDP depending on whether the economy is in a lower or upper stress period.

We find that the impact of financial stress on real GDP is insignificant for all horizons due to the not having financial frictions. However, the impact is significant and negative in the upper stress regime.

According to the main findings of this study, stress arising in financial markets can have a nonlinear impact on economic activity. Our results also support the RBC model propositions stating that financial variables have no impact on real activity in the case of no financial frictions. In this respect, we conclude that it would be more accurate to examine the effect of financial stress on economic activity depending on the stress regime.

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