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RESEARCH PAPER

Economic Dynamics during Periods of Financial Stress: Evidence from Iran

Abolfazl Shahabadi[a], Samineh Qasemifar[a,*], Masoume Shafieian[a]
a. Department of Economics, Faculty of Social Sciences and Economics, Alzahra University, Tehran, Iran
* Corresponding author, E-mail: s.ghasemifar@alzahra.ac.ir

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Abstract
The dynamic correlation between financial crises and declining economic activities progressively mandated analysts to distinguish the creating factors of financial instabilities and study their effects on the real economy. In some years of the last decade, Iran's economy has been encountering, on the one hand, sharp currency fluctuations and banking crises in the financial market sector and on the other hand, negative economic growth in the real sector of the economy. The objective of this study is to investigate the effects of financial stress on macroeconomic variables. The systemic stress index of Iran from (2008: 11 to 2020: 03) has been estimated using the basic portfolio theory. We have used an MSBVAR (Markov-Switching Bayesian Vector Autoregression Models) approach to analyze the effects of the financial stress index innovation on macroeconomic variables, our results show that the effect of financial stress innovation on economic growth, in low financial stress is negative and low, however in high financial stress, the variables reveal a strong negative reaction to financial stress. So the financial stress index can be utilized to gauge the solidness of the financial sector of Iran.
Keywords: Basic Portfolio Theory, Economic Growth, Financial Stress, Innovation, MSBVAR Approach, Systemic Stress.
JEL Classification: G01, G11, G12, C11, O40, O31, E60.

1. Introduction
Coinciding high currency crises with the frequent collapse of the stock market along with the atmosphere of stagflation in the economy of developing countries has drawn more attention to analyzing the proper performance of financial markets in these countries. Primary empirical studies on the financial stress index, the relationship between widespread financial instability, and macroeconomic variables show that economic growth influenced by financial stress has had a decreasing trend, generally (Cevik et al., 2013; Hollo et al., 2012; Illing and Liu, 2006).
In some studies, two behavioral regimes have been considered for financial stress and real macroeconomic variables respond differently to the innovation of

financial stress in two regimes of high and low financial stress (Abura and Van Roy, 2017; Cambón and Estévez, 2016; Hubrich and Tetlow, 2015; Miglietta and Venditti, 2019; Stona et al., 2018).

Domestic studies in the field of financial stress, however, have taken a simpler approach. The financial stress index in these studies has been formed using a limited number of financial market determinants, and finally, only the analysis of financial stress effects on economic growth has been considered (Dargahi and Nikjoo, 2012; Heydarian et al., 2019; Kordloui and Asaei, 2015). It should be noted that in economies where the capital market has not yet developed properly, the most basic part of a financial market is related to the intermediary sector or the banking market. In addition to the banking sector, the foreign exchange market, especially in developing countries with a single product and inefficient banking system, is another important part of the financial market. In the last decade, Iran's financial market has faced high instability in the foreign exchange market, capital market, and banking sector, which has affected the real sector of Iran's economy. Therefore, an index should be calculated that can identify and predict the extent of instability and fluctuations in the financial market and its impact on the real sector of the economy. In 2012, Iran's economy faced a high inflationary recession which was the result of issues like: depleting the effects of expansionary fiscal and monetary policies since 2006 without accompanying the entire economy's supply, repeated increases in exchange rates, intensification of international trade, and financial sanctions. According to the annual reports of the Central Bank, the country's economic growth reached -5.8 that year and the inflation rate was announced at 30.5%. In addition, the stock exchange index in August 2012 also decreased to 8.2%; after this date, it started an upward trend, and sharp fluctuations were observed in the stock exchange index. The coincidence of these financial and monetary events with the stagflation in 2012 is a strong reason to study the effects of financial stress in the macroeconomic context. In the recent decade, specifically in the years 2012 and 2018, foreign exchange and stock market fluctuations and critical trends in bank ratios -including ratios of banks' debt to the central bank which were increasing from 2008 to 2019, and growing debt ratios since June 2018, after the US withdraw "Joint Comprehensive Plan of Action" agreement- along with negative economic growth have been observed. The following questions will be answered: 1- Does the increase in currency fluctuations have a positive impact on the financial stress index? 2- Whether or not the short-term effects of financial stress innovations on economic growth are different in high and low financial stress regimes?

The objective of this study is to investigate the effects of financial stress on macroeconomic variables. Our contribution is in analyzing the macroeconomics effects of the financial stress innovation on economic growth and -in detail- on the

determinants of economic growth, including investment and total factor productivity using the Bayesian nonlinear approach. The present study is organized into five sections. In Section 2, we will have an overview of experimental and theoretical literature. Section 3 describes the model methodology and econometric approaches. Section 4 shows the estimated financial stress index and its compliance with the realities of Iran's economy, in this Section we analyze the effects of financial stress innovation on economic growth. Finally, Section 5 provides conclusions and policy recommendations.

2. Literature Review

After the global financial crises of the 1980s and 1990s, policymakers began exploring indicators that could predict the events of financial stress. The first financial stress index developed by Illing and Liu (2006) to examine systemic risk in Canada consisted of banking, currency, bond, and stock market variables, where they were combined using a variety of weighting methods, namely static factor analysis, weighing equal to variance and transforming variables based on their cumulative distribution. Other studies that have systematically assessed financial stress include: Hollo et al., 2012; Huotari, 2015; Johansson and Bonthron, 2013; Miglietta and Venditti, 2019; and The Spanish Bank, 2013.

In addition to calculating the financial stress index for developed countries, efforts have also been made in emerging countries to build a financial stress index, including Cevik et al., 2013; Dahalan et al., 2016; El Shal, 2012; Ishrakieh et al., 2020. In Iran, studies have been conducted to measure financial stress. For the first time, Dargahi and Nikjoo (2012) designed a financial stress index for Iran's financial market. Fallahpour et al. (2019) also calculated the systemic stress index for the first time.

The financial sector may influence the real economy in multiple distinctive ways. First, it is conceivable to watch how firms will make decisions to contribute to confronting vulnerability, following the approach of the Real Options Model pointed out by Bernanke (1983). In explaining this theory, the impact of financial tension can be caught on as a time of precariousness, which can influence agents' ventures and create impacts both in legislative arrangements and in financial cycles. Second, firms can be influenced by financial turbulence in terms of the restricted conceivable outcomes to borrow, producing assist restrictions in the credit market, as proposed by the accelerator financial model in Bernanke et al. (1999) and Davig and Hakkio (2010). In scenes of severe financial stress, firms waver to contribute or are hesitant to enlist new workers. This impact is in some cases called the "wait-and-see effect" (Bloom, 2009). With expanded instability from pressures within the financial market or with the increment in hazard change

in a particular industry, most delicate financial conditions influence adjust sheets and, thus, the capacity to get credit. Third, Banks will at that point increment the outside monetary premium, dreading that numerous firms will break. Banks are more cautious about loans since they increment credit measures (Bonciani and van Roye, 2016). This way can be summarized as a credit supply impact. This circumstance will in turn diminish investments and generation companies, creating modern instabilities and possibly expanding the harm to macroeconomic fundamentals. The last way, severe financial stress leads to higher financing costs in the private sector due to the impact of interest rate spreads and changing liquidity premia (Gilchrist and Zakrajsek, 2012).

From the experimental perspective, a vital piece of study has been composed concerning the transmission channels from the financial circle to the real circle. Some studies have revealed the effects of financial market disturbances on macroeconomic variables Bernanke and Gertler (1989), Kiyotaki and Moore (1997), and Bernanke et al. (1999). The negative effects of severe financial stress on macroeconomic determinants of countries have also been studied in some studies (see Aboura and Van Roye, 2017; Bloom, 2009; Baker et al., 2012; Cambón and Estévez, 2016; Hakkio and Keeton, 2009; Hollo et al., 2012; van Roye, 2014; Kliesen and Smith, 2010; Stona et al., 2018).

In the classification of financial stress studies in Iran, some studies have only calculated financial stress (Matoufi, 2015; Kordloui and Taheri 2016). Some other studies have measured the effects of financial stress on economic growth with the help of the VAR approach (Dargahi and Nikjoo, 2012; Khazalipour and Ranjbar, 2015; Heidarian et al., 2020; Fallahpour et al., 2020). In the research of Dargahi and Nikjoo (2012), the main determinants of financial stress are related to the money and credit market with a focus on the banking sector, meaning that the banking sector and the money market are considered one. Khazalipour and Ranjbar (2015) researched about three distinct stress indicators have been created from three financial market segments. Matoufi (2015) stated that financial stress in capital market has been introduced as a sharp decrease in the total stock market index. Heidarian et al. (2019), from only three financial market segments; The banking sector, the stock market and the foreign exchange sector have calculated the financial stress index. Shaghaghi et al. (2019) also estimated the financial stress uncertainty index instead of the usual financial stress index.

The present study tries to estimate a comprehensive financial stress index in terms of all parts of the financial system by considering domestic and foreign studies of financial stress and utilizing econometric knowledge. Carefully separating the main parts of the financial system according to the theoretical and experimental literature and adding new determinants of financial stress index, despite the limited access to data, this study has a significant contribution in

improving the estimated financial stress indicators in Iran. Most domestic studies have used only two or three parts of the financial system to calculate financial stress. Also, aspect of critical changes in the derivatives market for estimating the financial stress index, is another strength of the research compared to domestic studies. In addition, the determinants of stress in the intermediate market, including the banking sector, have been selected according to the empirical basis and the realities of Iran's economy, which is another contribution in the field of financial stress estimation.

After introducing the determinants of financial stress, to investigate the effects of financial stress on the real sector of the economy, periods with high and low financial stress (normal state of the economy) are identified in the MSBVAR model. To perform this step, it is assumed that financial stress is dependent on the State because financial instability is essentially an event that occurs rarely, so based on an empirical basis, it is assumed that there are only two regimes. This model is very suitable for non-linear relationships between variables and it can detect sudden changes in the financial behavior of financial variables. Moreover, the first generation of endogenous growth models has been used to study the effects of financial stress shocks on economic growth .

To further explain the effects of financial stress on economic growth, Queralto's (2020) approach is used and the production function is specified as a Cub-Douglas:

$$y_t = A_t k_{t-1}^{\alpha} l_t^{1-\alpha} \tag{1}$$

where Y denotes Economic growth, k illustrates the total capital of the previous period, and l represents Labor force; one of the risk sources in this model enters through the level of technology or total productivity of factors of production; A. After the logarithm operation of the Equation 1, Equation 2 is obtained:

$$lny_t = lnA_t + \alpha lnK_{t-1} + (1-\alpha) lnL_t \tag{2}$$

By describing the dynamics of A in Equations 3 and 4 and substituting them in Equation 2, the Equation 5 is obtained:

$$A_t = e^{a_t} \tag{3}$$

$$\boldsymbol{a_t = \rho_a a_{t-1} + \varepsilon_t^a} \tag{4}$$

$$\boldsymbol{lny_t = a_t + \alpha lnK_{t-1} + (1-\alpha) lnL_t} \tag{5}$$

$$\boldsymbol{lny_t = \rho_a a_{t-1} + \varepsilon_t^a + \alpha lnK_{t-1} + (1-\alpha) lnL_t} \tag{6}$$

ε_t^a is identified as a technology shock and one of the transmitting sources of a financial shock to the economic growth model. This technology shock can be a shock to financial instability or financial stress (Paul et al., 2020).

3. Methodology

The systemic stress index is constructed by selecting the main components of financial stress in the sectors of the financial system (money market, bond market, foreign exchange market, stock market, and derivatives market). The advantage of this approach over other approaches to financial stress index aggregation is that portfolio theory - in addition to considering the correlation between financial market components - considers the weight of each sector in proportion to the impact of that sector on the growth of domestic production. After examining the main financial determinants, principle variables are standardized for the systemic stress index. In the systemic stress index estimation method, each variable is aggregated in the sub-index related to itself. To calculate the weight (w) according to the approach of Hollo et al. (2012), each financial market segment in the systemic stress index, a VAR model is designed to measure the effect of each of the six financial sector markets on GDP. Also, to estimate the effects of financial stress on the economy and consider the change in behavior of the financial stress variable over time, the Bayesian Markovian Switching Vector Autoregressive Model (MS-VAR), as developed by Sims et al. (2008) has been adopted in this study. We identified the appropriate endogenous growth models; then MS-VAR technique by Hamilton (1989), was introduced in business cycle analysis. This model, considering the behavioral regimes of variables, provides a cost-effective feature for examining macroeconomic conditions during economic periods. According to the research hypotheses, it is very important to study and analyze the impulse response functions of these models. The Bayesian approach is also very suitable for estimating models with many parameters and models with complex forms of impulse response functions, which are difficult to estimate using classical algorithms.

3.1 Data Collection

We have collected monthly data of variables from 2008 to 2019 (Equation 7); in addition, the article of Ghasemifar et al. (2021) has been used in selecting the variables of the banking sector. Accordingly, details of the variables are given in Table 1 in the appendix:

$$Stress_t = f\begin{pmatrix} YSP_1.BIR_t.OIV.YSP_2.ERV.FC.\beta_t.BV_t \\ .DBD_t.FD_t.NPL_t \end{pmatrix} \quad (7)$$

3.2 Markov-Switching Bayesian Vector Autoregressive Model

Initially, periods of high and low financial stress are defined in the model. To do this, it is necessary to assume that financial stress is state-dependent. This is because financial instability is essentially an event that occurs infrequently and is assumed to be empirically based on only two regimes. In particular, it is assumed that sudden and accidental financial stresses occur with certain stability in each regime. The MSBVAR model of Sims et al. (2008) was used to identify regimes with high and low financial stress. According to the model described in the previous section, this model is very suitable for the space of nonlinear relationships between variables, because it can detect changes in the sudden behavior of financial variables well. To investigate the effects of financial stress shocks on economic growth, endogenous economic growth models have been used. According to this theory, one of the sources of financial shock transmission to economic growth is through total factor productivity (Paul et al., 2020). The model includes five endogenous variables: GDP logarithm (GDP), total factor productivity logarithm (TFP), investment logarithm (K), labor logarithm (L), and Iran financial stress index (Stress).

According to the research of Sims et al. (2008), the model is designed as Equation 9,

$$\acute{\boldsymbol{y}}_{\boldsymbol{t}}\boldsymbol{A_0}(\boldsymbol{s_t}) = \sum_{\boldsymbol{i=1}}^{\boldsymbol{\rho}} \acute{\boldsymbol{y}}_{\boldsymbol{t-i}}\,\boldsymbol{A_i}(\boldsymbol{s_t}) + \acute{\boldsymbol{z}}_{\boldsymbol{t}}\boldsymbol{C}(\boldsymbol{s_t}) + \acute{\boldsymbol{\varepsilon}}_{\boldsymbol{t}}\boldsymbol{\theta^{-1}}(\boldsymbol{s_t}) \quad \mathbf{t = 1 \ldots . T} \tag{9}$$

$$y_t = [LGDP_t, LTFP_t, LK_t, LL_t, Stress_t]$$

where y_t is a Five-dimensional column vector of endogenous variables; A_0 denotes coefficients of variables' matrix; s_t shows the states which are not observed at time t; ρ is the length of intervals; $\varepsilon_t \sim (0, \sigma^2)$ involves the process of shocks. In this study, two regimes are considered, $s_t = 1, 2$. In addition, Z_t is an index matrix with values of one representing a column vector of constants. $C(s_t)$ is m*n intercept matrix. θ, the diagonal matrix of factor loading that measures random fluctuations on the invisible shock vector.

Regime change is estimated by the Markov process for the first time. The Markov chain shows the probabilities of transfer: $p(s_t = j | s_{t-1} = i) = p_{ij}; p_{11} + p_{12} = 1,\ p_{21} + p_{22} = 1$. After determining the transfer probability matrix, the Bayesian technique is applied to estimate the model parameters. The model parameters $\hat{\theta} = (\hat{\varphi}_1, \hat{\varphi}_2)$ depend on non-observable regimes in the nonlinear

approach. Specifically in this study, the likelihood function $p(y_t|Z_t,\theta,w)$ is evaluated by calculating the conditional probability function at time t:

$$p\left(y_t\,|Y_{t-1},Z_t,\theta,w,s_t\right) \tag{10}$$

Equation 10 is conditional on the vector of exogenous variables. The likelihood function is also defined as Equation 11:

$$p(Y_T|Z_T.\theta.w.s_t) = \prod_n \left[\sum_{s_t\in H} p(y_t|Y_{t-1}.Z_t..\theta.w.s_t)\,p(s_t|Y_{t-1}.Z_{t-1}..\theta.w)\right] \tag{11}$$

3.2 Estimation of Financial Stress Index

The results of the analysis of variance obtained from the VAR model give the approximate weight of each section. The money market is 3.84%, the securities and derivatives market is 10.41%, the intermediary market is 25%, the foreign exchange market is 59.40%, Islamic treasury securities market is 1.24%. The standardization of variables in each financial market subset is done once by the cumulative distribution function and once by the recursive cumulative distribution function. After calculating the weights, standardization is done with two approaches of recursive and non-recursive and aggregation of variables in each sub-index (financial market subset) using the EWMA (Exponentially Weighted Moving Average) approach of two correlation matrices and consequently, two indicators of systemic stress recursive and non-recursive are obtained (Figure 1).

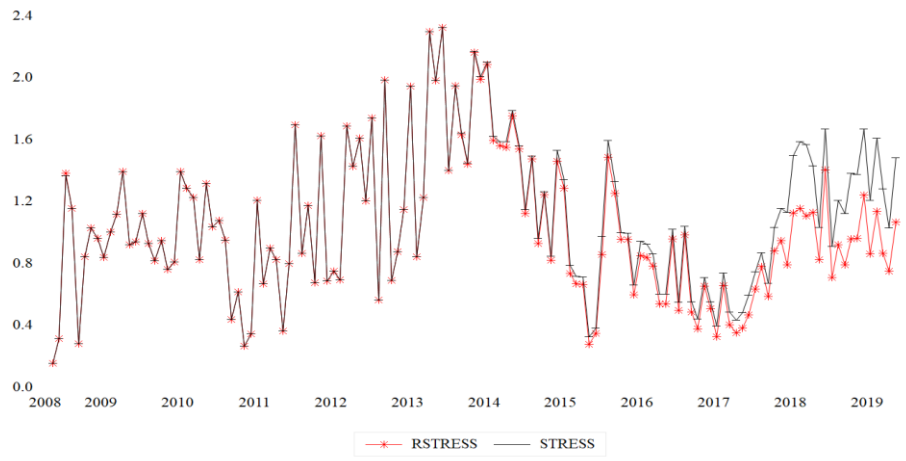

Figure 1. Recursive and Non-recursive Systemic Stress
Source: Research finding.

In explaining the historical developments of the systemic stress index, valuable points drawn are:

Recursive systemic stress shows fluctuations with less intensity exactly at the same time as non-recursive systemic financial stress. This small difference and time taken into account in calculating the systemic stress index are very important to examine the consequences of systemic stress in macroeconomics. In general, by examining systemic stress fluctuations in the financial market, it can be seen that at the end of 2011, the intensity of stress fluctuations increased. International sanctions highly affected the stability of financial markets and the manufacturing sector, especially in the second half of 2011. Another significant jump in the systemic stress index occurred in 2013. This jump coincided with a 30% drop in the Iranian Stock Exchange index. After a slight decrease in the financial stress index right from the first months of 2019, a jump in the non-recursive systemic stress index is observed, which is observed in the recursive systemic stress index with less intensity. This leap is accompanied by the announcement of the United States to withdraw from "the Joint Comprehensive Plan of Action" agreement.

3.3 Result of MSBVAR

Before estimating the economic growth model with the MSBVAR approach, the stationary variables have been measured according to the usual routine. The results of examining the stationarity of the model variables with both ADF and KPSS statistics have shown that all variables used in specifying the model are stationary. After examining the stationarity of the variables, the next step in estimating VAR models is to determine the optimal lag specification with the help of information criteria (Table 2, in the appendix). According to the results, the optimal lag length based on information criteria is four. Given the number of observations, Bayesian information criteria can be considered. In estimating the MSBVAR model, version 1.1.383 of RStudio has been used.

3.3.1 The Regime Probabilities

One of the results of the MSBVAR approach is also shown in Figure 2. This diagram shows the affiliation of each period to the two considered regimes, which shows the division of observations into regimes and smoothed probabilities. In the MS model, observations are divided between regimes based on smoothed probabilities. All the information in the sample is used to calculate the smoothed probabilities. In fact, in the smoothing phase, the goal is to calculate how likely the sample observation can be in regime one and how likely it can be in regime two. The left part of Figure 2 shows the observations belong to Regime One, and the right side depicts the observations in Regime Two. One of the most important

results of this chart is the identification of economic tensions. The diagram of regime two identifies three time points with the occurrence of high financial stress in them. One at the end of 2010, the second between 2011 and 2012, and another serious tension occurred in mid-2018. The process of historical analysis of the results of Figure 2 in some periods with one or two lags matches the graph of the systemic financial stress of Figure 1. To complete the discussion, Figure 3 shows the density of the regimes and the distribution of both regimes in the model variables. This chart shows the difference in the distribution of variables in both financial stress regimes.

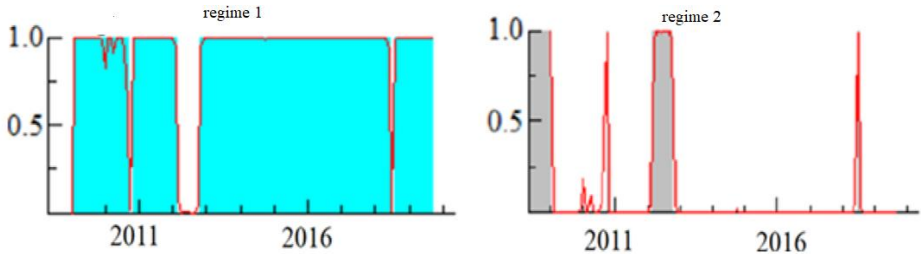

Figure 2. Smoothed States Probabilities Conditional Standard Deviation
Source: Research finding.

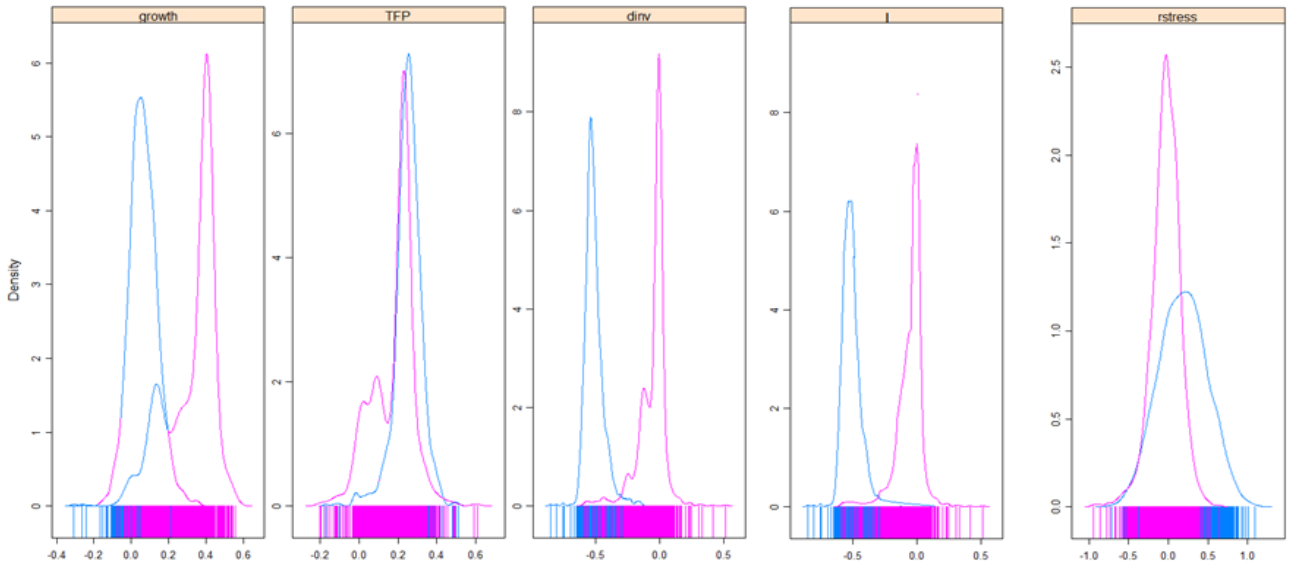

Figure 3. Intercept Densities by Regime
Source: Research finding.

Figure 4 shows the reaction functions for regimes one and two. The results of the research contain significant points: Financial stress innovation in regime one (low financial stress) has negligible negative effects on the variables of economic growth, investment, and productivity of all production factors, which diminishes after several periods (Figure 4: Dashed lines). In the second regime, the shock effect of systemic financial stress on economic growth, TFP growth, and investment (in the short term), at the beginning of the period is negative, after a few periods the effects of financial stress shocks on the studied variables have become very negative and it has been associated with high durability (Figure 4: red lines).

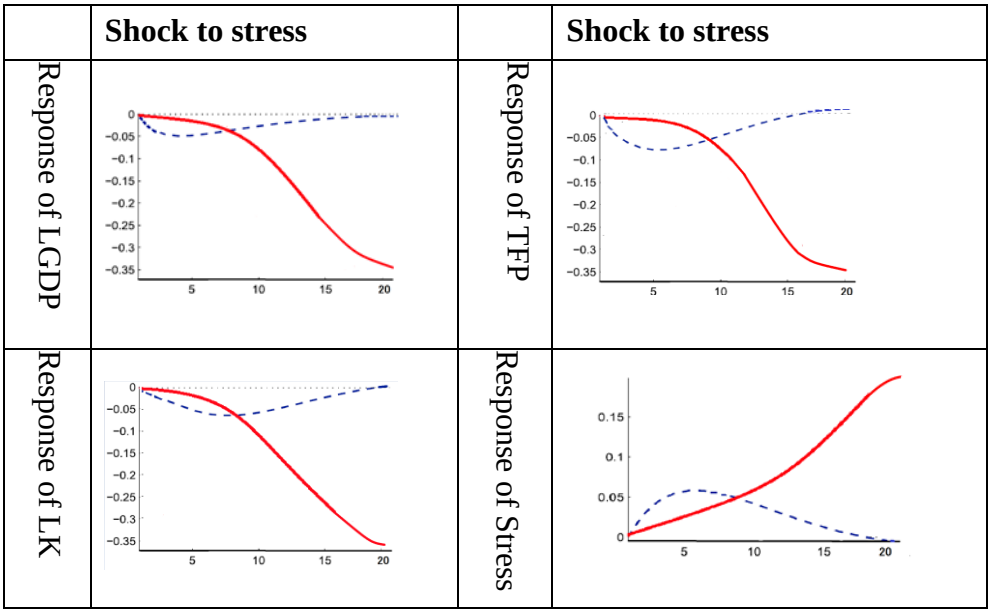

Figure 4. Impulse Response Functions: MSBVAR of Model
Source: Research finding.
Note: Dashed lines represent the high-stress Regime, and Red lines represent the low-stress Regime.

4. Conclusion

This study tried to understand the relationship between macroeconomics and the financial sector during periods of financial stress occurrence by constructing a monthly index of systemic financial stress in Iran between 2008 and 2019. In this study, by taking into account the empirical studies and also considering the facts of Iran's economy, a holistic set of determinants for the comprehensive index of financial stress has been selected. The method of calculating the systemic stress index is clear and repeatable and correctly identifies financial crises.

With further exploration of the estimated systemic stress index, the main determinants of the financial stress index are exchange rate fluctuations at 59.40%, the banking sector at 25%, the securities and derivatives market at 10.41%, the money market at 3.84%, and Islamic treasury bonds with 1.24% contributions. The effects of each of these determinants on the financial stress index are positive, so the first hypotheses of the study can't be rejected. In analyzing the situation of Iran's foreign exchange market, it can be said that the risk of currency fluctuations in the Iranian foreign exchange market is not well covered; part of this coverage is through futures contracts. Severe currency crises are directly related to the fragility of Iran's economic structure and lack of reliance on the components of a knowledge-based economy, because regardless of the components of the knowledge economy, in such a situation competitiveness of domestic products and the country's share of trade in international market will be severely reduced. It is important to note that the occurrence of currency fluctuations and severe banking crises in Iran's economy in some years, is the result of incorrect regulation and implementation of improper macro-policies of economic decision-makers over the years. These incorrect policies cause unintentional deviations of relative prices and send misleading signals to economic actors, consequently, the economic structure of Iran becomes very fragile and vulnerable; so in the occurrence of an external shock, severe financial stresses are created in the financial market. In this study, the importance of currency fluctuations and the banking sector in the financial stress index can be justified because Iran's economy, like many developing countries, is a major importer of capital goods, intermediaries, consumer goods, etc., therefore strongly affected by currency fluctuations. On the other hand, due to the bank-oriented financial markets, most of the liquidity is provided by the banking sector, so it can be said that two parts of fluctuations and crises of the currency and banking sectors are the result of the fragile economy. The economy's structure and the market's uncertainty are the main determinants of Iran's financial stress index in this study. In this regard, Dargahi et al. (2012) and Heidarian et al. (2017) also introduce the most important determinants of the financial stress index as the money and credit market (banking sector). But in foreign studies (Holo et al., 2012; Abura et al., 2017; Comban and Steves, 2016) in developed countries, the importance of determinants of financial stress varies. In a way in the financial stress indicators of these countries, the determinant of money market spreads plays an important role in the fluctuations of the financial stress index.

In analyzing the effects of financial stress on economic growth, the effects of financial stress innovation in the economic growth model with the approach of nonlinear autoregression models have been investigated. The important point about this model is the different behavioral responses of economic growth and its

determinants, including the total factor productivity, investment in financial stress regimes. In this model, there are periodic shifts in financial stress not only in the random shocks that have pressed the economy but also in the dynamic propagation of the shocks. It can be said that in periods of stability (low financial stress), the reaction of economic growth and its determinants is negative, brief and disappears after a few periods, but in the face of high and sudden stress, the negative reaction of the variables is relatively more intense and lasting in the short run.

In this context, periods of high financial stress, although rare, but according to the estimated results, cause serious damage to economic growth and its determinants. It seems that the concurrence of financial stresses and negative economic growth of Iran's economy in the last decade, which was preceded by a high inflationary recession in 2012, doesn't reject the second hypothesis of the study.

The results of this section are consistent with the studies of Miglietta and Venditti (2019), Polat and Ozkan (2019), Stona et al. (2017), and Hubrich and Tetlow (2015), which are also a much more intense and lasting reaction to the variables of economic growth and its determinants to financial stress innovation in severe financial stress. Besides, Stona et al. (2017) and Hubrich and Tetlow (2015) attribute the lasting effects of high financial stress on macroeconomic variables to the adoption of improper monetary policies by monetary authorities. In addition, an important part of the analysis of the response of economic growth to severe financial stress is related to the analysis of the interactive effects of financial stress on its determinants, because high financial stress not only directly has lasting effects on economic growth, but also, precisely impact the other two determinants of the economic growth model, including investment growth and all factors productivity growth, as severe.

In terms of the persistent effects of financial stress on economic growth in the short term, historical macroeconomic theories can be used, according to the Keynesian view, by including after the (financial) shock to economic growth, it tends to be relatively long if the situation remains chronic, with no sign of moving toward recovery. According to the Keynesian view, if the economy is exposed to a disturbance (financial stress), it will take a long time to get out of the recession in the absence of appropriate measures. Monetarists, on the other hand, have differing views on the persistence of the negative effects of disturbances on economic growth, arguing that changes in the money supply play an independent role in periodic fluctuations. Monetarists believe that incorrect monetary policy can lead to instability and worsen the current situation, not better because monetary policy is accompanied by long and variable interruptions.

Our study emphasizes the importance of financial stress and the extent of its negative effects on key macroeconomic variables and makes efforts to inform economic policymakers and monetary officials because the estimated stress index can act as a warning siren for policymakers and planners.

To cope with high financial stress in the face of sanctions, workout markets may not perform well because it is the sole supplier of government currency. In this situation, the central bank should have a fund to cover the risk of exchange rate fluctuations and respond to the problems of producers due to high currency fluctuations.

Regarding the negative effects of financial stress on total factor productivity and economic growth, it is recommended to place the economy on the evolutionary path of a knowledge-based economy. Since total factor productivity growth has a small share in current economic growth, to increase its share in economic growth, the economy can be placed on the mentioned path. This is achieved by increasing government demand for knowledge-based inputs and paving the way for increasing the supply of knowledge-based inputs by increasing the motivation of economic actors to conduct research and development activities; because knowledge and information become more effective where demand is higher and barriers to growth are lower. Creating the context of knowledge application leads to more effective usage of resources and limited capacities of the economy.

By identifying the foreign exchange and banking sectors as the main determinants of financial stress in both systemic stress index and dynamic financial stress, we can point out strategies to prevent the intensification of financial crises. In the foreign exchange sector, an approach should be sought to reduce the risk of currency fluctuations and create the basis for the proper functioning of the foreign exchange market. It is recommended to adopt a knowledge-based development strategy in the economy because knowledge as a public good increases competitiveness. In the case of banking stress, the central bank's supervisory department can adjust its instruments of encouragement and punishment based on the financial stress index so that it can prevent the banking crisis as much as possible through its direct, timely, and continuous supervision.

Finally, regarding the investment variable, it is recommended that in the event of financial stress to efficiently guide financial resources, taxes should be levied on unproductive speculative activities such as bulk buying and selling of gold and coins.

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Appendix

1. Data Group

Table A1. Data Description

	Variable	First observation	Resource
YSP_1	Yield Spread between Islamic Treasury bonds &50 financially active corporations	2014M03	Iran Fara Bourse
BIR	Balanced Interest rate	2008M11	Central Bank of the Islamic Republic of Iran
YSP_2	Yield Spread between Real bank interest rate & 50 financially active corporations	2008M12	Central Bank of the Islamic Republic of Iran
OIV	Overall Index Volatility	2009M01	Tehran Stock Exchange
FC	Future Contract	2009M02	Iran Mercantile Exchange
ERV	Exchange Rate Volatility	2008M11	Central Bank of the Islamic Republic of Iran (Economic Trend)
BV	Bank Stock Index volatility	2009M02	Tehran Stock Exchange
β_t	Banking Beta	2008M11	Tehran Stock Exchange
BD	Bank Debts to the Central Bank on Bank Deposits	2008M10	Central Bank of the Islamic Republic of Iran (Economic Trend)
FD	Facilities to Deposits	2008M11	Central Bank of the Islamic Republic of Iran (Economic Trend)
NPL	Non-Performing Loan	2008M12	Central Bank of the Islamic Republic of Iran (Economic Trend)

Source: Research finding.

2. Optimal Lag

Table A2. Optimal Lag Specification

lag	AIC (Akaike Information Error Criterion)	BIC (Bayesian Information Criterion)	HQ (Hannan-Quinn Information Criterion)
1	5.04	5.53	5.24
2	3.71	4.58	4.06
3	2.18	3.43	2.69
4	1	2.46	1.67

Source: Research finding.

2. Stationary

Table A3. Result of Stationarity Tests

Variables	ADF-Statistics	Critical level in 1%, 5%	Stationary	KPSS-Statistics	Critical level in 1%, 5%	Stationary
LGDP	-2.48	-1.94	I(0)	0.146	0.463	I(0)
LTFP	-2.28	-1.94	I(0)	0.323	0.463	I(0)
LK	-4.29	-1.94	I(0)	0.07	0.463	I(0)
LL	-2.11	-1.94	I(0)	0.19	0.463	I(0)
Stress	-4.23	-3.44	I(0)	0.145	0.463	I(0)

Source: Research finding.

3. Priors Hyper Parameters

Table A4. Priors Selection for Hyper Parameters

Type of Prior	Value
λ_0	0.57
λ_1	0.13
λ_3	0.1
λ_4	1.20
μ_5	10
μ_6	10

Source: Sims et al. (2008) for monthly data.

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