

# Threshold Effects of Regional Fiscal Stress Index on Employment

## Abstract

Economic shocks and structural budget imbalances, when combined with ongoing uncertainty, can lead to fiscal stress in governments. This fiscal stress, along with the resulting volatility in the financing of local governments, can worsen their ability to meet short-term and long-term financial commitments and increase their reliance on the central government. Consequently, the effects of this stress, whether positive or negative, are closely tied to the actions and responses of both central and local governments. This highlights the crucial need for policymakers in central and local governments to respond accurately and promptly, through constant monitoring and assessment of fiscal stress indices. This study aims to illustrate the fiscal situation in the 31 provinces of Iran by calculating the local fiscal stress index based on fiscal and budgetary variables specific to each province. Furthermore, it seeks to estimate the threshold and spatial effects of this index on employment during the period of 2005-2017 using the panel smooth transition regression method. The findings reveal that initially, financial stress has an immediate and positive impact on employment. However, once the threshold of financial stress is crossed, and the subsequent pressures accumulate, the ability to control this imbalance diminishes, resulting in a decline in employment. Additionally, the ability or inability of local governments to manage income and expenses not only affects the economic indicators of the region but also spills over to neighboring regions, leading to capital outflow and workforce migration, which are two major contributing factors to economic growth.

**Keywords:** Fiscal Stress, Employment, Regional Growth, Local Governments

**JEL Classification:** D8, C34, N2, E23

## 1. Introduction

Governments play a crucial role in the economy (Stiglitz, 2021; Turnovsky, 1991) and, in addition to their traditional responsibilities (Walker, 2011; Garvey, 1989), they must address various issues such as resource allocation, revenue distribution, inequality reduction, employment, and economic growth to achieve social welfare (Hughes, 1998; Mowery, 1983; Brim, 1974). Over the past two decades, there has been a gradual transformation in global public sector governance (Kulshreshtha, 2008). The aim of this transformation was to bring decision-makers closer to the people, enabling them to better understand and fulfill their preferences and needs. As a result, the role of local organizations and governments has increased, while central government duties have decreased (Sameti et al., 2014, 3).

Analyzing and predicting economic activities requires an examination of the significant stress in a country's economic structure (Kolari et al., 2019). Economic crises that affect the real sector of the economy can lead to reduced economic growth and increased unemployment (Bartels, 2016). Fiscal and economic stress refers to a condition where governments, institutions, manufacturing firms, and households are unable to meet their obligations and allocate fiscal resources effectively (Raudla and Kattel, 2013). Economic stress also results in widespread economic instability, negatively impacting economic growth and social welfare by disrupting the economic system and potentially leading to crises (Skidmore and Scorsone, 2011; Inman, 1995). The fiscal health of state or local governments has been a key focus in public financial management since the New York fiscal crisis in the mid-1970s (Chung and Williams, 2021). It encompasses the government's ability to meet financial

obligations and provide necessary services to the public (Arnett, 2021). Failure to fulfill these obligations can result in temporary or permanent shocks to macroeconomic, market, or company-specific variables (Soler and Sy, 2021). A recent IMF study highlighted that government bailouts average 3 percent of GDP in their sample countries and can rise to 15 percent of GDP in certain cases (Baum et al., 2020).

The initial step in measuring stress is to identify stress factors and areas within a country's economic structure (Wang et al., 2007). It is important to note that the signs and effects of stress may differ across countries, and each country's response to stressors may vary (Wang et al., 2021). These differences can be influenced by various factors such as development levels, inequality, political situations, and financial markets in each country (Overmans and Noordegraaf, 2014; Maher and Deller, 2007). As one of the world's largest oil suppliers and a developing country with a population exceeding 85 million, it is both opportune and timely to study this issue within the context of Iran's economy. It should be acknowledged that fiscal stress tends to be higher in developing and less developed countries. The reasons for higher stress in these countries can typically be attributed to three mechanisms: First, according to the 2013 World Bank Development Report, economies in developing countries are more susceptible to exogenous stresses. For instance, they may rely on a limited number of product exports, making their entire economy more vulnerable to fluctuations in production and commodity prices. Second, developing countries experience more internal stress due to instability in the development process, ineffective policymaking, and similar factors. Third, developing countries have fewer tools to absorb exogenous stresses and fluctuations, resulting in a greater impact on their macroeconomics, particularly within the natural environment (Hippler and Hassan, 2015).

Considering these relationships, if stress is caused by the actions and decisions of central and local governments, what are the impacts on economic, social, cultural, and political variables? Economic shocks and imbalances in structural budgets create a situation that, when persisting in an uncertain environment, leads to stress within governments. As fiscal stress is a widespread phenomenon in states and cities, there is a need to operationalize this index. A review of theoretical foundations and studies highlights the particular importance of fiscal stress for the structure and system of government financing, with numerous studies focusing on measuring the risks of fiscal stress in local governments to prevent crises (e.g., Elling et al., 2014; Kloha et al., 2005; Coe 2008; Clark 2015; Stone et al., 2015). However, these studies primarily rely on the mean and trend of influential variables. Therefore, this study makes a twofold contribution. Firstly, we attempt to capture the fluctuations of each variable that affects fiscal stress using statistical and econometric methods, and then derive a comprehensive index of local fiscal stress through Principal Component Analysis. Secondly, we investigate the spatial and threshold effects of this index on employment using the Panel Smooth Transition Regression and proximity matrix. Considering the impact of this index on macroeconomic and regional variables, its calculation can be seen as an intermediary channel for the influence of shocks on financing systems, and subsequently, on the decisions and policies of economic agents.

Furthermore, due to the significant importance of financial management in improving employment within local governments, an investigation into the effects of the local financial stress index on employment in Iranian provinces through threshold methods can not only determine the provinces' situation in terms of fiscal stress but also assist policymakers and authorities in central and local governments in making more accurate and comprehensive decisions and formulating effective strategies.

The remainder of this study is organized as follows; in section 2, are discussed the theoretical foundations of local fiscal stress, its effects on employment, and empirical studies. Section 3 presents the research methodology, variables, and estimation models. Section 4 presents the empirical research findings and concludes with suggestions in section 5.

## **2. Theoretical Foundations**

Local government authorities are increasingly facing a decline in disposable revenues while dealing with the growing demand for public goods and services (Kiewiet and McCubbins, 2014).

Understanding the financial condition of local governments is crucial for public managers and elected officials as they strive to align revenues with public demands for services while ensuring financial solvency. This task becomes even more critical when local officials have little to no control over the economic and financial conditions that may be experiencing a crisis. The concept of financial condition encompasses a complex set of relationships that encompass a government's ability to generate revenue, borrow funds, manage expenditures, and provide services. Definitions of financial condition, fiscal condition, or fiscal health usually consist of two components: the government's ability to meet its financial obligations and its capacity to deliver services to residents (Arnett, 2012).

Throughout the literature, three terms and their close variations consistently appear: (1) financial condition, (2) fiscal stress, and (3) fiscal crisis. These terms persist across time and different units of analysis. Regarding financial condition and its close variants (fiscal condition and fiscal health), they typically describe the overall fiscal circumstances of a state or local government (Wang et al., 2007; Hendrick, 2004; Kamnikar et al., 2006). The literature suggests that fiscal stress is a condition characterized by an imbalance (Gold, 1992; Copeland and Ingram, 1983; Scorsone and Plerhoples, 2010). This imbalance can stem from a mismatch between the services desired by the public and those provided by the government (Copeland and Ingram, 1983), or more specifically, from expenditures exceeding available financial resources (Gold, 1992).

Fiscal stress encompasses situations in which a government is unable to meet its financial or service obligations. The causes of such conditions may vary among governments, and research has identified several potential causes and reactions to fiscal stress.

For the purposes of this study, fiscal stress is defined as the inability of a government to meet its short-term or long-term financial obligations as they arise, often accompanied by challenges in revenue generation and service provision. Similar definitions highlight the relationship between fiscal stress and financial condition, emphasizing that fiscal stress indicates a weak financial condition.

On one hand, the fragility of financing systems in central and local governments reflects weaknesses in the system structure and fiscal situation. Shocks in this context can lead to stress. Causes of financial stress in local governments may include temporary economic shocks, structural budget imbalances, limited access to sustainable fiscal resources, unstable national economic performance, centralized government control, decentralization outcomes, and institutional and managerial weaknesses, including corruption in resource collection and utilization (Soler and Sy, 2021).

On the other hand, uncertainty in the budget processes at both the national and local levels can exacerbate differences and gaps in income streams, particularly because a significant portion of local government revenue relies on the central government. Moreover, short-term planning can result in repeated budgeting, significant delays, and project postponements, all of which contribute to financial stress in local governments (Chapman et al., 2003).

For instance, when a local government consistently operates with a deficit that accumulates over time, it creates fragility in the fiscal situation. Consequently, decision-making and planning occur in an atmosphere of uncertainty, which weakens fiscal structures such as the tax system. Additionally, overspending of revenues undermines a local government's ability to meet its short-term and long-term liabilities, leading to a heavy reliance on debt for fiscal expenditures and hindering the government's capacity to pay for essential services. Therefore, the persistence of this trend in local governments

generates local fiscal stress, which serves as a clear warning sign of a potential fiscal crisis (Chapman et al., 2003).

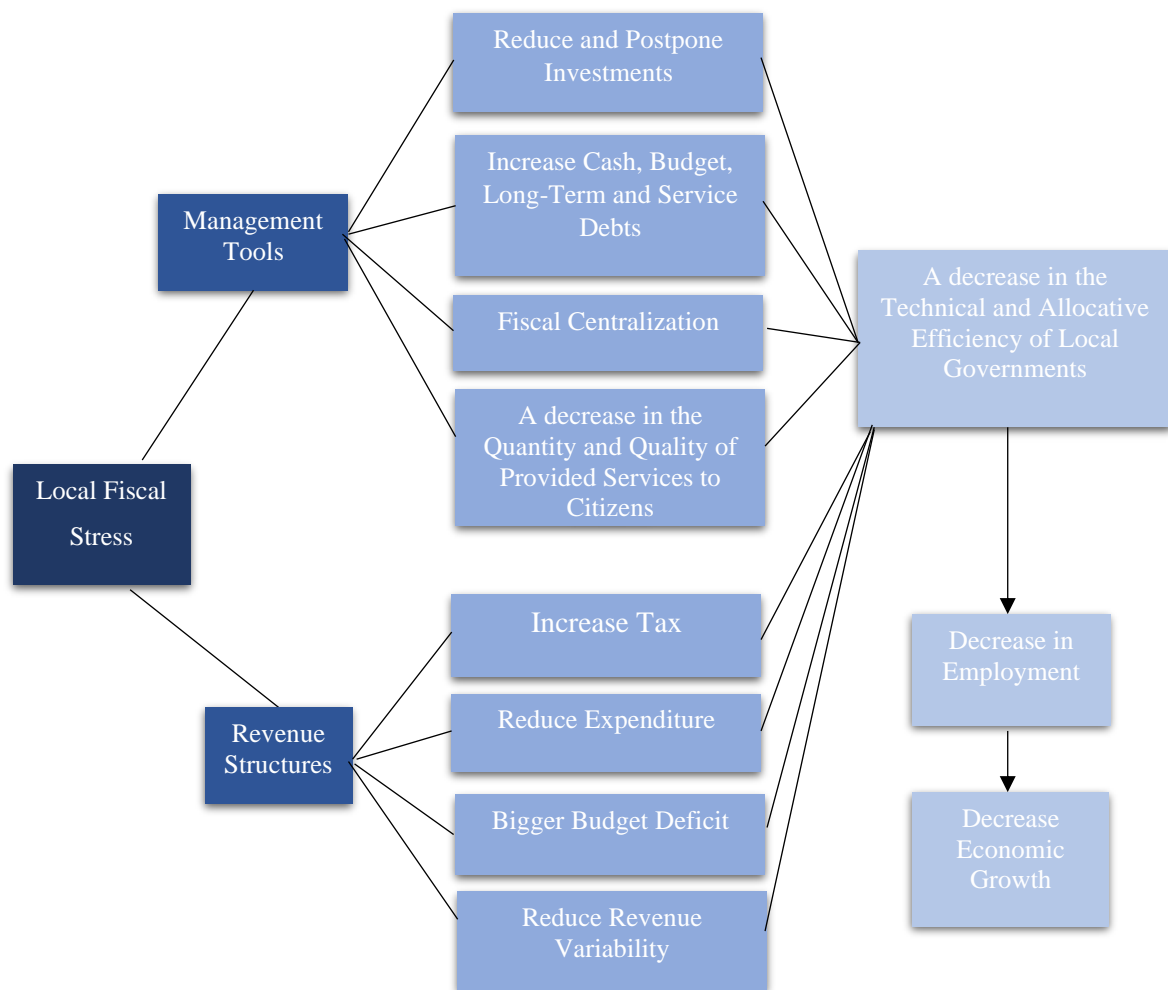
Hirsch and Rufolo (1990) define a fiscal crisis as a situation in which a city lacks the flexibility to address revenue losses. This can occur when tax revenues cannot be raised or are insufficient, expenditures cannot be reduced without compromising essential services, rainy day funds are not available, and the government faces the risk of default or bankruptcy.

The urban planning system encompasses a range of legal and illegal mechanisms (organizational, executive, etc.) that are crucial for achieving development goals and objectives in urban-rural planning (Dreze and Sen, 2002). Government economic policies play a significant role in fostering economic growth. These policies can stimulate investment, increase economic growth, and improve the labor market by creating a stable environment and encouraging investment. Shocks and uncertainties in the economic structure, which are sources of stress, can destabilize a country's economic system. One of the high costs associated with stress is its influence on businesses' and governments' decisions regarding production, savings, investment, employment, and consumption (Johannsen, 2014).

Causes and effects of fiscal stress can be classified into three groups. The first group is related to the impact of economic cycles on governments, which can lead to rapid growth or recession and contribute to increased unemployment in local governments. The second group is associated with a lack of business incentives and a decline in industrial activity in local governments, resulting in reduced tax revenues and increased demand for social services, thereby increasing stress. Moreover, the absence of business incentives hampers the government's ability to develop the underlying factors that attract investment, further exacerbating fiscal stress. The third group includes administrative inefficiencies, corruption, high salaries in certain municipalities, and excessive welfare spending, which can all contribute to fiscal stress in local governments (Shamsub and Akoto, 2004).

One of the key priorities for central and local governments is to allocate their revenues through channels that reduce unemployment and, consequently, increase employment. While tax revenues are typically used to finance government spending, unlike taxes, which have a contractionary effect, government spending stimulates aggregate demand in society by facilitating output expansion and employment. However, during periods of financial stress, increased taxes are often accompanied by decreased spending, leading to a significant budget gap and providing the grounds for an economic recession in the region, subsequently resulting in increased unemployment.

The conceptual model depicted in Figure 1 illustrates the responses of local governments to fiscal stress through the influence of tax and legal constraints on the labor market and labor productivity. The strategies employed by local governments to address fiscal stress depend on the extent and frequency of stress. Consequently, management tools such as budget constraints and taxation are more likely to be utilized (Figure 1).



**Figure 1: Channels of local fiscal stress effect on economic growth and employment**

Numerous studies have examined the fiscal stress experienced by local and state governments, with a majority of these reviews focusing on US states. However, in recent years, studies on fiscal stress have also been conducted in European and African countries. Berti et al. (2012) conducted a study that estimated an early warning indicator of fiscal stress for EU countries. The study classified the index into financial and fiscal sub-indices to analyze the separate effects on private firms, households, and the government. Additionally, the study identified thresholds for fiscal and financial stress.

Magkonis and Tsopanakis (2016) investigated the relationship between fiscal and financial stress in G5 economies. Their findings revealed a strong correlation between these two indicators, particularly during and after the global financial crisis. The fiscal stress index employed a combination of variables such as budget structure, net debt, dependency ratio, stock price fluctuations, stock returns, currency market fluctuations, bonds, and more.

Shi (2019) examined how states responded to the Great Recession of 2008-2009 in different ways. The study utilized four criteria to estimate fiscal stress, including cash, budget, long-term debt, and service debts. The findings demonstrated that the severity of the economic recession following the crisis led to a significant reduction in public sector workers as a means to cope with funding shortages.

Thompson (2017) explored the effects of fiscal stress on local government finance, housing prices, and the quality of public services in Ohio during the period 1999-2012. The study revealed that municipalities decreased per capita spending by approximately 25 percent, with a more pronounced

reduction observed in capital costs. The long-term consequences of fiscal stress were also evident in diminished public service quality, such as security and road maintenance.

Singla and Stone (2018) identified a relationship between long-term financial conditions and expenditure fiscal decentralization among 50 state governments from 2005 to 2013.

A local government that has control over the local planning system possesses authority over a variety of legal and illegal mechanisms (organizational, executive, etc.) within the urban and rural planning system. These mechanisms play a crucial role in achieving development goals and desired objectives in urban-rural planning (Dornaz & San, 2002). The economic and employment effects in cities can vary due to the diverse impacts of local governments and external forces. Moreover, examining the differences in employment and unemployment levels across geographical regions can shed light on spatial disparities. Analyzing social, cultural, and economic factors helps explain these differences. Various studies have explored the factors influencing employment and unemployment in a geographical area, with considerations ranging from natural resources, capital, and technology to social stratification, culture, population structure, and government policies. In Iran, particularly in Tehran, some of the most problematic factors for conducting business include limited financial resources, policy instability, inflation, bureaucratic hurdles, inadequate infrastructure, labor laws, insufficient education and skills of the workforce, and weak work ethics (Fani and Mayel Afshar, 2013, p. 45). Further research in this area can deepen our understanding of the problem's scope and emphasize the role of effective local government management and comprehensive planning in addressing these challenges.

Economic policies implemented by governments play a significant role in explaining economic growth. These policies contribute to increased investment, economic expansion, and improved job markets by creating stable environments and encouraging investment. Shocks and uncertainties in the economic structure, which are sources of stress, can lead to instability in a country's economy. The costs associated with stress include its impact on the decisions of economic enterprises and governments regarding production, savings, investment, employment, and consumption (Cuitin et al., 2012).

Recessionary conditions, characterized by negative growth rates, result in an abundance of unused production capacity, idle capital, and unemployed labor. These conditions are among the main causes of increased unemployment rates in a country's economy. Financial stress can be classified into three groups of causes and effects. The first group is related to the role of economic cycles in governments, which can lead to rapid growth or economic recession and contribute to increased unemployment in local governments. The second group pertains to a lack of business motivation and reduced industrial activities in local governments, resulting in decreased tax revenues and increased demand for social services, thereby exacerbating stress. Additionally, the absence of business incentives hampers the government's ability to develop infrastructure that attracts investment, further contributing to financial stress. The third group includes administrative inefficiency, corruption, high municipal salaries, and excessive welfare expenses as factors causing financial stress in local governments, which consequently have economic effects (Shamsoub and Ekoto, 2004). To achieve economic stability and macroeconomic equilibrium, central governments should focus on optimal budget allocation, while local governments should strive to balance their revenues and expenses. This approach is expected to lead to favorable employment conditions, reduced migration rates, and increased labor productivity. Enhancing employment is one of the central priorities for both central and local governments when allocating their revenues. Unlike tax collection, which has a contractionary effect, government expenditure boosts aggregate demand in society, facilitating sectoral production expansion and increased employment opportunities for human resources. However, during times of financial stress, increasing taxes while reducing expenses creates a significant budget gap, which sets the stage for economic recession and subsequent rises in unemployment and declines in labor productivity.

An important aspect to consider when discussing the impact of financial stress on economic growth and employment is the phenomenon of financial migration, which refers to the movement of local investors'

resources to other regions. This migration results in a reduction of available capital within a specific area, subsequently leading to decreased employment opportunities and a financial downturn. In the conceptual model (Figure 1), the responses of local governments to financial stress are illustrated, highlighting their potential impact on the labor market and labor productivity through the implementation of tax and legal restrictions. The strategies employed by local governments to address financial stress depend on the severity and frequency of the stress experienced. Therefore, the utilization of management tools such as budgetary constraints and tax measures becomes more likely.

### **3. Methodology and introduction of models and variables**

#### **3.1. Calculation of local fiscal stress index**

According to several definitions of financial stress, there are many criteria for measuring this index. Along with the abundance of criteria, there is a lack of coordination on how to best use indicators to show financial stress in local governments (Gold, 1992). It is necessary to determine the measure of financial stress in the financial future and the occurrence of financial problems at the national and local levels. The discussion about the appropriate criteria for financial stress depends on the size and events in which the characteristics of stress can be observed. Researchers in the public sector have used several variables to extract the financial stress index in the form of combined methods of principal factor analysis, which will be discussed in the following some of these studies. Morgan and England (1983), of three indicators; The ratio of long-term debts per capita to income per capita, expenditures per capita for 9 common factors as a percentage of income per capita, income from local resources to total income have been used to measure financial stress. Pammer (1990) uses an extreme index in the form of a measure of the difference between the total rate of long-term debt and total income to evaluate the financial stress index. Ladd and Yinger (1989) use a methodology to standardize the amount of expenses required to provide an average level of service despite the increase in earning capacity, by using this system, they are able to understand and examine the financial health. They were urban.

There are several frameworks available for measuring fiscal stress, both in theory and practice (Mead, 2006). However, in order to effectively measure fiscal stress, it is necessary to define the key factors that determine the fiscal condition of a local government and identify deviations from fiscal stress. In this study, fiscal condition refers to the local government's ability to meet its short- and long-term fiscal obligations while increasing revenues and providing goods and services. Fiscal stress, on the other hand, indicates a weak fiscal condition in which the government struggles to meet its financial obligations, resulting in disruptions in the provision of goods and services.

To operationalize the definition of fiscal condition and fiscal stress, the fiscal determination framework is commonly used by state and local researchers and planners. Notably, the comprehensive public policy research conducted by Groves et al. (1981) stands as one of the most robust frameworks for assessing the fiscal condition of state and local governments.

Additionally, Shamsub and Akoto (2004) employed three key revenue structures - state and local revenue and expenditure structures, local revenue diversification, and fiscal decentralization - along with the tax effort index to analyze fiscal condition and fiscal stress.

A) Therefore, in this study, the selection of variables is based on the aforementioned studies. However, adaptations have been made considering factors such as the type of variables and the calculation of fluctuations in each variable, in accordance with the financial structure of the Iranian economy. These adaptations are carried out through the following two steps: **Select important local fiscal variables and extract fluctuations**

An essential part of local fiscal stress construct is choosing variables. In choosing financial variables, it should be noted that each variable covers one or more components of the main characteristics of fiscal stress and according to the structure of the annual budget, they have annual frequency and are available. In order to extract the fluctuations of each of the variables, GARCH methods are used. Among the important and effective variables in building the composite index of local financial stress, we can refer to the variables in Table 1:

**Table 1: Effective variables in local fiscal stress index construct for Iranian provinces**

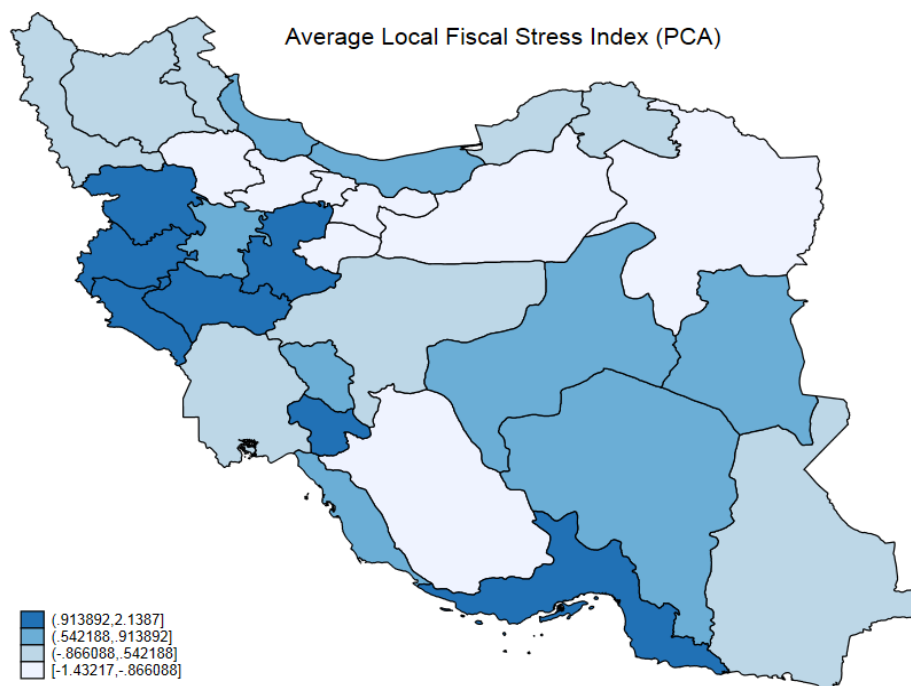
Variables	Criterion	Type of Effect *	Measurement Method
The ratio of current debt to total revenues in each province	Inability to pay cash debts	Positive	The fluctuations in expenditure payments performance ratio to revenue performance of each province
budget deficit in each province	Inability to pay budgetary debts	Positive	The fluctuations in the difference between receipts and payments performance of each province
The ratio of long-term debts to total revenues in each province	Inability to pay long-term debt	Positive	The fluctuations in payments performance of each province from capital or development assets acquisition (non-current and long-term debt)
Expenditure ratio to total revenues in each province	Inability to pay service debts	Positive	The fluctuations in services expenditure ratio (public services, defense and security, justice, economic, environment, housing, and urban development, health, culture, education, social welfare) to revenue of each province
Income diversity	Local government independence	Negative	The fluctuations Local revenues including types of income, sales, and assets tax to total revenues of each province (using Herfindahl–Hirschman Index)
Tax effort index	Local government independence	Positive	The fluctuations in the gap between actual and potential taxes as a percentage of GDP of each province
Local government revenue sources	Local government independence	Negative	The fluctuations in local revenues to total revenues of each province
Revenue decentralization index	Local government independence	Negative	The fluctuations in revenue of each province to the total revenue of the country
Expenditure decentralization index	Local government independence	Negative	The fluctuations in the expenditure of each province to total expenditure of the country
Vertical fiscal decentralization index	Local government independence	Negative	Calculation fluctuations in $(1 - \frac{\text{Revenue of each province}}{\text{Expenditure of each province}})$

\* By adjusting the index effects, reverse the variables that had a negative effect, so that all the selected variables have a positive and increase the effect on local fiscal stress.

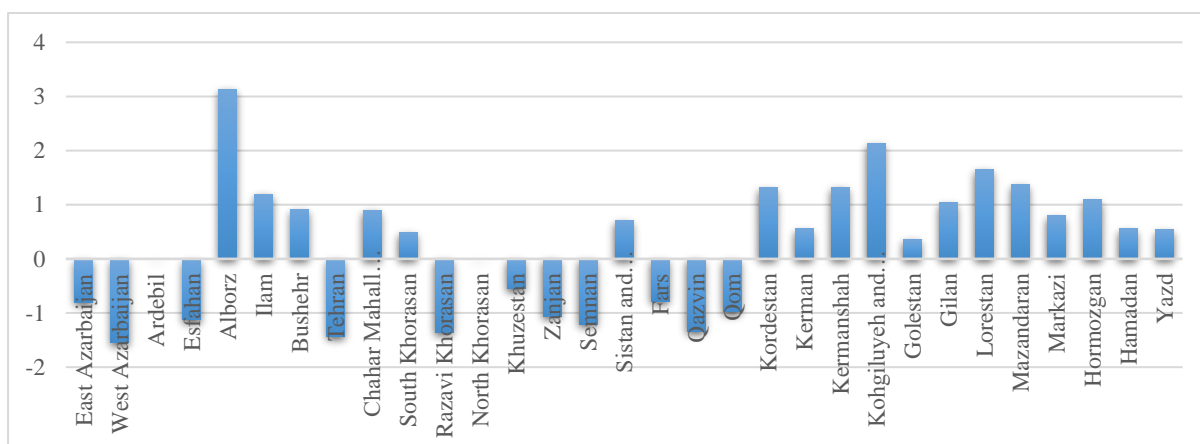
## **B) Construct a Composite Index of local fiscal stress using Principal Component Analysis (PCA)**

Aggregation and integration of various multidimensional indicators in the form of a single indicator are considered to be very suitable solutions. Parametric approaches for aggregating and integrating





**Figure 2: Average of local fiscal stress index in Iranian provinces during 2005-2017 using PCA.** Source: study Findings generated by Stata software



**Figure 3: Average of local fiscal stress index in Iranian provinces during 2005-2017 using PCA.** Source: study findings generated by Stata software

**Table 2. Descriptive statistics**

Variables	Mean	Max	Min	SD	Source
The ratio of current debt to total revenues in each province	74.23	684.42	1.20	84.12	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
budget deficit in each province	6.08	2011.06	-14.03	100.25	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
The ratio of long-term debts to total revenues in each province	73.11	455.70	0.54	61.56	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran

Expenditure ratio to total revenues in each province	69.76	318.52	0.54	59.03	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Income diversity	0.93	2.008	0.76	0.15	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Tax effort index	-0.00001	0.06	-0.04	0.01	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Local government revenue sources	1.49	4.09	1.005	0.53	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Revenue decentralization index	352.12	1471.14	3.63	276.44	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Expenditure decentralization index	357.21	1888.05	0.26	241.63	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Vertical fiscal decentralization index	-0.13	246.09	-209.94	27.30	Budget chapter from the statistical yearbooks of the provinces - Statistics Center of Iran
Local fiscal stress	0.13	5.31	-3.32	1.22	Authors' calculations
Employment rate	37.52	50.20	28	3.64	The results of labor force statistics - Statistics Center of Iran

*SD standard deviation, Observations=630*

*Source: Research findings*

### 3.2. Panel Smooth Transition Regression (PSTR) Method to Estimate the Impact of Local Fiscal Stress on Employment

Panel smooth transition regression models are the first example of the range of regression models based on panel data presented by Hansen (1999). In these models, the regression coefficients can change over time and for cross-sectional units, and panel observations in these models are divided into several homogenous groups or regimes according to the threshold variable that is lower or higher than the determined threshold value. However, in these models, there are observations very close to the threshold value, which is placed in two distinct groups due to small differences, and hence, their effect is met with a sharp leap. To overcome this problem, Fok et al. (2004), Gonzalez et al. (2017) and Colletaz and Hurlin (2006) presented the smooth panel transition regression model, which is, in fact, an extended form of the PTR model with transfer function. Therefore, the slope of the transfer function in the PSTR model represents adjustment speed, which determines regression coefficients change from one regime to another. A PSTR model with two limit regimes and a transfer function is stated by Gonzalez et al. (2017) as per equation (5):

$$y_{it} = \mu_t + \hat{\beta}_0 x_{it} + \hat{\beta}_1 x_{it} g(q_{it}, \gamma, c) + u_{it} \quad i = 1, \dots, N \quad t = 1, \dots, T \quad (5)$$

Where,  $y_{it}$  is the dependent variable,  $x_{it}$  is a vector of exogenous variables,  $\mu_t$  is the cross-section constant effect, and  $u_{it}$  is the disturbance component that is assumed to satisfy the condition  $u_{it} = iid(0, \sigma^2)$ . Also, the function  $g$  is a logistic, continuous, and boundary transfer function between zero and one, and shows the smooth transition between regimes.

$$g(q_{it}, \gamma, c) = (1 + \exp\{-\gamma \prod_{j=1}^m (q_{it} - c_j)\})^{-1} \quad \gamma > 0, c_1 \leq c_2 \leq \dots \leq c_m \quad (6)$$

In this function,  $\gamma$  is the slope parameter that represents adjustment speed from one regime to another and  $q_{it}$  transition or threshold variable. Also  $c = c_1, c_2, \dots \leq c_m$  represents a vector of threshold limit parameters or regime change locations. The  $m$  parameter also indicates the number of regime changes. The generalized form of the PSTR model with more than one transfer function is stated in (7):

$$y_{it} = \mu_t + \hat{\beta}_0 x_{it} + \sum_{j=1}^r [\hat{\beta}_1 x_{it} g_j(q_{it}^j, \gamma_j, c_j) + u_{it}] \quad (7)$$

Where,  $\gamma$  denotes the number of transfer functions for stating nonlinear behavior and other predefined cases. It is worth noting that the PSTR model will be estimated by eliminating the fixed effects by eliminating the individual averages and then estimate by the nonlinear least squares (NLS) method, which is the maximum likelihood estimator (ML).

According to studies by Fok et al. (2004), Gonzalez et al. (2017) and Jude (2010), the estimation steps of a PSTR model are as follows; first, the linearity test is performed against the PSTR, and if the null hypothesis based on the linearity of the relationship between the variables is rejected, the number of transfer functions must be chosen between the variables to fully express the nonlinear behavior. To test this hypothesis, Wald Lagrangian statistics, Fisher Lagrangian coefficient, and likelihood ratio are used. If the results indicate that the behavior of the variables follows a PSTR pattern, the next step is to select the number of transfer functions to fully express the nonlinear behavior. For this purpose, the null hypothesis of the existence of a transfer function should be tested against the hypothesis of the existence of at least two transfer functions. If the null hypothesis is not rejected, it is sufficient to include a transfer function to investigate the nonlinear relationship between the studied variables. But if the null hypothesis is rejected in this test, there will be at least two transfer functions in the PSTR model, and then the null hypothesis of the existence of two transfer functions against the hypothesis of three test transfer functions. This process must continue until the null hypothesis is accepted.

### 3.3. Determine spatial proximity in econometric models

We usually come across data in which spatial aspects are important and should be determined. One of the sources of spatial information is proximity and neighborhood, which reflects the relative position in the space of a regional unit relative to other units. The proximity criterion will be based on information obtained from the community map, and based on this information, it can be determined as to which areas are neighboring or adjacent. There are various methods for determining the proximity in which the W-square matrix represents a different definition of the proximity relations between studied regions. These include the following:

If  $W_{ij} = 1$  is defined for elements that have a standard edge immediately to the right or left, "linear proximity" is if they have a common side with the area, "cleavage-like proximity" is if with the area have a common vertex, "Elevated proximity" is if for two existing areas immediately to the right and left of the area, and "Bilateral linear proximity" is if for two existing areas to the right, left, north, and south of the area, they are called "bilateral cleavage-like proximity". In this study, all areas of the common boundary of cleavage-like proximity are used. Suppose we consider the W matrix for five regions:

$$W = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 1 & 0 \end{bmatrix} \quad (8)$$

Note that  $W$  is a symmetric matrix, and the matrix always has zero elements at the original diameter. Now we invert matrix  $W$  to have a matrix that is the sum of the rows that unit and this is shown as the "standard first-order" proximity matrix as  $c$  matrix:

$$c = \begin{bmatrix} 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & \frac{1}{2} & \frac{1}{2} \\ 0 & 0 & \frac{1}{2} & 0 & \frac{1}{2} \\ 0 & 0 & \frac{1}{2} & \frac{1}{2} & 0 \end{bmatrix} \quad (9)$$

If the multiplication of the  $c$  matrix and the observation vector of a number of variables are used for five regions, that is called the vector  $y$ , the standardization motivation can be observed. This matrix  $y^* = cy$ , represents a new variable equivalent to observations average from adjacent regions (Akbari, 2005, 48).

### 3.4. Introduce Models and Variables

We attempt to investigate the effects of local fiscal stress index on employment in 31 provinces in Iran during the period 2005-2017, based on the theoretical foundations (Shi, 2019). It should be noted that due to the spatial effects between provinces, we have attempted to use the proximity matrix multiplication in fiscal stress and employment. The advantage of using this approach in comparison to other econometric methods is the different fiscal stress in Iranian provinces, which is one of the effective factors in different revenues and expenditure structures of each province. On the other hand, the spatial effects of employment in any province can also affect neighboring provinces, cause migration or recruitment of labor, and act as one of the effective factors in unbalanced growth of provinces, and we provide more transparent policy implications for providers and planners.

$$EM_{it} = \beta_0 + \beta_1^{(1)} FSI_{it} + \beta_1^{(2)} FSI_{it} f(Q_{it}, \gamma, Q_D) + \beta_2 w_i FSI_{it} + \beta_3 w_i EM_{it} + \varepsilon_{it} \quad (10)$$

Where,  $FSI_{it}$ : Local Fiscal Stress index obtained using principal component analysis.

$EM_{it}$ : Employment rate, calculated as a ratio of the number of working population (15 years and over) to the total active population (15 years and over) (employed and unemployed), multiplied by 100. Data on this variable are collected from the labor force survey results available at the statistics center.

$w_i$ : Due to the spatial component in data and due to proximity of the provinces together, the effect matrix is formed and multiplied by the variables of local fiscal stress and employment as the spatial effects of these variables are given in (10) equation.

$f(Q_{it}, \gamma, Q_D)$ : The transfer function in the panel smooth regression model is chosen as the transfer function in Equation (10) and is defined as follows:

$$f(Q_{it}, \gamma, Q_D) = [1 + \exp(-\gamma \prod_{c=1}^m (Q_{it} - Q_c))]^{-1} \quad , \gamma > 0, Q_1 \leq \dots \leq Q_m \quad (11)$$

So  $Q_c$  is a spatial parameter of the transfer function,  $\gamma$  is the smooth parameter, and these parameters indicate the deviation degree and logistic function transfer and the regime transfer rate in different

systems. These parameters are used to determine the optimal combination of local fiscal stress on employment.

#### 4. Research Findings

##### 4.1. Results of panel unit root tests

One of the major problems in time series regression is the dummy regression phenomenon. That is, despite the high coefficient of determination, there is no significant relationship between variables. The dummy regression problem can be applied to the pool and panel model as well as to time series models. Therefore, before the estimate of the model, it is necessary to examine the stationarity of variables for which unit root tests are used. The results of these tests are presented in Table 2. The null hypothesis of these tests indicates that the variables are non-stationary.

**Table 3: Results of panel unit root tests (with intercept)**

Variables	Lag	Levin, Lin, and Chu (LLC) statistics	Im, Pesaran, and Shin (IPS) statistics	Phillips & Perron (PP) statistics	Dicky Fuller (ADF) statistics
Employment rate	0	*-5.5976 (0.0000)	-2.5989 (0.0047)	97.4992 (0.0027)	113.557 (0.0424)
Local Fiscal Stress index	0	-5.8539 (0.0000)	-3.1042 (0.0010)	94.0193 (0.0054)	113.557 (0.0001)

\* Figures represent coefficients of variables and figures in parentheses indicate their probability. Source: Research Results

Obtained statistics and their probability show that all the variables used in this study are at a stationary level. With constant mean, variance, and auto-covariance structure in their time series process, the null hypothesis will be rejected at 95% confidence interval.

##### 4.2. Results of spatial dependence

Before estimating the PSTR model, LM and Moran tests are performed to emphasize the necessity of using spatial variables. The results of these tests are summarized in Table 3:

**Table 4: Results of LM and Moran tests**

Test statistics	Possible level	Statistics value
LM	7.95	0.0114
Moran	0.142	0.0006

Source: Research Results

The LM test results reject the null hypothesis that there is no significant spatial dependence between observations at the 5% level and thus confirm the spatial dependence between observations. The result of Moran's test also rejects the hypothesis of spatial autocorrelation at the level of 5%, and thus there is autocorrelation among the disruptive sentences. Consequently, to estimate the model, the proximity matrix multiplication can be used as a spatial factor.

##### 4.3. Results of PSTR model estimation

Following the methodology discussions, first, the null hypothesis for linearity versus the hypothesis of a PSTR model is tested considering local fiscal stress in both employment and economic growth models as transfer variables whose results are presented in Table 4.

Based on the results, all the Wald Lagrange coefficient ( $LM_W$ ), Fisher Lagrange coefficient ( $LM_F$ ), and likelihood ratio (LR) for one or two thresholds ( $M=2$ ) and ( $M=1$ ) show that the relationship between variables follows a nonlinear model.

**Table 5: Tests of Nonlinear Relationship**

Transfer Variable	Test Hypothesis	M=1			M=2		
		$LM_W$	$LM_F$	LR	$LM_W$	$LM_F$	LR
Local Fiscal Stress	$H_0: r = 0$	4.768	2.473	4.796	10.359	2.609	10.494
	$H_1: r = 1$	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Note: M shows the number of provincial locations and r shows the number of transfer functions. The probability values for each statistic are also reported in parentheses. Source: Research Results

After concluding and verifying the existence of a nonlinear relationship between the variables, that is, the existence of at least one transfer function, the existence of a residual nonlinear relationship should be examined in order to determine the number of transfer functions. To this end, following Gonzales et al. (2005), the null hypothesis of the existence of PSTR pattern with one transfer function is tested against the hypothesis of the existence of PSTR pattern with at least two transfer functions, the results are presented in Table 5. The results show that the null hypothesis of considering a transfer function has one or two thresholds that have not been rejected. Thus, by considering a transfer function, there is no residual nonlinear relation. Therefore, the inclusion of a transfer function is capable of identifying the nonlinear behavior between local fiscal stress and employment.

**Table 6: Tests of residuals Nonlinear Relationship**

Transfer Variable	Test Hypothesis	M=1			M=2		
		$LM_W$	$LM_F$	LR	$LM_W$	$LM_F$	LR
Local Fiscal Stress	$H_0: r = 0$	2.794	0.845	2.804	8.771	1.335	8.868
	$H_1: r = 1$	(0.424)	(0.470)	(0.423)	(0.187)	(0.241)	(0.181)

Note: M shows the number of provincial locations and r shows the number of transfer functions. The probability values for each statistic are also reported in parentheses. Source: Research Results

After the tests of linearity and selection of a transfer function, the number of threshold locations for the final model should be selected. For this purpose and following Colletaz and Hurlin (2006) and Jude (2010), the PSTR model was estimated with one and two thresholds, for which, the sum of squared residuals, Schwartz criterion and Akaike information criterion were further calculated. The criterion for determining the number of thresholds is that for each of the ( $M = 2$ ) and ( $M = 1$ ) thresholds, the one that has the least squared criterion of residuals is selected. If this criterion is the same for both thresholds, then the criterion to select the optimal threshold is the minimum Akaike criterion.

In Table 6, the criteria for both PSTR models represent a transfer function and a threshold for nonlinear behavior among the variables.

**Table 7: Determine the number of provinces locations in a transfer function**

Transfer Variable	M=1			M=2		
	Schwartz criterion	Akaike information criterion	sum of squared residuals	Schwartz criterion	Akaike information criterion	sum of squared residuals
Local Fiscal Stress	1.6386	1.5592	2.1191	1.6567	1.5674	2.2095

Source: Research Results

After selecting the PSTR model with a transfer function and a threshold that indicates a two-regime model, the above model is then estimated. Table 7 shows the estimation results of the "effects of local fiscal stress on employment" equation.

In the employment equation, the slope parameter of local fiscal stress (as a transfer variable), which indicates adjustment speed from one regime to another, is equivalent to the moderate adjustment speed of 3.0788. It is also the location of the regime change at 1.9097. If local fiscal stress exceeds 1.9097, the behavior of the variables follows the second regime, and if lower than the threshold, it will be following the first regime.

**Table 8: Results of PSTR Model Estimation (Transition Variable: Local fiscal Stress)**

Variables	Nonlinear Model	Linear Model
Local fiscal stress	-0.4192 (-4.3915)**	0.2800* (4/2199)**
Spatial local fiscal stress	0.0752 (3.4582)**	0.1326 (3.1267)**
Spatial employment rate	-0.0406 (-3.1885)**	-0.0385 (-3.0172)**
Slope parameter	3.0788	
Location of regime change	1.9097	

\* The above numbers represent the coefficients and the numbers in parentheses of the t-statistic of variables.

\*\* Indicates significance at 1% level, \*\*\* Indicates significance at 5% level. Source: Research Results

Since the coefficients of the variables vary according to transition variables and the slope parameter and are not the same for different provinces during a time, the numerical value of the coefficients presented in Table 7 cannot be directly interpreted, and only the signals should be analyzed.

To provide a clearer understanding of the results two limit regimes in the model are examined. The first limit regime corresponds to the case that the slope parameter tends to infinity and the transfer variable (local fiscal stress) in the "employment and stress" model is less than the threshold where in this case the transfer function has a numerical value of zero, and it is stated as follows:

*The first limit regime for model effects of local fiscal stress on employment:*

$$EM_{it} = 0.2800FSI_{it} + 0.1326w_iFSI_{it} - 0.0385w_iEM_{it} \quad (12)$$

The second limit regime corresponds to the case that the slope parameter tends to infinity, but transfer variable (local fiscal stress) is greater than the threshold, in which case the transfer function has a numerical value of 1 and is specified as follows:

*The second limit regime for model effects of local fiscal stress on employment:*

$$EM_{it} = -0.1392FSI_{it} + 0.2075w_iFSI_{it} - 0.0791w_iEM_{it} \quad (13)$$

As can be seen, the local fiscal stress in the first regime has a positive and significant effect on employment in the provinces. But by crossing the threshold and entering the second regime, it has a negative effect on employment, as it has changed from 0.28 to -0.13, indicating an asymmetric relationship between "employment and stress" at different levels of local fiscal stress and in neighboring provinces.

The reason for this conclusion can be attributed to the structural differences and the planning of local governments as to what extent they can control their revenues and expenditures and benefit from the ability to improve economic growth and employment in the province. Fiscal stress disrupts the balance between provincial and local revenues and expenditures. Initially, these effects on employment have a positive and immediate effect. However, by crossing the threshold of fiscal stress and exerting pressures

on it, the ability to control this imbalance will be diminished. It will reduce economic growth and employment over the period studied.

Since labor market development and regional economic growth are not limited to regions and regional border only and spills over to other regions, therefore, due to the impact of local fiscal stress on neighboring and bordering provinces, the effects of the spillover resulting from the movement of labor and capital between regions have led to a greater impact of local fiscal stress on employment in the spatial case.

This indicates that the ability or inability of local governments to control revenues and expenditures not only affects the region's economic indicators but also spreads its impact to its neighboring areas and causes the outflow of capital and labor as two major factors in improving economic growth. Therefore, the decision-making and planning of local governments are of the utmost importance for national and local revenues and expenditures.

In the employment equation and the second regime, by exceeding the stress threshold, with the increase in fiscal pressures and stresses in local governments, or in other words the increase in the local fiscal stress index, employment declines by 0.1392, which is related to the same reasons for capital outflow and labor migration. The response of the labor market to fiscal and unemployment pressures reduces the workforce and leads to the migration of skilled labor. The same is true for local spatial fiscal stress and spatial employment, with increasing local fiscal stress in the bordering provinces, employment in the corresponding province increases by 0.2075.

## **5. Conclusions and recommendations**

The financing of local governments involves making decisions regarding revenue sources, including taxes (such as property, income, sales, and indirect taxes), intra-governmental transfers, as well as budgeting and financial management processes. This also encompasses the financing methods for infrastructure projects, which may involve operating revenue, borrowing, and the involvement of both public and private sectors.

In developing countries like Iran, the issue of government financing is of utmost importance due to various factors. Firstly, relying solely on tax revenues does not adequately cover the government's current and capital expenditures. Additionally, depending heavily on oil revenues lacks the necessary stability and sustainability. In these countries, the private sector often has higher efficiency and productivity compared to the public sector but does not play a significant role in economic activity. For the private sector to grow, there is a need for increased savings and investment, as well as confidence in the economy. However, when the government borrows from the domestic economy to finance budget deficits, it can impact the economic structure. The combination of different debt instruments can introduce uncertainty, restrict private sector access to finance, and reduce savings, among other effects. Consequently, the allocation of public resources becomes inefficient, disrupting the market system and leading to a contraction of the private sector within the economy. This, in turn, results in reduced economic growth, even in the long run, and contributes to long-term economic instability caused by government debt.

In Iran, the abundance of natural resources has necessitated a significant role for the government in the economy. However, economic shocks and structural budget imbalances create an environment of uncertainty that contributes to stress within governments. Fiscal stress refers to an unstable situation in which local governments struggle to meet their short- and long-term fiscal commitments and become overly reliant on the central government. Consequently, the effects of fiscal stress can either be positive or negative depending on the actions and responses of both central and local governments in a particular

country. Therefore, it is crucial for policymakers in both central and local governments to have accurate and timely indicators of fiscal stress in order to effectively respond to its effects. This is particularly important for Iran, which has faced fiscal and economic sanctions in recent years, resulting in reduced economic activity, lower corporate profit margins, and disruptions in financial markets that impact various macroeconomic variables.

Considering these signs in the fiscal situation of the central government and Iranian provinces, it becomes increasingly apparent that examining the other components of fiscal stress in the provinces of Iran is necessary to prevent a fiscal crisis. In our study, we aimed to clarify the fiscal situation in the provinces by calculating fiscal pressures and the stress index in Iranian local governments based on national and local revenues and expenditures in each province. We then estimated the effects of this index on employment, taking into account threshold and spatial effects. The results reveal that initially, fiscal stress has an immediate and positive effect on employment. However, as the fiscal stress surpasses a certain threshold and exerts greater pressures, the ability to control this imbalance diminishes, leading to a reduction in employment.

Furthermore, the ability or inability of local governments to control revenues and expenditures not only affects the economic indicators of a region but also extends its impact to neighboring areas, influencing the outflow of capital and labor, which are key factors in promoting regional economic growth. Therefore, the decision-making and planning of local governments are of utmost importance in managing national and local revenues and expenditures.

Implementing reform policies in the labor market, creating effective and flexible policies to reduce unemployment, developing strategies for regional production growth, decentralization, and adopting flexible tax policies that align with the provincial structure are crucial. Additionally, balanced regional development is essential, as it can reduce the unemployment rate not only at the provincial level but also at the national level. Neglecting balanced development patterns in the country's provinces will result in inefficient resource allocation at the macro level. Over time, the environmental and climatic opportunities and potentials of provinces may be lost. Based on Figure 2 and considering the share of the local fiscal stress index in Iranian provinces, particularly the higher fiscal stress in border provinces compared to central provinces, it is recommended that the central government pay special attention to regulating and budgeting these provinces. The provincialization of capital (infrastructural) projects and plans, which can boost production and employment in the region, should be considered. This entails delegating more authority regarding provincial surplus revenues and imposing provincial taxes. This approach will ideally reduce the dependence of local spending on national revenues, increase reliance on local revenues, and contribute to overall economic balance.

While the findings of this study provide valuable insights into the fiscal situation in provinces of Iran, it is important to acknowledge the limitations of the study's generalizability. As such, the findings may not be applicable to developed countries and other developing countries with different economic structure. Future research could seek to replicate the study with a more diverse sample to improve the generalizability of the findings.

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## Appendix

Table 9. Results of local fiscal stress index calculation using principal component analysis method

Province	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
East Azerbaijan	-0.22	-0.23	-0.15	-0.57	-0.59	-0.6	-0.97	-0.76	-0.99	-1.13	-1.11	-1.2	-1.29
West Azerbaijan	-1.16	-0.12	0.62	0.04	-0.41	-0.93	-0.37	-0.39	-1.01	-1.22	-0.81	-0.93	-1.1
Ardabil	-0.54	0.72	1.07	0.8	-0.22	-0.47	0.13	0.1	-0.6	-0.9	-0.23	-0.74	-1.06
Isfahan	-0.28	0.07	0.04	-0.23	-0.58	-0.67	-0.82	-0.97	-1.18	-1.4	-1.43	-1.62	-1.76
Alborz	-1.87	-0.97	-0.56	-0.36	-1.15	-0.53	-0.89	-1.07	-1.55	-1.84	-1.81	-2.11	-2.36
Ilam	1.97	1.58	1.63	0.9	0.43	0.05	0.32	0.4	1.27	1.51	1.4	1.9	2.1
Bushehr	0.83	0.01	0.08	0.72	0.74	0.53	0.63	0.79	1.22	1.48	1.36	1.65	1.56
Tehran	-1.63	-0.99	-1.38	-1.42	-1.53	-1.38	-1.37	-1.48	-1.56	-1.52	-1.51	-1.52	-1.25
Chaharmahal and Bakhtiari	0.34	0.25	0.43	0.74	2.09	0.15	0.37	0.15	1.17	1.24	0.24	0.95	0.95
South Khorasan	0.72	0.53	0.21	0.91	0.31	0.65	0.91	0.36	0.32	1.17	1.01	0.95	1.5
Khorasan Razavi	-1.48	-0.57	-0.07	-0.87	-1.18	-1.66	-1.21	-1.25	-1.74	-1.96	-1.74	-1.9	-1.88
North Khorasan	1.83	0.81	1.48	0.5	-0.4	-1.34	-2.46	-0.35	-1.1	0.7	-0.24	-0.76	-0.32
Khuzestan	0.14	-0.56	-0.14	-0.54	-0.8	-0.76	-0.69	-0.69	-0.91	-1.05	-1.05	-1.18	-1.18
Zanjan	-1.04	-0.24	0.25	-0.22	-0.77	-1.25	-0.83	-0.86	-1.32	-1.69	-1.85	-2.14	-2.32
Semnan	-2.21	-1.14	-1.06	-1.35	-3.32	-0.81	-0.17	-0.35	-0.73	-1.09	-0.97	-1.29	-1.06
Sistan and Baluchestan	1.13	1.26	1.3	0.66	0.06	0.57	0.03	0.63	0.21	0.42	0.43	0.08	0.07
Fars	-0.84	-0.47	-0.35	-0.56	-0.92	-1.01	-0.82	-0.73	-1.06	-1.22	-1.05	-1.13	-1.03
Qazvin	-0.83	-0.52	-0.27	-0.25	-0.75	-0.84	-1.15	-1.25	-1.75	-2.05	-2.27	-2.6	-2.81
Qom	-0.23	-0.1	-0.15	-0.63	-0.57	-1.31	-0.67	-0.33	-1.16	-1.66	-2.05	-2.29	-0.04
Kurdistan	1.07	1.44	1.32	1.61	1.38	0.81	2.13	2.5	1.18	0.75	1.37	0.85	0.65
Kerman	0.83	0.34	0.92	0.95	0.62	0.53	0.82	0.31	0.57	0.43	0.57	0.55	0.68
Kermanshah	0.62	1.92	2.71	2.32	2.48	0.98	0.84	0.89	0.54	0.71	1.18	0.86	1.12
Kohgiluyeh and Boyer-Ahmad	1.88	3.47	5.31	4.24	3.18	1.74	2.35	2.34	1.4	0.51	0.76	0.07	0.48
Golestan	0.33	1.03	1.66	0.06	0.04	0.43	0.001	0.28	0.03	0.21	1.004	0.66	1.26
Gilan	2.69	2.15	1.87	0.67	0.62	0.31	0.49	0.51	0.29	0.27	0.46	0.4	0.81
Lorestan	0.88	2.34	3.92	2.63	2.43	1.08	0.96	1.24	1.01	0.74	1.6	1.28	1.36
Mazandaran	1.54	1.55	1.81	0.65	0.4	0.47	0.57	1.16	0.68	0.62	0.75	0.72	0.88

Markazi	0.81	1.08	1.28	1.008	0.62	0.61	0.69	0.72	0.84	0.87	0.93	1.37	1.18
Hormozgan	0.99	2.37	2.19	1.52	0.91	0.79	0.51	0.62	0.82	0.75	0.78	0.86	0.91
Hamedan	0.48	2.04	2.5	1.42	0.98	0.33	0.8	0.79	0.003	0.01	0.3	0.39	0.47
Yazd	0.8	1.17	1.03	0.88	0.63	0.39	0.51	0.54	0.27	0.32	0.22	0.25	0.25