مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
Vol. 11, No. 43, Winter (2023)

Applied Economics Studies, Iran (AESI)
P. ISSN:2322-2530 & E. ISSN: 2322-472X
Journal Homepage: https://aes.basu.ac.ir/
Scientific Journal of Department of Economics, Faculty of Economic and Social Sciences, Bu-Ali Sina University, Hamadan, Iran.
Publisher: Bu-Ali Sina University.

Bu-Ali Sin University

Estimation of Gini Coefficient with Subject to the Size of Government by Using Fuzzy Nonlinear Regression

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Type of Article: Research
https://dx.doi.org/10.22084/AES.2022.25559.3388
Received: 2022.01.11; Accepted: 2022.09.13
Pp: 59-79

Abstract

This article examines the effect of government size on the high, medium and low thresholds of the Gini coefficient in Iran. For this purpose, the auto regression model of soft fuzzy logistic transfer (FLSTAR) has been used for the period of 1997-2019. One of the reasons for using this model is flexibility in its application. The main focus of this paper is to calculate the Gini coefficient bands according to the size of government in the economy. Hence, we calculate the bands (high, middle and low) of the Gini coefficient. The study show that the threshold size of the government is equal 0.499. Findings of this research are applied in a real case which reveal that with increase of government share in economy the Gini coefficient increases as well. Therefore, the government should seriously pursue privatization policies.

Keywords: Gini Coefficient, Fuzzy Regression, Size of Government.

JEL Classification: H23, H50, E42, O15.

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Citations: Ashrafganjoei, R. & Rahimi Ghasemabadi, M., (2023), "Estimation of Gini Coefficient with Subject to the Size of Government by Using Fuzzy Nonlinear Regression". *Journal of Applied Economics Studies in Iran,* 11(44): 59-79 (doi: 10.22084/aes.2022.25559.3388).
Homepage of this Article: https://aes.basu.ac.ir/article_4758.html?lang=en

1. Introduction

In this paper we study the interdependence between the Gini coefficient and the size of government. This size, defined as the share of income redistributed through the fiscal policy, is increasing in the mean-to median income ratio. This implies in turn a positive relationship between the degree of income inequality (a measure of skewness of the income distribution) and the size of redistribution in the presence of majoritarian institutions (Dotti, 2020). Economic views on income distribution and support for vulnerable groups have undergone major changes over the past decades. The Gini coefficient was developed by Corrido Gini (Gini, 1912). This concept can be used, so that graphically, the density ratio of various species could be placed against density ratio of each individual or each species. The Gini coefficient is a statistical dispersion measurement index that is usually used to measure inequality in the income or wealth distribution in a statistical population (Gini, 1912). It is defined as a ratio between 0 and 1. If it is equal to 0, everyone has the same income and wealth (absolute equality); if it is equal to 1, there is absolute inequality, so that wealth is only in the hands of one person and the rest have no income. Establishing social justice is one of the most important goals of any economic system. For many centuries, economists have been thinking about economic justice. For example, the classics saw the establishment of justice through the free market system and believed that the distribution of income from the free market system, though not equal, but it's justly. Although justice is a concept with great complexity and cannot be equated with the income equality of all groups of society, but at the same time, a key element in establishing justice is the low distance between the different income deciles of society and the neutral distribution of income. So, policymakers and Govern mentalist can by identifying the factors and variables affecting income distribution and its impact to take steps to distribute desirable income and reduce class distances as part of social justice. Therefore, an important factor in the distribution of income is the type of government expenditure, and the degree of government intervention in the economy. It is also argued that there may be a positive and negative relationship between government size and income distribution depending on the extent of government involvement in the economy or the rate of economic growth and development (Afonso and Tanzi, 2010). However, there is a difference point of view between the government's involvement in the economy and the different economic doctrine. However, there is always some degree of government involvement in the economy. The extent of government intervention in the economy has a significant impact on inequality. Therefore, the desired size of the government to influence the economy can be examined from different angles. One of these aspects could be its impact on inequality in economy. Studies has been much discussion about the factors that affect the amount of inequality. Within this studies, the amount of government spending in the economy is often argued to be a key influence (Bechtel and Scheve, 2018; Gouveia, 1998; Kakwani and Pernia, 2000; Kalwij and Verschoor, 2007; Ravallion, 2001). Fuzzy sets were introduced by L. A. Zadeh (1965). After introducing this notion the use of fuzzy data for modeling uncertain information in databases were considered, and that is where the need to expand the Takagi-Sugeno-Kang (TSK) model was felt (Li-Xin, 1992; Yen and Langari, 1999; Yu, Wang and Chen, 2006). Most of the researchers in this area have been focused on the development of the basic model and query language in order to display and retrieve uncertain data. Since then, modeling and regression analysis in fuzzy environment have been considered by theoretical and applied researchers (Ghasemzadeh and Shayesteh, 2019; Hesamian and Akbari,2017; John and Innocent, 2005; Sohn and Yoon,2016). In this paper we consider an application of fuzzy logistic smooth transition autoregressive (FLSTAR) model. The importance of this paper is in comparing the estimated bounds high, low, and middle Gini coefficients attention to the size of government. The rest of this research continues in six sections as stated in the following. Section presents a review of studies on the Gini coefficient and the size of government. Section 3 focuses on theoretical foundations needed in this research. Section 4 presents the research methodology; Section 5 incorporates all the results. Section 6 has a discussion and conclusion.

2. Review of Some Studies on the Gini Coefficient and the Size of Government

Different studies are performed on income distribution (Allingham, 1972; Bulíř, 2001; Champernowne, 1974; Clements and Kim,1988; Cysne and Monteiro, 2005; Moller and Nielsen, 2009; Nixson and Walters, 2006; Perotti, 1992; Sylwester,

2002) where most of them examined the effect of a macroeconomic index on income distribution (Albanesi, 2007; Clements and Kim,1988; Cok and Verbicˇ, 2013; De Mello and Tiongson, 2006; Easterly and Fischer,1999; Ganjoei, Akbarifard, Mashinchi and Esfandabadi, 2020; Perotti,1994). Regarding the effect of foreign trade on income distribution, the studies have evaluated its commercial liberalization and globalization on income distribution (Bhagwati and Srinivasan, 2002; Clements and Kim,1988; Obiols-Homs, 2005; Salvatore, 2007). Most studies, based mostly on cross-country data, do not find any statistically significant relationship between various features of the income distribution and some measure of the size of the government (Armey, 1995; Lustig, 2015; Lustig, Pessino and Scott, 2014; Perotti, 1994; Perotti, 1996; Persson and Tabellini,1994; Ravallion, 2001; Ravallion, 2007; Son, 2004; Son and Kakwani, 2008). The recent experimental studies show that increase in income inequality tends to have increase on distribution through taxation, but its effect on the size of the government may have the adverse sign (Agranov and Palfrey, 2015; Bechtel, Liesch, and Scheve, 2018). Studies of Sub-Saharan Africa countries show that government spending on agriculture has a moderate impact on economic growth. On the other hand, government spending on health and education has a significant impact on poverty reduction (Lofgren, and Robinson, 2008; Sylwester, 2002). The results of studies in OECD countries show that there is a negative relationship between the size of government and public spending with inequality (Bandyopadhyay and Esteban, 2009). Some studies have examined the nonlinear relationship between income inequality and government spending. The results of the study in (Colletaz and Hurlin, 2006) show a nonlinear relationship between income inequality and government spending (Dotti, 2020). The results of new experimental studies show that higher income inequality implies a more progressive tax system but, in contrast with the traditional analysis, it may also result in a smaller size of government (Dotti, 2020).

3. Theoretical Foundations of the Gini Coefficient and the Size of Government

In general, government expenditures (public expenditures) have an indirect effect on income distribution, which improves the income distribution of people. The government's investment expenses are actually expenses that will earn money in the future. In other words, it is necessary for the government to make various expenses for investment in order to fulfill its economic duties and responsibilities. Which will lead to direct and indirect income in the future. These investments include machines, buildings, research projects and various construction projects, most of the benefits of which can be obtained in the future. These types of investments also indirectly affect income distribution, but in the future, they can have a positive effect on income distribution. Transfer payments are expenditures that are unilaterally paid by the government to individuals that directly affect the distribution of income (Afonso, Schuknecht and Tanzi, 2010).

Public spending through the development of productivity and job opportunities can have indirect but significant effects on income distribution. For example: (A) An efficient public transport system will allow people to find jobs at lower travel costs (Afonso, Schuknecht and Tanzi, 2010). (B) If education spending increases their human capital stock, it may benefit the poor and improve income distribution. There are two compelling reasons why governments have significantly increased their spending on education. First, the social efficiency of this work is very high, and investment in these areas leads to increased labor productivity and, consequently, to national income and reduced income inequality (Afonso, Schuknecht and Tanzi, 2010). Second, it has been observed that girls' education has a positive effect on fertility and well-being. It has a positive impact on the distribution of income (Afonso, Schuknecht and Tanzi, 2010). (C) Free access to health facilities will maintain the health of the workforce, thereby increasing labor productivity and earning capacity (Afonso, Schuknecht and Tanzi, 2010). On the other hand, government spending and its size affect economic growth. By increasing the supply of productive public goods, the government increases the final return on investment, which has a stimulating effect on investment. Also, taxation to finance government spending has an anti-incentive effect on production and investment spending. In other words, with the increase in the tax rate, the rate of economic growth decreases. Consequently, the economic growth rate follows a reverse U relation to the relative size of the government in the economy. This nonlinear relationship between government size and economic growth is also known as the Armey's curve (Armey, 1995). This curve also shows the nonlinear relationship between government size and economic growth. According to this curve, excessive government growth in the economy has negative effects on economic growth and slows national income growth, therefore increasing the size of the government will lead to inequality in the economy. Because of the large presence of governments and the increasing inefficiency of the economy and the exclusion of more markets, it also means narrowing the space for private sector activity. Summarizing this section, based on the studies reviewed, we can conclude the impact of government spending on economic variables has a nonlinear behavior. The purpose of this article is to investigate the effect of government size on high, medium and low threshold of Gini coefficient in Iran. To this aim, in Section 4, we first review the literature on nonlinear models and then fuzzy logic.

4. Methodology of the Research

4. 1. Autoregressive Models

Statistical modeling of time series (Aznarte, Medeiros and Benítez, 2010) is one of the oldest and most successful tools to predict the future values of a time series as a combination of past values. Box and Jenkins stated the future values of a time series as a linear combination of its past values in the form of an autoregressive (AR) model based on $p \geq 1$, where p is past values y_t, defined in (1):

$$y_t = b'x_t = b_0 + b_1 y_{t-1} + \cdots + b_p y_{t-p} + \varepsilon_{t,} \quad t = 1,2,\ldots,n \qquad (1)$$

Where b' is vector of parameters, $x_t = \left(1, y_{t-1,\ldots,} y_{t-p}\right)'$ and $\varepsilon \sim N(0,\sigma^2)$ is usually known as white noise (or a random signal). For this model we write, $y_t \sim AR(p)$, and $\{y_t\}$ generated from this model is called the AR(p) process. The model (1) indicates the current status of y_t through the past values of $y_{t-1,\ldots,} y_{t-p}$ in terms of a linear regression. This model (1) explicitly specifies the relationship between its current and past values. Box and Jenkins' method covers a wide range of scientific fields such as biology, astronomy, and econometrics. Tong (1983) proposed a linear model called the threshold autoregressive model (TAR) which is divided into several models based on space-state idea and each is modeled by the autoregressive model, which is called self-existing threshold autoregressive. A TAR model (Aznarte, Medeiros and Benítez, 2010) with (k ≥ 2) is defined as (2):

$$y_t = \sum_{i=1}^{k} b_i' x_t I(S_t \in A_i) + \varepsilon_t = \sum_{i=1}^{k} \{b_{i,0} + b_{i,1} y_{t-1} + b_{i,p} y_{t-p} + \varepsilon_t\} I(S_t \in A_i) + \varepsilon_t , \quad (2)$$

Where S_t is threshold variable, I is indictor function with values 0 and 1, b_i' is a vector of parameters, b_i is unknown parameter, and $\{A_i\}$ are partition of the real line ℝ = (-∞ , ∞), so that:

$$\cup_{i=1}^{k} A_i = (-\infty, \infty) \ \ and\ A_i \cap A_j = \emptyset, \forall_i \neq j, \quad (3)$$

Here each $A_i = (r_{i-1}, r_i)$ as a part of a partition of ℝ is written in an autoregressive form. This partition is estimated by the transition variable S_t and r_i is the threshold limit, where

$$-\infty = r_0 < r_1 < \cdots < r_k = \infty, \quad (4)$$

4. 2. Smooth Transition Autoregressive Model

One of the key features of threshold autoregressive models is the discontinuous correlation of the autoregressive model (Aznarte, Medeiros and Benítez, 2010). An alternative model called smooth transition autoregressive (STAR) model was proposed by (Terasvirta, 1994). This model with k numbers of regimes is defined in (5):

$$y_t = b_0' x_t + \sum_{i=1}^{k} b_i' x_t f_i\,(S_t; \emptyset_i) + \varepsilon_t , \quad (5)$$

where b_i is a vector of parameters, $f_i(S_t\,; \emptyset_i)$ is transition function, $\emptyset_i$ consists of two variables γ and c, where γ shows the transition velocity between two bounds, and c is the transition point and $\{\varepsilon_t\} \sim \mathrm{N}(0, \sigma^2)$ usually known as white noise (equivalent to a random signal with a flat power spectral density).The STAR model in (5) can be re-written as in (6):

$$y_t = \sum_{i=2}^{k} b_i' x_t \, F(s_t; \gamma_i, c_i) + \varepsilon_t \quad , \qquad (6)$$

Where, γ shows the transition velocity and c_i is the transition point.

4. 3. Fuzzy Logic Methodology

Fuzzy logic involves a wide range of theories and techniques that are generally based on four concepts: fuzzy sets, verbal variables, membership function, and fuzzy if-then rules (Aznarte, Medeiros and Benítez, 2010; John and Innocent, 2005; Lee, 1990). The fuzzy logic consists of three stages as Fuzzification, fuzzy process (fuzzy inference) and defuzzification. In Section 4.3.1, we will review the application of fuzzy logic in prediction and modeling.

4. 3. 1. Fuzzy-based Models

Fuzzy systems are knowledge or rule-based systems. The heart of a fuzzy system is a knowledge based that is formed by fuzzy if-then rules. A fuzzy if-then rule is a conditional expression which are specified by continuous membership functions. These rules are (Aznarte, Medeiros and Benítez, 2010). fuzzy inference engine combined by a mapping of fuzzy sets in the While dealing with time series problems, the Takagi-Sugeno-Kang (TSK) model is preferred to the other types. The TSK type fuzzy rule (Aznarte, Medeiros and Benítez, 2010) is as(7):

$$\text{IF } x_1 \text{ is } A_1 \text{ AND } x_2 \text{ is } A_2 \text{ AND} \ldots \text{AND } x_p \text{is } A_p \text{ , THEN } y = b' x_t = b_0 + b_1 x_1 + b_2 x_2 + \cdots + b_p x_p \qquad (7)$$

Where x_j is input variable and A_j is a fuzzy sets. Given the fuzzy argumentation mechanism for the TSK rules, the firing strength of the ith rule is obtained via a t-norm (usually, multiplication operator) aggregating the membership values of the premise part terms of the linguistic variables as (8):

$$\omega(x) = \prod_{j=1}^{p} \mu_{Aj}\left(x_j\right), \text{ with } x = \left(x_1, \dots, x_p\right) \quad (8)$$

The membership function μ_{Aj} can be selected from a wide range of functions (Aznarte, Medeiros and Benítez, 2010). The most common one is the Gaussian bell presented as (9):

$$\mu_A(x) = exp\frac{-(x-c)^2}{2\sigma^2}, \quad (9)$$

Therefore, it can also be a logistic function as (10):

$$\mu_A(x) = \frac{1}{1+exp\left(\frac{c-x}{\sigma^2}\right)}, \quad (10)$$

The consequent is calculated as the average weight or total output weight of the rules. In the case of the total weight, the output is stated as in (11):

$$y_t = G(x_t; \Psi) = \sum_{i=1}^{R} b_i' x_t\, \omega_i(x_t), \quad (11)$$

where G is the general nonlinear function with parameters Ψ and r as the number of fuzzy rules in the system (Aznarte, Medeiros and Benítez, 2010; Kalwij and Verschoor, 2007; Sohn, Kim and Yoon, 2016; Son, 2004). When an infinite time series $\{y_t\}$ is used for modeling or predicting, the TSK type fuzzy-based rules are expressed as in (12). All the variables y_{t-i} are lagged values of the time series $\{y_t\}$.

$$IF\ y_{t-1}\ is\ A_1\ AND\ y_{t-2}\ is\ A_2\ AND \dots AND\ y_{t-p}\ is\ A_p,\ THEN\ y_t = b_0 + b_1 y_{t-1} + b_2 y_{t-2} + \cdots + b_p y_{t-p}$$

(12)

5. Results of Estimating Threshold the Size of Government

In this study, using the annual data presented by the Central Bank of Iran (CBI) during 1997 – 2017, the effect of internal factors including:

A-The size of government is computed as $SG = \frac{G}{GDP}$. This includes the general government expenditures as a share of GDP for; general public services; defense; public order and safety; economic affairs; housing and community amenities; health; recreation, culture and religion; education; social protection. B- Inflation. C- GDP is investigated via the Gini coefficient in Iran. The size of the government is a variable that causes a nonlinear effect on the Gini coefficient as the dependent variable. The choice of transition variable (The size of government) and nonlinear tests is performed according to (Sohn, Kim and Yoon, 2016; Son, 2004).

In this section we calculate the threshold value of the size of the government in the economy, as stated in Sections 4.1 and 4.2. For this purpose, the following steps are done:

1- Using Taylor's approximation to investigate the nonlinear relationship between variables (Colletaz and Hurlin, 2006; Terasvirta, 1994), where the Wald Lagrange multiplier (LM_W) test statistics is defined in (13)

$$LM_W = \frac{T(SSR_0 - SSR_1)}{SSR_0} \tag{13}$$

In the above equations, SSR_0 is the sum of residuals squared, SSR_1 is the sum of squared residuals, T is time period.

2-The variable LM_W that has the most test statistics is selected as the transition variable $\widetilde{S}$ (Tsay, 1989).

3-We determine the transition velocity γ and the transition point c_i, using the Newton-Raphson algorithm (Enders, Walter 2004).

4- By specifying the transfer speed, point and variable, we can calculate the value of the size of government threshold (the transition function) is defined in (5).

The size of government threshold is estimated to be 0.499. The implication of this threshold is that in a small regime, as long as the size of the state is less 0.499, increasing the size of government does not affect the Gini coefficient or the inequality of income distribution. But in a big government regime, when the size of government is greater than 0.499, increasing the size of government leads to the increase in the Gini coefficient. In other words, in a large government regime, increasing the size of the government leads to increase of income inequality in the country's economy. All the relevant calculations are performed on Windows 10, 64-bit and Eviews 10.

The innovation of this study is in using the logistic smooth transition autoregressive model in the form of fuzzy-based rules and fuzzy database. Accordingly, the logistic smooth transition autoregressive model that is generalized by (Aznarte, Medeiros and Benítez, 2010; Terasvirta, 1994; Tsay, 1989) will be as in (14). For the asthmatic of fuzzy numbers refer to references (Ganjoei, Akbarifard, Mashinchi and Esfandabadi, 2020; Perotti, 1992).

$$\begin{aligned}&\widetilde{Gini}_{i,t}\left(\widetilde{Gini}_{t-j}, \widetilde{GS}, \tilde{p}, \widetilde{GDP}, \tilde{S}_{it}, \tilde{c}, \tilde{v}\right)\\ &= \sum_{j=1}^{n} \alpha_j \widetilde{Gini}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{SG}_{t-j} + \sum_{j=1}^{n} \alpha_j \tilde{P}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{GDP}_{t-j}\\ &+\tilde{G}(\tilde{S}_{it}, \tilde{v}, \tilde{c}) * \{\sum_{j=1}^{n} \alpha_j \widetilde{Gini}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{SG}_{t-j} + \sum_{j=1}^{n} \alpha_j \tilde{P}_{t-j} + \sum_{j=1}^{n} \alpha_j \widetilde{GDP}_{t-j}\}\\ &\tilde{G}(\tilde{v}, \tilde{c}, \tilde{S}_t) = \frac{1}{1+\exp\left(\tilde{v}\left(\tilde{S}_{it} - \tilde{c}\right)\right)}, \quad i = 1, \ldots, N, t = 1, \ldots.. T.\end{aligned} \tag{14}$$

Where Gini coefficient $\widetilde{Gini}$, Gini coefficient of the previous period $\widetilde{Gini}_{t-j}$, the size of government $\widetilde{SG}_{t-j}$, inflation $\tilde{P}_{t-j}$, Gross Domestic Product $\widetilde{GDP}_{t-j}$, transition variable $\tilde{S}$, transition point $\tilde{c}$, transition velocity $\tilde{v}$ which are all fuzzified. In this study, $\widetilde{SG}$ is the transition variable and $\tilde{G}$ is the transition function TR. Note that ~ means the notion used is fuzzified. In order to obtain the transaction function (TR) in high, low, and middle bounds, in accordance with(14), the inputs are initially analyzed based on fuzzy-rules based. The transfer function consists of three parameters as $\tilde{c}$, $\tilde{v}$, and $\tilde{S}_{it}$.

5. 1. The Results of Estimation

We used fuzzy logic to calculate the transition function values, as in Table 1, the value of transition function in three classes as high, middle, and low bounds are estimated. Accordingly, when the transition function is in the high bound, the value of the Gini coefficient is in the high bound (high width). Similarly, when the transition function is in the middle bound, the Gini coefficient is in the middle bound (front), and when the transition function is in the low bound, the Gini coefficient is in the low bound (low width).

Table 1: Calculating transition function based on input parameters

Transition function parameters (input)	bounds		
	low bound	middle bound	high bound
Transition point c	(0, 0.25)	(0.25, 0.375)	(0.375, 0.75)
Transition velocity V	(0, 0.21)	(0.21, 0.5)	(0. 5, 0.99)
Transition variable S	(0, 0.281)	(0.281, 0.65)	(0.65, 1)
Transition function (output)	(0, 0.339)	(0.339, 0.68)	(0.68, 1)

The Gaussian function is used for the membership function for the output variable of the transition function, since its covered domain can be carefully adjusted. It should be noted that in the present study, there are 3 fuzzy sets (low, middle, and high) and the number of input variables is 3 which are $\tilde{c}$, $\tilde{v}$, and $\tilde{S}_{it}$. Therefore, the number of the required rules will be 27 (Aghaeipoor and Javidi, 2019). Data on all variables are taken from the CBI website. Which Figure 1 is plotted using (14) and with MATLAB software. Figure 1 shows how the transfer variable and the transfer function affect the Gini coefficient. After determining the bounds of the transition function, in the next stage, a domain is determined on each of the input variables A, B, C and D stated in Table 2. For this purpose, all data are initially transferred to the values in [0,1]. Prior to drawing the membership functions, in order to specify the range of linguistic input variables, the mean values, mean difference from standard deviation, and total mean and standard deviation of each input variable must be calculated. All the relevant calculations are performed on Windows 10, 64-bit and MATLAB R2019a.

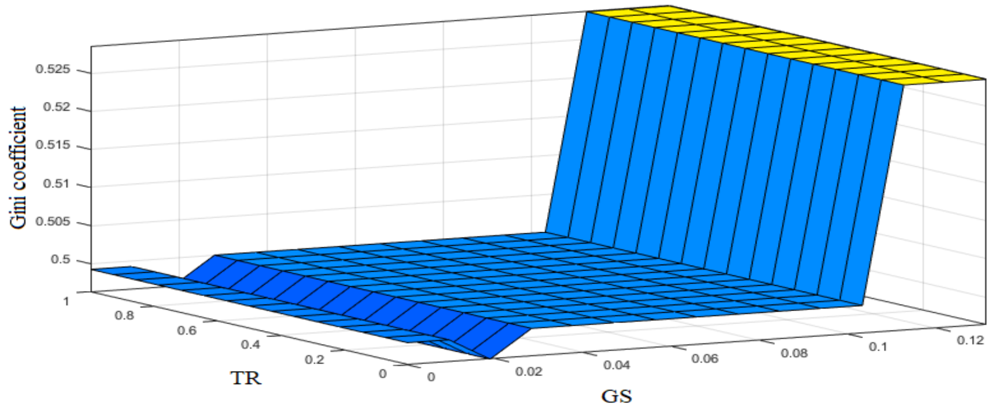

Fig. 1: Transition function (TR) in terms of the transition variable (unemployment) by using equation (14)

In this case, the range of low linguistic variable will be from the mean to 0. The range of middle linguistic variable will be from the total standard deviation and mean to the difference of standard deviation and mean. Finally, the range of high linguistic variable will be from the mean to 1. In Table 2, the values A, B, C and D are presented for the three variables. In the fuzzy inference stage, the required linguistic rules must be determined to link the input and output variables.

Table 2: Descriptive statistical indicators for input variables based on authors calculation

Descriptive statistical indicators	A: Size of government	B: Inflation	C: Gross Domestic Product	D: Gini coefficient with one the of lag (Gini t-1)
mean	0.08128971	0.281357778	0.246437012	0.39801
standard deviation	0.049904663	0.342497391	0.30066934	0.010266
total mean and standard deviation	0.131194373	0.623855169	0.547106352	0.387743

difference of standard deviation and mean	0.031385047	0.061139613	0.054232329	0.408276

In this study, following previous studies such as (Aghaeipoor and Javidi, 2019), four economic input A, B, C and D variables during 1997-2019 are identified as the most important effective variables for computing the Gini coefficient. For the fuzzification of the above variables, in the first stage, for each of the input and output variables, the low, middle, and high linguistic expressions are used. Then, for each of the linguistic expressions in each of the input variables, the Gaussian membership function is used (Dotti, 2020; Lee, 1990; Lofgren and Robinson, 2008). Then, as in Figure 2, the effectiveness of transition function and independent variables for the Gini coefficient is specified. To calculate the value of the high, low, and middle bounds (proportional to the high, low, and front width) for computing the Gini coefficient, three situations are considered for the transition function. Where is obtained based on (Lee, 1990). In the next stage, which is the defuzzification stage, the value of Gini coefficient is obtained.

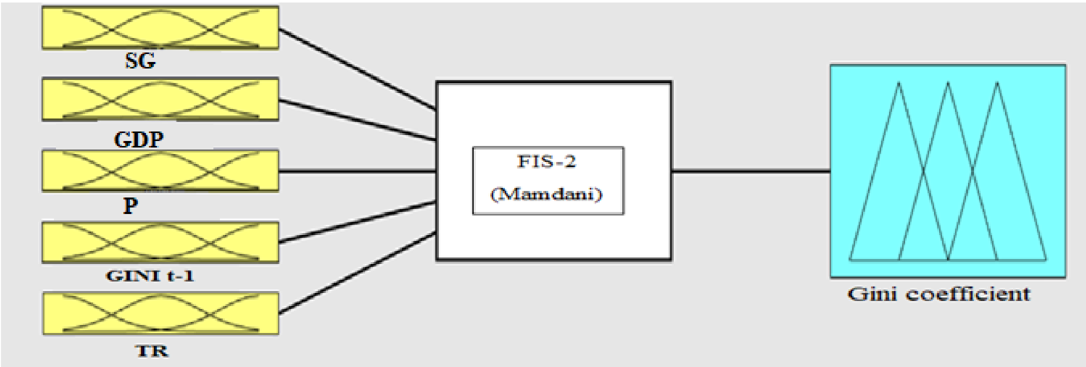

Fig. 2: Computing Gini coefficient as output via independent variables SG, GDP, P, $GINI_{t-1}$ and transition function TR. as fuzzy inputs

The results of which are presented in Table 3. The high, Low, and Middle width of the Gini coefficient is calculated.

Table 3: Gini coefficient calculations high, Low and Middle

year	Gini coefficient		
	Low width	Middle width	high width
1997	0.487	0.501	0.512
1998	0.421	0.498	0.5
1999	0.439	0.493	0.541
2000	0.431	0.451	0.485
2001	0.471	0.482	0.494
2002	0.497	0.499	0.507
2003	0.469	0.471	0.508
2004	0.401	0.495	0.509
2005	0.457	0.493	0.5
2006	0.454	0.460	0.468
2007	0.448	0.475	0.485
2008	0.461	0.470	0.485
2009	0.478	0.5	0.524
2010	0.497	0.504	0.5 07
2011	0.466	0.481	0.487
2012	0.401	0.507	0.508
2013	0.406	0.5	0.504
2014	0.457	0.481	0.487
2015	0.469	0.481	0.485
2016	0.477	0.49	0.501
2017	0.400	0.481	0.5
2018	0.417	0.440	0.501
2019	0.430	0.481	0.531

6. Discussion

We presented the FLSTAR model for estimating the relationship between the size of government and bounds of the Gini coefficients. One of the important features of this model is the flexibility and modeling of economic conditions. In this study, a threshold for the size of government is estimated. The results of this study shows that government spending and fiscal policies have a negative impact on Gini coefficients, which leads to increased income inequality. Many of these results are in the line with prior expectations, and mirror other findings in the literature. Studies in recent years have used meta-regression analyze (MRA) for investigating the relationship between government spending and income poverty by focusing on low- and middle-income countries. Results in (Anderson, Duvendack and Esposito, 2018) show that higher government spending has played a significant role in reducing income poverty in low- and middle-income countries. Also, the relationship between government spending and poverty is on average less negative for countries in Sub-Saharan Africa, and more negative for countries in Eastern Europe and Central Asia, compared to other regions (Anderson, Duvendack and Esposito, 2018).

There are several criteria to compare the performance of the models used in this study. The most common of these are Mean Absolute Error (MAE), Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Percentage Error (MAPE), all criteria are used in this study (Bal, Demir and Aladag, 2016), for model evaluation as well as for predictive power evaluation. Table 4 shows the result nonlinear regression of Gini coefficient estimation using fuzzy regression. Fuzzy nonlinear regression model had good results in all evaluation criteria (Anderson, Duvendack and Esposito, 2018; Cok, Urban and Verbic, 2013; Dotti, 2020; Kalwij and Verschoor, 2007; Moller, Alderson and Nielsen, 2009).

Table 4: Evaluating the results FLSTAR model estimation

Models	Membership	MAPE	MAE	RMSE	MSE
FLSTAR	Low bound	0.037	0.023	6.23	3.882
	Middle bound	0.047	0.0294	9.08	8.25
	high bound	0.001	0.000	40.000	0.000

7. Conclusion

In this paper, while presenting the application of fuzzy sets in regression, a situation was examined, where the classical regression methods could not be used to estimate dependent variables. In this study, using the fuzzy logistic smooth transition autoregressive (FLSTAR) model, the appropriate transition function was fitted to the data by using a fuzzy database and the dependent variable bounds were estimated. One of the merits of FLSTAR model is the flexibility in modeling and strong explanatory power by calculating the bounds of the Gini coefficients and comparing it in different years. In this way we can understand the impact of the size of government on the economy.

The results of this study show that the threshold of government size in Iran economy is 0.499. We calculated the Gini coefficient for when the government size is High, Meddle and Low. We found no evidence that increased government spending would lead to a decrease in income inequality. This is consistent with the view that financial policies in developing countries have no effect on reducing inequality. These results are important as they can be a guide for policy makers, because the value of Gini coefficient can be reduced until the Low width and Middle, and its current trend is not compatible with the optimal use of facilities. So it is suggested that the government consider privatization policy in order to improve the distribution of income in the country.

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مطالعات اقتصادی کاربردی ایران
Quarterly Journal of Applied Economics Studies, Iran (AESI)
سـال یازدهـم، شـمارۀ ۴۴، زمسـتان ۱۴۰۱

فصلنامۀ علمی مطالـعات اقتـصادیِ کاربـردی ایـران
شاپای چاپی: ۲۵۳۰-۲۳۲۲؛ شاپای الکترونیکی: ۴۷۲X-۲۳۲۲
وب‌سایت نشریه: https://aes.basu.ac.ir
نشریۀ گروه اقتصاد، دانشکدۀ علوم اقتصادی و علوم اجتماعی، دانشگاه بوعلی‌سینا، همدان، ایـران

برآورد ضریب جینی با توجه به اندازۀ دولت
با استفاده از رگرسیون غیرخطی فازی

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نوع مقاله: پژوهشی
شناسۀ دیجیتال: https://dx.doi.org/10.22084/AES.2022.25559.3388
تاریخ دریافت: ۱۴۰۰/۱۰/۲۱، تاریخ پذیرش: ۱۴۰۱/۰۶/۲۲
صص: ۷۹-۵۹

چکیده

ایـن مقاله به بررسی تأثیر انـدازۀ دولت بر آستانه‌های بـالا، متوسط و پاییـن ضریب جینـی در ایـران می‌پـردازد. بـرای این‌منظور از مـدل خـود رگرسیون انتقـال ملایم لجستیک فـازی (FLSTAR) بـرای دورۀ زمانی ۱۳۷۵-۱۳۹۷ استفاده شـده اسـت. یکـی از دلایـل استفاده از ایـن مـدل انعطاف‌پذیـری در کاربـرد آن اسـت. تمرکـز اصلی ایـن پژوهـش، محاسـبۀ باندهـای ضریب جینـی بـا توجـه بـه انـدازۀ دولـت در اقتصـاد اسـت. از ایـن‌رو، باندهـای (بـالا، متوسـط و پاییـن) ضریـب جینـی محاسـبه شـده اسـت. ایـن مطالعـه نشـان می‌دهـد کـه انـدازۀ آسـتانه دولـت برابـر ۰/۴۹۹ اسـت. یافته‌هـای ایـن تحقیـق در یـک اقتصـاد واقعـی کاربـرد دارنـد کـه بیانگـر آن اسـت بـا افزایـش سـهم دولـت در اقتصـاد، ضریـب جینـی نیـز افزایـش می‌یابـد؛ بنابرایـن دولـت بایـد سیاسـت‌های خصوصی‌سـازی را به‌طـور جـدی دنبـال کنـد.

کلیدواژگان: ضریب جینی، رگرسیون فازی، اندازۀ دولت.
طبقه‌بندی JEL: H23, H50, E42, O15.

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ارجاع به مقاله: اشرف‌گنجویی، رضا؛ و رحیمی‌قاسم‌آبادی، محمد، (۱۴۰۱)، «برآورد ضریب جینی بـا توجـه بـه انـدازۀ دولـت بـا اسـتفاده از رگرسـیون غیرخطـی فـازی». فصلنامـۀ مطالعـات اقتصـادی کاربـردی ایـران، ۱۱(۴۴): ۷۹-۵۹. (doi: 10.22084/aes.2022.25559.3388).
صفحۀ اصلی مقاله در سامانۀ نشریه: https://aes.basu.ac.ir/article_4758.html