Iran. Econ. Rev. Vol. 23, No. 1, 2019. pp. 47-62

The Evaluation of Suitability of Spatial Error STAR Model for Modeling Convergence of Social Welfare of Iran's Provinces

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Received: 2017, August 24 Accepted: 2018, January 16

Abstract

The purpose of this paper is the evaluation of suitability of spatial error STAR model for modeling convergence of social welfare of Iran's provinces between 2000 and 2013. In this paper the LM tests show that the non-linear method is appropriate for convergence evaluation. In addition, the results indicate that 2 groups of provinces are separable: group 1 in which the social welfare growth is affected by the welfare of the regions themselves and group 2 in which it is not merely the effect of social welfare of the regions themselves, and spatial effects are observed among the provinces of this group. Moreover, based on our results, there is convergence among the regions of the first group while there is no convergence among the provinces of the second group.

Keywords: Convergence, Social Welfare, Spatial Error STAR Model.
JEL Classifications: I31, C20, R12.

1. Introduction

Social welfare is a proper criterion to assess the people's situation and is one of the significant indices for progress and development of any society. Welfare is the indicator of purchasing power and the ability to obtain life facilities and conveniences (FitzPatrick, 2011) that feeling health, safety, peace and more confidence of society's people are considered as the important features of social welfare (Hewstone & Strobe, 2001). So, increasing the social welfare of the people in any society is one of the important goals of the policy makers in any

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society. To achieve this goal, increasing the income and its appropriate distribution as the criteria that are significant and effective on social welfare must be taken into consideration. However, the issue that should be considered in this regard is that applying and allocating the resources of one society in different regions must be done in a way that it provides social welfare for the people of all regions of a society, and for this purpose the function of each region may be also affected by the function of other regions. Hence, convergence must exist among social welfare of different regions. To achieve this goal, Iranian economic development programs also have been oriented from sectoral planning toward regional planning, and in fact, one of the main purposes of the programs must be public and fair development of the income of all classes of the society. So, one way to assess the performance of the policy makers in one society is that "Do the social welfares of different regions of a society converge toward each other or not"? Therefore, the purpose of this paper also is to investigate the convergence of social welfare of Iran' provinces using Non-Linear Spatial Error STAR model between 2000 and 2013.

Following the introduction, in section II, the theoretical framework is provided. In section III the model specification for our research is demonstrated. The model estimation and the results are shown in section IV and finally, some concluding remarks were presented in section V.

2. Theoretical Framework

In this discussion firstly, Sen Social welfare function as one of the most important function of social welfare, has been explained and then the relationship between economic growth and income distribution as the most significant factors of social welfare and its convergence with social welfare has been investigated. Sen Function of social welfare is one of the most important functions of welfare that has entered the income distribution issue in welfare function model, and by mentioning two variables of per capita income and income distribution as the significant factors of social welfare, is explained as follows:

$$\mathrm{WEL} = \mu(1 - \mathrm{G}) \qquad (1)$$

WEL is the index for social welfare, G is the Gini coefficient and μ is the average of income. Gini coefficient in social welfare function measures the effects of inequality extent in the society on social welfare (Kakwani & Son, 2016). In this field, the two mentioned variables together by forming other social, cultural, and political organizations, pave the ground to facilitate and accelerate the process of economic development in the country, and in achieving the economic development, the effectiveness of these two variables is very important (Mahdavi-adeli & Ranjbaraki, 2005), and it can be expected that their convergence results is social welfare convergence though in long-term.

According to theories and studies related to convergence, it is expected that economic growth convergence is created among the regions of a country because for establishing social justice, this important issue has been emphasized. In a country, different regions can use the force labor, knowledge, resources, and facilities of each other, and in fact knowledge spillover can be considered as the most important factor for the convergence of economic growth of different regions of a country, and knowledge transfer can be done faster with considering the rapid development of technology and communication to OLS. So, to achieve social justice in different regions of a country, it is important to pay attention to knowledge spillover. In connection with this issue, different theories and models such as Spatial Solow model and technology transfer model have been proposed. In Spatial Solow model, both types of capital that are physical and human capital including knowledge, characteristic and social specifications, creativity, etc. are considered in the model (Gilberto et al., 2015). In Spatial Solow model, the difference in primary per capita capital and as a result the existence of effects of knowledge spillover from rich regions to deprived ones has resulted in improvement of economic growth in poor regions, and the effects of knowledge spillover is seen in the form of economic growth and reaches a steady state. Therefore, the ability of different regions in learning and promoting the efficiency indicates the intensity and extent of the effects of spatial spillover that is shown in the form of spatial coefficient (Pfaffermayr, 2009). In the theory of technology transfer, Hume believes that by imitating technology, the countries bear lower costs in comparison to innovation and technology invention state but

technology imitation results in rapid growth when the primary conditions for its growth including management and technical abilities, political stability, financial institutions and also proper policies of government to guide the investors toward activities with high efficiency are already existing (Tunali and Yilanci, 2010). In the meantime, there are social and economic differences that cause spatial differences in different regions, that sometimes escaping these differences is not possible for the country but to prevent and decrease these differences the spatial justice must be taken into regard. The Spatial justice results in creating social and economic justice. The purpose of spatial justice is the fair distribution of facilities in different regions, in a way that none of the regions has spatial excellence in comparison to others (Harvey, 1996). In fact, social justice emphasizes on income distribution and material resources of population that income distribution is in connection with social welfare (Barry, 1989). To solve the problem of income unequal distribution, on one hand the effective factors must be recognized and attempts should be made to remove the problem; and on the other hand, since the income distribution has Spatial dependence and considering the effect of economic performance of one region on that of the adjacent region, in investigating the relationship of internal conditions and regions' economy, the convergence issue of income distribution must also be taken into consideration.

The fair distribution of income is a criterion that causes satisfaction increase of low-income class of the society. In addition, the government makes attempts to create social justice and income fair distribution using instruments such as subsides or tax exemption. If the income distribution is unfair in a region, so dissatisfaction is increased there and immigration is increased to richer regions, and since these immigrants have less income in comparison to the people of these regions, they affect the income distribution and income average of these regions too and decrease their income. Therefore, by continuing this process we can see the convergence of income distribution in the country regions. Thus, for economic stability, different regions must have equivalent development (Martic & Savic, 2001). Therefore, considering that income distribution and economic growth are two factors affecting the social welfare, it is expected that convergence of these two components will result in convergence of

social welfare though in long-term. Social welfare convergence is one of the important criteria for investigation and evaluation of policies of programmers, that in case of divergence of economic welfare among different regions, class gap and inequality increase in the society and inequality increase can have undesirable consequences such as theft and crime increase that result in increasing the government costs and cause government budget deficit that results in money distribution and inflation and it causes economic growth decrease and continuation of this procedure can decrease economic welfare and this issue is not desirable from the viewpoint of policy making. Hence, the economic policy makers believe that attempts must be made for establishing convergence of social welfare of the regions.

In this field, Baumol (1986), Denis (2006), Attia & Berenger (2009), Tian et al. (2010), Schmitt & STARke (2011) and Reis (2014) have investigated the convergence of welfare and regions growth in their papers that the results have indicated the existence of convergence. Wodon & Yitzhaki (2005) also have investigated the relationship among growth, inequality and social welfare during the period between 1996 and 1998 and concluded that convergence exist in some regions of the world and all regions are not convergent. Pede et al. (2009) and Pede et al. (2014) also have investigated economic growth convergence in United States using Spatial STAR technique and the results have indicated the existence of convergence among the regions of this country. Also, Seyed Hossein Mohaqeqi et al. (2015) have investigated the social welfare of Iran's provinces in a paper entitled "Territorial analysis of social welfare in Iran". The results of his paper show that the social welfare value is very low in marginal regions of the country and the highest social welfare performance belongs to Sistan and Baluchestan Province.

Vafaei et al. (2017) have investigated the convergence of social welfare in the Iran's provinces with using spatial STAR nonlinear technique during 2000 and 2013. The results indicate that there is a convergence between provinces that they have not spatial effects. Also, the results indicate that there is not a convergence between the provinces that they have the spatial effects.

Vafaei et al. (In press) have investigated social welfare and the convergence of social welfare of Iran's provinces. For the purpose

they used Nahar and Inder convergence during 2000-2013. The results indicate that Kermanshah, Kohkiloyeh and Boyerahmad and Mazandaran is convergence towards the average of welfare of the provinces. Also, policymaker's performance in this field are not suitable for balanced development of regions welfare.

Considering the mentioned studies and the significance of the issue, in this paper, suitability of spatial error STAR model has been investigated for modeling convergence of social welfare. The differences of this article with the mentioned articles are:

1) In this paper, this issue has been investigated which method is more suitable for convergence. Hence, ordinary least squares, spatial error and spatial error STAR techniques are compared with each other for the evaluation of social welfare convergence of the Iran's provinces.
2) It is necessary to mention that the spatial error STAR technique is different from spatial STAR technique.
3) Also, we use LM tests for the evaluation of several models.

3. Model Specification

The econometrics model of Spatial smooth transition to correct spatial procedures can be used that makes a framework for statistical deduction in relation to the fluctuations of spatial parameters and investigation of endogeneity of smooth transition among regimes. Therefore, the aim of this paper is to investigate this issue and to compare this method with OLS and spatial error models.

According to the studies of Pede et al. (2008) and Pede et al. (2009), spatial error STAR model is one of the most important models of Spatial STAR model that is obtained by expansion of spatial error model as follows:

$$Y = \mathrm{X}\beta + \boldsymbol{\varepsilon} \qquad (2)$$
$$\boldsymbol{\varepsilon} = \lambda \boldsymbol{W}\boldsymbol{\varepsilon} + \boldsymbol{\mu}$$

We will have:

$$\boldsymbol{\varepsilon} = \lambda \boldsymbol{W}\boldsymbol{\varepsilon} + \boldsymbol{\mu} \rightarrow \boldsymbol{\varepsilon} - \lambda \boldsymbol{W}\boldsymbol{\varepsilon} = \boldsymbol{\mu} \qquad (3)$$
$$\rightarrow \boldsymbol{\varepsilon}(1 - \lambda \boldsymbol{W}) = \boldsymbol{\mu} \rightarrow \boldsymbol{\varepsilon} = (1 - \lambda \boldsymbol{W})^{-1}\boldsymbol{\mu}$$

By substituting (3) in equation (2) we will have:

$$Y = \mathrm{X}\beta + (1 - \lambda \boldsymbol{W})^{-1}\,\boldsymbol{\mu} \tag{4}$$

y is the N*1 vector from observations, x is the N*1 vector from explanatory variable, N is the number of regions, W is a N*N spatial weight matrix and ε is the N*1 vector of error. Based on equation (4) the spatial ARSTAR model that is combined with a spatial lagged exogenous variable in transition function and spatial autoregressive error is obtained as follows:

$$Y = \mathrm{X}\beta + \mathrm{X}\delta^{\circ}\mathrm{G}(s, \gamma, \mathrm{c}) + \boldsymbol{\varepsilon} \tag{5}$$
$$\boldsymbol{\varepsilon} = \lambda \boldsymbol{W}\boldsymbol{\varepsilon} + \boldsymbol{\mu}$$

that can be rewritten as:

$$Y = \mathrm{X}\beta + \mathrm{X}\delta^{\circ}\mathrm{G}(s, \gamma, \mathrm{c}) + (1 - \lambda \boldsymbol{W})^{-1}\,\boldsymbol{\mu} \tag{6}$$

μ has steady and independent distribution. λ is the spatial autoregressive parameter depended on error. G is the transition function, s is the transition variable, γ is the slope parameter, and c is the location parameter. The transition variable can be the dependent variable, independent variable, lagged amounts of the mentioned variables or the trend variable. In this paper, we have used the spatial independent variable x (Wx) as the transition variable. W is the N*N weight matrix in which for the regions that are vicinal we use number one and for the other regions we use zero. Wx is the vector of N*1 from the observations and is obtained by multiplying W by x and is estimated by the method of Maximum Likelihood. In this paper, to facilitate showing the model non-linear procedure, we use logistic function for transition function (G) as follows:

$$G(Wx, \gamma, c) = [1 + exp(-\gamma(Wx - c)]^{-1} \tag{7}$$

G transition function varies between zero and one based on the value of transition variable (Wx). For the γ parameter large amounts, when the Wx is more than threshold (c), the logistic function tends to

one and when it is less than threshold (c) it tends to zero; and finally the model is expressed as follows:

$$Y = \mathrm{X}\beta + \mathrm{X}\delta°\mathrm{G}(Wx, \gamma, \mathrm{c}) + (1 - \lambda\mathrm{W})^{-1}\,\mu \qquad (8)$$

Hence, in this paper the spatial error STAR model has been used to evaluate convergence of social welfare of Iran's[1] provinces between 2000 and 2013, and based on neo-classical growth theory, the unconditional growth model has been used. The unconditional neo-classical model can be rewritten after logarithms calculation as follows:

$$Ln(\frac{x^T}{x^{t_0}}) = [\alpha_{01} + \alpha_{11}Ln(x^{t_0})] + [(\beta_{02} + \beta_{12})] * \mathrm{G}(\mathrm{WLn}(x^{t_0}), \gamma, \mathrm{c}) + (1 - \lambda)^{-1}\mu \qquad (9)$$

x^T is the social welfare in 2013 and x^{t0} is the social welfare in primary time (2000) and the relevant data between 2000 and 2013 have not been used, and panel date has been converted to cross-sectional data. Therefore, although the period of the study is between 2000 and 2013, due to not using the data obtained from this period, the discussion about conventional panel is not accurate. The trend information are not usable. So, trend variable and lagged amounts of dependent and independent variables cannot be used as transition variable. With regard to not using the dependent variable as the transition variable, it can be mentioned that the information of variables level is more complete than difference information and some information are deleted in difference calculation. So, the independent variable that is the social welfare in the primary time has been used as transition variable. It should be said that the mentioned data has been extracted from economic reports of Iran Statistics Center and Central Bank of Iran, and the social welfare has been calculated based on Sen Welfare function as follows:

1. The considered statistical population is 30 provinces. Due to lack of statistics Alborz and Tehran provinces are merged and the data related to North Khorasan, South Khorasan, and Razavi Khorasan provinces have been separated and have been estimated for the year 2000.

$$WEL(x) = 2\int_0^1 GDP\ L(p)d(p) = GDP(1 - \mathrm{G}) \tag{10}$$

That GDP is real per capita gross domestic product and G is Gini coefficient.

4. Model Estimation and the Results

In this study in order to evaluate and compare different patterns, to investigate social welfare convergence the OLS method, spatial error model and spatial error STAR non-linear model have been used, and the estimation results are shown in Table 1:

Table 1: The Results of the Social Welfare Unconditional Growth Model

	OLS	**Spatial Error**	**Spatial Error STAR**
Constant, Regime 1	1.9613 (4.281)	1.5606 (3.9684)	1.883 (3.529)
ln(WEL2000), Regime 1	-0.3024 (-2.904)	-0.2102 (-2.3493)	-0.2928 (-2.345)
Constant, Regime 2	-		-0.5586 (-0.414)
ln(WEL2000), Regime 2	-		0.1668 (0.564)
$\boldsymbol{\gamma}$, slope parameter	-		6.662 (0.003)
C, location parameter	-		4.592 (56.680)
AR parameter $\boldsymbol{\lambda}$		-0.43915	
Convergence rate (%)	2.7700	1.8151	2.6649
$\mathbf{LM_{\lambda} = o}$	0.3097***		-
$\mathbf{LM_{\varphi} = o}$	6.8908*	5.5346	-
$\mathbf{LM_{\lambda=\varphi} = o}$	7.2005*		-

Notes: The numbers in the parentheses are t-values

*, **,*** denote statistically significant results at 1%, 5%, 10% level of significance.

Based on these results it can be mentioned that the obtained coefficient for the model equals -0.3024 using OLS method. This means that the provinces that have higher social welfare have lower growth and those that have lower social welfare have higher growth during time, and as a result, these provinces converge toward each other during time and the convergence rate equals 2.77%.

Based on Model 2, it can also concluded that the obtained coefficient based on this model equals -0.2102 and it indicates the existence of social welfare convergence among the provinces, and the amount of λ equals -0.43915 and is not statistically significant. So, the spatial error is not a proper and complete model to investigate social welfare convergence.

Based on Model 3 it can be concluded that in this method 2 regimes of 1 and 2 can be considered for the analysis, that the social welfare growth of the regions existing in regime 1 follows the linear relationship, so the social welfare growth of these regions is merely affected by the social welfare of that region, and as a result no effects of neighborhood Spillover is observed, while the social welfare growth of the regions existing in regime 2 follows the non-linear relationship and social welfare growth of these regions is not merely affected by the social welfare of the regions themselves, but are affected by welfare variable and factors of other regions. So, the effects of Spillover can exist among the regions of this group of provinces, that the significant of location parameter can also be the indicator of existence of non-linear relationship in the process of social welfare growth of the provinces[1].

Considering that the threshold amount equals 4.5894, so during the study period, some regions that the amount of transition variable does not exceed the threshold amount, are located in regime 1, follow linear relationship, and linear relationship coefficients are considered for them, that the obtained coefficient for those regions is -0.2928. This group includes East Azarbaijan, West Azarbaijan, Ardebil, Kurdistan, Kermanshah, Ilam, Lorestan, Hamedan, Mazandaran and Qazvin, Sistan and Baluchestan, Hormozgan, Kohgiluyeh and Boyer-Ahmad, Kerman, Yazd, Razavi Khorasan, South Khorasan, Gilan, Tehran, Golestan, North Khorasan, Semnan and Zanjan provinces. In addition, the regions for which the transition variable amount exceeds the threshold are placed in regime 2 provinces, follow non-linear relationship, and non-linear relationship coefficients are considered for them. In the non-linear model in this group the slope amount is

1. For more information see the study of Pad et al. (2008).

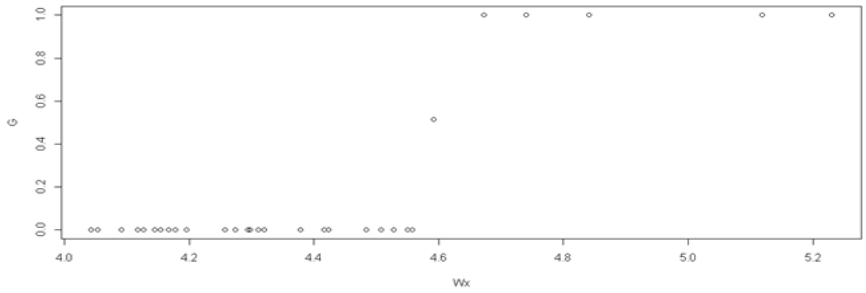
estimated -0.1260[1]. The provinces of this group include Qom, Esfahan, Khuzestan, Chaharmahal and Bakhtiari, Fars and Bushehr. Moreover, based on the results, the location parameter amount equals 4.592 and is significant that can indicate the existence of non-linear relationship in the process of social welfare of the provinces. In addition, considering the significance of the coefficients of regime 1, the results indicate that the welfare of group 1 provinces can converge toward each other, in a way that considering the slope coefficient in regime 1 to be negative, we can find that the β convergence exists in social welfare of the provinces, so the convergence coefficient is 2.6649 when G=0 (completely linear). But considering that the slope coefficient of regime 2 is negative and non-significant, the welfare of group 2 provinces does not converge toward each other.[2]

In this field, the important issue is that most of these provinces are Iran's oil regions and spatial effects in these regions has caused the welfare increase of adjacent regions; but the regions with lower welfare have not had more growth in comparison to the regions that have higher welfare, because the regions with higher welfare have been Iran's oil regions that have always had more growth in comparison to other regions. In this regard, considering that Iran's economy is based on oil, so as far as the dependency of Iran's economy to oil resources is not decreased, the convergence of these regions may not be possible. In addition, except Qom province, the rest of provinces of group 2, are neighbors of Kohgiluyeh and Boyer-Ahmad Province, and considering that it is a part of Iran's oil regions, too, but the growth of it has been -0.3419 during this period, this province is placed in group 1. Therefore, it is possible that inefficient tradeoff of this region with adjacent regions has taken place, and its neighbors may have been affected by the welfare of this region, but the welfare of this province has not been affected by the welfare of adjacent regions and has not been able to use the benefits of the region itself to increase the welfare. In addition, considering that the welfare growth of most regions of regime 1 is close to each other (minimum -0.4184, maximum 1.0987 and average 0.6004) and averagely most of the provinces with low welfare have higher growth in

1. his amount equals to the sum of coefficients of first and second regime. For more information see the papers related to non-linear models such as Trazvirta (1994), etc.
2. hese results conform to the results of the study of Pad et al. (2008).

comparison to provinces with high welfare, while some of the regions in regime 2 have higher welfare growth and some have lower (minimum 0.2807, maximum 1.9590 and average 0.8042) and also the number of these provinces is low (6 provinces) and the existence of Qom province that has had less growth with less welfare during time and Bushehr that have had very high growth, so the lack of convergence of the regions that follow regime 2 may be the result of intense difference of welfare growth of the regions in this regime[1]. Considering that in the estimated model, the parameter γ indicates the transition intensity and speed between two regimes, as the parameter γ has smaller amount, it indicates that transition from one regime to another is smooth and can have any amount between zero and one, and as the parameter γ is bigger this means that transition from one regime to another is done more rapidly and the transition function usually takes the amount of zero and one. Hence, considering the estimated transition speed (6.662) we can argue that the regime change in the present research is smooth that it is not proven statistically, and this significant issue is completely distinctive using Figure 1:

Figure 1: the Curve of Transition Function against Transition Variable



In this filed in order to diagnose that which estimation method is proper, LM tests are used that provide proofs for inappropriateness of linear model.

In fact, individual tests for spatial error model and non-linear test are significant as the common test for spatial and non-linear autoregressive error model. So, ignoring the spatial error model and

1. The reason for the difference between welfare growths in different regions is not in the scope of this study and needs more comprehensive studies.

spatial non-linear model causes that the estimation of OLS becomes inefficient. In addition, the significance of non-linear test for spatial error model also indicates that the spatial error model is inefficient, too and we should use a better and more complete method considering non-linear and spatial effects simultaneously. So, for this purpose, spatial error STAR model is efficient and this method must be used. The results of the third column also indicate that clear evidences in relation to this specification are expressed.

5. Conclusions and Recommendations

This paper has evaluated the spatial error STAR model in the convergence of social welfare in Iran's provinces between 2000 and 2013 using R software. The results of the model indicate that there is convergence in the group of provinces that follow regime 1; While, there is no convergence in the group of provinces that follow regime 2. In addition, the LM tests show that the estimation resulted from OLS method and spatial error model are inappropriate and spatial error STAR non-linear method must be used to investigate the convergence. Therefore, if the goal of the policy makers is the social welfare convergence of Iran's provinces, the political suggestion of this research is that:

- In the provinces in which there is linear relationship, the policy makers must adopt proper policies, in a way that in state programs, the quota of the more deprived areas with lower welfare must be increased and the regions with lower welfare must have priority from the viewpoint of accessing welfare facilities and services such as health, housing, etc. and direct investment must be done in these regions so that welfare convergence is created among the state provinces.
- The province in which non-linear relationship exist, must consider the spatial effects in programming and since most of them are Iran's oil regions, the key industries and activities with spillover effects must be identified and reinforced, and the efficient tradeoff should be created among these regions so that Iran's economy is saved from dependence to oil income and convergence is created among the regions welfare.

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