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A Mathematical Programing Model of Budget Allocation for Development Disparities Reduction among Iran Provinces

Hadi Rahmani Fazli*[1], Abbas Arabmazar[2]

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Abstract

The issues of disparities, regional imbalance development and attempt to reducing development disparities among various regions have been attracted considerable attention among researchers, planners and policy makers. In this regard, this study employs a mathematical programing model for budget resources allocation among Iran provinces in order to development disparities reduction among them. In this regard, the goal of the study is divided to several main sectors include education, economic development and welfare indicators. Then the mathematical model is designed in order to reduce development gap among Iran provinces in these several sectors. For this regard, we first identify the province which has best performance in under investigating indicator and then we define and calculate distance variable for other provinces. Finally, after the specification of objective function and restrictions, the designed model is solved. Comparison results of the model with the actual situation in 1390 shows that the used allocating method of provinces budgeting has not been optimal, so it seems to be necessary to review in the current method of provinces budgeting.

Keywords: Development Disparities, Mathematical Programing, Provinces of Iran, Budgeting.
JEL Classification: C61, H50, H72.

1. Introduction

Economic development disparities or imbalance and different economic development among regions and provinces are worldwide phenomenon in many countries, particularly in low and middle income countries. These disparities can enhance development diverge among regions and provinces. Disparities and inequalities contradict

1. Faculty of Economics, University of Allame-Tabataba'i, Tehran, Iran (Corresponding Author: Hady.rahmani@gmail.com).
2. Faculty of Economics, University of Shahid Beheshti, Tehran, Iran (Ab_arabmazar@sbu.ac.ir).

fairness at regional level and it is one of the main sources of social tensions which tend to socio-political instability. Consequently, a higher level of social and political instability among poor and rich provinces can have a negative effect on economic growth. In this situation, investment decisions are made under uncertainty. In the other hand, rising inequality and disparity lead to tensions within a country and compromise the prospect of long-term sustainable growth through of a variety of social, political and economic mechanisms (Kanbur and Lustig, 2000; Fan et al., 2011; Kanbur and Zhang, 2005; 2007).

In the economy of Iran, exclusion reduction of less developed regions has always been a challenge to achieve economic and social equality that has been not realized until for various reasons such as geographical isolation, war and insecurity arising from it and limitation factors that influence investment. In the other hand, the imbalanced of regional development cause to higher centralization and continuing immigration and marginalization, discrimination and lack of unemployment improvement. It is lead tend to unbalanced distribution of population (Amirahmadi, 1986; Amirahmadi and Atash, 1987).

Therefore, reducing these inequalities has become a major challenge for budget planner. Budgeting is a work or process that it is in progress to the allocation of government funds to various sectors or programs. The main issue in budgeting process is the following question. How much should each entry get? This question has two dimensions: the efficiency of public expenditure, and the priorities of government. Budget formulation is an important legislative activity as it determines how to government distributes public resources among different provinces and regions, especially in the Iran. Throughout the effectiveness and efficient budgeting, government can reduce regional disparities. For these regards, budget planner must be attention to the optimal mathematical models in order to reduce development distance among various regions and provinces in budget allocation.

This study is done to improve equity and fairness re-allocation in budget resources among Iranian provinces in order to reduce development disparities and gap reduction. Another goal of this study is re-allocation provincial budget resources in order to achieve

development convergence among provinces. In this regards, we employ a mathematical programing model. This model is a multi-criterion decision making model (MCDM) will assist management's understanding of resources allocation problems.

The rest of the paper is organized as follow. Section 2 contains the literature review. In section 3, the Iran's regional disparity is presented based on official statistics. In the section 4, the designed model is presented. Finally the section5 contains the empirical results of solved model based on provincial data.

2. Literature Review

There are different theories related to economic development and disparities explanation such as linear stages theory, Kuznets six characteristics theory and interregional relationship theory. Based on Kuznets (1955) theory, income inequality increase in the initial phase of industrialization and when reach a peak then it starts to decline. This pattern called Kuznets curve which define an inverted-U shape relationship between inequality and economic development. Another main contribution to the study of convergence is made by Solow (1956) and Swan (1956). This model is called neoclassical growth model. The neoclassical growth model predicts that conditional convergence is possible. But endogenous growth model of Romer (1986) and Lucas (1988) suggests that convergence is not guaranteed and trends in inequality can persist.

The existence of gap among regions over a period of time has been illustrated through the famous inverted-U curve suggested by Williamson (1965). The inverted-U curve illustrates that in the first stages of national economic growth, regional inequality grows. First from a certain transition point, the national economic growth is accompanied by a reduction of regional disparity. The Williamson transition theory is presented in figure 1.

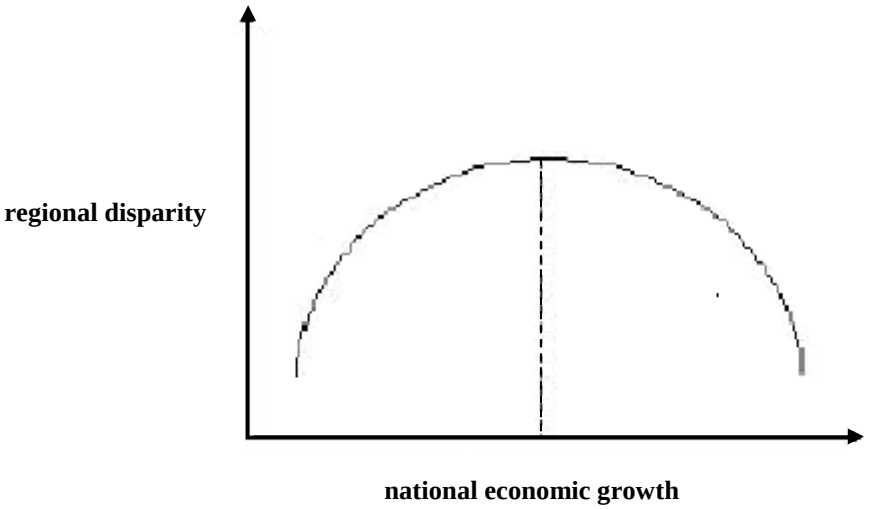

Figure 1: Relationship between Regional Disparity and Economic Growth Based on Williamson Theory

In the other hand, according to Pinder (1983), interregional theory attempt to explain the future of broad interregional development contracts among regions.

2.1 Empirical Studies

Norris and Weber (2001) examined economic disparities across regions in Russia. They analyze various transfer rules between different regions. The results show that there is a wide gap among various Russia regions.

Chae et al. (2006) offered two allocation models for policy makers in Papua New Guinea using goal programming. In first model, national financial resources allocate in health sector and among 19 provinces. The second model, utilizes the results from the first model to allocate resources among different health activities within each province. These models determine major health problems of each province and available health resources.

Du et al. (2012) employed spatial error model and spatial lag model to analyze the disparity of regional financial development of China's 28 provincial regions during 1992-2009. Their results show that the spatial dependent effect of financial development between China's

provinces is significant during 1992-1997 and 1998-2003, but this effect has converted to spatial spillover effect during 2004-2009.

Ohlan (2013) assessed the pattern of disparities in socio-economic development in the India. The results show that the wide level of development disparities among various regions in India. Based on this study results, the level of development in infrastructure services sector is found to be positively significant associated with the overall development indicators.

Banerjee and Kuri (2015) attempted to evaluate the trend and level of inequality across Indians states based on Human Development Indicator. Their results show that a targeted level of HDI reduces the extent of polarization and can bring out a balanced development in Indian states.

There are limited studies in the domestic literature. These studies have generally focused on providing ranking methods for the level of development of the regions, and have not provided optimal resource allocation approaches (Sepehrdoust, 2009; Abdollahzade and Sharifzadeh, 2012; Pourmohammadi and Valibeigi, 2015).

2.2 Regional Disparity in Iran

Currently, distribution of average income (in form of GDP per capita) is used to evaluate the development level of various regions. Figure2 shows the trend of real per capita GDP of selected highest and lowest level of GDP per capita of Iran's provinces during 2000 to 2010 in order to illustration regional disparity among these regions. Based on the provincial data, the real per capita GDP of the richest region, Kohkiloyeh, is about 8.6 times that of the poorest region, Sistan. The data show that, only 6 among 30 provinces have higher level of GDP per capita than the mean of country during 2000 to 2010.

Based on the figure2, during the 2000-2010 periods, there is a rising gap in GDP per capita among selected Iran's provinces. This figure shows the development gap and disparity among selected poorest and richest Iran's provinces.

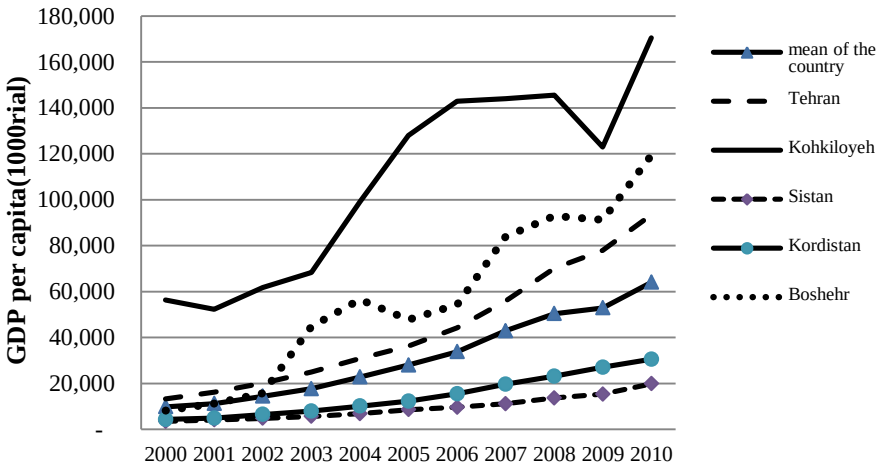

Figure2: GDP Per Capita of Selected Provinces during 2000-2010

3. The Model

The main goal of this study is to provide a re-allocation budgeting model in order to reduce development gap among various heterogonous regions or provinces of Iran. For this regard, we sort indexes or characteristics in four main sets include economic performance, education indicators, infrastructure indicators and welfare indicators. In figure1 we draw the total perspective of the model.

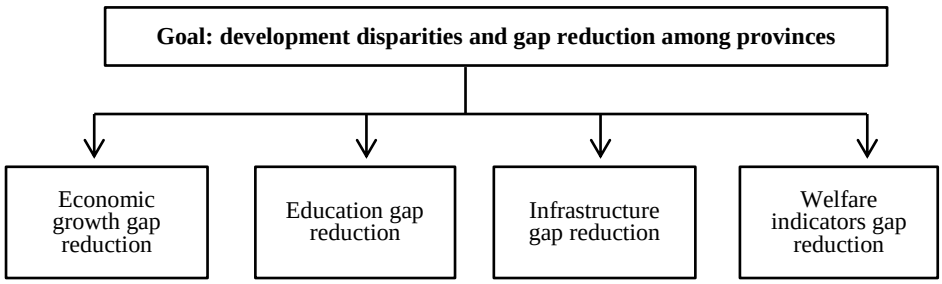

Figure3: The Total Perspective of the Model

In any sector, we define several indexes. For this purpose, we first suppose that there are N provinces with M Indies that we want to investigate them and then we define the following indicator:

$$x_{ij}^{*} \in A_i = \{x_{ij}, j = 1,2,...,N\} \quad for \quad i = 1,2,..,M \tag{1}$$

In the equation (1), x_{ij} presents the value of indicator i in the province j and x_{ij}^{*} shows the best performance among N provinces in the indicator i .These indicators are referring to economic development Indies such as education, health, and infrastructure and employment level. Now we define distance indicator as follow:

$$d_{ij} = \left| x_{ij} - x_{ij}^{*} \right| \tag{2}$$

In the equation (2), $|.|$ shows the absolute value. For any indexes in any province, d_{ij} is definable. It is clear that in the province with best performance the distance variable is equal to zero or $d_{ij} = 0$. The goal of study is to minimize cost of provinces development disparities. So we define the following objective function for any province:

$$\min \quad \ell_j = \sum_{i=1}^{M} w_i d_{ij} = w_1 d_{1j} + w_2 d_{2j} + ... + w_M d_{Mj} \tag{3}$$

In the equation (3), w_i presents the weight of index i in province j . So for any province, $\left[w_j \right]_{j=1,2,...,M}$ presents the vector of weights from dimension M . This vector is specified by using the AHP methods of operation research. Finally, the total objective function is as follow:

$$\min \quad \sum_{j=1}^{N} \alpha_j \ell_j = \alpha_1 \ell_1 + ... + \alpha_N \ell_N \tag{4}$$

In the equation (4), α_j shows the weight of province j . It is important to specify restrictions of the model. For this purpose and in the table1, we first define the following variables.

Table1: Variables Definition of Model Restrictions

Index	Explanation	Definition
MAB_j	The value of budget that can be allocated to province j.	Province budget ceiling
B_{ij}^*	The value of budget that it is needed to obtain 1 percent of goal i in province j.	The cost of achieving goals
MAB_i^*	The value of budget that can be allocated to goals in province j.	Index budget ceiling
$B_i^* = \sum_{j=1}^{N-1} B_{ij}^*$	The value of budget that it is needed to obtain 1 percent of goal i.	The cost of achieving goal i
$B_j^* = \sum_{i=1}^{M} B_{ij}^*$	The value of budget that it is needed to obtain 1 percent of goals in province j.	The cost of achieving goals in province j
$B^* = \sum_{j=1}^{N-1}\sum_{i=1}^{M} B_{ij}^*$	The value of budget that it is needed to obtain 1 percent of goals in total provinces	The cost of achieving M goals in N province

Then we specify the following restrictions based on the defined variables:

$$0 \le B_{1j}^* d_{1j} + B_{2j}^* d_{2j} + ... + B_{Mj}^* d_{Mj} \le MAB_j \quad (5)$$

$$0 \le B_{i1}^* d_{i1} + B_{i2}^* d_{i2} + ... + B_{iN}^* d_{iN} \le MAB_i^* \quad (6)$$

We also re-define the objective function as:

$$\min \quad \ell_j = \sum_{i=1}^{M} w_i B_{ij}^* d_{ij} = w_1 B_{1j}^* d_{1j} + w_2 B_{2j}^* d_{2j} + ... + w_M B_{Mj}^* d_{Mj} \quad (7)$$

Finally, total presentation of the designed model is as follow:

$$\min \quad \sum_{j=1}^{N} \alpha_j \ell_j = \alpha_1 \ell_1 + ... + \alpha_N \ell_N \quad (8)$$

s.t:

$$0 \le B_{1j}^{*} d_{1j} + B_{2j}^{*} d_{2j} + ... + B_{Mj}^{*} d_{Mj} \le MAB_j \qquad for \qquad j = 1, 2, ..., N \tag{9}$$

$$0 \le B_{i1}^{*} d_{i1} + B_{i2}^{*} d_{i2} + ... + B_{iN}^{*} d_{iN} \le MAB_i^{*} \qquad for \qquad i = 1, 2, ..., M \tag{10}$$

$$B_{ij}^{*} \ge 0 \qquad i = 1, 2, ..., N \qquad j = 1, 2, ..., M \tag{11}$$

$$d_{ij} \ge 0 \qquad i = 1, 2, ..., N \qquad j = 1, 2, ..., M \tag{12}$$

Equation (8) shows the objective function and equation (9) presents N restriction on provinces and equation (10) shows the M restrictions on sectors or indexes. Evaluation of MAB_j and MAB_i^{*} is difficult, so we normalize the model. For the normalization of restrictions, we divide restrictions (9) on MAB_j and also divide restrictions (10) on MAB_i^{*}. We also divide the objective function ℓ_j on MAB_j and then we obtain normalized objective function ℓ'_j. The modified model is as follow:

$$\min \qquad \ell'_j = \sum_{i=1}^{M} w_i b_{ij}^{*} d_{ij} = w_1 b_{1j}^{*} d_{1j} + w_2 b_{2j}^{*} d_{2j} + ... + w_M b_{Mj}^{*} d_{Mj} \tag{13}$$

$$\min \qquad \sum_{j=1}^{N} \alpha_j \ell'_j = \alpha_1 \ell'_1 + ... + \alpha_N \ell'_N \tag{14}$$

s.t:

$$0 \le b_{1j}^{*} d_{1j} + b_{2j}^{*} d_{2j} + ... + b_{Mj}^{*} d_{Mj} \le 1 \qquad for \qquad j = 1, 2, ..., N \tag{15}$$

$$0 \le b_{i1}^{*} d_{i1} + b_{i2}^{*} d_{i2} + ... + b_{iN}^{*} d_{iN} \le 1 \qquad for \qquad i = 1, 2, ..., M \tag{16}$$

$$b_{ij}^{*} \ge 0 \qquad i = 1, 2, ..., N \qquad j = 1, 2, ..., M \tag{17}$$

$$d_{ij} \ge 0 \qquad i = 1, 2, ..., N \qquad j = 1, 2, ..., M \tag{18}$$

Where in (13) to (18), we have:

$$b_{ij}^{*} = \frac{B_{ij}^{*}}{MAB_{j}} \qquad for \qquad j = 1, 2, ..., N \tag{19}$$

$$b_{ij}^{*} = \frac{B_{ij}^{*}}{MAB_{i}^{*}} \qquad for \qquad i = 1, 2, ..., M \tag{20}$$

The variable b_{ij}^{*} presents the proportion of province i in index j from total country budget resources. Now we can define provinces proportions in total country budget as follow:

$$y_{j}^{*} = \sum_{i=1}^{M} d_{ij} b_{ij}^{*} \qquad for \qquad j = 1, 2, ..., N \tag{21}$$

Our final goal of this study is to find the optimal value of y_{j}^{*} based on the designed model solution. There is also the following restriction in the designed model, based on definitions.

$$\sum_{j=1}^{N} y_{j}^{*} = \sum_{j=1}^{N} \sum_{i=1}^{M} d_{ij} b_{ij}^{*} = 1 \tag{22}$$

This equation indicates that the sum of provinces proportions in total budget resources equal to 1. We want to find optimal proportions of any provinces. In order to solve the designed model, we employ simplex method of operation research. For this regard, the MATLAB programing software is employed.

4. Empirical Results

In this sector, the empirical result of solved model is presented for Iran. We use provincial data getting out from Iran Statistics Center. These data include of provincial indicators in economy, education, infrastructure and welfare sectors in 2011 year. We employ six provincial indicators such as GDP per capita, economic participation rate, internet using rate, literacy rate, GINI coefficient and unemployment rate. Then we solve the designed model, practically. We first find and highlight the province which has best performance in any index. Then we calculate the distance indicator for any provinces

for every index. Finally, we solve the model by using MATLAB programing environment.

Table2: Iranian Provinces Data in 1390 Year

Province	GDP per capita	Economic participation rate	Internet using rate	Literacy rate	GINI coefficient	Unemployment rate
East Azerbaijan	67.12	0.411	0.157	0.821	0.367	8.1
West Azerbaijan	50.88	0.399	0.114	0.788	0.338	9.8
Ardebil	62.02	0.403	0.136	0.808	0.329	12.1
Esfahan	92.41	0.401	0.225	0.878	0.328	11.8
Alborz	80.03	0.342	0.221	0.902	0.272	9.6
Elam	53.27	0.365	0.164	0.823	0.340	8.7
Boshehr	226.25	0.363	0.198	0.836	0.319	7.8
Tehran	145.05	0.392	0.26	0.903	0.352	11.4
Charmahal	60.75	0.378	0.142	0.825	0.334	14.1
South khorasan	59.22	0.365	0.161	0.825	0.320	7.4
Razavi khorasan	66.99	0.364	0.151	0.863	0.327	8.9
North khorasan	50.95	0.431	0.129	0.803	0.332	13.5
Khozestan	85.95	0.346	0.148	0.835	0.337	9.6
Zanjan	67.77	0.373	0.17	0.823	0.284	8.7
Semnan	106.01	0.394	0.24	0.884	0.333	7.8
Sistan	39.85	0.29	0.066	0.715	0.401	11.1
Fars	73.80	0.359	0.174	0.863	0.357	10.1
Gazvin	92.04	0.416	0.17	0.841	0.274	14.0
Ghom	67.79	0.33	0.205	0.866	0.359	8.1
Kurdistan	50.83	0.407	0.123	0.779	0.311	11.1
Kerman	77.29	0.338	0.14	0.822	0.332	8.4

Province	GDP per capita	Economic participation rate	Internet using rate	Literacy rate	GINI coefficient	Unemployment rate
Kermanshah	66.53	0.369	0.13	0.817	0.341	15.3
Kohkiloyeh	52.31	0.292	0.145	0.819	0.305	13.7
Golestan	50.62	0.366	0.136	0.83	0.381	12.3
Gilan	64.90	0.378	0.149	0.843	0.312	12.3
Lorestan	52.74	0.354	0.127	0.804	0.307	14.9
Mazandaran	83.87	0.381	0.166	0.857	0.309	13.8
Markazi	98.18	0.367	0.171	0.838	0.345	5.5
Hormozgan	89.30	0.322	0.139	0.837	0.288	7.4
Hamedan	63.30	0.394	0.135	0.836	0.343	6.4
Yazd	142.065	0.369	0.212	0.878	0.316	6.7

Source: Iran statistical center

Based on the table2, Tehran province has best performance in two indicators literacy rate and internet using rate among 31 Iran's provinces. In the economic participation rate indicator, Gazvin province has best performance. Based on the table2, the lowest value of GINI coefficient, as the measure of income inequality, belongs to Gazvin province. The Markazi province has lowest value of unemployment rate among 31 provinces in Iran and Boshehr province has highest value of GDP per capita among these provinces. We calculate distance variable for any province in any indicator based on the provinces that have best performance in these indicators. For any provinces, the distance variable is calculated respect to best performance province.

The distance indicator (d_{ij}) for any provinces in any indexes is calculated based on the real data for $N = 31$ and $M = 6$. We also calculate weights vectors of indicators based on the AHP approach. Then we can solve model based on operation research methods. We employ simplex method by using MATLAB programing environment.

The results of solution are presents in table3. In this table, the optimal proportion of any provinces is presented based on the designed model.

Table3: Model Solution Results and Comparison with Actual Budget Allocation in 1390

Province	Provinces optimal proportion in total budget resources (y_j^*)	Actual Provinces proportion in total budget resources based on 1390 budget plan
East Azerbaijan	3.29	4.49
West Azerbaijan	3.55	3.65
Ardebil	3.22	1.90
Esfahan	3.55	5.36
Alborz	3.61	1.89
Elam	3.78	1.53
Boshehr	3.13	2.03
Tehran	2.34	11.26
Charmahal	3.26	1.56
South khorasan	3.12	1.46
Razavi khorasan	3.15	6.21
North khorasan	3.06	1.31
Khozestan	2.98	6.54
Zanjan	3.08	1.93
Semnan	3.24	1.35
Sistan	3.29	3.91
Fars	3.41	6.27
Gazvin	2.95	1.47
Ghom	3.17	2.86
Kurdistan	3.85	1.54
Kerman	3.16	2.68
Kermanshah	3.04	4.21
Kohkiloyeh	3.61	3.38
Golestan	3.25	2.31
Gilan	3.21	3.38
Lorestan	3.14	2.62
Mazandaran	3.45	4.31

Province	Provinces optimal proportion in total budget resources (y_j^*)	Actual Provinces proportion in total budget resources based on 1390 budget plan
Markazi	3.17	1.71
Hormozgan	3.07	2.62
Hamedan	2.98	2.44
Yazd	2.89	1.81

Source: Research finding

Based on the table3, the designed model has ability to set provinces budgeting. Comparison results of the model with the actual situation of provinces budget allocation in 1390 shows that there is significant difference between actual and optimal budget allocation. It is show that the actual method of provinces budgeting has not been optimal in 1390 year. So it seems to be necessary to review in the current method of provinces budgeting.

As it is presented in table3, in order to reduce development gap among provinces of Iran, the higher proportions of general budget must allocate to lower developed provinces with low performance in under study indicators that need to employ transfer policies among regions and provinces. In real, government must use mechanisms to transfer budget fund from more developed regions to less developed provinces of them. Thus, the possibility of achieving convergence in budget distribution, as a result of proposed model, is possible. We can develop the solution for any number of indicators. Our designed model can allocate budget resources to provinces in order to reducing gap among them.

5. Conclusion

The existence of regional disparities within a country remains as an important theoretical and practical issue which it is examined in planning and allocation of budget resources. In this study we design a mathematical multi-purpose programing model in order to re-allocation budget resources among Iran's provinces to achieve development convergence among them. In this regard, we attempt to design a model that allocates budget resources to provinces such that development distance and economic disparities among them be at

least. In order to fulfill this budgeting process, it is recommended that the transfer policies be used among more and less developed provinces. This will allow the convergence in redistribution of budgeting among Iranian provinces. The government, as budget planner, can increase relative proportion of less developed provinces in oil revenues in order to achieve convergence in budget distributions among heterogeneous Iranian provinces.

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