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Industrial Productivity Estimation And Mapping (A Case Study of Iran's Economy)

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Abstract

Productivity is among the most important indices for the performance evaluation of businesses. According to analyses, industrial productivity has increased in businesses with high growth rates due to structural developments and the transfer of resources from less productive to more productive industries, which is the major impetus for economic growth. Productivity is also an important index for attracting investment in manufacturing units. A method to improve this index is to calculate productivity accurately. Therefore, different industries should measure productivity to identify and improve their weaknesses. This study aims to measure industrial productivity in 31 provinces of Iran in 2019. After the total factor productivity (TFP) was measured through the Solow residual method in this study, the partial factor productivity (PFP) was also calculated (i.e., human resources productivity, capital productivity, and productivity of resources). Moreover, provinces were ranked in performance in each index, and their ranks were shown on Iran's geographical map. In addition to analysing the productivity status in the provinces of Iran, this study aimed to present national productivity maps.

Introduction

Recent empirical evidence underscores the vital role of industrial development in fostering structural change and promoting a country's long-run development objectives. Devising sound industrial policy institutions emerges as a key policy option to promote reallocating human, physical and financial resources to high-value-added sectors of the economy (Mbate, 2016). Total factor productivity (TFP) and partial factor productivity (PFP) are the prominent indices for the analysis of industrial development in countries or regions. This study addresses industrial productivity by using these indices. Furthermore, after these indices were estimated, hierarchical clustering classified the studied provinces as high-productivity, medium-productivity, low-productivity, and poor-productivity groups. The dispersion rates of all the TFP and PFPs were then shown on a geographical map of Iran. Before the productivity indices are estimated, theoretical and empirical foundations are first reviewed in the following section.

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Literature Review

Generally, regional planning may be defined as regulating and coordinating different socio-economic plans with local possibilities and needs. It frequently refers to people and regions' participation in the process of planning through providing suitable grounds for bottom-up planning, in order to adapt macro/national plans with areal characteristics (Shakoori, 2016, quoting from Misra, 1992; Glasson and Marshall, 2007). Through emphasising on a wide range of planning objectives at micro-meso- and macro levels such as meeting the specified targets for sectoral development and national economic growth; using financial and physical resources with a higher level of productivity; and providing a balanced and harmonised inter-regional development in the sense that no region of the society or the country is left neglected by the fast-moving wheel of time and that certain basic needs of a nation as a whole are satisfied (Shakoori, 2016). To better determine the state of Iran's economy, we have focused on total and partial productivity indicators, which needs a review on theory of production functions.

The Solow residual model considers four variables: production (*Y*), capital (*K*), labor force (*L*), and technical knowledge (*A*). At a given moment like *t*, an economy has certain values of independent variables (inputs) and combines them to produce products. Therefore, the production function is defined as below:

$$Y(t) = F\big(K(t).A(t)L(t)\big) \qquad (1)$$

Note that if inputs *A* and *L* are entered as a product, *AL* is considered the effective labor force. If it is entered into the function as below:

$$Y = AF(K.L) \qquad (2)$$

Then it is called the Hicks-neutral technical change. The production function must first be estimated to measure productivity. In fact, the production function indicates the mathematical relationship between the inputs of a production unit and its outputs. Nonetheless, the analysis can be extended to include natural resources and land. For better understanding, the Cobb–Douglas production function can be defined as below:

$$Y(t) = K_t^{\alpha} R_t^{\beta} T_t^{\gamma} [A_t L_t]^{1-\alpha-\beta-\gamma} \qquad (3)$$

$$\alpha > 0 \text{ , } \beta > 0 \text{ , } \gamma > 0 \text{ , } \alpha+\beta+\gamma < 1$$

Where *R* denotes the resources used in production, and *T* represents the piece of land (Romer, 2001).

In this analysis, the Cobb–Douglas function was employed to estimate the industrial production function by considering three production factors (labor force, capital, and fuel or energy). This function was defined as below:

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$$Y_t = A\ L_t^{\alpha}\ K_t^{\beta}\ R_t^{\gamma} \tag{4}$$

Where *L*, *K*, and *R* indicate the labour force employed in a period of time (*t*), capital, and the amount of fuel or energy consumed, respectively. Moreover, *Y* is the predicted product index for the manufactured product. The residual component of the Cobb–Douglas production function is then used in a logarithmic form to determine the TFP, which is calculated through the Solow residual method (*i.e.*, Divisia Index) for the sector of interest.

$$TFP = \frac{Y_t}{L_t^{\alpha} K_t^{\beta} R_t^{\gamma}} \tag{5}$$

In Equation 2, the TFP is the Solow residual, which results in the following through a logarithmic process:

$$LnTFP = LnY_t - \alpha LnL_t - \beta LnK_t - \gamma LnR_t \tag{6}$$

Moreover, coefficients α, β, and λ represent elasticities of production to the inputs of the labor force, capital, and resources, respectively. In this study, the same method was employed to reach the research goal, *i.e.* analysing the status of this index in 31 provinces of Iran. Based on the Cobb–Douglas function, the final PFP can be calculated in the following way for the three production inputs:

PFP of labor force: $MPL = \frac{\partial y}{\partial L} = A\alpha(L^{\alpha-1})(K^{\beta})R^{\gamma}$ (7)

PFP of capital: $MPK = \frac{\partial y}{\partial k} = A\beta(L^{\alpha})(k^{\beta-1})R^{\gamma}$ (8)

PFP of resources: $MPR = \frac{\partial y}{\partial R} = A\gamma(L^{\alpha})(K^{\beta})(R^{\gamma-1})$ (9)

Khan et al. (2021) showed that adopting advanced technology helps increase the teleworking pattern in Romania. The increased use of teleworking practices has been regarded as an important practice in Romania to follow the COVID-19 policies imposed by the Government on one side, yet to keep the business operation in smooth run by working from home through employing technology to maintain the firm productivity.
Shao *et al.* (2016) also present the fluctuation of TFP in the nonferrous metal industry from 2004 to 2013 and analyse the key factors responsible for this fluctuation from the perspectives of production techniques, management, and scale. The static analysis results show that the overall TFP of China's nonferrous metal industry is relatively low, and production inefficiency in the mining and smelting industries are two primary sources of this overall TFP inefficiency. There are significant differences among the 30 sub-sub-sectors in TFPs. During their sample period, some sub-sub-sectors experienced

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rapid growth in TFP, while others remained at a low level. The dynamic analysis results show differences in the key factors affecting the TFPs of three sub-sectors. Technical (Shao *et al.*, 2016).

Development planning started after the Second World War in Iran. Since then, many developing countries have implemented several national development plans, including in Iran. Regional planning and regionalisation of developmental efforts have been major objectives of all these plans. This paper scrutinises the status and nature of regional planning in the country's development plans. It intends to see to what extent and how this objective has been achieved. By examining the development plans both in pre- and post-revolutionary periods, the paper concludes that despite strong policy pronouncements on regional development, regional planning has not yet become an integral part of Iran's planning system, due mainly to the country's centralised political and administrative structure, the built-in resistance of the bureaucracy to changes implied in the regionalisation policies, the sectoral structure of the country's planning system, and regional inequality from the point of view of the executive authority, as well as excessive deprivation of some regions and their inability to mobilise local forces for development (Shakoori, 2016).

However, the analysis of this variable in Iran among different provinces has been neglected in the study of productivity. Generally, there are insufficient studies regarding in the analysis of productivity in terms of its dispersion in different countries or geographical regions. This study also aims to show the productivity dispersion and prepare a productivity map. After that, the estimated model and its results are analysed. The review of empirical studies on regional inequalities in Iran indicated that the dispersions of TFP and PFP have received insufficient research attention. In fact, different regions of a country vary in terms of income resources and competitive advantages, which can also be reflected in productivity indices. Therefore, after the theoretical studies are reviewed, these indices are estimated in order to prepare a map of their dispersions among the 31 provinces of Iran. Developing this map and proving a geographical presentation of TFP and PFP dispersions are considered research innovations in productivity studies.

Research Methodology:

This study aims to analyse productivity indices, including the TFP and PFPs (*i.e.*, labour force-productivity, capital, and fuel and energy productivity). For this purpose, the data were extracted from the Statistical Center of Iran for the census plan of industrial workshops with 10 workers and more in all provinces of Iran in 2019.[1]

In this study, the production function should first be estimated in Iran's economic industry to estimate the productivity indices. For this purpose, the Cobb–Douglas production function was adopted. The producer cost index was employed to modify all

[1] *This study was conducted on the cross-sectional data of the year 2019.*

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research variables (*i.e.*, value-added of the industrial sector, service compensation of the labour force, capital inventory, and value of resources) based on the constant prices of the year 2016. After TFP and PFP were estimated, hierarchical clustering was used with four groups (provinces with high, medium, low, and poor productivity rates) to classify the indices.

Hierarchical clustering is also another technique for performing data exploratory analysis. It is an unsupervised technique. Nielsen (2016) has described at length a technique to partition a data-set $X = \{x_1 . \cdots . x_n\}$ into a collection of groups called clusters:

$$X = \cup_{i=1}^{k} G_i \qquad (10)$$

by minimising the k-means objective function (i.e., the weighted sum of cluster intra-variances) (Nielsen, 2016).

Hierarchical clustering consists in building a binary merge tree, starting from the data elements stored at the leaves (interpreted as singleton sets) and proceeding by merging two by two the "closest" sub-sets (stored at nodes) until we reach the root of the tree that contains all the elements of X. The distance between any two sub-sets of X, called the linkage distance, is denoted by $\Delta\left(X_i . X_j\right)$. This technique is also called agglomerative hierarchical clustering since we start from the leaves storing singletons (the x_i's) and merge iterative.

Let $D(x_i . x_j)$ denote the elementary distance between any two elements of X (for example, the Euclidean distance). In order to select at each stage of the hierarchical clustering the closest pair of sub-sets, we need to define a sub-set distance $\Delta\left(X_i . X_j\right)$ between any two sub-sets of elements. Of course, when both sub-sets are singletons $X_i = \{x_i\}$ and $X_j = \{x_j\}$, we should have:

$$\Delta\left(X_i . X_j\right) = D(x_i . x_j) \qquad (11)$$

Three such common linkage functions are presented below:

Single Linkage (SL):

$$\Delta\left(X_i . X_j\right) = \min_{x_i \in X_i . \, x_j \in X_j} D(x_i . x_j) \qquad (12)$$

Complete Linkage (CL) (or diameter):

$$\Delta\left(X_i . X_j\right) = \max_{x_i \in X_i . \, x_j \in X_j} D(x_i . x_j) \qquad (13)$$

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Group Average Linkage (GAL):

$$\Delta(X_i.X_j) = \frac{1}{|x_i||x_j|}\sum_{x_i \in X_i}\sum_{x_j \in X_j} D(x_i.x_j) \qquad (14)$$

As mentioned before, we have implemented the hierarchical clustering method for classifying the provinces of Iran by their performance in productivity indicators. 4 stages are considered for analysis of development stages in the provinces of Iran, so this value is utilised in this study for the cluster analysis. The status of each index in each of the 31 provinces of Iran was also shown on a geographical map to better describe the indices. In fact, a research goal was to prepare a national productivity map. The effect of inflation in variables has been removed by implementing the industrial inflation indicator.

Findings

The logarithmic Cobb–Douglas production function was estimated in Stata to estimate the mentioned indicators. In this function, the regression coefficients of every input indicate its production elasticity. The research results indicated the rejection of the null hypothesis of the regression test, stating that the regression coefficients are zero. In other words, the regression coefficients are significant. The value of the R-squared statistic indicated the appropriateness of the model proposed to estimate the TFP through the Solow residual method (significance level: 10%).

Moreover, the Breusch–Pagan test was conducted to ensure the absence of inconsistence variance among the researcher data because this study used the cross-sectional data. According to this test, the null hypothesis stating the consistency of data variance was not rejected. The following table reports the test results.

Table 2. The Results of the Regression Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.26	0.80	2.86	0.00
LNW	0.34	0.17	1.98	0.06
LNK	0.48	0.08	5.85	0.00
LNR	0.28	0.06	4.37	0.00
R-squared				0.95
Adjusted R-squared				0.94
Root MSE	0.23			

Source: research findings

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Table 3. Breusch-Pagan / Cook-Weisberg test for Heteroscedasticity

chi2(1)	0.73
Prob > chi2	0.39

Source: research findings

According to the Skewness/Kurtosis test for normality, the normal distribution of residuals was confirmed in this estimation.

Table 4. Skewness/Kurtosis test for Normality

Pr(Skewness)	Pr(Kurtosis)	chi2(2)	Prob>chi2
0.14	0.85	2.45	0.30

Source: research findings

Since the residual component of the estimated regression is the logarithm of TFP based on Euler's number, the TFP can be obtained for all 31 provinces of Iran by converting this value into a non-logarithmic form. Hierarchical clustering also classified these indices as four groups of provinces (high, medium, low, and poor productivity ratios). According to the estimated indices, the best outputs resulted from Hormozgan, Kermanshah and Ardabil provinces, whereas the worst outputs came from Sistan and Baluchestan, Semnan and North Khorasan provinces. The other provinces were also ranked in terms of the values obtained from the TFP. The following table reports the values of this index for 31 provinces of Iran.

Table 5. Total Factor Productivity Index for 31 Provinces of Iran in the Year 2019

PROVINCES	*DEGREE OF PRODUCTIVITY*	*TFP INDEX*
HORMOZGAN	High Productivity	1.65
KERMANSHAH	High Productivity	1.47
ARDABIL	High Productivity	1.43
CHAHARMAHAL AND BAKHTIARI	High Productivity	1.43
EAST AZERBAIJAN	High Productivity	1.37
ILAM	High Productivity	1.27
GOLESTAN	Medium Productivity	1.18

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GILAN	Medium Productivity	1.15
HAMADAN	Medium Productivity	1.10
MARKAZI	Medium Productivity	1.04
KOHGILUYEH AND BOYER-AHMAD	Medium Productivity	1.04
LURISTAN	Medium Productivity	1.04
KURDISTAN	Medium Productivity	1.00
QOM	Medium Productivity	1.00
TEHRAN	Low Productivity	0.97
MAZANDARAN	Low Productivity	0.96
ISFAHAN	Low Productivity	0.95
FARS	Low Productivity	0.94
QAZVIN	Low Productivity	0.91
KHUZESTAN	Low Productivity	0.90
RAZAVI KHORASAN	Low Productivity	0.88
SOUTH KHORASAN	Low Productivity	0.87
KERMAN	Low Productivity	0.87
YAZD	Low Productivity	0.87
BUSHEHR	Low Productivity	0.85
ZANJAN	Low Productivity	0.84
WEST AZERBAIJAN	Poor Productivity	0.80
ALBORZ	Poor Productivity	0.77
SISTAN AND BALUCHESTAN	Poor Productivity	0.76
SEMNAN	Poor Productivity	0.74
NORTH KHORASAN	Poor Productivity	0.70

Source: research findings

Considering the important role of the TFP in analysing the performance of each province in the industrial sector, Map 1 demonstrates the status of this index.

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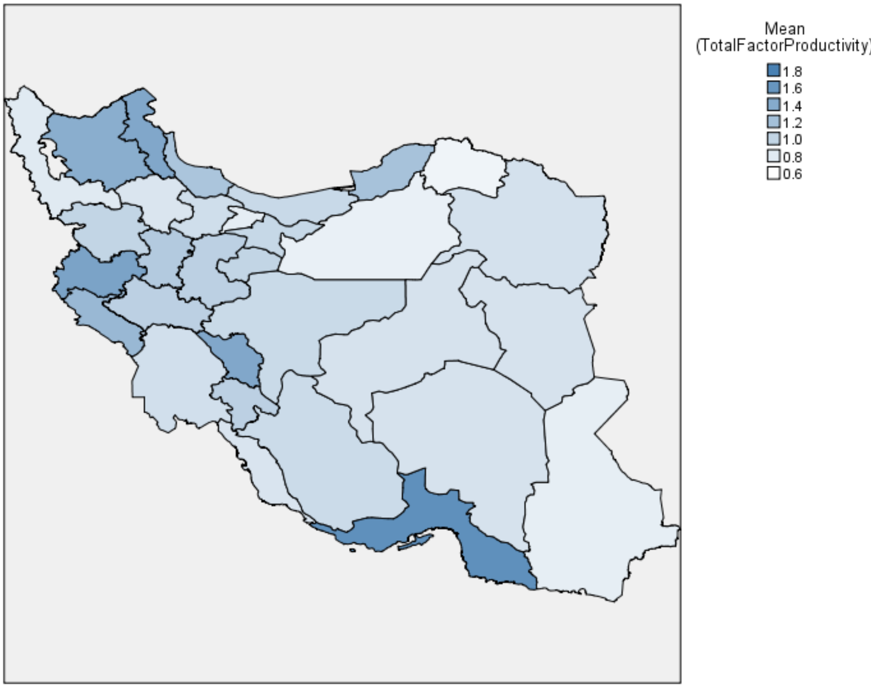
Map 1. The dispersion of the TFP in the provinces of Iran



Source: research findings

Equations 7 to 9 can be employed to calculate the PFPs by obtaining coefficients from the regression model of this study. For this purpose, the PFP of labor force was analysed first. According to these equations, Hormozgan, Bushehr and Chaharmahal and Bakhtiari were ranked the best provinces in the productivity of labor force, whereas North Khorasan, Sistan and Baluchestan and Kohgiluyeh and Boyer-Ahmad were ranked the worst provinces. The following table reports the results of this index.

Table 6. Partial Labour Productivity Index for 31 Provinces of Iran in the Year 2019

PROVINCES	*DEGREE OF PRODUCTIVITY*	*LP INDEX*
HORMOZGAN	High Productivity	3.49
BUSHEHR	High Productivity	2.01
CHAHARMAHAL AND BAKHTIARI	Medium Productivity	1.26
KHUZESTAN	Medium Productivity	1.13

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ZANJAN	Medium Productivity	1.07
KERMANSHAH	Medium Productivity	1.06
ISFAHAN	Medium Productivity	1.04
MARKAZI	Medium Productivity	1.02
YAZD	Medium Productivity	0.95
EAST AZERBAIJAN	Low Productivity	0.86
GILAN	Low Productivity	0.83
HAMADAN	Low Productivity	0.83
ILAM	Low Productivity	0.79
KERMAN	Low Productivity	0.79
KURDISTAN	Low Productivity	0.77
ARDABIL	Low Productivity	0.75
QOM	Low Productivity	0.74
GOLESTAN	Low Productivity	0.70
SEMNAN	Low Productivity	0.69
FARS	Low Productivity	0.67
LURISTAN	Low Productivity	0.65
QAZVIN	Poor Productivity	0.58
RAZAVI KHORASAN	Poor Productivity	0.57
SOUTH KHORASAN	Poor Productivity	0.55
WEST AZERBAIJAN	Poor Productivity	0.55
ALBORZ	Poor Productivity	0.54
MAZANDARAN	Poor Productivity	0.50
TEHRAN	Poor Productivity	0.49
NORTH KHORASAN	Poor Productivity	0.47
SISTAN AND BALUCHESTAN	Poor Productivity	0.42
KOHGILUYEH AND BOYER-AHMAD	Poor Productivity	0.28

Source: research findings

Map 2 demonstrates the productivity of labor force in the industrial sector for 31 provinces of Iran.

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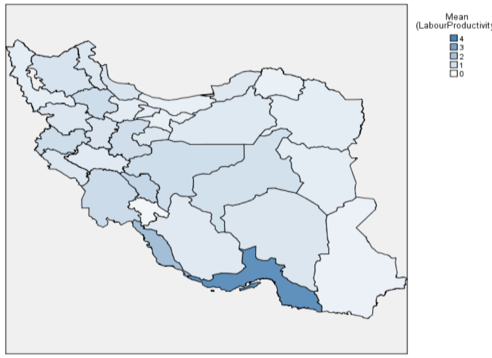
Map 2. The dispersion of the productivity of labour force in provinces of Iran



Source: research findings

According to the analysis of the PFP of capital in 31 provinces of Iran, this index also had the best values in Ilam, Kohgiluyeh and Boyer-Ahmad and Kermanshah provinces, whereas it had the worst values in Semnan, Zanjan and Alborz provinces.

Table 7. Partial Capital Productivity Index for 31 Provinces of Iran in the Year 2019

PROVINCES	*DEGREE OF PRODUCTIVITY*	*CP INDEX*
ILAM	High Productivity	0.67
KOHGILUYEH AND BOYER-AHMAD	High Productivity	0.36
KERMANSHAH	High Productivity	0.75
HAMADAN	High Productivity	0.38
ARDABIL	Medium Productivity	0.22
NORTH KHORASAN	Medium Productivity	1.38
LURISTAN	Medium Productivity	0.38
EAST AZERBAIJAN	Medium Productivity	0.37
CHAHARMAHAL AND BAKHTIARI	Medium Productivity	0.66
YAZD	Medium Productivity	0.49
HORMOZGAN	Medium Productivity	0.43
KURDISTAN	Medium Productivity	0.73
KHUZESTAN	Low Productivity	0.55
SISTAN AND BALUCHESTAN	Low Productivity	0.27
KERMAN	Low Productivity	0.31
GOLESTAN	Low Productivity	0.55

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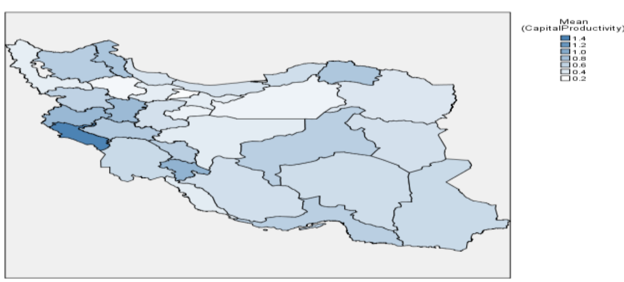
FARS	Low Productivity	0.50
MARKAZI	Low Productivity	0.37
SOUTH KHORASAN	Low Productivity	0.32
MAZANDARAN	Low Productivity	0.62
GILAN	Low Productivity	0.52
RAZAVI KHORASAN	Low Productivity	0.87
ISFAHAN	Poor Productivity	0.92
BUSHEHR	Poor Productivity	0.51
QAZVIN	Poor Productivity	0.46
TEHRAN	Poor Productivity	0.70
WEST AZERBAIJAN	Poor Productivity	0.47
QOM	Poor Productivity	0.49
SEMNAN	Poor Productivity	0.65
ZANJAN	Poor Productivity	0.85
ALBORZ	Poor Productivity	0.65

Source: research findings

Map 3 indicates the data of the productivity of industrial capital.

Map 3. The dispersion of the productivity of capital in different provinces of Iran



Source: research findings

Regarding in the PFP of resources, high values of industrial productivity were obtained from Tehran, Alborz, and Qom provinces, whereas low values of industrial productivity resulted from Sistan and Baluchestan, Yazd and North Khorasan provinces.

Table 8. Partial Resource Productivity Index for 31 Provinces of Iran in the Year 2019

PROVINCES	*DEGREE OF PRODUCTIVITY*	*RP INDEX*

TEHRAN	High Productivity	7.30
ALBORZ	High Productivity	6.46
QOM	High Productivity	5.43
GILAN	High Productivity	4.97
QAZVIN	High Productivity	4.90
EAST AZERBAIJAN	High Productivity	4.88
GOLESTAN	High Productivity	4.70
ARDABIL	Medium Productivity	4.39
HORMOZGAN	Medium Productivity	4.27
MAZANDARAN	Medium Productivity	3.98
ZANJAN	Medium Productivity	3.72
CHAHARMAHAL AND BAKHTIARI	Medium Productivity	3.60
KERMANSHAH	Medium Productivity	3.51
MARKAZI	Medium Productivity	3.26
ISFAHAN	Low Productivity	2.92
RAZAVI KHORASAN	Low Productivity	2.81
WEST AZERBAIJAN	Low Productivity	2.67
FARS	Low Productivity	2.44
KOHGILUYEH AND BOYER-AHMAD	Low Productivity	2.41
SOUTH KHORASAN	Low Productivity	2.21
SEMNAN	Low Productivity	2.11
BUSHEHR	Low Productivity	2.02
KERMAN	Low Productivity	1.94
KHUZESTAN	Low Productivity	1.90
KURDISTAN	Poor Productivity	1.78
LURISTAN	Poor Productivity	1.77
HAMADAN	Poor Productivity	1.27
ILAM	Poor Productivity	1.18
SISTAN AND BALUCHESTAN	Poor Productivity	0.98
YAZD	Poor Productivity	0.95
NORTH KHORASAN	Poor Productivity	0.72

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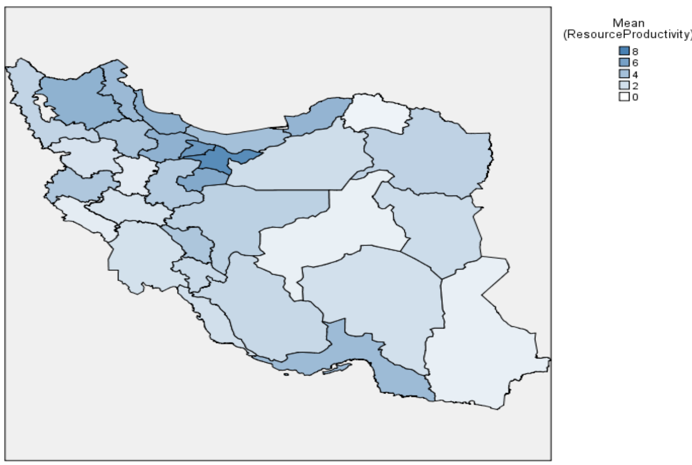
Source: research findings

Map 4 indicates the status of this index in terms of its geographical dispersion.

Map 4. The dispersion of the productivity of resources in different provinces of Iran



Source: research findings

Table 9 gives an overview of status of each province in the TFP and PFPs. This presentation method helps to perceive each province's status in terms of the studied indices well.

Table 9. Classification of Productivity Indicators in 31 Provinces of Iran

REGION (PROVINCE)	*TOTAL FACTOR PRODUCTIVITY*	*LABOR PRODUCTIVITY*	*CAPITAL PRODUCTIVITY*	*RESOURCE PRODUCTIVITY*
EAST AZERBAIJAN	High Productivity	Low Productivity	Medium Productivity	High Productivity
WEST AZERBAIJAN	Poor Productivity	Poor Productivity	Poor Productivity	Low Productivity
ARDABIL	High Productivity	Low Productivity	Medium Productivity	Medium Productivity
ISFAHAN	Low Productivity	Medium Productivity	Poor Productivity	Low Productivity
ALBORZ	Poor Productivity	Poor Productivity	Poor Productivity	High Productivity
ILAM	High Productivity	Low Productivity	High Productivity	Poor Productivity
BUSHEHR	Low Productivity	High Productivity	Poor Productivity	Low Productivity

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TEHRAN	Low Productivity	Poor Productivity	Poor Productivity	High Productivity
CHAHARMAHAL AND BAKHTIARI	High Productivity	Medium Productivity	Medium Productivity	Medium Productivity
SOUTH KHORASAN	Low Productivity	Poor Productivity	Low Productivity	Low Productivity
RAZAVI KHORASAN	Low Productivity	Poor Productivity	Low Productivity	Low Productivity
NORTH KHORASAN	Poor Productivity	Poor Productivity	Medium Productivity	Poor Productivity
KHUZESTAN	Low Productivity	Medium Productivity	Low Productivity	Low Productivity
ZANJAN	Low Productivity	Medium Productivity	Poor Productivity	Medium Productivity
SEMNAN	Poor Productivity	Low Productivity	Poor Productivity	Low Productivity
SISTAN AND BALUCHESTAN	Poor Productivity	Poor Productivity	Low Productivity	Poor Productivity
FARS	Low Productivity	Low Productivity	Low Productivity	Low Productivity
QAZVIN	Low Productivity	Poor Productivity	Poor Productivity	High Productivity
QOM	Medium Productivity	Low Productivity	Poor Productivity	High Productivity
KURDISTAN	Medium Productivity	Low Productivity	Medium Productivity	Poor Productivity
KERMAN	Low Productivity	Low Productivity	Low Productivity	Low Productivity
KERMANSHAH	High Productivity	Medium Productivity	High Productivity	Medium Productivity
KOHGILUYEH AND BOYER-AHMAD	Medium Productivity	Poor Productivity	High Productivity	Low Productivity
GOLESTAN	Medium Productivity	Low Productivity	Low Productivity	High Productivity
GILAN	Medium Productivity	Low Productivity	Low Productivity	High Productivity
LURISTAN	Medium Productivity	Low Productivity	Medium Productivity	Poor Productivity
MAZANDARAN	Low Productivity	Poor Productivity	Low Productivity	Medium Productivity
MARKAZI	Medium Productivity	Medium Productivity	Low Productivity	Medium Productivity
HORMOZGAN	High Productivity	High Productivity	Medium Productivity	Medium Productivity
HAMADAN	Medium Productivity	Low Productivity	High Productivity	Poor Productivity
YAZD	Low Productivity	Medium Productivity	Medium Productivity	Poor Productivity

Source: research findings

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Conclusions

Productivity is a factor that can improve the production outputs without any changes in quantity of inputs. Many studies have also been conducted on regional inequalities in Iran by both domestic and foreign researchers. This study aimed to analyse the provincial dispersion of the productivity index in Iran, for fewer studies addressed it as opposed to the other development indices. For this purpose, after the industrial production function was estimated through the Solow residual model and production elasticities obtained from each of the inputs, the TFP and PFPs of production inputs (labor force, capital, and resources) were estimated for the provinces of Iran. Despite the centralisation of economic development in central provinces of Iran and Tehran in particular, this study indicated that the provinces having lower income levels than the more developed provinces such as Tehran did not necessarily perform worse with lower productivity values. In fact, they can outperform such provinces as Tehran, Isfahan, Markazi, and Khuzestan in the use of inputs in the production process. According to the results of this study that analysed the industrial performance in particular, the best outputs were obtained from Hormozgan, Kermanshah and Ardabil provinces in the combinatorial use of production factors. Moreover, the worst outputs resulted from Sistan and Baluchestan, Semnan and North Khorasan provinces in terms of this index. Regarding in the productivity of labor force, Hormozgan, Bushehr and Chaharmahal and Bakhtiari were ranked the best provinces, whereas North Khorasan, Sistan and Baluchestan and Kohgiluyeh and Boyer-Ahmad yielded the worst outputs. According to the analysis of the capital productivity, the highest productivity rates resulted from Ilam, Kohgiluyeh and Boyer-Ahmad and Kermanshah provinces. Furthermore, the lowest productivity rates were obtained from Semnan, Zanjan and Alborz provinces in terms of the use of capital inventory. Regarding in the productivity of resources, the highest ranks were given to Tehran, Alborz and Qom, whereas the lowest ranks were given to Sistan and Baluchestan, Yazd and North Khorasan provinces. After these indices were estimated, they were shown on the geographical map of Iran to better clarify the status of each index. Although the map preparation method was used for many socio-economic indices such as poverty, the TFP and PFPs are among the factors that have been neglected. According to the results and potential capacities of different provinces such as Kermanshah and Ilam in the use of capital, it is necessary to direct capital resources to these provinces in order to mitigate poverty, reduce regional inequalities, and eliminate deprivation in addition to improve economic development in Iran through decentralisation of resources.

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