Quarterly Journal of Quantitative Economics(JQE) **(2022) 19(1) 101-126**

Shahid Chamran University of Ahvaz

Quarterly Journal of Quantitative Economics

Journal Homepage: www.jqe.scu.ac.ir
Print ISSN: 2008-5850
Online ISSN: 2717-4271

Simulation of human development index in Khuzestan province with emphasis on healthy living and access to knowledge and comparison with Iran

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ARTICLE HISTORY

Received: 24 May 2021
Revision: 25 February 2022
Acceptance: 25 February 2022

JEL CLASSIFICATION:
O15,C22

KEYWORDS:
Simulation, Human Development, Oil Free Income, DOLS, Khuzestan Province

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FURTHER INFORMATION:

The present article is taken from the Master thesis of Shiva Sharif Zade Ahvazi with Supervisor of Morteza Afghah and Amin Mansouri at the University of Shahid Chamran University of Ahvaz.

ACKNOWLEDGMENTS: The authors express thanks for Vice-Chancellor for Research Affairs of the Shahid Chamran University of Ahvaz for financially supported.

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(former Economic Studies)

CONFLICT OF INTEREST: The authors declare no conflict of interest.
FUNDING: This study was part of the master's thesis, which was supported by the Shahid Chamran University of Ahvaz, Ahvaz, Iran. (Grant no. SCU.EE98.30460).

ABSTRACT

The Human Development Index is a composite index for measuring the three criteria of long and healthy life, access to knowledge and the right level of well-being in life. Since 2011, the components of Human Development Index including, education, the combination of the average age of education for adults (25 years and older population) and the expected years of schooling, life expectancy index and per capita income. Human Development Index (HDI henceforth) is in fact the geometric mean of these three indexes. This index is calculated annually by the United Nations Development Program (UNDP) for countries but not for states, provinces, urban areas and regions in those countries. The main purpose of this study was to simulate human development index in Khuzestan province and compare it with that of Iran as a whole in 1996, 2006, 2011 and 2016. The results show that human development index in Khuzestan has reached from the average level of 0.64 in 1996 to the high level of 0.74 in 2016. The results also show that Khuzestan province is better in human development index with oil sector, and worse in human development index without oil sector. HDI simulation results show that there was a steady upward trend in the years under review, but there has been a structural break in Human Development Index since 2005. Based on this simulation, human development index in Khuzestan province reached an intermediate level until 2009, and a high level after 2010.

How to Cite:
Mansouri, Sayed Amin., Afghah, Sayed Morteza., Aghaei Jannat-Makan, Hosein & Sharif Zade Ahvazi, Shiva. (2022). Simulation of human development index in Khuzestan province with emphasis on healthy living and access to knowledge and comparison with Iran. *Quarterly Journal of Quantitative Economics(JQE)*, 19(1), 101-126.
10.22055/JQE.2022.37537.2376

1- Introduction

The importance of human, as the goal and factor for development, has made the countries of the world and international organizations pay special attention to " human development " and identify the factors which have influence on it through their researchers and scientists. Before raising the issue of human development index, per capita income was considered to be as a criterion for measuring the level of development in those countries, but since the growth of per capita income, income distribution and many social and cultural aspects does not encompass human life Mahbub ul Haq (1999), a Pakistani economist in collaboration with Amartya Sen (1999), a development expert and winner of the 1998 Nobel Prize in Economics, introduced and calculated a new index called "Human Development Index", which, in addition to per capita income, also included the index of education and public health (Haq, 2000; Sen, 2000). After this measure, the first Human Development Reports of United Nations Development Programme was compiled and published in 1990. Since 1990, Human Development Report has been published annually by United Nations Development Programme (UNDP), in which countries are compared in terms of educational and health indexes. One of the neglected aspects of human development index is its regional dimension which means that it is not calculated for provinces and states. Although there is no tendency for regional calculations in international dimension, its calculation for provinces can be of great help to regional planners in countries (Bhanojirao, 1991).

lack of such statistics in Iran is one of the statistical gaps in this country that has made regional and provincial research critically limited and inaccurate. To address this shortcoming, in this study, the human development index of Khuzestan province in years 1996, 2006, 2011 and 2016 has been calculated using the latest formula. It should be noted that simulating human development index is a very time-consuming and difficult task and lack of attention to details can distort the index. Therefore, in order to ensure the accuracy of calculations, human development index has been calculated for Iran and compared with the UN Human Development Index for Iran, to ensure the

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accuracy of calculations for the human development index in Khuzestan province.

2- The concept of human development and the introduction of its index (HDI)

Generally, development is an idea originated in the early nineteenth century and since World War II has found a special place in social, economic, political, and international affairs (Frazier, 1997). Criticizing the view that merely introduced economic growth as a measure of development, development economists have defined development as a concept beyond economic growth, and according to them, countries with higher per capita incomes are not necessarily considered more developed (Ramirez, Ranis, & Stewart, 1997). In fact, according to the historical evolution of the above mentioned concept, development is a process that includes all dimensions of a social system with the goals of growth, justice, poverty reduction, democracy and political stability (Basu, 1997). In the framework of this interpretation, increasing production and wealth is just a means, and the main goal of development is to improve the quality of human life or in fact human development and human development requires improving the process of expanding the range of choices for individuals (Nayak, 2008).

Streiten (1981) also argues that in the human development approach, development is not limited to per capita income growth but depends on improvement in other needs of human society such as health, enjoying the basic living standards and education (Streeten, 1981). According to the United Nations, human development is development through the creation of human capabilities that are achieved through human beings themselves by actively participating in the processes that shape their lives, and in fact human beings are not only the goal of development but also the axis of development (Selim, 2015).

To measure human development in countries, the United Nations has, since 1990, used a composite index consisting of three dimensions of education (health and economic welfare) on a scale ranging from

zero (lowest human development) to one (highest human development) (Bhanojirao, 1991). The Human Development Index was developed in 1990 by Amartyasen, a Nobel Award winner in economics as well as, a Pakistani economist, in collaboration with Ranis, a professor at Yale University, and Desai, a professor at the University of London, and since then, it has been used by the United Nations Development Programme (Stanton, 2007).

In the human development index estimation method by the United Nations, health dimension is measured by life expectancy index at birth. In the field of education, two indexes are being used: the average length of education for adults 25 years and older; and the length of the expected period for children's education when they reach school age. However, prior to 2010, instead of these two indexes, adult literacy rate and the enrollment rate of children at school age were used (Bhanojirao, 1991).

Prior to 2010, the components of Human Development Index included education indexes (weighted average of the composite index of gross education cover rate (Gross enrollment rate) in different educational levels (the division quotient of the number of employed people studying in different educational levels into Population of the same age group) and adult literacy rate index (the over 15 years old population), life expectancy index (life expectancy at birth provided that the common mortality pattern at birth is stable, which is a function of health, Quality of life, health facilities, access to minimum living, lack of anxiety, peace of mind as well as economic and social security) and per capita income index (logarithm of ratio of per capita gross income to the purchasing power parity of US dollar due to large gap between high- and low -income countries), and in fact, human development index was arithmetic average of these three indexes. Because the rate of adult literacy made it impossible to compare countries, adult literacy rate index lost the power to differentiate between countries and was replaced by another index. Since 2011, the components of the Human Development Index include education indexes (the combination of mean years of schooling for adults (25

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years and older population) and the index of expected years taken for education), life expectancy index (The average number of years a person is expected to survive if the current mortality rate situation continues) and per capita income index (the natural logarithm of ratio of gross national per capita to the purchasing power of dollar), and Human Development Index is actually the geometric average of these three indices. Replacing literacy with average years of adult education has led to covering more countries andit reveals differences between countries better than literacy rate. Using the expected years taken for children education instead of school enrollment ratio will include a change in the framework of this index from ratio to the number of years; Therefore, quantity in education indexes has turned into quality (Kovacevic, 2010).

For economic welfare, per capita gross national income of countries is also used based on the purchasing power parity of US dollar. In estimating this index, instead of the absolute figure of gross per capita national income to purchasing power parity, the logarithm of gross per capita national income to purchasing power parity of US dollar is used (Bhanojirao, 1991).

According to the classifications in 2015 Annual Report of the United Nations Human Development Report, Human Development Index above 0.8 is classified as a very high human development index, a Human Development Index above 0.7 and below 0.799 is classified as a high human development index and a Human Development Index above 0.550 and below 0.699 is classified as a moderate human development index and values below 0.549 are classified as low human development (Selim, 2015).

In 1977, the last year of the Pahlavi regime, Iran's human development index was 0.437. In this regard, it was ranked 130th among 180 countries in the world. According to the Human Development Report, Iran was classified as a country with low human development until 1980, but since 1981, with the improvement of the components of the index, especially health and education, it has been upgraded to the group of countries with moderate human development

index, and in recent years, it is located in middle and upper ranks of this group. According to the Program and Budget Organization report, which was published on the eve of the 40th anniversary of the Islamic Revolution, in accordance with the United Nations report on changes in the human development index, Iran's human development index has been increasing in the post-revolutionary years.Its value has increased from about 0.57 in 1990 to about 0.8 in 2017, which has placed Iran among the high ranking countries. According to this report, Iran's human development index in 2005, 2010 and 2015, respectively, is estimated at 0.695, 0.755 and 0.789, which has a growth of 13.5 percent. Also, according to the United Nations, Iran's human development index increased by 1.26 times between 1990 and 2015 (Selim, 2015).

Some researchers such as Bakhtiari et al. (2006), Ziari et al. (2010), Asefzadeh, Jahandideh and Mousavi (2013), Asefzadeh, Alijanzadeh and Nasiri Asal (2013), Zanganeh (2016) And Afgheh et al. (2016) have calculated the human development index based on the provinces of Iran (Afghah, Ahangari, & Askari por, 2020; Asefzade, Jahandideh, & Arefeh, 2013; Hesari, 2015; Sadegh, Majid, & Seyed Mojtaba, 1385; saeed Asefzadeh, Mehran Alijanzadeh, & Marjan Nasiri asl, 2013; Zanganeh, 2016; Zayyari, Zanjirchi, & Sorkhkamal, 2010).

3- Calculation of human development index for Khuzestan province

In this study, the human development index of Khuzestan province is calculated by modeling the formula introduced in the human development report of the United Nations Development Programme in 2018 as follows:

$$HDI = \sqrt[3]{LEI \times II \times EI} \quad (1)$$

where HDI is human development index, LEI is life expectancy index, II is income index and EI is education index.

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3-1- Life expectancy index

Long and healthy life is measured with life expectancy and is the average number of years during which a person is expected to survive if the current mortality rate continues. Life expectancy index is calculated by the difference of life expectancy (LE) and the minimum years of survival (which according to international standard equals to 20 years), divided by life expectancy difference of the world's top country (according to international standard equals to 85 years) and the minimum years of survival in those years, as follows:

(2) $$\text{LEI} = \frac{\text{LE (real value of life expectancy)} - \text{minimum years of survival}}{\text{minimum years of survival} - \text{maximum years of survival}} = \frac{\text{LE}-20}{85-20}$$

Accordingly, the life expectancy index of Khuzestan province is calculated and compared with the values of the life expectancy index of Iran as a whole (calculated by the researcher) and the life expectancy index of Iran (calculated by the United Nations Development Program), **Table 1** presented and compared :

Table 1. Calculation results of life expectancy index
Source: Research results

Year	Life expectancy of the whole of Khuzestan Province	Khuzestan's life expectancy index	Iran's Life expectancy index (researcher calculations)	Iran's Life expectancy index (UN calculations)
1996	66.85	0.71	0.728	0.75
2006	71.83	0.78	0.801	0.80
2011	72.44	0.79	0.831	0.84
2016	72.58	0.79	0.857	0.86

As shown in **Table 1**, the life expectancy index calculated for Iran is reasonably close to the UN calculations, and based on this, the life expectancy index for Khuzestan province can be trusted. According to the results, the life expectancy index in Khuzestan province, like the

country on the whole, has been improving from 1996 to 2016, however, it is lower than the national average.

3-2- Income index

Livelihood criteria or the same Living standard is measured by Gross National Index per capita (GNI pc). The calculation of income index requires considering the natural logarithm of GNI pc, before using it in the following general relation:

(3) Index=(actual value-minimum value)/(maximum value-minimum value)

Then, we will have:

$$II = \frac{\mathrm{Ln}\left(\mathrm{GNI\ pc}\right) - \mathrm{Ln}\left(100\right)}{\mathrm{Ln}\left(75000\right) - \mathrm{Ln}\left(100\right)} \quad (4)$$

where, II is income index and Ln (GNI pc) is the natural logarithm of the ratio of gross national income per capita equal to the purchasing power parity of US dollar in 2011, and Ln (100) is the natural logarithm of the gross national income per capita of a country with the lowest gross national income per capita in the world equal to the purchasing power parity of US dollar in 2011 (according to the international standard equal to 100 US dollar), and Ln (75000) is the natural logarithm of the gross national per capita income of a country with the highest gross national per capita income in the world to the purchasing power parity of US dollar in 2011 (according to the international standard equal to 75,000 US dollar).

To obtain the GDP per capita of Khuzestan province at the base price (2011= 100) to the purchasing power parity of US dollar in 2011, the following formula is used:

$$GDP - percapita = \frac{\dfrac{\text{Constant } GDP(2011)}{exchange\ rate}}{Khuzestan\ population} \times PPP \quad (5)$$

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By dividing Iran's current gross domestic product by Iran's gross domestic product by the fixed price in 2011, the price index (2011 = 100) is calculated to be placed in relation (5):

Table 2. Calculation results of the price index to the base price (2011 = 100)
Source: Research results

Year	Iran's Current GDP (billion Rials)	Iran's gross domestic product to base price in 2011 (billion rials)	Price index (100 = 2011)
1996	261529	3010017	0.09
1385	2486861.7	5476337	0.45
1390	6364368.6	6364369	1.00
1395	12722850	6691109	1.90

By dividing Iran's GNI_pc by the purchasing power parity of dollar in 2011 (calculated by the United Nations) by Iran's GNI_pc at a fixed price in 2011, the purchasing power parity rate in terms of base price to be placed in Equation (6) is calculated as follows:

$$Price\ base\ to\ buy\ power\ parity\ rate\ = \frac{\left(\left(UN\ Computing\right)\ Iran\ GDP\ per\ capita\right)}{\left(\left(Calculator\ researcher\right)\ Iran\ GDP\ per\ capita\right)} \tag{6}$$

By dividing Iran's GDP at a fixed price in 2011 by exchange rate and then by the population of Iran, Iran's GDP per capita is obtained at the base price:

$$Price\ base\ to\ Iran\ GDP\ per\ capita\ GDP = \frac{\left(\left(Iran\ GDP\right) /\ \left(exchange\ rate\right)\right)}{\left(Iran\ Country\ Population\right)} \tag{7}$$

Table 3. Calculation results of the purchasing power parity rate at the base price
Source: Central Bank of Iran and research results

Year	Iran's GDP at fixed price in 2011 (billion rials)	Official exchange rate (dollars to rials)	Iran's GDP in dollars	Iran's population (billion people)	Iran's GDP_pc (dollars per capita)	Iran's GNI_pc (UN calculation based on PPP)	Purchasing power parity rate at base price
1996	3010017	1751	1718.8	0.0601	28621	12731	0.44
2006	5476337	9171	597.1	0.0705	8471	16218	1.91
2011	6364369	10616	599.5	0.0751	7977	18194	2.28
2016	6691109	30915	216.4	0.0799	2708	18544	6.85

Now by placing the results of **Table 2** and **Table 3** into relation (5), we will have:

Table 4. Khuzestan's GDP_pc (2011 = 100) to the purchasing power parity of US dollar in 2011
Source: Research results

Year	Khuzestan's GDP at fixed price	Exchange rate (dollars to rials)	Khuzestan's GDP to exchange rate ratio	Population of Khuzestan (billion people)	Khuzestan's GDP_pc (dollars per person)	Purchasing power parity rate	Khuzestan GDP_pc at the base price to the purchasing power parity of US dollar
1996	430483	1751.2	245.8	0.0037	65622	0.45	29190
2006	811265	9170.94	88.5	0.0043	20697	1.92	39628
2011	805671	10616.3	75.9	0.0045	16749	2.28	38200
2016	582868	30914.9	18.9	0.0047	4003	6.85	27412

Now, after obtaining GDP_pc of Khuzestan province at the base price equal to the purchasing power parity of US dollar, the income index of Khuzestan province is calculated and compared with the values of Iran's income index:

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Table 5. Calculation results of revenue index in terms of base price
Source: Research results

Year	Khuzestan's GDP per capita (dollars per person)	Khuzestan Revenue Index (with oil)	Khuzestan Income Index (excluding oil)	Iran Income Index (Researcher Calculations)	Iran Income Index (UN Calculations)
1375	29190	0.86	0.71	0.7	0.73
1385	39628	0.90	0.78	0.76	0.77
1390	38200	0.90	0.77	0.77	0.79
1395	27412	0.85	0.79	0.78	0.79

The per capita GDP of Khuzestan province at the base price increased from 1996 to 2006 and decreased from 2006 to 2016, but the per capita GDP of Iran according to UN calculations increased until 2011 but in 1395 it remained constant compared to 90. Khuzestan province income index values with a slight difference compared to the country's income index values also increased from 1375 to 1390 and decreased from 1390 to 1395. Iran's per capita GDP at the base price (calculated by the researcher in **Table 3**) wasnot adjusted for the dollar purchasing power parity rate in 2011.

The results of this calculation show that Khuzestan province is in a better position than the country in terms of income index, especially in 2006 and 2011. It seems that the sanctions have shown more impact in the years after the nuclear sanctions in Khuzestan province. It also seems that the revenue index of Khuzestan province is relatively overestimated due to the added value of the oil sector. For this purpose, based on the same method, the revenue index of Khuzestan province without oil has been recalculated and placed in the table.

3-3- Education Index

The index of access to knowledge is a bit more complex than the other two indexes involved in calculating the index of human development

and, in fact it is obtained by combining the following two indexes of education:

(8) $$EI = \frac{\sqrt{EYSI*MYSI} - 0}{1 - 0} = \sqrt{EYSI*MYSI}$$

Where EI is education index, $\sqrt{EYSI * MYSI}$ is the index calculated in the understudy province or country, zero is the lowest value of the index according to the international standard and 1 is the highest value of the index according to the international standard.

A) Mean years of schooling: Obtaining average schooling years requires access to a population distribution based on degrees and educational levels.

(9) $$MYS = \sum_{a=1}^{A} l_t^a \times s_t^a$$

(10) $$s_t^a = \sum_j h_{j,t}^a \times dur_{j,t}^a$$

MYS (Mean Years of Schooling) is average number of years of study, l_t^a is the ratio (share) of the age group A population to the population aged 25 and over in year t, s_t^a is average number o fschooling years of age groups of 5 (a) to 75 years and older in year t, a = 1 is age group of 25 to 29 years, a = 2 is age group of 30 to 34 years,. ..,and a = 11 is age group of 75 years and older, $h_{j,t}^a$ is the share of the age group population (*a*) in year t who have education level of *j*, *j* is elementary, secondary and tertiary levels, $dur_{j,t}^a$is the duration of schooling years of age groups *a* in year *t*. The levels of educations include elementary, middle, high school, pre-university, higher education and Nehzat (education for older illiterate people), and the age groups are divided as much as possible into 5-age groups from 25 to 74 years old, and the highest age group is 75 years and older.

Based on Barro & Lee's (1997) method (Lee & Barro, 2001) the average schooling years is equal to the duration of schooling at each education level per year ($dur_{j,t}^a$), multiplied by the share of the

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population in different age groups who have reached that level of education as the highest level ($h_{j,t}^{a}$). At first, for each age group, the total number of students in each grade, including students studying and literate students not currently studying (the table for the population aged 6 and older by gender, age groups, literacy status and literacy level) , are multiplied by the number of years of formal education of the country until the end of that grade (for elementary level (5 years), middle school level (8 years), secondary school level (11 years), pre-university level (12 years), higher education level (16 years), Nehzat (2 years) and other indefinite and undeclared courses (11 years); The resulting numbers for each age group are added together to obtain the number of schooling years for each age group; afterwards, it is divided by the population of the same age group (population table according to age, sex and residence status) to obtain the average number of schooling years (s_t^a); Then the average schooling years of each age group is multiplied by the population share of the same age group (l_t^a), and their sum will be considered equal to the mean years of schooling (MYS):

(11) $$\mathrm{MYSI} = \frac{\mathrm{MYS} - \min MYS}{\max MYS - \min MYS}$$

(12) $$\mathrm{MYSI} = \frac{\mathrm{MYS} - 0}{15 - 0} = \frac{\mathrm{MYS}}{15}$$

where MYSI is Mean Years of Schooling Index, MYS is mean years of schooling(according to the international standard, 0 is the lowest and 15 is the highest mean years of schooling).

B) Expected Years of Schooling: it refers to the total number of schooling years which a 6-year-old child is expected to enjoy in the coming years.

(13) $$EYS = \sum_{i=a}^{n} \frac{E_t^i}{P_t^i} + \sum_{l=\text{level education}} \frac{E_t^{\text{unknown}}}{P_t^{\text{age of level}} / D_l}$$

where EYS is the expected years of schooling, E_t^i is the number of students enrolled in age *i* in academic year *t*, P_t^i is the number of

population in age i in academic year t, D_l is the number of years of course l, n is the highest age of education, $E_t^{unknown}$is the number of students enrolled in school in academic year tregardless of age, and $P_t^{age\ of\ level}$ is the number of population in schooling age in academic year t.

First, the number of students studying in the country at the age related to each academic year (E_t^i) separated by individual ages (for example, the number of 6-year-old students studying in the first grade of primary school or the number of 11-year-old students studying in the first grade of middle schools studying in the country) is divided by the total population at the age of each grade level (P_t^i) separated by individual ages (for example, the total number of people aged 6 or the total number of people aged 11);the Sum of the obtained numbers will become $\sum_{i=a}^{n} \frac{E_t^i}{P_t^i}$. Then the total number of students studying in the country at the relevant age (E_t^i) separated by each educational grade (for example, the total number of 6- to 10-year-old students studying within the country in the first to fifth grades of elementary school or the total number of 11- to 13-year-old students studying within the country in the first to third grades of middle school) are subtracted from the total number of people studying in each grade within the country (for example, the total number of people of all ages who are studying in primary schools in the country, or the sum of people of all ages studying in middle schools within the country) to find the number of students of other ages ($E_t^{unknown}$) for each grade. The Number of students in other ages ($E_t^{unknown}$) during the period of official education of the country for each grade is multiplied by the number of years (for elementary level=5 years, middle level=3 years, secondary level=3 years, pre- university level=1 year, higher education level= 6 years and other undeclared courses=18 years) and the summation of the population at the age of each grade(P_t^i) is divided by each grade ($P_t^{age\ of\ level}$for example, the total number of 6-10-year-old population schooling in the grades of 1-5 or the total number of 11-13 year-old population in the first to third years of middle school; the summation

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of the obtained numbers gives us $\sum_{l=\text{level education}} \frac{E_t^{unknown}}{P_t^{age\ of\ level} / D_l}$ and the summation of $\sum_{l=\text{level education}} \frac{E_t^{unknown}}{P_t^{age\ of\ level} / D_l}$ and $\sum_{i=a}^{n} \frac{E_t^i}{P_t^i}$ is considered to be quivalent to the expected years of scholling(EYS).

(14) $$EYSI = \frac{EYS - \min EYS}{\max EYS - \min EYS}$$

(15) $$EYSI = \frac{EYS - 0}{18 - 0} = \frac{EYS}{18}$$

where EYSI is the expected years of schooling index, EYS is the average of expected years of schooling, 0 is the lowest expected years of schooling according to the international standard and 18 is the maximum expected years of schooling according to the international standard.

Now the calculation results related to the mean years of schooling (for Khuzestan) obtained from Eq(12), the calculation results related to the expected years of schooling (for Khuzestan) obtained from Eq(13) and the calculation results related to the average years of schooling index and the expected years of schooling index of Iran are placed in Eq(8):

Table 6. Calculation results of education index for Khouzestan Province
Source: Research results

Year	Mean years of schooling in Khuzestan province	Mean years of schooling index in Khuzestan province	Expected years of schooling in Khuzestan province	Expected years of schooling index in Khuzestan province	Khuzestan's Education Index
1375	4.69	0.31	10.48	0.58	0.43
1385	6.52	0.44	11.20	0.62	0.52
1390	7.24	0.48	12.37	0.69	0.58
1395	8.42	0.56	14.20	0.79	0.67

Furthermore, the calculation results related to the mean years of schooling (for Iran) in Eq(12), the calculation results related to the expected years of schooling (for Iran) in Eq(13) and the calculation results related to the mean years of schooling index and the expected years of schooling index in Iran are replaced in Eq(8):

Table 7. Calculation results of Iran's education index
Source: Research results

Year	Mean years of schooling in Iran	Mean years of schooling index in Iran	Expected years of schooling in Iran	Expected years of schooling index in Iran	Iran Education Index
1375	4.81	0.32	11.26	0.63	0.45
1385	6.82	0.45	13.23	0.74	0.58
1390	7.56	0.50	13.82	0.77	0.62
1395	8.82	0.59	14.90	0.83	0.70

Now, after obtaining the mean years of schooling index and the expected years of schooling index, the education index of Khuzestan province calculated with the values of Iran education index (calculated by the researcher) and Iran education index (calculated by the UNDP), are compared:

Table 8. Calculation results of education index
Source: Research results

Year	Khuzestan's Education Index	Iran's Education Index (researcher calculation)	Iran's Education Index (UN calculation)
1375	0.43	0.45	0.49
1385	0.52	0.58	0.63
1390	0.58	0.62	0.68
1395	0.67	0.70	0.74

The results of the calculations show that in Khuzestan province, the education index is in a worse situation than the country. However, its trend has improved since 1996.

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3-4- Human Development Index

By placing the values of life expectancy index from Table 1, income index according to basic prices from **Table 5** and education index from **Table 8** into Eq(5),the human development index of Khuzestan province is calculated according to basic prices and compared with Iran's Human Development Index (calculated by the researcher) and Iran's Human Development Index (calculated by the United Nations Development Program):

Table 9. Calculation results of human development index in terms of base price
Source: Research results

Year	Khuzestan's Human Development Index with Oil	Khuzestan's Development Index without oil	Iran's Development Index (researcher calculation)	Iran's Development Index (UN calculation)
1375	0.64	0.60	0.62	0.65
1385	0.72	0.68	0.71	0.73
1390	0.75	0.71	0.74	0.77
1395	0.77	0.75	0.78	0.80

The results of calculating the human development index in Iran compared with the UN calculations show a high correlation, based on which the calculated human development index for Khuzestan province can be considered reliable.

Based on the results, the human development index of Khuzestan province since 1996 with a value of 0.64 from the average level to the high level in the years 2006-2016 has reached an acceptable growth in this index. As it is clear, the index of human development without oil in Khuzestan province is lower than the index of human development in the country and shows the worse situation of Khuzestan province than that of the country in this field. Moreover, based on these results, until 2006, the situation of the province was average in terms of indexes, and after 2011, it has improved and is considered at a high level.

3-5- Simulation of Human Development Index

Simulation is the creation of an artificial environment and the use of a theoretical model to estimate the behavior of a real-world system. An

artificial environment is a virtual space in which the analyst tries to model a system in the real world (Nawrocki, 2001). Depending on the purpose of the simulation, four types of simulation can be defined that are used individually or collectively in experimental works:

Simple generator simulation: This type of simulation is used when for some reason it is not possible to obtain a sample for the variable under consideration. The reason for that can be it has not yet occurred or been recorded or it is not economical to sample it. This type of simulation can be used to predict through regression models containing random perturbations. For example, suppose that there is a $Y = a + bZ + cX + e$ relation between X, Y and Z. Where Y is the studied variable, Z is the variable with the available sample, X is the positive variable with specified mean and distribution and non-sampling probability, and e is error term with normal distribution. In this case, the values of X and e must be simulated to investigate the behavior of Y. The Monte Carlo simulation is an example of this type of simulation (Nawrocki,2001).

Sensitivity or tactical analysis simulation: This type of simulation is used when the main question is how the model or variable under consideration behaves in the event of a change in the model parameters. For example, in a $Y = a + bX + cX^2$ relation in order to measure the sensitivity of y to changes in c, we can simulate this by making artificial changes.

Strategic or exploratory simulation: This type of simulation is mostly used when the effect of a controlled variable on the studied variable is considered. Suppose that in the example above the variable is controlled by x, that is, the value it gives depends on the decision and action of the reviewer. In this case, this type of simulation is changed into "What happens if?". Ex-post simulation is one type of this simulation.

Interactive simulation: This type of simulation is modelling of the human brain's decision-making process about the effective variables that are used in the construction of artificial intelligence after copying.

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Sugar space simulation is an example of this type of simulation (Rahman & Setayeshi, 2007).

The ex-post simulation method, which is a part of dynamic disequilibrium adjustment model (DDAM) is based on strategic or exploratory simulation. In this method, after performing the operation of estimating regression equations in the model, different scenarios can be simulated using the estimated model. In other words, numerical model is an estimation of the structural form of the model that must be solved for endogenous variables to find the summarized form. If this pattern is solved in the sample period, the sample period simulation or retrospective simulation will be obtained and the values of the solved endogenous variables can be compared with the real values to evaluate the performance of the model in the past but if the values of the exogenous variables are considered in the period, The sample will change and then the pattern is solved for the endogenous variables. The values of the endogenous variables are obtained based on the amount of the endogenous policy variable known as "shock analysis" (Bid Abad & Peykarjoo, 2007). In this research, using the econometric model, the human development index in Iran has been simulated. The adopted method is a simultaneous pattern of behavior that considers the effects of changes in the Human Development Index through the components of the UN Human Development Index and at the same time predicts it and considers it in the Human Development Index. The estimation method is based on the dynamic least squares method proposed by Stoke and Watson (1993) which is very useful for predicting variables. In general, the DOLS estimator compared to other convergence vector estimators has severaladantages, some of which are mentioned:

1. Similar to the ARDL estimator, this estimator does not need to be all first-order collective time series I (1) and can be used in cases where the collective degree of the variables is different.

2- This estimator is easy to calculate, so that the estimation of the model with the help of this estimator is much easier compared to other

estimators with asymptotic performance, and therefore the long-term estimation of the parameters is compatible with DOLS method.

DOLS estimator is a good way to correct the problem of endogenousness and autocorrelation.

4. The waste obtained through DOLS method is not correlated with any of the independent variables and can be considered completely exogenous.

5. In DOLS method, the endogenousness of explanatory variables does not affect asymptotic properties, especially estimator consistency.

6. In case all variables have a collective order of one and there is only one convergence vector, DOLS estimator is asymptotically equivalent to Johansson (1988) maximum likelihood estimator.

7. In small samples, estimations obtained by DOLS method have a lower mean squared error than those obtained by the Johansson maximum likelihood method. In addition, DOLS has the least esquaerd error among all convergence vector regression estimators (Stock & Watson, 1993).

Hence, , the short-term estimation equations have the following general form:

$$X_t = A_0 + A_1 Y_t + \sum_{i=-k}^{k} a_{it} \Delta Y_{t-i} + A_2 Z_t + \varepsilon_t \quad (16)$$

where X represents the dependent variable (in this study, the human development index for Khuzestan province HDI), Y is the vector of independent variables (in this study, including LEI life expectancy index, II income index and EI education index calculated by the UN), Δ is The difference sign and Z t is the vector of other variables that do not need delay and precedence. In order to obtain long-run equations and coefficients, it is assumed that t equals long - term antecedence and precedences. One of the main problems of DOLS method is determining the appropriate number of precedence and antecedence of

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variables, while DOLS estimator results are also sensitive to the selection of the number of precedence and antecedence periods. Due to the importance of this research subject , using Akaik statistics, the optimal length of antecedence and precedence is investigated. Therefore, the estimation of equations from this method is evaluated for the time data of 2017-2020 taken from the United Nations.

Various statistics have been used to evaluate the performance of the simulation model in the retrospective simulation period. One of the statistics that has traditionally been used as a measure of pattern simulation accuracy is the variance of simulation error (Pindyck & Rubinfeld, 1998). Based on these statistics, the degree of proximity of the simulation variable to the real series is measured. Assume that for the historical period $T1 = 1, \dots, T$ and for the retrospective period $T2 = T + 1, \dots, T + h$, then the criteria for predicting power are defined as follows:

(17)

$$(Root - Mean - Square\ Error\ of\ simulation)$$

$$RMSE = \sqrt{\sum_{i}^{N}(\tilde{Y} - Y)^2} \quad i = 1, \dots, T, T+1, \dots, T+h$$

(18)

$$Correlation\ coefficient$$

$$r = \sqrt{\frac{\sum_{i}^{N}(\tilde{Y} - Y)^2}{\sum_{i}^{N}(\tilde{Y} - \bar{\tilde{Y}})^2 \sum_{i}^{N}(Y - \bar{Y})^2}}$$

In the above equations, Y represents the real variable and $\tilde{Y}$ represents the simulated variable. The above traditional criteria show important properties in comparing simulation and real variables. Eq (7) shows that the closer minimum simulation error to zero, the closer simulation to the real values, and correlation coefficient is a coefficient in which the degree of correlation between two variables is obtained, regardless of being exogenous or endogenous. The closer the correlation coefficient to one, the better (Gujrati, 2004).

According to the research results, the human development index of Khuzestan province can be simulated for the period 1990-2018. The results of this simulation are shown in Table 10.

Table 10. Simulation of Khuzestan Human Development Index
Source: Research results

Indicator	Year	Indicator	Year	Indicator	Year
0.7	2010	0.62	2000	0.54	1990
0.71	2011	0.63	2001	0.55	1991
0.73	2012	0.64	2002	0.57	1992
0.73	2013	0.64	2003	0.58	1993
0.73	2014	0.64	2004	0.59	1994
0.73	2015	0.65	2005	0.6	1995
0.74	2016	0.68	2006	0.6	1996
0.74	2017	0.68	2007	0.61	1997
0.74	2018	0.69	2008	0.61	1998
0.74	2019	0.7	2009	0.62	1999

In order for further examination of simulation results with the actual data values, the results of the calculation of the simulation evaluation criteria are shown in **Table 11.** These results indicate the validity of the simulation performed.

Table 11. Predictive error criteria
Source: Research results

r	RMSE
0.97	0.02

As the results of Table 10 show, Khuzestan Human Development Index had a growing and gentle trend until 2005, but from 2006, it seems that a structural leap or failure occurred in the Human Development Index.Thenfrom 2016 to 2018, the trend stabilized and somehow

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reached a stable value. Also, based on this simulation, the human development index in Khuzestan province was at a moderate level until 2008, but has reached a high level since 2009.

4- Summary and Conclusion

Human Development Index is a composite index to measure success in any countryin three basic criteria of human development, long and healthy life and access to knowledge and awareness. Based on this index, the success rate of countries can be measured based on these three main criteria. Khuzestan province, with a large share of oil and gas resources and large and national economic units, is expected to have a relatively higher human development index than the national-level average.

To test this hypothesis, in this study, using the new formula, the human development index of Khuzestan province for the years 1996, 2006, 2011 and 2016 was calculated. The results of this study showed that life expectancy index and education index in Khuzestan province are worse than that of the country, but the income index (including oil) was higher than its counterpart in the country level. However, the calculation of the oil-free human development index for Khuzestan showed that this income index is in a more unfavorable situation than that of the country.

Based on the results, the human development index of Khuzestan province from 1996 with a value of 0.64 from the average level reached the high level in the years 2006 to 2016, which is an acceptable growth in this index. Also, the non-oil human development index of Khuzestan province is lower than the similar index of the country and shows the worse situation of Khuzestan province compared to the country in this field.

The simulation results of the Human Development Index show that there was a growing and gentle trend until 2005, but since 2005 it seems that there has been a leap or failure in the Human Development Index. Moreover, based on this simulation, the human development

index in Khuzestan province was at a moderate level until 2009, which reached a high level after 2010.

Reference

Afghah, S. M., Ahangari, A., & Askari por, H. (2020). Estimating Human Development Index of Iranian Provinces and Investigating its Impact on Economic Growth Using Fuzzy Logic. *Quarterly Journal of Quantitative Economics*, *17*(2), 89-121. doi:10.22055/jqe.2019.29152.2064.

Asefzade, S., Jahandideh, S., & Arefeh, M. (2013). Relationship between human development index and the number of scientific articles of countries. *JQUMS*, *17*(2), 33-40 .

Basu, S. (1997). The conservatism principle and the asymmetric timeliness of earnings1. *Journal of accounting and economics*, *24*(1), 3-37 .

Bhanojirao, V. (1991). Human development report 1990: review and assessment. *World Development*, *19*(10), 1451-1460 .

Frazier, J. (1997). Sustainable development: modern elixir or sack dress? *Environmental Conservation*, *24*(2), 182-193 .

Gujrati, D. (2004). Basic Econometrics. United States Military Academy, West Point. In: Mc Graw Hill Publications.

Haq, M. (2000). Human development in South Asia 1999: The crisis of governance. In: Oxford University Press Oxford, UK.

Hesari, A. (2015). Human Development Index, Challenges and Its Value for Islamic Republic of Iran at 2011. *Iranian Journal of Official Statistics Studies*, *26*(1), 1-24. Retrieved from http://ijoss.srtc.ac.ir/article-1-134-en.html

Kovacevic, M. (2010). Review of HDI critiques and potential improvements. *Human development research paper*, *33*, 1-44 .

Lee, J. W., & Barro, R. J. (2001). Schooling quality in a cross–section of countries. *Economica*, *68*(272), 465-488 .

Nawrocki, D. (2001). Finance and Monte Carlo Simulation. *Journal of Financial Planning*, *14*(11), 106-117 .

Nayak, P. (2008). Human Development in North East India. *Growth and Human Development in North-East India*, 151-165 .

Ramirez, A., Ranis, G., & Stewart, F. (1997). *Economic growth and human development*. Retrieved from

Sadegh, B., Majid, D. Z., & Seyed Mojtaba, H. (1385). Investigating the position of the country's provinces from the perspective of human development index *Journal of Knowledge and Development 15*(19), 11-39.

saeed Asefzadeh, Mehran Alijanzadeh, & Marjan Nasiri asl. (2013). Correlation between Human Development Index and maternal mortality rate. *Health Monitor Journal of the Iranian Institute for Health Sciences Research, 12*(6), 559-566. Retrieved from http://payeshjournal.ir/article-1-332-en.html

Selim, J. (2015). Human Development Report 2015. Work for Human Development. *UNDP Human Development Reports* .

Sen, A. (2000). Development as freedom. *DEVELOPMENT IN PRACTICE-OXFORD-*, *10*(2), 258-258 .

Stanton ,E. A. (2007). The human development index: A history. *PERI Working Papers*, 85 .

Streeten, P. (1981). *First things first: meeting basic human needs in the developing countries*: The World Bank.

Zanganeh, M. (2016). Evaluation and Analysis of Human Development Indices in Urban Areas. *Geography and Urban Space Development*, *3*(1), 149-160. doi:10.22067/gusd.v3i1.42556

Zayyari, K., Zanjirchi, S. M., & Sorkhkamal, K. (2010). A Study and Measurement of the Development Degree of the Counties of Khorasan Razavy Province Using TOPSIS Technique. *Human Geography Research, 42*(2), 17-30. Retrieved from https://jhgr.ut.ac.ir/article_24448_3f1ab5dfe74aae36a6773d800d66581c.pdf