

Human Development Index Based on Crime Rate

Pan-pan Liu¹, Guang Feng²

¹(School of Government, Beijing Normal University, China)
²(College of Engineering, Peking University, China)

Abstract: Human Development Index (HDI) is a widely used index to measure the level of human development, which usually covers three aspects: health, education and economy. But it can't fully reflect the level of human development in a region. Since social security is also an important index related to one of the most basic human needs, this paper selects crime rate as the fourth index of the original HDI indicator system, applies the entropy weight method to determine the weight of each sub-index, and finally forms a New Human Development Index (NHDI) including crime rate. Empirical study using data from 31 regions in China mainland shows that NHDI not only takes the regional crime rate into account, but also reflects regional differences. Therefore it is better than the original HDI.

Keywords: HDI, crime rate index, entropy weight method

Date of Submission: 11-03-2019

Date of acceptance: 28-03-2019

I. INTRODUCTION

When measuring the level of human development in a country or region, we intend to find a most comprehensive index to accurately reflect the development of a country or region in all aspects, but in fact, this is very difficult. Firstly, we can't use a set of limited numbers of sub-indexes to reflect all aspects of society. Secondly, if we choose too many sub-indexes, it will make the indicator system too large and produce a lot of overlapping and redundant information. At last, it is difficult to synthesize our indexes. Therefore, finding an almost perfect index to measure the level of development of a country or region is a problem that sociologists and economists have been concerned about focusing on.

For a long time, per capita Gross Domestic Product (GDP) has been regarded as the most important index to measure the level of development of a country or region. In 1990, the United Nations Development Programme (UNDP) put forward the Human Development Index (HDI) in the Human Development Report, which measures the level of human development from three dimensions: " the ability to lead a long and healthy life", " the ability to acquire knowledge" and " the ability to achieve a decent standard of living"[1]. It provides a new perspective for measuring and analyzing the level of human development in a country or region. Since HDI was put forward, scholars from various countries have continuously optimized and improved it in terms of index selection, threshold determination, weight distribution and calculation methods. In order to supplement HDI, UNDP proposed gender development index (GDI) to reflect the inequality of development level between men and women from three dimensions: health, education and economy. The Gender Inequality Index (GII) is proposed to reflect women's inequality in reproductive health, empowerment and labor market. It is proposed that Multidimensional Poverty Index (MPI) reflects the incidence and intensity of Multidimensional Poverty and the deprivation of individuals or families [2]. Kelly proposed a new Human Development Index [3], Noorbakhsh proposed that different calculation methods of HDI should be formulated according to the social development level of different societies, and that corresponding HDI indicator system should be designed according to developing countries with different development levels [4]. Based on HDI and considering the sustainable development of ecological resources and environment, Li constructed a human green development index (HGDI) with 12 sub-indexes, and estimated the human green development level of 123 countries in the world [5]. Fukuda discussed the impacts of human rights on HDI [6]. Zhu put forward the index of "ecological civilization" based on HDI [7]. Togtokh put forward the Human Sustainable Development Index (HSDI), which reflected the sustainable development of human-environment from three aspects: economy, society and environment [8]. Based on HSDI, Li and others systematically evaluated the level of human sustainable development in China from 1990 to 2010 from three levels: national, regional and provincial [9]. In terms of the empowerment of sub-indexes, Hopkins [10] and Booyesen [11] thought that the original weighting method was very subjective. Noorbash proposed to use factor analysis method to determine the weight of each sub-index [12]. Lai [13] and Hu [14] chose to use Principal Component Analysis (PCA) method to extract the principal component to determine the weight of each sub-index. In empirical research, Ahmad JafariSamimi compared

EPI with HDI indexes, and used the data of 2006-2011 to make a comparative study between developing and developed countries [15]. Hu and others used the analysis of variance (ANOVA) to analyze the regional differences of China's human development level [16]. Nie calculated the human development index of the countries along the belt, and sorted and analyzed them [17].

UNDP defines human development as: "Human development is a process of expanding human choices. These choices are infinite and change over time. And at all levels of development, health and longevity, education and a decent life are the three most basic elements. But with the development of human society and economy, people's demand for security is getting stronger and stronger, and people prefer to live in a safer environment. Living in a turbulent society and suffer from the threat of life and property at any time, human beings will not get a happy life no matter how high the development level of other aspects is. Over the past 20 years, With China's economic and social construction developing rapidly, the national income has increased by nearly 10 times, and the comprehensive national strength has been continuously enhanced. But the crime rate has increased from 47.9 to 94.4 in per 100,000 persons, then social security issues should not be ignored. Therefore, putting the crime rate into the indicator system of Human Development Index can further reflect the level of human development in a region under the background of building a harmonious socialist society. In this paper, I try to put the crime rate index into HDI indicator system, and use a more objective algorithm (entropy weight method) empowers the four sub-indexes. And the empirical research shows that compared with the original HDI, the NHDI based on crime rate can more adequately reflect the human development level of a region.

II. HUMAN DEVELOPMENT INDEX AND CRIME RATE

As described above, I try to put crime rate into the Human Development Index. In this part, I will elaborate on the specific measures of human development index and crime rate.

2.1 Human Development Index

Since HDI was put forward, UNDP has modified it in terms of index selection, threshold determination and calculation method. In 1990, UNDP defined the human development index as three dimensions: the ability to lead a long and healthy life, the ability to acquire knowledge and the ability to achieve a decent standard of living. Life expectancy at birth reflects the ability to lead a long and healthy life. Adult literacy rate index reflects the ability to acquire knowledge and the logarithm of per capita GDP reflects the ability to achieve a decent standard of living. Finally, the arithmetic average of the three dimensions is taken as the human development index. In 1991, UNDP revised the knowledge dimension into two indexes: adult literacy rate and mean years of schooling, which accounted for 2/3 and 1/3 weights respectively. And the per capita GDP adjusted by the Atkinson formula reflects the ability to achieve a decent standard of living [18]. In 2010, UNDP used the mean years of schooling and the expected years of schooling to reflect the knowledge dimension, the logarithm of GNI per capita to respect the decent living standard dimension. And Change the original arithmetic mean to geometric mean to synthesize HDI [19].

In this paper, I choose the calculation method of HDI in the Human Development Report 2016 [20] to calculate the HDI of the provinces and autonomous regions in the mainland of China. The specific calculation method is shown in Fig.1.

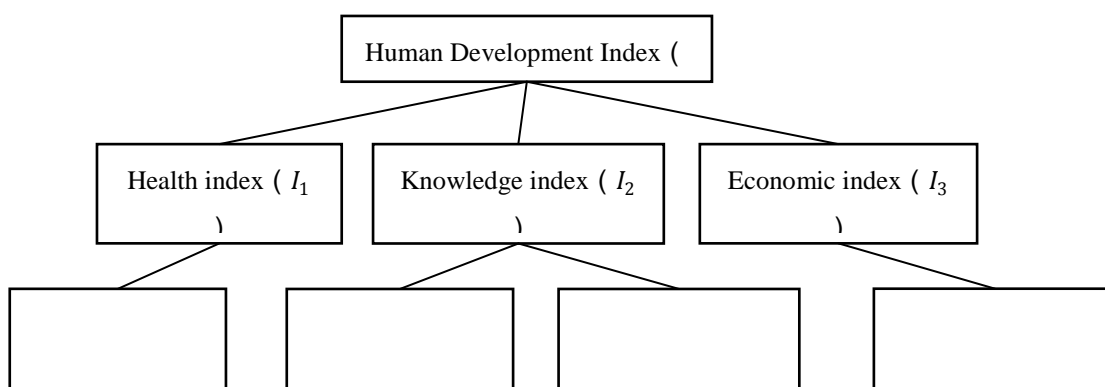


Figure 1: the framework of HDI

We define:

$$HDI = (I_1 \cdot I_2 \cdot I_3)^{1/3}$$

$$I_1 = \frac{\text{life expectancy at birth} - 20}{83.2 - 20}$$

$$I_2 = \frac{1}{2} (\text{mean years of schooling index} + \text{expected years of schooling index})$$

$$\text{expected years of schooling index} = \frac{\text{expected years of schooling} - 0}{18 - 0}$$

$$\text{mean years of schooling index} = \frac{\text{mean years of schooling} - 0}{13.1 - 0}$$

$$I_3 = \frac{\ln(\text{GNI per capita}) - \ln(100)}{\ln(56245) - \ln(100)}$$

2.2 Crime Rate

Safety refers to the absence of threats, dangers, hazards and losses. Harmonious coexistence between human beings as a whole and their living environment and resources does not harm each other. There is no hidden danger and harm, and it is a state of avoiding unacceptable risk of damage. Safety is to control the possible damage to human life, property and environment caused by the operating state of the system in the process of human production below the acceptable level of human beings. There are many indexes to measure the social security of a country or region. By referring to the relevant literature and comparing and analyzing, I finally choose the crime rate as the measurement index.

The Criminal Law of the People's Republic of China stipulates that all property endangering State sovereignty, territorial integrity and security, separating the state, subverting the people's democratic dictatorship and overthrowing the socialist system, undermining social and economic order, infringing upon state-owned property or collectively owned property of the working people, infringing upon private property of citizens, infringing upon citizens' personal rights, democratic rights and other rights. Rights, as well as other acts harmful to society, which should be punished according to law, are all crimes, but if the circumstances are significant, minor and not harmful, they are not deemed to be crimes. The concept of crime rate quoted in this paper refers to the proportion of criminal population in a region in the total population, that is, the number of criminal suspects arrested and decided by the Chinese People's Procuratorate per 100,000 permanent residents

$$\text{Crime Rate} = \frac{\text{the number of criminal suspects}}{\text{the number of permanent residents people}}$$

III. CORRELATION ANALYSIS BETWEEN CRIME RATE AND HDI

Correlation analysis is a statistical analysis method to study the correlation between two or more random variables in the same position. It is a process of describing the close degree of the relationship between objective things and expressing it with appropriate statistical indexes. If there is a correlation between crime rate and HDI, it shows that the original HDI index can reflect the level of crime rate in a region, so considering the overlap and redundancy of information, I deem that it is not necessary to incorporate the crime rate index into the evaluation system of HDI.

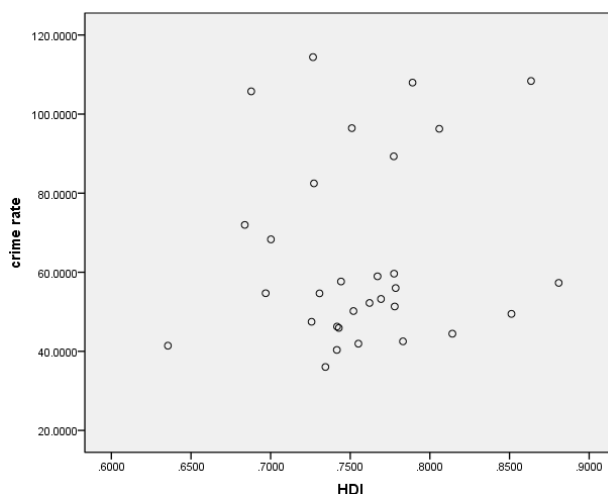


Figure 2: scatter plot between HDI and crime rate

Based on the above methods, the HDI and crime rates in the provinces and autonomous regions of China in 2016 are calculated. Draw a scatter plot about HDI and crime rate as shown in Fig.2. It can be seen from the scatter plot that there is no obvious correlation between HDI and the crime rate. The results of correlation analysis between crime rate and HDI, health index, education index and economic index are shown in Table 1. We can see that the sig value is more than 0.05, which indicates that there is no correlation between crime rate and HDI and its sub-indexes. So we can say that the original HDI model can't reflect the criminal situation of a provinces, however, crime rate is a very important index for people. Therefore it is reasonable and necessary to add the crime rate index to the HDI indicator system.

Table 1: correlation analysis results

	Pearson correlation	Sig.
Health index	0.068	0.6
Education index	0.046	0.724
Economic index	0.165	0.201
HDI	-0.081	0.533

IV. HUMAN DEVELOPMENT INDEX BASED ON CRIME RATE

People's security is the purpose of China's social governance, and the crime rate is an important index of the people's security situation in a region. The HDI proposed by UNDP reflects the level of human development from three aspects: health and longevity, education and decent living standards. Obviously, it does not include indexes reflecting regional security. Based on the above correlation analysis, there is no correlation between the crime rate and HDI and its sub-indexes, that is, HDI can't reflect the level of crime rate in a region. When introducing the crime rate into the indicator system of human development, this paper synthesizes the crime rate as the fourth index on the basis of the original indicator system, and empowers the four indexes with entropy weight method, finally forms a more perfect index of human development.

4.1 Entropy Weight Method

In information theory, entropy is a measure of uncertainty. The more information and the smaller the uncertainty, the smaller the entropy; the less information and the greater the uncertainty, the greater the entropy. According to the characteristics of entropy, we can judge the randomness and disorder degree of an event by calculating the entropy value. We can also use the entropy value to judge the discrete degree of an index. The greater the discrete degree of the index, the greater the impact of the index on the comprehensive evaluation. When measuring the level of human development in a region, if a certain index distributes evenly in the range of measurement, it can be considered that it is not important that this index can hardly reflect the degree of regional differences in evaluation, so we can give a smaller weight to this index; on the contrary, if an index varies greatly in the range of measurement, it is easy for this index to be in the range of measurement. It is important to reflect the degree of regional differences easily when evaluating, so we can give this index a larger weight. Therefore, I use the entropy weight method as the method to determine the weight of HDI.

When applying the entropy weight method to determine the weight, we follow the following steps:

1. Select n countries and m sub-indexes, and x_{ij} is the value of the sub-indexes j of the region i. ($i = 1, 2, \dots, n; j = 1, 2, \dots, m$)

2. Standardization of indexes:

Because the measurement units of various indexes are not uniform, before using them to calculate comprehensive indexes, we should standardize them, that is, to convert the absolute value of sub-indexes into relative value, so as to solve the problem of homogenization of different quality sub-indexes. Moreover, because the values of positive and negative sub-indexes represent different meanings (the higher the positive index is, the better; the lower the negative index is, the better), we use different algorithms to standardize data for high and low sub-indexes.

$$\text{Positive index: } x_{ij}' = \left[\frac{x_{ij} - \min(x_{1j}, x_{2j}, \dots, x_{nj})}{\max(x_{1j}, x_{2j}, \dots, x_{nj}) - \min(x_{1j}, x_{2j}, \dots, x_{nj})} \right] \times 100$$

$$\text{Negative index: } x_{ij}' = \left[\frac{\max(x_{1j}, x_{2j}, \dots, x_{nj}) - x_{ij}}{\max(x_{1j}, x_{2j}, \dots, x_{nj}) - \min(x_{1j}, x_{2j}, \dots, x_{nj})} \right] \times 100$$

Then x_{ij}' is the value of the sub-index j of the region i. ($i = 1, 2, \dots, n; j = 1, 2, \dots, m$). For convenience, it is still recorded as $x_{ij} = x_{ij}'$.

3. Calculate the proportion of the region i in the index j:

$$p_{ij} = \frac{x_{ij}}{\sum_{i=1}^n x_{ij}}, (i = 1, 2, \dots, n; j = 1, 2, \dots, m)$$

4. Calculate the entropy value of index j:

$$e_j = -k \sum_{i=1}^n p_{ij} \cdot \ln(p_{ij}), k > 0, k = 1/\ln(n), e_j \geq 0$$

5. Calculate the difference coefficient of the index j. For the index j, the greater the difference of the index value, the greater the effect on the evaluation of the scheme and the smaller the entropy value. Define the coefficient of difference:

$$g_j = \frac{1 - e_j}{m - E_e}, E_e = \sum_{j=1}^m e_j, 0 \leq g_i \leq 1, \sum_{j=1}^m g_j = 1$$

6. Calculate weights:

$$w_j = \frac{g_j}{\sum_{j=1}^m g_j} (1 \leq j \leq m)$$

7. Calculate the comprehensive score of each region:

$$s_i = \sum_{j=1}^m w_j \cdot p_{ij} (i = 1, 2, \dots, n)$$

4.2 New Human Development Index

In the evaluation system of HDI, UNDP uses arithmetic mean and geometric mean as the algorithms of HDI synthesis. These algorithms are subjective and it is the same with the importance of the three indexes. The Principal Component Analysis (PCA) method proposed by some scholars [13] [14] to determine the weight of sub-indexes is suitable for extracting the principal component when the sub-indexes are closely correlated. From the above correlation analysis, we can see that the crime rate has no correlation with the three sub-indexes of health index, knowledge index and economic index, thus it is not suitable for the principal component analysis method to determine the weight. The framework of NHDI is shown in Fig.3.

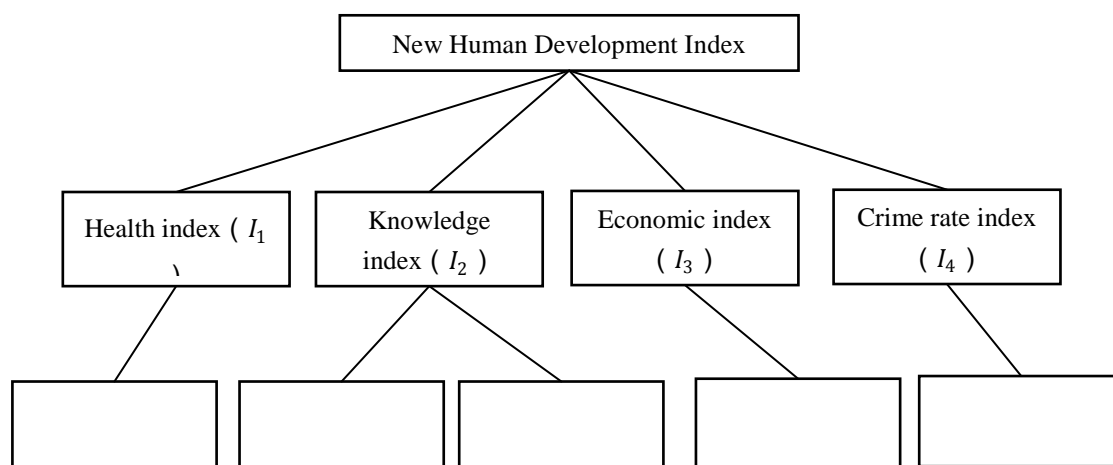


Figure 3: the framework of NHDI

We define:

$$NHDI = w_1 \cdot I_1 + w_2 \cdot I_2 + w_3 \cdot I_3 + w_4 \cdot I_4$$

$$I_4 = \frac{120 - \text{crime rate}}{120 - 20}$$

w₁, w₂, w₃, w₄ are the weight of each sub-index calculated by entropy weight method.

V. EMPIRICAL STUDY AND RESULT ANALYSIS

Using the above model, I calculate the weights of the four sub-indexes by using the method of entropy weight, which are 15.69%, 9.82%, 52.28%, 22.21% respectively. I calculated the data of 31 provinces, autonomous regions and municipalities directly under the Central Government in mainland China in 2016. The results are shown in Table 2.

Table 2: HDI and NHDI of 31 regions in China

Region	Health index	Knowledge index	Economic index	Crime Rate index	initial HDI rank	NHDI rank	Ranking change
Beijing	0.9522	0.8688	0.8263	0.6268	1	2	-1
Tianjin	0.9318	0.8059	0.8213	0.7053	3	1	2
Hebei	0.8698	0.7053	0.6649	0.6964	20	18	2
Shanxi	0.8690	0.7436	0.6343	0.7409	19	19	0

Inner Mongolia	0.8614	0.7313	0.7472	0.6865	9	7	2
Liaoning	0.8921	0.7702	0.6918	0.6399	8	12	-4
Jilin	0.8889	0.7537	0.7016	0.6035	10	17	-7
Heilongjiang	0.8858	0.7416	0.6556	0.7307	15	14	1
Shanghai	0.9535	0.8196	0.8240	0.5945	2	4	-2
Jiangsu	0.8960	0.7580	0.7944	0.7555	4	3	1
Zhejiang	0.9134	0.7413	0.7729	0.6372	5	6	-1
Anhui	0.8715	0.6979	0.6511	0.6395	22	23	-1
Fujian	0.8823	0.7073	0.7525	0.5969	11	9	2
Jiangxi	0.8597	0.6932	0.6547	0.6534	23	22	1
Shandong	0.8934	0.7274	0.7391	0.7748	7	5	2
Henan	0.8634	0.7049	0.6631	0.7375	21	16	5
Hubei	0.8682	0.7430	0.7058	0.6676	12	10	2
Hunan	0.8655	0.7261	0.6767	0.6982	16	15	1
Guangdong	0.8938	0.7325	0.7506	0.6101	6	8	-2
Guangxi	0.8720	0.6840	0.6448	0.3753	24	28	-4
Hainan	0.8908	0.7103	0.6695	0.4956	17	24	-7
Chongqing	0.8813	0.7180	0.7134	0.6102	13	13	0
Sichuan	0.8663	0.6757	0.6530	0.7253	26	20	6
Guizhou	0.8085	0.6455	0.6235	0.1425	29	31	-2
Yunnan	0.7839	0.6588	0.6129	0.4802	30	29	1
Tibet	0.7622	0.5335	0.6313	0.5858	31	27	4
Shaanxi	0.8652	0.7394	0.6919	0.6778	14	11	3
Gansu	0.8264	0.6890	0.5943	0.6531	28	25	3
Qinghai	0.7905	0.6516	0.6665	0.5169	27	26	1
Ningxia	0.8446	0.7186	0.6791	0.6234	18	21	-3
Xinjiang	0.8283	0.7076	0.6545	0.0559	25	30	-5

From the above calculation results, we can see that compared with the original HDI ranking, the ranking of the NHDI index including crime rate empowered by the entropy weight method has changed a lot, in which the rankings of Tianjin, Hebei, Inner Mongolia, Heilongjiang, Jiangsu, Fujian, Jiangxi, Shandong, Henan, Hubei, Hunan, Sichuan, Yunnan, Tibet, Shaanxi, Gansu and Qinghai have increased, that is to say relatively low crime rates have led to the ranking of human development in these regions increase.

The rankings of Beijing, Liaoning, Jilin, Shanghai, Zhejiang, Anhui, Guangdong, Guangxi, Hainan, Guizhou, Ningxia and Xinjiang have decreased, that is to say relatively high crime rates have lowered the ranking of human development in these regions. And the rankings of Shanxi and Chongqing have remained unchanged, that is to say the crime rate has not changed the ranking of human development in these areas.

Analyze the HDI calculated by two different algorithms quantitatively. In the original HDI algorithm, the mean, variance and coefficient of variation of HDI in the provinces, autonomous regions and municipalities directly under the Central Government of China in 2016 are 0.7582, 0.0027 and 0.0690, respectively. In the NHDI algorithm, the mean, variance and coefficient of variation of HDI in the provinces, autonomous regions and municipalities directly under the Central Government of China in 2016 are 0.0799, 0.0042 and 0.0912 respectively. It can be seen that compared with the HDI calculated from the formula, the value of NHDI is smaller and more discrete. That is to say, the use of the new NHDI formula can better reflect the differences of human development levels in different regions.

VI. CONCLUSION

Compared with the original HDI indexes, the NHDI indexes including the crime rate can more adequately reflect the human development level of a region. The original HDI was synthesized by geometric mean, which was subjective. Based on the actual data, this paper uses the method of entropy weight to determine the weight of the four sub-indexes, which is more objective. Empirical results show that 17 of the 31 regions in mainland China rank higher, 12 regions rank lower and 2 regions rank unchanged. Quantitative study of the two algorithms shows that the average value of NHDI is less than the original value of HDI, and the coefficient of variation of NHDI is larger than the original value of HDI. This shows that NHDI can better reflect the differences between different regions than the original HDI indicator system.

REFERENCE

- [1]. UNDP. Human Development Report 1990. New York: Oxford University Press.
- [2]. UNDP. Human Development Report 1994. New York: Oxford University Press.
- [3]. A C Kelley. The Human Development Index: Handle with Care[J]. *Population & Development Review*, 1991, 17(2):315-324.
- [4]. F Noorbakhsh. Human Development and Regional Disparities in Iran:A Policy Model[J]. *Journal of International Development*, 2002, 14(7):927-949.
- [5]. Xiaoxi Li, Yimeng Liu, Tao Song. Calculation of the Green Development Index[J]. *Social Science in China Press*, 2014(6):69-95.
- [6]. Sakiko Fukuda-Parr, A. K. Shiva Kumar. Rescuing Human Development Concept from the Human Development Index. New Delhi: Oxford University Press 2003.
- [7]. Chengquan Zhu, Bei Jiang. The Theoretical Construction and Positive Test of the Index of Ecological Civilization[J]. *Study in Dialectics of Nature*, 2009(8):114-118.
- [8]. C Togtokh. Time to Stop Celebrating the Polluters[J]. *Nature*, 2011, 479(7373):269.
- [9]. Jingwei Li, Zhifeng Liu, Chunyang He, et al. Assessing the Human-environment System Sustainability in China from 1990 to 2010 Based on Human Sustainable Development Index [J]. *Journal of Natural Resources*, 2015(7):1118-1128.
- [10]. M Hopkins. Human Development Revisited: A New UNDP Report[J]. *World Development*, 1991, 19(10):1469-1473.
- [11]. F Booyesen. An Overview and Evaluation of Composite Indices of Development[J]. *Social Indicators Research*, 2002, 59(2):115-151.
- [12]. F Noorbakhsh. The Human Development Index: Some Technical Issues and Alternative Indices[J]. *Journal of International Development*, 1998, 10(5):589-605.
- [13]. D Lai. Principal Component Analysis on Human Development Indicators of China[J]. *Social Indicators Research*, 2003, 61(3):319-330.
- [14]. Yongheng Yang, An-gang Hu, Ning Zhang. An Alternative to Human Development Index with Principle Component Analysis[J]. *Economic Research*, 2005(7):4-17.
- [15]. Sasimi, A., Kashefi, A., Salatin, P. & Lashkarizadeh, M. Environmental Performance and HDI: Evidence from Countries around the World. *Middle-East Journal of Scientific Research*, 2011, 10, 294-300
- [16]. An-gang Hu, Zidan Shi, Xiao Tang. The Continuous Decrease of China's HDI Regional Disparity and Its Causes (1982-2015)[J]. *Journal of Xinjiang Normal University (Philosophy and Social Sciences)*, 2018, v.39 ; No.155(04):2+49-57.
- [17]. Ying Nie. Social Development along the "One Belt and One Road"[J]. *Review of economic research*, 2017(15):120-148.
- [18]. UNDP. Human Development Report 1991. New York: Oxford University Press.
- [19]. UNDP. Human Development Report 2010. New York: Oxford University Press.
- [20]. UNDP. Human Development Report 2016. New York: Oxford University Press.

Pan-pan Liu. " Human Development Index Based on Crime Rate." *IOSR Journal of Humanities and Social Science (IOSR-JHSS)*. vol. 24 no. 03, 2019, pp. 25-31.