

# Research on Regional Differences of Chinese Low-Carbon Economy Development—Based on Capability Approach and Gini Coefficient Decomposition

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**Abstract:** Low-carbon economy development is the multidimensional effect which integrates growth effect, social effect, environmental effect and welfare effect. Based on Amartya's theory of capability approach, this article innovates the indicators of low-carbon economic development, measures the Gini coefficient of each province with the data in 2015, and the regional differences between provinces are compared. The results show that social differences and growth differences are the two most important factors of the overall impact of low-carbon economic development. Meanwhile, there are rising pressures for environmental differences and welfare differences. Because of the regional differences in the economic structure, resource endowment, environmental conditions and population structure, the development level of low-carbon economy is quite different in different provinces. Therefore, the government should formulate policy suggestions for different types of regions.

**Keywords:** low-carbon economy; economic development; capability approach; Gini coefficient

## 1 Introduction

Low-carbon economy development is the main political task of all governments in the world, and it is a problem that people pay close attention to [1, 2]. According to Amartya's methodology of capability approach and the idea of development as freedom, this article constructs a series of indicators of economic development to redefine the extension and connotation of economic development [3-5]. With the provincial data in 2015, Gini coefficient of indicators of economic development is measured. Based on this, the differences between different provinces are compared and influencing factors are analyzed. According to the imbalance between regional economies, this paper puts forward some policy suggestions to narrow regional differences.

The initial indicators of economic development are mainly used to describe economic growth. Although economic development indicators are numerous, but its design is based on the economic development of economic theory, and it gradually improves with the evolution of economic development theory. Zimmer et al. [6] pointed out that Vietnam should shift to low-carbon economic development model controlled by climate and environmental factors. Low-carbon economic development may be a powerful tool to mitigate societal vulnerability to climate change, that is, low-carbon sustainable economic development can reduce climate-related disasters and reduce mortality and morbidity [7-9].

China's socialist economic development index system matured slowly after 1950. Until 1980, China's mainstream economics considered the development of the economy as the development of productive forces. After 1980, some re-defined that industrialization as a series of basic production function continuous change process [10]. By 2016, China's economic development indicators are approaching international economic development indicators on diversity. Fan et al.

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[11] and Shen [12] described economic development from six dimensions. Li and Zhang [13] pointed out that economic development should not be limited to the rise of the overall data. In addition, government should pay more attention to the ways and results of economic development [14, 15]. Low-carbon economy needs to reduce high energy consumption status through energy structure optimization and innovation to improve energy efficiency.

The outline of this paper is subdivided into the following sections. Theory construction is set up and analyzed in Section 2. Section 3 is about measurement design and positive analysis. Section 4 provides concluding remarks.

## **2 Low-carbon economy development indicators of theory construction**

On the basis of Amartya Sen's methodology of capability approach [3] and the idea of development as freedom, this article argues that Low-Carbon Economy development is the development of multidimensional effect which integrates growth effect, social effect, environmental effect and welfare effect.

First, the indicators of economic growth effect include GDP per capita, urbanization rate and R&D expenditure proportion of GDP. GDP per capita is one of the most important macroeconomic indicators to measure economic development. It is a measure of how much of a country's gross domestic product (usually one year) is associated with the country's resident population (or household population). The urbanization rate is measured as a percentage of the total urban population, and is an important indicator of the economic development of a country or region. Independent innovation is now an important indicator of economic growth, R&D expenditure proportion of GDP can be an indicator. Scientific research output is not a good indicator. The reason is that scientific research output and the economic development level and future economic development prospects are closely related. And scientific research output not only depends on the funding, but also on the level of education, the quality of talent, which is related to education indicators. Therefore is not good to introduce here.

Second, the social effects of indicators can include the number of social service beds for children, the number of social service beds for the old, the proportion of students over teachers of schools at all levels (including primary, middle and ordinary high schools, secondary vocational schools, colleges and universities) and the proportion of 15 years of age and older illiterate over population. According to the data cited by China Women's Research Network on May 13, 2014, entitled Survey of Rural Left-behind Children in China, there are 96.83 million rural left-behind children and migrant children between 0 and 17 years old in China. The existence of children left-behind has become a more common phenomenon in China. It is more prominent in the rapid development of the economy and the process of industrialization of macroeconomic background. The problem of left-behind children essentially is a problem of floating population and migrant labor. It is only an external manifestation of this source. And there is the upward trend in the number of left-behind children in developing countries.

National policy strives to resolve the problem of left-behind children. It provides institutional protection in order to solve the problem of left-behind children. Therefore, this article selects the number of social service beds (10000) for children as an indicator of the social effect of economic development. In 2015, China's aged 65 and above population was 144.34 million. This decade, population over the age of 65 increased year by year. It implies that the peak of the aging population is coming and thus the seriousness and necessity of pension problems surfaced. Efficient, effective and professional pension industry is the only way to solve the aging burden of aging society. This article selects the number of social service beds for the old as an index to measure the social effect of economic development.

Thirdly, the indicators of environmental effects may include the proportion of service industry over GDP and the energy consumption per unit of GDP. With the economy entering the new normal, the high value-added information industry has gradually become the driving force of economic growth to achieve economic transformation of the emerging power, and the Internet-related services are gradually emerging. Before the advent of the new industrial revolution, the development of Internet will close to the economy and life, which likely to become new growth point of economic development in the world. Therefore, the proportion of the service industry in GDP is an indicator of the environmental effects of economic development. The energy consumption per unit of GDP refers to the amount of energy consumed by a country or region in a given period of time without producing a unit of GDP.

Finally, the indicators of welfare effects can include the dependency ratio of the elderly population, the proportion of orphans, the proportion of per capita health care expenditure and the proportion of per capita leisure expenditure. The most typical measure of happiness is the happiness index system of Bhutan in the world, containing 4 big system, 9 pillars and 72 indexes. Indicators of the welfare effect can be measured by subjective data such as personal satisfaction with income, and data is not easily collected. Therefore, this article uses quantifiable indicators to measure the welfare effect of economic development. Health is an important human capability and a very basic freedom. In addition to its own inherent important intrinsic value, health is also with varying degrees of instrumental value on the other dimensions of human development. Personal health is not static, but is influenced by many factors. Health investment can maintain or improve the level of health human capital. In this article, the proportion of per capita health care expenditure and the proportion of per capita leisure expenditure are taken as important indicators to measure the welfare effect of economic development.

Table 1 Low-carbon economic development evaluation index system

Four aspects	Indicators	Indicator description
Growth effect	per capita GDP	(yuan)
	urbanization rate	(%)
	R&D expenditure proportion of GDP	(%)
Social effect	the number of social service beds for children	(10000)
	the number of social service beds for the old students over teachers of all levels of school	(10000)
		including ordinary primary, junior high school, ordinary high school, secondary vocational schools, colleges and universities
Environmental effect	the proportion of illiterate population aged 15 and over	(%)
	the proportion of service industry over GDP	(%)
	the energy consumption per unit of GDP	
Welfare effect	the dependency ratio of the elderly population	(%)
	the proportion of orphans	(‰)
	the proportion of per capita health care expenditure	(%)
	the proportion of per capita leisure expenditure	(%)

### 3 Measurement design and positive analysis

The following question is to choose what kind of inequality indicators to measure the regional differences in low-carbon economy development in the provinces? In general, it is not appropriate to use absolute indicators. The relatively good indicators of the relative indicators include the Gini coefficient and the generalized entropy index (Theil index and the average logarithm deviation). Usually it is based on the purpose of the study to choose whether to use the Gini coefficient or generalized entropy index. This article focuses on the main measure of the degree of inequality between provinces, and thus it is more appropriate to use Gini coefficient.

Gini, an Italian economist, built the Gini coefficient on the basis of the Lorenz curve. The Lorenz curve, proposed by Lorenz in 1905, is a measure of the degree of inequality in social distribution. Gini coefficient varies between 0 and 1. The greater the Gini coefficient, the greater the regional differences. In general, when the Gini coefficient is less than 0.2, the regional difference is reasonable, 0.2-0.3 means that the regional difference is relatively reasonable, 0.3-0.4 means that the regional differences are more reasonable, 0.4-0.6 means that the regional differences is large, 0.6 and over means that the region difference is very large.

There are many methods to measure Gini coefficient, such as curve regression method, the average difference method, matrix method and so on. The Gini coefficient deduced by Amartya is used in this paper, which can be described by the following equation:

$$\begin{cases} G = A/(A + B) = (1/2n^2u) \sum_{i=1}^n \sum_{j=1}^n |x_i - x_j| = 1 - (1/n^2u) \min(x_i, x_j) \\ = 1 + (1/n) - (1/n^2u)[x_1 + 2x_2 + \dots + nx_n] \quad (x_1 \geq x_2 \geq \dots \geq x_n) \end{cases} \quad (1)$$

The main advantage of Gini Coefficient is that it can use an indicator to reflect the overall situation of regional disparities. First, Gini coefficient can avoid the randomness of variance method, variation method and logarithm variance method. Second, Gini coefficient is not affected by the absolute value, and is completely free from the focus on the mean difference. Third, Gini coefficient takes into account the gap between each two individual indicators. Fourth, Gini coefficient is convenient to measure and intuitive. Fifth, Gini coefficient has its own meaning. Therefore, Gini Coefficient is widely used in the literature of measuring the difference between samples.

In measuring regional differences in Low-Carbon Economy development in China, we selected thirteen indicators. Table 2 describes the 13 indicators of statistical analysis. Based on the Statistical data we have sorted out, Gini coef-

Table 2 Descriptive analysis of thirteen indicators of economic development

Four aspects	Specific indicators	Maximum	Minimum	Mean
Growth effect	per capita GDP	107960	26165	53084
	urbanization rate	87.6	27.74	56.64
	R&D expenditure proportion of GDP	2.15	0.03	1.03
Social	service	0.8	0.02	0.32
	social service beds (10000)for the old	38.86	0.5	11.55
	students over teachers of all levels of school	21.55	12.13	16.08
	the illiterate population aged 15 and over	37.33	1.72	6.77
Environmental effect	the proportion of service industry over GDP	79.65	38.8	47.05
	the energy consumption per unit of GDP	0.3	0.04	0.1
Welfare effect	the dependency ratio of the elderly population	18.69	8.07	13.67
	the proportion of orphans	27.65	0.56	4.92
	the proportion of per capita health care expenditure	11.77	2.78	7.77
	the proportion of per capita leisure expenditure	14.37	3.81	10.86

cient formula derived by Amartya Sen is used to calculate the regional differences of China's Low-Carbon Economy development. The results are shown in Table 3.

Note: The growth, social, environmental, and welfare effects of low-carbon economy development measures are given the same weight 1/4. Per capita GDP (yuan), urbanization rate (%), R&D expenditure proportion of GDP (%) are given the same weight 1/12. Social service beds (10000) for children, social service beds (10000) for the old, the proportion of illiterate population aged 15 and over (%), students over teachers of all levels of school are given the same weight 1/16. The proportion of service industry over GDP (%), the energy consumption per unit of GDP are given the same weight 1/8. The dependency ratio of the elderly population (%), the proportion of orphans, the proportion of per capita health care expenditure (%) and the proportion of per capita leisure expenditure (%) are given the same weight 1/16.

As shown in Table 3: First, Gini Coefficients of social service beds (10000) for the old and the proportion of illiterate population aged 15 and over are more than 0.7, indicating the two indicators exist the greatest regional difference. Second, Gini Coefficients of R&D expenditure proportion of GDP, social service beds (10000) for children, the energy consumption per unit of GDP and per capita GDP (yuan), are more than 0.6, indicating that regional differences of the four indicators exist are very large. Third, Gini Coefficients of the proportion of per capita health care expenditure, urbanization rate, the dependency ratio of the elderly population, students over teachers of all levels of school, the proportion of service industry over GDP, the proportion of per capita leisure expenditure are more than 0.5, indicating that regional differences of the six indicators are large. Fourth, Gini coefficient of the proportion of orphans is 0.3193, indicating that the difference in this aspect is in a relatively reasonable situation.

## 4 Concluding remarks

Low-carbon economy development is the development of multidimensional effect which integrates growth effect, social effect, environmental effect and welfare effect. Economic development should not only focus on economic growth,

Table 3 Inter-provincial disparities in low-carbon economy development in 2015

Four aspects	Specific indicators	Weight	Gini coefficients
Growth effect (1/4)	per capita GDP (yuan)	(1/12)	0.6302
	urbanization rate (%)	(1/12)	0.5760
	R&D expenditure proportion of GDP (%)	(1/12)	0.6808
Social effect (1/4)	social service beds for children(10000)	(1/16)	0.6798
	social service beds (10000)for the old(10000)	(1/16)	0.7294
	students over teachers of all levels of school	(1/16)	0.5596
	the proportion of illiterate population aged 15 and over (%) (1/12)	(1/12)	0.7090
Environmental effect (1/4)	the proportion of service industry over GDP (%)	(1/8)	0.5315
	the energy consumption per unit of GDP	(1/8)	0.6707
Welfare effect (1/4)	the dependency ratio of the elderly population (%)	(1/16)	0.5690
	the proportion of orphans (‰)	(1/16)	0.3193
	the proportion of per capita health care expenditure (%)	(1/16)	0.5847
	the proportion of per capita leisure expenditure (%)	(1/16)	0.5220
Total			0.5995

but also is considered people-oriented as the fundamental purpose of promoting economic development. In the process of development, regional imbalances are becoming increasingly prominent. In order to alleviate this problem, China's reform, economic and social development, policy formulation and implementation should promote the balanced development of the provincial economy as a long-run policy objective in the process of development.

Social differences and growth differences are the two most important factors of the overall impact of low-carbon economic development. Environmental differences and welfare differences are also increasing which could not be ignored. Because of the regional differences in the economic structure, resource endowment, environmental conditions and population structure of different provinces, Low-Carbon Economy development in different provinces is quite different, so the government should develop different policy suggestion in connection with Low-Carbon Economy development for different types of regions.

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