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## **On the Watts Multidimensional Poverty Index with Mixed Data Types and its Application in China**

### 1. Introduction

At present, more and more scholars are aware that poverty is essentially multidimensional deprivation, not just income deprivation. In the practical application research, many scholars use the dual cut-off method proposed by Alkier & Foster (2011) to measure multidimensional poverty in different countries. Although the Alkier & Foster approach reflects to some extent the multidimensional poverty situation in different countries, however, this method has great subjectivity in the weighting of each dimension, and cannot effectively reflect the relationship between the dimensions. Therefore, in the current practice of poverty alleviation in various countries, income is the main measure. The Watts index has a good axiomatic characterization, Zheng gave a strict mathematical proof of the axiomatic characterization of Watts index as early as 1992; Chakravarty (2008) and others further developed the relevant theory of Watts index, expanding it from the income dimension to multiple dimensions, taking into account the interaction between different dimensions without changing the good axiomatic characterization of Watts index. The good axiomatic characterization of Watts index is that it takes into account the depth and breadth of poverty and can reflect the true face of poverty more comprehensively.

Therefore, based on the good axiomatic characterization of Watts index and considering the multidimensional characteristics of poverty, this paper extends Watts index from quantitative data of income dimension to qualitative data of education, health, housing and other dimensions, thus constructs a Watts multidimensional poverty Index with mixed data types, and applies it to China's poverty alleviation practice, investigates the "targeted approach to alleviating poverty" policy. Since the implementation of the policy, China's poverty alleviation process has been analyzed from a multidimensional perspective, and the influence of various factors on the change of the overall Watts index under the multidimensional framework has been analyzed, so as to depict the path of poverty alleviation in China more comprehensively and truly.

### 2. Research Programmes

#### 2.1 Research objective

The main objective of this paper is to integrate qualitative data into the framework of Watts index analysis, construct multi-dimensional Watts index with mixed data types, reveal the axiomatic characterization of multidimensional Watts index, and apply it to China's poverty alleviation practice, depicting China's poverty alleviation path.

#### 2.2 Main research contents

### 2.2.1. Introduction

This part mainly introduces the background, reviews the classical literature related to Watts index, and puts forward the significance and main contributions.

### 2.2.2. Construction of Watts multidimensional poverty Index with mixed data types

In the income dimension, the Watts index can be expressed as:

$$W = \frac{1}{n} \sum_{i=1}^q \left[ \ln(z) - \ln(y_i) \right]$$

Usually when the rate of income growth  $g$  is known, the time needed for poor families to get rid of income poverty can be expressed as:

$$T_1 = \frac{1}{n} \sum_{i=1}^q \left[ \ln(z) - \ln(y_i) \right] / g = W/g$$

Furthermore, the time for income to be lifted out of poverty can be expressed as:

$$T_1 = H(t_1^{avg} + L_1)$$

When the income Watts index is extended to qualitative data dimensions such as housing, education and health care, the time of poverty alleviation in each dimension can be expressed as:

$$T_j = H(t_j^{avg} + L_j)$$

The total Watts index can be expressed as:

$$T = \sum_{j=1}^m H_j(t_j^{avg} + L_j)$$

Among them,  $H_j = \left( \sum_{j=1}^m n_{pj} \right) / n_p$ , so far, the construction of multi-dimensional Watts index with mixed data is completed.

### 2.2.3. The axiomatic characterization of multidimensional Watts Index

This part mainly examines the axiomatic characterization of the Watts multidimensional poverty Index with the above-mentioned mixed data types, tests whether the Watts multidimensional poverty Index satisfies the characteristics of anonymity and decomposition, and compares the multi-dimensional Watts index with the multidimensional poverty index (MPI), and analyses their advantages, disadvantages and applicability.

### 2.2.4. Application of Watts multidimensional poverty Index in China with mixed data types

At present, China's poverty standard is multidimensional. It not only considers income poverty, but also considers housing, education, medical and other dimensions related to basic human rights. However, unlike quantitative income poverty, poverty in housing, education, medical and other dimensions is often a qualitative standard. Using the concept of time for income poverty alleviation, the qualitative standards such as housing are transformed into time for poverty alleviation. The Watts multidimensional poverty Index with the mixed data types is constructed. The Watts multidimensional poverty Index is calculated by using the micro-survey data, and the time variation of the total Watts index is analyzed. Using the good decomposability of Watts index, the contribution rate of total Watts index in several dimensions such as income is analyzed.

### 2.2.5. Research on the influencing factors of Watts multidimensional poverty Index

From the Watts multidimensional poverty Index formula, the incidence of poverty and other factors are important factors affecting the total Watts index. According to Shapley decomposition, this paper analyzed the change of poverty incidence in Watts multidimensional poverty Index with mixed data in time dimension, and analyzed the main factors affecting poverty reduction in the process of poverty alleviation in China.

#### 2.2.6. Conclusion

This part mainly summarizes the conclusions, and according to the factors affecting China's Watts multidimensional poverty Index, puts forward targeted recommendations.

#### 2.3. Main innovative points

The innovation of this paper lies in the following two aspects:

- (1) Construction of Watts multidimensional poverty Index with mixed data. Drawing on the concept of the time of poverty alleviation for income Watts index, converting qualitative data such as housing, education and health care into the time of poverty alleviation, and constructing the time of poverty alleviation of Watts index in their respective dimensions. On this basis, considering the cross-influence of each dimension, the Watts multidimensional poverty Index with mixed data types is constructed.
- (2) Applied research on the measurement of China's poverty eradication process. At present, there are many studies on poverty in China, but relatively few studies on the process of poverty alleviation according to China's poverty standards. This paper fully considers the multidimensional characteristics of China's poverty standards, and uses Watts multidimensional poverty Index to describe the path of poverty alleviation of China's poor population from a multidimensional perspective, providing a more realistic picture of China's poverty alleviation and fortification to the world.