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Welfare Effect Evaluation of Land-Lost Farmers' Households under Different Livelihood Asset Allocation

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Abstract: Based on research into the theory of household assets and the welfare of farmers, the Analytic Hierarchy Process (AHP)-entropy weight method and cloud model were used to study the welfare level of land-lost farmers' households under the different livelihood assets of Taohuayi Village, Taohuasan Village and Taohuawu Village in Taohua Town, Nanchang City. The results show that (1) The comprehensive welfare level of asset-deficient farmers' households is between the "bad" and "medium" levels and is closer to the "bad" level. The comprehensive welfare level of asset-balanced farmers' households is between "general" and "good" and is closer to the "good" level. (2) Judging from the various functional activity indicators that affect the welfare of the land-lost farmers, after the asset-deficient farmers' households lose their land, the welfare level of the family's financial situation, social security, living environment, mental status, development opportunities, and political participation are generally at low to medium-low levels, and only living conditions are at medium-to-high levels. (3) The welfare level of the living environment of the asset-balanced farmers' households is at a moderately low level, and the welfare of the remaining functional activities is at a medium to a medium-high level. We then propose corresponding policy recommendations. After losing land, it is necessary to implement a differentiated circulation guarantee and support policies to achieve targeted compensation and support for the land-lost farmers' households to improve the welfare level of land-lost farmers' households under different living asset allocation.

Keywords: land-lost farmers; livelihood assets; welfare effects; cloud model

1. Introduction

1.1. Research Background and Significance

China is now experiencing urbanization and industrialization at an unprecedented rate [1], which is an inevitable trend and a strong driving force in China's economic and social development. The conversion of land between different uses in the agricultural and non-agricultural sectors plays a very important role in the socio-economic development of a country or region [2]. As one of the principal means of land-use conversion [3], rural-urban land conversion not only provides a land resource guarantee for urbanization but also the inevitable performance of regional social and economic development in land resource allocation [4]. Rural-urban land conversion means that in the process of expanding urban development scale and increasing urban land demand, urban land demanders use economic or administrative means to transform agricultural land around cities into urban construction land to meet the needs of urban land demanders for land development [5].

In China, land-lost farmers comprise a large number of vulnerable groups formed during the rural-urban land conversion. Each land acquisition or expropriation of 0.067 hectares of land will cause 14 people to lose land. According to statistics, the number of land-lost farmers had reached 40–50 million people by the end of 2010 [6,7]. However, the current state compensation and resettlement policies have experienced problems, such as low compensation levels, unreasonable compensation distribution, an inadequate settlement mechanism, a serious lack of a social security system, and the abuse of land acquisition rights. This makes it impossible for farmers to maintain their living conditions before land acquisition after land loss. Some farmers' production and livelihood are threatened because of the expropriation of land [8], which, in turn, triggers social conflicts. Therefore, the problem of land-lost farmers has become one of the long-standing and most urgent problems in the process of China's social and economic development and has received extensive attention from academic and political circles.

Welfare is one of the important indicators of the standard of living and quality of life and is an important research topic in today's society [9,10]. Land is the main source of livelihood and production materials for farmers. The changes in the lives of land-lost farmers after land acquisition are not only reflected in economic benefits but also in noneconomic aspects, such as employment opportunities, living environment, social security, ecological value, and emotional attachment.

The welfare economist Sen redefines the concept of welfare based on previous studies. He believes that personal welfare is not only related to the utility of the wealth and resources he possesses but also includes "nonmaterial" factors such as personal freedom and social fairness. Its essence is the substantial freedom of the various possibilities of activity that this person has the ability to achieve [11]. The welfare of land-lost farmers remains unchanged or improved. It refers to the ability of land-lost farmers to maintain their original living conditions following a rural-urban land conversion or to obtain the ideal freedom of life, that is, to improve their ability to survive [12].

Due to the differences in individual characteristics, environmental diversity and social background of the land-lost farmers, the degree and efficiency of the conversion of the same goods, services, and resources to welfare are also different. Sen refers to these factors as conversion factors. Although the conversion factor does not directly generate welfare, it can promote or hinder the ability of goods, services, and resources to convert to welfare [13,14], and it is crucial to analyze the importance of various functional activities in the formation of welfare [15].

Livelihood is a way of making a living [16], and the livelihood of farmers includes the abilities, assets (reserves, resources, claims, and enjoyment) and activities they have to survive and develop [17]. The farmer's livelihood assets, which are the basis of the farmer's livelihood structure, are the basis for choosing opportunities, adopting livelihood strategies and resisting livelihood risks, and they are also necessary conditions for obtaining positive livelihood results [18]. The stocks, flows, and combinations of livelihood assets are the most complicated and the most important. This study considers the farmers' livelihood assets as their own conversion factors and applies the quantitative evaluation of farmers' livelihood assets to the household classification of land-lost farmers. In addition, it is possible to more accurately determine the welfare status of the land-lost farmers' households following rural-urban land conversion.

1.2. Aims of the Study

To solve the abovementioned problems, this paper takes Taohua Town as the research area and surveys the land-lost farmers in the area to obtain corresponding data. Based on the theory of livelihood sustainability, the households of the land-lost farmers are classified using the farmer's livelihood asset quantification method. Based on Sen's welfare theory, the welfare theory of land-lost farmers' households is expanded, and an index evaluation system for the welfare of land-lost farmers' households is constructed. Combined with the Analytic Hierarchy Process (AHP)-entropy weight method, Sen's welfare theory comprehensively empowers the cloud model to evaluate the welfare effect of the land-lost farmers' households under different livelihood asset allocations following rural-urban land conversion and proposes detailed policies and suggestions to safeguard the welfare and rights of land-lost farmers. This can effectively solve the uncertainty conversion between quantitative data and qualitative concepts in the welfare evaluation process, as well as randomness and ambiguity. The effectiveness of the cloud model assessment method is verified by a case study, which provides a reference for other similar evaluation problems.

2. Literature Review

2.1. Research Progress on the Welfare Effect of Land-Lost Farmers

Extant studies show that the academic community has carried out in-depth research on the welfare effects of land-lost farmers from different perspectives. This work focuses primarily on the welfare changes of land-lost farmers, the factors affecting welfare, the social compensation mechanism, the distribution of value-added income, and the farmers' welfare gap caused by the transfer. Due to these different research perspectives and research areas, the measurement results of changes in the welfare level of land-lost farmers are also different. Lopez [19] calculated the optimal amount of rural-urban land conversion by estimating the marginal comfort benefits of rural land, the marginal production efficiency of rural land, the marginal production efficiency of the city, and the marginal production efficiency of societies in three communities of the United States. The study shows that rural-urban land conversion has increased the welfare of community farmland renters by 373,301 US dollars per year. Under the subsidy policy, the welfare of land-lost farmers increased by 748,396 US dollars, that is, the welfare level of land-lost farmers in the region increased following rural-urban land conversion.

The above research only remains at the level of change in the welfare of farmers who have lost their land and the degree of change. There is a lack of empirical research on the factors affecting the changes in the welfare of land-lost farmers. Nie [20] used Sen's feasible ability theory as an analytical framework and used structural equation modeling to test the factors affecting the welfare of land-lost farmers. Studies have shown that working conditions and compensation equity in the process of urbanization are the two most important factors affecting the welfare level of land-lost farmers.

It can be seen from the various factors affecting the welfare of land-lost farmers that whether compensation is fair and reasonable is an important factor restricting improvements in welfare level. Research on the current compensation system for rural land in China found that the current land acquisition compensation not only must solve the survival problem of the land-lost farmers but, more importantly, should be studied from the perspective of improving the overall welfare of farmers [21]. For example, Hui [22] reviewed the evolution of land acquisition policies since the reform and opening up and assessed the impact of these policies on land-lost farmers from the perspective of social exclusion. The results of the study indicate that the central government should consider revising existing social security measures and introducing other complementary policies that will help improve the competitiveness of land-lost farmers in the labor market and curb the exclusion of cultural, psychological and social networks from land-lost farmers.

However, the current land acquisition compensation standard does not include the value-added portion of the land. The distribution of land value-added income in the rural-urban land conversion in China has not been distributed according to the contribution rate of each entity to the value of rural land. Berry [23] believes that clear, reasonable and fair land property rights and interest distribution systems will promote the rational use of land and the advancement of corresponding technologies. Stimulating investment in land and increasing land trading opportunities will benefit the development and stability of the entire social economy. In recent years, increasingly more scholars have established land-based value-added income distribution models based on land development rights [24,25]. Yan [26] believes that by demonstrating the right to develop rural land, land-lost farmers can realize the value-added distribution of land in the process of urbanization and industrialization.

The above studies all treat land-lost farmers in the same area as a homogeneous subject and do not distinguish them from their own conversion factors. In recent years, scholars have begun to pay attention to the influence of the main construction of farmers on the welfare of land-lost farmers. For example, Peng [27] used four districts in Wuhan as a research area to study the welfare impact of rural-urban land conversion on land-lost farmers at various ages. The results show that the impact of rural-urban land conversion on the welfare of land-lost farmers at various ages is different, and the functional indicators of land-lost farmers at various ages have different directions and degrees of change following rural-urban land conversion.

2.2. Research Progress on the Measurement Methods of Land-Lost Farmers' Welfare

2.2.1. Research Progress on the Cloud Model

Welfare is a broad and somewhat vague concept [28] but not an extreme concept of one or the other. Its inherent ambiguity, complexity, and uncertainty make it impossible for scholars to precisely define it. In real life, it is difficult to obtain an absolute conclusion that the level of welfare is high or low [29], and thus, it is impossible to measure the welfare of land-lost farmers using classical mathematical methods. In 1965, American numerical control expert l.A. Zadeh founded the fuzzy mathematics method to solve the evaluation problems inherent in the fields of poverty, welfare, food and clothing, well-off status and quality of life [30]. Fuzzy set theory has become the main tool for dealing with fuzzy uncertainty problems [31]. At present, the research method model related to the evaluation of welfare effects of land-lost farmers is approaching assimilation, mostly based on the fuzzy comprehensive evaluation method [32–34]. However, as a subordinate function of the fuzzy set theory, once it is artificially assumed to be an accurate value, it will be included in the precise mathematics kingdom [35–37]. Thus, it is impossible to simultaneously consider the ambiguity and uncertainty of the welfare of the land-lost farmers. In 1995, Academician Li proposed a cloud model as a mathematical model for the qualitative and quantitative conversion of uncertainty knowledge [38–40], which can overcome the ambiguity and uncertainty in the process of welfare evaluation of land-lost farmers [41]. The cloud model theory and method have been successfully applied to the fields of knowledge representation, data mining, intelligent control, evolutionary algorithms, etc., and have been widely used in the field of comprehensive evaluation [42–44]. Wu [45] used the cloud model to comprehensively evaluate the comprehensive sustainability of the public housing community in the "Minxinjiayuan" of Chongqing. Studies have shown that the level of sustainability at the economic and social levels of the community is higher than sustainability at the environmental, institutional, and cultural levels. Wang [46] evaluated the water quality of Jinan Springs in China based on the cloud model. The research results show that the research method can not only reflect the water quality level of the area but also measure the pollution degree of different spring water quality. It is also suggested that the most likely cause of the pollution of these springs is caused by man-made pollution during the construction of underground passages. Finally, Wang compares the evaluation results of the cloud model with the single factor index (SFI) method, the Nemerow index (NI) method, the variable fuzzy sets (VFS) method, and the artificial neural networks (ANN) method, and concludes that the results obtained by different methods are consistent. Gao [47] believes that the sustainable use of water resources is becoming more and more important in the context of the increasing shortage of water resources and the widening gap between supply and demand. From the perspectives of water resources, society, economy, and environment, Gao has established a qualitative description index system through analysis of strengths, weaknesses, opportunities, and threats (SWOT). The Normal cloud model was used to evaluate the sustainable use of water resources in different cities in Shandong Province. The results show that water resources in most parts of Shandong Province face serious unsustainable problems. It is also proposed that cities in Shandong Province should pay attention to the development of circular economy and irrigation technology. Gao compares the evaluation results of normal cloud model (NCM), projection pursuit method (PP), and fuzzy comprehensive evaluation (FCM) in the discussion section of the article. The study found that NCM has considerable reliability in the evaluation process. However, there are relatively few studies on applying cloud models to the evaluation of welfare effects of land-lost farmers' households.

2.2.2. Research Progress on the AHP-Entropy Weight Method

In the evaluation system of the welfare effect index of the land-lost farmers, the different weighting of the evaluation indicators has a great influence on the evaluation results [48]. The determination of the weight of the evaluation index can be divided into two categories depending on the form of assignment. One is the method of determining the subjective weight represented by the Delphi method and the AHP. According to the decision-making goal of the system, the AHP method can organize many index factors, establish a hierarchical structure model, and determine the weight of the evaluation index according to the relative importance of the lower layer to the upper layer. The AHP method has been widely used in the evaluation and utilization of resources in rural areas, the evaluation of the potential of rural settlements, and the development of industrial areas in rural areas [49]. For example, Baffeo [50] uses AHP to explore the effectiveness of priority livelihood activities and effective rural development interventions in rural areas. The study found that the AHP method at the microscopic scale takes into account the actual needs of the beneficiaries and provides a transparent and powerful method. This helps local governments formulate development programs that may have the greatest social benefit. The other is the method of determining the objective weight represented by the correlation coefficient method, the entropy weight method, and the criteria importance through intercriteria correlation (CRITIC) method [51]. Although the subjective weighting method fully considers the knowledge and experience of experts, it cannot overcome the intentions and preferences of experts, and there are problems of subjective randomness. The objective weighting method determines the weight according to the information contained in the original data itself. Although it reduces the interference of human factors, it does not reflect the knowledge and experience of experts [52]. The AHP-entropy weight comprehensive weight determination method based on subjective and objective thoughts can make up for the shortcomings of the abovementioned weight determination methods and improve the scientific evaluation of the welfare effects of the land-lost farmers. Ma [53] takes Suzhou Industrial Park in China as an example. The AHP-entropy weight method is used to determine the weight of each index, and the central point triangle whitening weight function is used to comprehensively evaluate the urban green transportation planning. The research results show that the comprehensive weight determination method overcomes the subjectivity of traditional methods in weight determination and improves the scientific level of evaluation. In this paper, the weighting method combining the AHP and entropy weight method is used to fully combine the experts' empirical knowledge with the information of each data set to jointly determine the weight of the evaluation index of the welfare effect of the land-lost farmers.

2.3. Critical Missing Aspects

Through comparison and summary of the above studies, it is found that there are still some factors worthy of further study. (1) Farmers' household livelihood assets are the most critical factors affecting rural economic activities. Therefore, the impact of the rural-urban conversion on the welfare effects of land-lost farmers should be studied from the perspective of farmers' households. (2) In previous studies, the characteristics of land-lost farmers' households or the economic conditions of the local areas were used as the conversion factors of the land-lost farmers' households. The land-lost farmers were fixed at a certain point in time, and the characteristics and behavioral processes of the land-lost farmers were recognized by static thinking, or according to the characteristics of some surfaces to achieve the differentiation of farmers, in order to study the changes in welfare following rural-urban land conversion. (3) In the past, the weight of the indicators of welfare effects of land-losing farmers was often determined using the subjective weight determination method or the objective weight determination method. However, both of these have different degrees of shortcomings. The subjective weight determination method is often limited by the knowledge and experience of researchers and lacks reflection on actual evaluation data, while the objective weight determination method is susceptible to extreme values and does not reflect the opinions of the researchers. (4) The traditional fuzzy comprehensive evaluation method cannot simultaneously consider the ambiguity and randomness of welfare when quantitatively evaluating the welfare effects of land-lost farmers. In addition, it neglects the qualitative description of the evaluation indicators, the quantitative determination of the index value and the randomness of the evaluation level in the actual operation process of the welfare effect evaluation of the land-lost farmers.

3. Material and Methods

3.1. Selection of Indicators

3.1.1. Construction of a Quantitative Indicator System for the Livelihood Assets of Land-Lost Farmers' Household

The Sustainable Livelihoods Approach (SLA), established by the UK's Department for International Development (DFID) in 2000, divides livelihood capital into human capital, natural capital, physical capital, financial capital, and social capital [54]. The analysis framework describes how farmers use their farmer's livelihood capital and possible livelihood strategies to improve their livelihoods in the risk environment caused by the market, institutional policies, and natural factors. This is good for reflecting the interaction of birth capital, livelihood strategies, and livelihood outcomes. It provides researchers with a new perspective on the in-depth observation of farmers. Numerous studies have conducted qualitative and quantitative research on farmers' livelihoods based on SLA [55]. For example, Sampson [56] used the Bosomtwe community as a research area to identify farmers' alternative livelihood strategies for climate change in the community. Studies have shown that governments should use grassroots opportunities and resources to expand farmers' strategies for viable assets. Baffoe [57] proposed that a group's ability to get rid of poverty depends to a large extent on the livelihood assets owned by group members. Baffoe used the rural areas of Ghana as a research area to explore the level of livelihood assets of farmers' households from a gender perspective. The research results show that farmers' financial assets, natural assets, and social assets are abundant in the region, while human assets and physical assets are scarce. Through gender analysis, it is shown that the level of household livelihood assets of female-headed households is slightly higher than that of male-headed households. At the same time, Baffoe called for an increase in the total level of human and physical assets of households in the region.

According to the abovementioned research on livelihood assets, this study applies the quantitative evaluation of farmers' household livelihood assets to the classification of land-lost farmers' households. According to the results of the questionnaire survey of farmers, this paper selects indicators from five aspects: human assets, natural assets, physical assets, financial assets, and social assets [57–60]. Then, combines the ecological environment, resource endowment and actual situation of farmers' households in the study area to establish a quantitative evaluation index system for the livelihood assets of land-lost farmers' households (see Table 1). Through the quantitative analysis of household livelihood assets, land-lost farmers can visually see their households' livelihood asset portfolio and allocation status. At the same time, the government can provide detailed life support, entrepreneurship, employment, and other support depending on the welfare status of the land-lost households under different living assets.

Table 1. System of living assets measurement indicators and weights of land-lost farmers' households.

Types	Index	Indicator Definition	Assignment
Human assets	Education of the member with the highest education level (H1)		Illiterate is 0, primary school is 0.25, junior high school and secondary school are 0.5, high school and junior college are 0.75, and undergraduate or above is 1.
	Households' overall labor capacity (H2)	The sum of the working abilities of household members at different ages and health conditions	0 to 6-year-old children are 0, 7 to 15 year-olds are 0.3, 16 to 54-year-old female or 16 to 59-year-old male healthy family members are 1, 55-year-old female or 60-year-old male and the abovementioned healthy family members are 0.5, family members with chronic disease are 0.5, and those with major illness, disability or old age are 0.5.
	Number of family members attending training (H3)	The number of family members participating in professional skills training in the past 12 months and summing them.	No participation is 0, participating once is 1, participating twice is 2, and participating three times or more is 3.
Natural assets	Per capita cultivated area (N1)	The cultivated land per capita owned by the family	Cultivated area owned by the family/Number of family members
	Cultivated land quality (N2)	Farmer perception	Very poor is 0, poor is 0.25, neutral is 0.5, good is 0.75, and very good is 1.
	Number of livestock (N3)	Amount of livestock raised by the family	Continuous variable
	Whether to raise poultry (N4)		For a dichotomous variable, it is 1, otherwise, it is 0.
Physical assets	Family housing area (P1)		Continuous variable
	Family housing type (P2)		Grass house is 0, civil house is 0.25, brick and wood house is 0.5, tile house is 0.75, and brick house is 1.
	Family housing situation (P3)		Very poor is 1, poor is 2, generally is 3, good is 4, and very good is 5.
	Productive tools (P4)	Pumps, harvesters, rice machines, tricycles, storefronts	The measure of household productive tools is the ratio of the number of options owned by the farmer to all options.
	Durable consumer goods (P5)	Motorcycle, mobile phone/landline, air conditioner, refrigerator, washing machine, TV, water heater, combination furniture, car	The measure of household durable consumer goods is the ratio of the number of options owned by the farmer to all options.

Table 1. *Cont.*

Types	Index	Indicator Definition	Assignment
Financial assets (F)	Annual household income (F1)		Continuous variable
	Access to borrowing (F2)	Measured from three aspects: bank or credit union, loan shark, relatives and friends	For a dichotomous variable, the value is hectares if it can obtain a certain aspect of the loan, otherwise, it is 0. Next, give loans to banks or credit unions, usury, relatives, and friends, and give them a weight of 0.50:0.25:0.25. Calculate the value of the indicator of the opportunity for farmers to obtain loans.
	Access to cash assistance (F3)	Has the farmers' households received donations or remittances in cash in the past 12 months?	For the dichotomous variable, the farmers' household received a cash receipt or remittance with a value of 1, otherwise, it was 0.
Social assets (S)	Social connection degree (S1)	Are there relatives or friends working in government agencies or enterprises?	For a dichotomous variable, it is 1, otherwise, it is 0.
	Number of family members participating in social organizations (S2)	Number of professional cooperative economic organizations in which family members have participated in the past 12 months	Not participating is 0, 1 is 0.25, 2 is 0.5, 3 is 0.75, and 4 or more is 1.
	Trust in people around (S3)	Neighborhood trust	Almost all untrustworthy is 0, a few trustworthy is 0.25, half are trustworthy is 0.5, trust most is 0.75, and trust all is 1.
	Whether you get outside help when your family is in difficulty (S4)	Includes financial support, policy support, technical support, and human support	Cannot get help is 0, can get one type of support is 0.25, two types of support is 0.5, three types of support is 0.75, and four types of support is 1.

3.1.2. Construction of Evaluation Index System for the Welfare Effect of Land-Lost Farmers' Households

In traditional welfare economics, utilitarian economists believe that utility and income indicators can be used to measure welfare levels. However, Sen believes that welfare should not be determined solely by the utility of the wealth, basic goods or resources one possesses but should also cover all aspects of one's needs. Thus, on the basis of previous studies, Sen put forward the theory of feasible ability between the 1980s and 1990s. "Function" and "Ability" are the core of welfare analysis under the framework of feasible ability. The welfare status of a person can be evaluated by examining that person's function and ability. The function reflects the benefits that have been obtained, specifically the living conditions of the individual. Ability reflects the potential opportunity for a person to receive benefits. Thus, a person's viable ability refers to the substantial freedom that the person is likely to achieve in a combination of possible functional activities. In empirical research, functions and abilities are difficult to observe directly, and assessment of welfare must be achieved by assessing functional activities [61,62].

In recent years, farmers' means of livelihood have become diversified and the endowment of family livelihood is obviously differentiated. Especially in the process of rapid urbanization and urban-rural socio-economic transformation, the livelihood of rural households has undergone a fundamental change from the past. This difference appears in different types of functional areas and is reflected in the livelihood endowments of different farmers' households. As a direct entity of agricultural use, the status of livelihood assets at the farmer level has a fundamental impact on its own welfare level. The livelihood assets of farmers' households are the most critical factors affecting the changes in welfare levels after land acquisition and their own economic activities. For example, Baffoe [63] used the Fanteakwa District in eastern Ghana as a research area to try to find out why a farmers' households still choose to implement an activity when said activity is not economically viable. The results of the study indicate that livelihood priority is not the same as economic viability. It has also been found that most of the activities related to farmers in rural communities have not been well developed. From a gender perspective, female-headed households tend to be economically stable, while male-headed households prefer relatively high-income activities. Finally, policies aimed at improving livelihood activities in rural communities should focus on economically viable projects. Sujakhu [64] believes that climate change and related hazards seriously affect farmers' livelihoods and their level of vulnerability. Using the Melamchi River Valley, Nepal as a research area, Sujakhu uses the livelihood vulnerability index (LVI) to assess the vulnerability of households in the region in the context of climate change. The results of the study show that female-headed households are more affected by climate change. The reason is that this type of household is highly dependent on natural resources and lacks financial assets and social assets. It is also suggested that, given that Nepal is a low-income country, international assistance is needed to improve their ability to adapt to climate change. Therefore, this study attempts to investigate the impact of the heterogeneity of farmers' households on the welfare of land-lost farmers' households in the context of rural-urban land conversion. Based on Sen's feasible ability theory, combined with the actual situation of the study area, the family welfare evaluation index system of the land-lost farmers' households is constructed from seven aspects: family economic status, social security, living environment, psychological status, development opportunities, living conditions, and political participation (see Table 2). We then evaluate their welfare status.

Table 2. Construction of indicators of functional activities of family members in land-lost farmers' households.

Target Layer	Functional Activity (Level One Indicator)	Characterization Index (Secondary Indicators)
Evaluation of welfare effects of land-lost farmers' households (A1)	Family's financial situation (B1)	Per capita agricultural net income (C1)
		Per capita non-agricultural income (C2)
		Per capita net income (C3)
		Satisfaction with economic conditions (C4)
	Social Security (B2)	Pension security (C5)
		Medical security (C6)
		Social security satisfaction (C7)
		Education guarantee (C8)
		Unemployment protection (C9)
	Living environment (B3)	Air quality (C10)
		Noise pollution (C11)
		Green coverage (C12)
		Road dust case (C13)
		Solid waste disposal rate (C14)
	Mental state (B4)	Farmers' urban residents' identity (C15)
		Neighborhood relationship (C16)
		Confidence in future life (C17)
		Degree of respect (C18)
	Development opportunities (B5)	Number of development opportunities (C19)
		Work stability (C20)
		Employment difficulty (C21)
		Subjective feelings of entrepreneurial environment (C22)
		Employment training (C23)
	Living conditions (B6)	Housing types (C24)
		Security situation (C25)
		Residential satisfaction (C26)
		Surrounding facilities (C27)
		Hydropower supply (C28)
	Political participation (B7)	Informed status of land acquisition (C29)
		Willingness to land acquisition (C30)
		Feelings of compensation rationality (C31)
		Identity of land acquisition (C32)
		Social justice (C33)

3.2. Empirical Research Methods for the Welfare Effects of Land-Lost Farmers' Households

3.2.1. Establishment of the Cloud Model Evaluation Method

(1) Definition of the Cloud

The cloud can be defined as follows: Let U be a quantitative domain (one-dimensional, two-dimensional or multidimensional) expressed using exact numerical values, $X \in U, X = \{\chi\}$. C is a qualitative concept on the domain U. If any element $\chi \in X$ in the domain is a random implementation on the qualitative concept C, and the membership certainty $\mu_c(\chi) \in [0,1]$ for C is a random number with a tendency to be stable, which is,

$$\mu : U \rightarrow [0,1], \forall \chi \in U, \chi \rightarrow \mu_c(\chi) \quad (1)$$

the distribution of membership degrees on the domain has become a subordinate cloud, referred to as the cloud. Each χ is a cloud drop [65]. The cloud consists of many cloud droplets, each of which is a point that the qualitative concept maps to the number field space, that is, a specific implementation [66]. A single cloud drop may be insignificant, but the overall characteristics of the cloud reflect the basic characteristics of the qualitative concept.

(2) Digital Characteristics of the Cloud

The cloud model uses three numerical feature expectations, Expectation (E_x), Entropy (E_n), and Hyper entropy (H_e), to reflect the quantitative features of the qualitative concept C. Figure 1 is a schematic diagram of the digital features of the cloud, where the horizontal axis represents the uncertainty measure the range of a certain concept, and the vertical axis represents the membership degree (see Figure 1).

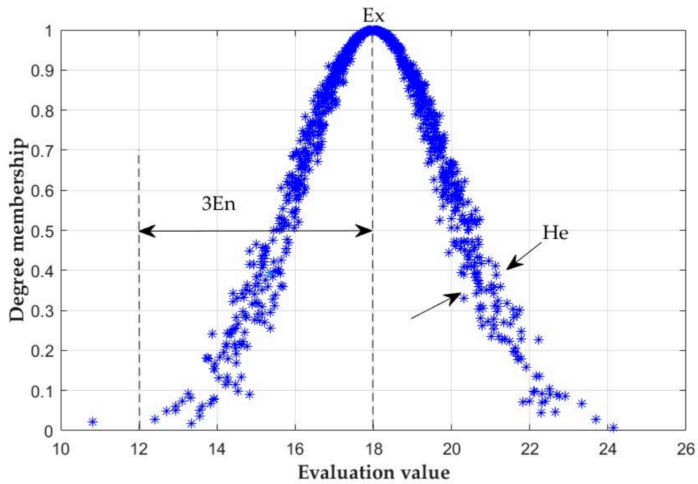

Figure 1. Cloud model.

E_x is the information center value that can represent the qualitative concept C in the domain space. It is reflected in the cloud map as the highest point of the "cloud", that is, the point with the membership degree of 1.

E_n is the uncertainty measure of qualitative concept C. This uncertainty is determined by the randomness and ambiguity of the qualitative concept. On the one hand, entropy reflects the range of numbers that cloud droplets can be accepted by the qualitative concept in the space of the universe, which reflects the ambiguity of the qualitative concept, that is, the ambiguity [67]. Entropy also reflects the degree of dispersion and randomness of cloud droplets representing qualitative concepts and is a measure of the randomness of qualitative concepts. The larger the entropy, the wider the width of the cloud's expected curve and the more macroscopic the concept is, the more difficult it is to quantify deterministically (see Figure 2).

H_e is the entropy of entropy and is a measure of the uncertainty of entropy. The cohesiveness of the uncertainty of the cloud droplets represents the natural language values in the universe. In the cloud image, the size of the Hyper entropy is reflected in the degree of dispersion of the cloud droplets and the thickness of the cloud. As shown in Figure 3a–d are four clouds in which the E_x, E_n and the number of cloud droplets are the same ($E_x = 18, E_n = 3, n = 1000$), but the H_e is different. The larger the H_e, the greater the dispersion of the cloud and the thicker the cloud. When the value of H_e is large, the peripheral cloud droplets become scattered, and the core cloud droplets appear to be "clustering". At this time, the cloud is called "fog" [36]. $H_e = E_n/3$ is the atomization point of the cloud, as shown in Figure 3c. When $H_e > E_n/3$, the cloud is in an atomized state. Although atomization will make the whole area of the cloud droplet discrete, the number of cloud droplets near the center E_x will not lose the quantitative advantage, as shown in Figure 3d.

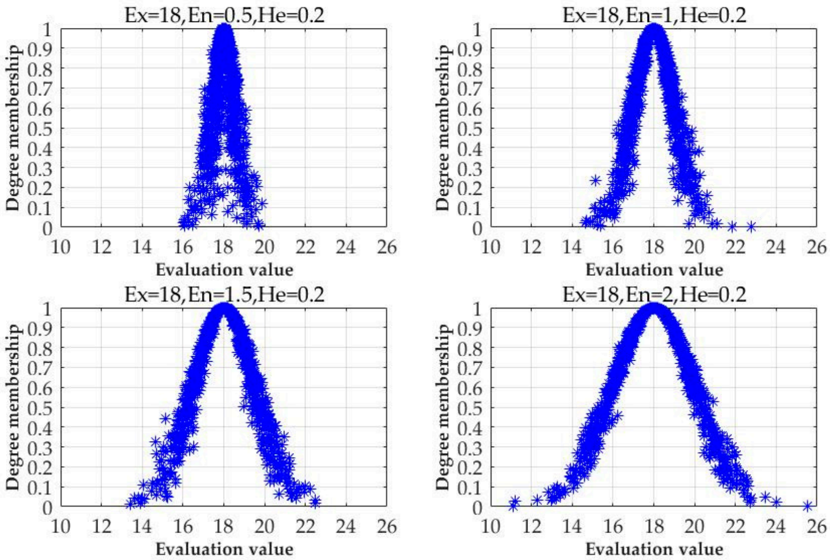

Figure 2. Effect of entropy change on cloud image.

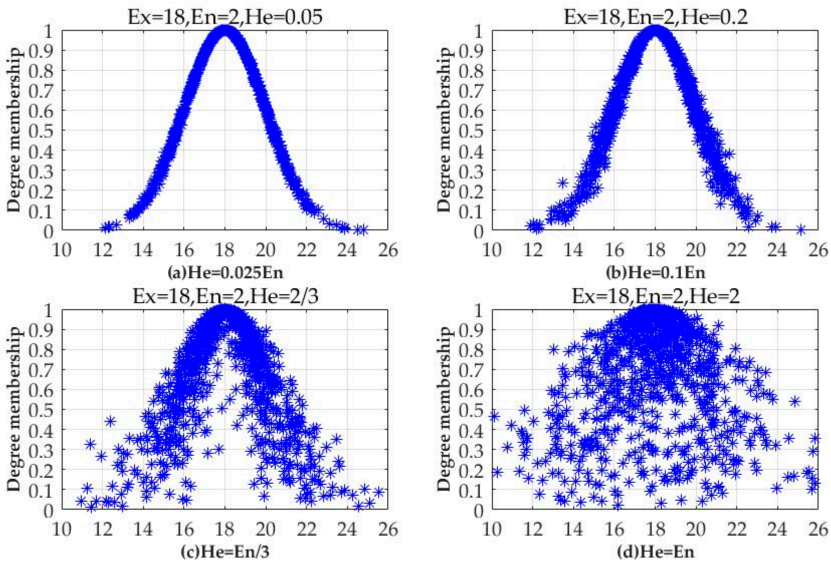

Figure 3. Effect of Hyper entropy change on cloud image.

(3) Cloud Generator

Cloud Generator (CG) is the cloud production algorithm. The tens of thousands of cloud droplets generated by the algorithm form the entire cloud, thus quantitatively expressing a qualitative concept through the uncertainty conversion cloud model [68]. The forward cloud generator and the reverse cloud generator are the two most critical algorithms in the cloud model algorithm and can be implemented using modular software or solidified hardware.

(a) Forward cloud generator

The conversion process from a qualitative concept to quantitative representation is called forward cloud generator, which realizes the range and distribution of quantitative data obtained from qualitative concept information [69]. Normal distributions and normal membership functions are universal in all branches of society and the natural sciences [70]. It is, therefore, most useful when expressing basic language values in natural language. By inputting the three digital features of the cloud (E_x, E_n, H_e), it is possible to generate a normal cloud from any number of cloud drops (χ, $\mu_c(\chi)$) (see Figure 4). The specific algorithm is as follows:

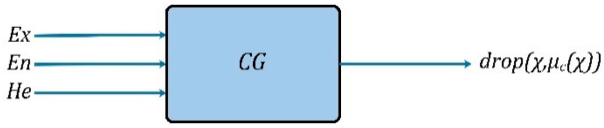

Figure 4. Forward Cloud Generator.

Enter: Represents the three numerical features (E_x, E_n, H_e) of the qualitative concept C and gives the number N of clouds.

Output: The quantitative value χ of N cloud droplets, and the degree of certainty $\mu_c(\chi)$ of each cloud droplet representing concept C.

(I) Generating a normal random number $E_n{'}$ with E_n as the expectation and H_e as the mean square error, $E_n{'} = NORM\left(E_n, H_e{}^2\right)$, $NORM$ is a normal random distribution function.

(II) Generating a normal random number χ with E_x as the expectation and $E_n{'}$ as the mean square error, $\chi = NORM\left(E_x, E_n{'}^2\right)$.

(III) Calculation $\mu_c(\chi) = \exp\left(-\frac{(\chi - E_x)^2}{2E_n{'}^2}\right)$.

(IV) $(\chi, \mu_c(\chi))$ is a cloud drop in the space of the universe.

(V) Repeat steps 1 through 4 until N cloud drops of the set condition are generated. Each cloud droplet in the digital domain space forms a cloud image.

(b) Reverse cloud generator

The reverse cloud generator is a collection of three digital features (E_x, E_n, H_e) of the qualitative concept described by the cloud from several given cloud drop samples $drop(\chi, \mu_c(\chi))$. To achieve the conversion from quantitative values to qualitative language values [70], see Figure 5. The traditional reverse cloud algorithm has the following disadvantages: A) The value of the membership degree $\mu_c(\chi)$ representing this qualitative concept C is difficult to obtain. B) It is difficult to extend the traditional algorithm to a high-dimensional level, and it will produce large errors. C) The cloud droplets are not fully utilized [71]. Based on the statistical characteristics of the cloud, this study uses only the quantitative values χ of the cloud to restore the three digital features of the cloud (E_x, E_n, H_e). The specific algorithm is as follows:

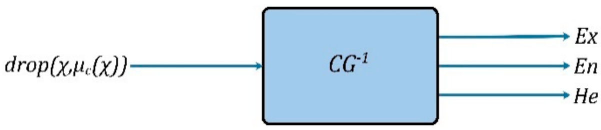

Figure 5. Reverse Cloud Generator.

Enter: The quantitative value of N cloud droplet samples in the number domain space $\chi_i (i = 1, \ldots, N)$.

Output: These N cloud drop samples reflect the digital characteristics (E_x, E_n, H_e) of the qualitative concept C.

(I) Calculate the sample mean $\overline{X} = \frac{1}{N}\sum_{i=1}^{N}\chi_i$ of this set of data based on N cloud titration values χ_i, First-order sample center distance $\frac{1}{N}\sum_{i=1}^{N}\left|\chi_i - \overline{X}\right|$, Sample variance $S^2 = \frac{1}{N-1}\sum_{i=1}^{N}\left(\chi_i - \overline{X}\right)^2$.

(II) $E_{\hat{\chi}} = \overline{X}$.

(III) $E_{\hat{n}} = \sqrt{\frac{\pi}{2}} \times \frac{1}{N}\sum_{i=1}^{N}\left|\chi_i - \overline{X}\right|$.

(IV) $H_{\hat{e}} = \sqrt{S^2 - E_{\hat{n}}{}^2}$

The new reverse cloud algorithm based on the cloud deterministic χ_i information can restore the three digital features of the cloud without the membership degree of the cloud drop $\mu_c(\chi)$, which is more effective in practical applications. The new algorithm does not discard any cloud drops when restoring E_n and H_e, which has higher precision than the traditional reverse cloud algorithm. In addition, the reverse cloud new algorithm is easier to promote to the high-dimensional reverse cloud, and no additional error is generated.

3.2.2. Determination of Index Weights Based on the AHP-Entropy Weight Method

(1) Subjective Weight Determination—AHP Method

AHP is a hierarchical weight analysis method proposed by American operations researcher Saaty to solve multi-objective complex problems by combining qualitative and quantitative concepts [72]. The principle is to divide the factors related to the decision-making objectives of the system into interconnected ordered layers (target layer, criterion layer, and program layer) to organize them, and to use less quantitative information to model, centralize and quantify scattered advisory opinions, thus providing convenient optimization decisions for complex problems with multiple objectives, multiple criteria, or no structural characteristics. Since this method is common, this article will not discuss its operation steps. The specific operation steps can be described in the literature [72].

(2) Determination of Objective Weights—Entropy Method

The concept of entropy comes from thermodynamics. Shannon, the founder of information theory, introduced information entropy into information theory, indicating the uncertainty of the signal from the signal source [73]. Entropy method empowerment is a method for determining the weight of an indicator based on the correlation of each indicator, the degree of variation, or the amount of information contained. It reflects the relative intensity of each indicator in the sense of competition in the case of determining the value of each indicator. The smaller the information entropy carried by an evaluation index, the greater the degree of variability, and the greater the amount of information that can be provided, the greater the weight of the indicator. Otherwise, the weight is smaller. Since this method is common, this article will not discuss its operation steps. The specific operation steps can be described in the literature [74].

(3) Determination of Comprehensive Weight

In the process of empowerment, AHP focuses on the subjective preference of experts, and the entropy method focuses on mining the objective information contained in the data itself. In this paper, the AHP method and the entropy weight method are combined to weight the welfare effect indicators of the land-lost farmers' households, realizing the subjective and objective integration, and using the multiplication integration method to determine the final combined weight value. The calculation method is as follows:

$$W_j = \frac{\omega_j w_j}{\sum_{j=1}^{n} \omega_j \omega_j}(j = 1, 2, \ldots, n) \quad (2)$$

where W_j is the combined weight, ω_j is the index weight obtained under the subjective weighting method, w_j is the index weight obtained under the objective weighting method, and j is the jth index.

3.3. Research Area and Data Source

The data in this paper comes from the author's field study of the three administrative villages of Taohuayi Village, Taohuasan Village, and Taohuawu Village in Taohua Town, Nanchang City, Jiangxi Province from October to November 2018 (see Figure 6). Taohua Town is located in the Xihu District of Nanchang City (around Fushang Road), between the Minjiang River and Fuhe River. The total area of Taohua Town is 17.1 square kilometers, with a resident population of 36,000 and a floating population of about 120,000. In recent years, with the construction and development of the Xihu District, a vast amount of agricultural land has been turned into urban construction land. Taking Taohuasan Village as an example, the total area of the village is approximately 90 hectares, and it has been expropriated. Of the original nine natural villages, six have now been demolished. There are several private enterprises, villages, cities, districts and towns and enterprises in the village. The phenomenon of non-agriculturalization of agricultural land in the town is very active and is becoming increasingly frequent. Therefore, the town is very representative of a survey area. In this study, the random sampling method and direct interview method were used. When not reporting the subject beforehand, 230 questionnaires were distributed, 223 questionnaires were collected and the recovery rate was 96.96%. Among them, there are 212 samples of land-lost farmers, accounting for 95.06% of the recovered questionnaires. Valid samples accounted for 92.17% of the total sample (see Table 3). The research object is the object of analysis and research in the text. It indicates that land demand in the region is strong and land acquisition activities are frequent.

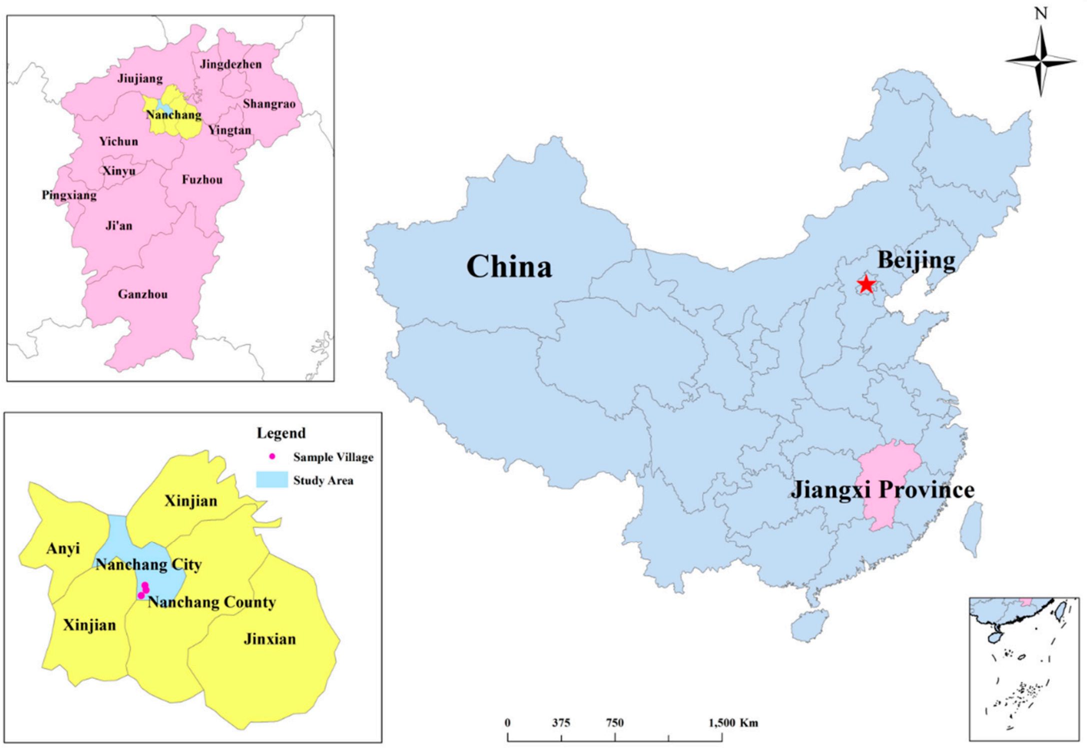

Figure 6. Study area.

Table 3. Statistical distribution table of questionnaires.

Name of the Village	Issued Questionnaire	Rate	Collected Questionnaires	Rate	Valid Questionnaires	Rate
Taohuayi	96	41.73%	93	41.70%	89	41.98%
Taohuasan	68	29.57%	67	30.04%	62	29.25%
Taohuawu	66	28.70%	63	28.25%	61	28.77%
Total	230	100%	223	100%	212	100%

4. Results and Analysis

4.1. Operation Process of Welfare Evaluation of Land-Lost Farmers' Households

The farmer households' assets quantification method is used to divide the land-lost farmers' households into asset-deficient and asset-balanced farmers. Based on Sen's Feasibility Capability Theory, a comprehensive evaluation index system for the welfare effect of land-lost farmers' households is constructed. The weight of each indicator is determined using the AHP-entropy method. Next, the cloud model theory is used to evaluate the welfare effect of the land-lost farmers' households under different living asset allocations. The specific process is shown in Figure 7.

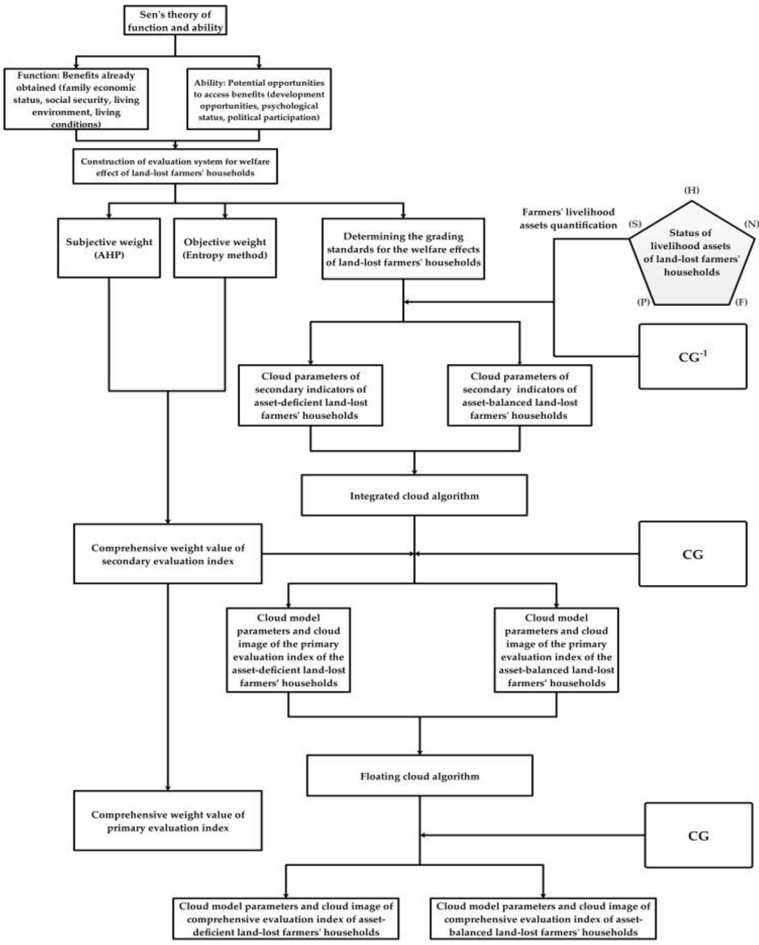

Figure 7. Evaluation of the welfare effects of land-lost farmers' households under different livelihood asset allocations.

4.1.1. Establishment of the Comment Set Cloud Model

Since the comments on the evaluation of the welfare effects of the land-lost farmers' households are all vague concepts, the level corresponding to each indicator in the evaluation is judged by the normal cloud-membership degree, that is, it can be described by a one-dimensional normal cloud [75,76]. The indicator change interval and cloud model parameters corresponding to each qualitative comment are shown in Table 4. For comments $[C_{min}, C_{max}]$ with bilateral constraints, if they are relatively poor, general, and relatively good, their corresponding satisfaction values have both an upper limit and a lower limit, and the expected value can be used as the median of the constraint. Use a symmetric cloud model with regions as bilaterally constrained regions to approximate this comment. The specific calculation formula is as follows:

$$\begin{cases} E_x = \frac{C_{max}+C_{min}}{2} \\ E_n = \frac{C_{max}-C_{min}}{6} \\ H_e = k \end{cases} \tag{3}$$

Table 4. Qualitative comments corresponding to the change interval and cloud model parameters.

Comment	Very Poor	Poor	General	Good	Very Good
Interval	(0, 2]	(2, 4]	(4, 6]	(6, 8]	(8, 10]
E_x	0	3	5	7	10
E_n	2/3	1/3	1/3	1/3	2/3
H_e	k	k	k	k	k

For comments with only one-sided constraints C_{min} or C_{max}, such as very poor or very good reviews, their corresponding satisfaction ranges only have a lower or upper limit.

The formula for calculating the semi-liter cloud parameters is as follows:

$$\begin{cases} E_x = C_{min} \\ E_n = \frac{C_{max} - C_{min}}{3} \quad , x < E_x \\ H_e = k \end{cases} \tag{4}$$

The formula for calculating the semi-falling cloud parameters is as follows:

$$\begin{cases} E_x = C_{max} \\ E_n = \frac{C_{max} - C_{min}}{3} \quad , x < E_x \\ H_e = k \end{cases} \tag{5}$$

In the formula, k is a constant, which can be adjusted according to the uncertainty and degree of ambiguity of the comment itself. Here, the empirical value is 0.1.

4.1.2. Classification of Land-Lost Farmers' Households under Different Livelihood Asset Allocations

According to the quantitative index system of the livelihood assets of the land-lost farmers' households, the household livelihood assets of the surveyed households are calculated. Since the five types of livelihood assets have different dimension units and orders of magnitude, the relative gap in maintaining the values of the indicators remains unchanged. In this paper, all the assigned and calculated variable data are subjected to range normalization (see Equations (A1) and (A2)). The determination of index weight is an important factor in determining the quantification of livelihood assets. To improve the accuracy of measurement results, the paper uses the combination of subjective and objective methods to determine the index weight. In the field survey, first, it is determined according to the degree of attention by experts and farmers on various asset indicators and by using the AHP method to obtain subjective weight. Second, the entropy weight method is used to process the standardized indicators to obtain the objective weight. Lastly, the combination weight method is used to weight the indicators. According to the standardized scores and weight values of the five types of livelihood assets, the values of various types of livelihood assets of the land-lost farmers' households and the total index of the livelihood assets T are calculated. The calculation formula is as follows:

$$T = \sum_{i=1}^{5} \sum_{j}^{n} W_{ij} I_{ij} \tag{6}$$

In the formula, T is the total index of farmer's livelihood assets, W_{ij} is the weight of the jth indicator of the ith generation of livelihood assets, and I_{ij} is the normalized value of the jth indicator of the ith generation of livelihood assets. After calculation, we find that the total value of 212 livelihood assets of the land-lost farmers' households is located in the interval (0.913–3.125) (see Table 5). According to the total value of the livelihood assets of the land-lost farmers' households, the sample farmers were divided into 47 households with a single-asset-deficient, 29 households with multi-asset-deficient, 73 households with ordinary assets, and 63 households with rich assets. To further study the impact of rural-urban land conversion on the changes in the welfare effects of land-lost farmers' households, this study refers to single-asset-deficient and multi-asset-deficient farmers as asset-deficient farmers, and to the ordinary-asset and rich-asset farmers as asset-balanced farmers.

Table 5. Classification and statistics results of landless households based on total assets of farmers' livelihoods.

Type of Land-Lost Farmers' Households	Multi-Asset-Deficient	Single-Asset-Deficient	Ordinary-Asset	Rich-Asset
Interval	0.913–1.274	1.275–1.747	1.755–2.449	2.454–3.125

The different types of livelihood assets of asset-deficient farmers and asset-balanced farmers are shown in Figure 8.

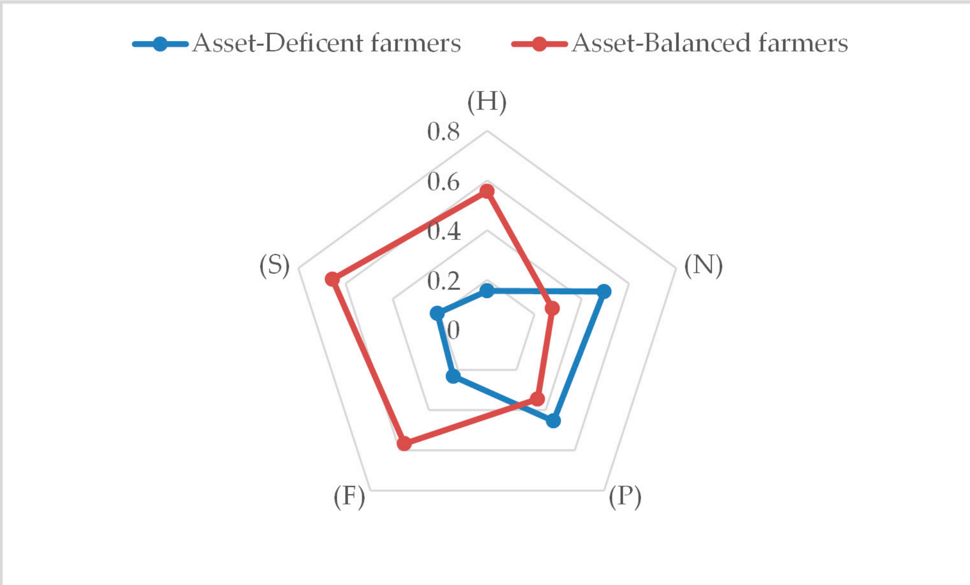

Figure 8. Status quo of land-lost farmers' households under different livelihood asset allocations.

4.1.3. Determination of Indicator Weights

Our study constructs an index system of the welfare effect of land-lost farmers' households. The AHP weights, entropy weights and comprehensive weights of each indicator of the land-lost farmers' households under different livelihood asset allocations are determined.

(1) Determination of the Weight of the AHP Method

In addition, using the expert data (scholar, members of the village committee, land-lost farmers' households) for the group decision-making calculation function, the seven first-level indicators for the welfare of the land-lost farmers' households under different livelihood asset allocations are respectively calculated by AHP method as follows:

$$\omega_D = (0.3034,\ 0.1545,\ 0.0272,\ 0.0226,\ 0.2606,\ 0.0604,\ 0.1723)$$

$$\omega_B = (0.0245,\ 0.2133,\ 0.0754,\ 0.1112,\ 0.4216,\ 0.0985,\ 0.0555)$$

Among them, CR values are 0.0915 and 0.09774, respectively, both of which are less than 0.1, so the consistency test is passed. ω_D and ω_B can be used as the weight value of the indicator of this level. Similarly, the weight coefficients of all secondary indicators can be calculated as follows:

$$\omega_{Dj} = (0.126, 0.0268, 0.1097, 0.0399, 0.0624, 0.0588, 0.0108, 0.0066, 0.0159, 0.0074, 0.0035, 0.013, 0.0012, 0.0021, 0.0012, 0.0116, 0.0022, 0.0076, 0.1096, 0.0372, 0.0157, 0.0082, 0.0899, 0.0058, 0.0052, 0.005, 0.0168, 0.0276, 0.0049, 0.0143, 0.0951, 0.0248, 0.0332)$$

$$\omega_{Bj} = (0.001, 0.0091, 0.0078, 0.0066, 0.0076, 0.0736, 0.013, 0.0275, 0.0916, 0.0045, 0.0279, 0.0060, 0.0053, 0.0317, 0.0092, 0.0071, 0.0690, 0.0259, 0.0818, 0.1765, 0.0215, 0.1113, 0.0305, 0.0321, 0.0167, 0.0036, 0.0070, 0.0391, 0.0030, 0.0030, 0.0269, 0.0030, 0.0196)$$

After calculation, all weight coefficients pass the consistency test.

(2) Determination of the Weight of the Entropy Weight Method

With the support of MATLAB 7.0 software, the entropy weight method is used to calculate the weights of each index as follows:

$$w_{Dj} = (0.0578, 0.0103, 0.0428, 0.0402, 0.0105, 0.0107, 0.0208, 0.0477, 0.0468, 0.0487, 0.0373, 0.0215, 0.0097, 0.0734, 0.0349, 0.0096, 0.0133, 0.0478, 0.0387, 0.0398, 0.0271, 0.0089, 0.0198, 0.0205, 0.0208, 0.0219, 0.0138, 0.0344, 0.0221, 0.0157, 0.0393, 0.0512)$$

$$w_{Bj} = (0.0350, 0.0162, 0.0333, 0.0377, 0.0140, 0.0182, 0.0236, 0.0318, 0.0169, 0.0790, 0.0823, 0.0592, 0.0336, 0.0170, 0.0237, 0.0520, 0.0333, 0.0204, 0.0232, 0.0220, 0.0399, 0.0256, 0.0143, 0.0366, 0.0164, 0.0167, 0.0295, 0.0250, 0.0171, 0.0239, 0.0175, 0.0147, 0.0505)$$

(3) Determination of Comprehensive Weights.

In this paper, the comprehensive weighting method combined with the AHP method and entropy weight method is used to determine the weights of the welfare evaluation indicators of land-lost farmers' households under different livelihood asset allocations. The comprehensive weight values are as follows:

$$W_{Dj} = (0.2158, 0.0082, 0.1368, 0.0506, 0.0744, 0.0183, 0.0034, 0.0041, 0.0225, 0.0103, 0.0051, 0.0144, 0.0008, 0.0006, 0.0026, 0.0120, 0.0006, 0.0030, 0.1554, 0.0427, 0.0185, 0.0066, 0.0236, 0.0034, 0.0032, 0.0031, 0.0109, 0.0113, 0.0050, 0.0094, 0.0443, 0.0289, 0.0504)$$

$$W_{Bj} = (0.0013, 0.0056, 0.0099, 0.0095, 0.0040, 0.0509, 0.0117, 0.0333, 0.0590, 0.0135, 0.0875, 0.0135, 0.0068, 0.0205, 0.0083, 0.0141, 0.0876, 0.0201, 0.0722, 0.1480, 0.0327, 0.1087, 0.0166, 0.0448, 0.0104, 0.0023, 0.0079, 0.0372, 0.0020, 0.0027, 0.0179, 0.0017, 0.0377)$$

4.1.4. Cloud Model Parameters of Secondary Evaluation Indicators for the Welfare Effects of Land-Lost Farmers' Households

The evaluation index system of the welfare effect of the land-lost farmers' households involved in this paper is mostly related to the personal experience of the land-lost farmers and is susceptible to subjective factors. Therefore, this study used a combination of questionnaires and expert scoring to determine the final initial score for each secondary indicator [77,78]. Based on the new reverse cloud algorithm of cloud deterministic χ_i information, the cloud model digital features (E_x, E_n, H_e) of each secondary indicator of the land-lost farmers' households under different livelihood asset allocations are obtained, as shown in Tables A1 and A2 (see Appendix B).

4.1.5. Cloud Model Parameters of Primary Evaluation Indicators for the Welfare Effects of Land-Lost Farmers' Households

Virtual cloud refers to the cloud of a new digital feature structure for some applications (such as the comprehensive evaluation of the welfare effect of the land-lost farmers' households) and to the calculation of the digital features of the given cloud (base cloud) [79].

Due to the inter-relationship and inter-influence between the secondary indicators of the welfare effect of the land-lost farmers' households, the interaction between the primary indicators is much larger, and the weighting factors of the secondary evaluation clouds must be considered in the comprehensive process. Therefore, this paper uses the virtual cloud's weighted integrated cloud for calculation. Integrated cloud computing is essentially a problem stemming from the integration of low-level concepts to high-level concepts, the essence of which is the promotion of concepts. The integrated cloud in the virtual cloud is used to synthesize two or more subclouds of the same type (secondary evaluation indicators) to generate a new high-level concept of the parent cloud (primary evaluation index) [80]. That is, to combine two or more language values of the same type into a broader integrated cloud. The specific calculation formula is as follows:

$$\begin{cases} E_x = \frac{E_{x1}E_{n1}w_1+E_{x2}E_{n2}w_2+\cdots+E_{xn}E_{nn}w_n}{E_{n1}w_1+E_{n2}w_2+\cdots+E_{nn}w_n} \\ E_n = E_{n1}w_1 + E_{n2}w_2 + \cdots + E_{nn}w_n \\ H_e = \frac{H_{e1}E_{n1}w_1+H_{e2}E_{n2}w_2+\cdots+H_{en}E_{nn}w_n}{E_{n1}w_1+E_{n2}w_2+\cdots+E_{nn}w_n} \end{cases} \quad (7)$$

In the formula, n is the number of secondary evaluation indicators, and E_{xi}, E_{ni}, and H_{ei} are the expectation, entropy, and hyper entropy of the cloud model of each secondary indicator. W_i is the weight of the secondary evaluation index of the i-th welfare effect of land-lost farmers' households. The virtual cloud calculation is performed on the secondary evaluation indicators of Tables A1 and A2 (see Appendix B) using the integrated cloud algorithm. The calculation results are shown in Table 6.

Table 6. Cloud model parameters of primary evaluation indicators for the welfare effects of land-lost farmers' households.

Functional Evaluation Index (Primary Evaluation Index)	Cloud Model Parameters of the Primary Evaluation Index of the Asset-Deficient Land-Lost Farmers' Households (E_x,E_n,H_e)	Cloud Model Parameters of the Primary Evaluation Index of the Asset-Balanced Land-Lost Farmers' Households (E_x,E_n,H_e)
Family's financial situation (B1)	(3.0286, 0.4575, 0.4782)	(6.5295, 0.0428, 0.6461)
Social Security (B2)	(4.3653, 0.1688, 0.4576)	(6.2639, 0.2097, 0.5638)
Living environment (B3)	(3.9626, 0.0439, 0.5609)	(4.6698, 0.2384, 0.7287)
Mental state (B4)	(3.4699, 0.0208, 0.4586)	(5.7826, 0.1917, 0.6138)
Development opportunities (B5)	(4.1430, 0.3487, 0.5914)	(6.7623, 0.5549, 0.5837)
Living conditions (B6)	(6.2544, 0.0478, 0.5132)	(6.3991, 0.1608, 0.6268)
Political participation (B7)	(3.9850, 0.1776, 0.4943)	(5.2882, 0.0892, 0.6007)

4.1.6. Representation of the Cloud Model of the Comprehensive Evaluation Index of the Welfare Effect of the Land-Lost Farmers' Households

For the comprehensive calculation of the welfare effect of the land-lost farmers' households, considering that the correlation between the primary indicators is relatively small, and each level of indicators is basically independent, the floating cloud algorithm in the virtual cloud is adopted for their comprehensive calculation [81]. The floating cloud algorithm in the virtual cloud is used to combine multiple independent language values into a more generalized language value [82]. Floating clouds can be used to fill in empty areas that are not covered by adjacent clouds in the universe. The entropy and hyper entropy of the floating cloud are obtained by linear interpolation of the entropy and hyper entropy of the base cloud, and the digital features of the floating cloud can also be defined as the weighted sum of the digital features of the base cloud. This is calculated as follows:

$$\begin{cases} E_x = \frac{E_{x1}w_1+E_{x2}w_2+\cdots+E_{xn}w_n}{w_1+w_2+\cdots+w_n} \\ E_n = \frac{w_1^2}{w_1^2+w_2^2+\cdots+w_n^2}E_{n1} + \frac{w_2^2}{w_1^2+w_2^2+\cdots+w_n^2}E_{n2} + \cdots + \frac{w_n^2}{w_1^2+w_2^2+\cdots+w_n^2}E_{nn} \\ H_e = \frac{w_1^2}{w_1^2+w_2^2+\cdots+w_n^2}H_{e1} + \frac{w_2^2}{w_1^2+w_2^2+\cdots+w_n^2}H_{e2} + \cdots + \frac{w_n^2}{w_1^2+w_2^2+\cdots+w_n^2}H_{en} \end{cases} \quad (8)$$

In the formula, n is the number of primary evaluation indicators, and E_{xi}, E_{ni}, and H_{ei} are the expectation, entropy, and hyper entropy of the cloud model of each primary indicator. W_i is the weight of the primary evaluation index of the i-th welfare effect of land-lost farmers' households. The virtual cloud calculation is performed on the primary evaluation indicators of Tables A1 and A2 (see Appendix B) using the floating cloud algorithm. The calculation results are shown in Table 7.

Table 7. Differences in the welfare effects of land-lost farmers' households under different livelihood asset allocations.

Comprehensive Indicator	Cloud Model Parameters of Comprehensive Evaluation Index of Asset-Deficient Land-Lost Farmers' Households (E_x,E_n,H_e)	Cloud Model Parameters of Comprehensive Evaluation Index of Asset-Balanced Land-Lost Farmers' Households (E_x,E_n,H_e)
Welfare effect of land-lost farmers' households	(3.7392, 0.3846, 0.4822)	(6.1240, 0.4076, 0.5394)

4.2. Determination and Analysis of the Evaluation Level of the Welfare Effect of the Land-Lost Farmers' Households under Different Living Asset Allocations

4.2.1. Determination of the Evaluation Result Level

Based on the reverse cloud generator algorithm, the cloud model characteristic parameters (E_x, E_n, H_e) of the evaluation index of the welfare effect of the land-lost farmers' households under the different livelihood asset allocations of Taohuayi Village, Taohuasan Village, and Taohuawu Village are determined, as are the symmetric model, the semi-liter cloud model, and the semi-falling cloud model to generate cloud model characteristic parameters (E_x, E_n, H_e) corresponding to each qualitative comment. Using the forward cloud generator algorithm, the cloud model feature parameter information obtained above is input into the Matlab 7.0 program, and 3000 cloud drops are generated. The evaluation result cloud model was subjected to 3000 random simulation operations, and the cloud image of the primary indicators, the comprehensive cloud image and each qualitative comment of the welfare effects of the land-lost farmers' households were obtained. Taking Figure 9 as an example, the above picture is a cloud image of the welfare effect of the asset-deficient land-lost farmers' households. The following picture is a cloud image of the welfare effect of the asset-balanced land-lost farmers' households. The abscissa is the degree of certainty of the evaluation index, and the ordinate refers to the corresponding degree of membership. From left to right, they represent the cloud of the "very bad" level to the "very good" level of the welfare effect indicators of the land-lost farmers' households. When a specific cloud map is given, it can be visually judged from the cloud image to the extent that it belongs to a certain welfare level.

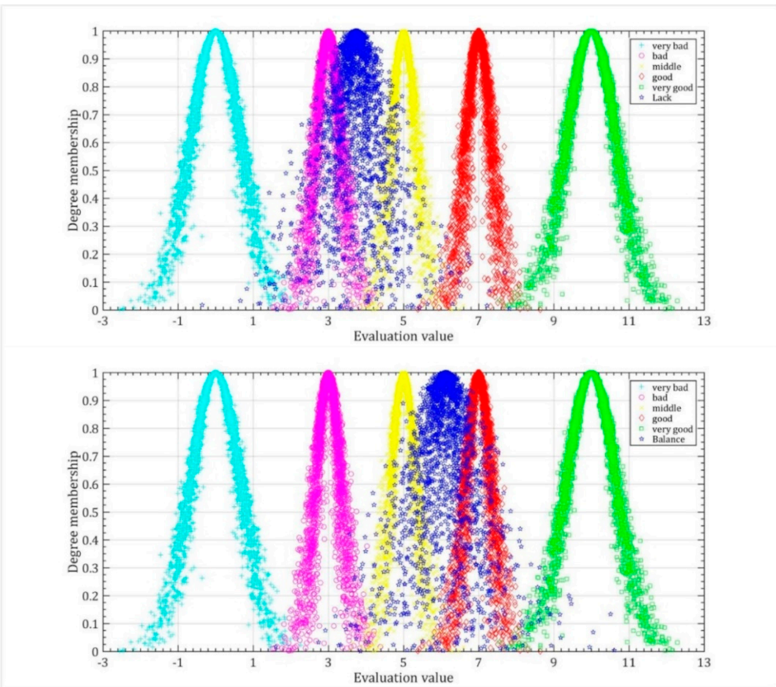

Figure 9. Cloud image of welfare evaluation grades of land-lost farmers' households under different livelihood assets.

4.2.2. Analysis of Evaluation Results

The uncertainty of the concept of welfare has characteristics such as ambiguity, randomness, and incompleteness. Among them, ambiguity and randomness are the two basic uncertainties. Although many theoretical models have emerged in the study of uncertainty, the uncertainty problem is dealt with from different angles. Such as probability theory [83], fuzzy set [31], rough set [84], evidence theory [85], random mathematics, etc. However, these theoretical models have relatively strict constraints and have certain limitations when dealing with problems. For example, although random mathematics can well describe the statistical characteristics of random phenomena, the preconditions of commonly used probability distributions are often too strict. On the other hand, fuzzy mathematics uses the membership function to accurately calculate the value of the fuzzy phenomenon. If the value is accurately calculated, it will no longer have ambiguity, and the setting of the membership function is subjective, ignoring the uncertainty of the membership function itself. The cloud model enables the transformation from qualitative concepts to quantitative data and is expressed in the form of a cloud map. This is more intuitive and specific than the traditional approach to dealing with fuzzy concepts.

It can be seen from Figure 9 that after the rural-urban land conversion, the changes in the welfare levels of the land-lost farmers' households under different living asset allocations in the study area vary. As shown in Figure 9, the cloud image of the comprehensive welfare effect of the asset-deficient land-lost farmers' households is located between "bad" and "general" and is closer to the "bad" level, which is a moderately low level. There is still much room for improvement in their welfare level. The welfare effect of asset-balanced land-lost farmers' households is better than that of asset-deficient land-lost farmers' households. The cloud image is located between "general" and "good" and is closer to the "good" level, which is moderately high. From the perspective of various functional activities of land-lost farmers' households, the impact of rural-urban land conversion on the acquisition of functional activities of land-lost farmers' households under different livelihood assets is different. The specific analysis is as follows:

(1) The family's financial situation. It can be seen from Figure 10 that the evaluation of the economic status of the asset-deficient land-lost farmers' households is located between "bad" and "general" and is very close to the "bad" cloud. The expectations of the cloud are 3.0286, so the economic status of the asset-deficient farmers' households is at a bad level after the loss of land. At the same time, it can be seen that the evaluation of the economic status of the asset-balanced farmers' households is located between the "medium" and "good" clouds. The expected value of the cloud is 6.5295, which is more biased toward the "good" level. The entropy value of the cloud is 0.0428, and the value is relatively small, so the evaluation results are concentrated and belong to the medium preference level.

The reason is that land resources have different roles in land-lost farmers' households under different livelihood asset allocations. The family members of asset-deficient farmers' households are traditional farmers who mostly use farming as their main production skill. Agricultural income is the main source of their livelihood assets. They mainly rely on planting and breeding to obtain income. There are a few choices and inputs of non-agricultural activities, and there are basically no non-agricultural activities. In terms of weights, the per capita agricultural net income of assets-deficient farmers' households has a weight of 0.2158, which has a greater impact on their overall welfare level. However, after the rural land is expropriated, the main agricultural income ceases to exist and the basic source of livelihood is lost. To alleviate the pressure of life after land acquisition and obtain a life that is equal to or higher than the level prior to rural-urban land conversion, farmers must invest more time and energy in non-agricultural production activities. Non-agricultural labor income is an important source of household income. However, for most asset-deficient farmers' households, family members are old and weak, lack culture and technology and have low employment skills. They are obviously at a disadvantage in market competition. It is difficult to smoothly realize the transfer of non-agricultural employment and maintain a stable income while relying only on land acquisition compensation and social security income to maintain a basic livelihood. Therefore, the economic status of the asset-deficient land-lost farmers' households is at a low level.

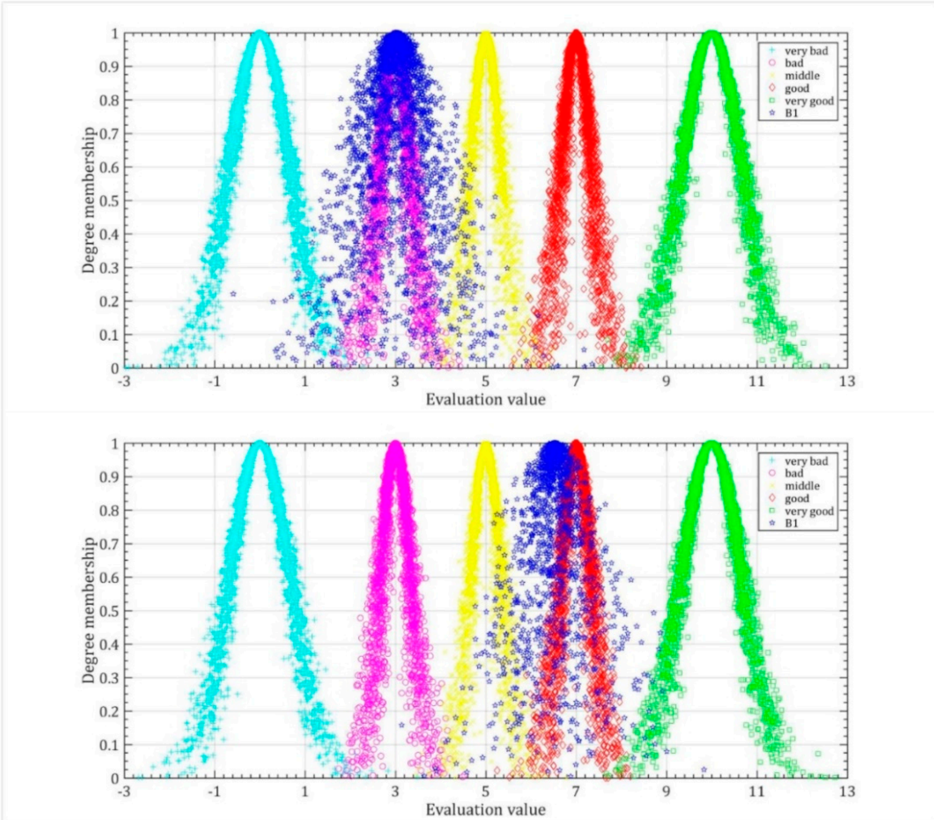

Figure 10. Cloud image of welfare evaluation grades of family's financial situation of land-lost farmers' households under different livelihood assets.

Compared with the assets-deficient land-lost farmers' households, the asset-balanced land-lost farmers' households have higher human capital endowments and more labor. The combination of livelihoods is mainly based on "work + farming". Most of the farmers have completely separated themselves from agricultural production, mainly working outside the home and engaging in diversified occupations, the industry is relatively stable, and employment and entrepreneurial skills are strong. Specific to the compensation and resettlement of the land-lost farmers in Taohua Town, the government adopted the method of "demolition and supplement one" in part to solve the problem of housing after the loss of land. Asset-balanced farmers' households will "make a fuss" on the buildings that have been exchanged for rural land housing exchange projects and rent out their own surplus buildings to obtain corresponding entrepreneurial or employment funds for self-employment and business. There are also other ways of achieving diversification of household income sources, thereby achieving asset appreciation and promoting the level of family economic welfare.

(2) Social security. From Figure 11, it can be seen that the social security evaluation cloud image of the asset-deficient farmers' households is located between "bad" and "medium" and is relatively close to the "medium" level. Therefore, the welfare level of social security for asset-deficient farmers' households is moderately low following rural-urban land conversion. The cloud image of the social security of the asset-balanced land-lost farmers' households is located between "medium" and "good" and is closer to the "good" level. Therefore, following rural-urban land conversion, the welfare level of social security for asset-balanced farmers' households is moderately high.

The reason is that under the conditions of the urban-rural dual system, the level of urban and rural security is very different, and the social security system is not perfect. For the asset-deficient farmers' households, agricultural land is not only an important means of production but also an important support for farmers' social security. After losing the land, the land-lost farmers lost the social security rights brought by the possession of the land and could not enjoy the same social security as the urban residents. Different household registrations in urban and rural areas lead to different social security rights and unequal opportunities for participation. Land-lost farmers often become second-class citizens of social security, and the function of social security for the people is difficult to reflect in land-lost farmers. At present, most of the existing compensation and resettlement or guarantee mechanisms belong to a one-size-fits-all approach. The government or land use owners compensate the land-lost farmers' households at one time according to the compensation standard for land acquisition.

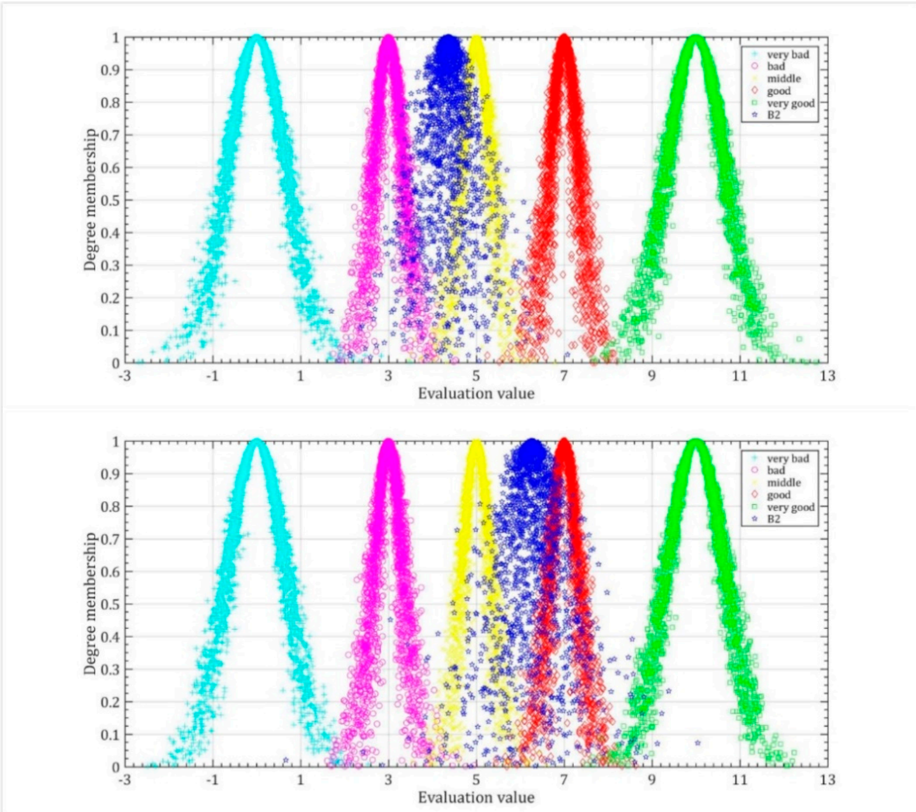

Figure 11. Cloud image of welfare evaluation grades of social security of land-lost farmers' households under different livelihood assets.

However, in the long run, this type of compensation is not sustainable. Asset-deficient land-lost farmers' households are subject to relatively weak social capital, and the access and utilization of wealth management information are significantly constrained, resulting in a weak financial management concept and a single financial management method. Most of them retain their wealth by retaining cash, time deposits, and demand deposits. Due to the lack of social capital and human capital, asset-deficient farmers' households find it difficult to obtain relevant employment information if their education level is low. They face large income uncertainty and instability, and the family pension function is weakened. Moreover, low insurance payments make it difficult for them to withstand the level of medical insurance for urban workers or urban residents. Asset-deficient farmers are mostly engaged in relatively low-end, poorly stricken and unsanitary industries (such as those prone to pneumoconiosis), while the new rural cooperative medical insurance (NCMS) level is not high and there is a lack of work-related injury insurance, which makes it difficult to obtain timely compensation and treatment. The lack of unemployment, work-related injury and maternity insurance, and the relative lack of pension and medical insurance, has resulted in asset-deficient farmers' households having a moderately low level of welfare after losing their land.

Compared with the asset-deficient farmers' households, some family members of the asset-balanced farmers' households go out to work or have settled in the city all the year-round. The income source is stable and they have urban household registration. They have been included in the urban social security system and are subject to the same social welfare and social rights as urban residents in terms of housing, employment, education, and social security. Therefore, the level of welfare benefits and security far exceeds that of the asset-deficient farmers' households. Moreover, the high quantity and quality of human capital in asset-balanced farmers' households is conducive to improving their ability to adapt to the production of modern enterprises, enhancing the negotiating position of individual workers in the labor market and helping them to obtain social insurance. At the same time, asset-balanced farmers have greater social capital stocks, so that they gradually recognize and accept the financial management methods and financial habits of urban residents. The compensation for land acquisition is used for human capital investment and employment venture investment, which helps to increase the expected income level and also the probability of participating in their health insurance and pension insurance. Therefore, the level of social security welfare of asset-balanced farmers is moderately high.

(3) Living environment. The cloud expectation value of the environmental situation of asset-deficient farmers' households is 3.9626, and the cloud expectation of the living environment of asset-balanced farmers' households is 4.6698. It can be seen from Figure 12 that the evaluation clouds of the two types of farmers are located between "bad" and "medium", indicating that the welfare of the living environment of the two types of farmers following the loss of land is poor.

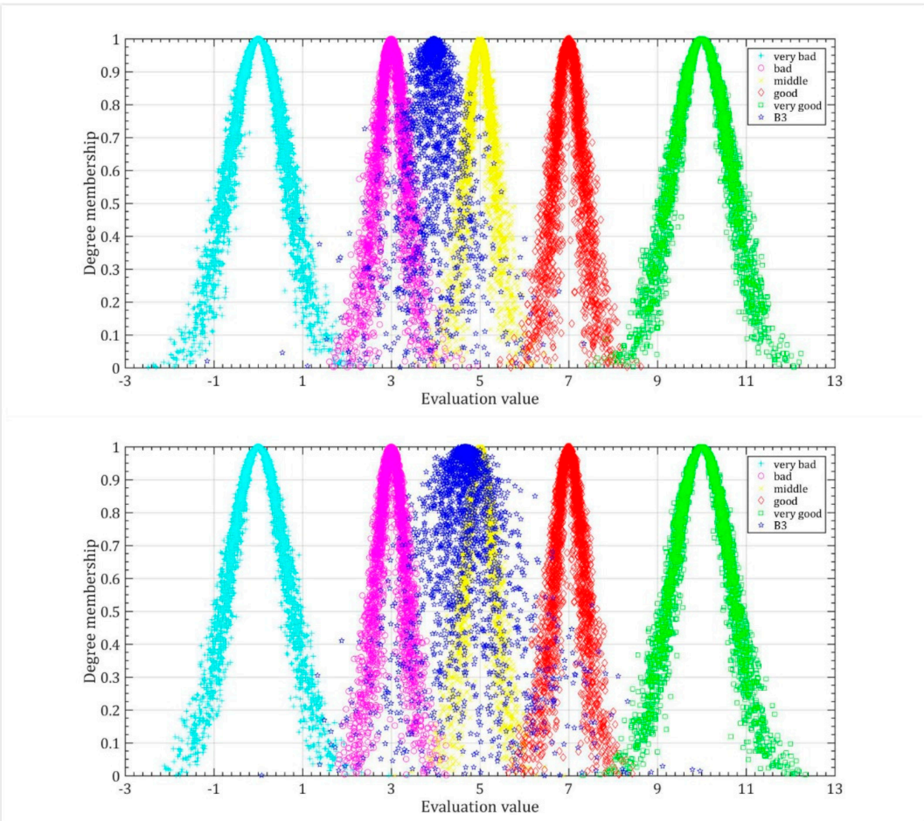

Figure 12. Cloud image of welfare evaluation grades of living environment of land-lost farmers' households under different livelihood assets.

The reasons are as follows. First, the traffic noise around the resettlement houses, the noise of social life and the noise pollution caused by urban construction have had serious impacts on the health, daily work, and life of land-lost farmers' households. Second, the rural-urban land conversion has caused more land-lost farmers' households to be exposed to air pollution caused by industrial sources, household sources, road-mobile sources and dust sources, which poses a huge threat to the health of land-lost farmers. Third, prior to loss of land, most of the farmers' holdings comprised rural land and trees, and the ecological environment was relatively good. However, after losing the land, the land-losing farmers' households in the study area were relocated to a resettlement community, and the surrounding environment was changed from farmland to roads, schools, and factories, and the green coverage rate was greatly reduced. Moreover, the greening around the resettlement house also has problems, such as single green space structure, heavy grass and light trees, an improper investment ratio, and unsound green maintenance facilities, which seriously affect the environmental greening quality around the resettlement community. Therefore, the welfare level of the living environment of the land-lost farmers' households following rural-urban land conversion is at a relatively low level.

(4) Mental status. It can be seen from Figure 13 that the evaluation of the mental state of the asset-deficient farmers' households is between "bad" and "medium", and the expected value of the cloud is 3.4699, which is very close to the "bad" cloud. The entropy value of the cloud is 0.0208 and the value is relatively small, so the evaluation results are relatively concentrated. Therefore, the mental status of the asset-deficient farmers' households is not good after the land loss. At the same time, it can be seen that the evaluation of the mental status of the asset-balanced farmers' households is located between the "medium" and "good" clouds. The expected value of the cloud is 5.7826, which is more inclined to the "medium" cloud image, and the welfare level is moderate. Although the welfare level of the mental status of asset-balanced farmers' households after land loss is better than that of asset-deficient households, the welfare level of both is generally not high.

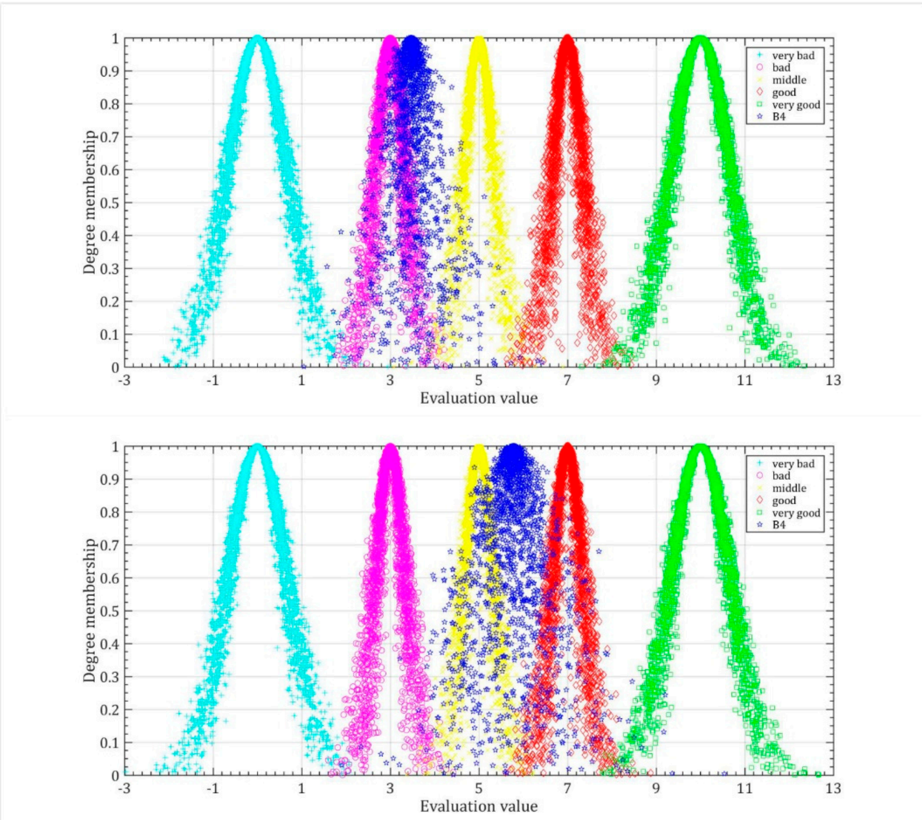

Figure 13. Cloud image of welfare evaluation grades of mental state of land-lost farmers' households under different livelihood assets.

The reason is that the total assets of the asset-deficient farmers' households are relatively scarce, while their natural assets are abundant. The labor, capital, and other factors are invested in the land for intensive cultivation. Farmers rooted in the land have a deep attachment to the land compared to non-agricultural populations, which are fluid and unrooted. Once the land is lost, the land-lost farmers' households will psychologically feel the sense of loss, sadness, anxiety, and nostalgia. Following loss of land, the land-lost farmers' households in Taohua Town adopted a centralized resettlement method. The living space was denser than that of the former villages, and the neighborhood with the original villagers was more closely related than in the past. Although this helps to eliminate the strangeness of urban culture, it is not conducive to the homogeneity of their production methods, lifestyles and cultural values with urban society. Due to the lack of social capital and the low quality of human capital, a new business relationship has not yet been fully established. This has led to asset-deficient farmers' households lacking the necessary psychological transition and adjustment mechanisms to cope with their new, resettled situation. Moreover, the discrimination and distrust of the original urban people made them experience the ruthlessness and indifference of a city and produced different degrees of inferiority and anxiety. In the resettlement area of Taohua Town, there are urban communities such as high-end residential quarters, but also many backward rural houses. The social environment around the residential areas is relatively complex, the floating population has accumulated, and the physical living space is disorderly and complicated. This will lead to a sense of relative deprivation and of crisis for land-lost farmers. Therefore, the welfare level of the mental status of asset-deficient farmers' households is low.

Although the mental status of the asset-balanced farmers is better than that of the assets-deficient farmers, the welfare level is only moderate. In fact, most farmers are more willing to choose a part-time production method. Once they lose their jobs, they can still work on the land in their hometown. The land plays a psychological security role for farmers in preventing job losses. Therefore, after losing the land, they remain psychologically uncomfortable. In terms of social interaction, asset-balanced farmers have higher quality human capital and social capital. Most of them actively participate in urban economic development and actively integrate into urban life. This shows a strong willingness to expand the network of social interactions, and actively establishes and expands new business relationships. The social network is characterized by openness and heterogeneity. The reconstruction of social relationships, the readaptation of urban society, and the transformation of social and cultural attributes and role connotations have promoted the identification and transformation of asset-balanced farmers' urban identity, which has significantly enhanced their confidence in life.

(5) Development opportunities. It can be seen from Figure 14 that the evaluation cloud of the development opportunities of the asset-deficient farmers' households is located in the middle-right of the "bad" and "medium" intervals. The expected value of the cloud is 4.1430. The development opportunity of the asset-deficient farmers' households is moderately low after the loss of land. At the same time, it can be seen that the evaluation cloud of the development opportunities of the asset-balanced farmers' households is located between "medium" and "good", and the expected value of the cloud is 6.7623. The entropy of the cloud is 0.5549, which is highly dispersed. The vast majority of cloud drops fall in the "medium preference" or "good" range, with only a few falling in the "medium" range, very close to the "good" cloud. Therefore, we can judge the welfare level of the development opportunity of the asset-balanced farmers' households after the loss of land to be at a good level.

The reason is as follows: First, most farmers are engaged in temporary or unsafe occupations, which leads to occupational treatment, low professional level, and unsatisfactory occupational status. Second, due to the household registration system dividing urban and rural areas, and some policy barriers implemented in the household registration system, the scope of employment of migrant workers has been clearly defined, and only the sub-labor market is allowed to work. Even if their labor skills meet the requirements of the first-class labor market, it is difficult to enter the market due to institutional obstacles. Third, the asset-deficient farmers' households have small social capital status, high density, a low-quality, and single target, and narrow sources of employment and entrepreneurial information, which significantly expands the probability of engaging in a bottom-level occupation. Fourth, Microfinance has problems of its own, such as poor accessibility to asset-deficient farmers' households, harsh loan conditions, and cumbersome operational procedures. Moreover, asset-deficient farmers' households face discrimination when applying for loans, in addition to limited assets available for mortgage guarantees, and thus, land-lost farmers do not dare begin a business. In short, for all these reasons, the level of welfare status of the development opportunities of asset-deficient farmers' households after land loss is not high.

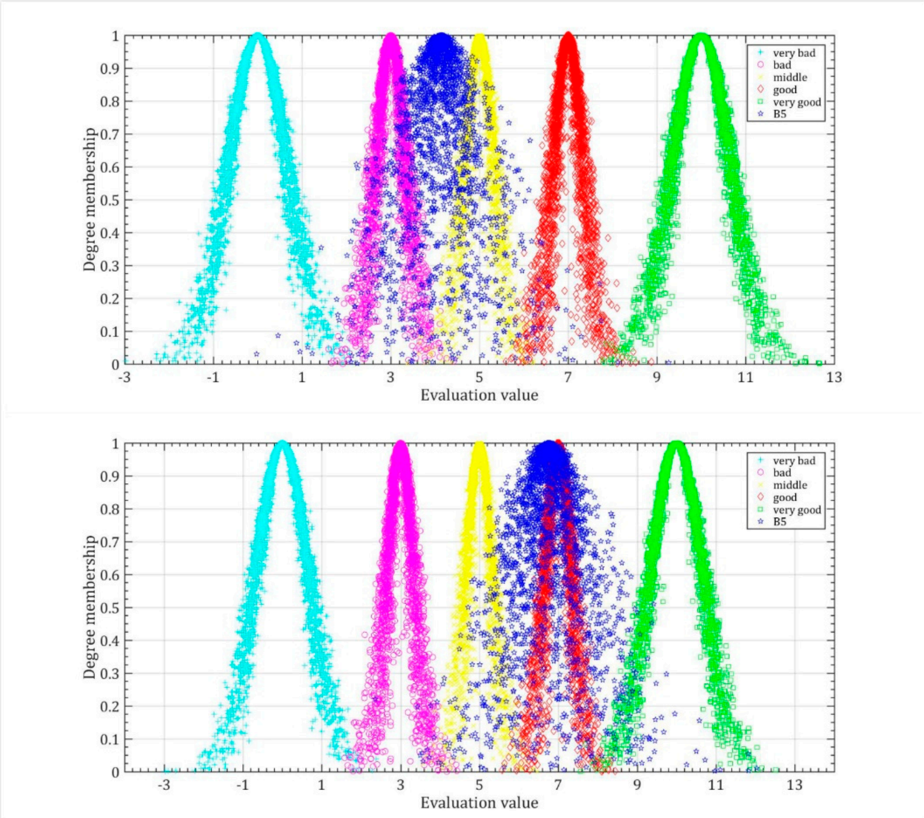

Figure 14. Cloud image of welfare evaluation grades of development opportunities of land-lost farmers' households under different livelihood assets.

In comparison, on the one hand, the human capital stock (education level), human capital level (knowledge skill level) and human capital quality (health care level) of asset-balanced farmers' households are better than those of asset-deficient farmers' households. Most of their family members are skilled in some kind of work or have received vocational skills training. They have a strong ability to apply employment information and a high probability of engaging in upper-middle and upper-level occupations. In addition, some asset-balanced farmers' households with high human capital endowments are good at seizing the opportunity of monetary compensation, making it easier for them to start their own businesses, while also helping them improve their non-agricultural occupation level. On the other hand, the asset-balanced farmers' households have a larger social network and higher social network members, which makes it easier for them to obtain employment information and vocational training information, thus gaining opportunities for career mobility. Therefore, the welfare situation of the development opportunities of asset-balanced farmers' households after losing their land is at a good level.

(6) Living conditions. The cloud expectation value of the living conditions of the asset-deficient farmers' households is 6.2544, and the cloud expectation value of the living conditions of the asset-balanced farmers' households is 6.3991. It can be seen from Figure 15 that the evaluation clouds of the two types of farmers are located between "medium" and "good". The entropy values of the clouds are 0.0478 and 0.1608, the entropy is small, and the cloud drops are concentrated.

The reasons are as follows. First, the public infrastructure as a kind of physical capital makes no difference in the impact of the land-lost farmers' households under the allocation of different livelihood assets. Therefore, there is no difference in the welfare status of the two types of farmers following the land loss. Second, the farmers who lost their original homesteads were uniformly placed in brick-concrete structures. Compared with their former housing structure, with its grass houses, civil, brick and tile structures, the housing value index has increased significantly. Third, prior to loss of land, there were problems such as unreasonable planning and imperfect infrastructure in Taohua Town. The resettlement community enjoys unified planning, unified construction and unified support, and the basic support systems, such as transportation and cultural and recreational facilities, which are now more complete and more convenient than those in rural areas. Therefore, the welfare of the living conditions of the two types of land-lost farmers' households is at a relatively good level.

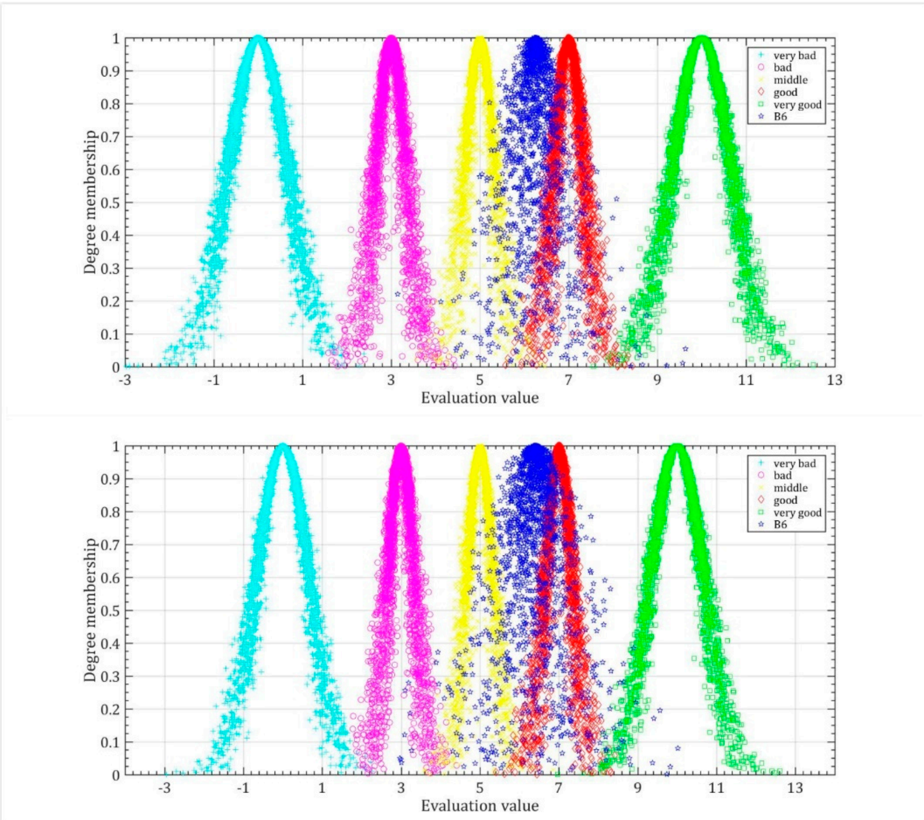

Figure 15. Cloud image of welfare evaluation grades of living conditions of land-lost farmers' households under different livelihood assets.

(7) Political participation. It can be seen from Figure 16 that the evaluation of the political participation of the asset-deficient farmers' households is between "bad" and "medium", and the expectation of the cloud is 3.9850, which is biased more toward the "bad" cloud. The evaluation of the political participation of asset-balanced farmers' households is located between the "medium" and "good" clouds, which is very close to the "medium" cloud. Therefore, the level of political participation welfare of asset-balanced farmers' households is better than that of asset-deficient farmers' households, but both are at medium or medium-low levels, and the welfare level is poor.

The reasons are as follows. First, land-lost farmers' households in China are given no information about land acquisition. Whether land acquisition should occur is only confirmed by government approval and has nothing to do with land-rights holders. Land-lost farmers are often in a state of ignorance. The purpose of a government-approved land acquisition announcement is only so that land-lost farmers cooperate with the registration of rights, and many of these have become similar to an ultimatum notice, which has no substantive significance. Moreover, asset-deficient farmers' households do not know how to protect their own interests through a wide range of regulations and policies, and thus cannot make meaningful recommendations on the basis of compensation and determine whether specific operations are reasonable, thus affecting the expression of farmers' opinions. The defects in the legal system and the lack of farmers' own abilities have led to a situation whereby land-lost farmers' right to know is poor. Second, for asset-deficient farmers' households, the land has a greater effect on their pension. Due to the lack of non-agricultural income and the deterioration of the surrounding environment following the land acquisition, most of them are reluctant to be requisitioned. However, in the process of rural-urban land conversion, the position of land-expropriated farmers is entirely passive. Land-lost farmers' households have no choice as to whether land acquisition can be carried out. Moreover, due to the lack of choice of land acquisition compensation and resettlement standards, the land-lost farmers' households lack the right to choose independently. Third, due to the low compensation standard, land acquisition compensation is not paid in time and land value-added income distribution inequity creates compression of the interests of land-lost farmers' space, resulting in falling living standards. Therefore, the welfare level of political participation of asset-deficient farmers' households following rural-urban land conversion is at a poor level.

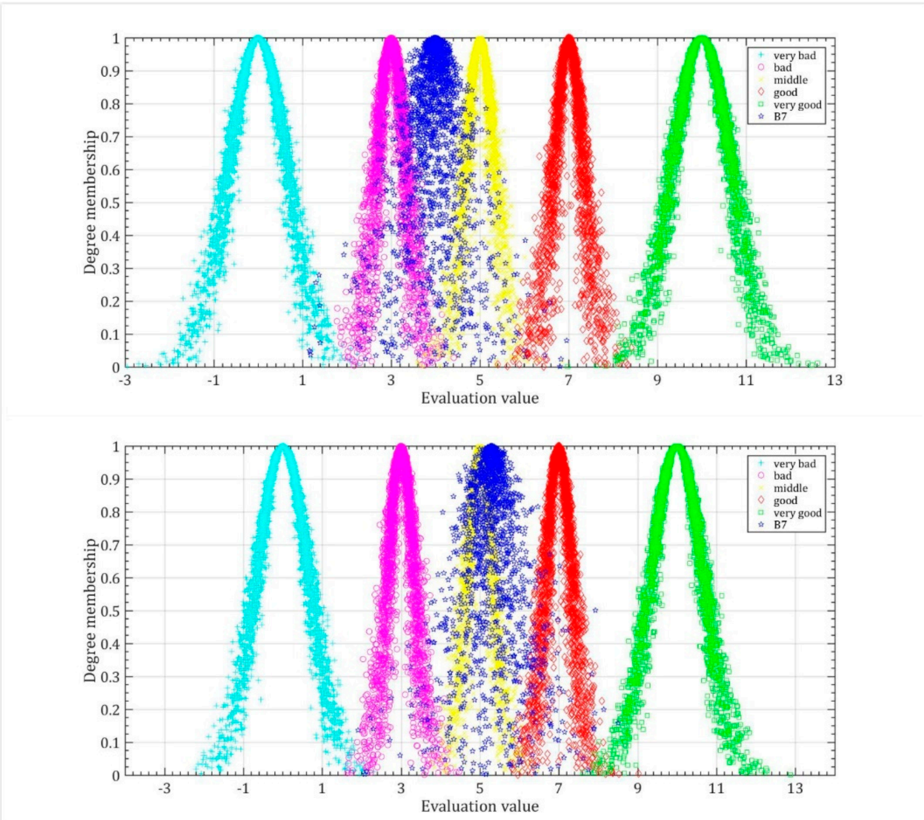

Figure 16. Cloud image of welfare evaluation grades of political participation of land-lost farmers' households under different livelihood assets 5. Discussion.

In comparison, asset-balanced farmers are highly educated and are skilled at using new information tools (such as mobile phones and the Internet) to obtain land acquisition information in a timely manner. This will help broaden the channels of information sources and enhance individual farmers' perception of their political capabilities, thus improving the knowledge of assets-balanced farmers' households regarding land acquisition. Following rural-urban land conversion, the convenience of living arrangements, the increase in employment opportunities, and the increase in the enrollment rate of children have given asset-balanced farmers' households greater opportunities to become wealthy, thus increasing their willingness to acquire land. However, the weights show that the weight of the sense of compensation rationality is 0.0179, which has the greatest impact on the welfare level of political participation. However, for asset-balanced farmers' households, there are still problems, such as land acquisition compensation not being in place and the unequal status of government and developers in the distribution of land value-added income. Therefore, the welfare level of asset-balanced farmers' political participation remains at a moderately low level.

In the process of analyzing the welfare level of land-lost farmers' households, only seven functional activity indicators were selected, which failed to cover all the indicators required in the welfare-level calculation. Therefore, the conclusions drawn can only roughly reflect the welfare level of land-lost farmers' households. As the functional activity indicators selected are different, the content of the welfare reflected will be different. For example, Yuan [86] also uses Sen's feasible ability theory as the research framework to assess the welfare level of land-losing farmers from the five aspects of family economic status, social security, living conditions, landscape environment, and psychological factors. Yuan believes that land acquisition activities have an inevitable negative impact on farmland landscape. Land development activities will destroy the original ecosystem of the farmland. Especially the urban-rural interlaced area with frequent land acquisition is a fragile area of the ecological environment. Without proper management and control measures, land development and urban sprawl will cause irreversible ecological and economic problems. Therefore, Yuan selected three indicators of landscape environmental sensitivity, single field area, and field fragmentation degree to reflect changes in landscape environment. In this regard, Sen believes that different indicator systems should be established for different research objects, and some of the indicators may not be entirely due to rural-urban land conversion, which may also include factors such as social and economic development. Therefore, how to determine a reasonable indicator system is still worth exploring.

According to Sen's theory of feasible ability, due to differences in personal, environmental and social factors, the efficiency and degree of conversion of goods and services to welfare are also different. These differences are called conversion factors. The conversion factors are divided into five aspects: individual heterogeneity, environmental differences, diversity of social atmosphere, differences in interpersonal relationships, and distribution within the family. This paper only studies the differences in the level of welfare effects of land-lost farmers' households under different livelihood asset allocations. Future research should continue to focus on the differences in welfare levels caused by other characteristics of the family and social environment. Therefore, it is possible to adopt a corresponding compensation method for the characteristics of different groups while implementing a regionally differentiated compensation policy. For example, Zhu [87] used Wulijie Town in Jiangxia District of Wuhan as the research area and applied AHP-fuzzy comprehensive evaluation method to analyze the impact of land acquisition on micro-welfare of land-lost farmers. The results show that the impact of land expropriation on the welfare of land-lost farmers is significantly different between different genders, different age groups, different educational levels, and different incomes. The method of land acquisition compensation is proposed to be diversified, and the compensation objects should be treated differently. This will be of great significance to improving the welfare of land-lost farmers' households, reducing welfare differences and promoting the harmonious development of society.

To better reflect the long-term lag welfare effect of rural-urban land conversion on the family's economic status, living environment and mental status, and the uncertainty of land-lost farmers' households adapting to urban life [88], dynamic observation of the multifaceted welfare status of sample farmers in the same sequence based on multiple time periods should be an important direction for future research.

The study of the land-lost farmers' welfare survey conducted in this paper uses the welfare perception approach to indirectly reflect the welfare level of the land-lost farmers' households. Due to differences in respondents' preferences and value judgments, there may be deviations in the measurement of welfare levels. Then, because human cognition has similarities and differences, data mining tasks based on qualitative concepts need to measure similarity. For land-lost farmers, with the increase of knowledge and experience, the perception of welfare concepts in different periods is also different. For different farmers, the perception of welfare concepts is not the same due to various factors. In view of this, using the cloud model to explore the similarity measure of different farmers' perceptions of welfare concepts is a problem worth studying in the future. At the same time, improvements should be made by optimizing the questionnaire.

In this paper, the membership function of the cloud model is used to determine the membership degree of each welfare index, which avoids the uncertainty of the evaluation process to the greatest extent. The evaluation result of the cloud model is a cloud model with three digital features of expectation, entropy, and hyper entropy. This cloud model is used to represent the welfare of land-lost farmers, which takes into account the central value, ambiguity, and randomness of the evaluation results, and greatly improves the accuracy of welfare evaluation. This provides a simple and effective method for quantitative analysis of the welfare level of land-lost farmers. However, according to Sen's theory, the available functional activities and viable capabilities are closely related to the individual differences of farmers (gender, age, education level, psychological quality) and the characteristics of the study area (natural resource environment, social-economic environment, institutional policy environment, social public consciousness status). The same resources can be converted into different functional activities by different people in different environments [89]. Although this paper selects only three villages in Taohua Town, Nanchang City, as the research area, and the research results can only reflect the welfare level of the land-lost farmers' households in the study area. However, the unique advantages of cloud model in dealing with ambiguity, randomness and discreteness issues can provide useful reference for future scholars to study the welfare problems of land-lost farmers in different regions (especially for developing countries where urbanization and industrialization are rapidly accelerating). If the number of samples increases, the concept of welfare has different manifestations at different levels of granularity. At this time, Gaussian cloud algorithm can be used to realize the transformation from fine-grained to coarse-grained concept, and then solve the problem of granularity change in the welfare evaluation process [90,91]. At the same time, the issue of the welfare of land-lost farmers' households is a national one, and thus the reflection of the welfare of land-lost farmers' households in the country remains to be studied further.

The lack of rights and interests of land-lost farmers in the process of urbanization is mainly due to the social exclusion of land-lost farmers. It mainly includes two aspects: structural exclusion and functional exclusion. On the one hand, the household registration system, social class, and social culture have produced an unreasonable social structure, which has resulted in the structural exclusion of land-losing farmers. On the other hand, due to the lack of human capital and social capital stocks of land-lost farmers, they are vulnerable to functional exclusion. Therefore, land acquisition will not only have a negative impact on the welfare status of land-lost farmers, but also affect the urban adaptation status, health level, and happiness of the land-lost farmers [92]. This will provide suggestions for the local government to revise the current land use policy, increase the compensation for land acquisition, and improve the income level and mental health of land-lost farmers.

This paper uses the AHP-entropy weight method to empower indicators of land-lost farmers' households. However, the linear combination weighting method tends to ignore the deviation between each basic weight. A combination weighting method based on game theory can be considered in future research. Game theory is a method to analyze the rational behavior and decision-making equilibrium when the behavior of decision-making subjects interacts. It is the theory and method of studying competitive things. The basic idea of game theory combined weighting is to find compromises or consistency between different weighting methods and to minimize the deviation between each weight and the optimal weight. Thereby a combined weight vector with relative equilibrium and coordination is obtained. In future research, the AHP-entropy weight method can be used to obtain the index weights respectively. On this basis, the idea of game theory combined weighting is introduced, and the two weights are combined and optimized. Finally, the optimal weight of a balanced subjective and objective weighting method is obtained. Using this method combined with cloud model theory to establish a comprehensive evaluation of the welfare status of land-lost farmers' households can make the evaluation results more convincing.

In addition, since the cloud model has been proposed, the two-way conversion between qualitative concepts and quantitative values can be achieved through forwarding cloud transformation algorithms and reverse cloud transformation algorithms. Although it has been widely used in the processing of uncertainty information, there are still the following problems to be solved: I) Most of the current research on cloud models focuses on one-dimensional cloud models and two-dimensional cloud models, and lacks effective methods for multidimensional attribute data processing. Therefore, the high-dimensional cloud model is a direction for future research of cloud model. II) Cloud models have been successfully used in areas such as intelligent control, data mining, system evaluation, and signal processing. However, few scholars have applied cloud model to the field of land science research. For example, Liu [93] believes that various uncertainties are involved in the process of land ecological security assessment. Although the cloud model can provide ideas for the randomness and ambiguity evaluation of land ecological security, it cannot simulate the distribution status of evaluation indicators within a limited interval. For multi-factor evaluation, the calculation process is very complicated. In view of this, Liu uses a novel multi-dimensional connection cloud model to evaluate land ecological security. The model can overcome the subjectivity of the digital feature determination of conventional cloud models and provide a new method for comprehensive evaluation of land ecological security. Ye [94] uses the normal cloud model and the entropy weight method to evaluate the reserve development potential of cultivated land resources, which can effectively reduce the accidental error in the evaluation process. It can be seen that land science research based on the cloud model will become a meaningful research topic in the future. III) There are still some problems to be solved in the calculation process of the cloud model. For example, the error in the reverse cloud algorithm is unavoidable, and how to further reduce the error in the reverse cloud algorithm remains to be studied. For example, the determination of the evaluation results using this method depends on the selection of some factors, such as hyper entropy. However, there is currently no complete theory to prove which method to determine H_e is more scientific. Therefore, the determination of H_e is a problem worthy of further discussion.

5. Conclusions and Policy Implication

5.1. Conclusions

The cloud model comprehensively considers the central value, ambiguity, and randomness of the evaluation results and provides a new simple and effective method for quantitatively evaluating the uncertainty in the process of evaluating the welfare level of the land-lost farmers' households. The results obtained are more intuitive, accurate and objective than those from the traditional fuzzy evaluation method. The feasibility and reliability of the method are shown by evaluating the welfare results of the land-lost farmers' households in Taohua Town, which makes this model widely used in the complex field of more uncertain problems.

Data collection and processing is simple and easy. The collected evaluation data are no longer accurate hard data but include a full consideration of the ambiguities and uncertainties of the real world. Using natural language values more accurately describes the real world and conforms to the human understanding of the objective world.

The comprehensive calculation of the secondary indicators of the evaluation of the welfare effect of the land-lost farmers' households adopts the integrated cloud algorithm, and the primary indicators adopt the floating cloud algorithm, which reflects the independence and correlation between the indicators. This makes the comprehensive evaluation process more detailed, and the rating results are more scientific and more realistic. The normal cloud generator algorithm makes it easy to use a computer's high-level language to visualize the final evaluation results as a cloud map, thereby obtaining the cloud drop distribution of each evaluation level. This can produce a more specific and subtle understanding of the evaluation information, and thus a more comprehensive evaluation of the welfare effect of land-lost farmers' households is possible.

Based on Sen's function and ability theory, the evaluation index system of the welfare level of land-lost farmers' households is proposed. The weighting method of each evaluation index is objectively determined by the AHP-entropy weight method. The weighted result not only reflects the experienced judgment of each expert on each functional activity index but also fully considers the difference and integrity of different functional activity indicators in the evaluation of the welfare effect of land-lost farmers' households, avoiding the bias caused by the single weighting method.

In the process of rural-urban land conversion, the difference in the endowment of livelihood assets of the land-lost farmers' households makes the welfare levels of all kinds of farmers' households following land loss different. The livelihood assets and welfare levels owned by farmers' households are highly positively correlated. The most significant correlations with welfare levels are natural assets, human assets, and social assets.

5.2. Policy Implications

Compensation for the welfare of land-lost farmers' households should not only be monetary but should be a comprehensive compensation that includes social insurance, job opportunities, and increasing years of education and opportunities. It is also necessary to formulate and implement differentiated rural-urban land conversion policies and measures for land-lost farmers' households under different livelihood asset allocations, improve the targeting of farmers with different welfare levels, and achieve accurate compensation and support for farmers' households.

Human capital investment such as education and training, as well as non-agricultural vocational skills training, should be increased for asset-deficient farmers' households. Moreover, efforts should be made to improve the non-agricultural employment skills of the asset-deficient farmers' households and their ability to enter the higher professional class. Establishing a training fund for land-lost farmers' households would strengthen employment training orientation so that the training content can meet the needs of the local labor market. Moreover, one should build a unified urban and rural labor market, break through the institutional barriers of the upward movement of land-lost farmers' households, and break down barriers and industry restrictions so that all sectors can enjoy equal opportunities for competition and development. In addition, the government should provide greater policy inclinations to asset-deficient farmers' households in terms of vocational training, technical title training and specific job placement. Asset-balanced farmers' households should be encouraged to pursue high-level employment, such as self-employment and to promote the employment of other family members through entrepreneurship to increase the non-agricultural employment of these farmers. For asset-balanced farmers' households, entrepreneurship training and entrepreneurship support are the main focus.

Establish a statutory minimum social security system covering the entire country. While gradually abolishing the urban-rural dual household registration system, we would construct a welfare package for land-lost farmers' households, which would include schooling, medical care, old-age care, unemployment, maternity, work-related injury, and insurance, to ensure the basic needs of land-lost farmers' households in the life cycle. The current urban social security system has a high entry barrier for land-lost farmers' households. Thus, the government should tailor a "low-cost, low-entry" security system that suits their individual characteristics of asset-deficient farmers' households and design gradient contribution rates for land-lost farmers' households with different livelihood assets, thus including these households in the social security system in a hierarchical and phased manner. In addition, the government should pass legislation to protect the legitimate rights and interests of land-lost farmers' households.

The government should strive to improve the mental status of land-lost farmers' households so that they can successfully integrate into the city and complete the transformation of farmers to urbanites. First, the government should effectively parallel the ideological education and cultural skills training of land-lost farmers' households so that they can better adapt to urban work and life. Second, community management should be strengthened to build a solid community platform for the association of land-lost farmers' households. The village committee should establish a variety of community cultural activities to help land-lost farmers' households expand their social network systems and enhance their sense of identity and belonging in order to promote their psychological harmony. Third, mass media should positively promote the contribution of land-lost farmers' households to urbanization. The government should guide the citizens to objectively evaluate farmers and eliminate prejudice, letting the general public enjoy associating with farmers and accept them psychologically.

The government should control the noise of surrounding construction projects, control the discharge of various pollutants, increase the green coverage around the resettlement community, and establish a "new home," suitable for living, for land-lost farmers' households. Improving the sense of identity of land-lost farmers' households in the new environment and new life will help promote their psychological harmony.

In particular, the government must strengthen the construction of a land acquisition information disclosure system and fully protect land-lost farmers' right to know. The compensation of land-lost farmers' households, based on the price of agricultural land development rights, itself based on the benchmark land price, should be in line with the principle of fairness and raise the compensation standard for land acquisition. It is necessary to further explore and establish a long-term mechanism for land-lost farmers' households to share in value-added income following land non-agriculturalization. In order to increase the proportion of land-lost farmers' households in land value-added income.

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Appendix A

For the benefit indicator (the bigger the better), the standardization method is as follows:

$$r_{ij} = \frac{x_{ij} - \min_j\{x_{ij}\}}{\max_j\{x_{ij}\} - \min_j\{x_{ij}\}} \tag{A1}$$

For cost indicators (smaller and better), the standardization method is as follows:

$$r_{ij} = \frac{\max_j\{x_{ij}\} - x_{ij}}{\max_j\{x_{ij}\} - \min_j\{x_{ij}\}} \tag{A2}$$

Appendix B

Table A1. The weight of the secondary evaluation index and the cloud model parameters of the welfare effect of the asset-deficient land-lost farmers' households.

Functional Activity (Level One Indicator)	Characterization Index (Secondary Indicators)	Secondary Evaluation Index Cloud Model Parameters	Weights	
		(E_x, E_n, H_e)	W_j	W_{ij}
Family's financial situation (B1)	Per capita agricultural net income (C1)	(2.1179, 0.8969, 0.3490)	0.4115	0.2158
	Per capita non-agricultural income (C2)	(6.4670, 1.2293, 0.5424)		0.0082
	Per capita net income (C3)	(3.3962, 1.3122, 0.6103)		0.1368
	Satisfaction with economic conditions (C4)	(4.0472, 1.4660, 0.4866)		0.0506
Social Security (B2)	Pension security (C5)	(4.0613, 1.4045, 0.4132)	0.1227	0.0744
	Medical security (C6)	(6.4717, 1.2408, 0.5509)		0.0183
	Social security satisfaction (C7)	(4.8726, 0.9492, 0.4163)		0.0034
	Education guarantee (C8)	(4.6132, 1.2155, 0.5127)		0.0041
	Unemployment protection (C9)	(3.8019, 1.4872, 0.5289)		0.0225
Living environment (B3)	Air quality (C10)	(4.0236, 1.5137, 0.4797)	0.0311	0.0103
	Noise pollution (C11)	(4.6840, 1.8604, 0.7803)		0.0051
	Green coverage (C12)	(3.3726, 1.2043, 0.5173)		0.0144
	Road dust case (C13)	(4.5330, 1.2340, 0.5444)		0.0008
	Solid waste disposal rate (C14)	(6.6085, 1.2063, 0.5176)		0.0006
Mental state (B4)	Farmers' urban residents' identity (C15)	(3.0660, 1.4290, 0.5049)	0.0182	0.0026
	Neighborhood relationship (C16)	(3.4009, 1.1671, 0.4891)		0.0120
	Confidence in future life (C17)	(5.0566, 0.8812, 0.2963)		0.0006
	Degree of respect (C18)	(4.1132, 0.8283, 0.2529)		0.0030
Development opportunities (B5)	Number of development opportunities (C19)	(3.9057, 1.5589, 0.6410)	0.2468	0.1554
	Work stability (C20)	(3.4811, 1.2722, 0.5783)		0.0427
	Employment difficulty (C21)	(4.0991, 1.4328, 0.4881)		0.0185
	Subjective feelings of entrepreneurial environment (C22)	(3.0377, 0.8761, 0.2775)		0.0066
	Employment training (C23)	(5.0896, 0.8396, 0.2524)		0.0236
Living conditions (B6)	Housing types (C24)	(6.0047, 1.4968, 0.5047)	0.0318	0.0034
	Security situation (C25)	(6.0283, 1.5438, 0.5552)		0.0032
	Residential satisfaction (C26)	(5.7358, 1.5054, 0.5634)		0.0031
	Surrounding facilities (C27)	(5.8962, 1.5673, 0.5618)		0.0109
	Hydropower supply (C28)	(6.9292, 1.4313, 0.4373)		0.0113
Political participation (B7)	Informed status of land acquisition (C29)	(3.4953, 1.1885, 0.5108)	0.1379	0.0050
	Willingness to land acquisition (C30)	(4.2689, 1.1659, 0.4626)		0.0094
	Feelings of compensation rationality (C31)	(3.9340, 0.8834, 0.3048)		0.0443
	Identity of land acquisition (C32)	(4.0566,1.3981, 0.4306)		0.0289
	Social justice (C33)	(3.9717,1.6130, 0.6203)		0.0504

Table A2. The weight of the secondary evaluation index and the cloud model parameters of the welfare effect of the asset-balanced land-lost farmers' households.

Functional Activity (Level One Indicator)	Characterization Index (Secondary Indicators)	Secondary Evaluation Index Cloud Model Parameters	Weights	
		(E_x, E_n, H_e)	W_j	W_{ij}
Family's financial situation (B1)	Per capita agricultural net income (C1)	(4.4575, 1.2380, 0.5454)	0.0263	0.0013
	Per capita non-agricultural income (C2)	(8.0472, 1.4306, 0.4369)		0.0056
	Per capita net income (C3)	(5.8396, 1.5480, 0.6122)		0.0099
	Satisfaction with economic conditions (C4)	(6.6321, 1.8768, 0.7787)		0.0095
Social Security (B2)	Pension security (C5)	(6.4717, 1.1212, 0.4589)	0.1589	0.0040
	Medical security (C6)	(6.3915, 1.2963, 0.5924)		0.0509
	Social security satisfaction (C7)	(5.4481, 1.2462, 0.5561)		0.0117
	Education guarantee (C8)	(6.0755, 1.5378, 0.5599)		0.0333
	Unemployment protection (C9)	(6.4292, 1.2458, 0.5487)		0.0590
Living environment (B3)	Air quality (C10)	(4.0519, 1.6107, 0.6195)	0.1419	0.0135
	Noise pollution (C11)	(4.5755, 1.8864, 0.7942)		0.0875
	Green coverage (C12)	(3.5047, 1.2529, 0.5603)		0.0135
	Road dust case (C13)	(4.5425, 1.2272, 0.5383)		0.0068
	Solid waste disposal rate (C14)	(6.5755, 1.2766, 0.5764)		0.0205
Mental state (B4)	Farmers' urban residents' identity (C15)	(5.4953, 1.2649, 0.5701)	0.1301	0.0083
	Neighborhood relationship (C16)	(3.6321, 1.2053, 0.5209)		0.0141
	Confidence in future life (C17)	(6.1038, 1.6097, 0.6495)		0.0876
	Degree of respect (C18)	(5.5330, 1.1568, 0.4847)		0.0201
Development opportunities (B5)	Number of development opportunities (C19)	(7.0330, 1.5031, 0.4866)	0.3782	0.0722
	Work stability (C20)	(7.1698, 1.5197, 0.5735)		0.1480
	Employment difficulty (C21)	(6.6462, 1.9166, 0.7808)		0.0327
	Subjective feelings of entrepreneurial environment (C22)	(5.5189, 1.3374, 0.6328)		0.1087
	Employment training (C23)	(5.0142, 0.8043, 0.0853)		0.0166
Living conditions (B6)	Housing types (C24)	(5.9057, 1.6473, 0.6690)	0.1026	0.0448
	Security situation (C25)	(6.4623, 1.2315, 0.5476)		0.0104
	Residential satisfaction (C26)	(6.5849, 1.2620, 0.5618)		0.0023
	Surrounding facilities (C27)	(5.9670, 1.4452, 0.4863)		0.0079
	Hydropower supply (C28)	(7.0660, 1.6095, 0.6215)		0.0372
Political participation (B7)	Informed status of land acquisition (C29)	(6.5236, 1.2761, 0.5790)	0.0620	0.0020
	Willingness to land acquisition (C30)	(5.4481, 1.2568, 0.5628)		0.0027
	Feelings of compensation rationality (C31)	(6.4670, 1.2821, 0.5844)		0.0179
	Identity of land acquisition (C32)	(5.0236, 0.8312, 0.1809)		0.0017
	Social justice (C33)	(4.7736, 1.5612, 0.6201)		0.0377

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