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Livelihood Resilience and Its Influencing Factors of Worker Households in the Face of State-Owned Forest Areas Reform in China

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Abstract: To promote the sustainable development of state-owned forest areas, the Chinese government announced the reform of state-owned forest areas in 2015. It mainly includes the logging ban of natural forests and the separation of government and enterprises. Timely investigation of the changes in the livelihood resilience of worker households before and after the reform of state-owned forest areas is of great significance to the sustainable development of state-owned forest areas. With the application of livelihood resilience theory, we established an evaluation index system from three dimensions of buffer capacity, self-organization, and learning capacity. Taking five forest industry enterprises operating state-owned forest areas in Northeast and Inner Mongolia in China as an example, we measured worker households' livelihood resilience, and identified the key factors of worker households' livelihood resilience. The results showed: (1) The reform of state-owned forest areas has improved the livelihood resilience of worker households in Longjiang, Daxing'anling, Inner Mongolia, and Jilin forest industry groups, but reduced the livelihood resilience of worker households in Changbai Mountain forest industry groups. (2) With the advancement of the reform of state-owned forest areas, the gap of livelihood resilience of worker households of forest industry groups shows an expanding trend. (3) The influencing factors that affect the worker households' livelihood resilience of various forest industry groups are similar. Among them, the education of household head, household head health, household size, work experience, and neighborhood relationships are the key factors that affect the resilience of worker households.

Keywords: state-owned forest areas; worker households; livelihood resilience; grey correlation

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1. Introduction

The development history of state-owned forest areas in Northeast and Inner Mongolia in China can be traced back to the 1950s. Five forest industry groups (FIGs) have been established in the state-owned forest areas of Northeast and Inner Mongolia in China for timber production and processing. As of 2015, the state-owned forest areas in Northeast and Inner Mongolia have provided nearly 1.1 billion cubic meters of commercial timber, accounting for nearly half of the national commercial timber output during the same period [1]. In the past 60 years of development and utilization, a series of problems have also appeared in the state-owned forest area in Northeast and Inner Mongolia. The forest resources were gradually depleted, and the ecological functions were seriously degraded [2]. In particular, the outbreak of catastrophic floods in the Yangtze River, Songhua River, and Nen River in 1998 directly exposed the fragility of the ecological environment [3,4]. At the beginning of the establishment of state-owned forest areas in Northeast and Inner Mongolia, they adhered to the concept of "production first, life later" [5]. Therefore, a special social form with integration of government administration with the enterprise has been formed. On the other hand, the economy is poor. In the golden age of timber production, forest workers used to have the highest per capita income of employees in

China with an average of 20%–30% higher. However, now the average annual salary of employees in state-owned forest areas in Northeast and Inner Mongolia is much lower than the average level of local cities and towns [6]. To solve the above problems, the Chinese government issued the "Guiding Opinions on the Reform of State-owned Forest Areas" in 2015. The main objectives are as follows: Orderly stop commercial logging of natural forests in the state-owned forest areas of Northeast China and Inner Mongolia. Realize the separation of government and enterprise and improve the forest resource management and supervision system. Integrate the economic and social development of the forest area into the local area, improving production and living conditions and ensuring the basic livelihood of workers [7].

The reform of state-owned forest areas will play a positive role in the sustainable development of state-owned forest areas in Northeast and Inner Mongolia in China [8]. The implementation of a comprehensive logging cessation "forces" the transformation of the forestry economy from the source. It promotes the sustainable development of forests. The separation of government and enterprise is conducive to straightening out the chaotic state-owned forest resource management system, which can stimulate FIGs' vitality. However, in a short time, the impact on workers is huge. With the transformation of the FIGs, the livelihood structure of worker households has also changed. Workers are facing transfers (from lumberjack to the tree keeper) and even unemployment [9]. The livelihood of worker households in the reform of state-owned forest areas is facing many uncertainties. How to improve the livelihood capacity of worker households in a complex environment and should become the focus of livelihood research. In the face of an uncertain future and external disturbances, many scholars believe that resilience is the most effective way to improve livelihoods and promote sustainable development [10–12]. The theory of resilience originated from ecology and was introduced by Holling in 1973 to describe the ability of an ecosystem to recover to its original state when it is disturbed and stressed [13,14]. In recent years, many scholars have introduced resilience into livelihood research as an expansion of the research field of resilience [12,15,16]. The research content mainly focuses on the impact of major external changes and challenges such as ecologically fragile areas [17,18], resettlement [19,20], and climate change [12,16]. The state-owned forest areas in Northeast and Inner Mongolia are facing such an external challenge.

In the related research on the livelihood of worker households in the state-owned forest areas of Northeast China and Inner Mongolia, few scholars have studied the livelihood of worker households from the perspective of resilience, so it is difficult to fully grasp the development status of the workers' households. For the livelihoods of local residents, policy change is not an instantaneous impact, but a long-term impact. So, the impact of the reform of state-owned forest areas on the livelihood of worker households and the livelihood resilience should be analyzed, which can determine the endogenous force of worker household livelihood. Therefore, this paper introduced livelihood resilience into the study of worker household livelihoods. Through the calculation of the livelihood resilience index of worker households and the different coefficients of livelihood resilience, the impact of the reform of state-owned forest areas on the livelihood resilience of worker households was analyzed. Then, we used the grey relational model to analyze the influencing factors of the livelihood resilience of worker households. Finally, relevant countermeasures and suggestions were put forward to improve worker households' livelihood resilience in the state-owned forest areas in Northeast and Inner Mongolia in China, and then promote the sustainable development of state-owned forest areas in Northeast and Inner Mongolia in China.

2. Method and Data

2.1. Method

2.1.1. Method of Calculating Livelihood Resilience Level

There are different dimensions and orders of magnitude in the evaluation indicators of livelihood resilience; the range standardization method was adopted to standardize the

data of each indicator. According to different indicator types, different data standardization formulas were selected.

Dichotomous variables:

$$X_{ij} = \begin{cases} 0 & x = 0 \\ 1 & x = 1 \end{cases} \quad (1)$$

Continuous variables and virtual qualitative variables:

$$X_{ij} = \begin{cases} 0 & 0 \le x_{ij} \le {x_{ij}}^{min} \\ \frac{x_{ij} - {x_{ij}}^{min}}{{x_{ij}}^{max} - {x_{ij}}^{min}} & {x_{ij}}^{min} \le x_{ij} \le {x_{ij}}^{max} \\ 1 & x_{ij} \ge {x_{ij}}^{max} \end{cases} \quad (2)$$

Among them, x_{ij} is the original value of column i and column j, ${x_{ij}}^{min}$ is the minimum value of the original value of column j, ${x_{ij}}^{max}$ is the maximum value of the original value of column j, and X_{ij} is the data of column i and column j after normalization.

2.1.2. Method of Calculating Livelihood Resilience Gap

(1) The "Lorentz curve" of livelihood resilience.

The Lorentz curve was proposed by Max Otto Lorenz in 1903 to measure the income distribution of a country or region. Using the idea and method of the Lorentz curve, the "Lorentz curve" of worker households' livelihood resilience was drawn to intuitively analyze the gap of worker households' livelihood resilience. Firstly, we calculated the livelihood resilience of each worker household in the sample. Then, we arranged the livelihood resilience of each worker household from small to large and accumulated it in turn. Finally, we drew the "Lorentz curve" of worker households' livelihood resilience (Figure 1). Like the Lorentz curve, the greater the degree of $f(x)$ bending means the farther away from the absolute equity line, and the greater the gap of livelihood resilience between worker households is bigger When $f(x)$ is closer to the absolute equity line, meaning that the livelihood resilience gap between worker households is smaller.

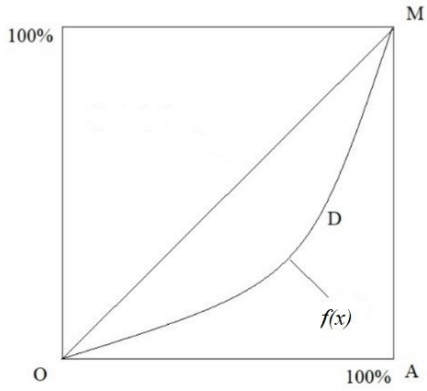

Figure 1. Schematic diagram of the "Lorentz curve" of the worker households' livelihood resilience.

(2) Livelihood resilience gap coefficient.

Corrado Gini proposed the Gini coefficient in 1912 to quantify the Lorentz curve. According to the calculation method of the Gini coefficient, we defined the livelihood resilience gap coefficient to analyze worker households' livelihood resilience gap quantitatively. The expression of the calculation formula of the worker households' livelihood resilience gap coefficient can be expressed by the Gini coefficient formula:

$$G = 1 - \frac{\int f(x)dx}{S_{\Delta OAM}} \quad (3)$$

Among them, $f(x)$ represents the "Lorentz curve" of the worker households' livelihood resilience, and $S_{\Delta OAM}$ represents the area of ΔOAM in Figure 1. Like the Gini coefficient, the livelihood resilience gap coefficient ranges from 0 to 1. The smaller the livelihood resilience gap coefficient G is, the more even the distribution of livelihood resilience is. On the contrary, it means the greater the difference in livelihood resilience between worker households.

2.1.3. Grey Correlation

Grey correlation is a quantitative method used to describe the relationship between multiple factors in the development of a system [21]. The basic idea is to measure the degree of correlation between factors based on the degree of similarity or difference in development trends between factors. According to the idea of grey correlation degree, the relationship between the livelihood resilience of worker households and the evaluation indicators was regarded as a grey relationship, and the key factors affecting worker households' livelihood resilience were identified by calculating the grey correlation coefficient. The formula is as follows:

$$\gamma(x_0(k), x_i(k)) = \frac{\min\limits_k \min\limits_k |x_0(k) - x_i(k)| + \xi \max\limits_k \max\limits_k |x_0(k) - x_i(k)|}{|x_0(k) - x_i(k)| + \xi \max\limits_k \max\limits_k |x_0(k) - x_i(k)|} \tag{4}$$

$$\gamma\gamma(X_0, X_i) = \frac{1}{n} \sum_{k=1}^{n} \gamma(x_0(k), x_i(k)) \tag{5}$$

Among them, X_0 represents the index of the livelihood resilience of the worker households, and X_i represents the index to evaluate the resilience of the livelihood. $\gamma(x_0(k), x_i(k))$ represents the correlation coefficient between X_i and X_0 at point k. γ represents the grey correlation degree between X_0 and Xi. ξ is the resolution coefficient, and $\xi \in (0, 1)$ generally takes the value 0.5.

2.2. Data

2.2.1. Variable Descriptions

Livelihood resilience is a multi-dimensional complex system that describes the ability to maintain or improve the livelihoods of worker households when they are disturbed by the outside world [15,22]. A resilient livelihood system is not only manifested in its ability to use its resource endowments to buffer unfavorable changes, but also manifested in its behaviors of summarizing its practical experience, creating self-organizing opportunities, and cultivating learning capacity to consolidate its livelihood results and update and improve [12]. Based on relevant research, we established an evaluation index system for the livelihood resilience of worker households in state-owned forest areas in Northeast and Inner Mongolia, as shown in Figure 2.

Livelihood resilience mainly consists of three dimensions: buffer capacity, self-organization, and learning capacity. Buffer capacity refers to the ability of a household's resource endowments to maintain the internal structure, functions, and characteristics of the system when disturbed by external forces and shocks, and to formulate corresponding feedback [16]. Self-organization refers to the endogenous interaction process of collective actions, institutional policies, and social network relationships to affect the resilience of livelihoods, thereby reflecting the ability of worker households to integrate into the local economy, and the social and institutional environment [23,24]. Learning capacity refers to the ability of worker households to repair the negative impact of disturbance by acquiring knowledge, skills, and information, transferring, imitating, updating, and creating them to improve their adaptability to the changing environment [25].

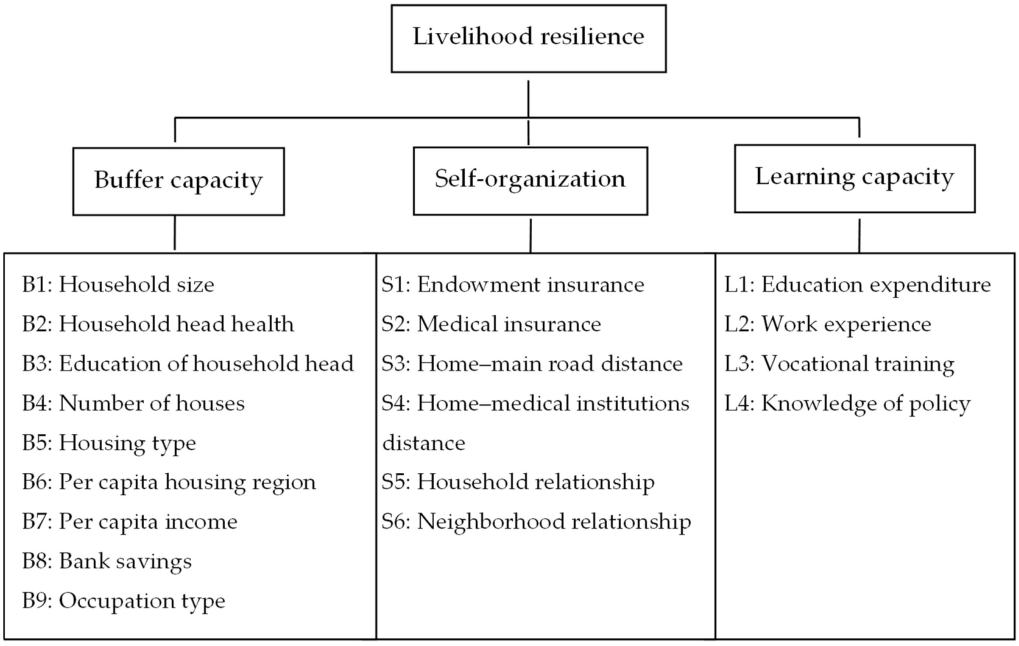

Figure 2. The evaluation index system of livelihood resilience of worker households.

2.2.2. Data Sources

The state-owned forest areas in Northeast and Inner Mongolia in China (longitude 118° E–135° E, latitude 48° N–55° N) are the largest state-owned forest areas in China. From the geographical distribution point of view, they are located in the Great Xingan Mountains, Xiaoxing'an Mountains, and Changbai Mountains. From the perspective of administrative regions, they include the Heilongjiang Province, Jilin Province, and the northeastern part of Inner Mongolia Autonomous Region. From the perspective of business entities, they are mainly composed of Longjiang FIGs, Daxing'anling FIGs, Inner Mongolia FIGs, Jilin FIGs, and Changbai Mountain FIGs to operate.

The data come from field surveys conducted by the Northeast Forestry University research team from July–August of 2015 and 2019. The survey is a part of a regular survey being conducted by the National Forestry and Grassland Administration of China. Data acquisition uses structured questionnaires. The sample number of each FIG is shown in Table 1.

Table 1. The sample number of each FIG.

FIGs	2015		2019	
	Number	Proportion (%)	Number	Proportion (%)
Longjiang	417	40.56%	706	44.88%
Daxing'anling	148	14.40%	146	9.28%
Inner Mongolia	224	21.79%	392	24.92%
Jilin	150	14.59%	137	8.71%
Changbai Mountain	89	8.66%	192	12.21%

3. Results

3.1. The Livelihood Resilience Level of Worker Households

The livelihood resilience of different FIGs' worker households was different (Table 2). According to the data for 2019, The livelihood resilience level of worker households of all FIGs was at a medium level, and the best were Jilin FIGs (0.557), followed by Longjiang FIGs (0.549) and Daxing'anling FIGs (0.548), Changbai Mountain FIGs (0.543); the worst were Inner Mongolia FIGs (0.540). In terms of the magnitude of change, the livelihood resilience of Longjiang, Daxing'anling, and Inner Mongolia FIGs showed an upward trend, increasing by 2.96%, 5.74%, and 3.64% respectively from 2015. The livelihood resilience of

Jilin FIGs did not change much, while the Changbai Mountain FIGs showed a downward trend, with a decrease of 3.53% from 2015. It showed that the reform of state-owned forest areas has little impact on the livelihood resilience in Longjiang, Daxing'anling, Inner Mongolia, and Jilin FIGs, but has a certain impact on the livelihood resilience in Changbai Mountain FIGs.

Table 2. Worker households' livelihood resilience level.

Index	Longjiang		Daxing'anling		Inner Mongolia		Jilin		Changbai Mountain	
	2015	2019	2015	2019	2015	2019	2015	2019	2015	2019
Buffer capacity	0.375	0.347	0.343	0.346	0.333	0.273	0.419	0.356	0.435	0.366
B1	0.385	0.356	0.373	0.379	0.401	0.392	0.425	0.393	0.391	0.341
B2	0.636	0.642	0.664	0.634	0.593	0.538	0.643	0.670	0.663	0.660
B3	0.546	0.411	0.555	0.402	0.529	0.297	0.568	0.392	0.543	0.399
B4	0.400	0.458	0.338	0.479	0.397	0.247	0.427	0.467	0.449	0.448
B5	0.404	0.070	0.360	0.048	0.363	0.070	0.398	0.055	0.446	0.096
B6	0.470	0.721	0.291	0.747	0.339	0.531	0.733	0.818	0.730	0.760
B7	0.244	0.142	0.224	0.123	0.194	0.103	0.231	0.132	0.243	0.143
B8	0.114	0.176	0.103	0.177	0.093	0.172	0.103	0.139	0.134	0.208
B9	0.179	0.149	0.177	0.127	0.088	0.107	0.240	0.137	0.320	0.237
Self-organization	0.888	0.897	0.874	0.898	0.870	0.895	0.911	0.898	0.907	0.872
S1	0.942	0.984	0.959	1.000	0.969	0.992	0.993	1.000	1.000	0.990
S2	0.957	0.979	0.966	1.000	0.973	0.995	0.987	0.993	1.000	0.990
S3	0.944	0.943	0.963	0.962	0.973	0.996	0.970	0.956	0.933	0.910
S4	0.882	0.856	0.796	0.832	0.730	0.711	0.898	0.801	0.820	0.707
S5	0.821	0.832	0.792	0.832	0.809	0.858	0.830	0.836	0.874	0.844
S6	0.779	0.786	0.765	0.764	0.768	0.816	0.785	0.801	0.812	0.793
Learning capacity	0.336	0.402	0.340	0.401	0.360	0.453	0.336	0.418	0.345	0.390
L1	0.114	0.118	0.139	0.144	0.158	0.153	0.128	0.123	0.134	0.106
L2	0.521	0.424	0.463	0.418	0.461	0.492	0.488	0.412	0.477	0.425
L3	0.209	0.312	0.257	0.274	0.321	0.372	0.227	0.350	0.270	0.339
L4	0.500	0.755	0.500	0.767	0.500	0.793	0.500	0.788	0.500	0.688
Livelihood resilience	0.533	0.549	0.519	0.548	0.521	0.540	0.555	0.557	0.562	0.543

The reason is that Longjiang and Daxing'anling FIGs logging was stopped in 2014, exploring ways and experiences for the reform of state-owned forest areas in advance of other FIGs. FIGs actively support worker households to engage in the under-forest economy, forest tourism, labor export, forest carbon sink, etc. [26]. The central government has also increased its subsidies to pilot forest areas through channels such as increasing funding for natural forest protection projects. It shows that the series of policies piloted by Longjiang and Daxing'anling FIGs in response to the reform of state-owned forest areas have positive effects and practical significance. The Changbai Mountain FIGs are the "youngest" compared with the other four FIGs. It should be noted that before the state-owned forest area reform in 2015, its livelihood resilience was the best. However, in 2019, the livelihood resilience dropped to the second-to-last place, which shows that its ability to cope with the transformation of state-owned forest areas is insufficient.

3.1.1. Buffer Capacity

The buffer capacity of various FIGs is generally low, and various FIGs have large differences. Changbai Mountain FIGs (0.366) scored the highest, followed by Jilin FIGs (0.356), Longjiang FIGs (0.347), Daxing'anling FIGs (0.346), and Inner Mongolia FIGs (0.273). In terms of the magnitude of change, the buffer capacity of Daxing'anling FIGs increased slightly, from 0.343 in 2015 to 0.346 in 2019. Longjiang, Inner Mongolia, Jilin, and Changbai Mountains FIGs all showed a downward trend to varying degrees. Among them, Inner Mongolia and Changbai Mountain FIGs' buffer capacity declined the most, down 18.02% and 15.86% respectively.

The possible reason is that with the advancement of the reform of state-owned forest areas in 2015, a series of housing renovation projects have been carried out, including the transformation of shanty towns in state-owned forest areas, and the relocation of employees in the forest areas of deep mountains and remote mountains. In the past, due to work

needs, some families had housing both on forest farms and in the community in the town. As the relocation work progressed, the number of worker households in multiple houses decreased. At the same time, in the 2015 survey, there were still some worker households without housing, but in the 2019 survey, it was found that the number of worker households without housing was zero, indicating that a series of policies to help the settlement of worker households have played a positive role. In addition, although the government and FIGs have raised the financial capital of worker households through a series of forestry subsidy policies, the ability to convert the financial capital of worker households is not high and still stays at the stage of subsistence. Therefore, "hematopoietic assistance" is more conducive to the development in the state-owned forest areas of northeast and Inner Mongolia.

3.1.2. Self-Organization

The self-organization of each FIG was generally high, and there was little difference among the FIGs. The best were Daxing'anling FIGs (0.898) and Jilin FIGs (0.898), followed by Longjiang FIGs (0.897) and Inner Mongolia FIGs (0.895), and the worst was Changbai Mountain FIGs (0.872). From the perspective of the magnitude of change, the self-organization of worker households in Longjiang, Daxing'anling, Inner Mongolia FIGs showed an upward trend, which increased by 1.01%, 2.75%, and 2.87% respectively from 2015. The self-organization of Jilin and Changbai Mountain FIGs showed a downward trend, with a decrease of 1.43% and 3.75% compared with 2015.

It showed that the social security situation of worker households in the state-owned forest areas of Northeast and Inner Mongolia in China is relatively good. The reason is that the research subjects are mainly the workers of the FIGs, and the medical and endowment insurance is paid in time. At the same time, roads in state-owned forest areas are included in the relevant road network planning according to their attributes, and the transportation is more convenient.

3.1.3. Learning Capacity

The learning capacity of each FIG was in the lower medium. Among them, Inner Mongolia FIGs (0.453) were better, followed by Jilin FIGs (0.418), Longjiang FIGs (0.402), Daxing'anling FIGs (0.401), and Changbai Mountain FIGs (0.390). In terms of the extent of change, all FIGs showed an upward trend. Among them, Inner Mongolia FIGs increased by 25.83% compared with 2015, followed by Jilin FIGs, which increased by 24.40%, and Longjiang and Daxing'anling FIGs, respectively, which increased by 19.64% and 17.94%. Changbai Mountain FIGs increased by 12.75%.

The forestry "14th Five-Year Plan" of China pointed out that it is necessary to create jobs through multiple channels and to ensure the improvement of people's livelihood through the development of characteristic industries and the encouragement of independent entrepreneurship. Local residents living in forest areas also rely more on forestry for their livelihoods [27]. In the face of policy changes, people should learn to expand their thinking and improve their work abilities to grasp development opportunities and meet challenges. People have long been used to relying on forest industry enterprises and lack autonomy. Before the reform of state-owned forest areas, the staff of FIGs mainly worked in logging, with low technical content. After the reform of state-owned forest areas, all posts have been transferred, mainly to manage, protect, and raise workers. The nature of work has changed greatly, and the required knowledge also needs to be updated. Therefore, professional and technical training should be strengthened to create a new-type of forest worker.

3.2. The Livelihood Resilience Gap of Worker Households

3.2.1. The "Lorentz Curve" of Worker Households' Livelihood Resilience

Based on the livelihood resilience of each worker household led in 2015 and 2019, we drew the "Lorentz curve" of the livelihood resilience of worker households in state-owned forest areas in Northeast and Inner Mongolia, as shown in Figure 3. The livelihood

resilience' gap among FIGs showed an expanding trend. It showed that with the promotion of the reform of state-owned forest areas, the livelihood resilience of worker households of FIGs is expanding. Specifically, Longjiang FIGs and Daxing'anling FIGs were the closest, while Inner Mongolia, Jilin, and Changbai Mountain FIGs were far apart.

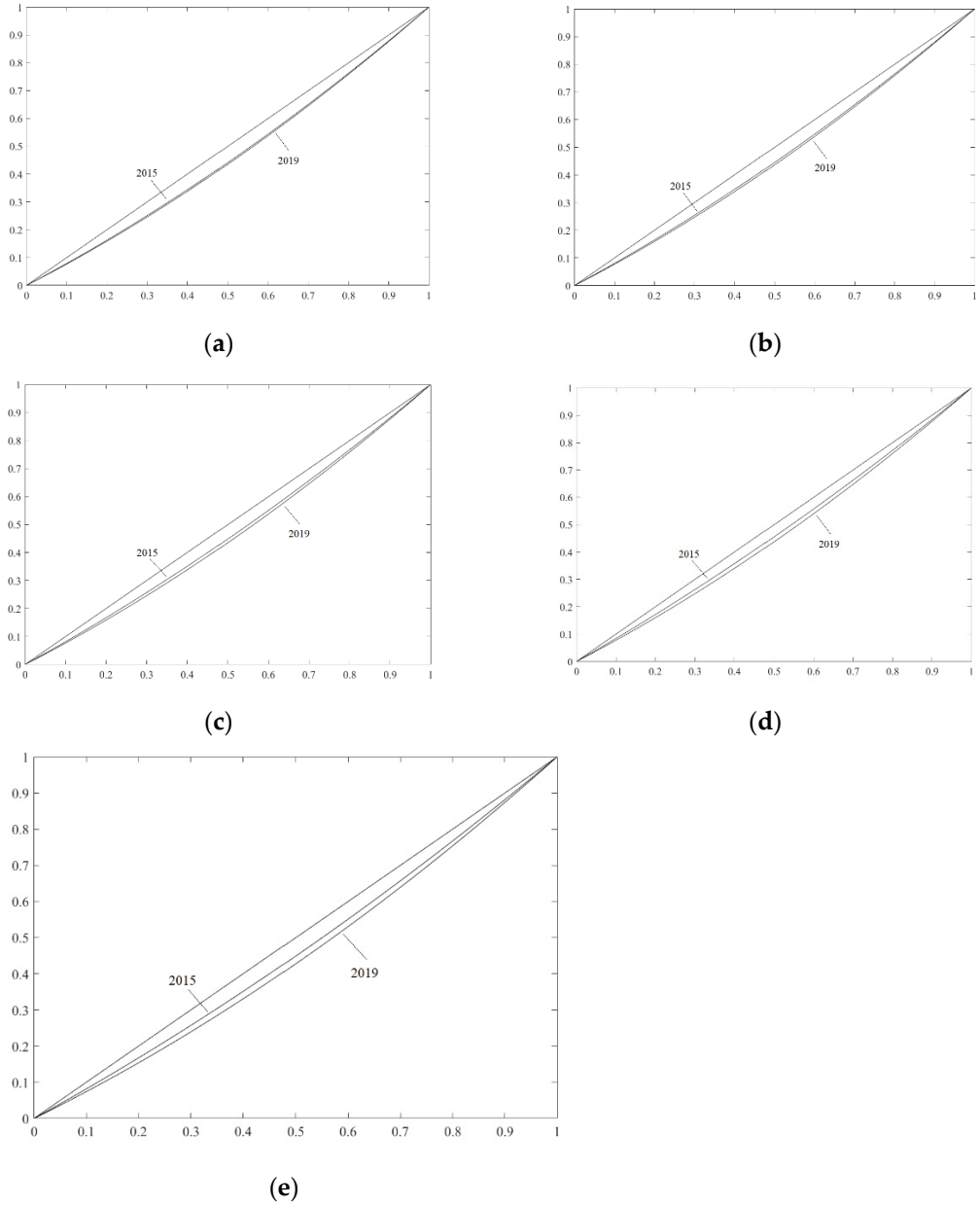

Figure 3. The "Lorentz Curve" of worker households' livelihood resilience. (**a**) Longjiang FIGs; (**b**) Daxing'anling FIGs; (**c**) Inner Mongolia FIGs; (**d**) Jilin FIGs; (**e**) Changbai Mountains FIGs.

3.2.2. The Livelihood Resilience Gap Coefficient of Worker Households

However, the "Lorentz curve" of worker households' livelihood resilience can only roughly judge the changes of livelihood resilience of each FIG, and it is impossible to quantify the changes of livelihood resilience differences. It is difficult to compare the livelihood resilience' gap among FIGs. Therefore, according to the previously defined livelihood resilience gap coefficient, we calculated the livelihood resilience gap coefficient of five FIGs. The results are shown in Table 3. The biggest difference was in the Changbai Mountain FIGs (0.098), followed by Inner Mongolia FIGs (0.088), Longjiang FIGs (0.087), and Daxing'anling FIGs (0.086); the smallest was in the Jilin FIGs (0.084). From the perspective of changing

trends, the range of changes in livelihood resilience of each FIG was different, and they all showed an expanding trend. Among them, Changbai Mountain FIGs and Jilin FIGs had the largest change, divided into an increase of 42.03% and 40.00%, followed by Daxing'anling FIGs, which expanded by 16.22%. The smallest changes were Longjiang FIGs and Inner Mongolia FIGs, with a distribution of 15.79% and 10.00%.

Table 3. Worker households' livelihood resilience gap coefficient.

FIGs	2015	2019	Change
Longjiang	0.079	0.087	10.13%
Daxing'anling	0.074	0.086	16.22%
Inner Mongolia	0.079	0.088	11.39%
Jilin	0.060	0.084	40.00%
Changbai Mountains	0.069	0.098	42.03%

It showed that although the livelihood resilience gap within the households of each FIG was relatively small, with the advancement of the reform of the state-owned forest areas, the livelihood resilience gap tended to expand. The reason is that some worker households with good buffer capacity, self-organization, and learning capacity can adapt to the new environment quickly according to their endowments, combined with social networks and learning ability when they are subjected to external disturbances. However, some worker households have low buffer capacity, weak social competence, and poor adaptation. When they are subjected to external disturbances, they may suffer a greater impact on their livelihood resilience, be slow to adapt to the new environment, and not improve or even reduce their livelihood resilience. As a typical resource-based enterprise, the state-owned forest industry enterprise cannot escape the "resource curse". With the economic transformation of the state-owned forest area, it will inevitably have higher requirements on the overall quality of the worker households. For workers who cannot actively change roles in time, there will be a risk of elimination. The long-standing government-enterprise integration system has made worker households accustomed to a stable life, but now the changes in the top-level design will directly affect their career planning, income expectations, children's education, and so on.

3.3. Influencing Factors of Livelihood Resilience

3.3.1. Dimension Level

To reveal the impact of dimensions on worker households' livelihood resilience, we used Pearson's correlation coefficient to analyze the correlation between buffer capacity, self-organization, learning capacity, and worker households' livelihood resilience. The results are shown in Table 4. Buffer capacity, self-organization, and learning capacity all reached a significant positive correlation, and there were differences in the degree of impact on worker households' livelihood resilience in different FIGs. Buffer capacity plays a leading role and the coefficient influences the resilience of livelihoods of each FIG. However, self-organization and learning capacity showed great differences in different FIGs. Buffer capacity plays a leading role, and the coefficient of influence on the resilience of livelihoods of each FIG was above 0.800. However, self-organization and learning capacity showed great differences in different FIGs. Specifically, self-organization had the greatest impact on the livelihood resilience of Longjiang FIGs (0.548) and Changbai Mountain FIGs (0.642). Learning capacity had the greatest impact on the livelihood resilience of Daxing'anling FIGs (0.663), Inner Mongolia FIGs (0.629), and Jilin FIGs (0.601).

It can be seen that buffer capacity had the most significant impact on the livelihood resilience of worker households, and was the leading force to improve livelihood resilience. Longjiang and Changbai Mountain FIGs paid more attention to the cultivation of self-organization. Daxing'anling, Inner Mongolia, and Jilin FIGs paid more attention to the cultivation of learning capacity. At the same time, this reflects the lack of livelihood resilience caused by policy changes, although the "blood transfusion" financial subsidies

and subsidies to worker households can help them recover in a short time. However, this is not a long-term mechanism. Therefore, we should improve the skill training of workers and help them to create new jobs.

Table 4. Correlation coefficients between the livelihood resilience of worker households and dimensions.

FIGs	Buffer Capacity	Self-Organization	Learning Capacity
Longjiang	0.818 ***	0.548 ***	0.541 ***
Daxing'anling	0.821 ***	0.480 ***	0.663 ***
Inner Mongolia	0.816 ***	0.445 ***	0.629 ***
Jilin	0.863 ***	0.423 ***	0.601 ***
Changbai Mountains	0.815 ***	0.642 ***	0.623 ***

Note: *** indicate that they are valid at the significance level of 0.01.

3.3.2. Indicator Level

To reveal the impact of indicators on worker households' livelihood resilience, we used grey correlation to analyze the correlation between indicators and worker households' livelihood resilience. The results are shown in Table 5.

Table 5. Correlation coefficients between the livelihood resilience of worker households and indicators.

Order	Longjiang		Daxing'anling		Inner Mongolia		Jilin		Changbai Mountains	
	Index	Correlation	Index	Correlation	Index	Correlation	Index	Correlation	Index	Correlation
1	B3	0.742	B2	0.744	B2	0.727	B3	0.718	B3	0.718
2	B2	0.709	B3	0.730	B1	0.710	B1	0.710	B2	0.701
3	B1	0.703	B1	0.715	B3	0.645	B2	0.706	B1	0.657
4	B7	0.527	B7	0.537	B7	0.53	B7	0.488	B7	0.538
5	B6	0.504	B8	0.501	B6	0.479	B6	0.484	B8	0.499
6	B8	0.502	B6	0.499	B8	0.478	B8	0.474	B6	0.49
7	B4	0.482	B5	0.474	B3	0.478	B9	0.46	B4	0.483
8	B5	0.466	B9	0.471	B5	0.446	B5	0.459	B5	0.451
9	B9	0.463	B4	0.464	B9	0.44	B4	0.452	B9	0.449
1	S6	0.622	S6	0.649	S4	0.566	S6	0.604	S6	0.608
2	S5	0.585	S5	0.593	S6	0.559	S5	0.579	S5	0.560
3	S4	0.523	S4	0.571	S5	0.527	S4	0.537	S4	0.519
4	S3	0.479	S3	0.479	S3	0.429	S3	0.476	S3	0.479
5	S2	0.457	S2	0.463	S1	0.428	S1	0.452	S1	0.441
6	S1	0.457	S1	0.463	S2	0.427	S2	0.452	S2	0.441
1	L2	0.690	L2	0.730	L2	0.727	L2	0.702	L2	0.702
2	L1	0.503	L1	0.528	L1	0.528	L1	0.496	L1	0.479
3	L4	0.464	L4	0.474	L4	0.443	L4	0.461	L4	0.454
4	L3	0.450	L3	0.459	L3	0.440	L3	0.444	L3	0.441

From the perspective of buffer capacity, the main factors affecting the livelihood resilience of worker households were B3 (education of household head), B1 (household size), and B2 (household head health). Although the specific degree of impact was different in each FIG, there was a certain convergence. The higher the level of education, the better the ability to look at problems from a developmental perspective, and it has a long-term perspective. When subjected to external disturbances, it can effectively adjust household resource endowments to resist the impact on livelihoods. The size of the household can indicate the size of the labor force, indicating that the livelihoods of workers and families in the state-owned forest areas in Northeast and Inner Mongolia are still labor-intensive. It is worth noting that Daxing'anling FIGs and Inner Mongolia FIGs had a high degree of correlation with health. This is because Daxing'anling and Inner Mongolia FIGs have a higher latitude and short frost-free period, and the production and living environment is worse than that of other FIGs. Therefore, health conditions play a significant role in the buffering capacity in Daxing'anling and Inner Mongolia FIGs.

From the perspective of self-organization, the main factors influencing the self-organization of worker households were S6 (neighborhood relationship), S5 (household relationship), and

S4 (home–medical institutions distance). This showed that neighborhoods and households still play an important role in forestry production and life in this area, especially after the economic transformation of state-owned forest areas. Non-timber forest products (NTFPs), forest planting and breeding, and forest tourism require social networks to keep abreast of new market information. Good relationships can increase trust, promote the sharing of information and knowledge between worker households, and help worker households improve their livelihood resilience. The aging of the state-owned forest areas in Northeast and Inner Mongolia has increased, and the existing FIGs hospitals have been reorganized and disbanded, making it more difficult to seek medical care. Therefore, guaranteeing medical conditions in the state-owned forest areas of Northeast China and Inner Mongolia is of practical significance.

From the perspective of learning capacity, the main factors affecting the learning capacity of worker households included L2 (work experience), L1 (education expenditure), and L4 (knowledge of policy). Work experience had the highest correlation. Compared with other industries, the production and management of forestry is a typical resource-based industry. Compared with mineral resources, it is renewable. Compared with agriculture, the production cycle is longer. What is more important is that forestry's production and operation behaviors have externalities. The particularity is a double-edged sword. How to grasp this particularity requires higher work experience for employees. By learning new knowledge and understanding policies, it is helpful to make up for the lack of work experience. Educational expenditure and policy understanding also reflect the subjective initiative of worker households to improve their livelihoods. The more familiar with the policies, the easier it is for worker households to seize policy opportunities, which has a positive role in promoting worker households' livelihoods resilience.

4. Discussion

All reforms are aimed at letting the subjects of their living jurisdictions have a better life, as the most microscopic subjects of the state-owned forest areas are worker households bearing the "the Pain of Reform" [28]. Different scholars gave answers from different perspectives; the income of employees in the forest area is relatively slow [8] and the structure is single and the main income is still the wage income [6]. The employment area continues to expand, which reduces the degree of dependence on forestry [29], but it is still difficult to find employment in general. Different scholars answered from different angles: the per capita annual income of workers in state-owned forest areas in Northeast and Inner Mongolia has increased greatly compared with that before the reform, but their satisfaction with forestry subsidy policies is not high [30], and cannot significantly improve the family incomes [31]. Most worker households' life satisfaction is, in general, satisfactory, but it is still lower than the urban residents of China [32]. Employment satisfaction and medical satisfaction have not reached the "relatively satisfactory" level [33]. It can be seen that the livelihood of worker households in the state-owned forest areas of northeast and Inner Mongolia is still the focus of attention, but the above studies start from the perspective of results, and there is little analysis of the internal recovery and adaptability of worker households in the face of the external disturbance of the reform of state-owned forest areas from the perspective of the endogenous strength of worker households.

Livelihood resilience has significant advantages for analyzing the adaptability to external changes, and it also provides new ideas for improving group livelihoods and eliminating poverty [34], which has attracted widespread attention from scholars. Based on the survey data in 2015 and 2019, this paper measured the livelihood resilience of worker households in the state-owned forest areas in Northeast and Inner Mongolia in China from the perspective of the level of the livelihood resilience and livelihood resilience gap. We further used the grey correlation model to analyze the main factors affecting the livelihood resilience of worker households. Re-examining from the perspective of livelihood resilience, we found the endogenous driving force for the sustainable development of the livelihood

of worker households in the face of external disturbances such as the reform of state-owned forest areas.

There are also some limitations in this paper. Firstly, this paper only analyzed the results and influencing factors of livelihood resilience of worker households and did not study how employee families consolidate and enhance livelihood resilience through livelihood strategies, production methods, and means. This needs to be supplemented and improved in the follow-up research. Secondly, in the future, we should carry out the subjective perception evaluation of the livelihood resilience of worker households, combined with the objective evaluation of the livelihood resilience in this paper, to provide a more comprehensive and comprehensive useful reference for the follow-up work of the reform of state-owned forest areas.

5. Conclusions

With the advancement of the reform of state-owned forest areas, various reform tasks have been completed. How to consolidate the achievements of the reform of state-owned forest areas has become the next important task. This study used the 2015 state-owned forest area reform as the time node and selected survey data from 2015 and 2019 to compare the impact of state-owned forestry reform on the livelihood resilience of worker households. The following conclusions were drawn: (1) The reform of state-owned forest areas has improved the livelihood resilience of worker households in Longjiang, Daxing'anling, Inner Mongolia, and Jilin FIGs, but reduced the livelihood resilience of worker households in Changbai Mountain FIGs. (2) With the advancement of the reform of state-owned forest areas, the gap of livelihood resilience of worker households of FIGs showed an expanding trend. (3) At the dimensional level, buffer capacity had the most significant impact on livelihood resilience, and it was the leading force in improving worker households' livelihood resilience. Longjiang and Changbai Mountain FIGs should mainly strengthen self-organization, and Daxing'anling, Inner Mongolia, and Jilin FIGs should strengthen their learning capacity. (4) At the indicator level, the influencing factors that affect the livelihood resilience of worker households of various FIGs were similar. Among them, the education of household head, household head health, household size, work experience, and the neighborhood relationship were the key factors that affected the resilience of worker households.

Based on the above analysis, two paths are proposed that can improve worker household' livelihood resilience: (1) Take advantage of the region to develop special forestry such as characteristic ecotourism, carbon sink, non-timber forest products, and etc. (2) Promote balanced development among regions and realize regional cooperation. Share experience and finally achieve common development in dynamic balance.

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