

Article

Linkage Analysis of the Resources, Population, and Economy in China's Key State-Owned Forest Areas

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Abstract: With the evolution of forestry policy, society, and the economy, the relationship between the resources, population, and the economy in key state-owned forest areas has continuously changed, and this has had an important impact on China's forestry development and protection of resources. Based on the China Forestry Statistical Yearbook and forest resource inventory data, this paper conducts a macroanalysis of the linkages between forest resources, the number of employees, and economic development in key state-owned forest areas from 1975 to 2017. The research results show that in these areas, forestry policies and the external macroenvironment has a strong impact on the relationship between resources, population, and the economy; there is a decoupling relationship between resources and the economy; the population has a restrictive relationship with the economy; and a sustainable development relationship has not yet formed between resources, population, and the economy. Based on these findings, policy suggestions are put forward, including scientific felling and moderate management, introducing and training of high-quality talents, strengthening of industrial reform, and introduction of a market-oriented mechanism.

Keywords: state-owned forest areas; linkage analysis; resource protection policy

1. Introduction

Key state-owned forest areas represent an important means of macro-controlling forestry in China and play an important role in reducing greenhouse gas emission. These areas are mainly distributed in Jilin, Heilongjiang, and the Inner Mongolia Province. In 2019, China's state-owned forests covered an area of 327,000 km², and more than 300,000 individuals were employed in their management and maintenance. As a small closed community under government control and influenced by the macroenvironment and forestry policies, these forest areas exhibit complex characteristics related to their population, resources, and economy. Due to unregulated logging activities during the "wood economy" in the 1970s, a resource scarcity crisis began in these forest areas, which led to an employee welfare crisis. In addition, economic and environmental protection development has prompted shifts in forestry policies to favor resource protection. Since 1998, China has been implementing the Natural Forest Protection Project to gradually increase the protection of forest resources and forest carbon sequestration. As part of this project, in 2015 the State Forestry Administration explored plans to stop commercial logging of natural forests (hereinafter referred to as the "stop logging policy") and implemented pilot projects in key state-owned forest areas in Northeast and Inner Mongolia to ensure sustainable forest development in China. The resource protection policy represented by the stop logging policy has made significant progress in protecting forest resources.

In 2019, the total managed area of China's key state-owned forest areas reached 320,000 km², the forest stock volume reached 2566 million m³, and the forest stock volume per hectare exceeded 100 m³ [1]. However, the decline in timber felling caused by the stop logging policy has directly affected

employees' livelihoods and economic development and has brought about a more complex three-crisis situation: the crisis of harvestable forest resources; the economic crisis of forestry enterprises; and the crisis of employees' welfare [2]. The "China Forestry Statistics Report 2015" shows that nearly 70% of key state-owned forest areas had no harvestable wood in that year [3], and that more than 60,000 redundant employees needed to be resettled. In 2017, the average salary of employees in forest enterprises operating in these areas was 5250 USD (The output value and salary data of the full text have been converted into the current US dollar value in 2017 according to the agricultural, forestry, animal husbandry and fishery industry price index and the 2017 US dollar exchange rate. The price index of agriculture, forestry, animal husbandry and fishery industry is derived from the China Statistical Yearbook, and the exchange rate is 1 USD = 6.8 CNY), which was 48% of the average salary of employees in nonprivate enterprises (10,929 USD). The state-owned forest areas' resources and economic and social systems cannot be balanced to the satisfaction of all parties, which results in chaos. Therefore, resolving the relationship among forest resources, population, and the economy in key state-owned forest areas has become an important prerequisite for solving the "three crises" problem and exploring the means of ensuring the efficient development.

Focusing on this issue, and based on the macro historical analysis method, this article uses long-term macro-level data, including data for China's key state-owned forest areas from 1975 to 2017, the second to eighth forest inventory data, and government documents, to analyze the evolution of the relationship between resources, population, and the economy in China's key state-owned forest areas. The characteristics of the main stages and important influencing factors of the development process are then discussed in order to analyze the sustainable development of resources, population, and the economy and increase forest carbon sequestration under the current Chinese forestry policy and macroenvironment.

2. Literature Review

The relationship among resources, population, and the economy has received sustained and extensive attention from the academic community, and a large number of scholars have conducted in-depth research on the topic. However, these studies generally focus on the relationship between two of the factors, and there is limited work that analyzes the linkage between all three factors. Based on the neoclassical economic model, Wang and Liang (2012) examined the impact of resource endowment and population size on economic development and found that, in China, the differences in resources and population between different regions can be eliminated through the transfer mechanism of transaction efficiency [4]. Another part of the literature uses quantitative methods such as variation coefficients to analyze the spatial and temporal changes in resources, population, and harmonious economic development in some areas [5,6]. Similarly, in research of state-owned forest areas, most of the literature focuses on the in-depth study of the relationship between two of the factors [7–9], and there is limited literature that performs a comprehensive analysis of the three factors over a long historical period.

In terms of the relationship between resources and population, advocacy of moderate population has become the consensus position of the academic community [10]. Population and resources are mutually dependent. Rapid population growth will lead to the consumption of large amounts of existing resources, resulting in resource exhaustion and unsustainable conditions. Similarly, the level of endowment of resources has become a constraint on population growth. Based on population pressure, people tend to convert land to different types of use and reduce areas of forest [11,12]. However, based on technological progress, the negative relationship between forests and population can be gradually decoupled [13]. In the study of state-owned forest areas, due to its special nature, a large number of scholars focused on the field of employees and studied their numbers and their wages and benefits under resource-protection policies. They generally found that the implementation of natural forest protection policies has exacerbated the conflict between resource protection and population size, which makes population movements more frequent and employment issues more prominent [14]. Some scholars have studied the impact of population on the protection of resources. They believe that

the quality of education and skills of the population will also affect the sustainable development of resources, and that highly educated and high-tech talents will contribute to the growth of resources in state-owned forest areas [15].

In terms of the relationship between resources and the economy, there are several basic theories. The environmental Kuznets curve theory asserts that there is an “inverted U-shape” relationship between environmental resources and economic benefits. In the early stage, a large amount of resources is consumed to develop an extensive economy. The consumption of resources and environmental sustainability were in conflict. With the scale effect, structural effect, and technological development in the later stage of development, the two factors complemented each other [16]. The resource curse theory proposes another paradox in the relationship between resources and the economy. Auty (1993) first proposed a phenomenon that the level of economic growth in some resource-rich regions was slower than in other regions [17]. A large number of scholars have sought to explain this phenomenon, arguing that the advantages brought by resource endowment give people a false sense of security, leading them to ignore the promotion of effective mechanisms for economic growth such as technology, management level, and innovation [18]. However, different views have emerged on the issue of the “resource curse” in Chinese forests. Li et al. (2000) used the southern collective forest area as the research object and argued that the endowment of forest resources is positively associated with poverty levels [7]. Some scholars have conducted empirical analyses for specific provinces in China and found that forest resources could not promote local economic development and that there was a phenomenon of “rich resources endowment resulting in poverty” [19]. However, Liu et al. (2015) conducted a quantitative analysis based on national data from 1985 to 2012 and concluded that there is a positive correlation between China’s forest resources and economic development and that the resource curse theory does not hold true for China’s forestry development [8]. In addition, the Organization for Economic Cooperation and Development (OECD) proposed a decoupling theory, which aims to interrupt the relationship between economic growth and high environmental consumption. Some scholars believe there is a phenomenon of pseudo decoupling in China, based on the quantitative analysis of the Tapio elastic analysis method [9]; that is, after the implementation of ecological protection policies such as the Natural Forest Protection Project, the growth of forest resources has led to a continuous decline in economic benefits.

In terms of the relationship between population and the economy, the theory of population scale economy asserts that the increase in consumption power brought about by population aggregation will stimulate economic development. This effect, known as the “demographic dividend,” is considered to be a powerful driving force in economic development, and its contribution rate to GDP exceeds 25% [20]. A larger proportion of the population working and a lower dependency ratio imply that a society should have cheap and sufficient labor and a high investment rate [21]. However, in later studies, some scholars have suggested that the coupling relationship between population migration and the economy is not obvious, and that a more significant driver of economic development is the inflow of high-quality human resources [22]. In the special case of state-owned forest areas, population migration brought about by the movement of employees reflects the development trend of forest-area enterprises and the economy. Poor profitability of forest enterprises has caused a large number of temporary employees to lose their jobs, resulting in serious population loss as people move away from such areas. As with the Chinese society more generally, state-owned forest areas are facing turning points in their economic and demographic transitions. The gradual disappearance of the demographic dividend has led to a situation of “aging preceding richness” (getting old before being rich), and the increase in the dependency ratio in such area populations has created excessive economic burden [23]. Maintaining or increasing population size does not necessarily ensure good economic development. Some scholars believe that the limited professional skills of workers and the excessive burden of retired workers indicate that population size and economic benefits are negatively related [24]. The gradual depression of the economy prompted a large number of individuals, who represented surplus labor, to transfer to emerging sectors [23]. The lack of talented workers, the loss of effective labor, the continuous decline

in the efficiency of economic output, and the further increase in the dependency ratio have created problems in the economy of state-owned forest areas.

On this basis, forest resources, as environmental public goods with strong positive externalities, have special characteristics in their resource utilization methods, economic development models, and population accumulation trends. Although the basic economic theory that the market can efficiently allocate resources is generally accepted, it is controversial in sustainable forestry management (SFM). Some scholars believe that the commercialization of goods and services from natural forests is not efficient [25]. For example, forest certification, as a representative voluntary market-based tool, is considered not to promote SFM efficiently [26]. McElwee (2012) found that payments for environmental services (PES) is likely to be unable to reduce deforestation because of uneven land tenure and a lack of participation by local communities in conservation [27]. However, some scholars believe that under certain conditions, market-based tools can achieve SFM. In countries lacking governance capacity, forest certification can reduce unsustainable logging of forests [28]. Alix-Garcia et al. (2012) adopted an empirical analysis method to investigate Mexico's National Payments for Ecosystem Services Program and concluded that it could significantly reduce deforestation rates [29]. On the other hand, the efficiency of government-led model, which is a substitute for market-based tools, has also been studied. Some scholars believe that the management model based on government regulation is an effective means to solve the externality of forest resources and market failure, and this model has been practiced in many developing countries [30]. However, some scholars believe that a model where government plays a dominant role falls short of the capacity to achieve SFM, because of the complexity of the macroenvironment [31].

In summary, there is currently a lack of analysis in the literature of the linkage among resources, population, and the economy. A large number of studies focus on the relationships between two of these factors or on the analysis of the degree of coupling and spatial distribution. As an environmental public good, forest resources are special in achieving sustainable development. China's key state-owned forest areas are in a contradiction between the impact of the forestry market and government-led management, but there are few literatures discussing SFM in these areas. Further analysis is needed at the macro-level of the impact mechanism between these three factors and the large amount of historical data that exists in respect of them. In order to address this gap in the research, this paper proposes a mechanism of impact among resource changes, population migration, and economic change, and uses statistical data for the period from 1975 to 2017 to analyze the historical changes and the linkage relationship among the three factors. Based on our findings, policy recommendations are proposed.

3. Theoretical Framework

Based on the above literature review, we see that, in nonforestry areas, economic development is a primary goal of local areas and brings economic improvement and population aggregation through the consumption of multiple resources. In the later period of their economic development, nonforestry areas reduce resource consumption and improve resource utilization efficiency by means of industrial transformation and technological progress, which results in the sustainable development of resources, population, and the economy. In nonforestry areas, the general basic relationship among resources, population, and the economy is as follows: (1) in terms of resources and population, resources, used in production, provide basic living materials for the population, enabling the population to grow quickly. Areas with high endowment of resources are often areas where population is concentrated. On the other hand, a large influx of people will increase the consumption of resources and may even cause resource depletion: (2) in terms of the relationship between population and the economy, the dividend brought by population growth is an important driving force for economic development, which has a natural appeal to the population. The rapid development of a region's economy and related industries creates a large demand for labor, which leads to a large population inflow and forms a trend of aggregation. In addition, technological progress and innovation brought about by economic development improve production efficiency, thus enabling an area to carry and attract more people

under the same resource conditions. The “aggregation effect” brought about by population inflows can further enhance the momentum of economic development: (3) in terms of the relationship between resources and the economy, natural resources are the foundation of economic development. In the early stages of economic development, a lot of resources will be consumed. However, in the later stages of economic development, more efficient use of resources will be promoted by resource waste reduction and production efficiency improvements caused by technological improvements, the development of less-consumable industries, and the increasing awareness of the importance of ecological protection.

Unlike nonforestry areas, key state-owned forest areas are highly dependent on a single resource, i.e., trees; further, most of the enterprises in these areas are engaged in forestry harvesting and processing. There is therefore a single model of economic development in such areas, and their main population is employees of forestry enterprises. These qualities have meant that forestry policies exert a strong influence on the relationship among resources, population, and the economy via the constraints imposed on the use of forestry resources. In addition, compared with collective forest areas (owned by collectives), key state-owned forest areas undertake part of the government’s functions. Therefore, their organization structure and personnel system cannot be changed without permission; furthermore, mainly directed by national policies, their primary development goal is not economic growth but the provision of a stable supply of forest products for the whole country and macro-level control of forest resources. At the same time, these areas require a large number of employees to undertake both production and administrative functions, which require economic growth and the sound development of forestry enterprises in order to maintain population welfare. As a result, the dual goals of management of resources and the economy have emerged in the development.

When there is a conflict between resources and economic goals, the resources, population, and economy cannot develop sustainably. Therefore, due to the characteristics of ecological protection and administrative coercive force, when impacted by the external macroenvironment and forestry resource protection policies promoting “natural forest protection” and “stopping logging in commercial forests,” the relationship among resources, population, and the economy in key state-owned forest areas will show different characteristics from those in nonforestry areas. In particular: (1) the forestry resource protection policy weakens the relationship among resources, the economy, and the population by means of government coercive force; (2) when the macroenvironment changes, such as the opening of the forest product market or changes in timber prices, conflicts will arise between resources and economic goals. The system adopted to undertake government functions cannot adapt quickly to changes in the external environment, leading to the breakage or even distortion of the relationship between the economy and population.

In summary, due to the high resource dependence and institutional rigidity brought about by the state-owned system and the single forestry industry that exists in forest regions, compared with other regions, the relationship among resources, population, and the economy is shaped by a more complicated influence mechanism that is affected by changes over time in the macroenvironment and forestry policies. This article first summarizes the impact mechanism map for resources, population, and the economy in key state-owned forest areas (see Figure 1). Second, a long-term dataset is used to conduct a historical macroanalysis of the population, resources, and the economy from 1975 to 2017 in order to explore the evolution of the relationship between the three factors and the impact of the external macroenvironment and forestry policies. Finally, based on current conditions, the relationship among the resources, population, and the economy of China’s key state-owned forest areas is described, providing a reference for such areas’ sustainable development.

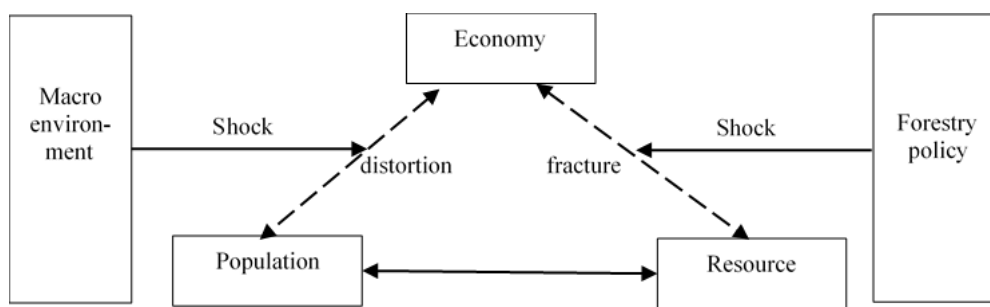


Figure 1. Impact mechanism of resources, population, and the economy in key state-owned forest areas.

4. Linkage Analysis of Resources, Population, and the Economy

This article is based on data from 1975 to 2017 for key state-owned forest areas taken from the China Forestry Statistical Yearbook and the second to eighth forest inventory data. Other public data such as government documents, official reports, and research reports are also used for data supplementation and cross-validation. First, the forest area, the output value of the secondary forestry industry (the secondary forestry industry refers to the industry manufacturing products from wood) and the number of employees are selected as the main measures of resources, the economy, and population, to be used to make overall trend judgments. As shown in Figure 2, the resources, economy, and population underwent tremendous changes in 1988 and around 1997. From 1975 to 1988, the resources, population, and economic conditions all showed good growth trends. From 1989 to 1997, the forest area fell sharply, the number of employees remained stable, and the output value of the secondary industry experienced a large decline followed by a large rise, which suggests a chaotic relationship among the three factors. From 1998 to 2017, while the number of employees and the output value of the secondary industry declined rapidly, the forest area increased steadily. From this it can be seen that the resources, population, and economy exhibit different influence relationships at different stages. Based on the above general trend analysis and changes in the macroenvironment and forestry policies, this article divides the development process into three stages; further, in-depth analysis of the influence relationship among the three factors in each stage is combined with specific indicators such as forest stock volume, timber cutting volume, forestry industrial structure, employee wages, and total population.

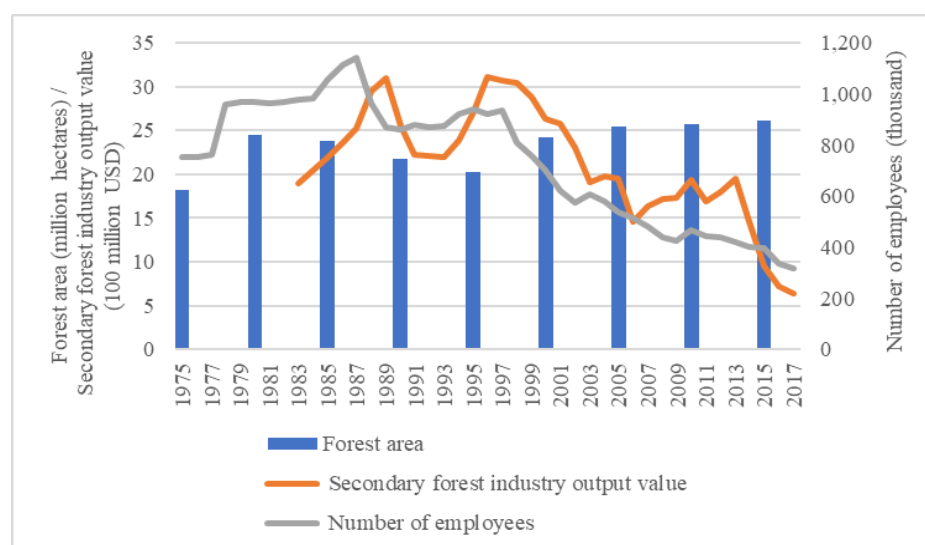


Figure 2. Levels of resources, population, and the economy in China's key state-owned forest areas from 1975 to 2017.

4.1. Wood Finance Stage (1975–1988)

This stage is considered to be the golden age of the forestry sector. With the implementation of the reform and opening up in 1978 (the reform and opening up is also known as China's economic reform, and its main result was to transform China from a planned economy to a market economy) and the end of the "unified purchase and sales" model of the forestry market in 1980 (the "unified purchase and sales" model refers to the system whereby the federal government implemented centralized acquisition, allocation, and distribution of timber across the country at a uniform price, which used the price of timber in the early days of the founding of the People's Republic of China as a reference; it is essentially the embodiment of the planned economy in the forestry market. The end of the "unified purchase and sales" model of the forestry market allowed forest farmers and collectives to purchase and sell their timber at negotiated prices determined by the market), the price of timber increased rapidly. Timber prices climbed to 12.84 USD/m³ in 1981 [32]. Compared with a price of 0.84 USD/m³ in the early days of the founding of the People's Republic of China, the average annual growth rate was more than 40%, far exceeding general price increases over the same period. The huge levels of demand and profits created by the market meant that state-owned forest areas had abundant funds and offered good employee benefits. In 1983, the value of industrial outputs reached 1.99 billion USD; in 1988, it reached 2.95 billion USD, representing an average annual increase of 11%. Economic development at this stage directly stimulated population growth and improvements in employee welfare. As shown in Figure 3, economic development stimulated the production enthusiasm of state-owned forest-area enterprises, which led to the recruitment of a large number of employees for timber collection and processing activities. In 1978, the number of employees in key state-owned forest areas increased rapidly from 761,100 in the previous year to 957,700, an increase of more than 25%. Since then, it has maintained a high level of approximately 1 million people. During this time, high standards of employee welfare also provided a good basis for population inflow from external regions. From 1975 to 1985, the average salary of employees was at least 15% higher than the national average level in the same period.

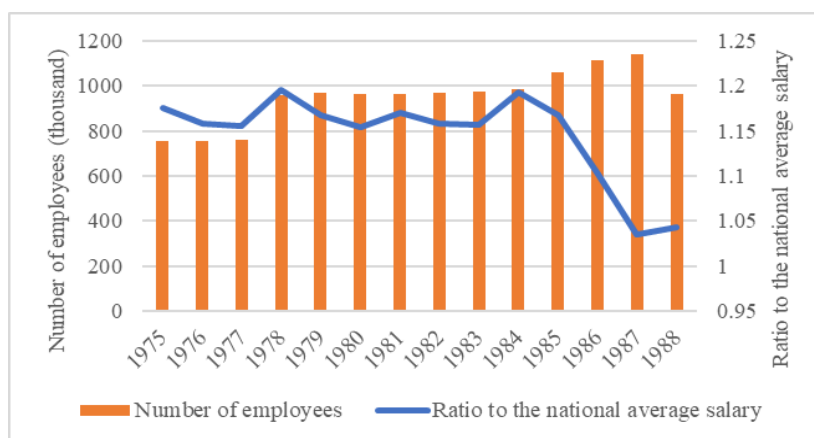


Figure 3. Number of employees and salary levels in key state-owned forest areas from 1975 to 1988.

The stimulation of the market and the ample labor force provided by the growth in employee numbers led to a sharp increase in deforestation in state-owned forest areas. Taking the Greater Khingan Mountains forest area of Inner Mongolia as an example, the timber output during the period of 1975–1980 was 17.9 million m³, and this grew rapidly to 24.5 million m³ during the period of 1986–1990. A high yield means extensive deforestation, and, as shown in Table 1, the felling area reached 250,000 hectares in 1983. Within this total, the clean felling area (areas for which all trees were removed in one operation) was 84,000 hectares, which exceeded the afforestation area in that year. In 1988, the felling area exceeded 400,000 hectares, and clean felling areas exceeded 100,000 hectares, which was equivalent to 59.3% of the afforestation area in that year.

Table 1. Resources and production of key state-owned forest area from 1975 to 1988. Volumes in million m³; areas in thousand hectares.

Year	1975	1980	1983	1985	1986	1987	1988
Forest stock volume	417.28	546.06	-	652.86	-	1014.20	-
Afforestation area	-	148.27	79.53	177.96	122.73	101.73	210.67
Felling area	-	-	250.67	-	-	-	406.80
Clean felling area	-	-	84.00	-	-	-	124.93

The statistics suggest that, at this stage, there was a substantial increase in forest stocks, along with economic development and population size, and a healthy relationship was formed among the economy, population, and resources. However, in fact, economic prosperity and population growth are achieved at the expense of forest resources, and the increase in forest stocks masks the reality of resource damage. Due to the characteristics of forest growth, the growth function curve shows a marginal decreasing trend. The increase in the stock volume of young forests generated by new afforestation enables the state-owned forest areas to maintain a statistical trend of high growth in forest stocks while felling a large number of mature and over-mature forests; however, the newly growing young forest does not meet the harvestable standard.

Harvestable resources on which key state-owned forest areas depend are continuously being consumed, but the severe cold climate in northeast China makes it impossible for new afforestation to replace logged forests in a short period of time. The superficial prosperity is therefore unsustainable. At this stage, the relationship among the economy, population, and resources complies with the most basic economic assumptions: economic development stimulates population inflows and requires the consumption of large quantities of resources to maintain a stable rate of high economic growth and high population welfare. In addition, while standards of high population welfare have promoted population inflows, they have also led to ineffective forms of population growth. The proportion of the population who are actual workers has decreased from 83% in 1975 to 59% in 1987. Forestry enterprises are typically characterized as having redundant management systems and an excessive quantity of administrative staff, which cannot bring expected economic growth. The dramatic reduction in employee welfare from 1987 to 1988 and the changes in the number of employees also signal the unsustainability of this resource-consuming development model. The drastic and unplanned levels of timber production and low-quality population growth brought about by market prices herald the change in steady-state and the bubble-burst in the next stage.

4.2. The Two Crisis Stage (1989–1997)

The contradictions that accumulated in the previous stage of excessive logging and the population's unqualified growth manifested in serious problems in this stage. The key state-owned forest areas first faced a resource crisis: uncontrolled felling during the “wood finance” period caused damage to harvestable resources. At the beginning of the two-crisis stage, these forest areas expected to maintain their original levels of timber output by expanding their felling areas. In 1989, the felling area was 514,100 hectares, representing a 26.4% increase in relation to 1988. In 1990, 656,500 hectares were logged, and the clean felling area was 203,400 hectares. With the further depletion of forest harvestable resources, this resource-destructive approach could no longer maintain the original high level of output, and the felling volume and timber output continuously decreased. In 1993, the felling area was reduced to 540,000 hectares, and the clean felling area was reduced to 94,000 hectares. Taking the Greater Khingan Mountains forest area of Inner Mongolia as an example, the total timber output during the period of 1991–1995 was 20.7 million m³, which was 15.3% lower than the previous period. During the period from 1996 to 2000, a further decline was obvious, and the timber output for this period was only 18.2 million m³.

Under the triple impact of the crisis in forest resources, domestic timber prices fell due to the development of the forestry import market in 1989 and the national macroeconomic monetary

tightening policy in 1993; further, the economic development of state-owned forest areas was severely hit. As shown in Figure 4, from 1990 to 1993, the industrial output value revealed dramatic negative growth. However, the new round of state-owned enterprise reforms that began in 1992 gave new opportunities for the economic development of key state-owned forest areas, and from 1994 to 1997 the industrial output value increased. This development trend was not sustainable and came at the cost of reducing employee welfare. Therefore, the increase in output value fluctuated greatly and was characterized by uncertainty. Due to the long-term integration of government and enterprise, regular employees are “highly sticky” (i.e., cannot be easily dismissed from their roles), which made it difficult to significantly reduce the number of employees in a short time. As shown in Figure 5, after reducing the number of temporary employees in 1988, the total population and number of employees did not maintain a continuous decline from 1989 to 1997 and remained at levels of approximately 2.7 million and 900,000, respectively. However, the decline in corporate revenue brought about by the resource crisis and the decrease in timber prices could not sustain the original high levels of employee welfare and thus triggered an employee welfare crisis. Under economic pressure, enterprises commonly endeavor to maintain a constant total salary in order to control costs (see Figure 5). However, compared with the economic development of the external regions, actual standards of employee welfare in key state-owned forest areas decreased year by year. In 1997, salaries were only 50% of the national average salary of employees.

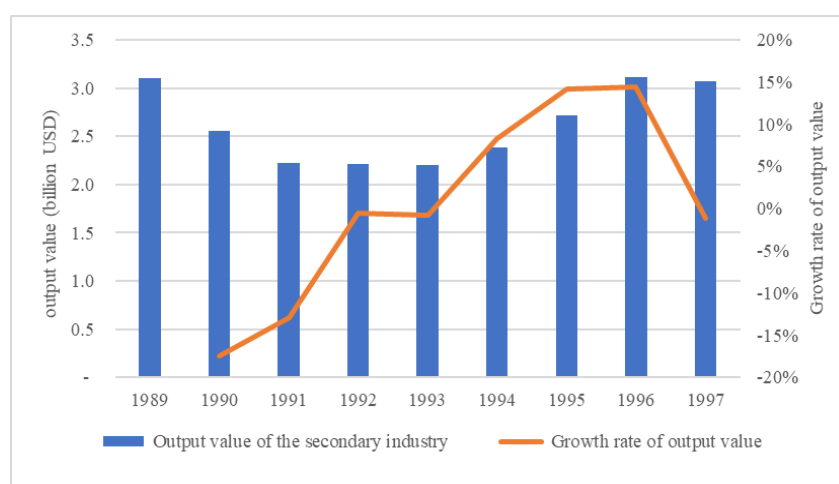


Figure 4. Secondary industry’s output value of key state-owned forest areas from 1989 to 1997.

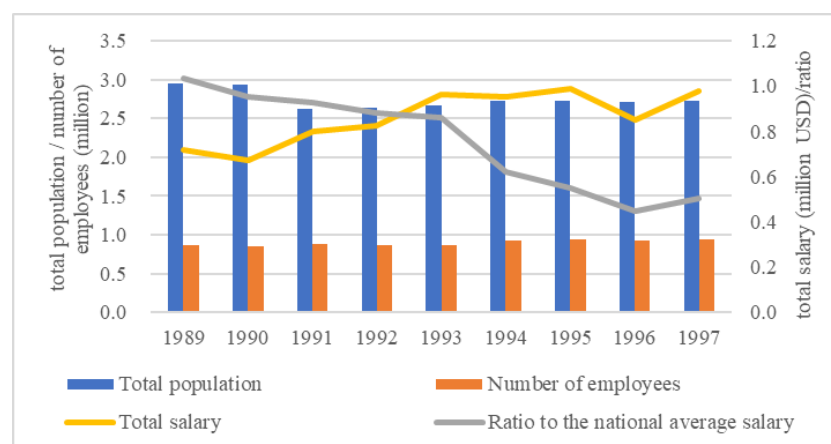


Figure 5. Employee numbers and salaries in key state-owned forest areas from 1989 to 1997.

At this stage, the resources, economy, and population of key state-owned forest areas formed a mutually restrictive relationship. The hidden resource utilization problem began to have visible consequences, which directly affected the economic development trend. External economic policies, such as opening the forest market, made this impact even more dramatic. Affected by the characteristics of the forestry industry and state ownership, the role of economic development in population migration has been weakened. The economic recession had no obvious effect on population migration in the short term; in the long term, however, it had a negative effect. The declines in company income and employee welfare caused by the stable population have exacerbated the loss of technical personnel and made the management system more rigid. Around 1992, workers in key state-owned forest areas accounted for only about 50% of the total number of employees, and management personnel were twice as numerous as engineering and technical personnel. Uncreative and inactive personnel systems would negatively affect the future economic development.

4.3. Diversification Stage (1998–2017)

In 1998, China began to implement the “Natural Forest Protection Project” pilot, taking state-owned forest areas as the key focus of implementation. The project’s specific measures included gradually reducing the amount of felling of natural forest resources in key state-owned forest areas in Northeast and Inner Mongolia, strictly controlling timber consumption and eliminating over-limit logging. In 2000, the “Natural Forest Protection Project” was officially implemented, and the felling volume of all key state-owned forest areas was limited. The output of logs gradually decreased from 17.3 million m³ in 1998 to 11.3 million m³ in 2001 and remained at approximately 11 million m³ from 2001 to 2010. With the implementation of the second stage of the project, felling volumes declined further, from 6.1 million m³ in 2011 to 3.5 million m³ in 2014. In 2015, in order to further improve the natural forest protection system and increase protection of forest resources, commercial logging of natural forests was completely stopped in state-owned forest areas.

The felling volume in these areas fell sharply to less than 1.9 million m³ in 2015, representing a decrease of more than 40% from the previous year. In 2016, the felling volume declined by a further 30%. At the same time, the forest resources in key state-owned forest areas has generally been on the rise, and the development goals for such areas have changed from a focus on quantity to quality of resources. As shown in Figure 6, during the fifth to eighth forest data inventories, forest areas and stock volumes both increased. The forest area increased from 25 million to 26 million hectares, and the forest stock volume increased rapidly from 2.27 to 2.60 billion m³. The rate of growth of forest area was significantly smaller than that of the forest stock volume and was stable at about 2% per year in the later period. By contrast, the forest stock volume was growing rapidly, with the growth rate increasing to close to 10% during the eighth forest inventory. The harvestable forest stock volume increased year on year, from 115 million m³ in the period from 2004 to 2008 to 134 million m³ in 2017 (the harvestable forest stock volume is defined as the forest stock volume of mature and over-mature forests. Relevant data were collated by the authors from a number of papers on forest resource exploration in key state-owned forest areas [33–36]. On this basis, the missing data were supplemented based on the proportion of harvestable resources in key state-owned forest areas of Heilongjiang Province). It can be seen that the implementation of the Natural Forest Protection Project has led to the continuous improvement of the quality of state-owned forest resources, and the original goal of pursuing area expansion has been gradually abandoned in favor of improvement in quality.

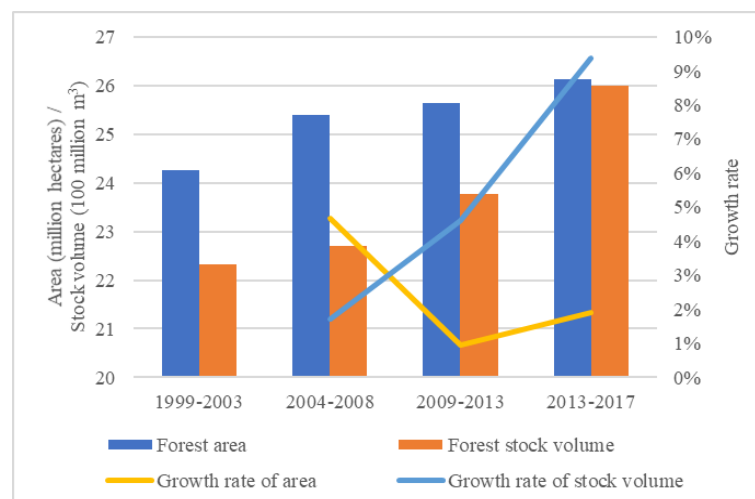


Figure 6. Changes in key state-owned forest resources from 1999 to 2017.

Affected by a series of resource protection policies, the harvestable timber resources on which the economic development of key state-owned forest areas depended are insufficient, resulting in a shift in such areas to the diversified development of nonforest resource-consuming industries. As shown in Figure 7, the output value of the traditional forest products industry (mainly comprising forest felling and forest processing) at this stage decreased year by year, and this trend was especially pronounced after 2015, coinciding with the stopping of commercial logging of natural forests in state-owned forest areas. However, the total output value (across all forest industries) has increased. In 2013, the transformation occurred, whereby the strategic focus changed from high growth in production value to industrial upgrading, and the trend of diversification became more apparent. The proportion of secondary industry output value decreased from 32% in 2003 to 6% in 2017. At the same time, the proportion of tertiary industry output value has increased year by year, accelerating since 2013 and reaching 37% in 2017, representing an average annual increase of 3% of total industry output. Faced with increasingly tight felling quotas, key state-owned forest areas have begun to gradually develop a variety of low-resource-consuming economies such as nonwood forest products, under-forest economy, and ecotourism. As shown in Figure 7, the output of nonwood forest products represented by economic forests (trees for producing oil, emulsion, etc.), Chinese medicinal materials, edible fungi, and wild vegetables has flourished at this stage, growing rapidly from around 2010. Taking the Heilongjiang Forestry Industry Bureau as an example, the output value of the under-forest economy increased from 570 million USD in 2007 to 1.3 billion USD in 2013, with an average annual growth rate of 14.73%. From 1998 to 2017, as the main representative of the tertiary forestry industry, the forest tourism industry entered a period of rapid development. The number of forest parks in China increased from 1002 to 3505, and the total number of annual recreational visits increased from 58.6 to 962 million. The comprehensive social output value rose rapidly from 20.92 billion USD in 2008 to 161.76 billion USD in 2017, with an average annual growth rate of more than 25%. It can be seen that the performance of resource-intensive industries represented by secondary industry is closely related to changes in forestry resources, and resource protection will cause a rapid decline in this type of industry. Technology-intensive industries such as the tertiary industry have decoupled from the chain of resource consumption to generate value and achieve economic development in other ways. However, their development depends on factors such as technology and innovation, so excessive confidence and backward management may trigger the “resource curse” phenomenon.

Contrary to the trend of growth in the economy of key state-owned forest areas, the total number of employees and retired workers in these forest areas revealed a gradual decline and then remained stable at around 900,000 in the later period. The reason for this is that, after the economic downturn in the early part of this period, a large increase in the number of redundant workers was created,

which does not subsequently decrease when the economy changes. With the reform of the state-owned enterprise system, enterprises have gradually developed to adopt modern models that are separated from government functions. Employees, who would originally never have been fired due to the fact that forest enterprises are government-affiliated, were resettled by means of layoff mechanisms and early retirement. As shown in Figure 8, the number of employees continued to decline from 800,000 in 1998 to 315,300 in 2017, with an average annual rate of decline in excess of 4.6%. In this period, the number of retirees has continued to rise, surpassing the number of employees in 2008 and reaching 510,000 in 2017 (1.6 times the number of employees in that year), with an average annual rate of increase of 5.5%.

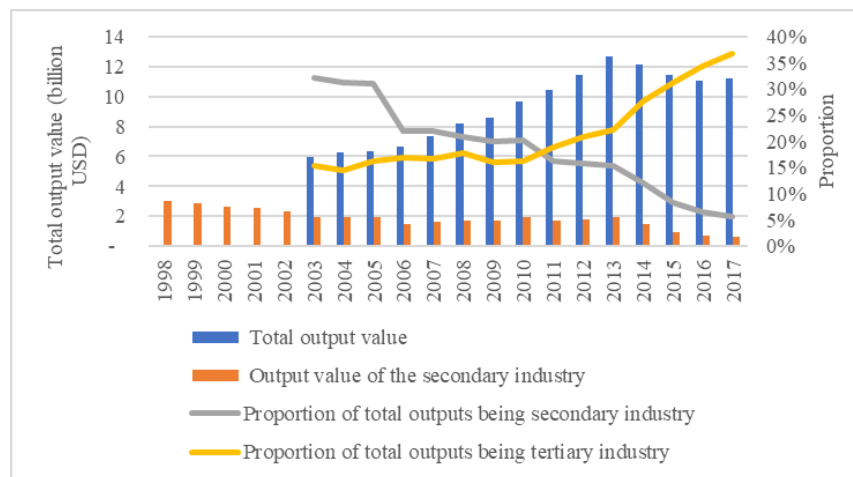


Figure 7. Output value and industrial structure of key state-owned forest areas from 1998 to 2017.

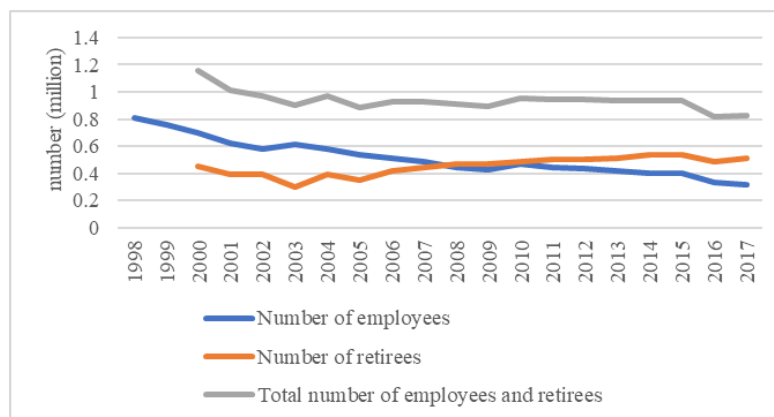


Figure 8. Number and structure of employees in key state-owned forest areas from 1998 to 2017.

In general, under the impact of resource protection policies and the reform of state-owned enterprises, the declining number of employees in key state-owned forest areas has corresponded with the reduction in total resource consumption, but the rising proportion of retirees has made enterprises overburdened and caused them to lose vitality. The redundancy of job roles cannot be solved in a short time, and the number of skilled employees required in such areas is relatively small. Therefore, it is not possible to fully utilize population and labor according to the requirements of the economic transformation taking place, nor can the high resource consumption problems brought about by economic development be fully alleviated by high-quality technological development and management model innovation. In other words, the defects in population quality and structure make the technological innovation level and management model relatively backward in these areas, which is

unable to promote the economy from extensive development to intensive development and cannot alleviate the resource consumption problem caused by economic development.

5. Discussion

5.1. Forestry Policy and the External Macroenvironment Have a Strong Impact on the Relationship among Resources, Population, and the Economy

Due to the long-term nature of forestry development and the sensitivity to government policy, key state-owned forest areas are both internally stable and strongly influenced by external forestry policies and the macroenvironment. In the 1970s and 1980s, the external macroenvironment enhanced the economic and population promotion effect of resource growth through the channel of timber prices, which increased dividends brought by forest resources and stimulated production by enterprises. A large number of young and middle-aged laborers have moved to such areas for employment in resource development and maintenance, and key state-owned forest areas have provided sufficient living resources for them, forming a trend of population accumulation and economic growth in a short period of time. In the later period, forestry policies forming part of the government's "natural forest protection projects" and "stop commercial logging of natural forests" policies reduced the negative impact of economic development and population growth on resources. The government forestry policy unilaterally prevented the excessive consumption of resources, and the carbon emission increase with coercive force promoted the upgrading of economic structures and accelerated the decoupling between resource consumption and the economy. The relationship among resources, the economy, and population in key state-owned forest areas, while respecting basic economic principles, shows a long-term industrial foundation, and its characteristics are influenced by policy and the external macroenvironment and forestry policies.

5.2. Decoupling between Resources and the Economy in State-Owned Forest Areas

At present, there is no significant causal relationship between the consumption of forest resources and the total economic output of enterprises, and the growth of one factor has no obvious effect on the development of another. The resource curse hypothesis in the state-owned forest area has not been realized, and the decoupling goal appears, on high-level analysis, to have been achieved. At the same time as implementing resource protection policies, a certain scale of economic development has been achieved by the development of tertiary industries, nonresource-intensive industries (e.g., under-forest diversified operations), and industrial transformation. This intensive economic development method reduces greenhouse gas emissions caused by the high consumption of forest resources. However, due to the serious residual effects of the planned economy in state-owned forest areas, the main economic income at present comes from government investment subsidized by natural forest protection projects, and nonresource-consuming industries such as forest economy and forest tourism are still in their infancy. Coupled with the constraints of resource-protection policies, the growth rate of forest volume has exceeded the rate of economic growth at this stage, demonstrating that economic growth cannot bring about further improvement in the quantity and quality of resources; thus, forest carbon sequestration cannot be effectively promoted. On the other hand, these trends also show that the current levels of science, technology, and innovation brought about by the economic development of state-owned forest areas still has room for development and has a limited ability to improve the level of resource protection.

5.3. Population Has a Restrictive Effect on the Economy in State-Owned Forest Areas

As mentioned above, in the short term, the economic growth of key state-owned forest areas can increase the number of employees; however, this increase in the number of employees has a negative effect on the economy. This is caused by the structure and technical quality of the population. The high proportion of retirees in the population has increased the burden on state-owned forest enterprises.

At present, the quality of employees in state-owned forest areas still needs to be improved; as a result of the limited quality, state-owned forest-area enterprises' technology-intensive and talent-driven industries are at an immature state of development and so cannot greatly stimulate these areas' economic development potential. The large increase in retirees caused by the state-owned forest-area reform and the stop logging policy has also increased the burden on enterprises. The rise in retired workers' pensions and compensation for early retirees has directly weakened the economic performance of enterprises. The amount of economic value created by employees is less than the total consumption of retirees, meaning that population growth is not driving economic development.

5.4. Sustainable Development Relationship Has Not yet Formed among Resources, Population, and the Economy in State-Owned Forest Areas

The state-owned forest area has not formed a successful trend of sustainable development. Growth in forest resource levels is dependent on administrative orders and mandatory forestry policies, and forest quality and forest carbon sequestration has not improved significantly. Although economic development has facilitated a reduction in resource consumption, it has not achieved true decoupling between the economy and resources, which means economic development cannot effectively promote resource protection. The imbalance in the population structure and low quality of the labor force means that economic growth cannot bring about corresponding scientific and technological progress or management model innovation, nor can it alleviate the problem of high resource consumption caused by economic development; as such, population growth has inhibited economic development. At present, due to the orientation of forestry ecological protection and the rigidity of the state-owned enterprise system, there is an adverse coupling relationship among resources, population, and the economy in state-owned forest areas. The development of one factor cannot positively promote the improvement of the other two factors. State-owned forest areas therefore face stagnation and system imbalances.

6. Policy Recommendations and Research Prospects

6.1. Policy Recommendations

6.1.1. Scientific Felling and Wood Cropping, Moderate Management

In state-owned key forest areas, the dilemma of having “no harvestable resources” appeared in the 1990s. In the later period, in order to ensure resource protection, new large-scale planting of single-tree species was performed. Due to the long-term characteristics of forest growth, although the forest area has increased, the recovery of harvestable quantities of wood still takes time to be manifested. However, the simplistic practice of single-species tree planting ignores biodiversity and market timber demand and cannot cope with the emergence of diseases or insect pests specific to particular tree species. In addition, these forest areas have gradually changed from an extensive development model that seeks quantity but not quality and have pursued improvement of quality instead of increasing forest area.

However, the excessive pursuit of the harvestable resource growth and the practice of stopping commercial logging of natural forest did not consider the scientific process of forest felling and wood cropping. A reasonable amount of felling is conducive to the regeneration and succession of forests, which stimulates forest growth, thereby effectively increasing forest carbon sequestration, and forests of different age classes are suited to performing different economic and ecological functions. Young forests and middle-aged forests have rapid initial growth and high carbon sink efficiency per unit area, whereas mature forests and over-mature forests provide high harvestable timber volume. Simply planting a single-tree species on a large scale, setting up areas of no-man's land, and stopping commercial logging of natural forest will cause the wild growth of forests and the waste of resources left idle, which will thus fail to achieve effective use, in terms of both economic and ecological functions. The key state-owned forest areas should develop a reasoned distribution of forest tree species and

age classes, conduct appropriate felling and management, and develop a variety of forest resource utilization methods, such as under-forest economy, to allow the realization of both the economic and ecological benefits of forests. Coercive resource protection policies are not suitable for the long-term sustainable development of forest resources. Although the existing resource protection policies are initially effective, they come at the cost of huge economic sacrifices. Forests with no economic output cannot stimulate managers to implement effective scientific management and felling methods and will thus result in waste and quality decline of resources.

6.1.2. Introduce and Train High-Quality Talents

As mentioned in Section 5, the introduction of high-quality talents has promoted the protection of resources in state-owned forest areas, but its impact has failed to promote economic development. The introduction of high-quality talents has obvious effects on industrial upgrading, scientific and technological innovation, and improvement in forest management standards. At present, the overall quality of employees in state-owned forest areas still needs to be improved. The education level of employees is generally high school or below, and technical personnel account for a relatively low proportion. Key state-owned forest areas should implement strong talent-introduction policies during the reform process, such as increasing subsidies for benefits, housing, research funding, and the treatment of spouses and children, in order to promote the inflow of high-quality talent, thereby improving employee quality and promoting technological development and industrial transformation. In addition, the government and enterprises in these forest areas should continue to train high-quality talent within the forest area and strengthen the employment “stickiness” of talented employees. Talent must not only be attracted or developed but also be retained. It is thus necessary to improve vocational training, increase title awards, etc., to promote the professional skills of all employees.

6.1.3. Promote Industrial Reform and Introduce Market-Oriented Mechanisms

The chaotic relationship among resources, population, and the economy in key state-owned forest areas is mainly a consequence of the contradiction between resource protection and economic development. The compulsory resource protection policy restricts the sourcing of raw materials without providing flexibility. As a result, enterprises are unable to promptly implement countermeasures such as employee placement or industrial transformation. At present, state-owned forest areas rely on strong resource protection policies to achieve the decoupling of the relationship between resource consumption and economic development. As concluded by some scholars, there is a “pseudo decoupling” relationship between resources and the economy in state-owned forest areas [9]. The relationship does not enter the second half of the environmental Kuznets curve. With limited resource consumption, economic and industrial development lacks momentum. Therefore, these forest areas need strengthened industrial reforms, lengthening of the forestry industry chain, change to the current lack of high-tech value-added innovative forest products, and to be a primary location for the processing of forest products [37]. It is further necessary to develop technology-intensive environmental protection and efficient industries. On the other hand, factors such as rigid thinking, reliance on government support, and large residuals of the planned economy within state-owned forest enterprises have led to a lack of adaptability in response to resource-protection measures and compulsory reform. It is thus necessary to introduce a market-oriented mechanism and change administrative industrial organizations into market-oriented independent management units. The government should clarify its own supervisory function and change from “participants” into “supervisors” who ensure the market gives play to allocation functions in order to reverse the phenomenon of dislocation between supply and demand. Moreover, the government should also promote the market-oriented development of rising industries and continuously promote the development of traditional industries toward high-quality and refined processing.

6.2. Deficiencies and Prospects

Based on long-term statistical data for key state-owned forest areas, this paper summarized the changes in resource fluctuations, population movements, and economic performance and conducted a comprehensive linkage analysis of the relationship among the three factors, overcoming the limitations of previous studies that only focused on the relationships between two of these factors. In addition, this article also constructed a model of the influence mechanism between the three factors, provided a basic theoretical framework for subsequent analysis, and used data for the period from 1975 to 2017 to analyze the linkage relationship. This paper further argued that these forest areas will improve their response efficiency to resource-protection policies in the future. Under the influence of policy interventions and market mechanisms, its industrial transformation and upgrading will optimize the linkage relationship among resources, population, and the economy and thus will gradually adjust the cyclical impact structure and reach a new stage of balance. On this basis, more advanced economic models, population welfare, and resource protection and utilization are expected to emerge. It is worth noting that this article focuses on the analysis of the relationship among resources, population, and the economy at the macro-level and does not address regional differences between forest areas. The authors plan to take this relevant factor into account in future research.

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