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Does Classification-Based Forest Management Promote Forest Restoration? Evidence from China's Ecological Welfare Forestland Certification Program

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Abstract: Classification-based forest management (CFM) is generally regarded as an important political means of achieving sustainable forest development. However, in the upsurge of publicly managed forest devolution, the impact of CFM policies on forestland restoration remains uncertain and needs to be explored. This study contributes to the scant literature on this topic in China, where CFM has long been implemented based on the ecological welfare forestland (EWF) certification program. We use provincial data from China to examine the relationship between EWF-certified areas and forest restoration. Based on inter-provincial panel data from the third to the ninth consecutive forest resource inventories in China (1984–2018), we use a dynamic spatial autoregressive model to analyze the impact of forest classification management on forest restoration. The results show that, contrary to appearances, increasing EWF-certified areas promotes forest restoration. However, after controlling for other possible influencing factors, increasing EWF-certified areas plays a minimal role in promoting forest restoration and regrowth by inhibiting investment in forest management and even has a negative impact on forest restoration in the southern collective forest area.

Keywords: classification-based forest management; forest restoration; ecological welfare forest certification program; dynamic spatial autoregressive model

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1. Introduction

Halting the loss and degradation of forests will help to address two of the world's greatest and most interlinked global environmental challenges: biodiversity loss and climate change [1,2]. In this regard, an increasing number of scholars and policymakers support classification-based forest management (CFM), by which forests are divided into two or more uses of forestland by balancing their ecological and economic functions to reduce forest degradation [3–5]. However, there is still a lack of direct empirical evidence regarding whether CFM policies can promote forest restoration in China and other countries.

Based on global practices, in the early stages of CFM policy implementation, the protected areas are mainly natural forests or forestland in ecologically fragile areas, which tend to be managed by governments [6–9]. In 2000, China officially implemented its CFM policy, which is a two-class system applying different management strategies to different categories of forestland, namely, commodity forestland (CoF) and non-commodity forestland, commonly known as ecological welfare forestland (EWF) [10]. EWF covers most of the forests with high conservation value [11]. However, because the Chinese government has paid increasing attention to forest protection in recent years, the certification scope of

China's EWF has been extended to forestland managed by farmers. After EWF certification, farmers are not allowed to harvest from EWF land, a practice in exchange for which they receive annual insurance compensation from the government [2,10]. The certified EWF area in China has increased from an initial 13.3 million hectares to 169.7 million hectares in 2018, accounting for 52.43% of the total forest area, whereas the certified EWF area for farmers accounts for 47.38% of the total EWF area [12]. The EWF certification project is currently the forest protection program with the widest coverage and the largest number of farmers in China [7].

Generally, protecting forests in ecologically fragile areas is conducive to forest restoration [13]. However, in the context of the global decentralization of forest rights, the question of whether larger-scale protection really helps restore forest areas requires further study. As forest managers, farmers cannot obtain harvesting income after EWF certification and the positive externalities generated by EWF are usually not effectively quantified for technical reasons, resulting in a decline in farmers' enthusiasm for managing EWF areas [14–16]. Additionally, EWF certification would lead to a reduction in the CoF available for logging, thus leading to diseconomies of scale and reducing farmers' enthusiasm for investing in CoF [17,18]. Therefore, in the long run, the decline in the enthusiasm for forestry production and management caused by EWF certification may not be conducive to continuous forestland growth [19].

According to existing studies, there are many challenges in accurately assessing the impact of CFM on forest restoration and in clarifying its mechanisms. First, from a practical perspective, after the implementation of CFM, the forest area in China showed a substantial increase, but this does not mean that there is a positive causal relationship between CFM and forest restoration [7,10]. Accompanied by the implementation of CFM, the transfer of rural labor to cities and the increase in the import of forest products have reduced deforestation [20]. The implementation of forest ecological projects, such as natural forest protection projects and the return of farmland to forests, also promotes forest restoration [21,22]. However, these factors may obscure the net effects of the CFM on forest restoration. Second, the long growth cycle of forests, the time lag of forest governance effects, and the environmental spillover effect between neighboring areas will make obtaining unbiased and effective empirical analysis results challenging [23,24]. Finally, unlike the forest land in the state-owned forest areas, following the decentralization of forest rights, farmers have become the main operators of collective forest areas. Ignoring the impact of different property rights arrangements on forest restoration, it is difficult to understand the role of CFM in forest restoration in the context of the decentralization of global forest rights [25,26].

Compared to previous studies, the contributions of this study are fourfold. First, the study conducts a rigorous empirical test on whether CFM can promote forest restoration, identifies the corresponding influence mechanism, and provides empirical evidence from China. Second, by distinguishing collective forest areas and state-owned forest areas, this study analyzes the heterogeneous effects under different property rights arrangements and supplements and revises the relevant theories of CFM. Third, the dynamic spatial autoregression model (SAR) is used to solve spatial autocorrelation and time-delay problems, which improves the reliability of the empirical results and provides a reference for subsequent related studies.

2. Materials and Methods

2.1. Data

We built a longitudinal dataset for 28 provinces over 30 years. The temporal span captures the entire duration of the EWF certification program, making our empirical findings adequate and robust. The relevant data for the forest areas of each province come from the third to ninth National Forest Resources Inventory, whereas other data were obtained from the *China Forestry Statistical Yearbook* and the *China Statistical Yearbook*. In 1988, the central government demarcated the Hainan administrative region from Guangdong

Province, making Hainan a separate province. In 1997, Chongqing separated from Sichuan Province and became a municipality directly under the central government. To ensure data consistency, we merged the data for Hainan Province with those of Guangdong Province, and the data of Chongqing city with those of Sichuan Province. Additionally, given the availability and completeness of the data, we excluded Hong Kong, Taiwan, Tibet, and Macau from the analysis. Therefore, 28 sample provinces were used in this study for a sample period from 1984 to 2018.

2.2. Methods

Generally, the effect of forest governance does not change instantly with the implementation of CFM, and the forest restoration status in the current period is also susceptible to the influence of the previous period. Therefore, a time delay should be considered in the empirical analysis. Moreover, owing to inter-regional climate conditions, economic exchanges, and population flows, as well as the mutual learning effect between local governments that occurs during policy implementation, forest change will have a certain spatial dependence [27,28]. To better deal with the problems of time delay and spatial dependence, a dynamic spatial econometric model was used in this study [29]. Common dynamic spatial econometric models include the dynamic spatial Durbin model (SDM), shown in Equation (1), and the dynamic spatial autoregression model (SAR), shown in Equation (2) [30]:

$$F_{it} = \tau WF_{it-1} + \psi F_{it-1} + \rho WF_{it} + \zeta WC_{it} + \theta WX_{it} + \delta C_{it} + \beta X_{it} + \alpha_i + \gamma_t + \mu_{it} \quad (1)$$

$$F_{it} = \tau WF_{it-1} + \psi F_{it-1} + \rho WF_{it} + \delta C_{it} + \beta X_{it} + \alpha_i + \gamma_t + \mu_{it} \quad (2)$$

In Equation (1), the dependent variable F_{it} is used to measure forest restoration, which is represented by forest area in this study. F_{it-1} indicates forest area with a time lag period of 1. W is the spatial coefficient matrix, and the adjacency matrix was primarily used in this study. τ is the time and space lag effect coefficient, which is used to reflect the influence of the forest area on the neighboring area during the lag period. ψ is the time lag coefficient, which reflects the influence of forest area in the previous period on the current period and represents the magnitude of its time lag effect. ρ represents the spatial lag effect coefficient of the current period, reflecting the influence of the forest area in the neighboring area of the current period on the local forest area. C is the management variable for forest classification. In this study, we used the proportion of the public welfare forest area to the total forest area. X_{it} represents a group of control variables. α_I is the fixed effect of savings. γ_t is the time effect; μ_{it} is the error term. Compared with the dynamic SDM model, the dynamic SAR model in Equation (2) does not consider the influence of the spatial lag of explanatory variables on the explained variables. Since it is impossible to determine the form of existence of spatial relations a priori, the best specific model to use can be determined using the Bayesian information criterion (BIC) in empirical research [31,32]. Both the dynamic SAR and the dynamic SDM were run using stata16.0 (StataCorp LLC, College Station, TX, USA).

Based on the forest transformation theory [13,33], the control variables X_{it} selected in this study were as follows.

Economic development. We used the GDP per capita to measure economic development. Economic development is closely related to forest transformation and the path of economic development is considered important for forest transformation [34]. As the level of economic development increases, people's consumption preferences and patterns change. Their consumption preferences for the ecological environment continue to increase, leading to an increase in the demand for forest ecological service functions, which in turn leads to an increase in the forest area [35].

Population size. We used population density to measure population size. Most related studies analyze the impact of population on forest transition from the perspective of demand for forest products. Scholars consider that an increase in population increases the demand for forest products, which increases deforestation and leads to forest degradation [33,36].

Forestry support services. Extant studies show that agricultural support services can use advanced production technologies to improve production efficiency [22,37,38]. Based on data availability, in this study we selected the sum of the output value of forestry production services, forestry professional technical services, forestry public management, and other organizational services for measuring forestry support services.

Livelihood. The transformation of farmers' livelihoods has long been a focus of scholars. In this study, we used wood production and the proportion of urban population to characterize the transformation of farmers' livelihoods. Under normal circumstances, when farmers are highly dependent on forestry production, they generally have higher enthusiasm for logging and higher timber yields, with higher rates of timber harvesting often leading to forest destruction [21,39,40]. In addition, the increase in the urban population size will also expand the demand for forest social aspects (tangible and intangible needs: culture, foods, etc.) and ecological aspects (water, soil prevention, etc.), which is conducive to forest protection [41,42].

Demand for wood products. Generally, the higher the demand for wood products, the higher the demand for forest harvesting, which leads to forest destruction [43]. With reference to existing research, in this study we chose the output of wood-based panels to measure the demand for wood products [18].

Policy support. Forest governance policies have a significant impact on forest restoration. Since the 1990s, China has changed its position on timber production, gradually shifting the function of forestry to ecological protection and ecological services. To this end, it has implemented several major forestry projects, covering various fields, such as forest resource protection, soil and water conservation, and biodiversity protection [22]. Policy support plays an important role in forest restoration in China [18]. Therefore, in this study we used the afforestation ratio of key projects to measure government support.

Forest products trade. Amid globalization, an increase or decrease in a country's forest area depends on global factors and its trade relations with other countries [35,44]. China has become the largest importer of timber. Studies have shown that the forest product trade plays an important role in protecting China's forests [45]. For this reason, in this study we used the total imports of sawn timber and veneer logs to measure forest product trade.

Table 1 lists the descriptive statistics for all variables included in the analysis.

Table 1. Descriptive statistics.

Variable Category	Variable Name	Calculation Method	Mean	Std. Dev.
Explained variable	Forest area	The logarithm of forest area	5.74	1.56
Core explanatory variable	Proportion of EWF	EWF area/total forest area	0.27	0.26
Other control variables	Economic development	The logarithm of GDP per capita	2.79	0.79
	Population size	The logarithm of population density	5.30	1.31
	Forestry support services	The logarithm of the output value of forestry production services, professional technical services, public management, and other services was taken after summing	4.67	2.36
	Livelihood	The logarithm of wood yield	3.76	3.65
	Demand for wood products	The output of wood-based panels was logarithmic	3.43	2.45
	Policy support	The afforestation area of key projects was logarithmic	5.08	17.60
	Forest products trade	The logarithm of sawlog and veneer imports was taken after summing	7.68	1.09

3. Results

3.1. Correlation Test

Figure 1 shows a fitting diagram of the relationship between the ratio of the EWF area and forest restoration. The ratio of EWF areas in China was positively correlated with the change in forest area; that is, with the continuous increase in the ratio of EWF areas, China's forest area expanded. Simple linear regression shows that the regression coefficient on the ratio of EWF area to forest area was 477.9767, and the significance test at the 1% level further indicated that there may be a positive relationship between the two variables. However, this is only a preliminary fitting of the ratio of the EWF area to forest restoration, without excluding the influence of other factors. A strict econometric analysis is carried out in the following section.

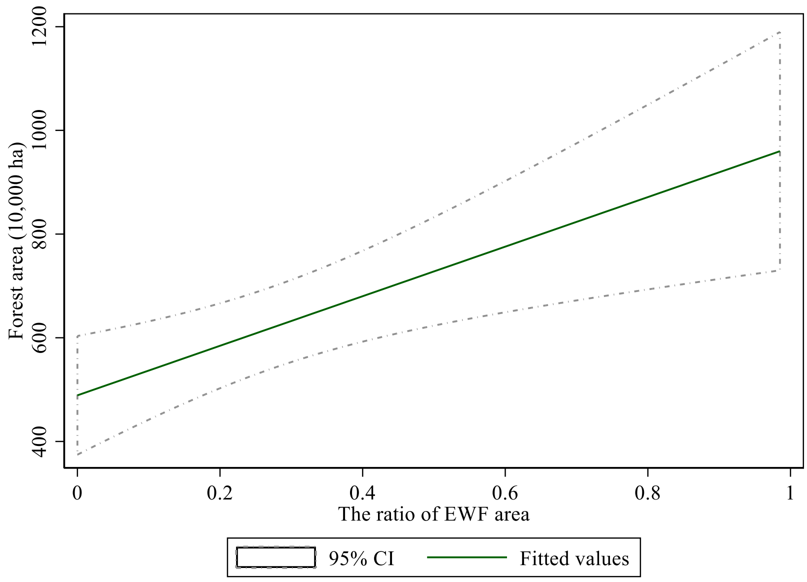

Figure 1. Correlation between the ratio of EWF area and forest restoration.

According to the geographical weight matrix, in this study we used the Moran index to test the spatial correlation of forest area change and we present a Moran scatter diagram in Figure 2. The test results show that the global Moran index of forest area in all forest inventories was significantly positive, strongly rejecting the hypothesis that there is no spatial autocorrelation. This indicates that the forest area was spatially correlated. One possible reason for this is that there were some similarities in climate, hydrological conditions, and tree species between neighboring provinces, and the catch-up effect was more likely to occur between neighboring regions in terms of forest ecological construction projects. Additionally, these factors lead to a spatial correlation of forest restoration because of the closer interactions of economic activities between adjacent areas. Therefore, it is necessary to use a spatial econometric model for empirical analysis.

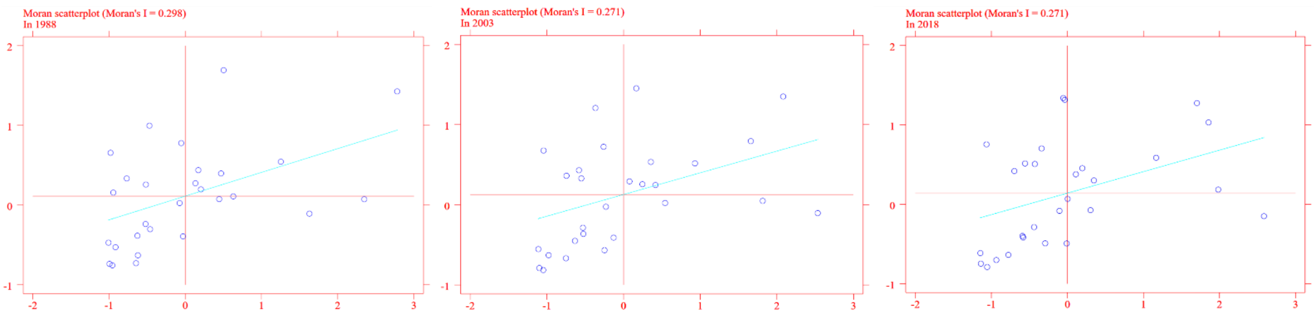

Figure 2. Moran scatter diagram. Data source: The third, sixth, and ninth Forest Resources Inventories.

3.2. Benchmark Regression Results

In view of the spatial correlation of forest area in the previous test, in this study we used a spatial econometric model that can solve spatial dependence to carry out the empirical analysis [46]. Table 2 presents the regression results using a spatial econometric model. As shown in Table 2, the static SAR and SDM models were first used for regression, with the addition of only the proportion of EWF as the core explanatory variable. Then, the dynamic SAR and SDM models were used for regression with other control variables being added to observe the impact of ignoring other explanatory variables on the empirical results. Comparing the BIC values of each model, the dynamic SAR model was found to have a smaller value than that of the dynamic SDM model. Therefore, in this study we focused on the dynamic SAR model.

Table 2. Effects of the EWF-certified area on forest restoration.

Variable	SAR	Dynamic SAR	SDM	Dynamic SDM
Proportion of EWF	0.5811 ***	−0.0268	0.2704 *	−0.0299
	(0.0942)	(0.0818)	(0.1511)	(0.0820)
Economic development		0.0472		0.0395
		(0.0403)		(0.0423)
Population size		0.2144		0.1717
		(0.1446)		(0.1602)
Livelihood		−0.0159 **		−0.0174 **
		(0.0078)		(0.0082)
Demand for wood products		−0.0275 **		−0.0269 **
		(0.0110)		(0.0110)
Policy support		0.0752 ***		0.0738 ***
		(0.0226)		(0.0227)
Forestry support services		0.2915 ***		0.2810 ***
		(0.1001)		(0.1015)
Forest products trade		0.1381 **		0.1378 **
		(0.0672)		(0.0672)
L. Forest area		0.9049 ***		0.9068 ***
		(0.0550)		(0.0550)
L. W * Forest area		−0.2071		−0.2144 *
		(0.1294)		(0.1295)
rho	0.5450 ***	0.2368 **	0.4509 ***	0.2380 **
	(0.0699)	(0.0983)	(0.0833)	(0.0983)
sigma2_e	0.0419 ***	0.0177 ***	0.0417 ***	0.0176 ***
	(0.0044)	(0.0017)	(0.0043)	(0.0017)
Regional fixed effects	control	control	control	control
Time fixed effects	control	control	control	control
BIC	−32.81088	−158.2225	−34.34823	−153.3117

Notes: Robust standard errors are shown in parentheses. *, **, and *** show significance at the 10%, 5%, and 1% levels, respectively.

For the core explanatory variables considered in this study, when no control variables were added, the coefficient on the proportion of EWF was positive, and all values passed the significance test, indicating that classified forest management can promote forest restoration. This verifies the results of the descriptive statistics mentioned in Table 1. However, after the addition of control variables, the coefficient on the proportion of EWF became negative but not significant, indicating that when other conditions are unchanged, CFM has no significant effect on forest restoration. According to the regression results of the control variables, the regression coefficients on policy support, forestry support services, and forest products trade were significantly positive. This shows that the restoration of China's forest area occurred mainly due to policy support, the development of socialized forestry services, and an increase in timber imports. This result was confirmed by both dynamic spatial models. The addition of control variables was equivalent to controlling for other factors that may affect forest restoration. The net effect of CFM on forest restoration can be obtained, but the results are inconsistent with the above descriptive statistics.

3.3. Heterogeneity Analysis of Different Forest Regions

CFM has been shown to inhibit forest restoration. Does CFM have the same influence on forest restoration in different forest regions? In contrast to state-owned forests, collective forest ownership is achieved by the collective in the south and farmers play an important role in forest management. Therefore, from the perspective of different property rights arrangements, the heterogeneity of the impact of CFM on the growth of forest areas in different forest regions is discussed using subsample regressions.

China's state-owned forest areas are mainly distributed in Inner Mongolia, Jilin, Heilongjiang, Shaanxi, Gansu, Xinjiang, Qinghai, Sichuan, and Yunnan provinces; the southern collective forest area usually refers to Zhejiang Province, Anhui Province, Fujian Province, Jiangxi Province, Hubei Province, Hunan Province, Guangdong Province, Guangxi Zhuang Autonomous Region, Guizhou Province, Hainan Province, and nine other provinces. Using this criterion, we divided the sample into state-owned forest provinces and southern collective forest provinces and estimated Equation (2).

Table 3 reports the results of the regression by sample. According to the regression results of the static SAR model, the proportion of public forest area had a significant positive impact on forest restoration in both state-owned and collective forest areas without controlling for other variables. However, when the dynamic SAR model was used and other factors were controlled, the coefficient on the proportion of the EWF area in the state-owned forest region was negative but insignificant. However, in the collective forest area, the ratio of the area of EWF was negative and passed the significance test at the 10% level when other factors remained unchanged. The results show that an increase in the proportion of EWF area has a significant negative impact on forest restoration.

Table 3. Heterogeneity analysis of the different forest regions.

Variable	State Forest Province		Southern Collective Forest Province	
	SAR	Dynamic SAR	SAR	Dynamic SAR
Proportion of EWF	0.4604 ***	−0.0436	0.4596 ***	−0.2577 *
	(0.1285)	(0.1104)	(0.1078)	(0.1362)
Economic development		0.0048		0.4734 ***
		(0.0620)		(0.1217)
Population size		0.9333 **		0.5297 ***
		(0.3814)		(0.1640)
Livelihood		0.3490*		0.0397
		(0.1783)		(0.1269)
Demand for wood products		−0.1083 ***		−0.0298 ***
		(0.0377)		(0.0071)
Policy support		−0.0090		−0.0360 **
		(0.0232)		(0.0169)
Forestry support services		0.2273 ***		0.1302 ***
		(0.0594)		(0.0232)
Forest products trade		0.1513		0.1242
		(0.1285)		(0.0757)
L. Forest area		0.7268 ***		1.0938 ***
		(0.1017)		(0.0663)
L. W. * Forest area		−0.6651 ***		2.3189 ***
		(0.2308)		(0.1982)
rho	0.4575 ***	−0.0147	0.6931 ***	0.3576 **
	(0.1164)	(0.1542)	(0.0781)	(0.1433)
sigma2_e	0.0423 ***	0.0140 ***	0.0084 ***	0.0115 ***
	(0.0078)	(0.0023)	(0.0015)	(0.0013)
Regional fixed effects	control	control	control	control
Time fixed effects	control	control	control	control

Notes: Robust standard errors are shown in parentheses. *, **, and *** reflect significance at the 10%, 5%, and 1% levels, respectively.

3.4. Endogeneity and Empirical Robustness Tests

Although the region and time fixed effects were controlled for in the empirical analysis presented above, the potential omitted variables that do not change over time can be eliminated and relevant control variables can be added to eliminate other possible omitted variables. However, considering the endogeneity problems caused by lagging explained variables, we used a systematic GMM for the regression, and the results are shown in column (1) of Table 4. The proportion of EWF-certified area still had no significant impact on forest restoration. To test the robustness of the spatial matrix, in this study we used a dynamic SAR model to conduct a regression analysis, again based on the distance matrix between provincial capitals, as shown in column (2) of Table 4. The results show that the EWF-certified area ratio did not significantly affect forest restoration. This indicates that the main empirical results above are relatively robust.

Table 4. Endogeneity and empirical robustness tests.

Variable	**(1)**	**(2)**	**(3)**	**(4)**
Proportion of EWF	−0.0370	−0.0160	0.1166	0.1125
	(0.0373)	(0.0761)	(0.0861)	(0.0816)
L. Forest area	0.4568 ***	1.2465 ***		
	(0.0823)	(0.0568)		
L. W. * Forest area		7.1177 ***		
		(0.6573)		
L. Forest accumulation			0.5176 ***	0.6965 ***
			(0.0509)	(0.2178)
L. W. * Forest accumulation			0.4435 ***	
			(0.1020)	
rho		−0.5280	0.3295 ***	
		(0.4295)	(0.0906)	
sigma2_e		0.0140 ***	0.0260 ***	
		(0.0013)	(0.0024)	
AR (1)	−2.0489 **			−2.0330 **
AR (2)	0.2441			0.5992
Sargan	12.9575			8.9253
Control variables	control	control	control	control
R-squared	-	0.4784	0.8439	-

Notes: Robust standard errors are shown in parentheses. *, **, and *** reflect significance at the 10%, 5%, and 1% levels, respectively.

Forest restoration can be expressed by forest stock, in addition to forest area. In this study, forest stock was used as the explanatory variable and a dynamic SAR model was used for the regression analysis. The results are shown in column (3) of Table 4. The observation results showed that, similarly to the use of forest area as an explanatory variable, although the coefficient on the proportion of the EWF-certified area was positive, it was still insignificant. The regression method using the systematic GMM draws the same conclusion, as shown in column (4) of Table 4; that is, the proportion of EWF-certified areas still had no significant impact on forest stock. This again proves the robustness of the empirical results.

4. Discussion

At present, CFM has become an important pathway to achieving sustainable forestry development in China and other countries. Although countries have different types and quantities of forest classifications, more and more countries are carrying out CFM practices as the competition for land use and the competition between forest ecological and economic functions intensifies [47–49]. Because the forest land used to obtain ecological benefits mainly provides ecological public goods, most countries usually divide state-owned forest land into forestland that exerts ecological benefits, as implemented in Canada, France, Austria, Japan, Malaysia, and Thailand. In recent studies, scholars have found that after the implementation of CFM, more and more forestland has become protected, and forest restoration has gradually accelerated [5,50]. However, some scholars have found that due to imperfect government laws and insufficient implementation of forest management and protection, the forest land that provides ecological products in some areas has experienced deforestation and there has been a decline in forest ecological functions, such as increased pests, diseases, and fires [51,52].

The EWF certification program, as an important policy for promoting forest restoration in China, has been in place for approximately 20 years and is expected to remain in place for many more years. We provide empirical evidence from China for the impact of CFM on forest restoration and address the problems of spatial autocorrelation and time lag in the empirical analysis. Our estimations suggest that the EWF certification program has failed to increase forest stock. The specific reasons for this include the following.

(1) The ecological benefits generated by the EWF have attributes of public goods and belong to a kind of functional and utility public good [48,53,54]. With the reform of the collective forestland ownership system, farmers have gradually become the management subjects of collective forestland [55,56]. As operators of the EWF, farmers have also become suppliers of ecological benefits [21]. Although the government provides a certain loss compensation to farmers operating EWF, it is difficult for them to form effective incentives to manage and protect EWF [3,26]. Moreover, in terms of policies, the government imposes strict restrictions on EWF harvesting, which further reduces farmers' enthusiasm for managing and protecting EWF [57]. As far as CFM policy itself is concerned, the associated fiscal system [58,59], financial reasons [41], and conflicting local interests [60,61] may also have a negative impact on forest restoration.

(2) CFM reduces the commercial forest area of participating households, making the forest land more fragmented. Zhu et al. [54] found that small-scale forestland increased the cost of forestland management. Similarly, Xu et al. [23] found that scattered small-scale forest land makes the transaction cost of large-scale operations through circulation more expensive. Accordingly, the EWF certification program can also reduce farmers' investment and enthusiasm for CoF.

In summary, this study considers that CFM reduces farmers' enthusiasm for forestry production and their input into forestland, and does not promote the growth of forest areas in the long run. A previous finding, that the EWF certification program had a negative impact on forest restoration in southern collective forest areas compared to state-owned forest areas, supports this view. By contrast, the EWF certification program has had a negative impact on forest restoration in the southern collective forest areas. In collective forest areas, the scale of forestland managed by farmers is usually small [62].

Similar to Liu and Xia [18] and Xu and Hyde [57], we found that the restoration of China's forest area occurred mainly due to policy support, the development of socialized forestry services, and the increase in timber imports. Therefore, when these factors are not controlled for, it is unsurprising that the increase in EWF-certified areas is positively correlated with forest restoration.

Although we discussed the reasons for the impact of forest certification areas on forest restoration, we did not empirically test these due to a lack of farmer data. Future research could qualitatively analyze differences in local government responses when the central government implements CFM policies [63–65] and apply farmer data to improve our understanding of the impact of forest certification programs on forest restoration processes.

5. Conclusions

Based on panel data from the forest resource inventory, this study is the first to explore the effects of EWF certification on forest restoration using a dynamic SAR model. In the context of the current decentralization of forest management, CFM has not resulted in the forest restoration expected by its proponents. Moreover, expanding the proportion of EWF certification inhibited forest restoration in the southern collective forest area. The main reason for this is that EWF certification renders the property rights of forestland incomplete and reduces the scale of forestland, thus increasing the cost of forestland management. Farmers would thus not be interested in planting more trees or making more management efforts. Therefore, over the longer term, the decline in forest investment has limited the rapid improvement in China's forest quality and reduced the increase in forest ecological output.

This study argues that the Chinese government needs to optimize its current CFM policy. To reduce the negative spillover effect of forest fragmentation caused by CFM, the government should continue to encourage the transfer of forest land to realize the large-scale management of forest land. Simultaneously, the government should adopt a more comprehensive approach to provide large-scale households with training, information, credit, and other assistance to reduce their resistance to large-scale forest management. Additionally, the government should focus on the management and protection of EWFs. Given that CFM has led the imperfect property rights of the EWF program to reduce the enthusiasm of farmers to invest in EWF, the government could redeem farmers' EWFs on the premise that farmers participate voluntarily.

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