forests

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Essay

The impact of grassroots forestry institutions on forest carbon sequestration: evidence from China's collective forests

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1. Development history of TFW

TFWs are grassroots public welfare institutions that oversee and manage forest, wetland, desert, wild animals and plants, and other resources in accordance with the law, as well as provide forestry production and socialized services to rural economic organizations and individuals. They are comprehensive management and service institutions at the most basic level in China's forestry management and are the most extended end of forestry work. It is an essential link between forestry work and forest farmers [12]. As shown in Figure 1, the development of TFW in China has experienced four critical stages since 1950 [20–22,26].

Slow development period (1950–1987). The Chinese government's construction of TFW was to implement the national strategy of planting trees and greening the nation, organizing local people to hedge against forestation campaigns, managing forest resources, guiding the closure of mountains for forestry, and protecting wildlife resources[45]. In 1964, with the approval of the State Council, forestry stations were established in more than 100 counties in five provinces in the middle and lower reaches of the Yellow River, where soil erosion was severe, and the number of staff increased to more than 4200 people. From the 1960s to the late 1980s, when various political campaigns often impacted the continuity and routine of forestry policies, the construction of forestry stations nationwide developed very slowly. By the end of 1987, there were only 17,000,000 TFWs in 57,000 townships [20].

Rapid development period (1988–1991). With the rise of national timber prices, which led to the difficulty of controlling the over-harvesting of forest trees, forest resources continued to decline. In June 1987, the State Council issued "Instruction on Strengthening Forest Resources Management in Southern Collective Forest Areas to Resolutely Stop Indiscriminate Logging," emphasizing the enrichment of forestry grassroots management institutions. 1988 saw the establishment of the General Forestry Workstation. In the same year, the Ministry of Forestry issued the "Notice on the Issuance of the National District and Township Forestry Workstation Construction Plan," proposing that by 1992, the total number of TFW built nationwide should reach 35,000. From 1987 to 1992, the number of TFW increased to 36,974, with an average annual growth rate of 35.14%, and the number of employees increased by more than 32,000, an increase of 77%.

Consolidation and improvement period (1992-2005). There are many places to "build all in one step, gradually improving " the TFW's construction policy. The Ministry of Forestry issued a "Notice on Construction of Forestry Stations Nationwide to Meet the Standards" in 1992, indicating that the emphasis of forestry station construction work is shifting from quantity to quality.. The State Forestry Administration put forward ten indicators for TFW's staffing and staff quality, office space, transportation, communication tools, system construction, and file construction. After acceptance, awards are given to TFW that meet the standards of construction-qualified counties [20]. By the end of 2006, the total number of forestry stations in townships nationwide had reached 28,418.

Critical construction period (2006–2022). 2006, the State Forestry Administration issued the "National Forestry Workstation Construction Key County Inspection and Acceptance Measures (for trial implementation)." TFW construction policy is to "sound, standardize, and improve," primarily to build the national forestry key project area TFW, also known as "Key County" construction.. Through the construction of TFW in critical counties, to improve the overall level of forestry station construction. With the objective need for the construction of a forestry ecological civilization and the need to promote the employment of foresters, in 2015, the State Forestry Administration issued "Opinions on Further Strengthening the Construction of Forestry Workstations in Townships," taking into account the ecological status of the region and the task of forestry construction, guided by the actual local needs, rational layout, scientific planning and construction of forestry stations. The main goal is to stabilize the number of forestry stations at about 25,000 and maintain coverage of townships at more than 90% by 2020.

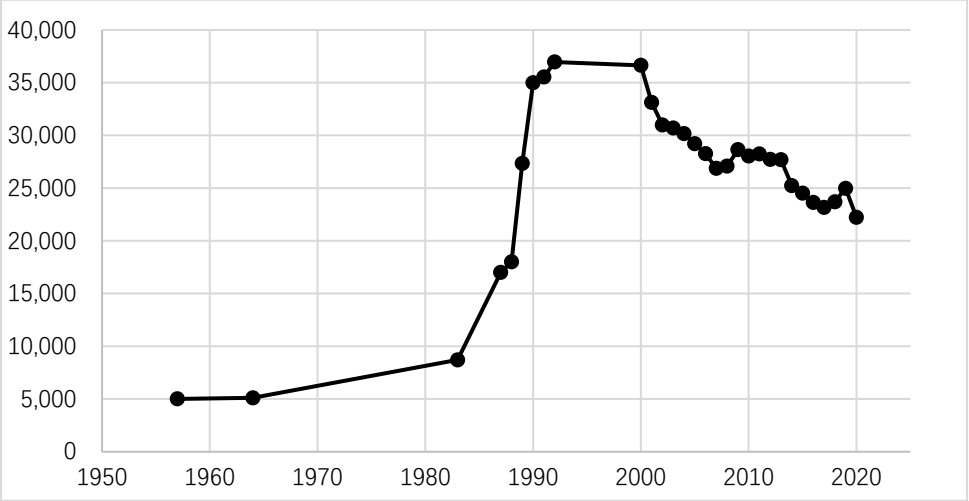

Figure S1. The evolution of township forestry workstations.

2 Significance and interpretation of control variables

Among the control variables, the coefficient of CFTR is significantly positive at the 1% statistical level, indicating that the Collective Forest Tenure Reform has extensively promoted collective forest carbon density. On the one hand, farmers obtained long-term and stable forest land tenure, which increased their incentive to create forests [46]; on the other hand, the Collective Forest Tenure Reform gave farmers legal security for their forest land and strengthened the sense of security of plot tenure [47]. However, other studies have shown that secure forest land ownership does not necessarily motivate forest operators to take care of it [48]. With the rapid increase in urbanization and the non-farm transfer of rural labor, some farm households no longer consider forestry production as the primary source of household income. The Collective Forest Tenure Reform has only released some farm households' production incentives. It is often necessary for TFW to select ecological rangers to nurture and care for collective forests.

The coefficient of FCR is significantly positive at the statistical level of 10%, indicating that the greater the forest coverage, the more beneficial the increase in collective forest carbon density. The carbon sequestration of forest vegetation depends on forest vegetation resources, and rich forest resources will improve the local climate conditions, thus promoting the continuous accumulation of forest resources. The coefficient of temperature (Temp)is significantly negative at the statistical level of 10%, which means that the greater the annual maximum temperature is, the more unfavorable it is to increase the carbon density of the collective forest. Wang (2019) used principal component analysis to study the effects of climate and topography on forest biomass and carbon change and found that both biomass-carbon density and carbon sink rate were positively correlated

with mean annual precipitation and minimum temperature but negatively correlated with mean annual maximum temperature[49]. Keith (2009) believed that the relatively cool temperature and moderately high precipitation environment were conducive to the rapid growth of plants and slowed down the decomposition rate, which could improve the carbon storage of forests[50].

Table S1. Baseline regression results of the impact of TFW on the carbon density of collective forests.

	(1) OLS	(2) Re	(2) Fe TW
TFW	0.458*	0.108**	0.091*
	(0.224)	(0.046)	(0.049)
CFTR		0.519***	0.543***
		(0.076)	(0.079)
FCR		0.017**	0.016*
		(0.007)	(0.008)
FFI		0.000	0.000
		(0.000)	(0.000)
AA		0.001	0.003
		(0.006)	(0.007)
GVF		-0.002	-0.003
		(0.008)	(0.008)
IFP		-0.003	-0.003
		(0.003)	(0.003)
lnTemp		-0.005*	-0.042*
		(0.003)	(0.023)
lnAP		-0.000	-0.016
		(0.000)	(0.010)
year	n	y	y
province	n	n	y
_cons	2.082***	1.971***	2.141***
	(0.317)	(0.266)	(0.182)
N	633.000	612.000	612.000
r2	0.079	-	0.746

Standard errors in parentheses.
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.