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Effect of Key Priority Forestry Programs on off-farm employment: Evidence from Chinese rural households

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ABSTRACT

This paper examines how 3 Key Priority Forestry Programs (the KPFPs) influenced rural off-farm employment time using a long-term panel dataset that spans 18 years (1995–2012) and includes 6 provinces in China. The programs included the most significant forest policies, including the Sloping Land Conversion Program (SLCP), Desertification Combating Program around Beijing and Tianjin (DCBT), and Natural Forest Protection Program (NFPP). A labor supply model with both fixed and cluster effects were used to identify the programs' disparate impacts in the different regions and on various policy stages. We found the following results: (i) the overall effect of the SLCP was pronounced in relation to the off-farm participation time, but it weakened gradually after the first policy stage; (ii) the DCBT had less impact than the SLCP in increasing the work time of farmers who already had off-farm jobs, but it was better than the SLCP during the various subsidy policy stages; (iii) the NFPP's total effect was insignificant; (iv) forestry subsidies tended to be decoupled for farmers in China, since the substitution effect was greater than the income effect and increased the supply of non-agricultural labor hours. The researches and policy implications of our work are also discussed here.

1. Introduction

1.1. Key Priority Forestry Programs in China

In the late 1990s, China suffered severe natural disasters, including serious land degradation (Xu and Cao, 2001), the blockage of the flow of the Yellow River (276 days) (China State Forestry Bureau, 2001), sand storms (Liu and Zhang, 2016), and severe biodiversity loss (Li et al., 2007) that resulted in the destruction of the natural ecosystems' self-regulation and deterioration of the environment. To protect the fragile ecosystems, the Chinese government launched 6 Priority Forestry Programs (PFPs) in 1998 and integrated them with the existing forest resources. The Sloping Land Conversion Program, Desertification Combating Program around Beijing and Tianjin, Natural Forest Protection Program, Shelter-belt Development Program, Industrial Timber Plantation Program, and Wildlife Conservation and Nature Reserve Program were included in the PFPs. The first 3 programs have an impact on farmers' livelihood and are better than the rest of the programs (Liu et al., 2014). Our paper focuses on the SLCP, DCBT, and NFPP, which are also known as the Key PFPs (KPFPs).

These KPFPs are ongoing and operate as effective policies for the ecological restoration of these areas in China. The SLCP was started in Gansu province, Shaanxi province, and Sichuan Province in 1999. Until 2002, it was carried out formally across China. By the end of 2013, plantations on the restored farmland encompassed about 9.063 million hectares, 16.255 million hectares on barren hills and wasteland, and 2.881 million hectares of closing hills for forest conservation (China State Forestry Bureau, 2014a,b). Farmers received annual subsidies of food and cash worth 140 yuan 1 mu[1] of returned farmland in the Yellow River basin and 210 yuan in the Yangtze River basin. After the first allowance period of the SLCP ended, the annual subsidies in these 2 basins were cut in half to 70 yuan and 105 yuan, respectively, in the new round. Besides these subsidies, a 20-yuan subsistence allowance for the subsequent protection of the returned land was in effect. The different types of returned land had varying allowance periods: 8 years for an ecological forest, 5 years for an economic forest, and 2 years for grasslands (Liu et al., 2014).

In 2000, the DCBT executed measures to turn cultivated land into

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[1] Note that mu is a Chinese measure of land area where 1mu = 1/15 ha; the yuan is a Chinese currency unit ($1 = 6.74 yuan as of July 2017).

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forests and grazing land into grassland; these measures were also used to harness the small watersheds and migration for ecological restoration in order to deal with the sandstorms in Beijing and Tianjin. By the end of 2013, the total controlled area reached 10.271 million hectares. The program then moved into the second stage, which had an initial range of 75 counties in 5 provinces that eventually extended to 138 counties in 6 provinces, with a total planned investment amounting to 877.92 billion RMB.

Like the DCBT, the NFPP also entered into the next stage of its project in early 2011. The key components of the new round of the NFPP program included forest tending and the strengthening of non-commercial forest protection, a plan for the policy on logging bans in the natural forest, and the reduction of the use of commercial wood by 50 million cubic meters (ITTO, 2015).

1.2. Key issues and research objectives

The original goal of the PFPs was to repair fragile ecosystems, so the total annual investment from the government is large. In 2013, the resources allocated to the PFPs went up to 31.4% of the entire forestry construction investment (China Forestry Statistical Yearbook, 2013). The implementation of the projects plays a positive role in addressing Chinese farmers' livelihood problems, such as low rural household incomes and the labor force structure (Liu et al., 2014; Ying and Shunbo, 2014). Over the past 3 decades, China has been experiencing the middle-income stage of development, with an annual GDP growth averaging 7.4% (World Bank, 2012; China State Statistics Bureau, 2015). In spite of this great achievement, China's demographic dividends are fading, which are crucial supports for the rapidly developing economy. By 2012, the annual increment of the working-age population shrunk by 3.5 million people (Cai and Wang, 2013). China's labor force supply is in a transition from excess to shortage. Therefore, the reasonable distribution of the labor force between the urban and rural areas is a means to solve the dualistic structural problems and construct a new socialist countryside (Cai, 2010; Cai and Duo, 2011). In the face of such difficulties, the PFPs' goal of solving ecological problems could release a significant proportion of the surplus labor force and change farmers' desires for employment in the non-agricultural market through subsidies; it could also limit logging. The PFPs could be an effective policy measure to solve the labor structure problems in China. They could also reduce the population pressure on the land, since the PFPs would promote local economic development (Yi and Chen, 2006) and decrease the urban-rural income gap with the household's off-farm income, which has been increasing in proportion to the total income (Findeis and Reddy, 1987; Mishra et al., 2002). What effect will the PFPs have on a labor force market that is undergoing profound change? Will it be positive or negative? Or will they have only a subtle impact on rural labor transfer?

1.3. Literature review

In the studies of the labor force distribution focusing on exogenous factors, government policy, as the adjusting instrument for market economy, cannot be ignored. Typically, policy research concentrates more on the evaluation of government agricultural projects. Agricultural policy subsidies are divided into 2 parts, the coupled and decoupled. The coupled subsidies are given to increase farmers' labor margin value in agricultural practices through the planting of particular species of “cash crops”; the decoupled subsidies are, to some extent, obtained without planting any crops (Ahearn et al., 2002; Burfisher and Hopkins, 2003). The decoupled subsidies have 2 kinds of potential impacts. One is the substitution effect, in which labor forces are redistributed between farm and off-farm production activities according to the principle of utility maximization, and this tends to favor work in the off-farm market. The other is the income effect, which relaxes budget constraints because the subsidies increase the household non-labor income. In cases where the original consumption level is unchanged, the labor force's leisure time rises while the amount of time spent working decreases (Burfisher and Hopkins, 2003; Hennessy and Rehman, 2008). Before the enforcement of the 1996 Federal Agricultural Improvement and Reform (FAIR) Act, government agricultural subsidies were usually decoupled, and the income effect was greater than the substitution effect. As a result, they became stumbling blocks during the labor transference into the off-farm market process (EI-Osta and Ahearn, 1996; Mishra and Goodwin, 1997; Ahearn et al., 2002). Hennessy and Rehman (2008) evaluated the influence of the EU Common Agricultural Policy (CAP) on workforce allocation on Irish farms. They found that this government policy's subsidies, as the decoupling reform, had a greater effect on the substitution than income and increased the off-farm working time. With respect to government agricultural financial expenditures, D'Antoni et al., 2012 estimated the effect of these payments on labor migration (including the Loan Deficiency Payments (LDPs)) using time-series data from 1993 to 2007. The results indicated that there was a positive effect on farmers and their spouses, as well as an increase in hiring workers outside of the agricultural sector. Similarly, Chinese scholars drew the firm conclusion that there is a substitutional relationship between agricultural investment and labor force non-farming employment (Ran and Cao, 2007; Cheng and Ruan, 2010). Li and Xiang (2013) analyzed the dynamic influences of government fiscal expenditures for agriculture on rural labor migration by using the State Space Model and VECM (Vector Error Correction Model), and found that expenditures that supported agricultural production, public utilities, and agricultural technology had positive effects that lasted a long time (from 1978 to 2011 in China). The short-term effects were not obvious. The reform of the taxes and fees in China experienced a change, as well, moving from a tax-for-fee system to a cancelation of all agricultural taxes in 1997. In view of this reform, Xu et al. (2009) showed that it made farmers' labor input increase slightly, but not significantly. Farmers arranged the land and labor factors more reasonably to enhance productivity and household income, while there was a significant improvement in the agricultural production awareness.

In comparison to the studies on agricultural policy, the studies of environmental and forestry policy on the issues of labor distribution started relatively late. USDA officials announced that the Conservation Reserve Program (CRP), an environmental economic policy, would be carried out as the dual pressures of environmental problems and economic issues increased, including the excessive exploitation of land resources, serious soil erosion, over-supply of food and the associated price drops, and high budget deficits (Hyde et al., 2003). Although it helped to protect the ecological environment, the effect on off-farm employment was not positive (Ahearn et al., 2006). Unlike the American socioeconomic circumstances, China's Priority Forestry Programs have had more complicated effects on labor allocation. A number of studies have found that the SLCP does not play a significant role in labor force restructuring; in addition, labor force reflows occurred after the workers were no longer engaged in this program (Xu et al., 2004; Uchida et al., 2005; Yi et al., 2006). However, other studies showed that the SLCP freed up a significant proportion of the labor force to work in off-farm jobs because of the decrease in cultivated land (Yang, 2006; Yao et al., 2010). The NFPP has had a direct negative impact on local farmers' and workers' interests, which means that the supply of the labor force is greater than the demand. A new surplus labor force has been built (Liu et al., 1999), and this labor is being transferred to other industries (Hu, 2005; Guo et al., 2005; Yang and Xu, 2009; Zha and Lai, 2010).

Although the impact of environmental economic policy (especially the PFPs) on the labor force allocation has been analyzed in a certain number of studies, there are still some problems. Our paper takes a different approach from that found in previous perspectives on the income impacts of the PFPs (such as that found in Liu et al., 2014). This paper examines how the KPFPs change the labor factor distribution between farm production and off-farm employment in order to assess the programs' effects. Past research has concentrated on only one of the PFPs and rarely investigated more than one program, let alone an integrated evaluation of the interactions among the PFPs. The interactions between the SLCP and NFPP are included in our model. Due to the difficulty of field investigations and limitations of survey data, most research conclusions have not included enough data, but used a single region or discrete time series sample. Here, we use a unique panel dataset of 1158 sample households with a long time series and broad cross sections to estimate the impacts of the KPFPs on the rural labor supply. This large and comprehensive dataset covers 15 counties of 6 provinces and spans over 18 years, from 1995 to 2012. Most of the existing research analyzed the initial stages of the SLCP's first phase, so the conclusions from these works are not significant. One of the main reasons is that the labor time, which is released from forestry production, has been largely put into building individual's houses or switching to herding (Uchida et al., 2007). We therefore used the long-term survey dataset to estimate the impacts of the KPFPs with different policy stages in order to master the variation in the rural labor allocation. This approach also avoids the estimation errors of the short-term model. To the best of our knowledge, few studies have been involved in regional levels to deal with the KPFPs assessment. Our work can help estimate the impacts of the SLCP, DCBT, and NFPP on rural labor in different counties to address this gap. An important feature of our paper is that the cluster effect has been considered in the integrated assessment. Typically, only using the ordinary least square (OLS) method without taking into consideration the correlation of the errors at the province or county level could result in incorrect inferences. Therefore, we chose the fixed-effect model as our main analysis approach with clustered standard errors, which were controlled for heterogeneity at the county level.

The rest of our paper is as follows: “Impact Mechanisms” discusses the mechanisms of the KPFPs' impact on rural labor distribution by using models and graphics. “Data and Descriptive Facts” presents the data. “The Model” presents our model and descriptive statistics of the variables in it. “Econometric Findings” elucidates the role of the KPFPs in rural off-farm employment and the empirical results from 3 aspects. The last section is the conclusion.

2. Impact mechanisms

2.1. Model mechanisms of the KPFPs' impacts on rural labor distribution

The agricultural household model is mostly used to discuss the decisions of rural labor behavior in a theoretical framework (Ahearn et al., 2006; Hennessy and Rehman, 2008; Cheng, 2014). This household model combines agricultural production, consumption, and labor time allocation into a consistent equation according to the principle of utility maximization. The individual is supposed to distribute all of their time into leisure time, agricultural work, and non-agricultural work in such a fashion that the optimal distribution can be obtained if the marginal values of every activity are the same (Becker, 1965; Singh et al., 1986).

First, we created an objective function based on an agricultural household's utility maximization:

$$MaximizeU = U(C, L) \tag{1}$$

Subject to:

$$T = L + E + F \tag{2}$$

$$P_c C = W_e E(H, M) + P_f C_f - W_f X_f + SUB_f - TAX_f + V \tag{3}$$

$$C_f = f(A, F, X_f, Z) \tag{4}$$

In Eq. (1), C is the consumption of goods while L is the leisure time. Eq. (2) is for the time constraints, where T denotes the total time; L, E, F represent the time allocated to leisure, off-farm work, and farm work, respectively. Eq. (3) is for budget limitations, where P_c is the price of goods consumed, W_e is the wages from the off-farm employment, and H denotes the individual capital, which is put into off-farm work by farmers. M denotes the off-farm labor market conditions, then P_f and C_f are the price and the quantity of agricultural production. W_f is the farm input price, X_f is the farm input quantities (including fertilizers and pesticides), and SUB_f denotes the agricultural subsidies that farmers get from the government. TAX_f denotes the agricultural taxes imposed and V denotes the non-labor income, which is like the government paying for farmers to not plant any crops. Eq. (4) comes from the production technology constraints, where A is the cultivated land of a household; Z describes the local environment characteristics (including the weather conditions and soil productivity).

Through solving the above equations and then taking the first derivative, the optimal conditions for the off-farm time allocation can be found. These conditions depend on the leisure and farm work time:

$$E = T - L - F = f(W_e^*, (P_f C_f - W_f \mathrm{X}_f + \mathrm{SUB}_f - \mathrm{TAX}_f), \mathrm{H}, \mathrm{M}, \mathrm{V}) \tag{5}$$

Among the factors of Eq. (5) that can affect the optimal allocation of the labor time, the KPFPs may impact the farmers' choices directly or indirectly in 3 ways.[2] First, participating in the KPFPs would directly vary the land quantity. In the SLCP and DCBT, slope land is returned to ecological or economic forest and some crop fields are converted into shelter-forest to act as a wind prevention, sand fixation and cut soil erosion. That is, the household land factor A decreases and then the labor factor would be set free. These surplus laborers would have to work outside to maintain their current utility and ensure that their marginal values for their labor time are unchanged (or even increased). In the NFPP, commercial logging is banned in the upper part of the Yangtze River and the midstream area of the Yellow River. It is restricted mostly in other forested regions. This leads to a decline in the part of the household income that comes from logging ($\mathrm{P}_f \mathrm{C}_f - \mathrm{W}_f \mathrm{X}_f$). Therefore, these individuals tend to transfer into the off-farm market to stabilize their income.

Second, the KPFPs could cause a blockage when labor forces allocate their time to off-farm work. This is because those household lands involved in the SLCP are mostly of poor quality. The farmers cannot make high profits from these lands. If the remainder, which is richer, could be made good use of with additional capital and labor time, its marginal value would increase and household agricultural income would be raised. Since the primary goal of the KPFPs is to improve the ecological environment, once the local environment condition Z improved, there could be a positive increase in the crop output. So to some extent, farmers can be re-attracted to do the work based on the high quality of the land.

Finally, the important point is that the government subsidizes the KPFPs. Farmers, who have to participate in the SLCP or DCBT, obtain the related subsidies according to the area of returned land. This kind of subsidy is not associated with growing crops on the involved land, but is similar to the decoupled government subsidies mentioned in our literature review. Therefore, this subsidy from the programs has 2 different results: an income effect and a substitution effect. The government payment effect is related to how individuals make decisions in developed and developing countries (Uchida et al., 2009). The average income level of farmers in developed countries is higher than that in developing countries, so farmers have a higher marginal value of income in developed countries. Although subsidies can improve farmers' non-labor income, higher wages from off-farm jobs are more attractive and make farmers leave farm work. However, farmers have to pay more money to migrate for an off-farm job in developed countries. That causes them prefer to stay on the farm instead of going out to work. In this paper, we analyze which of the KPFPs' effects is greater in China.

[2] See Appendix A.

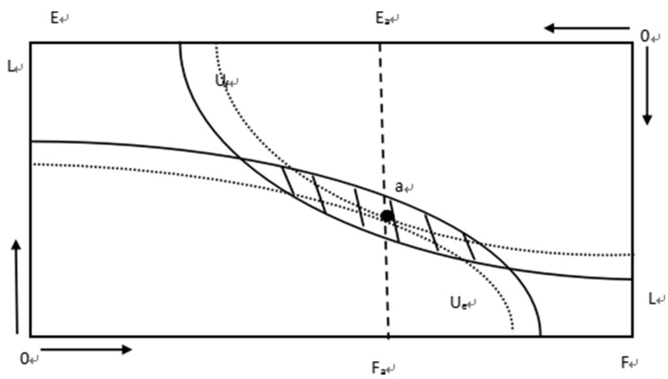

Fig. 1. The individual time allocation's Edgeworth Box.

2.2. Graphical mechanisms of the KPFPs' impacts on rural labor distribution

We illustrate individuals' leisure time, farm work time, and off-farm work time with the Edgeworth Box (see Fig. 1) in order to show how labor element allocation occurs under the KPFPs.

Different from previous researches, we focus on the working time of farmers rather than decision to work outside. The labor force, as a special factor of production, needs to be in contact with objects to play its part. Therefore, to measure the role of labor force in the social and economic relationship, it is needed to determine the magnitude of value in the abstract connection between labor force and its value to explore the flow of labor force. That is to confirm the work time.

We assumed that one person's total time could be divided into 2 parts: leisure time (L) and time for work. Furthermore, the work time was separated into farm work (F) and off-farm work (E); either of these values could replace the other completely. In this figure, U_f is drawn as the indifferent curve of the leisure time utility and farm work time utility. U_e is another indifferent curve for the utility of the leisure time and off-farm work. When the curve of U_f is tangent to U_e at point a, the marginal rates for the substitution of farm work and off-farm work are equal. At this point, we believe that the time resource location is the Pareto efficiency between E and F. Therefore, the combination (F_a, E_a) is optimal. During the process of these utility curve moves, the KPFPs play a role in changing the indifferent curve U_f by land reconfiguration, environmental improvement, and other programs like these. These activities would lead to the creation of a new indifferent curve for the farm work utility and change the location of the point of contact. As a result, the optimal combination would vary.

3. Data and descriptive facts

The data used in this paper come from rural surveys made by a State Forestry Administration research team in China. Their study subject, *The Priority Forestry Programs and Eradication of Poverty*, was supported by the Asian Development Bank and China's Ministry of Finance. A stratified random sampling strategy was used to collect rural household data. First, according to the geographic coverage of the KPFPs, the condition of the enrollment in the KPFPs, and general regional income distribution, 15 counties were chosen in 6 provinces, including Sichuan, Jiangxi, Hebei, Shaanxi, Shandong, and Guangxi. The number of counties in each province was selected according to the treatment of the KPFPs. For instance, the average SLCP government investment weight of the total PFP government investment in Sichuan was 25.27% over the span of 14 years (2000 − 2013). That is why most of the counties in this province were chosen as part of the sample data. Shandong province was selected as the control group since it does not have any forest programs currently being carried out; we only included one county from Shandong province (Pingyi County). The sample townships, villages, and households were randomly chosen in each selected county. The number of sample townships in each county was generally 6 while the number of sample villages in each township was 3. In every sample village, 15 households were chosen as the final respondents. In order to ensure our survey quality, preliminary research, group discussions, and adjustments to the research plan were conducted. Our questionnaire had 3 different levels: townships, villages, and households. These complemented each other nicely.

This survey began in 2004. For the initial field work, we helped interviewees to recall their production activities and other relevant information back to 1995, before they participated in the KPFPs. We then interviewed those same households every other year to collect the survey data, which included family characteristics, household economic structure, and program enrollment conditions. This tracking survey was conducted 5 times and a unique long-term panel dataset was built from 1995 to 2012 using the treatment and control households.

We did not obtain the complete information for all the initially-chosen households in all of the years, and there were some missing data. This is partially because some households migrated into townships or other provinces, so we could not contact them anymore. Some interviewees failed to remember their production activities and employment conditions clearly, so we could not use their information. Human error was also introduced by our interviewers. We finally obtained balanced panel data of 1158 sample households over 18 years from 1995 to 2012. We compared the variables for the off-farm work time in the unbalanced panel dataset with the balanced one by using the one-way analysis from the variance method to ensure that there were no significant errors before and after culling the incomplete household data. The test results showed that this fluctuation had little effect on our main variable.

Our survey panel dataset covers almost main forest regions in China. It therefore has a strong representation with: 115 households in Nanbu county, 117 households in Nanjiang county, 148 households in Mabian county, 54 households in Muchuan county of Sichuan province; 118 households in Pingquan county,19 households in Zhangbei county, 63 households in Yi county of Hebei province; 33 households in Xiushui county, 99 households in Xingguo county, 91 households in Suichuan county of Jiangxi province; 25 households in Zhenan county,88 households in Yanchang county of Shaanxi province; 53 households in Huanjiang county,59 households in Pingguo county of Guangxi province; 76 households in Pingyi of Shandong province. We calculate kinds of the KPFPs involved in each county.[3] Some of these counties has participated more than one of the KPFPs. For example, four counties in Sichuan province has carried out the SLCP and the NFPP, and two counties in Shaanxi province has also participated in these two programs. That is why we have to consider about interaction effects between different programs in our econometric.

3.1. The KPFPs and sample famers' off-farm work time

The average off-farm work time of sample households rose 122.05% in 2012 from 1998, according to the figures in Table 1, appearing an upward trend. Before 2002, off-farm work time of sample farmers not participated in the SLCP had been more than that participated in this program so that the difference was negative. However, absolute value of the difference decreased from 22.00 persons-days to 11.12 persons-days. From 2003 to 2012, off-farm work time of households participated in the SLCP had been increasing continuously, going over those not participated. Notably, the difference in 2008 was the largest with 25.76 persons-days. As to the farmers participated in the DCBT, their off-farm work time was all less than those who was not in this program significantly. It had the greatest difference in 2004 with 106.34 persons-days, while the difference was the least in 2010 with 12.40 persons-days. Finally, considering about the NFPP's effect, off-farm work time of famers in this program had been not higher than that of others

[3] See Appendix B.

Table 1
Off-farm work time of sample households participated and non-participated in the KPFPs from 1998 to 2012 (persons-days).

Years	All Samples	Non-participated in the SLCP	Participated in the SLCP	Difference	Non-participated in the DCBT	Participated in the DCBT	Difference	Non-participated in the NFPP	Participated in the NFPP	Difference
1998	117.23	117.23*	–	–	–	–	–	115.46	156.32	40.86**
1999	129.96	131.78	109.78	− 22.00**	129.96	–	–	126.22	196.06	69.85***
2000	147.56	150.64	133.50	− 17.14	147.56	–	–	145.39	186.49	41.10
2001	164.56	168.08	150.95	− 17.13***	164.56	–	–	160.96	226.08	65.12
2002	177.93	181.32	170.20	− 11.12***	183.82	90.41	− 93.41***	174.80	228.93	54.13
2003	190.10	185.45	196.62	11.17	200.96	103.49	− 97.47***	187.35	231.01	43.67
2004	197.78	192.58	204.93	12.35	209.90	103.56	− 106.34***	194.16	257.71	63.55
2005	208.11	207.86	208.43	0.57	217.76	129.06	− 88.70***	205.14	226.79	21.66
2006	219.02	215.64	223.40	7.75	230.03	129.69	− 100.34***	215.12	242.84	27.72
2007	255.36	246.96	265.70	18.73**	264.51	181.07	− 83.44***	256.65	250.13	− 6.52
2008	276.18	264.88	290.64	25.76	287.97	182.16	− 105.81***	280.01	262.60	− 17.41
2009	240.19	235.38	246.03	10.65	241.54	227.54	− 14.00**	238.40	262.20	23.79
2010	242.68	237.34	249.16	11.82	243.88	231.47	− 12.40**	241.01	263.22	22.21
2011	257.09	255.55	259.00	3.46	266.11	169.36	− 96.75***	260.17	234.49	− 25.68
2012	260.31	258.37	262.72	4.36	269.42	171.72	− 97.70***	263.17	238.77	− 24.40

* Means significant at 90% level.
** Means significant at 95% level.
*** Means significant at 99% level.

in most years except for 2007, 2008, 2011 and 2012. But the difference was significant only in the span of two years (1998–1999).

3.2. Regional differences between the KPFPs and sample farmers' off-farm work time

The reasons for these results are related to regionalism, which means that the numbers of participants who enrolled, degree of implementation, and other aspects related to the program were not the same in every region. There were a number of effect trends for the average off-farm work time of the sample households enrolled in the SLCP in the provinces from 1999 to 2012 (see Fig. 2). In Sichuan, Jiangxi, and Shaanxi, the trend for the average off-farm time allocation showed an increased basis (with some fluctuation) and Shaanxi had to be pointed, especially because of its larger increase in the peasant-workers' time between 2006 and 2008. The trend for Hebei rose in 2007 after falling slightly from 2002, but dropped to its lowest point again in 2009. Guangxi showed a high level wave as a whole and experienced a rising stage before 2008, with large reductions in 2011; this trend leveled off until 2012. Guangxi experienced smaller growth compared to that found in 2002. Therefore, it is not enough to only consider the influence of the participating KPFPs on the overall sample of farmers. The regions have to be further divided into different provinces and even different county territories.

The *Impact Mechanisms* analysis indicated that the KPFPs, especially the SLCP, affect the distribution of the farmers' time though

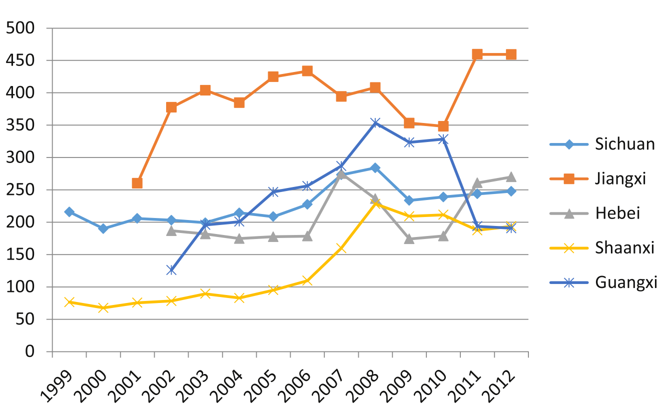

Fig. 2. Average off-farm time allocation dynamics of sample households participated in the SLCP from 1999 to 2012 (person days).

government subsidies. For farmer households converting farmland into forest, the relevant subsidies from the government are 140 yuan/mu in the Yellow River basin and 210 yuan/mu in the Yangtze River basin. There are therefore different effects on the labor time distribution in the basins due to the varying amounts of subsidies (see Table 2). From the items shown in Table 3, we see that the average off-farm work time of the sampled farmer households participating in the SLCP in the Yangtze River basin was higher than that found in the Yellow River basin over the span of 14 years. However, as time went on, the absolute value of the difference was gradually reduced. It decreased 61.74% to 48.32 person days in 2010 compared to the number of those days in 1999. After 2010, the difference slowly improved until 2012, but it had still not yet exceeded the values from 2007.

3.3. The KPFPs' different policy stages

In addition to the influence of the different regions, a number of policy stages also changed farmers' off-farm work time through changes of the subsidy terms. We considered the KPFPs' specific policy implementations in order to divide projects into policy stages for further detailed analysis. The SLCP has been carried out since 1999. Farming households who returned farmland to economic forest or ecological forest were given subsidies for 5 years or 8 years, respectively. The first

Table 2
Average off-farm time of sample households participated in the SLCP in different basin from 1999 to 2012 (person days).

Year	The Yellow River basin	The Yangtze River basin	Difference
1999	49.26	175.57*	126.31***
2000	44.11	181.84	137.73***
2001	49.87	198.37	148.50***
2002	89.46	207.24	117.78***
2003	95.09	228.80	133.71***
2004	98.45	236.28	137.83***
2005	115.69	238.85	123.17***
2006	126.15	255.38	129.23***
2007	163.22	294.87	131.65**
2008	215.11	312.99	97.88***
2009	208.69	257.63	48.94**
2010	212.30	260.61	48.32**
2011	170.24	285.03	114.79***
2012	180.28	286.90	106.62**

* Means significant at 90% level.
** Means significant at 95% level.
*** Means significant at 99% level.

Table 3
The number of sample households' enrollment in different stages of the KPFPs.

Year	The SLCP			The DCBT		The NFPP	
	First stage	Second stage	Third stage	First stage	Third stage	First stage	Second stage
1997	0	0	0	0	0	0	0
1998	0	0	0	0	0	50	0
1999	96	0	0	0	0	62	0
2000	208	0	0	0	0	61	0
2001	238	0	0	0	0	64	0
2002	353	0	0	73	0	67	0
2003	482	0	0	129	0	73	0
2004	484	4	0	132	0	66	0
2005	483	19	0	126	0	159	0
2006	475	30	0	127	0	163	0
2007	380	0	139	114	13	229	0
2008	275	0	233	108	21	255	0
2009	249	0	274	95	16	278	0
2010	163	0	360	41	70	278	0
2011	155	0	361	39	69	0	322
2012	155	0	361	39	69	0	322

Note: there is no sample household in the second stage of the DCBT.

round of government subsidies had finished by the end of 2003 and the second one started in 2007. These caused the farming households enrolled in the first policy stage of the SLCP to continue reforestation, but without any additional cash. According to this specific policy implementation, we divided the whole process into 3 stages: from 1995 to 2003, from 2004 to 2006, and from 2007 to 2012 (we divided up the segments for the DCBT the same as for the SLCP). However, the NFPP did not have detailed subsidies rules for every enrolled farming household, so we could only divide its policy process into 2 stages: from 1998 to 2010 and from 2010 to 2011. Table 3 shows the number of sample households' enrollment.

4. The model

In past models, a labor participation model and labor supply model were chosen to measure the labor factor allocation problem (Singh et al., 1986; Cheng, 2014). These 2 models use the labor participation rate and labor supply time as dependent variables. However, it is not easy to get data about the labor supply time. There are inevitable human errors that occur during the process of the survey, so most studies tend to use a labor participation model for the empirical analysis rather than the labor supply time data because of its weak reliability (Huffman and EI-Osta, 1997). However, if the reliability of the supply time data could be guaranteed, the labor supply model's explanation is much stronger (Hennessy and Rehman, 2008; Cheng, 2014). We conducted a field tracing investigation for our paper to ensure the quality and integrity of the data.

We used 4 independent variables for the basis of the theoretical analysis framework to gauge the labor off-farm supply time: market factors, family characteristics, external environmental factors, and the implementation of the KPFPs. Our econometric equation is shown in Eq. (6).

$$Y_{it} = \alpha_0 + \sum_{n=1}^{n_1} \alpha_{n_1} M_{itn_1} + \sum_{n=1}^{n_2} \beta_{n_2} X_{itn_2} + \sum_{n=1}^{n_3} \gamma_{n_3} Z_{itn_3} + \sum_{n=1}^{n_4} \lambda_{n_4} P_{itn_4} + \theta_{it} + \varepsilon_{it} \tag{6}$$

where M_{itn_1} represents variables for the market factors. In theory, the core of the labor time allocation between the departments mainly lies in the labor wage rates gap (Lewis, 1972; Fei and Ranis, 1964; Todaro, 1980; Stiglitz, 2013). However, considering that it is hard to measure the market wage rate directly, we used the village-level average nonagricultural work wage and village-level average return on farmland work to replace the wage rate in the various departments. Additionally, the production costs per unit area, agricultural subsidies, and taxation were included. X_{itn_2} represents the variables for the family characteristics. It should be noted that labor act decisions, to a great degree, are a result of the whole family's decision (Mincer and Polachek, 1974). Meanwhile, the head of a household is the primary family decision maker, so the personal characteristics of the head of the household have to be considered, such as gender, age, and years of education. Other factors represent the basic condition of the family as a whole, such as whether there are children receiving an education in the family, household size, and the area of farmland and forestland per capita. Z_{itn5} denotes the external environmental conditions and we set a dummy variable for the road conditions in the sample villages to reflect it. P_{itn_4} represents the KPFPs implementation and it includes whether people participated in the project and the farmland areas enrolled. The interaction between the SLCP and NFPP was included.[4]

In the labor supply model, we used the labor off-farm work time as the dependent variable. A Hausman test was used to determine whether a fixed effect model or a random effect model should be chosen (Wooldridge, 1999). The test results showed that a fixed effect model was needed at a 0.01 confidence level to control unobserved fixed factors that may confound the estimation. Furthermore, although the correlation could be eliminated by the fixed effect, there is still intra-class correlation issues unobserved in error term ε_{it}. An intra-class correlation indicates that there is a degree of household consistency within a certain scope and, if this consistency is high, then a new farming household could provide less unique information. To deal with it, we estimated the degree of the intra-class correlation with the Intra-Cluster Correlations (ICC).[5] The concept of the ICC was first put forward in the field of Biostatistics (Harris, 1912), and Bartko (1966) applied it in Sociology to evaluate reliability.

To test whether there was self-selection during the enrollment process of the KPFPs, we used village-level participating condition as instrumental variable to conduct Hausman test. The result showed to reject the null hypothesis with p equaled to 1.00. So, endogeneity of participating in the KPFPs could not be taken account. Moreover, most previous studies have indicated that the government, to some extent, is mandatory on the issues of farmer households participating the KPFPs (Mullan and Kontoleon, 2012; Liu et al., 2010). Therefore, our paper would not consider it.

5. Econometric findings

Based on the labor supply model with the fixed effect and cluster effect, the empirical results demonstrate the impacts of the SLCP, DCBT, and NFPP on laborers' off-farm working time from 3 aspects and at different stages of the policy implementations.[6]

5.1. Overall estimated effect

The standard error in the fixed effect model with the cluster effect is larger, resulting from the existence of the intra-class correlation in the sample dataset. Given that the results would be biased if the cluster effects are not considered, the conclusions from the fixed cluster model are more significant. Further, model 1 and model 2 are used to measure the impacts of the KPFPs from the project participation and participation areas (See Table E.1).

The econometric findings of the SLCP, DCBT, and NFPP Priority Forestry Programs show the different effects on the labor off-farm supply. Model 1 shows the fixed and cluster effects; participation in the SLCP and DCBT are both significantly positive at a 95% confidence level, while the NFPP is not significant. Specifically, participation in the

[4] Descriptive statistics of household survey data could be seen in Appendix C.
[5] The formula and calculation could be seen in Appendix D.
[6] See Tables E.1–E.3 in Appendix E.

Table E.1
Estimated coefficients of labor supply model regression.

Independent variable		Model1		Model2	
		FE	FE & cluster effect	FE	FE & cluster effect
Gender of household head (if man = 1;otherwise = 0)	X_1	0.47 (0.47)	0.47 (0.96)	0.44 (0.47)	0.44 (0.97)
Square of household head's age	$\ln X_2^2$	− 0.49*** (0.15)	− 0.49*** (0.13)	− 0.50*** (0.15)	− 0.50*** (0.13)
Age of household head (year)	$\ln X_2$	3.16*** (0.46)	3.16** (1.24)	3.15*** (0.46)	3.15** (1.24)
Education level the household head (if received education = 1;otherwise = 0)	X_3	0.59*** (0.14)	0.59* (0.31)	0.59*** (0.14)	0.59* (0.31)
Headman of village (if yes = 1;otherwise = 0)	X_4	0.58*** (0.23)	0.58 (0.52)	0.56** (0.23)	0.56 (0.52)
Children receiving education (if yes = 1;otherwise = 0)	X_5	− 0.46*** (0.09)	− 0.46 (0.29)	− 0.44*** (0.09)	− 0.44 (0.29)
Household size (person)	$\ln X_6$	4.99*** (0.16)	4.99*** (0.36)	5.00*** (0.16)	5.00*** (0.35)
Farmland area per capita (mu)	$\ln X_7$	− 0.04 (0.03)	− 0.04 (0.06)	− 0.03 (0.03)	− 0.03 (0.06)
Forestland area per capita (mu)	$\ln X_8$	0.06*** (0.01)	0.06** (0.02)	0.06*** (0.01)	0.06** (0.02)
Road condition (if hard road surface = 1;otherwise = 0)	Z_1	0.57*** (0.14)	0.57 (0.39)	0.57*** (0.14)	0.57 (0.39)
Village-level off-farm work wage (yuan/person-days)	$\ln M_1$	0.26*** (0.02)	0.26** (0.10)	0.27*** (0.02)	0.27** (0.10)
Village-level land-based work wage (yuan/person-days)	$\ln M_2$	− 0.02 (0.05)	− 0.02 (0.09)	− 0.03 (0.05)	− 0.03 (0.09)
Production costs per unit area (yuan/mu)	$\ln M_3$	0.01 (0.02)	0.01 (0.02)	0.00 (0.02)	0.00 (0.01)
Agricultural subsidies per unit area (yuan/mu)	$\ln M_4$	0.07*** (0.01)	0.07* (0.03)	0.07*** (0.01)	0.07* (0.03)
Agricultural tax per unit area (yuan/mu)	$\ln M_5$	0.02***(0.01)	0.02 (0.04)	0.03***(0.01)	0.03 (0.04)
The SLCP (if yes = 1; otherwise = 0)	P_1	0.88*** (0.14)	0.88** (0.33)		
The NFPP (if yes = 1; otherwise = 0)	P_2	0.35 (0.25)	0.35 (0.31)		
The DCBT (if yes = 1; otherwise = 0)	P_3	0.68*** (0.24)	0.68** (0.31)		
Both the SLCP and the NFPP (if yes = 1; otherwise = 0)	P_4	− 1.08*** (0.29)	− 1.08*** (0.29)		
Area enrolled in the SLCP (mu)	$\ln P_5$			0.07*** (0.03)	0.07 (0.04)
Area enrolled in the NFPP (mu)	$\ln P_6$			− 0.03* (0.02)	− 0.03 (0.04)
Area enrolled in the DCBT (mu)	$\ln P_7$			0.07*** (0.02)	0.07* (0.03)
Interaction of area enrolled in the SLCP and the NFPP	$\ln P_5{*}P_6$			− 0.00 (0.00)	− 0.00 (0.01)
Constant	cons	− 15.88*** (1.41)	− 15.88*** (4.76)	− 14.66*** (1.49)	− 14.66** (5.13)
R^2		0.09	0.09	0.09	0.09

FE is for fixed effect; FE & Cluster Effect is for fixed and cluster effect.
* Means significant at 90% level.
** Means significant at 95% level.
*** Means significant at 99% level.

SLCP increases off-farm work time for 2.41 person-days ($e^{0.88}$), higher than that of the DCBT increase of 1.97 person-days ($e^{1.97}$). After considering the interaction effects, independent effect of the SLCP becomes 2.12 person-days ($e^{0.75}$). In comparison to the results of the fixed effect in model 1, the significance level of the SLCP and DCBT's regression coefficients declined from 10% to 5% under the cluster effect. This prompted us to consider the intra-class correlation one more time. Likewise, the interaction between the participation in the SLCP and NFPP had a significant effect on the off-farm labor supply and the regression coefficient is 1.08 at a 99% confidence level. On the other hand, model 2 examines another indicator, the enrolled area in the project, for further evaluation. After processing with the fixed and cluster effects, only the DCBT-enrolled areas can still positively affect the off-farm labor time with a correlation coefficient of 0.07 at a 90% confidence level. However, the effects of the SLCP, NFPP, and their interaction are no longer significant. Notably, it is interesting that the regression results of the NFPP in model 2 are not only insignificant, but also negative, which is in contrast to the results from model 1. This could be the result of some farming households in larger enrolled areas in the NFPP that are still being encouraged to engage in planting during the woodland or afforestation activities being carried out by the government (Li et al., 2008).

In model 1 and model 2, the regression results of the family characteristics, market factors, and external environmental factors are basically identical. This proves that the survey data used in our paper has a high stability and the regression results are reliable. Therefore, we decided to only focus on model 1. We found that the gender of the head of the household had no pronounced effect, regardless of whether that person was a village leader, had children in school, or had a certain amount of farmland. The influence of the age of the head of the household age is affected by its quadratic component and this impacts off-farm work time negatively at a 99% confidence level. The age itself has a positive effect, at a 95% confidence level. The relationship between the age of the head of the household and the off-farm labor work time is an inverse U shape, which means that as the age increases, its promotion first increases and then decreases. More years of schooling of the head of the household are correlated with an increase in off-farm work time, with a 0.59 regression coefficient at a 90% confidence level. Also, the influence of the family population is most significant, suggesting that more people will lead to more off-farm work time, with a 4.99 regression coefficient. Additionally, the forested areas per capita have a positive impact on the off-farm labor time rather than the farmland areas per capita, with a 0.06 elastic coefficient at a 95% confidence level. To some extent, this is due to the particularity of forestry, where the early stages need more labor time input than the later stages. Therefore, some labor time could be allocated into the off-farm employment market in the later stages.

Second, the contributions of the village-level off-farm work wage and village-level land-based work wage to the off-farm labor time are in opposition, with the former being positive at a 95% confidence level and the latter being insignificantly negative. This suggests that the high wages of the non-agricultural market are appealing to farmers. Moreover, the production costs per unit area are positively correlated with off-farm work, indicating at some level that there is substitutability between capital and labor. The agricultural tax per unit area under the fixed effect is significantly positive, but not obvious after the cluster effect processing. The agricultural subsidies per unit area, another agricultural policy variable, has a positive effect on the off-farm labor supply, with a 0.07 elastic coefficient at a 90% confidence level (this finding is different from previous research). Finally, the regression results indicate that access to a hard surface road does not significantly benefit the off-farm labor supply time. That is mainly because of the increasing percentage of hard roads in each province. For instance, this percentage was as high as 80.3% in Shandong in 2012. The importance of pavement improvements in promoting the movement of farmers into the non-agricultural market has weakened.

5.2. Effects in the different regions

The effect of the KPFPs on labor supply was considered from 3 perspectives: the river basin, province, and county in paper. The identical R^2 in model 1 and model 2 proves once again that the data used are stable. In the regression model of the river basins, we only considered the differences in the SLCP according to the subsidies and distribution of the sample households. The results in model 1 are similar to those in model 2. Under the fixed and cluster effect processing, it is in the Yangtze River basin where participation is positively correlated with the off-farm labor time while in the Yellow River basin where the participating areas in the SLCP are positively correlated (a 99% and 90% confidence level, respectively). The corresponding coefficients are 0.95 and 0.28. After considering the interaction effects, independent effect of the SLCP in Model1 becomes 0.82 accurately.

There are 5 provinces involved in the SLCP. In Sichuan, Jiangxi, and Shaanxi, participation in the SLCP has caused the off-farm labor time to increase significantly. The regression coefficient is 1.87 in Shaanxi, which is higher than that in other 2 provinces. In contrast, there is a negative effect of the SLCP in Hebei (at a 99% confidence level), suggesting that second plowing would potentially appear. In addition, the impact of the SLCP is not totally remarkable in Guangxi. The participating areas are still positively correlated with off-farm labor time in Jiangxi and Shaanxi, with elastic coefficients of 0.12 and 0.16, respectively. For the NFPP, there are 2 provinces involved. In Sichuan, the participating areas caused an off-farm time decrease with a 7% degree of influence at a 95% confidence level. However, in Shaanxi, there was no significant effect. For the DCBT, only farming households in Hebei province were involved in it, so the participation or participating areas did not matter. This result is consistent with the estimated one in results of 5.1.

Furthermore, we performed the domain decomposition to the county level to analyze the different impacts of the KPFPs on the off-farm allocations. Fixing the cluster effect to the county level, we thus considered the county influences without the cluster effect processing. The regression results show that participation in the SLCP in 4 counties of Sichuan caused the off-farm labor time to increase, especially in Muchuan County (which had the highest regression coefficient after considering the interaction effect, 1.84). However, among the other participating areas, only Nanjiang County experienced significantly positive impacts. Moreover, regardless of the participation or area, the counties in Jiangxi province experienced a significant increase in off-farm work. The positive impact of the SLCP in Xiushui County is the largest, with regression coefficients of 2.74 and 0.27. Because Yi County is the only one enrolled in the SLCP in Hebei province, the regression result of 5.2 is the same as that in results of 5.1. Additionally, Yanchang and Zhenan counties in Shaanxi province show that one is significantly positive and the other is not obvious. Nevertheless, the impact of the SLCP in 2 counties of Guangxi is not significant, which is consistent with the provincial results. Among the 6 counties related to the NFPP, it is only in Muchuan where the 2 indicators are positively correlated with the off-farm labor supply; the coefficients are 3.14 at a 99% confidence level and 0.12 at a 95% confidence level. For the DCBT, Pingquan was the only region where the project caused off-farm work time to increase significantly.

5.3. Effects in different policy stages

Due to the longer life span of the KPFPs, we classified the SLCP and DCBT according to the varieties of the trees and governmental subsidies, while the NFPP was classified according to national policy modification time for different policy stages.

The 2 kinds of results from the fixed model and fixed cluster model have the same shape as that shown above. After the cluster effect is taken into consideration, the coefficient of participation in the first stage of the SLCP is 0.92 at a 99% confidence level. However, the other stages are not obvious, and have different results from those of the fixed model. Notably, the project impact during the second stage was negative but positive again in the third stage for both the fixed model and fixed cluster model. Therefore, this suggests that governmental subsidies in the SLCP are useful for increasing farmers' off-farm work time. Their most significant impact exists in the early involvement stage. Moreover, the first stage and third stage of the DCBT both have positive effects in the 2 models and the coefficient in the third stage is higher than that in the first stage (1.21 and 0.54, respectively). Here, it should be noted that more farmers tended to go out as migrant workers to increase their income at the beginning of the project, mainly because the amount of arable land shrunk. Meanwhile, the industrial structure of the households began to change. After a period of adjustment, the structure went into a stabilization trend and the promotion of the SLCP or DCBT became weaker. In addition, as urban household register barriers and labor right security defects increased in China, some farmers also gave up the off-farm employment and turned to second plowing. However, there is no obvious relationship between off-farm employment and the NFPP. The key issue is the government subsidies, which were not distributed to each household.

6. Conclusion and discussion

This study was conceived mainly by the desire to show a succinct relationship between the KPFPs and rural off-farm labor supply so that their implementation and impact could be better understood to further enhance policy making. Instead of gauging these impacts with only one fixed model, we used the labor supply model with both fixed and cluster effects as well as data collected from 6 provinces from 1995 to 2012. Generally speaking, the KPFPs have a certain effect on rural off-farm employment, but because of the varying content of local policies, goals, and implementation processes, the degree of influence is inconsistent.

Our results showed a number of important facts. In comparison with other the 2 programs, the contribution of the SLCP to the rural off-farm labor supply is significantly positive. Obviously, its impact mainly comes from the decrease in farmland and the smaller planting scale, which resulted in changes in land use and release of more surplus labor time. From the estimated regression results in the different basins, the government subsidies, which are gained by participation in the KPFPs, could not be ignored due to their positive effects. The percentage of the SLCP subsidies as a proportion of a household's entire income is calculated in Table 4. We found that the percentage dropped gradually to 2.344% in 2012 from 2005, which indicates that farmers in China did not give up opportunities for higher income, even with the existence of subsidies. So, the government subsidization of the KPFPs tends to be decoupled, and the substitution effect is greater than the income effect in reducing the off-farm employment costs and risk of unemployment as material security. However, it should be noted that the impact of the SLCP on the off-farm labor supply is higher in the first stage and not obvious in the rest of the stages. This may be caused by the decline of the decoupled subsidies and the increase in the unemployment risk. As a result, farmers did not allocate their labor time to go outside for off-farm work with a higher transfer cost. Additionally, since the labor market in China is highly regulated, and creates issues such as the

Table 4
Percentage of the SLCP's subsides in household income (%).

Year	The percentage (%)	Year	The percentage (%)
1999	1.37	2006	6.96
2000	2.75	2007	6.67
2001	2.87	2008	6.15
2002	4.92	2009	5.07
2003	7.09	2010	4.28
2004	7.03	2011	2.84
2005	7.54	2012	2.34

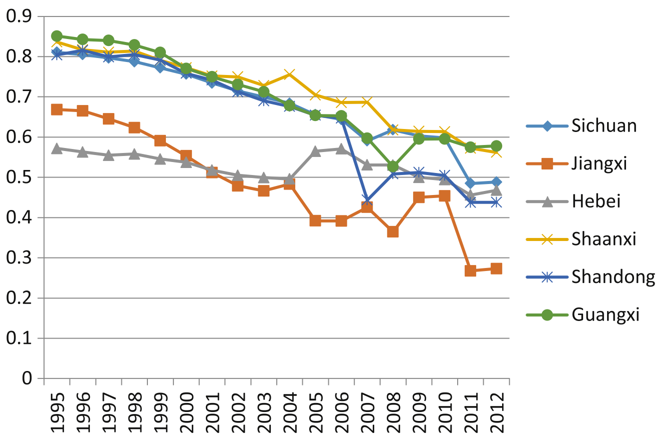

Fig. 3. The proportion of land-based labor input in different provinces.

urban household registration problem, off-farm income is not desirable so farmers frequently return to performing agricultural work. The implementation process in the DBCT is consistent with that in the SLCP for the conversion of cultivated land into forests, so the participating households obtain the subsidies from the government. In addition, environmental migrant and grassland treatment are included in this program. Due to prohibited grazing in the project region and the rise in feed costs, households depending on animal husbandry for their livelihood have to adjust themselves to a more productive structure. They typically give up agricultural activities to seek off-farm employment. Overall, the impact of the DCBT on the rural off-farm labor supply is weaker than that of the SLCP, mainly because of the smaller scale of the former. The significantly positive impact in different policy stages of the DCBT is greater both in the first stage and third stage. Meanwhile, the extent of the influence of the DCBT increases over time. Moreover, it is more obvious in the participating areas of the DCBT, suggesting that the labor supply redistribution in the DCBT mainly comes from the change in the land allocation. Participation in the NFPP hardly affected the sample households' labor allocation. Due to a ban and limitations on logging during the project's practical process, firms related to forestry, like wood cutting, processing, and transport, was forced to halt production so the opportunities for off-farm employment were greatly reduced. There were no public institutions for job retraining for those who lacked skills in off-farm working technologies and farmers participating in the NFPP do not have another way to enter the non-agricultural labor market. As a result, invisible unemployment worsens and impoverishes many households.

The impact of the SLCP on Hebei province and the impact of the NFPP on Muchuan County in Sichuan province are especially noteworthy. In comparison with the other provinces, the SLCP participation in Hebei province has a negative effect on the off-farm labor supply. To explore the causes, we calculated the proportion of the land-based labor input in different provinces (see Fig. 3). The figure illustrates that, except in Hebei province, the proportions in the other 5 provinces have been falling over time. However, there has been a reverse trend in Hebei, and even a slight increase after 2005. Therefore, this trend suggests that the implementation of the SLCP has not caused large fluctuations in the rural labor allocation. This could be explained by the fact that the participation areas of the SLCP in Hebei are smaller than those in other provinces and the average quality of cultivated land is higher because Hebei is located in the plains area of China. With food prices recovering, farmers are more willing to spend working time on land-based activities.

Furthermore, we also find that the impact of the NFPP in Muchuan County is different from the others. Farmers participating in the NFPP in this county increased their off-farm work time. Through our investigations, we realized that the government in Muchuan, as the key implementation area for the NFPP, had adjusted the industrial structure as soon as possible after it experienced the serious impact from the timber industry. Some new businesses, such as hydropower, minerals, and bamboo, have been established to replace the older ones. These businesses could be absorbing the surplus labor. This will hopefully encourage the use of subsidies for each participating household during the second stage of the NFPP so that farmers' livelihoods can be more secure when they enter the off-farm labor market.

In China, the Priority Forestry Programs are now fully into their second phase. How the PFPs can better accomplish their ecological and economic goals is worth substantial attention. Our empirical results show that subsidies played an important role on the allocation of the rural labor supply. From the different regions' regressions, the persistence of the effect of the SLCP on off-farm labor time did not prove very satisfactory, while the incentive for farmers in the Yangtze River basin (who obtained higher subsidies) to work at off-farm jobs was more powerful. Hence, the subsidy policy has to be improved and pertinent regulations must be strong enough to reduce corruption. Additionally, subsidy policies in the NFPP should also be closer to those in the SLCP or DCBT so that it could play a greater role in the rural off-farm labor supply. Except for the subsidy policies, a series of supporting measures that take place during the implementation of the KPFPs is important. Farmers lack skills in using professional technology, making it difficult to take up an off-farm occupation for a long time. If the government does not give some related support, most of these workers will be poor again. Furthermore, the impact of the KPFPs in Guangxi is insignificant, mainly due to its imperfect transportation infrastructure. In 2012, hard surfaces covered only 23% of all the roads in Guangxi, which is the lowest percentage in those 6 provinces. This implies that the relevant government departments have to strengthen the establishment of the supporting measures to provide farmers with technical training and improve the hardware facilities for lower transfer costs.

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Appendix A

Through the theoretical model (Eqs. (1)–(5)), the influence mechanism of the KFPFs could be deduced. The process is:

① $$\frac{\partial E}{\partial A} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial A}$$

From: Eq. (5) Eq. (4)
Sign: - +

So: $$\frac{\partial E}{\partial A} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial A} < 0$$

If: $A \downarrow$ And then: $E \uparrow$

② $$\frac{\partial E}{\partial F} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial F}$$

From: Eq. (5) Eq. (4)
Sign: - +

So: $$\frac{\partial E}{\partial F} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial F} < 0$$

If: $F \downarrow$ And then: $E \uparrow$

③ $$\frac{\partial E}{\partial Z} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial Z}$$

From: Eq. (5) Eq. (4)
Sign: - +

So: $$\frac{\partial E}{\partial Z} = \frac{\partial E}{\partial C_f} \bullet \frac{\partial C_f}{\partial Z} < 0$$

If: $Z \uparrow$ And then: $E \downarrow$

Appendix B

Table B.1
Specific kinds of the KPFPs in sample counties.

Province	County	SLCP	NFPP	DCBT
Sichuan	Nanbu	✓	✓	-
	Nanjiang	✓	✓	-
	Mabian	✓	✓	-
	Muchuan	✓	✓	-
Jiangxi	Xiushui	✓	-	-
	Xingguo	✓	-	-
	Suichuan	✓	-	-
Hebei	Pingquan	-	-	✓
	Zhangbei	-	-	✓
	Yi	✓	-	-
Shaanxi	Zhenan	✓	✓	-
	Yanchang	✓	✓	-
Shandong	Pingyi	-	-	-
Guangxi	Huanjiang	✓	-	-
	Pingguo	✓	-	-

Note: ✓ indicates that the sample county involves in the corresponding program; - indicates otherwise.

Appendix C

Table C.1
Descriptive statistics of household survey data.

		1995		1998		2003		2008	
		Mean	Std.	Mean	Std.	Mean	Std.	Mean	Std.
Gender of household head (if man = 1; otherwise = 0)	X_1	0.961	0.193	0.961	0.193	0.961	0.193	0.956	0.205
Age of household head (year)	X_2	37.764	10.616	40.764	10.616	45.764	10.616	50.874	10.893
Education level the household head (if received education = 1; otherwise = 0)	X_3	0.503	0.500	0.503	0.500	0.503	0.500	0.410	0.492
Headman of village (if yes = 1;otherwise = 0)	X_4	0.104	0.306	0.104	0.306	0.104	0.306	0.089	0.285
Children receiving education (if yes = 1; otherwise = 0)	X_5	0.485	0.500	0.529	0.499	0.530	0.499	0.467	0.499
Household size (person)	X_6	3.598	1.178	3.737	1.196	3.941	1.284	4.231	1.510
Farmland area per capita (mu)	X_7	2.300	2.893	2.231	2.754	1.516	1.869	1.366	1.838
Forestland area per capita (mu)	X_8	2.873	6.593	2.799	6.478	3.764	6.910	4.704	9.232
Road condition (if hard road surface = 1; otherwise = 0)	Z_1	0.393	0.489	0.393	0.489	0.393	0.489	0.532	0.499
Village-level off-farm work wage (yuan/person-days)	M_1	49.529	78.912	42.186	67.071	39.507	75.648	38.333	29.525
Village-level land-based work wage (yuan/person-days)	M_2	13.791	8.611	13.656	7.911	17.258	9.478	26.305	18.136
Production costs per unit area (yuan/mu)	M_3	121.026	229.699	131.039	260.652	224.859	453.139	715.636	3797.809
Agricultural subsidies per unit area (yuan/mu)	M_4	0.000	0.000	0.000	0.000	0.765	24.299	76.220	214.309
Agricultural tax per unit area (yuan/mu)	M_5	51.434	84.488	59.875	102.432	29.569	52.818	53.291	298.119
The SLCP (if yes = 1; otherwise = 0)	P_1	0.000	0.000	0.000	0.000	0.416	0.493	0.439	0.496
The NFPP (if yes = 1; otherwise = 0)	P_2	0.000	0.000	0.043	0.203	0.063	0.243	0.220	0.415
The DCBT (if yes = 1; otherwise = 0)	P_3	0.000	0.000	0.000	0.000	0.111	0.315	0.111	0.315
Both the SLCP and the NFPP (if yes = 1; otherwise = 0)	P_4	0.000	0.000	0.000	0.000	0.052	0.222	0.149	0.357
Area enrolled in the SLCP (mu)	P_5	0.000	0.000	0.000	0.000	2.872	7.021	3.774	9.434
Area enrolled in the NFPP (mu)	P_6	0.000	0.000	0.137	0.815	0.173	0.893	2.741	11.767
Area enrolled in the DCBT (mu)	P_7	0.000	0.000	0.000	0.000	0.444	2.088	0.529	2.768
Interaction of area enrolled in the SLCP and the NFPP	$P_5 * P_6$	0.000	0.000	0.000	0.000	0.525	4.495	22.255	185.046
Off-farm labor time inputs (person-days)	Y	95.568	143.344	117.228	167.352	190.099	223.509	276.180	281.481

Appendix D

The formula of ICC is defined as

$$\tilde{n} = \frac{1}{N-1}\left(M - \frac{\sum_{N}^{j=1} n_j^2}{M}\right)$$

$$ICC = \frac{F-1}{F-1+\tilde{n}}$$

where N is the number of clusters, M is the square of the total sample size, n_j is the square of the sample size in j cluster, and F is the F statistic from the analysis of the variance. When the value of the ICC is not less than 0.1 (see the table below), it cannot be ignored, otherwise the estimation of the standard error will be low. In order to solve this problem, we took into consideration the cluster effect on our fixed-effect model and set it at the county level. That is because county-level government agencies are responsible for the KPFPs' detailed implementation rules in China.

Table D.1
The intra-cluster correlations of main variables.

ICC	Off-farm income	Land-based income	Off-farm work time	Farmland area per capita	Household consumption
1995	0.09	0.12	0.17	0.27	0.15
1996	0.10	0.13	0.17	0.27	0.16
1997	0.14	0.13	0.18	0.27	0.16
1998	0.14	0.13	0.20	0.28	0.15
1999	0.16	0.13	0.22	0.26	0.12
2000	0.16	0.13	0.24	0.25	0.15
2001	0.16	0.12	0.26	0.28	0.13

2002	0.16	0.13	0.28	0.18	0.17
2003	0.16	0.17	0.28	0.15	0.13
2004	0.13	0.15	0.25	0.12	0.13
2005	0.19	0.15	0.27	0.25	0.10
2006	0.21	0.15	0.26	0.25	0.10
2007	0.13	0.06	0.14	0.31	0.02
2008	0.12	0.10	0.14	0.29	0.01
2009	0.08	0.02	0.07	0.27	0.06
2010	0.08	0.02	0.06	0.26	0.05
2011	0.08	0.03	0.12	0.31	0.06
2012	0.00	0.03	0.12	0.31	0.05

Appendix E

Econometric findings

Table E.2
Estimated results of the KPFPs' effects in different regions.

Variable	Model 1 (whether participated in)		Model 2 (areas participated in)	
	FE	FE & cluster effect	FE	FE & cluster effect
The SLCP (the Yellow River basin)	0.60** (0.26)	0.60 (1.25)	0.29 (0.26)	0.28* (0.14)
The SLCP (the Yangtze River basin)	0.96*** (0.15)	0.96*** (0.22)	0.02 (0.02)	0.02 (0.04)
The NFPP (if yes = 1; otherwise = 0)	0.36 (0.25)	0.36 (0.32)	− 0.05** (0.02)	− 0.05* (0.03)
The DCBT (if yes = 1; otherwise = 0)	0.65*** (0.24)	0.65** (0.30)	0.07** (0.02)	0.07* (0.03)
Both the SLCP and the NFPP (the Yellow River basin)	0.16 (1.13)	0.16 (0.69)	0.02 (0.03)	0.02 (0.02)
Both the SLCP and the NFPP (the Yangtze River basin)	− 1.16*** (0.29)	− 1.16*** (0.21)	− 0.01*** (0.00)	− 0.01** (0.00)
Constant	− 15.03*** (1.34)	− 15.03*** (4.78)	− 14.51*** (1.49)	− 13.71** (5.25)
R^2	0.09	0.09	0.09	0.09
The SLCP (Sichuan Province)	1.10*** (0.19)	1.10*** (0.23)	0.01 (0.02)	0.01 (0.03)
The SLCP (Jiangxi Province)	1.10*** (0.28)	1.10** (0.40)	0.12*** (0.03)	0.12** (0.04)
The SLCP (Hebei Province)	− 1.63*** (0.39)	− 1.63*** (0.30)	− 0.17*** (0.04)	− 0.17*** (0.03)
The SLCP (Shaanxi Province)	1.87*** (0.29)	1.87*** (0.44)	0.16 (0.19)	0.16*** (0.04)
The SLCP (Guangxi Province)	0.16 (0.40)	0.16 (0.41)	0.02 (0.04)	0.02 (0.04)
The NFPP (Sichuan Province)	0.36 (0.25)	0.36 (0.33)	− 0.07*** (0.02)	− 0.07** (0.03)
The NFPP (Shaanxi Province)	− 0.92 (3.07)	− 0.92* (0.46)	− 0.04 (0.06)	− 0.04 (0.02)
The DCBT (Hebei Province)	0.71*** (0.24)	0.71** (0.33)	0.07*** (0.02)	0.07* (0.03)
Both the SLCP and the NFPP (Sichuan Province)	− 1.37*** (0.32)	− 1.37*** (0.17)	− 0.01*** (0.00)	− 0.01*** (0.00)
Both the SLCP and the NFPP (Shaanxi Province)	0.38 (3.08)	0.38 (0.34)	− 0.00 (0.02)	− 0.00 (0.00)
Constant	− 15.55*** (1.40)	− 15.55*** (4.76)	− 15.04*** (1.44)	− 15.04*** (4.97)
R^2	0.10	0.10	0.10	0.10
The SLCP (Nanbu County)	0.86** (0.40)		0.02 (0.05)	
The SLCP (Nanjiang County)	1.31*** (0.33)		0.11* (0.06)	
The SLCP (Mabian County)	0.65* (0.38)		− 0.03 (0.04)	
The SLCP (Muchuan County)	1.86*** (0.39)		− 0.01 (0.10)	
The SLCP (Xiushui County)	2.74*** (0.76)		0.27*** (0.07)	
The SLCP (Xingguo County)	0.95** (0.48)		0.09* (0.05)	
The SLCP (Suichuan County)	0.82** (0.38)		0.09** (0.04)	
The SLCP (Yi County)	− 1.63*** (0.39)		− 0.17*** (0.04)	
The SLCP (Zhenan County)	0.92 (0.67)		0.12 (0.20)	
The SLCP (Yanchang County)	2.06*** (0.32)		0.18*** (0.03)	
The SLCP (Huanjiang County)	0.22 (0.56)		0.03 (0.06)	
The SLCP (Pingguo County)	0.10 (0.57)		0.01 (0.05)	
The NFPP (Nanbu County)	− 0.57 (0.45)		− 0.16*** (0.04)	
The NFPP (Nanjiang County)	0.33 (0.63)		− 0.02 (0.03)	
The NFPP (Mabian County)	0.54 (0.35)		− 0.04 (0.04)	
The NFPP (Muchuan County)	3.14*** (1.06)		0.12** (0.06)	
The NFPP (Zhenan County)	− 1.49 (3.08)		− 0.02 (0.06)	
The NFPP (Yanchang County)	− 0.09 (1.10)		− 0.02 (0.09)	
The DCBT (Pingquan County)	0.78*** (0.25)		0.08*** (0.02)	
The DCBT (Zhangbei County)	0.10 (0.73)		− 0.00 (0.06)	
Both the SLCP and the NFPP (Nanbu County)	− 0.98* (0.58)		− 0.01 (0.01)	
Both the SLCP and the NFPP (Nanjiang County)	− 1.00 (0.75)		− 0.00 (0.01)	

Both the SLCP and the NFPP (Mabian County)	− 1.01* (0.56)	− 0.01*** (0.00)
Both the SLCP and the NFPP (Muchuan County)	− 2.45** (1.25)	− 0.02* (0.01)
Both the SLCP and the NFPP (Zhenan County)	1.26 (3.14)	0.01 (0.02)
Both the SLCP and the NFPP (Yanchang County)	0.00 (0.00)	0.00 (0.00)
Constant	− 15.30*** (1.41)	− 14.48*** (1.44)
R^2	0.10	0.10

* Means significant at 90% level.
** Means significant at 95% level.
*** Means significant at 99% level.

Table E.3
Estimated results of the KPFPs' effects in different policy stages.

Variable	FE	FE & cluster effect
First stage of the SLCP (if yes = 1; otherwise = 0)	0.92***(0.14)	0.92***(0.27)
Second stage of the SLCP (if yes = 1; otherwise = 0)	− 0.75 (0.87)	− 0.75 (1.69)
Third stage of the SLCP (if yes = 1; otherwise = 0)	0.53**(0.22)	0.53 (0.70)
First stage of the DCBT (if yes = 1; otherwise = 0)	0.54**(0.25)	0.54*(0.29)
Third stage of the DCBT (if yes = 1; otherwise = 0)	1.21***(0.39)	1.21**(0.42)
First stage of the NFPP (if yes = 1; otherwise = 0)	0.06 (0.27)	0.06 (0.33)
Second stage of the NFPP (if yes = 1; otherwise = 0)	1.20***(0.40)	1.20 (1.31)
Both first stage of the SLCP and the NFPP (if yes = 1; otherwise = 0)	− 3.19*(1.73)	− 3.19 (2.05)
Both third stage of the SLCP and the NFPP (if yes = 1; otherwise = 0)	− 3.29*(1.73)	− 3.29 (2.43)
Both the SLCP and first stage of the NFPP (if yes = 1; otherwise = 0)	2.73 (1.73)	2.73 (2.05)
Both the SLCP and second stage of the NFPP (if yes = 1; otherwise = 0)	0.86 (1.78)	0.86 (2.75)
Constant	− 16.11***(1.41)	− 16.11***(4.81)
R^2	0.09	0.09

* Means significant at 90% level.
** Means significant at 95% level.
*** Means significant at 99% level.

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