sustainability

MDPI

Article

Long-Term Impact of China's Returning Farmland to Forest Program on Rural Economic Development

Yuchen Gao [1], Zehao Liu [2], Ruipeng Li [3,4,*] and Zhidan Shi [5]

1 School of Economics and Management, Tsinghua University, Beijing 100084, China; gaoych@sem.tsinghua.edu.cn
2 School of Finance, Renmin University of China, Beijing 100872, China; liuzehao@ruc.edu.cn
3 School of Finance & Investment, Guangdong University of Finance, Guangzhou 510521, China
4 International School of Business & Finance, Sun Yat-sen University, Zhuhai 519000, China
5 School of Public Policy and Management, Tsinghua University, Beijing 100084, China; szd18@mails.tsinghua.edu.cn
* Correspondence: liruipeng@mail.sysu.edu.cn

Received: 17 December 2019; Accepted: 14 February 2020; Published: 17 February 2020

Abstract: The Returning Farmland to Forest Program (RFFP) is widely known as one of China's largest and most successful payment schemes for ecosystem service projects for the achievement of both environmental and economic sustainability. By sponsoring afforestation activities and compensating farmers for converting cropland to forest, the project was designed to achieve multiple goals. Ecologically, the program aims to expand forest cover and to reduce flood and soil erosion. Economically, it aims to alleviate poverty and improve rural livelihoods. Although the official metrics indicate successful program outcomes in the short term, researchers have reported mixed and controversial results for long-term outcomes. We combined the difference-in-difference (DID) with instrumental variables (IVs) regression to examine the long-term effects of China's RFFP on local economic development. We found that (1) the RFFP has had a remarkably positive impact on local economic growth in the primary sector, but considerably limits the growth of enterprises above a designated size by 16.8%; (2) the RFFP is unable to promote the development of the secondary industry because it cannot effectively promote the transfer of rural laborers to the secondary industry sector; and (3) in addition to increasing the general budgetary expenditure of local finance by 7.50%, this program has significantly reduced local fiscal revenue by 35.50%. We suggest that eco-compensation should consider the performance of the RFFP in its evaluation criteria.

Keywords: returning farmland to forest program; payment for ecosystem service; regional economic development; instrumental variable; difference-in-differences methods

1. Introduction

As of 2019, China's Returning Farmland to Forest Program (RFFP) had been in operation for 20 years. The RFFP is the largest payment for ecosystem services (PES) and ecological restoration program in the world in terms of scale, monetary investment, and impact [1–3]. In addition to improving ecological conditions, the program aims to alleviate poverty in rural areas by compensating households for the conversion of marginal farmland on steep slopes to forestland or grassland and financing the afforestation [4,5]. Between 1999 and 2003, the Chinese government invested 354.2 billion yuan into the RFFP's implementation. In return, forest coverage has increased remarkably. A forest cover increase of 447 million mu (mu is the measurement unit for land in China and one mu is equivalent to 1/15th of a hectare) was reported by 2013, including 139 million mu of retired farmland converted to forests and 308 million mu of barren mountainsides afforested or reforested. The program has had positive outcomes in terms of the reduction of soil erosion, flood prevention, and some degree of biodiversity improvement [6].

Along with efforts to raise awareness of the issues with China's agriculture, farming, and rural areas, the RFFP aims to improve the regional economy and rural livelihoods [7,8]. Households participating in the program are expected to increase their annual income and improve their employment conditions by transitioning from on-farm labor to off-farm activities and by receiving eco-compensation. The actual outcomes of the RFFP, however, show mixed results [9]. For example, participants are compensated by the Chinese government with cash and food subsidies for the loss of income caused by converting croplands to forests. The current compensation scheme has not always fully covered farmers' economic losses. Under the current compensation scheme, participants are given 100 kg of raw grain and 20 yuan annually for completing 1 mu of afforestation. This can result in reduced annual income for farmers and in the suppression of local economic development due to a reduction in farmland. In addition, the program is reported to increase forest cover and reduce the risk of flooding and soil erosion. This provides opportunities for farmers to engage in alternative activities, such as shifting from farming to fruit cultivation, animal husbandry, and tourism, which can contribute to the development of the local primary industry. These activities may also encourage farmers and migrant workers to avoid deforestation altogether [1,7]. As a result, local communities would benefit from improvements in their rural economic structure, increased funding invested in constructing local infrastructure, and upgraded living conditions [10]. Thus, rural sustainable economic development has become an essential factor when assessing the impacts of the RFFP.

China's RFFP, having been in operation for 20 years as of 2019, is reported as a tremendous success in improving the ecological environment at the national level. However, many studies evaluated the ecological and economic impacts across multiple dimensions. These studies discussed the mixed results of the program in terms of the ecological and economic impacts, but few scholars evaluated the long-term effects of the RFFP on local economic development. In this study, we employed a difference-in-differences (DID) method to empirically evaluate the effects of the RFFP on rural economic development. We specifically assessed the program's impacts on local finance, the value addition of industry, and food production through analysis of the China Statistical Yearbooks from 1992 to 2010 at the county level. To ensure a robust result, we defined local land slopes as instrumental variables (IVs) in the regression. This allowed us to eliminate the potential endogeneity within the government criteria on the land selection, which is based solely on economic indicators.

The findings are expected to contribute to the literature on the RFFP specifically and on PES more generally: First, we examine the long-term impact of the RFFP on rural economic development, which enhances our understanding of evaluating program performance based on empirical evidence. We ask the following questions: Has the RFFP had a positive effect on re-shaping the local industrial structure? How have local finance revenues and expenditures changed after the implementation of the program? Second, the effect of the RFFP on economic development is relatively exogenous due to the initial ecological focus when the program was introduced. Our research broadens the range of analysis by evaluating whether the program has solved rural economic issues. In doing so, our analysis contributes valuable insights to Chinese agriculture, farmers' livelihoods, and elucidation of the broader economic impacts of PES programs.

In Section 2, we provide background information on the RFFP program, including the criteria for selecting land for afforestation and its phases of implementation. Section 3 provides a literature review. The empirical data and methods as well as the research results are presented in Sections 4 and 5. Section 6 discusses the results and provides conclusions and policy recommendations.

2. Background Information on China's RFFP

After the cataclysmic floods that swept across the Yangtze region in 1998, the Chinese government rethought its environmental strategies and developed the RFFP to return farmland to forest and restrain heavy deforestation and forest degradation. This became an important scheme for post-disaster reconstruction, and water restoration and remediation. The RFFP aims to protect and improve the ecological environment to gradually stop the cultivation of sloping farmland, which causes soil erosion, and complete afforestation using scientific methods to restore forest vegetation. Land included in the RFFP includes sloped and sandy land with serious soil and water loss, which results in low and unstable agricultural productivity. As such, the two key components of the RFFP are the conversion of sloped cropland to forest and the afforestation of barren mountains and wasteland suitable for forest growth. According to the RFFP guidelines, farmers who own land suitable for conversion voluntarily convert their farmland to forests and manage the land in exchange for economic benefits. The government compensates individual farmers who enroll in the program for their income reduction when ceasing to grow crops and returning their farmland to forest. The RFFP's regulations stipulate that the fiscal and forestry departments must compensate farmers on a yearly basis, and the payment amount is determined based on the geographical conditions and local income level. The compensation mainly consists of a subsidy for the afforestation of seedlings and a livelihood subsidy. The subsidy for afforestation is mainly used to purchase seedlings, whereas the subsidy for livelihood mainly compensates the farmers for the decrease in income caused by ceasing to cultivate crops [11].

The RFFP was first initiated as a pilot project in a few chosen areas starting in 1999 and was then extended to 20 provinces by the end of 2001. Based on the experience of successful pilots, the RFFP was officially launched at the national level in 2002, covering a total of 25 provinces, including 1897 counties. Two years later, in 2004, the government increased the annual scope of the RFFP based on the substantial growth and development of the national economy. The compensation scheme was also improved by issuing a policy-improvement notice to compensate the RFFP participants with cash rather than food, which was the original form of compensation.

The total area covered by the program from 1999 to 2004, set by the government, was 19,165,500 hectares. This included the conversion of 7,886,200 hectares of cropland to forests and the afforestation of 11,279,300 hectares of barren and mountainous land. As a result, between 2000 and 2004, the central government invested a total of 74.803 billion yuan in the RFFP's implementation. Specifically, 121 million yuan were spent on program administration, 14.374 billion yuan on seedlings, and 6.285 billion yuan on subsidies for participants, and 54.023 billion yuan on food and cash.

In its early stages, the RFFP was mainly implemented in areas affected by soil erosion and desertification, and on agricultural land with slopes higher than 15 or 25 degrees. A notice was issued in 2000 named The Guidance for Improving the Pilot of Returning Farmland to Forest Program from The State Council [12]. In 2014, the criteria for eligible land were similar and included farmland with slopes above 25 degrees, areas with severe land degradation, and croplands near water sources, and those with slopes between 15 and 25 degrees. Governments at the provincial level are responsible for project coordination and planning. Local governments at the city, county, and township levels are responsible for implementing the program locally.

The government has modified the RFFP's guidelines and policies every few years in an attempt to improve the efficiency of afforestation activities. Reforms have included determining the scope of returning farmland to forest, signing contracts with farmers, and supervising the implementation of farmers' contracts. The government also bears the costs of verification, participant selection, and issuing payments to farmers to ensure the smooth implementation of the program. In addition to the national subsidy policies, other preferential policies exist for returning farmland to forests in some areas. For example, farmers in many areas can be made exempt from agricultural taxes, land contract fees, and can receive subsidies for environmentally beneficial activities. Farmers in state-owned forest districts can also receive additional financial support, such as subsidized loans and interest rate reductions, in exchange for managing forest areas [11].

The RFFP subsidy duration is eight years for ecological forests and five years for economic forests. In 2016, the State Forestry Administration of China increased the length of the subsidy for ecological forests to up to 16 years, and the length of the subsidy for the economic forest to up to 10 years. At the end of the subsidy period, farmers can conduct activities on their land that generate income, transfer their land to others, or harvest the trees in the forested areas with the permission of the government [13]. In 2016, China's State Forestry Administration declared that the total subsidy amount per mu of cultivated land was 2890 yuan for ecological forests, 1825 yuan for forest in the Yangtze River Basin and South China (2050 yuan for ecological forests there), and 1300 yuan for economic forests in the Yellow River Basin and North China [13]. The RFFP has created strong incentives for farmers to return farmland to forests and protect the natural environment since implementation in 1999. Thus, the RFFP has had a long-term impact on the local economy and society.

3. Literature Review

Previous studies assessing the impact of the RFFP on rural economic development mainly focused on farmers' income, off-farm employment, and poverty alleviation [1,9,10,14,15]. The main research focus was whether households have increased their incomes in the long term after participating in the program. Some scholars stated that the RFFP had a positive influence on local farmers' earnings. Peng et al. [10] adopted an integrated assessment approach in a case study of the Zhangye region in Northwestern China. They found that the RFFP increased the net income of local farmers and improved local sustainable development. A similar result was obtained in the study by Lin and Yao [15]. Yet, the source of farmers' income growth is debatable. Some scholars argued that the income growth of local households after converting croplands to forests is attributable to the government's financial compensation in addition to the income obtained by the shift from agricultural labor to non-agricultural employment [16,17]. When the eco-compensation exceeds the opportunity cost of applying to participate in the RFFP, local farmers' incomes will increase [17]. Some studies argued that participating in the RFFP does not always have a positive effect on local farmers' incomes [18–20]. Therefore, whether the eco-compensation policy will help local households' earnings grow in the long term is questionable. According to some scholars, the labor shift from on- to off-farm work could be the primary driver of increased household incomes and local economic growth [21–24]. For example, Liu and Lan [21] found that the RFFP has led farmers to shift from crop farming, their traditional form of agriculture, to fruit growing, animal husbandry, and working in secondary and tertiary industries. Simultaneously, the implementation of the RFFP has freed households from rural labor and enabled former farmers to work in different industries [25]. However, some farmers are struggling to increase or even maintain their incomes after enrolling in the RFFP, as their current farming skills do not serve them in non-agricultural jobs [26]. Some studies revealed that the program has failed to transform the traditional structure of local agricultural production and has not improved farmer income in rural areas [2].

In addition to the findings discussed above, existing studies explored the role of regional differences and individual factors in the RFFP's implementation and local economic development [6,14,27,28], such as farmer income [6]. For instance, studies showed that young farmers with a higher level of education are more likely to participate in the program [4,14]. Young and educated farmers also have better employment opportunities in off-farm work [23], which increases their net income [14]. Trac et al. [9] found considerable disparities in rural economic development in different regions that participated in the RFFP. One of the reasons for such differences is the inconsistent capabilities of local governments to coordinate and supervise the implementation of the RFFP. Likewise, the different capabilities of local governments affect the extent of the transition from on- to off-farm labor after the program has ended. Farmers in rural regions with lower education levels are less likely to engage in non-agricultural employment. These areas also show a higher chance of deforestation after participating in the project [23]. Yao et al. [24] found that households earning a higher income can transition to non-agricultural jobs more effectively after participating in the RFFP.

Although the financial level of local governments is an important indicator reflecting economic development in rural areas [29,30], few studies considered the impact of the RFFP on the local government's fiscal revenue and expenditure [5,31]. By examining how the program affects local finance, including the primary and secondary industries, we aimed to develop a deeper understanding of the sources of economic growth in rural areas affected by the RFFP. The current studies mainly include case studies or descriptive statistics, which complicates generalization because study subjects are independent and heterogeneous. Most of these studies collected data through questionnaires, and the accuracy of the data is not guaranteed. The data were collected for a short time, which does not adequately assess the program's long-term influence. Without econometric analysis, determining the causal relationship between the RFFP and regional economic development is difficult. Hence, the long-term effects of the RFFP on local economic development still need to be systematically evaluated and verified through empirical evidence. Wang and Yue [6] were the first to adopt the DID method to evaluate the RFFP's outcomes. Inspired by their study, we evaluated the long-term impact of RFFP on economic development in rural areas. We analyzed data from 1992 to 2010 at the county level and combined the DID method with the instrumental variables (IVs) in using the regional slopes to control the potential endogeneity and obtain more robust results.

4. Data and Econometric Model

4.1. Data Processing

We conducted our study using datasets at the county level, which were categorized into three groups: (1) economic indicators at the county level and other control variables, (2) datasets relevant to the RFFP, and (3) geographical data at the county level, in particular, the local sloping land data. The overall timeframe was divided into before and after the RFFP implementation, as our data provided cumulative values rather than yearly figures. We compare the datasets between these two timeframes in this paper.

4.1.1. Economic Indicators at the County Level and Other Control Variables

The data in the study were sourced from the China County Statistical Yearbook between 1992 and 2010 [32]. They provided an economic overview of each county per year in terms of the economic development, agricultural development, industry and investments, education, health, and social security. Although the program was initially implemented in 1999, our control variables start in 2000 to ensure data consistency and to consider impact lag. Thus, the first timeframe starts in 2000 (for which we have detailed data, but the RFFP had not been implemented nationally), which we denote here as 0. The second timeframe begins in 2007, when the first round of the RFFP implementation was completed, which we set here as 1. A detailed description of the variables used in this paper is provided in the index interpretation of the National Bureau of Statistics of China [33].

The general budget revenue of local governments includes the urban maintenance and construction tax (excluding the part paid by the railway department, the head office of each bank, and the head office of each insurance company), the real estate tax, the urban land use tax, the land value-added tax, the vehicle and ship tax, the land occupation tax, the deed tax, the tobacco and stamp tax (excluding the stamp tax on securities trading), 50% of the value-added tax, 40% of the corporate income tax, 40% of personal income tax, other resource taxes, excluding the offshore oil resource tax, and local non-tax income. The general budget expenditure of local finance refers to the expenditure determined according to the different responsibilities of the government in economic and social activities and the responsibilities and powers of the government. These include the general public services, public security expenditure, and local overall social expenditure, among other variables.

The added value of industrial enterprise above the designated size is the sum of added value in all departments of the industry in one year compared to the last year. Enterprises above the designated size are industrial enterprises with an annual main business income of 5 million yuan and above in 2011 and the previous years. The industrial divisions considered here were as follows: primary industry refers to agriculture, forestry, animal husbandry, and fishery (excluding agriculture, forestry, and animal husbandry and fishery services); secondary industry refers to the mining industry (excluding mining auxiliary activities), the manufacturing industry (excluding metal products, machinery, and equipment repair industry), electric power, thermal power, gas, and water production and supply industry, and the construction industry. Secondary industry includes (1) the exploitation of natural resources, such as mining, salt drying, etc. (but excluding animal hunting and fishing); (2) the processing and reprocessing of agricultural and sideline products, such as grain and oil processing, food processing, silk reeling, textile, and leather production, etc.; (3) the processing and reprocessing of extracted products, such as iron and steel production, chemical production, petroleum processing, machine manufacturing, wood processing, etc., as well as the production and supply of electricity, gas, and water; and finally (4) the repair and renovation of industrial products, such as the repair of machinery and equipment.

4.1.2. Datasets Relevant to the RFFP

Data on divisions of administrative areas in China were prepared and provided by the Ministry of Civil Affairs based on the changes in the divisions of administrative areas as approved by the State Council at the end of the previous year [32]. The relevant data, including the target for conversion from cropland to forest and afforestation of barren lands and mountains, were sourced from the Forestry Science Data Centre. Here, we define a county where the RFFP was implemented as a unit, and there were 1894 counties according to the data from 2002. We reviewed the policy documents between 1999 and 2007 and confirmed that the number of units did not change during this period. We excluded developed urban areas from our sample. We also considered the specificity of regional economic development, and we excluded counties from four chosen provinces (autonomous regions or municipalities): Beijing, Shanghai, Tibet, and Xinjiang. This is because county-level data in Xinjiang and Tibet are difficult to obtain, and the rapid urbanizations of Beijing and Shanghai will result in the evaluation bias of the RFFP programs. We retained 1386 out of the 1894 counties and defined 927 other counties in undeveloped urban areas where the RFFP had not been implemented. Our final sample consisted of a total of 2313 counties and 3528 county observations.

The distribution map, displaying areas where the RFFP had been implemented in 2002, is shown in Figure 1. The provinces near the Yellow River basin (e.g., Gansu, Shaanxi, Inner Mongolia Autonomous Region, Shanxi, Liaoning, Jilin, and Heilongjiang) and the Yangtze River basin (e.g., Sichuan, Guizhou, Chongqing City, Yunnan, Hunan, and Hubei) assumed more RFFP responsibilities than other regions. On average, these provinces (autonomous regions and municipalities) were expected to complete over 1.8 million mu of afforestation and conversion of croplands to forests in 2002. The task undertaken by each of those regions accounted for more than 4% of the national RFFP target in 2002.

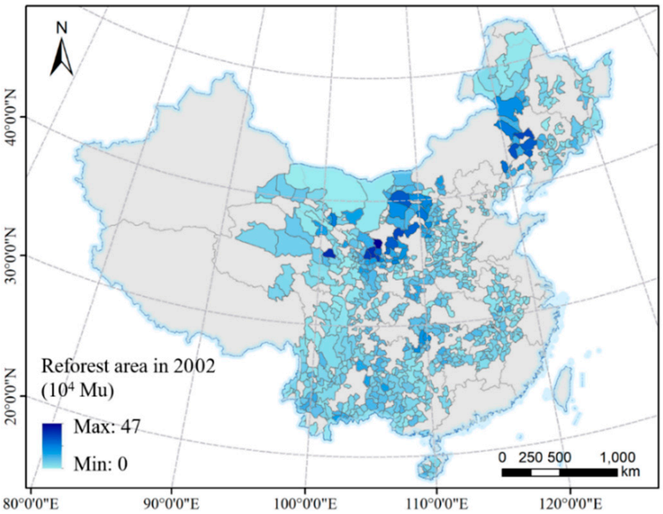

Figure 1. The distribution map of reforesting areas in 2002.

4.1.3. Geographical Data at the County Level

Factors such as local food production and level of economic development are indicators of location choice for the program implementation, as well as dependent variables that are endogenous. However, the slope degree in an area is an entirely exogenous variable that can effectively eliminate endogeneity. Therefore, we defined the regional slopes as the instrumental variable to minimize the endogenous impact caused by land selection. In this study, the regional slopes were evaluated from the Shuttle Radar Topography Mission (SRTM) global digital evaluation model (DEM) at a 90 m resolution. We matched the China administrative division data at the county level with the DEM, calculating the slope value for each cell in the regional area. The slope values for each county, e.g., minimum, maximum, mean, and standard deviation, were obtained.

4.2. Econometric Model

In this study, we combined a difference-in-differences (DID) method with a fixed-effect model using IVs to conduct an empirical evaluation. The benefit of choosing the DID method is the elimination the interference caused by synchronic factors in the project's implementation. The DID technique is usually used for evaluating the effect of policies. The underlying logic is based on the counterfactual framework, which evaluates changes in observed factors (i.e., dependent variables) in the presence and absence of policies. The sample is divided into two groups: a treatment group affected by the policy and the control group unaffected by the policy. Initially, no significant differences exist between the treatment group and the control group, i.e., the y value of both groups has no significant difference before the exogenous policy shock. The change in the y value of the control group before and after the occurrence of the policy is regarded as the portion of the treatment group not affected by the policy. Thus, by comparing the change (D1) in the treatment group y value with the change (D2) in the control group y value, the actual effect of the policy shock can be obtained (DD = D1 − D2). The DID method can solve the endogeneity issues to a certain extent, so it has widely been adopted in the field of policy evaluation [7,34–36].

The econometric model used to estimate the impact of the RFFP on the regional economic development is

$$Y_{it} = \beta_0 + \beta_1 \times T_t + \beta_2 \times RFFP_i + \beta_3 \times (T_t \times RFFP_i) + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

where the outcome variable Y_{it} is a dependent variable indicating how the economic development in county i is affected by the RFFP program; subscript i and t represent county and time, respectively; T_t is an explanatory variable as well as a time dummy variable, it represents the project time frame before the program was implemented and its value is 0, otherwise, it is 1. The coefficient β_1 measures how other factors affect the economic development variables of the control group before and after the implementation of the RFFP; $RFFP_i$ is a policy dummy variable and its value is 1 when the program is applied in county i, otherwise it is 0; the coefficient β_2 indicates the difference of the time-invariant effects between the counties with the RFFP's influence and those without it; the interaction term $T_t \times RFFP_i$ is called the DID estimator, and its coefficient β_3 indicates the extent to which the project application influences the economic development variables in the county i. X_{it} denotes the control variables.

When considering the locations in which to implement the RFFP, the government considered the level of local economic development and political factors, such as areas with a relatively developed or fast-growing economy. This may have aggregated the endogenous problems when studying the effect of the RFFP on economic development in rural areas.

To eliminate the endogenous influence, we used an instrumental variable approach. A good IV should be as exogenous as possible (such as history, nature, climate, geography, etc.) and should have no direct impact on the explained variable (hereinafter referred to as y), but it should indirectly affect the explained variable y by influencing the variable (hereinafter referred to as x) of the instrument. Duflo and Pande [37] used river slope as an instrumental variable for dam construction when estimating the effect of dams on crop production. The river slope is geographical and exogenous, but the river slope affects the difficulty of dam construction. Similarly, we used regional slopes as the instrumental variable for the RFFP. Because the regional gradient of a region impacts whether the policy of returning farmland to forest is implemented in a region, cropland with a gentler slope is easier and more cost-effective to convert into a forest. The slopes do not directly impact the regional economy. The panel fixed effects (FE) model was used to remove the effects of time-invariant characteristics on the results, including the trend in regional economic growth and the government's location choice for implementing the RFFP. When constructing the instrumental variable model, we first used a dummy variable representing whether the program has been applied in a county between 1999 and 2007. If the RFFP has been implemented, the value is 1; otherwise, it is 0. Thus, we obtained the fixed effects model:

$$Y_{it} = \alpha_0 + \alpha_1 \times t + \alpha_2 \times V_i + \alpha_3 \times D_i + \alpha_4 X_{it} + \varepsilon_{it} \quad (2)$$

where Y_{it} is the dependent variable observed for region i at time t. As the fixed effects are included, t is time, a binary variable that controls time effects by restraining the impact of varying time trends; D_i controls for area fixed effects by limiting the impact of the fundamental differences in the regional variance on the outcomes of the RFFP implementation; V_i is a dummy variable showing whether area i has applied the RFFP, where a value of 1 means yes and a value of 0 means no; X_t is the control variable representing the time-variance characteristics of the population, education level, and so forth; and the coefficients α_2 and so on tell us the impact of implementing the program on the outcome variable Y_{it}.

In addition, the dependent variable Y_{it} includes the industrial added value of the primary industry, the industrial added value of the secondary industry, the general budgetary revenue of local government, the general budgetary expenditure of local government, the industrial gross output value of enterprises above the designated size, and the total number of employees in rural areas of agriculture, forestry, animal husbandry, and fishing. The control variable X_t contains the number of townships (towns), the number of village committees, the number of village households, the total population at the end of the year, the rural population, the number of employees at the end of the year, the number of rural employees, the total power of agricultural machinery, local telephone users, the number of students in middle schools, and the number of students in primary schools.

5. Results

5.1. Descriptive Statistics

First, we found that the ratio of RFFP contracts allocated to each province over the national target substantially differed (see Figure 2), ranging from just under 8% to roughly 1%. Some provinces did not participate in the program at all.

Table 1 shows that the target of the RFFP was negatively correlated with the output of the primary industry; the higher the grain output, the more savings are obtained. The higher the output value of the primary and secondary industries, the fewer RFFP contracts are allocated. In other words, areas with relatively developed economies undertake fewer RFFP responsibilities, whereas regions with disadvantages in economic development have taken on more contracts to convert croplands to forests. This is partly because relatively less agricultural land exists in developed areas and because these areas are mostly located in Eastern China, where the amount of cultivated land on slopes above 25 degrees is relatively low. The statistical characteristics of each variable are shown in Table 2.

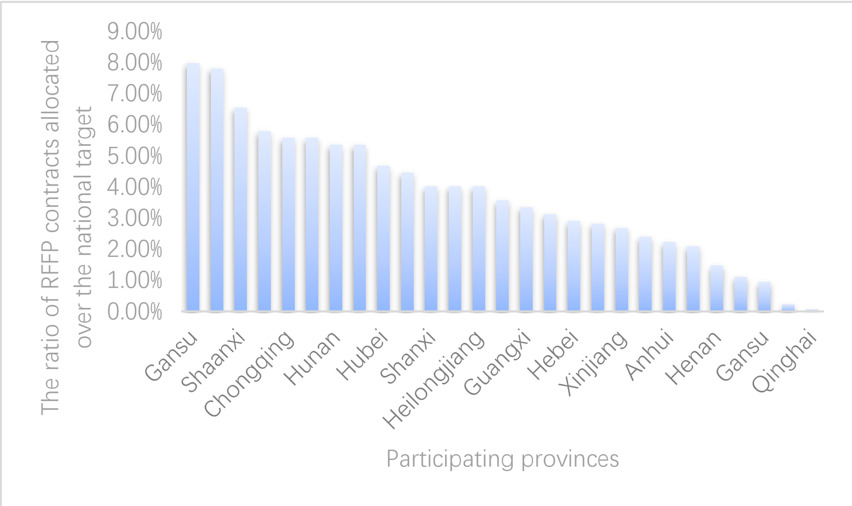

Figure 2. The ratio of Returning Farmland to Forest Program (RFFP) contracts allocated to each province over the national target.

Table 1. The correlation coefficients between the Returning Farmland to Forest Program (RFFP) target allocation and the key variables.

	RFFP Target	Food Production per Capita	Output of Primary Industry	Output of Secondary Industry
RFFP target	1.0000			
Food production per capita	−0.2654 *** (0.0000)	1.0000 (0.1793)		
Output of primary industry	−0.3151 *** (0.0000)	0.4894 *** (0.0000)	1.0000	
Output of secondary industry	−0.2196 *** (0.0000)	−0.0285 (0.4558)	0.2252 *** (0.0000)	1.0000

Note: p-values are in brackets. *** $p < 0.001$.

Table 2. The statistical characteristics of each variable.

Variables	Observation	Mean	SD	Minimum	Maximum
Target of the RFFP	3528	8.289	11.568	0	94
Land area of administrative divisions	3528	2970.991	5825.055	56	122,285
The number of townships (towns)	3528	16.895	8.757	1	110
The number of village committees	3528	304.310	224.500	4	2017
Total households at the end of the year	3528	139,855.3	94,369.9	2312	540,436
The number of village households	3528	108,792.6	78,376.93	649	468,400
Total population at the end of the year	3528	49.786	33.883	1	396
The rural population	3527	41.806	29.405	0	192
The number of employees at the end of the year	3528	30,491.28	43,226.14	1126	837,383
The number of rural employees	3528	221,797.4	162,318.6	1220	1,036,432
Total number of employees in rural areas of agriculture, forestry, animal husbandry and fishery	3528	141,048.7	102,469.8	4	660,200
The total power of agricultural machinery	3528	29.258	39.380	0	1512
Local telephone users	3513	67,474.32	87,173.81	565	1,108,205
The industrial added value of the primary industry	3528	96,303.89	85,001.23	1055	589,585

Table 2. *Cont.*

Variables	Observation	Mean	SD	Minimum	Maximum
The industrial added value of the secondary industry	3528	238,085.4	492,948	600	8,228,603
The general budgetary revenue of local finance	3528	20,411.89	47,957.59	136	900,647
The general budgetary expenditure of local finance	3528	42,337.79	51,159.09	1273	962,482
The industrial gross output value of enterprises above designated size	3528	548,201.4	1,790,081	78	36,900,000
The student number in middle schools	3528	30,136.07	22,817.8	140	161,463
The pupil number in primary schools	3528	47,784.49	37,586.94	729	347,365

5.2. Main Results

The DID estimation value indicates the interaction variable and the coefficient indicates the effect of the RFFP. The DID regression result (Table 3) shows the industrial added value of the local primary industry increased after the RFFP was implemented in the region, which was 10.9% higher than in areas where the program was not implemented (Model 1, Table 3). Although the RFFP was successful in reducing the amount of cultivated land to some degree, this land was mostly not suitable for agricultural production. As a result, the conversion of farmland to forest with trees that can be harvested may be more financially beneficial. Therefore, the RFFP can facilitate the industrial added value of the primary industry. In other words, the RFFP had a positive effect on the industrial added value of the primary industry.

In terms of industrial production, although the effect of the RFFP on the industrial added value of the secondary industry was not significant, it considerably restrained the growth of the total output of industrial enterprises above the designated size, as the policy requires cropland to be converted to forest rather than used for developing industry. As shown in Model 5 in Table 3, the policy of returning farmland to forest significantly reduced the total industrial output value above the level of the experimental group by 16.80%. Thus, the program slowed the increase in the industrial output in the region. We further tested the effect of the RFFP on the total number of employees in rural areas characterized by agriculture, forestry, animal husbandry, and fishing. The results indicate that the policy boosted the total number of employees in rural areas with agriculture, forestry, animal husbandry, and fishery. As shown in Model 6 in Table 3, the policy of returning farmland to forest significantly increased the rural employees in the experimental group working in agriculture, animal husbandry, and fishery by 8.20%. Therefore, we think that the failure to effectively encourage the rural population to enter the labor force in the secondary industry indicates that the RFFP has not been effective in promoting the development of the secondary industry.

The program also requires the local government to compensate households after the RFFP contracts have ended. For this reason, the local fiscal expenditure has substantially increased by 7.50% (Model 4, Table 3). Due to the negative effect on the industrial added value of the secondary industry, the program led to the shrinking of local fiscal revenue by about 35.50% (Model 3, Table 3).

The regressions were re-run by adding the instrumental variable. As shown in the result of the first-stage regression with slopes as the IV (see Appendix A Table A1), the regression coefficient of the slope was statistically significant at a significance level of 5%, and the IV had higher explanatory power on the endogenous variables for the RFFP. Apart from this, the regression F-value was 59.25, which is strictly more significant than 10, indicating that slope is not a weak instrumental variable. Therefore, we used slopes as the instrumental variable of RFFP here.

Table 3. The difference-in-differences (DID) regression result.

Variables	Industrial Added Value of Primary Industry	Industrial Added Value of Secondary Industry	General Budgetary Revenue of Local Finance	General Budgetary Expenditure of Local Finance	Industrial Gross Output Value of Enterprises above Designated Size (Current Price)	Total Number of Employees in Rural Areas of Agriculture, Forestry, Animal Husbandry, and Fishing
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
DID estimation value	0.109 ***	−0.048	−0.355 ***	0.075 ***	−0.168 ***	0.082 **
	(6.40)	(−1.43)	(−11.20)	(4.56)	(−3.76)	(2.69)
$RFFP_i$	−0.380 ***	−0.759 ***	−0.440 ***	−0.315 ***	−1.056 ***	0.102 **
	(−8.23)	(−12.89)	(−10.69)	(−12.85)	(−13.59)	(2.73)
T_t	0.447 ***	1.147 ***	1.059 ***	1.362 ***	1.776 ***	−0.268 ***
	(30.30)	(38.74)	(39.01)	(93.71)	(45.11)	(−8.77)
Number of village committees (per 10,000 people)	−0.027 ***	−0.014 *	−0.023 ***	−0.010 ***	−0.023 **	−0.027 ***
	(−4.34)	(−2.50)	(−4.85)	(−3.80)	(−2.94)	(−6.30)
Total population at year end	0.014 ***	0.017 ***	0.014 ***	0.010 ***	0.019 ***	0.016 ***
	(4.78)	(7.94)	(9.91)	(9.26)	(8.44)	(9.44)
Employment rate	0.252 ***	0.436 **	0.314 **	0.220 ***	0.727 ***	0.786 ***
	(3.67)	(3.10)	(2.75)	(3.46)	(3.94)	(5.23)
Pupil number in primary schools	−0.781 ***	−0.366	−0.152	−0.341 *	−1.757 ***	−1.120 **
	(−4.44)	(−1.00)	(−0.49)	(−2.08)	(−3.51)	(−2.71)
Constant	10.61 ***	10.47 ***	8.478 ***	9.305 ***	10.64 ***	10.84 ***
	(54.71)	(63.94)	(78.71)	(124.66)	(57.94)	(64.52)
N	3524	3524	3524	3524	3524	3524

Note: The t–value statistics are denoted in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Next, the industrial added value of the primary industry, the industrial added value of secondary industry, and other variables as dependent variables were used to test the impact of the RFFP, using the slopes as a tool variable for RFFP. Table A2 shows the regression results of the second stage. The results show that the policy had a significant impact on the industrial added value of primary industry, the industrial added value of secondary industry, and the local fiscal revenue and expenditure; however, the impact was limited on the total number of employees in rural areas of agriculture, forestry, animal husbandry, and fishing. Specifically, except for increasing the general budgetary fiscal expenditures, it adversely affected the other explanatory variables.

We compiled the regression results of the DID model and the IV model into Table 4. We compared the effects of the RFFP on different outcome variables. For some explanatory variables, such as the industrial added value of the secondary industry, the industrial gross output value of enterprises above the designated size, and the general budgetary revenue and expenditure of the local government, the conclusions obtained through both models are consistent. However, for the industrial added value of primary industry, the empirical results of the two methods are not consistent. We think this may be because there is no control for the in-variance time trend in the fixed effect. The results of the DID model are provided in Table 3. Taking the industrial added value of primary industry as an example, the coefficient before the dummy variable of the policy was significantly negative, and the difference between the experimental and the control groups was as high as 38%. That is, the dummy variables in the DID model show that the industrial added value of primary industry in the counties participating in the RFFP was lower than in counties that have not implemented the conversion of farmland to forests. This is also supported by the descriptive statistics in Table 2, which indicate a significant difference in the value-added of the primary industry between the experimental and control groups. Therefore, we found that there is no control for this difference in the fixed-effect model, but the DID model identified the impact generated by the policy. In summary, our research conclusions are mainly based on the empirical results of the DID model.

Table 4. Comparison of the regression results of the DID model and the instrumental variable (IV) model.

Variable	IV Model	DID Model	Comparison
Industrial added value of primary industry	Significant, negative	Significant, positive	Not consistent
Industrial added value of secondary industry	Significant, negative	Not Significant, negative	Consistent
Total number of employees in rural areas of agriculture, forestry, animal husbandry, and fishing	Not significant, positive	Significant, positive	Consistent
Budgetary revenue of local finance	Significant, negative	Significant, negative	Consistent
Budgetary expenditure of local finance	Significant, positive	Significant, positive	Consistent
Industrial gross output value of enterprises above designated size (current price)	Significant, negative	Significant, negative	Consistent

6. Conclusions and Recommendations

We examined the impact of the RFFP on regional economic development using econometric analysis. Regarding the industrial structure of regional economic development, the program has significantly increased the industrial added value of local primary industry by 10.9% in comparison with counties that have not participated in the RFFP. The program also increased the total number of employees in rural areas with agriculture, forestry, animal husbandry, and fishing in the region by 8.20%. However, the RFFP restrained the industrial added value of secondary industry in the region, notably slowing the increase in the gross output of industrial enterprises above the designated size by 16.80%. In addition, the increase in the industrial added value of the primary industry cannot compensate for the suppression of industrial output caused by the program. This is due to two primary reasons. First, the RFFP requires cultivated lands to be converted to forests with trees that can be harvested for economic gain rather than for alternative purposes, such as the development of local industries. Thus, to some degree, the program has curbed the increase in industrial output in the participating counties. Simultaneously, the program was initially designed for improving the ecological environment, and reducing industrial production could help achieve this goal. China's economy has become fast-growing after joining the World Trade Organization in 2001. However, before reaching the turning point of the environmental Kuznets curve, this environmental policy negatively affects the growth of industrial output. Also, the project has not boosted off-farm employment by transitioning on-farm labor to labor in secondary industry. Since areas enrolled in the RFFP are less developed and have lower education levels, they tend to be more risk-sensitive and continue their agricultural production. For this reason, they are less likely to shift to secondary industry.

Another finding is the impact of the project on the local government's fiscal revenues and expenditures. Local governments are crucial coordinators and responsible units for the regional economy and their financial status is an essential indicator of economic development. We found that the RFFP increased local fiscal expenditure, especially the general budgetary expenditure of local government, by 7.50%, mainly because this scheme requires the local government to subsidize participating farmers after their contracts have ended. Simultaneously, the project considerably reduced the general budgetary revenues of local governments by about 35.50% due to the suppression of the industrial added value of secondary industry in the region. This further indicates that the surplus of industrial added value of primary industry is not able to compensate for the decrease in the industrial output. This financial loss may demotivate local governments in promoting and implementing the RFFP. To reach the allocated target, they might even convert farmlands that do not meet the criteria for forest conversion (e.g., arable land with suitable agriculture condition or croplands with a slope below 15 degrees).

Given our analysis, we propose a few recommendations for policymakers. First, the government could improve technical training and employment guidance for the households who convert their farmland to forest. Government officials could provide institutional support to effectively help participating farmers build their non-agricultural skills and eventually shift to non-farm employment. The labor transformation from conventional agriculture to secondary and tertiary industries would restructure the local industry and boost sustainable economic development at the local level. Second, the eco-compensation scheme can be refined. Specifically, when the central government decides whether to subsidize local households for a project period, it needs to consider if the incentive will motivate the local government and farmers to implement the project in the next period. In other words, the eco-compensation from the central government should be determined by the expectations of social welfare in each period. When the net welfare is positive, the central government should pay the subsidy; otherwise, the government should cease compensation. Third, implementing the RFFP could be added as an indicator for assessing the performance of local governments to effectively measure the program's outcomes and reduce related agency problems.

Author Contributions: Conceptualization, Y.G., Z.L., and R.L.; methodology, Y.G. and Z.L.; formal analysis, Y.G., Z.L., and Z.S.; data curation, Z.S.; writing—original draft preparation, Y.G. and Z.L.; writing—review and editing, Z.L. and R.L. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the China Postdoctoral Science Foundation, grant number 2018M641397; the National Natural Science Foundation of China, grant number 71902196; and the Doctoral Start-Up Fund of the Natural Science Foundation of Guangdong Province, China, grant number 2018A030310287.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. The result of the first-stage IV regression.

Variables	The RFFP Implementation
Average slope	0.005 *** (3.38)
Number of townships (towns)	0.007 *** (5.92)
Number of village committees	−0.000 *** (−10.05)
Number of village households	−0.000 ** (−2.39)
Total population at the end of the year	0.003 *** (3.21)
Number of employees at the end of the year	−0.000 ** (−2.48)
Total power of agricultural machinery	0.001 ** (2.41)
Local telephone users	−0.000 *** (−10.14)
Pupil number in primary schools	−0.000 (−0.92)
Hospital bed number	0.000 * (1.75)
Constant	0.726 *** (30.13)
N	3414

Note: t-value statistics in denoted in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table A2. Results of the second-stage IV regression.

Variable	Industrial Added Value of the Primary Industry	Industrial Added Value of the Secondary Industry	General Budgetary Revenue of Local Finance	General Budgetary Expenditure of Local Finance	Industrial Gross Output Value of Enterprises above Designated Size (Current Price)	Total Number of Employees in Rural Areas of Agriculture, Forestry, Animal Husbandry, and Fishing
T_i	−6.242 ***	−8.017 ***	−3.554 ***	1.788 **	−9.716 ***	0.516
	(−2.87)	(−3.07)	(−3.05)	−2.51	(−2.97)	−1.14
Number of townships (towns)	0.036 **	0.023	0.003	−0.032 ***	0.018	0.003
	(2.18)	(1.14)	(0.34)	(−5.44)	(0.70)	(0.84)
Number of village committees	−0.003 ***	−0.003 ***	−0.002 ***	0.000	−0.004 ***	0.000
	(−3.24)	(−2.70)	(−2.93)	(1.28)	(−2.67)	(1.36)
Number of village households	−0.000	−0.000	0.000	0.000 **	−0.000	0.000 ***
	(−0.06)	(−0.95)	(0.00)	(2.27)	(−1.02)	(7.52)
Total population at the end of year	0.033 ***	0.034 ***	0.017 ***	0.009 **	0.044 ***	0.005
	(2.84)	(3.01)	(3.20)	(2.29)	(3.05)	(1.64)
Number of employees at the end of the year	−0.000	−0.000	−0.000	0.000	−0.000	−0.000
	(−1.45)	(−1.23)	(−0.50)	(1.06)	(−1.32)	(−0.69)
Total power of agricultural machinery	0.008 ***	0.009 ***	0.003 **	0.001	0.011 ***	0.000
	(2.60)	(2.65)	(2.27)	(1.04)	(2.70)	(0.73)
Local telephone users	−0.000 ***	−0.000 **	−0.000	0.000 ***	−0.000 *	−0.000 **
	(−2.76)	(−2.05)	(−0.94)	(5.57)	(−1.80)	(−2.13)
Pupil number in primary schools	−0.000 **	−0.000 ***	−0.000 ***	−0.000 ***	−0.000 ***	0.000 *
	(−2.41)	(−2.99)	(−3.90)	(−5.27)	(−3.73)	(1.76)
Hospital bed number	0.000 **	0.001 ***	0.001 ***	0.000	0.001 ***	0.000
	(2.13)	(4.62)	(7.58)	(1.09)	(4.50)	(0.59)
Constant	14.947 ***	16.638 ***	11.153 ***	8.403 ***	18.120 ***	10.146 ***
	(8.68)	(8.07)	(12.20)	(15.02)	(7.01)	(28.18)
N	3414	3414	3414	3414	3414	3414

Note: t–value statistics in denoted in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

References

1. Xu, J.; Qin, P. *Case Study on Socio-Economic Impact of Converting Farmland to Forestry and Natural Forest Resources Conservation Project*; China Forestry Publishing House: Beijing, China, 2004.
2. Chen, Y.; Wang, K.; Lin, Y.; Shi, W.; Song, Y.; He, X. Balancing green and grain trade. *Nat. Geosci.* **2015**, *8*, 739. [CrossRef]
3. Zinda, J.A.; Trac, C.J.; Zhai, D.; Harrell, S. Dual-function forests in the returning farmland to forest program and the flexibility of environmental policy in China. *Geoforum* **2017**, *78*, 119–132. [CrossRef]
4. Guo, H.; Li, B.; Hou, Y.; Lu, S.; Nan, B. Rural households' willingness to participate in the grain for green program again: A case study of Zhungeer, China. *For. Policy Econ.* **2014**, *44*, 42–49. [CrossRef]
5. Chen, C.; König, H.; Matzdorf, B.; Zhen, L. The institutional challenges of payment for ecosystem service program in china: A review of the effectiveness and implementation of sloping land conversion program. *Sustainability* **2015**, *7*, 5564–5591. [CrossRef]
6. Wang, S.; Yue, X. How china's grain-for-green project contributes to farmers' income growth. *China Econ.* **2018**, *13*, 88–102.
7. Xie, L.; Zeng, B.; Jiang, L.; Xu, J. Conservation payments, off-farm labor, and ethnic minorities: Participation and impact of the grain for green program in China. *Sustainability* **2018**, *10*, 1183. [CrossRef]
8. Zhang, B.; Li, P.; Xu, Y.; Yue, X. What affects farmers' ecocompensation expectations? an empirical study of returning farmland to forest in china. *Trop. Conserv. Sci.* **2019**, *12*, 324258103. [CrossRef]
9. Trac, C.J.; Schmidt, A.H.; Harrell, S.; Hinckley, T.M. Environmental reviews and case studies: Is the returning farmland to forest program a success? three case studies from Sichuan. *Environ. Pract.* **2017**, *15*, 350–366. [CrossRef]
10. Peng, H.; Cheng, G.; Xu, Z.; Yin, Y.; Xu, W. Social economic, and ecological impacts of the "Grain for Green" project in China: A preliminary case in Zhangye, Northwest China. *J. Environ. Manag.* **2007**, *85*, 774–784. [CrossRef]
11. Regulations on Returning Farmland to Forests. Available online: http://www.forestry.gov.cn/main/3950/20170314/459878.html (accessed on 14 March 2017).
12. Guidance for Improving the Pilot of Returning Farmland to Forest Program from the State Council. Available online: http://www.gov.cn/gongbao/content/2000/content_60486.htm (accessed on 12 January 2019).
13. Suggestions on Extending the Period of Subsidy for Returning Farmland to Forest. Available online: http://www.forestry.gov.cn/main/4861/content-918757.html (accessed on 8 November 2016).
14. Cao, S.; Xu, C.; Chen, L.; Wang, X. Attitudes of farmers in China's northern Shanxi Province towards the land-use changes required under the Grain for Green Project, and implications for the project's success. *Land Use Policy* **2009**, *26*, 1182–1194. [CrossRef]
15. Lin, Y.; Yao, S. Impact of the sloping land conversion program on rural household income: An integrated estimation. *Land Use Policy* **2014**, *40*, 56–63. [CrossRef]
16. Uchida, E.; Xu, J.; Xu, Z.; Rozelle, S. Are the poor benefiting from China's land conservation program? *Environ. Dev. Econ.* **2007**, *12*, 593–620. [CrossRef]
17. Uchida, E.; Xu, J.; Rozelle, S. Grain for green: Cost-effectiveness and sustainability of china's conservation set-aside program. *Land Econ.* **2005**, *81*, 247–264. [CrossRef]
18. Song, C.; Zhang, Y.; Mei, Y.; Liu, H.; Zhang, Z.; Zhang, Q. Sustainability of forests created by china's sloping land conversion program: A comparison among three sites in Anhui, Hubei and Shanxi. *For. Policy Econ.* **2004**, *38*, 161–167. [CrossRef]
19. Wang, C.; Ouyang, H.; Maclaren, V.; Yin, Y.; Shao, B.; Boland, A. Evaluation of the economic and environmental impact of converting cropland to forest: A case study in Dunhua county, China. *J. Environ. Manag.* **2007**, *85*, 746–756. [CrossRef]
20. Yin, R.; Liu, C.; Zhao, M.; Yao, S.; Liu, H. The implementation and impacts of China's largest payment for ecosystem services program as revealed by longitudinal household data. *Land Use Policy* **2014**, *40*, 45–55. [CrossRef]
21. Kelly, P.; Huo, X. Land retirement and nonfarm labor market participation: An analysis of China' s sloping land conversion program. *World Dev.* **2013**, *48*, 156–169. [CrossRef]
22. Liu, Z.; Lan, J. The sloping land conversion program in china: Effect on the livelihood diversification of rural households. *World Dev.* **2015**, *70*, 147–161. [CrossRef]

23. Uchida, E.; Rozelle, S.; Xu, J. Conservation payments, liquidity constraints, and off-farm labor: Impact of the grain-for-green program on rural households in China. *Am. J. Agric. Econ.* **2009**, *91*, 70–86. [CrossRef]
24. Yao, S.; Guo, Y.; Huo, X. An empirical analysis of the effects of China's land conversion program on farmers' income growth and labor transfer. *Environ. Manag.* **2010**, *45*, 502–512. [CrossRef]
25. Zhou, D.; Zhao, S.; Zhu, C. The grain for green project induced land cover change in the loess plateau: A case study with Ansai County, Shanxi Province, China. *Ecol. Indic.* **2012**, *23*, 88–94. [CrossRef]
26. Groom, B.; Grosjean, P.; Kontoleon, A.; Swanson, T.; Zhang, S. Relaxing rural constraints: A 'win-win' policy for poverty and environment in China? *Oxf. Econ. Pap.* **2009**, *62*, 132–156. [CrossRef]
27. Qin, P.; Carlsson, F.; Xu, J. Forest tenure reform in China: A choice experiment on farmers' property rights preferences. *Land Econ.* **2011**, *87*, 473–487. [CrossRef]
28. Zhao, M.; Yin, R.; Yao, L.; Xu, T. Assessing the impact of China's sloping land conversion program on household production efficiency under spatial heterogeneity and output diversification. *China Agric. Econ. Rev.* **2015**, *7*, 221–239. [CrossRef]
29. Bennett, M.T. China's sloping land conversion program: Institutional innovation or business as usual? *Ecol. Econ.* **2008**, *65*, 699–711. [CrossRef]
30. Xu, Z.; Bennett, M.T.; Tao, R.; Xu, J. China's Sloping Land Conversion Program four years on: Current situation and pending issues. *Int. For. Rev.* **2004**, *6*, 317–326. [CrossRef]
31. Yin, R.; Zhao, M. Ecological restoration programs and payments for ecosystem services as integrated biophysical and socioeconomic processes—China's experience as an example. *Ecol. Econ.* **2012**, *73*, 56–65. [CrossRef]
32. China National Bureau of Statistics. *China County Statistical Yearbook*, 1st ed.; China Statistics Press: Beijing, China, 1992–2010.
33. China National Bureau of Statistics. Available online: www.stats.gov.cn/tjsj/zbjs/index.html (accessed on 12 January 2019).
34. Lechner, M. The estimation of causal effects by difference-in-difference methods. *Found. Trends Econom.* **2011**, *4*, 165–224. [CrossRef]
35. Moser, P.; Voena, A. Compulsory licensing: Evidence from the trading with the enemy act. *Am. Econ. Rev.* **2009**, *102*, 396–427. [CrossRef]
36. Treacy, P.; Jagger, P.; Song, C.; Zhang, Q.; Bilsborrow, R.E. Impacts of China's grain for green program on migration and household income. *Environ. Manag.* **2018**, *62*, 489–499. [CrossRef]
37. Duflo, E.; Pande, R. Dams. *Q. J. Econ.* **2007**, *122*, 601–646. [CrossRef]