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Promoting Effect of Whole-Region Comprehensive Land Consolidation on Rural Revitalization from the Perspective of Farm Households: A China Study

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Abstract: With the rapid advances in globalization, industrialization, urbanization, and informatization, rural space continues to be occupied by urban expansion, and numerous production elements are aggregated in cities, resulting in global rural decline. The long-standing Chinese urban-rural dual system and urban-first development strategy have exacerbated a downturn in rural areas during the socio-economic transition. Combined with land management systems and innovation policies, whole-region comprehensive land consolidation (WRCLC) has become a crucial tool and platform for rural revitalization, extensively implemented nationwide. From the perspective of farm households, this paper employs the element-structure-function framework in the system theory to theoretically reveal the mechanism by which different WRCLC modes promote rural revitalization. Based on the questionnaire survey data from 1080 farm households in Zhejiang Province, the propensity score matching-difference in difference (PSM-DID) method based on quasi-experiment was employed to explore the impact of different WRCLC modes on the overall rural revitalization and its five dimensions (thriving industry, ecological livability, rural civilization, effective governance, and affluent life). The results show that WRCLC can optimize the rural structure and enhance rural functions by integrating the core elements of rural development to achieve complete rural revitalization. The empirical results show that implementing all WRCLC modes has significantly increased overall and five-dimension rural revitalization levels, with the city-suburb integration mode having a better effect on promoting rural revitalization than the characteristic industry mode and small-town construction mode. Based on this, some relevant policy recommendations have been put forward to enhance the effectiveness of WRCLC in promoting rural revitalization. Our findings will provide a Chinese practice for other countries and regions to develop more effective WRCLC modes and policies for promoting rural revitalization.

Keywords: whole-region comprehensive land consolidation; rural revitalization; effect; farm households' perspective; modification of TOPSIS method; PSM-DID

1. Introduction

The rural area is an indispensable territorial spatial system for human production and life. This system consists of the rural internal system (including natural, social, economic, and ecological systems) and the external system (including regional development policies, industrialization, and urbanization development stages, etc.) [1,2]. With the rapid advancement of globalization, urbanization, industrialization, and informatization, a large number of production elements (e.g., population and capital) have been concentrated in cities, resulting in a global issue with rural decay [3–7]. The urban-rural dual division system (land ownership and household registration) and the city-first development strategy have exacerbated the decline of the countryside in China during the socio-economic transformation [8]. Rural areas have a serious lack of capacity for sustainable development due to the rapid

aging and weakening of rural subjects, the hollowing out of villages, the inefficient use of land resources, the shortage of public infrastructure, the deterioration of the ecological environment, and the disorderly governance of rural areas [4,9–16]. In order to reverse the trend of rural decline and alleviate the contradictions of inadequate agricultural and rural development and unbalanced development between urban and rural areas, the Chinese government proposed the rural revitalization strategy in 2017 [15–17]. With the ultimate goal of achieving comprehensive rural revitalization, this strategy follows the principles of priority development of agriculture and rural areas and the dominant position of farmers to meet the general requirements of "thriving industry, ecological livability, rural civilization, effective governance, and affluent life" [17].

Although rural revitalization requires the integration and coordination of intrinsic and extrinsic driving forces, the important prerequisite is to optimize the allocation of rural production elements (e.g., land, population, industry), improve the utilization efficiency of these elements, and promote the reasonable flow of urban and rural resources and elements [10,18–20]. Land consolidation can solve the rural development dilemma by taking land resources as the core element of rural development to activate other production elements (e.g., human resources, funds, and technology) [13–15,21]. However, the traditional Chinese land consolidation (TCLC) that takes agricultural land or construction land as the single consolidation object and its consolidation projects are scattered, it has difficult to effectively solve the multidimensional rural development issues such as disorderly spatial layout, inefficient utilization of resources, and the degradation of ecological quality [22–24]. As a result, the TCLC has failed to adequately promote rural revitalization. Since the whole-region comprehensive land consolidation (WRCLC) was implemented in Hangzhou, Zhejiang Province, in 2016, it has been actively used as a tool and platform for rural revitalization nationwide. Many documents, such as the National Land Consolidation Plan (2016-2020), Notice of the Ministry of Natural Resources on the Pilot Work of Whole-Region Comprehensive Land Consolidation, and Central Document No. 1 of 2021, have made clear requirements for implementing WRCLC to promote rural revitalization. Based on the concept of "multiple plan integration" and "life community", WRCLC plans and designs the target area as a whole that takes towns or villages as the basic consolidation unit, systematically consolidating and restoring all of the area's elements (mountains, rivers, forests, fields, lakes, and grasses). The WRCLC, combined with land management systems and policies innovation, to tap villages' internal potential and draw in outside elements like capital and technology to coordinate the ecological civilization construction and the sustained development of urban and rural areas [14,15,22–25].

Exploring the mechanism and effect of WRCLC on rural revitalization will provide the competent departments of natural resources with theoretical support and a quantitative management foundation to guide the implementation of WRCLC, and enhance the effectiveness of rural revitalization through WRCLC. In recent years, research on the pathways and effects of promoting rural revitalization through WRCLC has attracted great attention. The existing literature involves three aspects. Firstly, analyzing the pathway of land consolidation on promoting rural revitalization through the typical practical cases implemented in some regions. Existing studies have found that land consolidation promotes rural revitalization by optimizing the allocation of rural production elements, improving rural productive, living, and ecological conditions, and then enhancing rural productive, living, and ecological functions [13,15,21,25–29]. Secondly, field surveys and comparative analyses have been conducted to explore the effects of land consolidation on rural revitalization. Some scholars used the cost-benefit method to measure and compare the differences in benefits before and after land consolidation, and between the consolidation area and non-consolidation area, and found that land consolidation can improve the economic, ecological, and social benefits [30,31], and play an important role in promoting rural revitalization [32]. Thirdly, the existing studies have explored the effect of land consolidation on multiple dimensions of rural revitalization, including rural industrial development, ecological livability, cultural revival, social governance, and affluent life. To be specific, previous studies

have found that land consolidation can not only boost agricultural transformation towards scalization, marketization, and modernization, but also optimize the rural industrial structure [15,30,33–38]. From the perspective of farmers' perception and satisfaction, some studies have shown that land consolidation can increase ecological livability by improving the living and ecological environment, infrastructure, and public services [39–41]. Other studies from a public perception perspective have revealed that land consolidation is an important tool for reshaping and preserving rural culture, landscape, and heritage [42,43]. In other case studies, it is demonstrated that social governance in rural areas can be more effective via a multi-subject governance system was formed during land consolidation implementation [15,44,45]. In addition, based on survey data and case analysis, some scholars have found that land consolidation contributes to reducing poverty and improving farmers' happiness and life quality [14,38,46]. From what has been discussed above, it can be found that land consolidation is an effective tool for promoting rural development and has a positive effect on the overall and multiple dimensions of rural revitalization.

In summary, previous study findings provide important insights into WRCLC promoting rural revitalization. Most existing research focuses on the pathways and the effects of promoting rural revitalization through land consolidation, but the mechanisms and effects of promoting rural revitalization by different modes (city-suburb mode, characteristic industry mode, and small town construction mode) of WRCLC have not been analyzed in any depth. The differences in investment standards, consolidation objectives, contents, and intensity, between different WRCLC modes will result in significantly different mechanisms and the effects of promoting rural revitalization across the modes. In addition, the indicator system for measuring rural revitalization is not systematic and comprehensive enough from the perspective of farm households against the background of WRCLC. The existing studies only focus on one single dimension or several aspects within multiple dimensions of rural revitalization, but farm households as the subject of WRCLC and rural revitalization are ignored. However, the development of a systematic and scientific measuring indicator system from the perspective of farmers is the foundation for promoting rural revitalization through WRCLC. Moreover, the existing studies only compare the levels of rural revitalization and its five dimensions before and after WRCLC's implementation, or measure the impact of land consolidation on a single dimension of rural revitalization by using the metrological method, making it impossible to accurately and comprehensively evaluate WRCLC's net effect on promoting rural revitalization. By decreasing sample selection bias and eliminating the influence of unobservable or omitted variables, propensity score matching-difference in difference (PSM-DID) is regarded as a more accurate approach for evaluating the net effects of policy [47,48].

In addressing these gaps, this paper aims to analyze the mechanism for promoting rural revitalization through the WRCLC, and then the differences in the effects between the three modes of WRCLC in promoting rural revitalization and their five dimensions (thriving industry, ecological livability, rural civilization, effective governance, and affluent life) are evaluated using PSM-DID based on field survey data collected in Zhejiang Province, China. This study will provide a China experience for promoting the implementation of WRCLC and accelerating the modernization of agriculture and rural areas, and it will offer suggestions for the formulation of policies related to rural revitalization through WRCLC. The paper is structured as follows. Section 2 analyzes the internal logic of WRCLC promoting rural revitalization. Section 3 presents the methodology and data collection. Section 4 reports the empirical results, followed by the discussion in Section 5. The final section summarizes the main findings and outlines key policy implications.

2. Internal Logic of WRCLC Promoting Rural Revitalization

2.1. Implementation Mode of WRCLC

National and local government authorities around the world often utilize various instruments to solve land use issues in rural development by implementing land consolidation, thereby stimulating economic growth, environmental protection, and social prosperity

in rural areas [49]. To fulfill realistic demands for regional social and economic development, many nations have been exploring land consolidation schemes. Land consolidation in developed countries began with the purpose of consolidating plots and improving agricultural production conditions and has now progressed to a stage that coordinates comprehensive rural governance, ecological landscape protection, and integrated urban-rural development [50]. The developed countries started land consolidation relatively early and have made great achievements in promoting rural revitalization. Modern land consolidation in China began in the 1980s and has progressed through three stages: a single land consolidation stage (agricultural land consolidation), a comprehensive land consolidation stage (agricultural and construction land consolidation and environmental protection), and a whole-region comprehensive land consolidation stage (area-wide and comprehensive) [51]. In seeking to resolve land use issues and enhance the promoting effect of rural development by land consolidation, the Chinese government has attempted to adopt a number of land reforms and policy innovations [11]. A solid foundation has been laid for intensive and economical land use, industrial development, financing, and balancing urban and rural development through the application of the system of land rights (ownership, contract right, management right) separation, and the land policies of cultivated land requisition-compensation balance and increasing vs. decreasing balance of urban-rural construction land.

The WRCLC has multiple functions, including optimizing territorial resources, reshaping rural space, improving living and ecological environment, and promoting the urban-rural integrated development, making it an important tool that contributes to the construction of beautiful countryside and ecological civilization [14,15,22–25].

WRCLC was first implemented in Hangzhou, Zhejiang Province, in 2016, then expanded across the entire province in 2018, and finally nationwide in 2019. China has explored the practical mode and working pathway of promoting rural revitalization through WRCLC that meets development needs, and Zhejiang Province is a pioneer and model of China's WRCLC practice. Between 2018 and 2020, Zhejiang has completed more than 1800 eco-environmental restoration projects, and 930 living environment improvement projects, and consolidated over 4000 pieces of fragmented arable land and 800 hm^2 of construction land. As a consequence, 5800 hm^2 of new arable land has been created, as well as 162 high-quality villages for rural revitalization, 130 model villages for beautiful and livable living, and 300 A-class tourist villages[1]. In November 2022, the Zhejiang Province government explicitly proposed a new phase of WRCLC with Zhejiang characteristics. It emphasizes regional planning as a starting point, overall design standards, and the effectiveness of full execution starting with village planning, engineering design, and engineering facilities. The three features of village renovation, farmland improvement, and ecological restoration, accelerate the promotion of ecological product value realization, farmers' income enrichment, and rural revitalization.

Taking into account that the WRCLC emerged very late, the project's implementation period is relatively long (generally three years), and there are few completed projects in Zhejiang Province in 2020 (the investigation time). To examine the promoting effect of rural revitalization by WRCLC, the selected WRCLC projects must be completed for at least one year. Of the limited number of projects meeting all the criteria, this paper selects three typical modes with WRCLC projects completely implemented and passing government inspection acceptance as our research objects from the existing successful cases of WRCLC: city-suburb integration (CSI) mode, characteristic industry (CI) mode, and small town construction (STC) mode.

The CSI mode is implemented in suburban areas with greater natural endowment and higher economic levels, it has the highest investment standards, and its consolidation goal is urban-rural integration development. This mode optimizes production, living, and ecological space, by the implementation of high-standard farmland construction, land transfer, construction land reclamation, idle farmhouses demolition, village renovation, living environment improvement, ecological restoration, and beautiful countryside construction.

As a result, the rural environment, the quality of life of farmers, and the level of economic development, are all improved.

The CI mode is implemented in the outer suburbs, which have flat terrain, abundant resources, and appropriate infrastructure. It has higher investment standards and its consolidation goal is industrial integration. Relying on regional natural, historical, and cultural resources, this mode develops new industries such as modern agriculture, ecological tourism, bed and breakfast, and exhibition through the joint implementation of high-standard farmland and rural complex construction, arable land reclamation, land transfer, construction land reclamation, ecological and living environment improvement, and the exit of inefficient industries. As a result, rural production efficiency and spatial layout have been improved.

The STC mode is implemented in remote mountainous areas with poor transportation and location, a scarcity of resources, and low economic level. It has a general level of investment standards, and its consolidation goal is to gather rural settlements and improve the village's appearance. This mode implements projects like dry land and paddy field reclamation, land transfer, ecological migration, centralized resettlement of farmers, small town construction, mountain ecological restoration, and living environment improvement. As a result, this mode contributes to concentrating rural settlements, increasing farmer income, and improving village appearance and infrastructure construction.

2.2. Mechanism of Promoting Rural Revitalization through WRCLC

Using the element-structure-function framework from system theory, this paper develops a theoretical framework for analyzing WRCLC promoting rural revitalization in order to reveal the pathways and effects of promoting rural revitalization under different WRCLC modes from the perspective of element integration, structure optimization, and function promotion (Figure 1).
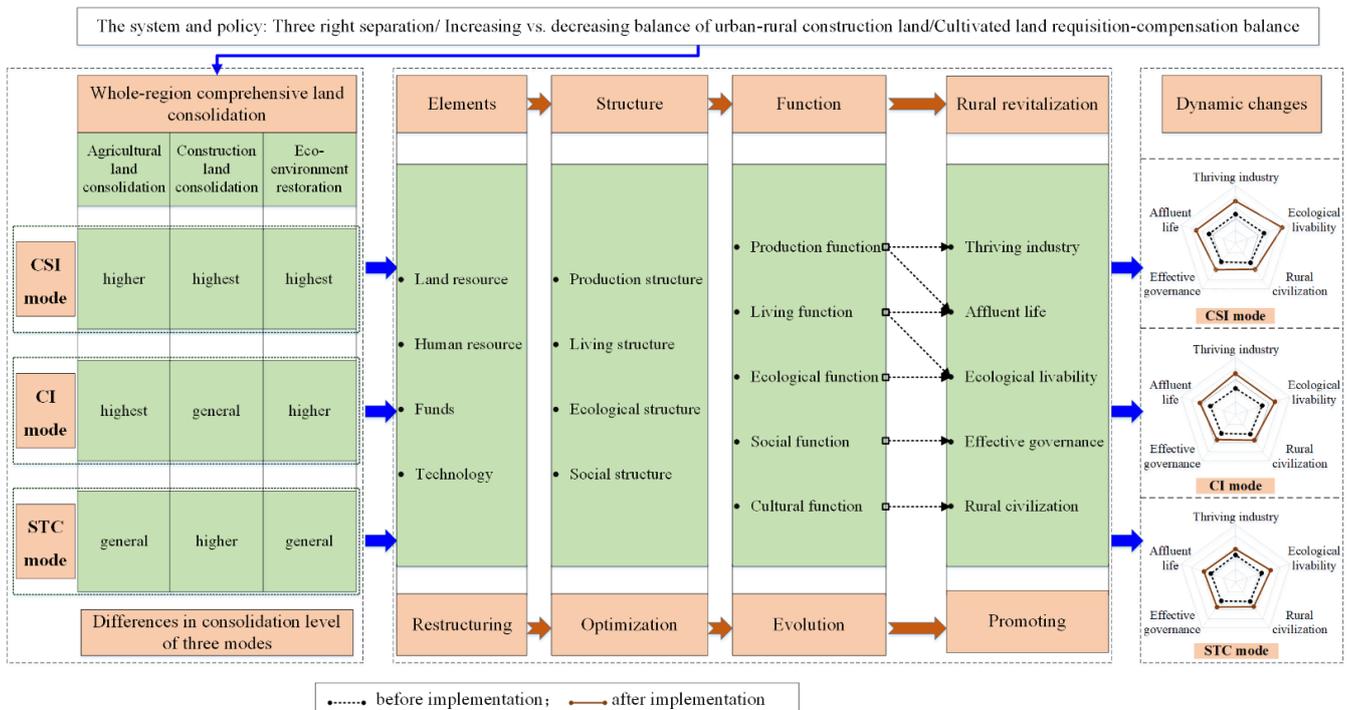
Figure 1. Internal logic of whole-region comprehensive land consolidation promoting rural revitalization. Note: 1. SI-mode, CI-mode, and STC-mode, respectively, refer to city-suburb integration mode, characteristic industry mode, and small-town construction mode. 2. The highest, higher, and general, respectively, refer to the degree of consolidation of agricultural land (construction land and eco-environment) by the three typical consolidation modes.

Under the system and policy guarantee of land management, urban and rural governance, WRCLC can restructure the village's development elements and improve the efficiency of rural resource utilization and element integration by coordinating the comprehensive consolidation of agricultural land, construction land, and eco-environment. WRCLC can provide a space carrier for rural development by optimizing the allocation of land resources and improving its multidimensional values such as social, economic, and ecological values [13,21,29]. WRCLC can release the dividend of rural consolidation and attract the return of labor and talents by improving infrastructure construction and public service capability, thereby providing human resources for rural development [15]. WRCLC can provide financial guarantees for rural development by combining policies such as increasing and decreasing the balance of urban-rural construction land, financial assistance, rural financial services, and social capital investment [14,15]. Technical elements can be supplemented for the high-quality development of agriculture and rural areas by introducing advanced agricultural engineering technology and modern industrial production and management technology [14,21].

Under the guidance of scientific planning, the WRCLC reconstructs intensive and efficient production space, rebuilds moderately agglomerated and livable living space, and reshapes ecological space with beautiful scenery by integrating the four key elements of rural development, thus promoting the spatial structure optimization of production, life, and ecology [52]. The transformation of rural social governance structure can be promoted by coordinating government, rural collectives, social investors, farmers, and other subjects to implement the land consolidation work and building smart villages to promote digital empowerment of grassroots governance [15].

WRCLC can promote the transformation of rural functions from simple to complex, and from single to diverse by optimizing the rural structure, thereby comprehensively improving the function of the rural regional system. WRCLC enhances rural production, living, and ecological functions, by optimizing the spatial structure between them [29,39–41,52]. By optimizing the social governance structure, WRCLC can lay a solid foundation for the development of agriculture, rural areas, and farmers to provide a stable, harmonious, orderly, and efficient social environment, thereby enhancing rural social functions [40,45]. Through the excavation and the protection of characteristic landscapes and culture in the process of reconstructing the production, living, and ecological space, humanistic quality, and rural cultural functions, are improved [29].

WRCLC provides a platform for rural revitalization by promoting the orderly transformation of rural regional functions. The improvement of a rural production function enhances the village's ability to provide products and services, and promotes a rural industry system construction and industry integration development, to realize thriving industry [17,53]. At the same time, WRCLC can also promote the development of the rural economy, drive farmers to increase their incomes, and achieve a prosperous life [14,15]. The improvement of living functions has enhanced the village's ability to meet farmers' well-being needs by improving infrastructure and public service capacity, therefore promoting affluent life and ecological livability [15]. The improvement of ecological functions can increase the ability to regulate, recover, and stabilize, the rural eco-environment through promoting green production (energy saving, consumption reduction, and pollution reduction), and the comprehensive consolidation of rural living and eco-environment to promote ecological livability [39–41]. The improvement of social functions can promote the optimization of the rural governance structure and the enhancement of governance capability, thereby laying the foundation for the stability of rural society and sustainable development, eventually realizing effective rural governance [15]. The improvement of cultural functions can promote rural cultural confidence, cultural renaissance, and cultural prosperity and development, thus increasing the level of the rural social civilization, finally realizing rural civilization [15–17].

Under different WRCLC modes, the pathways and effects of promoting rural revitalization are different, due to the differences in investment standard, land consolidation

target, content, and intensity. CSI mode mainly takes urban-rural integration development as its consolidation goal to meet the need for rural development transformation. The investment standard of this mode is relatively high. The land consolidation objects including agricultural land, construction land, and eco-environment are more comprehensive, and land consolidation intensity is greater, by strengthening the guarantee of the policy, capital, talents, and organization. CSI mode has a strong ability to promote the total level of rural development element endowments and optimize the configuration of the structure. Therefore, this mode enhances the ability to integrate and utilize elements, the ability to optimize the rural space, economic and social structure, and the ability to improve regional functional attributes and functional strength, thus having a significant effect on promoting rural revitalization. CI mode mainly takes industry transformation, upgrading, and integration development as consolidation goals, and this mode's investment standard is lower than that of the CSI mode. Depending on the unique resources such as rural nature and historical culture, this mode focuses on the comprehensive consolidation of rural land and eco-environment to develop a characteristic industry that is concentrated, contiguous, intensive, efficient, and ecological. The capacity of the CI mode to integrate elements, optimize the structure, and improve the function is weaker than that of the CSI mode, resulting in a lower promotion effect on rural revitalization. The consolidation goal of the STC mode is mainly to build a new pattern of beautiful rural areas with intensive spatial forms. The investment standard of this mode is lower than that of the other two modes, and the STC mode focuses on comprehensive construction land consolidation, resulting in a lower ability of elements integration, structure optimization, and function improvement, thereby having a minimum effect of promoting rural revitalization.

3. Methodology and Data Collection

3.1. Methodology

3.1.1. Modification of TOPSIS Method

A necessary part is calculating the evaluation indicators' weights and conducting a thorough assessment of the degree of rural revitalization in light of those weights. The technique for order preference by similarity to an ideal solution (TOPSIS) method is a common method for multi-objective decision analysis of finite solutions in system engineering. The Euclidean distance between each solution and the positive ideal solution (the optimal value of each indicator) and the negative ideal solution (the worst value) is calculated to determine the superiority or inferiority of the solution based on this distance [54]. This method has been widely used in research due to its advantages, such as low requirements on sample size and simple calculation. However, the traditional TOPSIS method mainly relies on expert subjective scoring to determine the weight, which may cause a deviation from the evaluation's actual results. Therefore, referring to the previous study [55,56], this paper determines the indicators' weights by the combination of the analytic hierarchy process (AHP) and the entropy weight method (EWM), and then uses the TOPSIS method to evaluate the level of rural revitalization. Once the TOPSIS method has been modified, it will be possible to estimate the level of rural revitalization both before and after the implementation of WRCLC with more accuracy by reducing the subjective errors caused by expert judgment and the objective errors resulting from data [56]. The specific steps of the rural revitalization level measurement are as follows:

First, normalize the decision matrix. The decision matrix is normalized (also known as normalized evaluation matrix R = [r_{ij}]) using the following equation:

$$
\begin{aligned}
r_{ij} &= \frac{x_{ij}-\min_j}{\max_j-\min_j}, \text{Positive Indicator} \\
r_{ij} &= \frac{\max_j-x_{ij}}{\max_j-\min_j}, \text{Negative Indicator}
\end{aligned}
\tag{1}
$$

In Equation (1), x_{ij} denotes the actual value of the *j*th indicator of the *i*th household; $r_{ij} \in [0,1]$ value ranges from 0 to 1; $\max_j$ and $\min_j$ denote the maximum and minimum values of the *j*th indicator, respectively.

Second, weight determination by the combination of two methods. AHP is a multi-level weighting analysis method, which can decompose the elements related to the measurement into levels such as objectives, criteria, and schemes. On this basis, the method combines qualitative and quantitative system analysis to determine the weight of each indicator [57]. EWM is an objective weighting method that determines the weight by calculating the entropy of information contained in the indicator. The more information the indicator contains, the smaller the entropy value of the indicator, thus the larger the weight coefficient of the indicator, otherwise, the smaller the weight coefficient of the indicator. The final weights of the indicators are calculated as the average of the weight obtained from the two methods (AHP and EWM). The calculation formula is as follows:

$$w_j = \gamma AHP_j + (1 - \gamma)EWM_j \tag{2}$$

In Equation (2), w_j is the weight coefficient of each indicator obtained by combining two weighting methods, $0 \leq w_j \leq 1$, $\sum_{j=1}^{n} w_j = 1$; AHP_j is the weight coefficient obtained by the AHP, EWM_j is the weight coefficient obtained by the EWM; γ is the equilibrium coefficient, $0 < \gamma < 1$. Drawing on existing studies, this paper values γ as 0.5 [56].

Third, indicator score calculation. A weighted decision matrix $y_{ij} = r_{ij} \times w_j$ is constructed to obtain the score of each indicator for farm household i.

Fourth, TOPSIS integrated measurement model. A TOPSIS model was established to comprehensively measure the industry prosperity level index (TI_i) before and after the WRCLC according to the scores of each indicator, and its calculation formula is as follows:

$$TI_i = \frac{D_i^-}{(D_i^- + D_i^+)} (i = 1, 2, \ldots, m) \tag{3}$$

Among them,

$$D_i^+ = \sqrt{\sum_{j=1}^{n} (y_i^+ - y_{ij})^2}, \ D_i^- = \sqrt{\sum_{j=1}^{n} (y_i^- - y_{ij})^2}, \ y_i^+ = \max_{m \geq i \geq 1} (y_{ij}), \ y_i^- = \min_{m \geq i \geq 1} (y_{ij})$$

In Equation (3), the larger the value of TI_i, the better the result; y_i^+ and y_i^- denote the positive and negative ideal solutions of the evaluated object; D_i^+ and D_i^- are the Euclidean distance from the *i*th farm household to the positive and negative ideal solutions.

According to the above four steps, the industrial prosperity level index, ecological livability level index, rural civilization index, effective governance index, and affluent life index, are calculated before and after the WRCLC, respectively. Finally, based on the level index matrix on the five dimensions, the rural revitalization level index is calculated according to the above steps (2) to (4).

3.1.2. PSM-DID Estimator

After applying the modified TOPSIS method to evaluate the level of rural revitalization before and after the implementation of WRCLC, the PSM-DID estimator is used to calculate the promoting effect of rural revitalization by WRCLC. Once WRCLC is implemented, the level of rural revitalization will change in two aspects. The first is the 'time trend effect' caused by inflation and economic development, in which the level of rural revitalization naturally increases over time. The second is the 'policy shock effect' influenced by WRCLC, which is the key to this study. Existing studies have indicated that the PSM-DID estimator achieves the complementary advantages of PSM and DID and that this estimator can effectively remove the 'treatment effect' of policy implementation, making it a common method for assessing the net effect of policy implementation [46,58,59]. A PSM-DID estimator is therefore applied to scientifically evaluate the net effect of different modes of WRCLC implementation on rural revitalization. This method treats the imple-

mentation of WRCLC as a quasi-natural experiment, with farmers in the consolidated areas serving as the treatment group and the farmers in the unconsolidated areas serving as the control group.

PSM is a scientific approach to searching for the control group samples with the maximum resemblance to the treatment group. It reduces the sample selectivity bias by matching the sample farm households between the treatment group and control group so that both groups can have the same "time effect", but it cannot eliminate estimation bias caused by omitted variables [47,48]. The DID estimator effectively solves this estimation bias by eliminating the effects of time-variant (such as inflation) and time-invariant factors (individual fixed effects), but the DID estimation results are biased by a lack of comparability in farmer households between the treatment and control groups due to selective bias [60]. Therefore, the present study combines these two methods and obtains the PSM-DID estimator, and its application is as follows. First, the PSM is used to search the sample (farm households) similar to those in the treatment group before WRCLC implementation from the control group, based on the control variables so as to ensure conformity with the assumption of sample homogeneity, and long-term trend consistency between the treatment and control groups. Second, using the DID method, counterfactual estimation is conducted for the matched farm household samples between the treatment group and control group with no significant difference, but with even distribution in order to obtain accurate and reliable policy effects [61]. The specific steps are as follows:

First, propensity score estimation. The propensity score refers to the probability that households receive the support of WRCLC policy, and it is estimated based on a vector of observed covariates by the Logit model.

Second, matching treatment and control groups according to propensity scores. In order to ensure the robustness of the matching results, this paper adopts kernel-based matching (KBM), nearest-neighbor matching (NNM), and radius matching (RM). KBM is the overall matching method using an Epan kernel and 0.06 bandwidth. NNM is to obtain *k* different samples from the control group matching those with closest propensity score in the treatment group, and in this paper, *k* is valued as 5. RM is to match the samples whose absolute distance from the propensity score is within ε, and ε value is 0.03 in this paper.

Third, calculation of the net effect of WRCLC on rural revitalization. After matching sample farm households between treatment group and control group, the DID method is applied to estimate the net effect of WRCLC on rural revitalization. The average treatment effect on the treated is expressed as $ATT^{PSM-DID}$. The calculation formula is as follows:

$$ATT^{PSM-DID} = \frac{1}{N}\sum_{i \in I_1 \cap S_p}\left[\left(Y^1_{i,t_1} - Y^1_{i,t_0}\right) - \sum_{j \in I_0 \cap S_p}w(i,j)\left(Y^0_{j,t_1} - Y^0_{j,t_0}\right)\right] \qquad (4)$$

In Equation (4), I_1 is a treatment group collection and I_0 is control group collection. S_p is a set of common support region. N denotes the number of samples included in $I_1 \cap S_p$. Y^1_{i,t_0} and Y^1_{i,t_1} represent the rural revitalization level of sample household *i* in the treatment group before and after WRCLC implementation, respectively. Y^0_{i,t_0} and Y^0_{i,t_1} represent corresponding rural revitalization level in the control group. $w(i,j)$ is a weighting function based on the above-mentioned three matching methods (KBM, NNM, and RM).

According to Equation (4), the differences in rural revitalization level before and after consolidation, are calculated for the sample farm households in the treatment group $\left(Y^1_{i,t_1} - Y^1_{i,t_0}\right)$ and the matched control group $\left(Y^0_{j,t_1} - Y^0_{j,t_0}\right)$, respectively. According to the three matching methods, the net effect of WRCLC on rural revitalization is estimated.

3.2. Variable Settings

3.2.1. Selection of Dependent Variables

This study developed a five-dimensional evaluation indicators system from the perspective of farmers, adhering to scientificity, systematicity, comparability, and operationality principles, to measure the level of the five dimensions (thriving industry, ecological livability, rural civilization, effective governance, and affluent life). It drew from the existing

research conducted on the conception and the evaluation indicators system of five dimensions and was based on the connotation and general requirements of relevant documents on five dimensions and the practice of WRCLC.

The thriving industry is the economic foundation of rural revitalization, and this paper adopts land productivity, agricultural labor productivity, comprehensive mechanization rate of crop cultivation and harvest, and local employment opportunities of labor, to measure the degree of rural industrial prosperity [62–65]. Ecological livability is the environmental basis of rural revitalization. This study selects drinking water quality, domestic sewage treatment degree, household garbage treatment degree, domestic energy source, and toilet types, to measure the level of ecological livability [62–64]. Rural civilization is the cultural foundation of rural revitalization. This paper adopts five indicators including culture, education, and entertainment expenditure proportion, kinship and neighborhood harmony degree, social contact expenditures, feudal superstition activities, and excellent family tradition inheritance degree to measure the rural civilization level [32,64–66]. Effective governance is the social foundation of rural revitalization. This paper selects four indicators including democratic right guarantee, public affair participation ability, public affair participation enthusiasm, and villagers' moral quality to measure the level of effective governance [64–66]. Affluent life is the well-being construction of rural revitalization. This paper selects four indicators, per capita net income, Engel's Coefficient, the happiness index, and per capita housing area, to measure the level of affluent life [17,63–65]. Thus, a multi-dimensional variable system, consisting of 1 first-level indicator, 5 second-level indicators, and 22 third-level indicators, is constructed to measure the overall and five-dimensional levels of rural revitalization before and after the implementation of WRCLC. The name, code, definition, assignment rules, and weight of each indicator, are shown in Table 1.

Table 1. The measurement indicators and its weight of rural vitalization and its five dimensions.

First-Level Indicator	Second-Level Indicators	Weight	Third-Level Indicators	Definition and Assignment Rules	Weight
Rural revitalization	Thriving industry	0.17	Land productivity	Output value of agricultural products per unit land area (CNY Yuan/mu)	0.26
			Agricultural labor productivity	Ratio of annual agricultural income to the number of agricultural labors (CNY ten thousand/person)	0.15
			Comprehensive mechanization rate of crop cultivation and harvest	Machine farming area/Total farming area×40%+Machine sowing area/Total sowing area×30%+Machine harvesting area/Total harvesting area×30%	0.14
			Local employment opportunities of labor	Very few = 1; few = 2; general = 3; many = 4; very many = 5	0.47
	Ecological livability	0.29	Drinking water quality	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.18
			Domestic sewage treatment degree	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.26
			Household garbage treatment degree	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.33
			Domestic energy source	Firewood or straw = 1; coal = 2; natural gas or liquefied gas = 3; electricity = 4; solar or biogas = 5	0.15
			Toilet types	Simple toilet = 1; sanitary toilet = 2; flush toilet = 3	0.10
	Rural civilization	0.16	Culture, education, and entertainment expenditure proportion	The proportion of culture, education, and entertainment expenditure in total family expenditure	0.57
			Kinship and neighborhood harmony degree	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.10
			Social contact expenditures	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.14
			Feudal superstition activities	Very many = 1; many = 2; general = 3; few = 4; very few = 5	0.08
			Excellent family tradition inheritance degree	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.12

Table 1. *Cont.*

First-Level Indicator	Second-Level Indicators	Weight	Third-Level Indicators	Definition and Assignment Rules	Weight
	Effective governance	0.14	Democratic right guarantee	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.30
			Public affair participation ability	Very weak = 1; weak = 2; general = 3; strong = 4; very strong = 5	0.28
			Public affair participation enthusiasm	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.25
			Villagers' moral quality	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.19
	Affluent life	0.25	Per capita net income	Annual household per capita net income (CNY)	0.47
			Engel's Coefficient	Proportion of total household food expenditure in total expenditure	0.16
			Happiness index	Very low = 1; low = 2; general = 3; high = 4; very high = 5	0.09
			Per capita housing area	Per capita housing area of households (m²)	0.29

Note: 1. The weight of each indicator is calculated according to the modification TOPSIS method. 2. Dataset origins from field survey data. 3. The sum of the weights of four indicators of the thriving industry, five indicators of ecological livability, five indicators of rural civilization, four indicators of effective governance, four indicators of affluent life, and five indicators of rural revitalization are 1.02, 1.02, 1.01, 1.02, 1.01, and 1.01, respectively.

3.2.2. Selection of Independent Variables

The WRCLC is the main independent variable (dummy variable); if the village implements the WRCLC's modes (either of the three modes), the value is 1; otherwise, the value is 0.

Farmers, as finite rational persons, are influenced by a number of factors when assessing the overall and multidimensional level of rural revitalization. In addition to the WRCLC, this paper also introduces three types of independent variables at the head of the household, family, and village as independent variables in an effort to limit the influence of other independent variables on the level of rural revitalization as much as possible and in accordance with previous studies on the evaluation of rural revitalization. The household head is the primary decision-maker in the home, and the characteristics of the household head affect farm families' cognition, information processing, and other abilities. One previous study uses the Ordinary Least Squares method to analyze the factors affecting farmers' evaluation on the effectiveness of rural community reconstruction, taking gender, age, and education level into consideration [67]. Another study reveals that variables such as age and education level significantly affect farmers' evaluation on rural livability [40]. Therefore, this paper introduces the household head's gender (X_1), age (X_2), and education (X_3) to measure the household head's value cognition. Family characteristics mainly include endowment characteristics such as labor force, land resources, and social relationships, and they are major factors affecting family survival, development, and decision-making. Family characteristics, such as household labor force level, land area, and the presence or absence of village cadres in farm households, are control variables in the study of the collective action capacity of rural infrastructure maintenance [68]. As a result, the current paper introduces four variables: the proportion of household labor force (X_4), the proportion of agricultural labor force (X_5), the household contracted land area (X_6), and social capital (X_7). Among external environmental factors, the rural revitalization level is directly connected to village endowment conditions, also bounded rationality farmers' decision-making, choice, and cognition are often constrained by unique environmental external conditions [69,70]. Topography, geomorphology, transportation, economic foundation, and governance subject capacity are internal driving forces of rural development, as well as major variables influencing the efficiency of rural public investment [19,71]. Therefore, this paper introduces four variables: landform characteristics (X_8), transportation convenience (X_9), economic development level (X_{10}), and village cadres' decision-making and behavior ability (X_{11}). Table 2 displays the name, code, definition, and assignment rules of 11 variables.

Table 2. Control variables and their code, definition, and assignment rules.

Variable	Code	Type	Meaning and Assignment Rules	Source
Household head's gender	X_1	Discrete	1 = male; 0 = female	[67]
Household head's age	X_2	Discrete	1 = under 40; 2 = between 41 and 55; 3 = between 56 and 64; 4 = over 65	[67]
Household head's education	X_3	Discrete	1 = illiterate or semi-literate; 2 = primary school; 3 = secondary school; 4 = high school; 5 = college or higher	[40]
The proportion of household labor force	X_4	Continuous	Proportion of the labor force in the total family population (%)	[68]
The proportion of agricultural labor force	X_5	Continuous	Proportion of the agricultural labor force in the total labor force (%)	[68]
The household contracted land area	X_6	Continuous	Land area contracted by farm households (ha)	[68]
Social capital	X_7	Discrete	Presence or absence of village or town leader in the farm household (1 = yes, 0 = no)	[68]
Village's landform characteristics	X_8	Discrete	Mountain = 1; Hills = 2; Basin = 3; Plain = 4	[19,71]
Transportation convenience degree	X_9	Discrete	Very low = 1; low = 2; general = 3; high = 4; very high = 5	[19,71]
Economic development level	X_{10}	Continuous	Per capita annual net income of farmer households (CNY)	[19,71]
Village cadres' decision-making and behavior ability	X_{11}	Discrete	Very weak = 1; weak = 2; general = 3; strong = 4; very strong = 5	[19,71]

3.3. Data Collection and Descriptive Statistics

Zhejiang Province, on China's southeast coast, is one of the country's most wealthy areas. As of 2021, Zhejiang has a 65.4 million population and a 72.7% urbanization rate. Zhejiang is the first province in China to build a demonstration zone of common prosperity, with a provincial GDP of CNY 735.16 billion in 2021, ranking fourth in the nation, and an average disposable income of CNY 57,541 for all residents, ranking third in the nation for years. It has a land area of 105.500 km² but just 0.02 hm² of arable land per resident.

The data used in this study were collected from a household survey conducted in Zhejiang Province in November 2020. The sampling procedure for the field survey is as follows. Following the importance sampling and representative sampling principles, as well as controlling for regional differences in resource conditions and public policies, six survey areas were selected: Xihu District and Jiande City of Hangzhou, Xiuzhou District and Jiashan County of Jiaxing City, and Yuyao City and Xiangshan County of Ningbo City, taking into account the progression of WRCLC implementation in Zhejiang Province (see Figure 2). Hangzhou City is a pioneer in the practice of WRCLC across Zhejiang Province; the city established and implemented 136 WRCLC projects between 2018 and 2020, ensuring that the "Hangzhou experience" in the field of WRCLC is continuously exported to other regions. Jiaxing City excelled in Zhejiang Province from 2018 to 2020 in terms of WRCLC implementation performance evaluation and was the city with the most provincial quality projects for WRCLC in 2020. Between 2018 and 2020, Ningbo City established and carried out more than 37 WRCLC projects, and the city holds three of the 26 quality provincial projects in 2020. Through the collaboration of the entire consolidation process, Ningbo has achieved considerable progress in WRCLC implementation. Additionally, due to the late emergence of the WRCLC, the lengthy implementation period of the project, and the relatively few completed projects, this study selected the WRCLC projects implemented in 2017 and completed in 2019 (including the CSI mode, the CI mode, and the STC mode). Subsequently, we chose unconsolidated areas with similar economic development levels, natural geographical features, location conditions, and policy environments to project areas. Finally, a list of farmer names was obtained from the village committees where the selected the CSI mode, the CI mode, the STC mode, and non-consolidation areas are located, and 10% of the farm households in each sample village were then randomly selected from the list

for a face-to-face interview-based questionnaire survey, in accordance with the principles of comprehensiveness, representativeness, and randomness sampling. The survey areas are of strong representativeness and typicality, and we follow the principle of typical and random sampling to ensure the scientificity and reliability of research data.
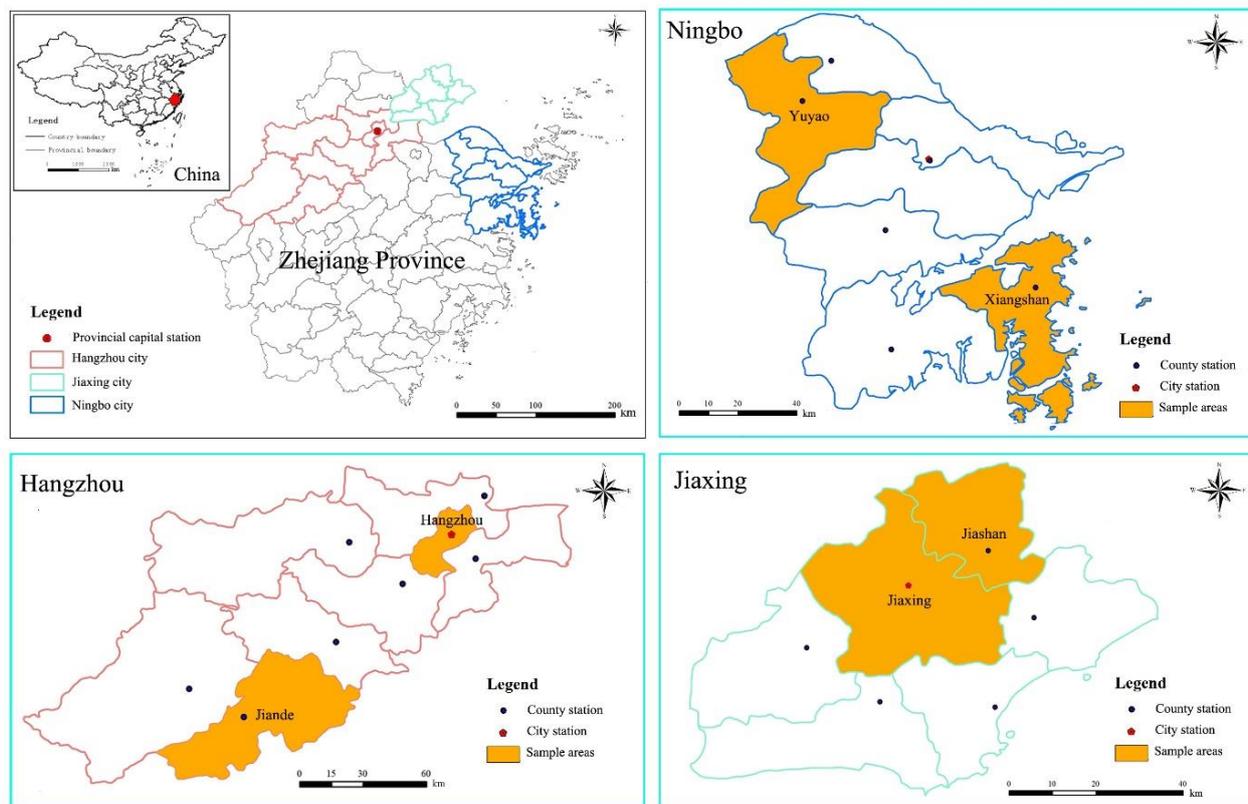

Figure 2. Location of the study area.

Data was collected in 2016 and 2020; the data in 2016 are chosen to represent those of the baseline period before WRCLC implementation. Given that there are very few WRCLC projects that have been fully completed and approved for more than one year, and that the time point of the survey was near the end of the year 2020, the data in 2020 are selected to reflect those after WRCLC project implementation. This study interviewed 1320 households, and 1080 valid questionnaires were collected after deleting invalid and partial information questionnaires. The efficiency percentage of the questionnaire was 81.82%. The sample size of farm households in the CSI mode area, the CI mode area, the STC mode area, and unconsolidated area were 203, 217, 221, and 439, respectively. The majority of the interviewed household heads (90.74%) were male, and household heads aged 41–64 accounted for 60.83% of the total. The education level of the household heads was concentrated in junior high school and lower, accounting for 89.07%. The household size ranged from 4 to 6 people, accounting for 70.93% of the total. The households with contracted land area $\leq$ 0.3 ha occupied 69.81%. Furthermore, the levels of rural revitalization, industrial prosperity, ecological livability, rural customs, effective governance, and affluent life were calculated using farmer survey data and the modified TOPSIS method. It can be found that their average values were determined to be 0.482, 0.462, 0.505, 0.459, 0.452, and 0.481, before the WRCLC project implementation (2016), and they increased to 0.618, 0.610, 0.650, 0.558, 0.548, and 0.613, after the WRCLC project implementation (2020). This indicates that the overall and five-dimensional rural revitalization levels have improved after the implementation of WRCLC when compared to the level before implementation.

4. Results

4.1. Estimation and Testing of Propensity Scores

The propensity score was estimated initially using a vector of observed matching variables [47,72]. Only by controlling these variables can the impact of sample self-selection bias on the objectivity of the study findings be reduced [73]. Matching variables must simultaneously satisfy two conditions, namely affecting both WRCLC implementation and rural revitalization level from the households' perspective. The propensity scores of the sample farm households from WRCLC project areas (the CSI mode area, the CI mode area, the STC mode area) and unconsolidated areas were calculated using a Logit regression model with 11 control variables (Table 2) as matching variables.

Following the calculation of the propensity score, a series of tests were performed to verify the accuracy of the matching results (Tables A1 and A2 in the Appendix A and Figure 3). Table A1 showed that there was no significant difference in all variables between the treatment and control groups after three matching methods were used, and the absolute value of the standardized deviation for all the variables was less than 15% (about within 10%). Thus, the standardized deviation was less than 20%, indicating that the matching results from the three matching methods passed the balancing test. Table A2 showed that after matching, both Pseudo R^2 and LR chi^2 values decreased and p-values increased, indicating that there was no systematic difference in the distribution of variables between the treatment and control groups, and thus matching results passed the joint test. The upper and lower parts of each histogram exhibited a large overlapping area, as shown in Figure 3, indicating a high similarity in the distribution of propensity scores between the treatment and control groups. The matching results passed the common support test, suggesting that the sample size was sufficient and that the sample matching quality was reliable.
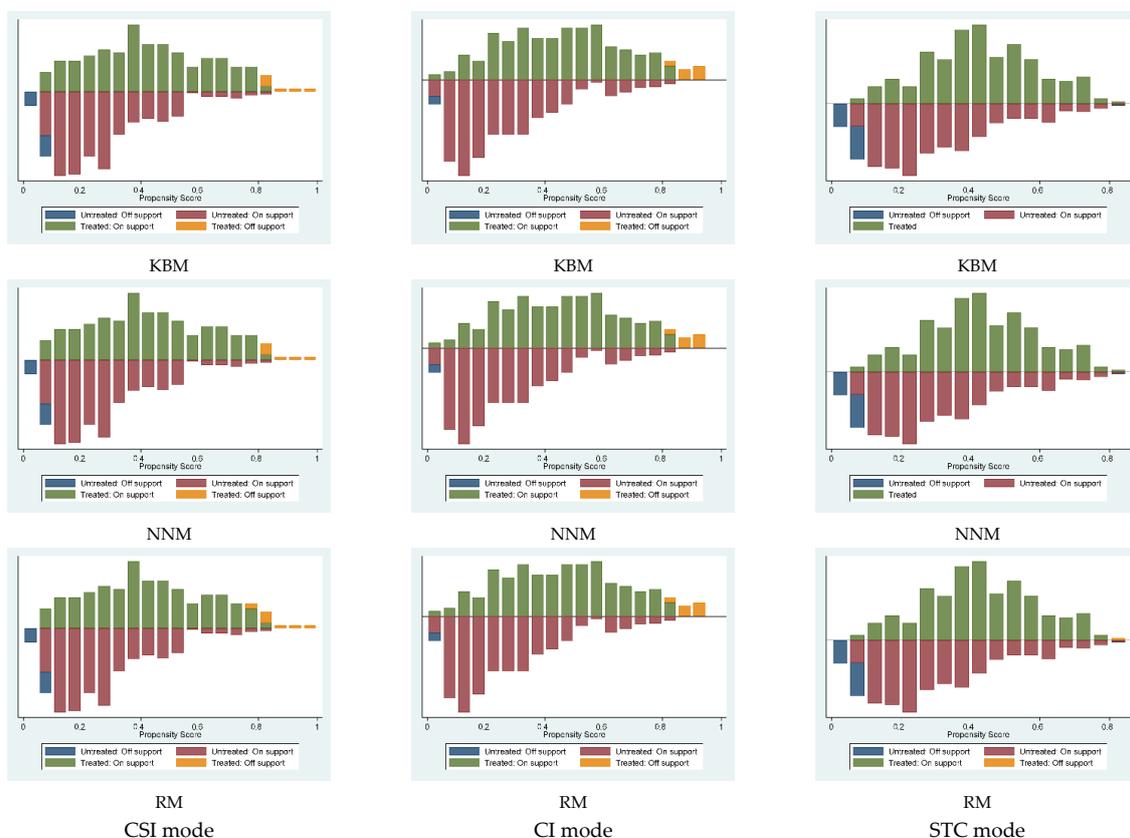

Figure 3. Propensity score distribution and common support for propensity score estimation. Note: 1. KBM, NNM, and RM stands for kernel-based matching, nearest-neighbor matching, and radius matching, respectively; 2. CSI mode, CI mode, and STC mode refers to city-suburb integration mode, characteristic industry mode, and small-town construction mode, respectively.

4.2. Model Estimation and Result Analysis

This paper evaluates and compares the effects of the different WRCLC mode implementation on rural revitalization overall level and its five dimensions using KBM-PSM-DID, NNM-PSM-DID, and RM-PSM-DID methods, with the results presented in Table 3 and Figure 4.

Table 3. Effects of different WRCLC modes on rural revitalization and its five dimensions.

	Matching Algorithm	CSI Mode			CI Mode			STC Mode		
		PSM-DID ATT	STD Error	t-Value	PSM-DID ATT	STD Error	t-Value	PSM-DID ATT	STD Error	t-Value
Rural revitalization	KBM	0.211 ***	0.011	19.28	0.162 ***	0.011	14.86	0.127 ***	0.010	12.94
	NNM	0.208 ***	0.011	19.00	0.157 ***	0.011	14.40	0.123 ***	0.010	12.53
	RM	0.200 ***	0.011	18.18	0.154 ***	0.011	14.15	0.116 ***	0.010	11.83
	Average	0.206			0.158			0.122		
Thriving industry	KBM	0.195 ***	0.015	13.24	0.204 ***	0.014	14.38	0.134 ***	0.013	10.12
	NNM	0.186 ***	0.015	12.63	0.199 ***	0.014	14.03	0.129 ***	0.013	9.75
	RM	0.180 ***	0.015	12.19	0.198 ***	0.014	13.95	0.124 ***	0.013	9.35
	Average	0.187			0.200			0.129		
Ecological livability	KBM	0.231 ***	0.011	20.83	0.172 ***	0.012	14.72	0.133 ***	0.011	12.21
	NNM	0.225 ***	0.011	20.30	0.162 ***	0.012	13.86	0.129 ***	0.011	11.89
	RM	0.220 ***	0.011	19.92	0.158 ***	0.012	13.52	0.121 ***	0.011	11.13
	Average	0.225			0.164			0.128		
Rural civilization	KBM	0.132 ***	0.022	6.04	0.124 ***	0.016	7.73	0.118 ***	0.020	5.87
	NNM	0.128 ***	0.022	5.86	0.120 ***	0.016	7.48	0.113 ***	0.020	5.62
	RM	0.122 ***	0.022	5.63	0.112 ***	0.016	6.98	0.108 ***	0.020	5.37
	Average	0.127			0.119			0.113		
Effective governance	KBM	0.128 ***	0.015	8.45	0.119 ***	0.015	8.04	0.110 ***	0.013	8.18
	NNM	0.124 ***	0.015	8.19	0.116 ***	0.015	7.84	0.104 ***	0.013	7.71
	RM	0.115 ***	0.015	7.65	0.107 ***	0.015	7.23	0.101 ***	0.013	7.48
	Average	0.122			0.114			0.105		
Affluent life	KBM	0.223 ***	0.020	11.09	0.167 ***	0.021	8.11	0.138 ***	0.022	6.41
	NNM	0.218 ***	0.020	10.85	0.152 ***	0.021	7.39	0.134 ***	0.022	6.23
	RM	0.213 ***	0.020	10.59	0.148 ***	0.021	7.19	0.121 ***	0.022	5.60
	Average	0.218			0.156			0.131		

Note: 1. KBM, NNM, and RM stands for kernel-based matching, nearest-neighbor matching, and radius matching, respectively; 2. CSI mode, CI mode, and STC mode refers to city-suburb integration mode, characteristic industry mode, and small-town construction mode, respectively; 3. *** denotes significance at the 1% level.
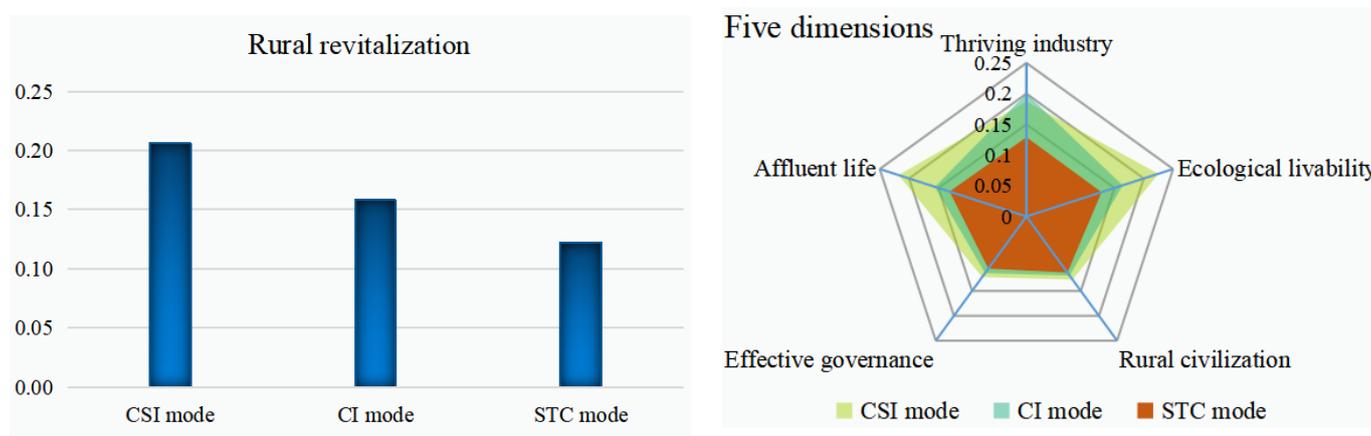

Figure 4. Comparing the promoting effects of different WRCLC modes on rural revitalization and its five dimensions. Note: The data in Figure 4 are the average values from Table 3.

The implementation of the three WRCLC modes significantly improves the level of rural revitalization (Table 3). The average values of the average treatment effect on the treated (ATT) calculated by the three matching methods are 0.206, 0.158, and 0.122, for the CSI, the CI, and the STC modes, respectively. This indicates that implementing

the CSI mode contributed to an increase of 0.206 in the overall rural revitalization level, which is 0.048 and 0.084 higher than the ATT value in the CI mode and the STC mode, respectively. This result suggests that the CSI mode implementation has the optimal effect on the rural revitalization overall level, followed by the CI mode and the STC mode (Figure 4). This finding might be attributed to the CSI mode's higher investment standards, better supporting policies, and more comprehensive consolidation contents, as well as its greater potential to integrate rural development elements than the other two modes, which benefit the countryside the most. Following consolidation, the countryside is more likely to achieve a relatively adequate and balanced development, with strong agriculture (the level of thriving industry ATT = 0.187), beautiful countryside (the level of ecological livability ATT = 0.225), and rich farmers (the level of affluent life ATT = 0.218).

The implementation of WRCLC in all three modes has a significant positive impact on the level of thriving industry (Table 3). The average values of ATT calculated by the three methods are 0.187, 0.200, and 0.129, for the CSI, the CI, and the STC modes, respectively, indicating that the CI mode has led to an increase of 0.200 in the level of thriving industry, which is 0.013 and 0.071 higher than that in the CSI mode and the STC mode, respectively. This result shows that the CI mode has the greatest effect on promoting the prosperity of industry, followed by the CSI mode and the STC mode. This might be attributed to the fact that the CI mode has as its main objective industrial integration development, and it considerably enhances the production function of the countryside, thereby increasing employment opportunities and improving production efficiency.

The implementation of WRCLC in all the three modes has a significant positive impact on the level of ecological livability (Table 3). The average values of ATT calculated by the three methods are 0.225, 0.164, and 0.128, for the CSI mode, the CI mode, and the STC mode, respectively. This indicates that the implementation of the CSI mode increases the level of ecological livability by 0.225, which is 0.061 and 0.097 higher than that in the CI mode and the STC mode, respectively. Thus, the CSI mode has the greatest effect on improving ecological livability, followed by the CI mode and the STC mode. This could be associated with the fact that the CSI mode emphasizes comprehensive construction land and eco-environment consolidation, therefore greatly enhancing rural living and ecological functions, as well as improving the rural living environment and infrastructure construction.

The implementation of three WRCLC modes has a significant positive impact on the rural civilization level (Table 3). For the CSI mode, the CI mode, and the STC mode, the average values of ATT calculated by the three methods are 0.127, 0.119, and 0.113, respectively. This indicates that the implementation of the CSI mode increases the level of rural civilization by 0.127, which is 0.008 and 0.014 higher than that in the CI mode and the STC mode, respectively. Therefore, it could be concluded that the CSI mode has the greatest effect on rural civilization level increase, followed by the the CI mode and the STC mode, with very few variations across the three modes. The key to enhancing rural civilization lies in the construction of human capital, namely increasing the social civilization level by improving farmers' personal quality and spirituality. The implementation of the CSI mode has significantly increased the share of spending on culture, education, and entertainment, contributing to the development of a civilized countryside.

The implementation of all the three WRCLC modes has a significant positive impact on the effective governance level (Table 3). For the CSI mode, the CI mode, and the STC mode, the average values of ATT calculated by the three methods are 0.122, 0.114, and 0.105, respectively. This indicates that the implementation of the CSI mode increases the effective governance level by 0.122, which is 0.008 and 0.017 higher than that in the CI mode and the STC mode, respectively, suggesting that the CSI mode has the greatest effect on the growth in effective governance, followed by the CI mode and the STC mode. The possible reason could be that the CSI mode implementation allows subjects such as village collectives and farmers to reap greater consolidation dividends (level of rural revitalization ATT = 0.206), that the CSI mode implementation necessitates the collaboration of multiple

subjects, in turn inducing an increase in grassroots organizations' self-management ability, farmers' participation ability and participation enthusiasm, and that the construction of digital villages promotes smarter grassroots governance.

The implementation of all the three WRCLC modes has a significant positive impact on the level of affluent life (Table 3). For the CSI mode, the CI mode, and the STC mode, the average values of ATT calculated by the three methods are 0.218, 0.156, and 0.131, respectively. This indicates that implementing the CSI mode increases the affluent life level by 0.218, which is 0.062 and 0.087 higher than that in the CI mode and the STC mode, respectively. Thus, it could be concluded that the CSI mode has the greatest effect on supporting the improvement of affluent life level, followed by the CI mode and the STC mode. This result could be associated with the fact that the CSI mode greatly promotes rural infrastructure construction and livelihood development by significantly enhancing rural production and living functions, and that the CSI mode also broadens the channels for farmers to increase their income, thereby continuously narrowing the disparity between urban and rural areas and raising farmers' sense of happiness and gain.

5. Discussion

5.1. Mechanism of Promoting Rural Revitalization through WRCLC under Framework of "Element-Structure-Function"

Previous studies have explored the pathway of promoting rural revitalization through WRCLC based on some typical practical cases, and the findings revealed that land consolidation promotes rural revitalization by optimizing the allocation of rural production elements, improving rural productive, living, and ecological conditions, and then enhancing rural productive, living, and ecological functions [13,15,21,25–29]. Although existing studies have described the general pathway of WRCLC promoting rural revitalization [51], they have not thoroughly analyzed the internal logic of typical WRCLC modes to boost rural revitalization. Therefore, this paper applies system theory's "element-structure-function" framework to reveal the mechanism by which different WRCLC modes promote rural revitalization; these contributions provide theoretical guidance for developing WRCLC schemes and helping rural revitalization strategy. The results show that with the support of land management, urban and rural governance, and other policies and systems, WRCLC integrates and allocates the four core countryside development elements (land, human resources, capital, and technology) by coordinating the comprehensive agricultural land consolidation, construction land consolidation, and eco-environment consolidation and restoration. Consequently, rural productive, living, ecological, and social structures are optimized, thus thoroughly enhancing rural productive, living, ecological, social, and cultural functions, eventually contributing to the comprehensive revitalization of the countryside. The pathways and effects of promoting rural revitalization varied depending on the different WRCLC modes' investment standards, consolidation goals, contents, and efforts.

5.2. Promotion Effect of WRCLC on Rural Revitalization Based on Quasi-Experimental Research

Previous studies have demonstrated that comprehensive land consolidation (CLC) is an effective tool for promoting rural revitalization by simply comparing changes in the level of rural revitalization before and after consolidation, or by using the econometric method to measure the promoting effect of rural revitalization merely on a single dimension (e.g., rural industry, livability, culture, and governance) [15,21,25,29–32]. Rao (2022) found that CLC could promote rural revitalization by using a case study approach and comparing changes in agricultural production, livelihood structures, living space, and rights and interests before and after consolidation [25]. However, when it comes to the advanced stage of CLC, namely WRCLC, descriptive or qualitative analyses are usually adopted to explain its effect on promoting rural revitalization, and quantitative research evaluating the effect using scientific measurement methods and field survey data is missing. Therefore, this study systematically constructs a rural revitalization measurement indicator system from

the perspective of farmer households (behavior and beneficiary subject), employs 1080 farm households survey data, and applies the PSM-DID estimator based on quasi-experiment to measure a more scientific and accurate effect of promoting rural revitalization through WRCLC. Furthermore, this paper investigates three WRCLC modes and five dimensions of rural revitalization, which contributes to a better understanding of WRCLC's role in promoting rural revitalization. Our findings will provide a Chinese practice for other countries and regions to develop more effective WRCLC modes and policies for promoting rural revitalization.

First, the implementation of the CSI mode, the CI mode, and the STC mode all have significant positive effects on rural revitalization, which is consistent with previous studies reporting that land consolidation can promote rural revitalization [15,21,29,30,32]. Moreover, this study also reveals that implementing the CSI mode leads to a greater increase in the total level of rural revitalization than the CI and the STC modes, indicating that urban-rural integration is the path to achieving rural revitalization, and that rural revitalization, in turn, can systematically promote urban-rural integration development. The WRCLC CSI mode better satisfies the demands of rural development and transformation, therefore greatly enhancing rural revitalization. However, WRCLC might be a double-edged sword. Due to China's existing policies of urban-rural construction land increase-decrease balance and construction land quota tradability, the goal of consolidation is to obtain construction land quotas for urban development in some places, which induces the emphasize-urban-and-neglect-countryside governance tendency and the consolidation merely focusing on short-term benefits with no regard for issues such as later project supervision, maintenance, and operation. This necessitates the government to improve its strategic positioning and incorporate WRCLC as a basic policy tool into the growth pattern of urban-rural integration. Under the guidance of the national territorial development plan, the administrative boundaries of WRCLC's project should be broken through so that the scattered projects can exert the multiplier and scale effects to drive rural transformation and development. Furthermore, in order to maintain and strengthen the momentum of rural subsequent endogenous development and achieve sustainable rural revitalization and integrated urban-rural development, the government should prioritize meeting agricultural and rural development land demand, as well as allocating more revenue from land consolidation to rural construction.

Second, the implementation of all three WRCLC modes has a significant positive effect on the five dimensions, which differs from the findings of Yin et al. (2022) [65], who revealed that land consolidation has a significant positive effect on the thriving industry and affluent life, but not on the other three dimensions. This is mainly explained by the fact that WRCLC places greater emphasis than traditional land consolidation on whole-region planning and design, as well as the consolidation of all elements in the countryside, resulting in higher living, productive, ecological, social, and cultural benefits. Furthermore, this study also finds that the promoting effect on thriving industry, ecological livability, and affluent life is greater than that on rural civilization and effective governance, which is consistent with the research findings reported by Yao and Long (2020) [32]. These findings clearly confirm previous descriptive and qualitative research opinions that, as a multi-functional policy instrument, the promoting effect of WRCLC on five dimensions of rural revitalization may not be synchronized and thorough. Against the background of the current economic structure transformation and the accelerated labor mobility between urban and rural areas, WRCLC aimed at boosting rural revitalization may focus on improving the hardware conditions of rural development by providing the material basis and infrastructure. Meanwhile, rural civilization is a unique requirement for the creation of spiritual civilization in rural areas, and effective governance necessitates promoting the current governance system and governance capabilities so as to achieve modernization transformation. In conclusion, building a harmonious, civilized, and well-governed countryside is a lengthy and tough task. In comparison to the thriving industry, affluent life, and ecological livability, rural civilization and effective governance remain to be further promoted by WRCLC. As a basic platform for the country's top-level design and overall planning of the development strat-

egy, WRCLC must coordinate the construction of rural material civilization and spiritual civilization to promote the overall revitalization of the village.

Since the village is likely to be an agriculture-dominated society in most developing countries, the primary stage of rural revitalization relies on revitalizing agriculture. According to international experience, the rapid advancement of globalization, urbanization, and industrialization, will gradually decouple rural life and farmers' livelihoods from agriculture and land, making the development of rural multi-functionality, industrial diversification, and farmers' livelihood diversification inevitable [74,75]. Although this study demonstrates that WRCLC boosts agricultural industry growth through the optimal allocation of rural resources and elements (especially land), and has become an effective tool for contributing to rural revitalization, to fulfill the realistic needs of rural revitalization at an advanced stage, WRCLC must have the function of supporting the sustainable production and operation of rural space and rural economy, as well as providing farmers with channels and opportunities for diversified development.

5.3. Limitations and Future Work

This study finds that the WRCLC has a significant promoting effect on rural revitalization, and also reveals that different WRCLC modes have diverse promoting effects on various dimensions of rural revitalization. Both WRCLC and rural revitalization need the coordination of multi-subjects such as institutions, organizations, groups, or individuals, but the demands, goals, and interests, of different behavioral subjects might differ substantially. Other than farmers, further studies should examine the perceptions of other interest subjects such as government and village collectives. Moreover, a macroscopic regional scale (such as village area, and town area) is required to measure the promoting effect of WRCLC on rural revitalization, in addition to a microscopic subject viewpoint (farmers). With the typical WRCLC modes gradually constructed and operated across the country, it is crucial to explore the pathways and effects of other WRCLC modes to promote rural revitalization. Furthermore, a long-term tracking investigation on farmers is required to eliminate the impact on the estimation accuracy of the research results caused by collecting data through retrospective methods, as well as to examine the stability and sustainability of the promoting effect of rural revitalization by WRCLC. Besides, as the execution of high-quality WRCLC projects across the country that promote the achievement of ecological product values, future studies should focus on measuring the effect of WRCLC on ecological livability, which includes human settlements, infrastructure, public services, and the ecological environment, and establishing the link between WRCLC and ecosystem services.

6. Conclusions and Policy Implications

With the rapid advancement of economic globalization, industrialization, urbanization, and agricultural modernization, urban development occupies rural space, thus making a large number of production elements gather in cities, causing a global problem of rural decay and severely affecting rural sustainable development. Therefore, there is an urgent need to revitalize the countryside and achieve integrated urban-rural development. WRCLC in combination with the systems and policies of land management, and urban and rural governance, can restructure rural development elements, optimize the rural structure, and improve rural functions, thus becoming an important tool to promote rural revitalization. Under the framework of "element-structure-function" in system theory, this study theoretically analyzes the mechanism by which different WRCLC modes promote rural revitalization. Based on questionnaire survey data from farm households in Zhejiang Province, China, the PSM-DID estimator was employed to estimate the promoting effects of different WRCLC modes on rural revitalization and its five dimensions. In accordance with our findings, we proposed the following policy suggestions to strengthen the promoting effect of WRCLC on rural revitalization.

The implementation of all the three WRCLC modes has significantly increased the overall and five-dimension rural revitalization level, and the promoting effect on thriving industry, ecological livability, and affluent life, is better than that on rural civilization and effective governance. Based on this, we suggested that the government put more emphasis on the role of WRCLC in promoting rural revitalization, and strongly encourage WRCLC development. Some problems with implementing WRCLC exist in some places, such as low-level public participation, difficulties in multi-subject interest coordination, and negligence of rural spiritual civilization construction and governance system reconstruction. In conclusion, a government-led, department-coordination, and public-participation working mechanism should be established and improved by the government, and the typical and successful WRCLC cases should be timely summarized and publicized. Efforts should also be made to encourage farm households and the general public to participate actively in WRCLC by publicizing the value and significance of the land consolidation. In general, the government is suggested to innovate the benefit sharing mechanism, coordinate the beneficial relationship between farmers and other subjects, and protect farmers' rights and interests when formulating policy and implementing WRCLC. In addition, WRCLC may improve not only rural infrastructure construction (hard power) but also rural cultural prosperity (soft power), therefore the excavation and inheritance of local culture should be addressed during the implementation process. Furthermore, the government is also suggested to actively transform its functions, innovate the grassroots democracy management system, and coordinate material and humanistic revitalization, all of which contribute to the long-term and sustainable development of rural areas.

The CSI mode has the greatest promoting effect on the overall level of rural revitalization, followed by the CI mode, and the STC mode. It should be emphasized that, among the five dimensions of rural revitalization, the CI mode has the largest promoting effect on thriving industry, whereas the CSI mode has on the remaining four dimensions. Although the CSI mode has the most significant positive effect on overall rural revitalization when compared to the other two WRCLC modes, it cannot achieve balanced growth of the five dimensions. Based on our findings, we recommend that the government adheres to the concept of systematic consolidation and planning guidance, deepen land policy reform, broaden financing channels to strengthen fund guarantee, strengthen talent guarantee, establish a sound organizational system, and increase the proportion of the CSI mode in underdeveloped areas to enhance the CSI mode's promoting effect on multidimensional rural revitalization. Given that, a different WRCLC mode is suited for rural regions with diverse endowment conditions, phased development goals, and functional orientations. It is suggested that the government adopt the appropriate WRCLC mode and pathways according to local background conditions, regional characteristics, social and economic development stages, and rural development demands, so as to reasonably determine the phased consolidation goals, modes, projects, and scientifically arrange the implementation steps and timing with the final purpose of promoting all-round rural revitalization. Overall, this study will provide a Chinese experience for other countries and regions to formulate WRCLC policies for rural revitalization.

Appendix A

Table A1. Indicators of covariates balancing after matching.

		Variable	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
CSI node	KBM	%bias	−2.7	−4.2	2.2	6.4	−0.9	−6.7	9.2	−5.4	8.5	−5.1	2.0
		t-value	−0.30	−0.40	0.21	0.66	−0.09	−0.65	0.91	−0.54	0.84	−0.51	0.19
	NNM	%bias	−7.0	−4.4	4.9	11.9	2.3	−1.8	10.6	−5.4	13.4	−10.7	2.1
		t-value	−0.84	−0.42	0.47	1.23	0.22	−0.18	1.07	−0.55	1.32	−1.05	0.20
	RM	%bias	−4.0	−5.9	2.3	7.0	−3.3	−4.3	7.8	−5.5	9.6	−7.9	1.7
		t-value	−0.45	−0.55	0.22	0.71	−0.32	−0.42	0.79	−0.55	0.93	−0.78	0.16
CI mode	KBM	%bias	−1.6	−5.1	1.8	13.1	−1.4	11.7	4.6	−12.1	−2.0	2.5	9.7
		t-value	−0.17	−0.51	0.20	1.40	−0.15	1.15	0.50	−1.26	−0.22	0.26	1.00
	NNM	%bias	1.3	−8.8	6.1	10.9	1.2	13.3	3.2	−14.2	−4.5	−0.8	9.8
		t-value	0.14	−0.89	0.66	1.16	0.12	1.32	0.34	−1.50	−0.48	−0.08	1.00
	RM	%bias	1.6	−2.4	−0.4	14.4	0.1	14.1	6.5	−14.3	−2.5	1.6	10.7
		t-value	0.17	−0.24	−0.04	1.55	0.01	1.39	0.73	−1.49	−0.27	0.17	1.09
STC mode	KBM	%bias	−8.3	−8.4	0.8	−0.5	−6.3	−0.0	5.4	10.3	−1.4	1.7	−4.3
		t-value	−0.82	−0.87	0.08	−0.05	−0.68	−0.00	0.52	1.33	−0.16	0.18	−0.44
	NNM	%bias	−7.3	−8.4	6.0	1.1	−6.1	3.3	6.2	10.6	2.0	−4.1	−5.2
		t-value	−0.72	−0.87	0.63	0.12	−0.66	0.35	0.60	1.37	0.22	−0.42	−0.53
	RM	%bias	−7.8	−9.3	1.3	−0.8	−6.0	−1.2	7.5	9.1	1.3	1.3	−3.7
		t-value	−0.79	−0.95	0.14	−0.09	−0.64	−0.13	0.73	1.17	0.15	0.14	−0.38

Note: 1. KBM, NNM, and RM stand for kernel-based matching, nearest-neighbor matching, and radius matching, respectively; 2. CSI mode, CI mode, and STC mode refer to city-suburb integration mode, characteristic industry mode, and small-town construction mode, respectively.

Table A2. Joint test of whole covariates before and after matching.

		CSI Mode			CI Mode			STC Mode		
		Pseudo R^2	LR chi^2	$p >$ chi^2	Pseudo R^2	LR chi^2	$p >$ chi^2	Pseudo R^2	LR chi^2	$p >$ chi^2
	Unmatched	0.144	115.44	0.000	0.171	142.76	0.000	0.133	111.53	0.000
KBM	Matched	0.006	3.38	0.985	0.013	7.41	0.765	0.007	4.28	0.961
NNM	Matched	0.012	6.64	0.827	0.014	8.08	0.706	0.008	4.99	0.932
RM	Matched	0.007	3.68	0.978	0.017	9.62	0.565	0.007	4.21	0.963

Notes: 1. KBM, NNM, and RM stand for kernel-based matching, nearest-neighbor matching, and radius matching, respectively; 2. CSI mode, CI mode, and STC mode refer to city-suburb integration mode, characteristic industry mode, and small-town construction mode, respectively.

Notes

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