Economics

AGRICULTURAL OUTPUT EFFECT OF RURAL FINANCE: AN EXTENDED REGRESSION APPROACH

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Abstract: *Agricultural output growth is an everlasting realistic problem in human society. Rural finance aims to relieve the financing constraint and pressure on the rural society with capital scarcity through credit aid and support agricultural output growth. However, credit funds cannot be adequately input into agricultural production and management, which adversely impacts agricultural output. To accurately investigate the agricultural output effect of rural finance, using the 2015 China Household Finance Survey's large-sample micro-survey data, an extended regression model (ERM) was established that could effectively eliminate the endogeneity problem. Then, the agricultural output effect of rural finance was empirically estimated. Subsequently, the robustness of empirical results was tested using the propensity score matching (PSM) method and the Kernel density map. Agricultural technical guidance was introduced to explore its regulating effect on the relationship between rural finance and agricultural output. Furthermore, the robustness test was conducted for different groups, such as the eastern region, the western region, and the central region, to investigate the regional differences in the agricultural output effect of rural finance. The estimation results of ERM indicate that rural finance exerts a significantly positive influence on the agricultural output, and a large estimated coefficient manifests the considerable agricultural output effect of rural finance. The estimation results of the PSM method show that rural finance significantly increases the agricultural output of all peasant household samples averagely by 11,100 CNY. Agricultural technical guidance has a significantly positive regulating effect on the agricultural output effect of rural finance. According to the regional heterogeneity analysis, rural finance is significantly promoted in central and western regions, but it presents an insignificant crowding-out effect in the eastern region. Conclusions in this study can provide pertinent enlightenment for strengthening the productive functions of rural finance and lay a theoretical foundation for facilitating its healthy development.*

Keywords: *Rural finance, agricultural output effect, extended regression model, endogeneity.*

JEL Classification: *Q14.*

Introduction

In recent years, the fund shortage faced by worldwide rural economic development has become a common plight, which cannot be resolved through peasants' saving and loaning behaviours with rural financial institutions as intermediary agents. Agriculture can hardly be the credit object because of the long agricultural production cycle, slow capital operation, short and concentrated labour time, partially low labour efficiency, and strong dependence on the natural environment (Bianco, 2020). Thus, rural economic development lacks external financing paths (Donou-Adonsou & Sylwester, 2017; Liu & Liu, 2020). The situation is not optimistic in China, either. In the initial years after the founding of New China, financial policies were formulated to solve rural capital constraints and support agricultural development. Since 1978, rural financial development successively experienced four major phases: development recovery, expansion, supplementation and perfection, and deepened reform and innovation. China's rural financial service system was gradually formed, and a plural, competitive and wide-coverage rural financial market was formed (Ding et al., 2016; Lu & Xu, 2020; Mushtaq & Bruneau, 2019; Wen & He, 2020). However, the credit availability to Chinese peasants is still not high. Under the limited availability of rural credits, peasant households still keep their decision over budget balance. The expenditures must be less than or equal to the sum of the income during this period, accumulative savings, and credit availability. Given rural credit constraints, peasant households' agricultural production factor input and the production factor input combination deviate from the optimal levels. Thus, the government must formulate innovative and fundamental rural financial policies to optimize and innovate rural financial systems, reduce the high transaction cost of rural finance, and mitigate the information asymmetry. Nevertheless, the rural development reality shows that the controversies over the agricultural output effect of rural finance affect the formulation of rural financial policies to some extent. Generally speaking, rural financial credits increase the agricultural output by drawing the agricultural input level closer to the optimal level, enlarging the land investment scale, dispersing agricultural risks, and increasing the investment rate of peasant households (Grossman & Tarazi, 2014). In consideration of the hysteresis quality of agricultural input and agricultural output, however, rural financial credit funds cannot be sufficiently input by peasant households into the agricultural production and management, which goes against the agricultural output (Zhou, 2018; Wan & Qie, 2020; Li, 2016). Thus, further considerations are triggered: Is the promoting effect of rural finance on the agricultural output greater than its hindering effect to improve the agricultural output level? How does agricultural technical guidance influence the relationship between rural finance and agricultural output?

To the questions above, existing studies have discussed the relationship between rural finance and agricultural output and the regulating effect of agricultural technical guidance by establishing ordinary panel regression models. According to some scholars, the agricultural output is significantly promoted by rural finance (Zhou & Li, 2003; Bolarinwa & Fakoya, 2011). However, as indicated in some other research findings, rural finance represses the agricultural output, or the two are not significantly correlated (Yao et al., 2010; Pederson et al., 2012). The divergence has been explained differently through the existing theoretical explorations as follows: Errors exist in the measurement of rural financial indexes (Yang & Guo, 2007); the research results are inconsistent because of the regional heterogeneity of research samples (Chen et al., 2020; Ana et al., 2021; von Cramon-Taubadel & Saldias, 2014); the influence of endogeneity problem is ignored (Cao, 2008; Wang, 2011). If the relationship between rural finance and agricultural output, which are of reciprocal causation and mutual restriction, is generally discussed, the robustness of conclusions will be seriously impacted. Predecessors have analyzed such a relationship in consideration of different regional features, but limitations are unavoidable. First, the total grain output is taken as the proxy variable for agricultural output, but the commercial crop, forest product, and animal product, which are important constituent parts of total output value, are neglected, thus leading to the not robust enough research conclusions (Wen & Wang, 2005; Wang & Qin, 2020). Second, although the influence of rural finance on the agricultural output in different countries or regions has been discussed in the existing studies, the influence of regional

differences within the same sample on the agricultural output is ignored. As pointed out by the financial repression theory and financial deepening theory (Ajide, 2015; Dawood et al., 2019), the backward financial system will impede economic development, whereas economic stagnation will restrict the financial system construction; thus, the two are mutually influenced. The interaction problem between rural finance and agricultural output has not been well solved in existing studies.

Based on the above analysis, the total grain output, total commercial crop output, total forest product output, total animal product output, and the total output of the other agricultural products were taken as the proxy variable of agricultural output in this study according to financial repression theory and financial deepening theory (Ajide, 2015; Dawood et al., 2019). Next, an extended regression model (ERM) that could effectively solve the endogeneity problem was established to explore the influence of rural finance on the agricultural output and the regulating effect of agricultural technical guidance, considering the influence of regional heterogeneity on their relationship. Given the difference in the fields where rural financial credit funds were inputted, the agricultural output effect of rural finance was heterogeneous. Therefore, the difference in the agricultural output effect among the regions with different economic development degrees was tested in groups.

The contributions made in this study were described as follows: First, the proxy variable of agricultural output included the total agricultural outputs in the aspects of agriculture, forestry, animal husbandry, and fishery. Thus, it was more comprehensive, which contributed to the more accurate measurement of the influence of rural finance on agricultural output. Second, ERM was chosen to eliminate the endogeneity problem of rural finance and agricultural output to ensure more accurate empirical results. Third, regional heterogeneity was investigated to explore the different agricultural output effects of rural finance in different regions to provide a reference for healthy rural financial development to strengthen the productive functions of rural finance.

The remainder of this study was arranged as follows. The literature regarding rural finance and agricultural output was combed, and the related research hypotheses were proposed in Section 1. The data sources, sample screening, the measurement method of main variables, and the modeling process were introduced in Section 2. In Section 3, the model regression results were displayed, the relationship between rural finance and agricultural output was expounded, the influence of regional heterogeneity on the relationship was investigated, and the robustness of empirical results was further tested using the propensity score matching (PSM) method. In Section 4, the empirical results were further discussed, and the conclusions were drawn in the last section.

1. Literature Review

Rural financial development experienced several phases, including agricultural credit subsidy theory, rural financial market theory, and imperfectly competitive market theory, and realized the transformation from rural financial development forcedly intervened by the government into the combination of market orientation and appropriate government intervention. In the continuous perfection of rural finance, the agricultural development was found to have the following features: First, the poor residents in rural areas are faced with low income and weak capability of savings, which results in the seriously insufficient fund supply in rural areas (Zhang et al., 2015). Second, agriculture can hardly become the investment object of commercial banks due to its industrial characteristics like seasonality, inferiority, and uncontrollability. It is difficult for peasants to acquire loans from commercial banks for agricultural production activities. Thus, agricultural production is faced with a capital shortage, which impedes rural economic development (von Cramon-Taubadel & Saldias, 2014). Based on the features of agricultural development, perfecting rural finance and promoting agricultural development are especially important.

According to the new economic growth theory, rural credits mainly facilitate agricultural output through two paths. The first one is direct action, that is, agricultural credits influence the agricultural output by purchasing agricultural production materials, such as chemical fertilizers, seeds, and pesticides, and constructing agricultural infrastructure. As pointed out by some scholars, good farmland water conservancy facilities regulate the spatial-temporal distribution of water sources,

effectively reduce the irrigation cost, and generate a significant positive effect on the agricultural output (Zhang & Dai, 2018). The main contributions of rural financial credits are that they draw the agricultural input level closer to the optimal level, further increase the agricultural output (Yang & Guo, 2007), and obtain the specific agricultural output elasticity coefficient as 0.6662 (Zhou & Li, 2003). The land investment and agricultural productivity will be repressed by rural credit constraints, whereas the land investment scale can be enlarged, and the agricultural output efficiency can be improved by strengthening the rural financial credit support (Pederson et al., 2012). The second is indirect action; the flow of agricultural funds into the agricultural technical field is mainly manifested by the agricultural technical progress and human capital accumulation (Wu & Zhou, 2017). Agricultural technology is a process of applying new technological achievements and new production knowledge into the field of agricultural production (Plaščak et al., 2021); reconfiguring all kinds of production factors; establishing a new high-quality and efficient production technology system (Perez-Ortega et al., 2021); increasing the agricultural social, economic, and ecological benefits; improving the agricultural productivity; and promoting the effective agricultural output. Agricultural credit funds provide financial support for agricultural technologies, effectively improve the quality of agricultural production materials, enrich the categories of agricultural products, reduce the labour cost, enhance the agricultural labour productivity and the quality of agricultural products, and increase the agricultural output (von Cramon-Taubadel & Saldias, 2014). Scholars have pointed out that rural financial development exerts direct and indirect effects on agricultural technological innovation and further boosts agricultural output (Jiang & Xia, 2017; Lu, 2016). Besides, the structure, scale and efficiency of rural financial development are in direct proportion to the contribution rate of agricultural scientific and technological progress. The contribution rate of agricultural scientific and technological progress can be elevated by improving the rural financial development level, and financial support is significant for realizing agricultural technological innovation and increasing agricultural output (Xiao & Xu, 2012). Financial capitals can help

strengthen the agricultural technical R&D, form a new agricultural cooperation model, promote agricultural industrial renovation with an innovative agricultural financial system, further realize the comprehensive agricultural reform and upgrading, and increase agricultural output (Tan, 2018). Besides, rural finance can promote agricultural output by elevating the socioeconomic status of peasant households (Duong & Izumida 2002; Bolarinwa & Fakoya, 2011). Furthermore, rural finance can disperse the investment risks of peasant households, influence their investment efficiency, and further increase agricultural output (Zhu, 2015).

Although many scholars have stated the promoting effect of rural finance on the agricultural output, some scholars deem that rural finance exerts a noticeable inhibiting impact on the agricultural output or the two are not significantly correlated. According to the theory of the rural financial market, rural credits make it more possible for small peasant households to acquire funds, but the funds may be used in different directions (Park & Mercado, 2017; Sabasi et al., 2021). The VAR model, error correction model, and the time series model have been established by scholars from the aspects of financial support in agriculture, agricultural economic growth, mechanized input, and fixed asset investment, all indicating that rural financial policies do not exert the deserved effects in reality. They instead bring about adverse impacts to the agricultural output. The agricultural output will be reduced by 0.04% for every 1% increase in agricultural loans (Wen & Wang, 2005; Cao, 2008; Yao et al., 2010). The specific reasons are concluded as follows. First, restricted by the uncertain agricultural output level and influenced by the time hysteresis between agricultural input and agricultural output, rural financial credit funds cannot be fully input by peasant households into the agricultural production and management, thus generating adverse impacts on the agricultural output (Sadoulet & Janvry, 1995). Second, peasant households have applied most of the loans to consumption but not production, and the poorer a peasant household is, the higher its consumption expenditures will be, no matter whether the consumption expenditures come from the peasant household itself or credit loans; thus, the agricultural output cannot be effectively increased by ordinary rural financial policies

in reality (Zeller & Sharma, 2000). In a study, the micro-data of peasant households in the Gongzhuling region, Jilin province, China were sampled to analyze the output effect of rural finance empirically. If partial regular financial funds were transferred to the consumption field, the actual output effect of rural finance could not reach the highest level (Feder et al., 1999; Gao & Wang, 2012). Third, although the rural credit supply facilitates land acquisition, the greater rural credit support will also impose up-going pressure on land, making it difficult for peasant households to enlarge their plantation scale, increasing the agricultural output.

According to the existing studies, the promoting and inhibiting effect of rural finance on the agricultural output and their irrelevance has been effectively argued within the academic circles based on theories of agricultural credit subsidy, rural financial market, imperfectly competitive market, and the new theory of economic growth. No deterministic research conclusion has formed over the effect of rural finance on the agricultural output, thus failing to provide explicit policy guidance for rural financial development. Furthermore, the following defects exist in the previous studies. First, the previous studies, which are not based on large-sample micro-survey data, fail to handle the model endogeneity problem effectively with weak reliability and the low reference value of research conclusions. Second, the existing studies have laid more emphasis on the income effect of rural finance. Whether the income effect is generated by transferrable payment or productive agricultural investment cannot be effectively distinguished. However, only the income effect generated by the latter is an effective index for measuring rural financial productivity. Therefore, the existing studies are incapable of guiding the current rural financial governance well. The accurate relationship between rural finance and agricultural output must be determined, and the output functions of rural finance in productive agricultural investment must be effectively mastered.

Given this, based on the large-sample micro-survey data of the CHFS database, an empirical model that could solve the endogeneity problem was used in this study to accurately estimate the agricultural output effect of rural finance. Next, agricultural technical guidance was introduced to explore its regulating effect on the relationship between rural finance and agricultural output effect, followed by the robustness test and regional heterogeneity analysis, which could eliminate the biased error generated in the sample selection and effectively verify the agricultural output effect of rural finance. Furthermore, policy suggestions strengthening the productive functions of rural finance were proposed according to the accurate empirical research results, to provide an effective reference for the healthy development of rural finance.

2. Methodology

2.1 Sample Selection and Data Sources

Partial data from the 2015 China Household Finance Survey (CHFS2015) were selected, 3,819 effective samples were chosen, and surveyed sites included rural areas in 28 mainland provinces except Shanghai, Xinjiang, and Tibet. The CHFS2015 database was featured with scientific sampling and wide coverage. Thus, the micro-survey data of this database could comprehensively and effectively reveal the realistic problems concerned in this study. The software used was Stata 15.0.

2.2 Definitions of Main Variables

Rural finance (FFC): In the rural society with capital scarcity, the capital constraint is usually a key restricting factor giving rise to the insufficient agricultural production investment. The rural financial market improves rural productive functions and promotes rural economic development, mainly using credit support. Thus, the regular rural financial credit amount of peasant households were selected as the proxy variable of rural finance.

Agricultural output (AGO): The agricultural output has not been comprehensively measured in previous studies, thus leading to insufficient empirical results. More comprehensive indexes were selected in this study to measure the agricultural output and avoid the above problem. The proxy variable for the agricultural output was the sum of total grain output, total commercial crop output, total forest product output, total animal product output, and the total output of other agricultural products.

Total asset of peasant households (FAT): The OLS regression of sectional data can usually trigger a serious endogeneity problem (Cui & Jo, 2019). Furthermore, the total asset of peasant households is an important factor influencing traditional financial institutions to

give credit support to peasant households and the main mortgage assets with which peasants acquire credit loans, without any direct effect on the agricultural output. Thus, the total asset of peasant households (FAT) was chosen as the instrumental variable of rural financial credit amount to eliminate the endogeneity problem induced by the linear model regression of sectional data and accurately estimate the agricultural output effect of rural finance.

2.3 Models

To estimate the agricultural output effect of rural finance, the extended regression model (ERM)

that could effectively eliminate the endogeneity problem was selected in this study for the empirical analysis. Stata 15.0 provided four submodules – Eregress, Eprobit, Eoprobit, and Eintreg – for ERM. Eregress aimed to process linear models, with continuous variables as dependent variables. Endogenous variables could also serve as continuous variables. Eprobit, Eoprobit, and Eintreg were nonlinear extended models. Thus, Eregress applied to processing the endogeneity problem in this study. As for the ERM, the instrumental variables of endogenous explanatory variables were used to establish the main regression formula and the auxiliary regression formulas

Tab. 1:	Descriptive statistical characteristics of model variables		
Type	**Variable**	**Meaning**	**Instruction**
Agricultural output	AGO	Total agricultural output	Unit ten thousand CNY
Rural finance	FFC	Rural financial credit amount	Unit ten thousand CNY
Agricultural technical guidance	ATG	Acceptance of agricultural technical guidance	1 Yes, 0 No
	AGE	Householder age	Unit all year old
Household characteristics	EDU	Education level of head of household	Seven incremental levels
	HEL	Health status of head of household	Five gradations of decline
	FAR	Arable land	Unit Mu
	LAB	Agricultural labor force	Unit person
	FLT	Total household debt	Unit ten thousand CNY
	AHW	Agricultural employment	Unit person
	CEE	Expenditure on children's education	Unit ten thousand CNY
Characteristics of peasant households	MTE	Agricultural machinery and transport vehicles	Unit ten thousand CNY
	RWE	Wedding and wedding expenses	Unit ten thousand CNY
	POF	Poor families	1 Yes, 0 No
	APD	Monthly number of agricultural production and operation	Unit month
	PFC	Rural private credit	Unit ten thousand CNY
	HCU	Frequency of use of Huinong card	1 Yes, 0 No
Characteristics of farmland transfer	ATO	Transfer out of agricultural land area	Unit Mu
	ATI	Area transferred to agricultural land	Unit Mu
Social network relationships	PMC	Whether party member cadre family	1 Yes, 0 No
Instrumental variable	FAT	Total household assets	Unit ten thousand CNY

Source: own

of endogenous variables. The model was then estimated using the maximum likelihood method. The concrete form of this ERM was constructed as follows:

Principal regression formula:

$$AGO_i = \beta_0 + \beta_c FFC_{ci} + \phi X_i + \varepsilon_i \quad (1)$$

Regression formula of endogenous variables:

$$FFC_{ci} = \alpha_0 + \alpha_c FAT_{ci} + \varepsilon_{ci}, \quad (2)$$

where the explained variable AGO_i is the agricultural output of peasant household i. The endogenous explanatory variable FFC_{ci} denotes the rural financial credit amount of peasant household i. X_i stands for one group of control variables of the main regression formula, including the characteristic variables of householder, a peasant household, farmland transfer, and social network relation. The instrumental variable FAT_{ci} represents the total asset of peasant household i, β_0 and α_0 are the constant terms of two formulas, β_c and ϕ are the to-be-estimated coefficients of the main regression formula, α_c is the to-be-estimated coefficient of the regression formulas for endogenous variables, and ε_i and ε_{ci} represent the stochastic disturbance terms of two formulas.

According to the quality and importance of sampled data, the control variables were chosen mainly from householder characteristics, peasant household characteristics, farmland transfer characteristics, and social-relational characteristics, specifically as follows: (1) Householder characteristic variables mainly included householder age, degree of education, and health status, among which the degree of education was at seven progressive levels from low to high, and the health status included five progressive levels from good to bad. (2) Peasant household characteristic variables mainly included household cultivated land area, number of agricultural labour forces, total liabilities, number of hired workers, expenditure on children's education, expenditure on leasing farm machinery and transport vehicles, expenditure on weddings or funerals, whether being a needy family, whether any family member accepted agricultural technical guidance, annual average number of agricultural production and management months of family members, rural non-governmental credit amount, and utilization frequency of peasant household preferential card. (3) Farmland transfer characteristic variables mainly included the area of transferred-out farmland and the area of transferred-in farmland. (4) Social network relational variable was denoted by whether being a family with party members and cadres.

3. Results Analysis
3.1 Descriptive Statistics of Variables

The descriptive statistical results of variables are listed in Tab. 2. The mean value of FFC was smaller than its maximum value, indicating that the financial credit utilization level was low among rural households. The standard deviation of AGO was larger than its mean value, manifesting the great agricultural output fluctuations among different peasant households. The mean value of AGE was 58.78, meaning that rural labor forces were of a partially aged structure, which was adverse to agricultural development. The standard deviation of FAT was relatively larger than its mean value, indicating that peasant households differed a lot in wealth level.

Tab. 2: Descriptive statistical characteristics of variables – Part 1

Variables	Mean	SD	Min	Max
AGO	1.960	5.369	0.000	151.088
FFC	0.204	1.513	0.000	60.000
ATG	0.015	0.122	0	1
AGE	58.776	10.606	22	80
EDU	2.516	0.981	1	7
HEL	2.857	0.989	1	5

Tab. 2: Descriptive statistical characteristics of variables – Part 2

Variables	Mean	SD	Min	Max
FAR	9.795	17.930	0.500	400.000
LAB	1.985	0.838	0	10
FLT	2.279	7.062	0.000	150.000
AHW	0.887	4.224	0	60
CEE	0.274	0.728	0.000	15.000
MTE	0.086	0.432	0.000	22.000
RWE	0.210	0.352	0.000	6.500
POF	0.146	0.353	0	1
APD	6.795	3.659	0	12
PFC	0.307	2.014	0.000	50.000
HCU	0.013	0.115	0	1
ATO	0.282	1.674	0.000	40.000
ATI	3.111	15.368	0.000	400.000
PMC	0.069	0.253	0	1
FAT	26.429	43.885	0.013	1,160.000

Source: own

3.2 Regression Results

The relationship between rural finance and agricultural output was reported in Tab. 3, with the endogeneity problem considered. Tab. 3 shows that, in the ERM estimation results in column (1), the error term correlation coefficient Corr(e.FFC, e.AGO) between the main regression formula and the regression formula of endogenous variable was statistically significant at a level of 1%, indicating that the endogeneity problem existed between rural finance and agricultural output. Besides, endogenous variables were significantly correlated with instrumental variables, indicating that the selected instrumental variables were effective without weak instrumental variables; that is, the empirical results in this study were robust. As seen in Tab. 3, the estimation coefficient in column (1) was greater than 0 and significant at the level of 1%, manifesting that, after the endogeneity problem was controlled, the rural financial credit amount exerted a significant positive promoting effect on the agricultural output. The OLS estimation and regression results were listed in column (2) of Tab. 3. The coefficient was also greater than 0

and significant at the level of 5%. However, the influence coefficient of rural finance on agricultural output was elevated from 0.141 to 6.010, indicating that the traditional OLS analysis results underestimated the agricultural output effect of rural finance. However, the accurate ERM estimation revealed that the positive promoting effect of rural finance on the agricultural output was extremely intense, meaning the good supporting effect and driving effect of rural finance on the agricultural output growth.

Tab. 3 shows the estimated results of control variables, education level of household head, arable land area of household, number of agricultural employees, children's education expenditure, rural private credit amount, and area of farmland transferred to agricultural land and other factors have significant positive effects on agricultural output. The age of household head has a significant negative effect on agricultural output.

3.3 Robustness Test

To test the robustness of the above ERM estimation results, the PSM method that could

Tab. 3: **Extended regression model ERM estimation results**

Variables	ERM estimate (1) AGO	OLS estimate (2) AGO
FFC	6.010*** (3.07)	0.141** (2.47)
AGE	−0.015* (−1.92)	−0.017** (−2.05)
EDU	0.161* (1.86)	0.204** (2.35)
HEL	−0.127 (−1.52)	−0.171** (−2.04)
FAR	0.087*** (18.64)	0.090*** (19.15)
LAB	0.001 (0.01)	0.027 (0.28)
FLT	−0.014 (−1.03)	0.003 (0.19)
AHW	0.041** (2.12)	0.044** (2.27)
CEE	0.473*** (4.25)	0.484*** (4.31)
MTE	0.256 (1.33)	0.279 (1.44)
RWE	0.306 (1.30)	0.497** (2.11)
POF	−0.226 (−0.98)	−0.341 (−1.48)
ATG	0.633 (0.97)	0.655 (1.00)
APD	0.018 (0.79)	0.017 (0.77)
PFC	0.179*** (4.08)	0.167*** (3.77)
HCU	−0.216 (−0.31)	−0.136 (−0.19)
ATO	0.022 (0.47)	0.028 (0.59)
ATI	0.030*** (5.49)	0.029*** (5.21)
PMC	0.370 (1.15)	0.508 (1.57)
Constant	0.243 (0.31)	1.382** (2.08)
Corr(e.FFC, e.AGO)	−0.874*** (−12.69)	−
Wald chi2 = 617.38***		Root MSE = 4.948
Log likelihood = −18,426.49		F = 37.30***

Source: own

Note: Z value is in parentheses of ERM estimation; OLS estimates are T values in parentheses; *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

Tab. 4: PSM estimation results

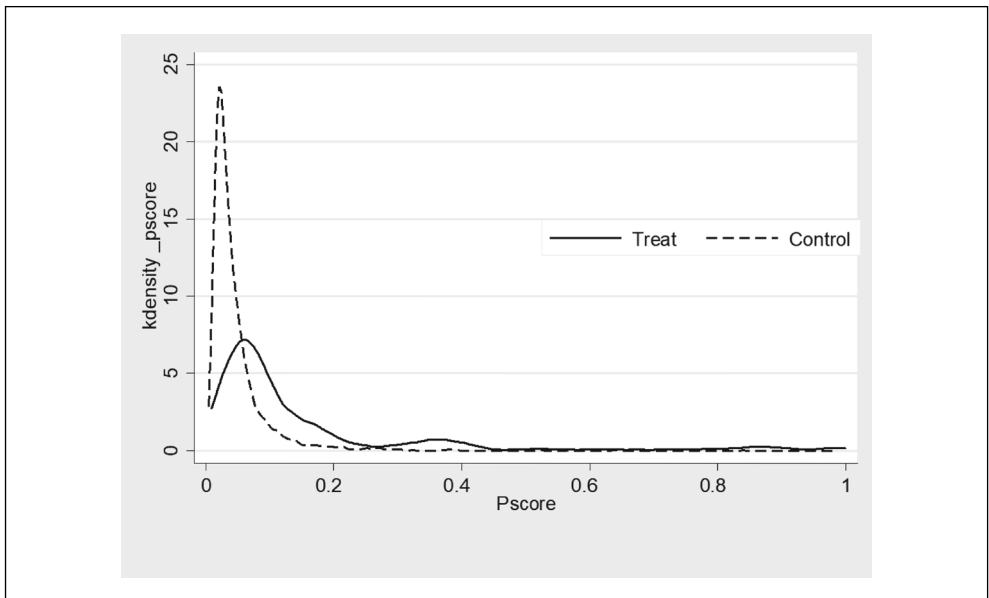| Variables	ATE	ATT	ATC
AGO	1.109** (2.44)	0.857 (0.84)	1.123** (2.43)

Source: own

Note: Z values are in brackets, where *, ** and *** represent significance levels of 10%, 5% and 1% respectively.

overcome the biased error of sample self-selection was chosen to estimate the agricultural output effect of rural finance. Through the observed values of covariables, the samples were divided by this method into treatment group and control group. The average causal effect was estimated by analyzing the average difference between the treatment group and control group at the observed values of covariables. The average causal effect was weighted to acquire the overall causal effect, which was the unbiased agricultural output effect after the biased error of sample self-selection was eliminated. On this basis, the overall average treatment effect (ATE), the average treatment effect (ATT) of the treatment group, and that of the control group (ATC) for peasant households to accept rural financial credit support were obtained through the PSM method. ATE denoted the agricultural output difference among all peasant household samples when accepting and not accepting rural financial credit support: the accurate influence of rural finance on the agricultural output. The binary dummy variable of whether to accept rural financial credit support was taken as the core independent variable of the PSM model to construct a PSM model. If the rural financial credit support was accepted, the dummy variable was 1; otherwise, it was 0. In this study, ATE, ATT, and ATC were empirically estimated through 200 times of bootstrap sampling by using the PSM operational program and the

Fig. 1: Nuclear density map before matching

Source: own
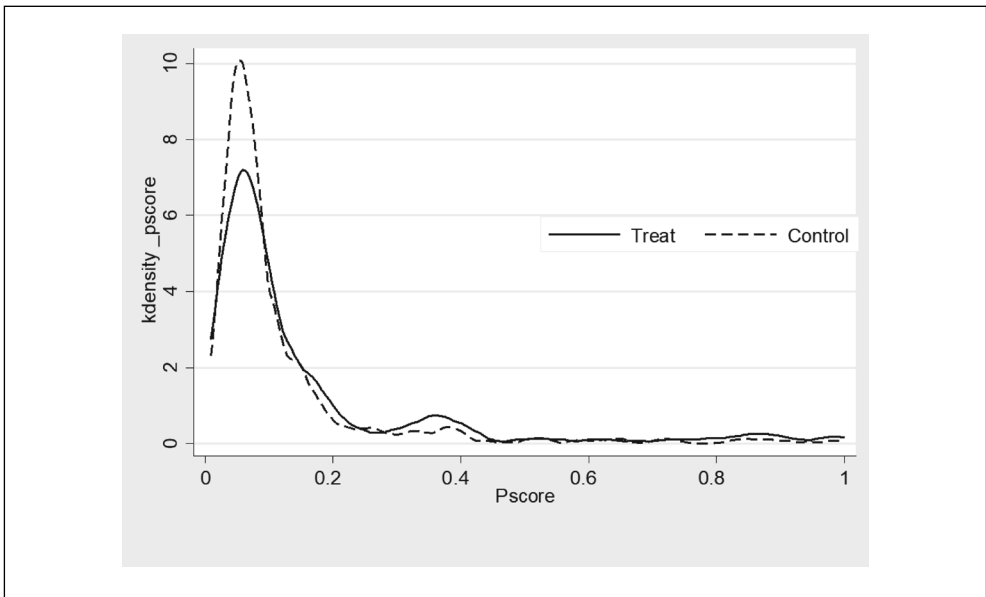
Source: own

nearest neighbourhood matching method and establishing a logit model. The analysis results are presented in Tab. 4.

As can be seen from Tab. 4, rural financial credit support resulted in an average increase of 11,100 yuan in agricultural output of all sample households at the 5% significance level. The kernel density analysis method was further used to perform the co-support test of the results and verify the reliability of PSM estimation results (Tab. 4). The kernel density maps before and after the matching are seen in Fig. 1 and Fig. 2, respectively. After PSM matching, the curve of the treatment group approached closer to that of the control group in comparison with the situation before the matching. The propensity scores of the treatment group and control group showed a broader co-value range, indicating that the range of the co-support set of the two groups was expanded and the PSM quality was high. Thus, the PSM method achieved a small estimation error with effective analysis results. After the PSM matching, the results still manifested that rural finance had a significant promoting effect on the agricultural output (i.e., rural finance) presented a stable and reliable

agricultural output effect. On this basis, the robustness of the empirical results in Tab. 3 was effectively verified.

3.4 Regulating Effect of Agricultural Technical Guidance on the Agricultural Output Effect of Rural Finance

The regulating effect of agricultural technical guidance on the relationship between rural finance and agricultural output and reveal the driving mechanism of agricultural technology embedding for the agricultural supporting effect of rural finance was further investigated. The cross term between rural financial credit amount and agricultural technical guidance was introduced into the ERM to identify the regulating effect of agricultural technical guidance, and the concrete results are as seen in Tab. 5. In Tab. 5, the error term correlation coefficient Corr(e.FFC, e.AGO) between the main regression formula and the regression formula of endogenous variable was still statistically significant at the level of 1%, indicating the endogeneity problem between rural finance and agricultural output, which was

overcome by the selected instrumental variables in this study. After the cross term was introduced, rural finance still exerted a significant positive promoting effect on the agricultural output at the level of 1%. The cross term also had a strong positive effect on the agricultural output at the significance level of 1%, manifesting the significant positive regulating role of agricultural technical guidance between rural finance and agricultural output. Through training and guiding agricultural specialized skills, farmers can be

induced to invest rural financial credit funds in agricultural production and operation, to realize the scale and specialization of agricultural production and operation. At the same time, after receiving agricultural technical guidance, farmers will more actively invest rural credit funds in agricultural technology upgrading, improved seed varieties, agricultural organization model optimization, agricultural risk prevention and other aspects, and finally realize the sustainable improvement of agricultural output.

Tab. 5: Results of moderating effect estimation – Part 1

Variables	ERM estimate	OLS estimate
	(1)	(2)
	AGO	AGO
ATG	0.187 (0.28)	0.633 (0.97)
FFC* ATG	4.783*** (4.81)	
AGE	−0.016* (−1.95)	−0.015* (−1.92)
EDU	0.165* (1.92)	0.161* (1.86)
HEL	−0.131 (−1.57)	−0.127 (−1.52)
FAR	0.088*** (18.85)	0.087*** (18.64)
LAB	−0.014 (−0.15)	0.001 (0.01)
FLT	−0.013 (−1.00)	−0.014 (−1.03)
AHW	0.041** (2.12)	0.041** (2.12)
CEE	0.477*** (4.29)	0.473*** (4.25)
MTE	0.282 (1.47)	0.256 (1.33)
RWE	0.301 (1.28)	0.306 (1.30)
POF	−0.219 (−0.96)	−0.226 (−0.98)
APD	0.015 (0.70)	0.018 (0.79)
PFC	0.181*** (4.13)	0.179*** (4.08)

Tab. 5: **Results of moderating effect estimation – Part 2**

Variables	ERM estimates (1) AGO	ERM estimates (2) AGO
HCU	−0.200 (−0.29)	−0.216 (−0.31)
ATO	0.023 (0.48)	0.022 (0.47)
ATI	0.028*** (4.94)	0.030*** (5.49)
PMC	0.399 (1.24)	0.370 (1.15)
Constant	0.301 (0.39)	0.243 (0.31)
Corr(e.FFC, e.AGO)	−0.875*** (−12.70)	
Wald chi2 = 644.27***		
Log likelihood = −18,414.96		

Source: own

Note: Z value is in parentheses of ERM estimation; OLS estimates are T values in parentheses; *, ** and *** represent significance levels of 10%, 5% and 1%, respectively.

3.5 Regional Heterogeneity Test

The regional difference of agricultural output effect of rural finance was investigated further. The samples were divided into eastern, central, and western regions, and an ERM was established to test different samples. The empirical results are listed in Tab. 6. The error term correlation coefficient Corr(e.FFC, e.AGO) between the main regression formula and the regression formula of endogenous variable was statistically significant at the level of 1% in columns (1), (2), and (3), indicating the existence of endogeneity problem in all the three types of rural finance. The endogenous variables were highly correlated with instrumental variables, manifesting no weak instrumental variables, meaning that the estimation results were reliable and effective in all three regions. The coefficients in columns (2) and (3) were greater than 0 and significant at the level of 5%, meaning that rural finance exerted a significant positive promoting effect on the agricultural output in the central and western regions. However, the coefficient in column (1) was smaller than 0 and insignificant, manifesting that rural finance had an insignificant negative influence on the agricultural output in the eastern region.

Tab. 6: **Regional heterogeneity test results – Part 1**

Variables	Eastern (1) AGO	Central (2) AGO	Western (3) AGO
FFC	−3.379 (−0.36)	5.972** (2.41)	4.168** (2.24)
AGE	−0.016 (−0.93)	−0.037** (−2.50)	0.005 (0.51)
EDU	−0.006 (−0.03)	0.310** (1.98)	0.122 (1.26)

Tab. 6:	Regional heterogeneity test results – Part 2		
Variables	**Eastern**	**Central**	**Western**
	(1)	**(2)**	**(3)**
	AGO	**AGO**	**AGO**
HEL	0.039 (0.22)	−0.187 (−1.28)	−0.222** (−2.27)
FAR	0.014 (0.57)	0.094*** (15.89)	0.061*** (7.10)
LAB	−0.056 (−0.25)	0.025 (0.15)	0.082 (0.76)
FLT	−0.014 (−0.55)	−0.110*** (−3.56)	0.051*** (3.69)
AHW	0.060 (1.50)	0.030 (0.96)	0.051** (2.00)
CEE	−0.028 (−0.13)	0.904*** (5.01)	−0.005 (−0.03)
MTE	2.291*** (2.86)	1.427*** (2.92)	−0.227 (−1.48)
RWE	0.653 (1.10)	−0.494 (−1.34)	0.956*** (3.20)
POF	0.039 (0.07)	−0.336 (−0.82)	−0.171 (−0.69)
ATG	1.118 (0.69)	0.586 (0.47)	1.156* (1.79)
APD	0.021 (0.49)	−0.003 (−0.07)	0.065** (2.41)
PFC	0.091 (0.64)	0.363*** (5.53)	−0.153** (−2.52)
HCU	−0.564 (−0.15)	−2.288 (−1.24)	0.650 (1.21)
ATO	0.073 (0.62)	0.206 (2.39)	−0.102** (−2.04)
ATI	0.064*** (4.28)	0.006 (0.78)	0.054*** (4.70)
PMC	0.180 (0.27)	1.574*** (2.73)	−0.628* (−1.70)
Constant	4.135 (0.61)	1.386 (1.03)	−1.052 (−1.13)
Corr(e.FFC, e.AGO)	0.977*** (7.77)	−0.903*** (−12.59)	−0.858*** (−8.12)
Wald chi2	41.55***	466.98***	162.50***
Log likelihood	−4,087.11	−7,893.26	−5,234.04

Source: own

Note: Z values are in brackets, where *, ** and *** represent significance levels of 10%, 5% and 1% respectively.

4. Discussion

The above analysis results reveal that, in the full-sample test, the elevated rural credit level mitigated the influence of credit constraint on the agricultural input and drew the agricultural input level closer to the optimal level. It also improved agricultural technologies and increased agricultural output by applying new technological achievements and new production knowledge to agricultural production. The promoting effect of rural finance on the agricultural output could be further enhanced by strengthening the agricultural technical guidance. In practice, the rural financial system has been continuously perfected, and the agricultural technical guidance has been strengthened among peasants. In the grouped test, the rural financial gap was large in the central and western regions, and rural finance showed a high marginal output effect. In the eastern region, the marginal output effect of rural finance presented a progressive declining trend, specifically as follows.

First, in Tab. 3, the error term correlation between the main regression and endogenous variable regression in the ERM estimation was significant at the level of 1%. ERM estimation and OLS estimation coefficients were significantly positive, and the former was increased from 0.141 of the OLS estimation coefficient to 6.010. Therefore, in the traditional OLS test, rural finances had a causal relationship with the agricultural output, and the results were inaccurate. In this study, this problem was solved by selecting appropriate instrumental variables, which verified the financial repression theory and financial deepening theory (Ajide, 2015; Dawood et al., 2019) and was consistent with the conclusions drawn by Duong and Izumida (2002), and Bolarinwa and Fakoya (2011). According to the research results, rural financial institutions continuously took advantage of financial instruments to increase the rate of return on savings-type financial products, attracting more peasants to transform their idle funds into savings. The rural financial institutions then transformed the deposits into productive investments by granting loans to peasants. After obtaining agricultural credit funds from rural financial institutions, peasants purchased agricultural production materials to promote agricultural output. The agricultural credit funds provided capital investments on agricultural infrastructure and effectively improved agricultural production efficiency. Agricultural credits also provided capital support for agricultural technological progress and effectively improved the quality of agricultural production materials. They also enriched the categories of agricultural products, reduced labor cost, enhanced agricultural productivity, improved the quality of agricultural products, and further increased agricultural output.

Second, Tab. 4 shows, that rural finance still significantly promoted the agricultural output after the biased error of sample self-selection was overcome. The coefficient in column (1) was the overall average treatment effect for peasant households to accept rural financial credit support. That in column (2) represented the average treatment effect of the treatment group for peasant households to accept rural financial credit support. That in column (3) denoted the average treatment effect of the control group for peasant households to accept rural financial credit support. According to the research findings, the agricultural output of all peasant household samples was averagely increased by CNY 11,100 at the significance level of 5% because of rural financial credit support. Thus, when accepting and not accepting rural financial credit support, the agricultural output difference among all the peasant household samples was CNY 11,100. This study provided new empirical evidence for the conclusions obtained by Yang and Guo (2007), and Pederson et al. (2012).

Third, the results (Tab. 5) after introducing the cross term between rural financial credit and agricultural technical guidance showed that the cross-term coefficient was significantly positive at the level of 1%, and this conclusion provides new empirical evidence for the research carried out by von Cramon-Taubadel and Saldias (2014). The results manifested that through training agricultural professional skills, peasants were more willing to invest rural financial credit funds into the large-scale professional agricultural production and management. The peasants accepting the agricultural technical guidance were more voluntary to input credit funds into the agricultural technological upgrading, variety improvement, the optimization of agricultural organization pattern and agricultural risk prevention, with the capital flow meeting the relevant specifications more, which facilitated the continuous increase of agricultural output. Given this, the agricultural technological embedding promoted the agricultural supporting

effect of rural finance, and more rural financial capitals could flow into the field of agricultural technical training among peasants.

Fourth, the research samples were divided into three groups – eastern region, central region and western region – according to their geographical locations, to observe the difference agricultural output effects of rural finance, as seen in Tab. 6. It could be found through the results that the estimation coefficient was significantly positive in the central and western regions but insignificantly negative in the eastern region. The conclusion supplemented the research by Wen and Wang (2005). The results indicated that the rural financial gap was large in the rural areas in the central and western regions, the marginal output effect of rural finance was high, the agricultural support policies by rural finance showed a good implementation effect in the central and western regions, so the agricultural output effect of rural finance was fully exerted. Hence, rural finance exerted a significant promoting effect on the agricultural output in the central and western regions. In the eastern region, the rural economic development level was high, and the marginal output effect of rural finance presented a progressive declining trend. Moreover, the rural financial marketization level was high in the eastern region, and peasants acquired funds not just through regular financial credits. When the regular financial policies did not match with the market demand, the normal agricultural productive investment behaviours were disturbed on the contrary, manifesting an inhibiting effect on the agricultural output. This reflected that in the poorer areas, the agricultural output was more obviously promoted by complete rural finance.

Conclusions and Implications
Conclusions
In this study, the 2015 financial survey data of Chinese households were selected as the research samples. Next, an ERM was established to investigate the agricultural output effect of rural finance as a whole and in different regions, respectively, with the endogeneity problem between the two considered. The following conclusions were drawn:

(1) From the aspect of full samples, as rural finance relieves the capital constraint of rural production, improves the agricultural technologies, reduces the agricultural production risk and motivates the entrepreneurial spirit of peasant households, it is capable of significantly facilitating the agricultural output. After the endogeneity problem is solved, the promoting effect of rural finance is more intense, indicating that the agricultural output effect of rural finance is underestimated by the traditional OLS regression.

(2) The regulating effect is estimated by introducing the cross term between rural finance and agricultural technical guidance. According to the research findings, agricultural technical guidance exerts a marked positive driving effect on the agricultural output effect of rural finance. After the samples are divided according to their geographical locations, the agricultural output promoting effect of rural finance is fully verified in the central and western regions, but rural finance shows an insignificant inhibiting effect on the agricultural output in the eastern region.

(3) From the angle of full samples, after the biased error of sample self-selection is overcome, rural finance still shows a significant promoting effect on the agricultural output. Moreover, it is found through PSM estimation that due to rural financial credit support, the agricultural output of all peasant household samples is averagely increased by CNY 11,100 at the significance level of 5%, which pass the co-support test of kernel density analysis and sufficiently verify the robustness of the results.

(4) It is discovered by analyzing the control variables that the agricultural output is significantly positively influenced by factors like the householder's degree of education, cultivated land area, number of fired workers, expenditure on children's education, rural non-governmental credit amount and area of transferred-in farmland, while householder age generates a significant negative influence on the agricultural output.

Managerial Implications
(1) Design differential rural financial credit service mechanisms. The credit demand of daily expenses of peasant households should be separated from the credit demand of productive investments. The preferences and support for agricultural productive investment credit should be enhanced, and the credit gap for agricultural productive investments of peasant households should be narrowed, thus facilitating the continuous optimization and upgrading agricultural productive investments,

avoiding the degradation of rural financial projects into temporary income transfer projects, and fully motivating the multiplication effect of rural finance on the agricultural economic development by enhancing the agricultural productive investment credit services.

(2) Innovate the rural financial service pattern by establishing the embedding relation between rural finance and agricultural productive investment project chain. To effectively introduce rural financial credit funds into the field of agricultural productive investment, besides giving credit support to peasant households, sustainable and stable credit services should be provided to agricultural product processing enterprises in the agricultural productive investment chain, enterprises establishing contractual relationship with peasant households, agricultural cooperatives, agricultural production factor operating organizations and subjects participating in agricultural projects. Moreover, credit support is recommended to new-type rural financial institutions like village banks and rural capital mutual-aid groups, to help peasant households to carry out agricultural productive investments better using direct and indirect credit services.

(3) Reinforce the organic coordination between rural financial policies and other agricultural supporting policies. The policy package combining a series of policy instruments is more effective than the single rural financial policy instrument in the aspect of increasing the agricultural output. Therefore, it is necessary to organically combine rural finance with other policy instruments like financial support in agriculture, establish the normalized interactive coordination mechanism between rural financial organizations and other policy enforcement bodies to link the agricultural supporting policies internally, guarantee the uniform coordination of various policies in capital scale and time consistency, and form large-scale collaborative impetus to realize the rapid growth of agricultural output.

Research Limitations and Expectations

The agricultural output effect of rural finance was investigated from full samples and the samples in different regions, respectively, but some problems remained to be solved: Only the relationship between rural finance and agricultural output and the regulating effect of agricultural technical guidance on the relationship was explored. However, the other mechanisms influencing such a relationship were not considered, e.g., capital constraint degree of peasant households. The concrete promoting or inhibiting effect on different fields of agricultural output and the influence degree were not respectively studied. Moreover, the influences of the rural financial policies in different regions on their relationship were not taken into account, and only the rural credit funds therein were investigated. Therefore, the classified influences of different rural financial instruments on the agricultural output and the regulating effect of other intervening mechanisms on the relationship between rural finance and agricultural output can be probed according to the different rural financial policies in different regions. Furthermore, the study on the agricultural output effect of rural finance can be further perfected.

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