Financial Threshold Effect and Financial Bottleneck Effect of Agricultural Economic Growth: Empirical Evidence From Jilin Province

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1 Introduction

This paper will use county-level data in Jilin Province to explore in depth the impact mechanism of rural financial development on agricultural economic growth. Compared with previous studies, the contribution of this paper is mainly reflected in the following three aspects: firstly, at the level of data use, thanks to the increasing improvement of sub-provincial statistics. Second, at the practice-oriented level, previous studies have mostly focused on the financial threshold effect of agricultural economic growth, i.e., finance will only contribute to economic growth when the level of financial development reaches a certain level, but this has overlooked another important problem, instead of boosting economic growth, excessive financialization increases financial risks. Therefore, on the basis of previous studies, this paper further explores the financial bottleneck effect of agricultural economic growth, that is, the level of rural financial development will bottleneck the pulling effect on agricultural economic growth, which will certainly provide a reference for the coordination of the stable growth of agricultural economy and the risk prevention of financial system. Finally, at the methodology level, considering that the commonly used panel threshold model cannot smooth the data and usually faces the disadvantage of system jump, this paper uses a panel smoothing migration model to correct the above problem, which enables us to smooth the data around the threshold value and thus more accurately portray the time-varying dependence between rural financial development and agricultural economic growth. The full paper is organized as follows: **Part 2** is a theoretical analysis based on an extended Pagano model, **Part 3** is a empirical analysis of county-level rural data in Jilin Province, and **Part 4** is a conclusion and empirical implications.

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2 Theoretical Basis of the Mechanism Financial Development on Agricultural Economic Growth

Pagano[1] (1993) introduced the financial sector on the basis of the growth theory, thus constructing a simple linear equation to describe the mechanism financial development on agricultural economic growth. Dong[2] (2004) introduced the interest rate level into the Pagano model and examined the mechanism of capital prices on agricultural economic growth; Ran and Zhang[3](2008) added a time variable to the model and found that the mechanism between the two changed significantly after 1994. Although all these studies provide useful attempts to extend the Pagano model, they also have a common drawback, namely, introducing variables into the theoretical model without derivation, making the study too adaptive and lacking theoretical or factual basis. Therefore, the revision of the Pagano model in this paper will change the previous thinking, we do not directly change the theoretical basis of the Pagano model, but introduce new elements in the model estimation, and adopt the panel smoothing migration technique to extend the linear form of the base model, this improvement can not only introduce the nonlinear elements into the system and portray the nonlinear effect of the two; At the same time, it can also describe the law of diminishing marginal utility of financial development, so as to capture the financial bottleneck effect. This expansion will not only provide an important supplement to improve the Pagano's growth theory, but also be closer to the impact mechanism of rural financial development on agricultural economic growth in reality. The specific model is described as follows:

Consider a simple closed economy in which the output sector produces only one product, the product can be used for investment or consumption, the rate of depreciation of the capital stock is constant as σ, and the base form of output is

$$Y_t = AK_t, \tag{1}$$

where Y_t is the output in the period t, A is the corresponding technology level, and K represents the capital stock under the period t, whereby the investment behavior in the period t can be further described

$$I_t = K_{t+1} - (1-\sigma)K_t, \tag{2}$$

where the economic growth rate g_t in the period t can be expressed by

$$g_t = Y_t/Y_{t-1} - 1. \tag{3}$$

Coupling (1), (2) and (3) easily shows that

$$g_t = A\left(I_{t-1}/Y_{t-1} - \sigma\right). \tag{4}$$

Under the classical AK theory, the market clears conditional on total investment (I_t) = total savings (S_t), but in actual economic operation, savings are usually difficult to be fully utilized, so we set a savings surplus ratio, denoted as $1-\theta$, and have

$$\theta S_t = I_t, \tag{5}$$

where θ denotes the investment conversion rate of savings, while the savings rate s is

$$s = S/Y. \tag{6}$$

Rectify equations (4), (5) and (6) yields

$$g = A(s\theta) - \sigma. \tag{7}$$

A subsequent log-linearization of equation (7) has

$$\ln g = \ln A + \ln \theta + \ln s. \tag{8}$$

Equation (8) is the basic form of the Pagano model, where A represents the marginal contribution of capital, θ is the investment rate of savings, which measures financial development, and s is the savings rate, which jointly determines output variation. In practical studies, people usually adopt the rate of investment in agricultural fixed assets tz as a proxy for the marginal contribution rate of capital and it ' s accustomed to decompose θ into financial scale and financial leverage, using the rural financial correlation rate fir as a proxy for the scale of rural financial development, and the loan-to-deposit ratio dc as a proxy for the rural financial leverage; and the rural deposit ratio ck as a proxy for the savings rate s. Finally, for agricultural economic growth, the natural logarithm y measures real add value of agriculture, forestry, animal husbandry and fishery in rural areas. Accordingly, we can obtain

$$y_{it} = \beta_1 fir_{it} + \beta_2 dc_{it} + \beta_3 ck_{it} + \beta_4 tz_{it} + \epsilon_{\mathrm{it}}. \tag{9}$$

It should be noted that in order to make the systematic estimation more economically meaningful, we don't log the ratios in the estimation process. In addition, considering that this linear model does not reflect the nonlinear nature of rural financial development on agricultural economic growth, we also use a smoothing migration function to transform equation (9) into the PSTR form.

$$\begin{cases} y_{it} = \beta_1 fir_{it} + \beta_2 dc_{it} + \beta_3 ck_{it} + \beta_4 tz_{it} + \sum_{k=1}^{K} \left(\beta_1^k fir_{it} + \beta_2^k dc_{it} + \beta_3^k ck_{it} + \beta_4^k tz_{it}\right) \Gamma^k \left(fir_{it}; \gamma, \overline{fir}_h\right) + \varepsilon_{it} \\ \Gamma^k \left(fir_{it}; \gamma, \overline{fir_h}\right) = \left[1 + \exp\left(-\gamma^{H_k} \prod_{h=1}^{H_k} \left(fir_{it} - \overline{fir}_h\right)\right)\right]^{-1} \end{cases}. \tag{10}$$

The most important part of equation (10) is the transfer function Γ, through which we can identify where the financial threshold appears by estimating the value of fir within the Γ function, i.e., identify the financial threshold effect on agricultural growth; Moreover, according to the form of the Γ function, it is easy to see that the range of the function is between 0 and 1,which means that when the level of financial development reaches a certain level, the value of the transfer function will no longer change, i.e., the coefficient of financial development on economic growth will no longer change, named the financial bottleneck effect. Accordingly, this paper improves the economic significance of the Pagano model without changing the rigor of the underlying theory.

3 Estimation of financial thresholds and financial bottlenecks for agricultural economic development in Jilin Province

3.1 Data Selection

This paper selects annual data of 38 counties in Jilin province for panel estimation, with the sample interval of 2009-2017. The data sample includes Yushu, Dehui, and Nong'an counties in Changchun, Panshi, Huadian, Jiaohe, Shulan, and Yongji counties in Jilin, Fuyu, Changling, Qian'an, and Qian Gorlos counties in Songyuan, Shuangliao, Gongzhuling, Lishu, and Yitong counties in Siping, Dongliao and Dongfeng counties in Liaoyuan, Meihekou, Ji'an, Huinan, Liuhe, and Tonghua counties in Tonghua, Linjiang , Jingyu, Fusong, Changbai counties in Baishan, Da'an, Taonan, Zhenlai, Tongyu Counties in Baicheng, Dunhua, Tumen, Hunchun, Longjing, Helong, Antu, Wangqing counties in Yanbian.

3.2 The Estimation of the PSTR Model

The Panel Smoothed Migration Model (PSTR) originates from the Panel Threshold Model (PTR) and is an important extension in the field of nonlinear panel model research. Initially, Hansen[4] (1999) constructed a panel threshold model (PTR) using a lattice search method, which provided an important foundation for solving the estimation of threshold effects in panel data. However, the PTR Model has an important drawback that the system will shift above and below the threshold in a jumpy manner, which does not allow for data smoothing, which is usually contrary to the actual economic conditions. To address this problem, González et al.[5] (2005) constructed a panel smoothed migration model (PSTR), which allowed the data to be smoothed across samples. This overcomes the drawback of jumping around the threshold in the PTR Model.

3.3 Estimation Results

In this paper, the threshold diagnosis method proposed by González et al.[5](2005) is used to test the validity of equation (10), and the results are shown in Table 1.The P-values of LM, LMF and LRT are all less than 0.1, indicating that equation (10) does have a significant threshold effect and contains at least one transfer position co-variate. In order to further target the number of transfer parameters, we also need to perform a nonlinear diagnosis on the residual part of the model.

Table 1: Nonlinear Diagnosis

Statistics	Values	P Values
LM	92.242	0.000
LMF	27.699	0.000
LRT	107.496	0.000

In Table 2, the original hypothesis of each statistic is that equation (10) contains only one transfer position, while all three statistics fail the hypothesis test, indicating that the system cannot reject the original hypothesis. We can accurately judge that Jilin province's rural financial development on agricultural economic growth does have a significant nonlinear characteristic, and this characteristic is a single financial threshold effect.

Table 2: Nonlinear Diagnosis for the Rest Part

Statistics	Values	P Values
LM	7.469	0.113
LMF	1.630	0.167
LRT	7.522	0.109

Table 3 and equation (11) further give the estimation results of equation (10). It can be seen from Table 3 that in the exponential term, γ takes a larger value, which proves that the system transitions faster, which means that most of the samples will be distributed among the two steady-state regimes, and for the purpose of analysis, we further give the parameter expressions within the two steady-state regimes.

Table 3: Estimation of the PSTR Model

Coefficient	β_1	β_2	β_3	β_4	$\overline{fir}$
Estimation	-0.178*	-1.068***	0.503***	0.038	1.655
P Value	0.08	0.000	0.000	0.160	—
Coefficient	β_1'	β_2'	β_3'	β_4'	γ
Estimation	0.538**	0.465***	-1.326***	-0.062***	6.340
P Value	0.0113	0.0000	0.0000	0.002	—

$$\begin{aligned}\hat{y}_{it} = & -0.178 firir_{it} - 1.068 dc_{it} + 0.503 ck_{it} + 0.038 tz_{it} \\ & + [1+\exp(-6.34(\text{ fir } - 1.655))]^{-1} (0.538 \text{ fir }_{it} + 0.465 dc_{it} - 1.326 ck_{it} - 0.062 tz_{it}) .\end{aligned} \tag{11}$$

Equation (12) depicts the parameter correlation mechanism when the financial development is far below the threshold level, i.e., the primary stage of rural financial development; Equation (13) depicts the parameter correlation mechanism after the financial development is far beyond the threshold level, i.e., the financial bottleneck state; When the financial development is near the threshold level, the system will show complex time-varying characteristics, at which the influence of each variable on $\hat{y}_{it}$ needs to be obtained by finding the partial derivatives.

$$\hat{y}_{it} = -0.178 fir_{it} - 1.068 dc_{it} + 0.503 ck_{it} + 0.038 tz_{it}, \tag{12}$$

$$\hat{y}_{it} = 0.360 fir_{it} - 0.603 dc_{it} - 0.823 ck_{it} - 0.024 tz_{it}. \tag{13}$$

In the following, we will analyze the values of the parameters in the three states in turn. First, at the initial stage of rural financial development, the coefficient of fir_{it} is significantly negative, which indicates that at the early stage of rural financial development, the limited financial resources are used for financial development not only cannot improve agricultural economic growth, but also have a "crowding-out effect" due to resource seizure, which is consistent with the theory of agricultural credit subsidy. Besides, the estimated coefficient of the financial leverage is also negative and has an absolute value greater than one, indicating that excessive leverage not only inhibits economic growth but also produces a "financial gas pedal" effect. This phenomenon is mainly due to the fact that at the early stage of rural financial development, when the market mechanism is far from sound, information asymmetry is usually abundant between credit providers and rural borrowers, and if the leverage ratio of lending is increased, the financial risk will be rapidly amplified by the high underlying bad debt ratio, thus reflecting a significant risk acceleration effect. Third, an increase of one basis point in the savings rate will increase the agricultural economy by 0.503 basis points, which reaffirms that the agricultural economy at the early stage of rural financial development is mostly dependent on the reinvestment of farmers' own savings, and the pulling effect of external loans on the agricultural economy is extremely limited. Finally, the estimated results of the investment efficiency variate are not significant, which indicates that the early agricultural economy of Jilin Province is relatively backward and relies on human labor capital.

Further comparison of the financial bottleneck effect in equation (13) reveals three significant changes. First, fir_{it} turns from negative to positive, indicating that the impact of financial development on agricultural economic growth starts to change from inhibiting to pulling when the threshold level is crossed, which is consistent with the rural financial market competition theory; Second, the coefficient of the financial leverage rate narrows from -1.068 to -0.603, indicating that With the increasing level of rural financial development, the substitution effect between financial risk and economic growth begins to decline significantly, which means that the controllability of financial risk increases significantly when rural financial development crosses the threshold level; Third, the impact of savings rate begins to change from positive to negative, considering that there is a pairwise relationship between savings and consumption, so this phenomenon indicates that at this stage agricultural economic growth at the county level in Jilin Province begins to transform from self-owned savings growth to consumption-driven growth. This implies that the development of rural finance is not only conducive to the correction of mechanism between finance and economy, but also conducive to the adjustment of the economic growth structure. Finally, the investment efficiency variable also changes from insignificant to significant, indicating that the county-level agricultural economy of Jilin Province also begins to gradually enter into a factor-driven virtuous development mode.

To facilitate the analysis, we further inscribe the transfer function in equation (11) in order to fully reflect the financial development of rural counties in Jilin Province, as shown in Figures 1

and 2, where the horizontal coordinates represent the values of the financial correlation rate fir_{it}, while the vertical coordinates represent the transfer function values.

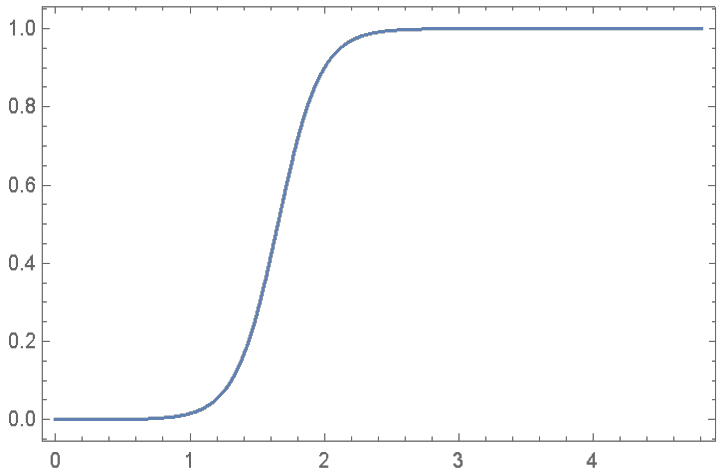

Figure 1: Smooth Transfer Function

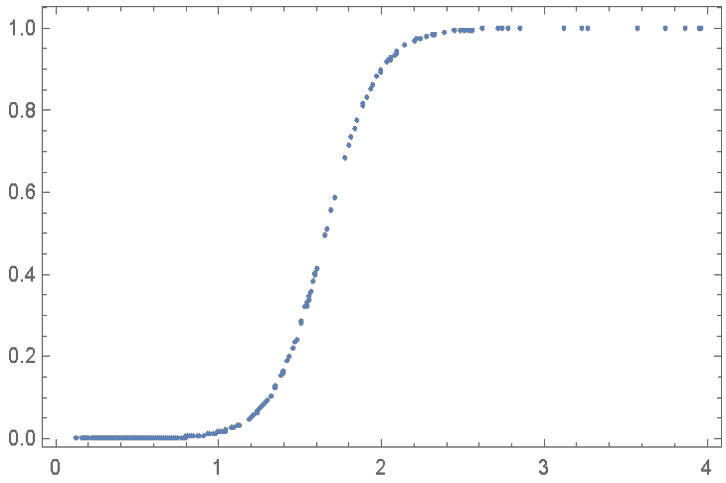

Figure 2: Distribution of the Full Sample

Firstly, observing Figure 1, we can see that when the financial correlation rate fir_{it} is between 1 and 2.4, the system behaves in a non-stationary state, when the coefficient of fir_{it} is $(\beta_1 + \Gamma\beta_1')$, and according to the magnitude of β_1 and β_1', it is known that when $\Gamma = 0.33$, $\beta_1 + \Gamma\beta_1' = 0$, at this time, we can solve for $fir_{it} = 1.55$, which means that when $fir_{it} > 1.55$, the influence mechanism of rural financial development on agricultural economic growth will turn from negative to positive. In addition, when the financial correlation rate is 1, $\Gamma = 0.01$, which means the system is extremely close to the zone 1, and when the financial correlation rate is 2.4, $\Gamma = 0.99$, when the system is extremely close to the zone 2. Considering that Γ is a monotonic function of fir_{it}, it can be determined that when the financial correlation rate is below 1, the county-

level rural areas of Jilin Province are at the initial stage of financial development, subject to the description of equation (12), during which the financial efficiency will not improve with the improvement of financial development, reflecting a strong financial exclusion. When the financial correlation rate is higher than 2.4, the county-level rural areas in Jilin Province will be at the bottleneck stage of financial development, subject to the description of equation (13), at this time to improve financial development will no longer improve financial efficiency, on the contrary, it can only increase financial risks, reflecting a significant law of diminishing marginal utility, this conclusion cannot be obtained from the panel threshold model, is an incremental discovery of this paper.

4 Conclusion

At present, with the increasing improvement of county-level economic statistics, studies on rural issues have begun to gradually extend to the micro county level. In view of this, this paper takes the lead in conducting a study on mechanism between rural financial development and agricultural economic growth using county-level micro data in Jilin Province, and mainly draws the following conclusions.

First, from the early financial development of each county in Jilin Province, the "financial exclusion" effect is widespread, which indicates that the dual financial structure of urban and rural areas generally exists in rural counties, which is an important factor limiting the development of county agricultural economies for a long time. Second, from the rural financial development of Jilin counties in recent years, with the continuous promotion of financial inclusion, the financial development level of most rural counties has crossed the financial threshold in recent years. Thirdly, from the micro mechanism between rural financial development and agricultural economic growth, the rural financial development threshold at county level is much higher than the provincial statistics, mainly because the unbalanced and non-sufficient development among rural counties is much higher than the differences between regions and provinces. finally, from the overall situation of county-level data in Jilin Province, the mismatch between finance and economy is still widespread, one of the most important appearances is that rural counties with better economic development are more entity-oriented, and finance does not fully play a facilitating role, while on the contrary, rural counties with relatively backward economic development have a certain hidden danger of excessive financialization out of the purpose of catching up.

The research in this paper shows that the current pattern of overall positive agricultural economic growth and rural financial development nationwide has a solid county-level micro foundation. However, in this process, we should also be deeply aware that unbalanced and insufficient development is not only reflected between urban and rural areas, between regions, but also between rural counties. At the same time, as of now, the starting years of county-level statistics in each province still vary greatly, making it difficult to conduct a nationwide study of counties, but

with the gradual improvement of micro statistics in each province, a nationwide study of counties will be possible, and this will certainly provide important micro evidence for solving the current social contradictions and testing the effectiveness of high-quality development.

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