

Research On the Dynamic Influence of Rural Finance on Rural Industry Revitalization in Heilongjiang Province: Based On TVP-VAR Model

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Abstract. Rural revitalization strategy is the core power to promote China's agricultural modernization, Heilongjiang as a large agricultural province, its rural finance and industrial revitalization synergy has an important research value. Based on the time series data of rural areas in Heilongjiang from 1990 to 2023, this paper analyzes the correlation mechanism between rural finance and industrial revitalization dynamically based on TVP-VAR model and MCMC method. The results show that: (1) the long-term cumulative effect of financial scale is significant, and it is necessary to invest continuously to support industrial upgrading; (2) The time-varying difference of financial factors is prominent. Residents rely on short-term stimulus at the initial stage of consumption and release medium and long-term power for industrial optimization at the later stage. Research innovation lies in introducing dynamic perspective and regional targeted analysis, revealing policy stability and structural adaptation is the key to release financial efficiency, providing scientific basis for Heilongjiang to optimize resource allocation and formulate time-series policy, and expanding methodology of regional economic research.

Keywords: TVP-VAR Model, Rural Finance, Rural Industrial Revitalization, Heilongjiang Province, Dynamic influence.

1. Introduction

Rural finance plays an important role in the revitalization of rural industry. In order to make rural finance promote the development of rural industry, the CPC Central Committee and local governments have issued a series of policies. For a long time, the development of rural economy has been relatively slow. At the same time, the traditional concept of small-scale agricultural management has influenced the progress of rural finance to a certain extent. The key to promoting the development of rural finance is to systematically assess the impact of rural finance on the revitalization of rural industries.

Hongmei Wang and Weizhen Zhu (2018), based on the spatial panel SDM model, analyzed the relationship between rural financial scale, structure, efficiency and agricultural economic growth in 2008-2016[1]. TingYang (2019) uses VAR model to discuss the influence of rural finance on rural economic growth in China [2]. He finds that rural finance has positive influence on rural economic growth. Chizoba P.Anunobietal[3]. Yedan Chen and Yunfang Fan (2021) built time-varying parameter vector autoregressive model to study the poverty reduction effect of rural finance on poor areas, and pointed out that rural finance development can effectively promote the income and consumption level of rural residents. Jianbo Hu and Weidan Zheng (2022) used fixed effect model and spatial SDM model to explore the influence of rural finance on the prosperity of rural industry in 2003-2019[4].

Most of the existing studies are based on static perspective, while less attention is paid to the

dynamic impact of rural finance on rural industrial revitalization. And most scholars focus their research on the whole country, with little focus on a specific province. This study dissects the impact of rural finance on rural industry revitalization in Heilongjiang Province from a dynamic perspective, introduces the TVP-VAR model, and combines the time-series data from 1990-2023 to reveal the key role of policy stability and structural appropriateness in unleashing the financial efficacy, which will provide support for optimizing the allocation of resources and promoting the policy precision in Heilongjiang, and at the same time, expanding the methodological path of regional economic research.

2. Model construction and variable selection

2.1. Model construction

The TVP-VAR (time-varying parameter vector autoregressive) model breaks through the static parameter limitation of the traditional VAR model by introducing time-varying coefficients and random fluctuation characteristics. Its core advantage lies in its ability to characterize the time-varying dynamic relationship between economic variables, especially for analyzing structural changes across economic cycles. Based on the consumption function theory, this paper constructs a three-variable TVP-VAR model including rural financial development (F), rural residents' income (Y) and consumption (C).

$$y_t = B_{1,t}y_{t-1} + \dots + B_{k,t}y_{t-k} + \mu_t, t = k + 1, \dots, n \quad (1)$$

In the context, $y_t = [\ln F_t, \ln Y_t, \ln C_t]$ represents the vector of logarithmic variables,

$B_{i,t}$ denotes the time-varying coefficient matrix, while A_t and Σ_t respectively characterize contemporaneous correlations and heteroskedasticity through Cholesky decomposition.

$$A_t \Omega_t A_t' = \Sigma_t \Sigma_t' \quad (2)$$

Time-varying parameters obey random walk process:

$$B_{t+1} = B_t + v_t, a_{t+1} = a_t + \delta_t, \sigma_{t+1} = \sigma_t + \zeta_t. \quad (3)$$

The model adopts Markov chain Monte Carlo (MCMC) method under Bayesian framework to estimate, and through 30000 sampling to ensure the convergence of parameters, analyzes the dynamic influence of rural financial development on income and consumption.

2.2. Variable selection

Interpreted Variable:

In this paper, the comprehensive score of rural revitalization system is selected. Referring to Xinlu Zhao(2023), Xinmei Guo and Jinyang Guo(2025)on the construction of indicators of rural industrial revitalization evaluation system, six indicators are finally selected, including rural per capita output value of primary industry, rural per capita output value of major agricultural products, labor productivity, labor industry structural adjustment index, urban and rural residents' per capita disposable income ratio, and the proportion of non-farm employment. The corresponding weights of each index are calculated by entropy weighting method, and then weighted and summed to get the comprehensive score of rural revitalization system.[5][6]

Interpretation variable:

Drawing on Yang Ting's (2019) and Guangyao's Zhao(2022) construction of rural finance, this paper selects rural financial scale, rural financial efficiency, and rural financial structure as interpretation variables.[7]

Control variable:

In this paper, per capita disposable income of rural permanent residents and per capita consumption expenditure of rural permanent residents are selected as control variables.

Data sources:

The data of the above indicators are all from China Statistical Yearbook, China Statistical Abstract, Heilongjiang Statistical Yearbook, and the missing values are filled in by interpolation method.

Table.1. Variables And Variable Definitions

Category	Variable Name	Variable Definition	Formula
Interpreted Variable	XC	Comprehensive score of rural revitalization system	-
Interpretation Variable	FIR	Rural financial scale, by rural deposits(R.D.) and rural loan composition(RPL)	$FIR = R.D. + RPL$
	RFE	Rural financial efficiency, composed of rural loans(RPL) and rural deposits(R.D.)	$RFE = \frac{RPL}{R.D.}$
	RFS	Rural financial structure, composed of rural credit cooperatives(RCL)and rural loans(RPL)	$RFS = \frac{RCL}{RPL}$
Control Variable	CW	Per capita disposable income of rural residents	-
	DC	Per capita consumption expenditure of rural residents	-

3. Empirical analysis

3.1. Unit root test

The purpose of unit root test is to judge whether the time series composed of various variables are stable, avoid pseudo-regression, and provide basis for selecting appropriate measurement model and analysis method.

Table.2. Test Value Table of Variables

Variable	Inspection form	ADF Inspection Quantity	1% Critical Value	5% Critical Value	Prob.	Smoothness
LNXC	(C, T,1)	-2.2098	-4.2733	-3.5578	0.4684	Non-stationary
DLNXC	(C, T,1)	-5.6486	-4.2733	-3.5578	0.0003	Smooth
LNFIR	(C, T,1)	-2.5639	-4.2627	-3.5529	0.2979	Non-stationary
DLNFIR	(C,0,0)	-5.4718	-3.6537	-2.9571	0.0001	Smooth
LNREF	(C, T,1)	2.4342	-4.2627	-3.5529	0.3565	Non-stationary
DLNREF	(C, T,1)	-5.8596	-4.2733	-3.5578	0.0002	Smooth
LNRFs	(C, T,1)	-1.5016	-4.2733	-3.5578	0.8081	Non-stationary
DLNRFs	(C,0,0)	-2.9333	-2.6392	-1.9517	0.0047	Smooth
LNCW	(C, T,0)	-1.7073	-3.6537	-2.9571	0.4181	Non-stationary
DLNCW	(C, T,0)	-4.3407	-4.2733	-3.5578	0.0002	Smooth
LNDC	(C,0,0)	-0.4989	-3.6463	-2.9540	0.8791	Non-stationary
DLNDC	(C,0,0)	-4.2157	-3.6537	-2.9571	0.0023	Smooth

It can be seen from Table 2 that LNXC, LNFIR, LNREF, LNRFS, LNCW and LNDC are subjected to ADF test respectively. Since the P value is greater than 0.05, each variable is judged to be a non-stationary sequence. Since each variable has the problem of unit root, the first-order difference is used to obtain DLNXC, DLNFIR, DLNREF, DLNRFS, DLNCW and DLNDC. At this time, the P value is less than 0.05, indicating that each variable is a stationary sequence at the significance level of 5percent. Cointegration inspection can be performed.

3.2. Selection of optimal hysteresis order

The optimal hysteresis order of the VAR model was selected according to Eviews13.0, and then the Johansen cointegration test and impulse response analysis were carried out.

Table.3. Optimal Hysteresis Order Running Table

Lag	LogL	LR	FPE	AIC	SC	HQ
0	139.1429	NA	1.52E-09	-6.1121	-5.8809	-6.0367
1	371.0662	361.2114	4.16E-15	-18.9477	-17.5600*	-18.4953
2	405.9590	32.3211	4.76E-15	-18.9508	-16.4067	-18.1215
3	477.9322	42.43430*	2.08e-15*	-20.1668*	-16.4663	-18.9606*

Table.3. shows that the optimal lag order of the conventional VAR model is 3.

3.3. Cointegration test

Since the optimal hysteresis order of the conventional VAR model is three, the hysteresis order of the cointegration test is two, the Johansen cointegration test is performed, and the Eviews13.0 operation results are as follows:

Table.4. Johansen Cointegration Inspection Trace Inspection Results

Hypothesized No. of CE(S)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.9186	186.6915	95.7537	0.0000
At most 1 *	0.8062	111.4281	69.8189	0.0000
At most 2 *	0.5839	62.2051	47.8561	0.0013
At most 3 *	0.4683	35.8978	29.7971	0.0088
At most 4 *	0.3742	16.9489	15.4947	0.0300
At most 5 *	0.0917	2.8861	3.8415	0.0893

Table.5. Johansen Cointegration Test Maximum Characteristic Root Test Results

Hypothesized No. of CE(S)	Eigenvalue	Max-Eigen Statistic	5% Critical Value	Prob.**
None *	0.9186	75.2634	40.0776	0.0000
At most 1 *	0.8062	49.2230	33.8769	0.0004
At most 2 *	0.5839	26.3073	27.5843	0.0721
At most 3 *	0.4683	18.9489	21.1316	0.0983
At most 4 *	0.3742	14.0628	14.2646	0.0538
At most 5 *	0.0917	2.8861	3.8415	0.0893

It can be seen from Table 4 that there are five co-integration equations at the 0.05 level in the trace test, indicating that there is a co-integration relationship among the five variables. It can be seen from Table 5 that the maximum characteristic root test has two cointegration equations at the 0.05 level, indicating the cointegration relationship between the two variables.

3.4. Estimation Results of MCMC Algorithm

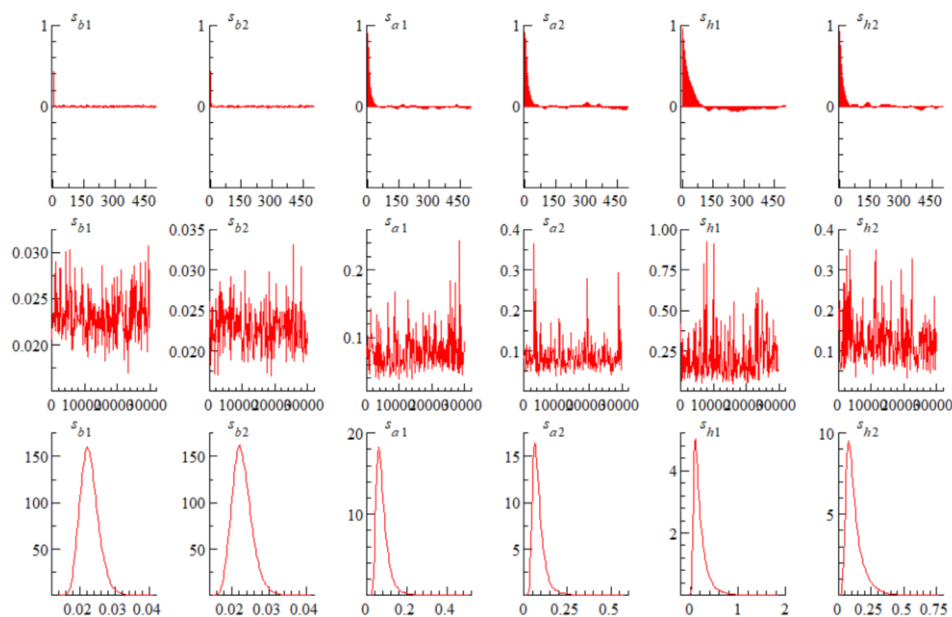


Figure 1. Parameter Autocorrelation Coefficient, Simulation Path and Posterior Distribution

It can be seen from Figure 1. that the autoregressive system tends to be stable after fluctuation, and the sample path of 30000 times is relatively uniform, showing obvious fluctuation clustering characteristics. It can be seen that the MCMC sampling method is effective, and the impulse response function can be further analyzed.

3.5. Time-varying pulse

3.5.1 Equal interval impulse response analysis

Under the TVP-VAR model, the equal interval impulse response can capture the "impulse" of rural financial policy adjustment and fund investment, and promote the industrial revitalization to provide scientific basis. This paper chooses Phase 2, Phase 4 and Phase 6 as the lag period to study the short-term, medium-term and long-term influence of rural finance elements on rural industry revitalization in Heilongjiang Province.

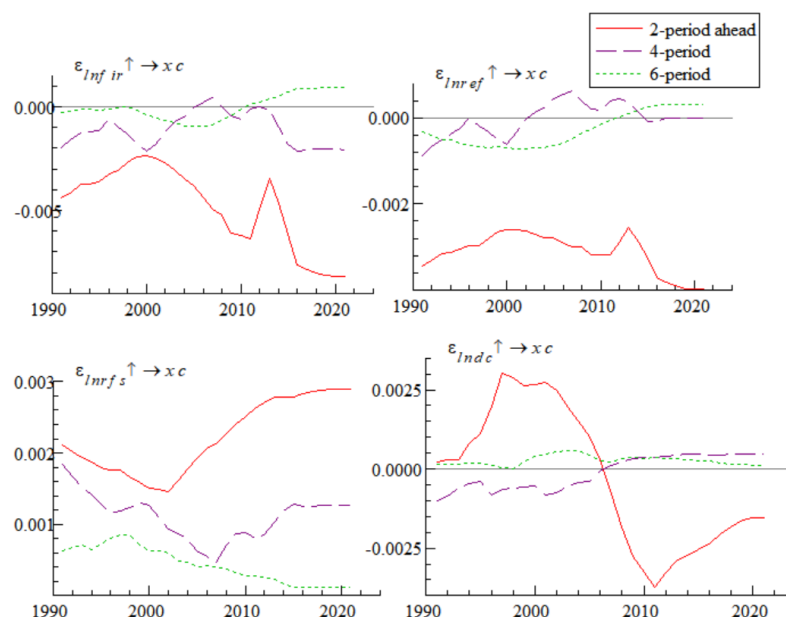


Figure 2. Impulse Response Plots for Different Hysteresis Periods

The impulse response produced by XC to LNFIR, LNREF and LNRFS is in the positive effect as a whole, and the impulse response produced by XC to LNDC is in the positive effect as a whole in the medium and long term, while it is in the fluctuation trend in the short term. The impact of each element on XC is further analyzed.

(1) Effect of LNFIR on XC

The impulse response of lag phase 6 is much higher than that of lag phase 4 and lag phase 2. The initial curve of lag phase 6 tends to 0, and the highest values of lag phase 4 and lag phase 2 are basically the same. The impulse response of lag phase 2 is the largest, the impulse response of lag phase 4 is the middle, and the impulse response of lag phase 6 is the smallest.

It shows that the scale of rural financial development in Heilongjiang Province has obvious long-term effect on the rural industrial revitalization system, and the short and medium-term effects tend to be consistent. The reason is that the period of rural industrial construction is long and long-term capital investment and accumulation are required.[8] In the short and medium term, the improvement is limited due to the efficiency of financial resources allocation and the delay of policy implementation. In the long run, funds are continuously injected to promote industrial upgrading, improve the industrial chain and gradually highlight its role[9].

(2) Effect of LNREF on XC

The impulse response of lag phase 4 is higher than that of lag phase 6 and lag phase 2. The impulse response curve of lag phase 4 is the highest, the impulse response curve of lag phase 6 is the middle, and the impulse response curve of lag phase 2 is the lowest.

The results show that the impact of rural financial development efficiency on rural industrial revitalization system in Heilongjiang Province is characterized by large and weak impact in medium and long term, and the long term trend in 2014 is higher than that in medium term. Short-term financial service adaptation and policy implementation in Heilongjiang Province are delayed and have weak impact. [10]After the financial resources are optimally allocated and the industry adapts to the financial services, the steady development is realized. Long-term input and output effects are more prominent due to the deepening of industrial structure adjustment in 2014.

(3) Effect of LNRFS on XC

The impulse response of lag phase 2 is higher than that of lag phase 4 and lag phase 6. The initial phase of the curve in the lag 6 period tends to 0. The impulse response curve of lag phase 2 is the highest, the impulse response curve of lag phase 4 is the middle, and the impulse response curve of lag phase 6 is the lowest.

The results show that the influence of rural financial structure in Heilongjiang Province on the revitalization system of rural industry is great in the short term, sustained in the medium term and small in the long term. Because Heilongjiang Province early rural financial capital into the rapid activation industry. The inertia of rural industrial development needs sustained financial support. This in turn has a sustained impact in the medium term. The advantage of the old model was weakened because the financial structure could not fully adapt to the industrial upgrading demand. As a whole, it descends first and then ascends, which is due to the fading of stimulus in the early stage, the appearance of contradictions, the adjustment of policy in the later stage and the transformation of industry to promote the adaptation of financial structure and the recovery of function[11].

(4) Effect of LNDC on XC

The impulse response of phase 2 lag before 2016 is higher than that of phase 4 lag and phase 6 lag, and the impulse response of phase 2 lag after 2016 is lower than that of phase 4 lag and phase 6 lag. The impulse response curves of lag phase 4 and lag phase 6 tend to be consistent.

The results show that the per capita consumption expenditure of rural residents in Heilongjiang Province has great impact on the rural industrial revitalization system in the short term and small impact in the medium and long term in 2016. After 2016, the medium and long-term impact is sustained, and the short-term impact is small. Because the consumption expenditure of residents in Heilongjiang Province stimulated the rural industry in the short term before 2016, it is difficult to undertake the continuous consumption power due to the weak industrial foundation and slow

upgrading in the medium and long term. Since 2016, Heilongjiang has strengthened the rural industrial construction and optimized the industrial structure, which can carry out the medium and long-term consumption of residents and the rise of leisure agriculture. Therefore, the medium and long-term and short-term impacts are small[12].

3.5.2 Time-sharing point impulse response analysis

Under the TVP-VAR model, the time-sharing impulse response analysis can delineate the adjustment of rural finance at different time nodes and provide a powerful support for the dynamic optimization of rural finance policy. In this paper, the three years of 1997, 2007 and 2017 are selected as the years of analysis before, during and after.

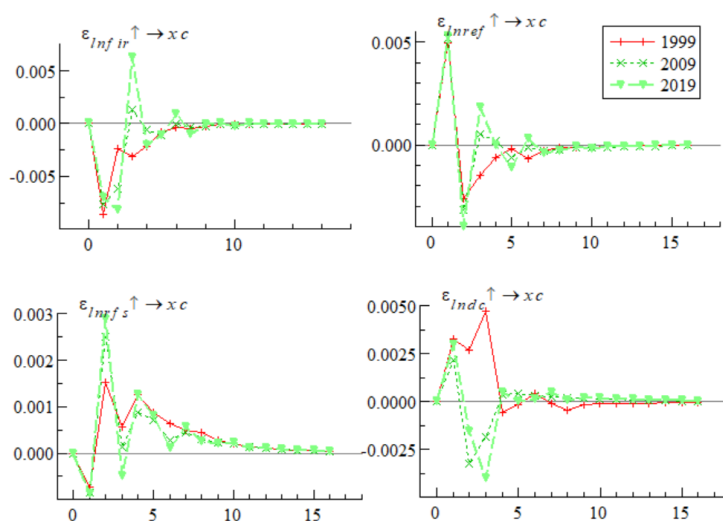


Figure 3. Impulse Response Diagram At Different Time Points

It can be seen from Fig. 2 that the three pulse curves of the selected three years tend to coincide from the fifth period, so the influence of various factors of rural finance in Heilongjiang Province on the revitalization of rural industry is weak in time. Analyses were made for 1999, 2009 and 2019 respectively.

(1) Analysis of Impulse Response in 1999

In 1999, the impulse response of XC to LNFIR peaked in the third phase and remained stable in the seventh phase. The impact of LNREF on XC was fluctuating. The impulse response of XC reached its peak in the first phase, dropped sharply in the second phase, then rose steadily to the fifth phase and remained stable in the seventh phase. The impact of LNRFS on XC is fluctuating, and the 11th phase is basically stable. The impulse response of LNDC to XC peaked in phase 3 and remained stable in phase 5.

The results show that the rural finance of Heilongjiang Province showed an obvious fluctuation trend to the revitalization of rural industry in 1999, with weak positive effect and partial negative effect. Because in 1997, the rural financial system of Heilongjiang Province was not perfect, the financial products were single, and the accuracy of credit investment was low, it was difficult for financial resources to effectively match the industrial development demand, and it was vulnerable to external factors[13].

(2) Impulse Response Analysis of 2009 and 2019

Given a negative impact of LNFIR, LNREF, LNRFS, LNDC, the impulse response generated by XC is positive. By observing the impulse response curves in 2009 and 2019, it can be seen that the impact response of XC to LNFIR, LNREF and LNRFS is relatively similar, and the overall trend is stable.

Compared with 1999, the impact response of rural industry revitalization in 2009 and 2019 to rural financial related indicators, such as financial related ratio (LNFIR), financial efficiency (LNREF)

and rural financial scale (LNRFS), has been improved. With the advancement of time series, the role of rural finance in the process of rural industry revitalization in Heilongjiang Province is becoming more and more prominent[14].

4. Conclusion

Based on the TVP-VAR model and the MCMC method, using the time series data of Heilongjiang rural area from 1990 to 2023, this study examines the dynamic impact of rural finance on rural industrial revitalization. The stability and long-term equilibrium of variables were confirmed by ADF test and cointegration analysis. Bayesian MCMC algorithm was used for 30000 samples to estimate the time-varying parameters. The conclusions are as follows:

(1) The cyclical effect of rural finance is significant. The long-term cumulative effect of financial scale (LNFIR) is prominent, that is, it lags behind the sixth phase and needs continuous investment to support industrial upgrading; Financial efficiency (LNREF) and structure (LNRFS) show the trend of "rising first and falling later." The industry is activated at the initial stage, fluctuating in the medium term due to inadequate policy adaptation, and rising after structural adjustment at the later stage.

(2) The time-varying difference of financial factors is obvious. Before 2016, residents' consumption (LNDC) relied on short-term stimulus, and then industrial foundation optimization released medium and long-term consumption motive force, highlighting the necessity of production and consumption cooperation. Time-division analysis shows that the financial promotion effect in 2009 and 2019 is significantly stronger than that in 1999, which confirms the strengthening effect of financial system perfection and policy precision on dynamic effect.

The results show that the influence of rural finance on the revitalization of rural industry presents significant cycle heterogeneity and institutional sensitivity.

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