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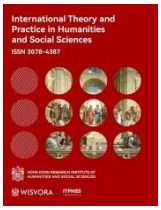

An empirical analysis of the coordinated development of transport and agricultural economy and trade in Xinjiang

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Abstract

Transportation is an important infrastructure for the development of agricultural economy and trade, which has a driving effect on agricultural structural adjustment, farmers' income increase and agricultural modernisation, and strengthening the infrastructure of the transportation industry is of great significance to the development of agricultural economy and trade.

This paper selects the relevant data in Xinjiang from 1990 to 2023, and uses the VAR model to analyse the impact of transport inputs and outputs on the agricultural economy, and the conclusions are as follows:

1. There is a long-term stable interactive relationship between agriculture and transport industry in Xinjiang, and there is a long-term stable interactive relationship between agricultural economy and trade and transport industry in Xinjiang, forming a pattern of stable development. In order to better promote the development of agricultural economy and trade, enhance the energy level of agricultural industry and promote agricultural modernisation, it is necessary to strengthen the supporting role of transportation, simultaneously improve the level of agricultural mechanisation, develop smart agriculture and digital agriculture based on the advantages of agricultural resources, and promote the transformation and upgrading of agriculture.

2. Data from 1990-2023 show that when the scale of Xinjiang's transport industry expands (especially the growth of freight volume), the agricultural economy shows a clear upward trend, indicating that the transport industry continues to promote the agricultural economy. It is recommended to increase investment in Xinjiang's transport infrastructure, improve the transport network, enhance freight transport security capacity, and support the high-quality development of the agricultural economy.

1. Introduction

1.1 Background and significance of the study

Agriculture is fundamental to China's socio-economic development, and transport is an important basic industry that drives national economic growth. A good agricultural transport environment can effectively improve the regional agricultural economy and trade and farmers' circulation environmental conditions, and promote the healthy development of the whole region's overall agriculture [1]. Taking Xinjiang as an example, we will explore the level of mutual coordination between transport and regional agricultural economic and trade development in

Xinjiang since 1990, and judge whether the existing agricultural transport in the region has the comprehensive ability to meet the existing economic and trade transport demand in a region, so as to provide important references for the next step of Xinjiang's transport to serve the three rural areas, and to better meet the development of the regional agricultural demand.

Agricultural economic and trade development and China's economic development is closely related to the practical interests of farmers. In the context of the new era, with the rapid development of science and technology, the three rural issues have received unprecedented attention, China has always attached importance to the three rural issues, introduced a series of policies to promote agricultural development, transport for leading the agricultural economy and trade, promote the construction of agricultural modernisation, the implementation of the revitalisation of the countryside has an important role.

First of all, it is necessary to increase the investment in transportation infrastructure to achieve agricultural modernization, agricultural modernization is the foundation and support of the country's modernization, is not only conducive to improving agricultural productivity, especially to improve the way of agricultural resource allocation, but also to promote the scientific development of the organization of agricultural production and business structure. Agricultural modernization is a necessary condition for the process of advancing, as well as conform to the correct choice of rural development, for the construction of a moderately prosperous society in all aspects has an important role to play, will be the new science and technology, brought into the food production, to obtain considerable food production, to achieve the modernization of the country to provide support for the farmers to enjoy the convenience of the traffic, the early realization of the results of the investment in transport infrastructure.

Secondly, Xinjiang is an important economic corridor connecting Northwest Asia, West Asia and Europe in the construction of “One Belt, One Road”, which is a new economic growth point for China in the future. It is fundamental to comprehensively and accurately implement the Party's strategic management of Xinjiang in the new period, seek long-term strategies, and consolidate the foundations, and strive to build a new era of socialism with Chinese characteristics, unity and harmony, prosperity, prosperity, civilization, prosperity, peace, and ecology in Xinjiang. The modernization of Xinjiang's agriculture is of great significance to the consolidation of harmony, stability and long-term peace and stability in Xinjiang.

1.2 Current Research Status at Home and Abroad

Economic development cannot be separated from the supply of personnel, equipment, and raw materials, as well as the flow of products and finished goods. Therefore, studying the economy requires studying transportation. The early research on the relationship between transportation and economy in the West began with the impact of transportation on product circulation.Early studies of the relationship between transportation and the economy in the West began with the impact of transportation on the flow of products. The German economist Johann Heinrich von Thünen (1826) first discussed the relationship between transportation and the economy in his book The Relationship of the Isolated State to Agriculture and the National Economy, arguing that the influencing factors determining the type of land use and the agricultural layout of a region were, in addition to the natural condition of the land, the more important was the transportation distance of the agricultural products to the market. Transportation distance[2].American scholar Edgar M. Hoover (Edgar Malone Hoover, 1948) pointed out in his book “Location of Economic Activities” that the convenience of transportation conditions will affect the location decision of enterprises, and that areas with superior transportation conditions will form a tendency of industrial concentration [3].Walter Isard (Isard W., 1956, 1975) applied the methods of econometrics and system analysis to extend the study of

the optimal size and layout of individual firms and sectors to the region, and comprehensively studied the regional general equilibrium and the impact of various factors such as production, distribution, transportation, ecology and policy on the regional general equilibrium, including the impact of regional transportation[4]. This includes the impact of regional transportation[4].The growth pole theory of French economist Francois Perroux (1950) suggests that there are centers of different sizes in economic space, called “growth poles,” and that forces point toward or away from these "growth poles. ". Economic growth in space is not evenly distributed, but is first concentrated in different states in some “growth poles”, and then shifted from these “growth poles” to the surrounding areas through economic exchanges along corridors such as transportation, thus having an overall impact on regional economic space[5]. This has an overall impact on regional economic space[5].According to Zhou Qingming of Zhejiang University, there are two kinds of spillover effects of transportation, one of which is called “positive spillover effect”, which is manifested in the fact that the development of regional transportation strengthens the links between different regions, so that the economic influence of the dominant region can be expanded to other regions by convenient transportation, and the regions are further connected as a whole; the other is called “negative spillover effect”, which is manifested in the fact that the region with convenient transportation will have an advantage in transportation cost, which will enhance the competitive advantage of the region and attract the concentration of the disadvantaged regions, thus further strengthening the advantage of the dominant region. The other is called “negative spillover effect”, which is manifested in the formation of transportation cost advantages in regions with convenient transportation, enhancing the competitive advantages of the region and attracting the concentration of human resources and materials in the surrounding disadvantaged regions, thus further strengthening the advantages of the advantaged regions and increasing the disadvantages of the disadvantaged regions, forming the so-called “poverty around the developed regions”. The phenomenon of “poverty belts around developed regions” is a negative spillover effect of transportation [6].Niu Shuzhen (2024) and Ma Wenbo (2024) pointed out that the railroad transportation-oriented distribution situation determines the degree and scope of agricultural development in each region, and even the formation and development of several agricultural economic zones with varying degrees of development and their central towns in the domain [7-8].Cao Mengyuan (2025) and Wang Weiping,Shan Youcheng (2025) believe that traffic, transportation industry is again the basis of agricultural development, is a guarantee industry for agricultural development, these two industries can completely achieve the effect of 1+1>2 [9-11].

In summary, the above studies basically explore the overall coordination of transport and economic trade, and there is no study on the coordination of transport and economic trade subsystems, especially the coordination effectiveness between regional transport and regional agriculture. This paper takes Xinjiang region as an example and uses VAR method to explore the coordination effectiveness between regional transport and agriculture economy and trade.

2. Data sources and processing

In selecting variable indicators, the total mechanical power and total output value of agriculture, forestry, animal husbandry and fishery are used to measure the level of agricultural development; and the transportation freight volume section is used to measure the development of the transportation industry. And the data of total mechanical power (J), gross output value of agriculture, forestry, animal husbandry and fishery (N) and freight volume (H) for the data years 1990-2023 were selected, and the time series of the three indicators of scientific and technological inputs, total power of agricultural machinery and gross output value of agricultural production

were regressed and analyzed by using the VAR model, and the source of the data is: Cathay Pacific.

H: Total freight volume (10,000 tons);

N: Total output value of agriculture, forestry, animal husbandry and fishery (billion yuan):

J: Total power of agricultural machinery (10,000 kilowatts).

3. Empirical Analysis

3.1 Model Setup

The VAR model avoids the requirement of a structured model by constructing each endogenous variable in the system as a function of the lagged values of all the endogenous variables in the system.The VAR model is an effective forecasting model for systems of interconnected time series variables. Meanwhile, vector autoregressive models are commonly used to analyze the dynamic effects of different types of random error terms on system variables [7].

Yt= A1ht- 1 + ... + Ak ht - k + Mk Zt + ...Ml Zt - L + μt（1,2,3...T）

where Yt is the column variable of the n-dimensional endogenous variable, Zt is the column vector of the exogenous variable, k and l are the number of lags, T is the number of samples, the n*n-dimensional matrix A1.... .Ak and matrix n*g dimensional matrix Mk.... .ML are matrices with estimated coefficients, and μt is the n-dimensional perturbation column vector.

3.2 Unit root test

In order to prevent heteroskedasticity, both sides of the data were taken to logarithmic, and the test of unit root was carried out on the series of time data between 1990-2023, and the results are shown in the following chart 1. In the following table, the first unit root test is carried out on the 1990-2023 time series of agricultural gross product (N), total mechanical power (J) and freight volume (H), and the T-values of the time series variables H, N and J after taking the logarithm of the time series variables are -1.541515, 9.606083, and -2.733347, respectively, which are all greater than the critical value of the confidence level, so the original time series variables are non-stationary. series variables are non-stationary series. The first-order difference test for variables J, K, Z, the P-values of DlnH, DlnN, DlnJ are 0.0000, 0.0000, 0.0076 respectively, which are less than 0.050, i.e., these three variables are first-order single-integrated series.

Table 3.1 Results of ADF Unit Root Test for Variables

Variables	C L G	T-value	1% level	5% level	10% level	P	Conclusion
lnH	0 ,I, 1	-1.541515	-3.546099	-2.91173	-2.593551	0.5058	Not smooth
DlnH	1 ,I, 1	-5.322026	-3.548208	-2.912631	-2.594027	0.0000	Smooth
lnN	0 ,I, 1	9.606083	-3.544063	-2.91086	-2.59309	1.0000	Not smooth
DlnN	1,I, 1	-6.452617	-3.550396	-2.913549	-2.594521	0.0000	Smooth
lnJ	0 ,I, 1	-2.733347	-3.546099	-2.91173	-2.593551	0.0745	Smooth
DlnJ	1,I, 1	-3.645408	-3.546099	-2.91173	-2.593551	0.0076	Smooth

Note: C denotes 0, 1st and 2nd order at normal level; L denotes the intercept I, trend T and 0, G denotes the number of lag periods

3.3 Model Lag Determination

In the following model, the optimal lag is generally selected based on the minimum of both AIC and SC at the same time, which is derived from Table 2, then it can be seen that the 1st order is the optimal lag, then the VAR model is established, then the equation is:

LNJ = 1.50985220566*LNJ(-1) - 0.488158409119*LNJ(-2) + 0.0177152835261*LNH(-1) - 0.107266383685*LNH(-2) + 0.0216571784197*LNN(-1) + 0.00628614412105*LNN(-2) + 0.620178384853

LNH = 0.856213858384*LNJ(-1) - 0.561259769957*LNJ(-2) + 0.572989917411*LNH(-1) - 0.237300403423*LNH(-2) + 0.219098584603*LNN(-1) - 0.0460503239529*LNN(-2) + 3.68732154457

LNN = -0.979470530543*LNJ(-1) + 0.933681405088*LNJ(-2) + 0.358169232068*LNH(-1) - 0.137312583281*LNH(-2) + 0.971242235677*LNN(-1) - 0.079817192607*LNN(-2) - 1.10623002934

Table 3.2 Determination of model lags

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-135.1192	NA	0.020048	4.603972	4.708690	4.644933
1	199.8313	625.2410*	3.83e-07*	-6.261045*	-5.842176*	-6.097202*

Note: "***", "**", "*" represent the significance level of 1%, 5% and 10%,

3.4 Cointegration test and model stability test

Due to the small sample, the cointegration test is used to check whether there is a long-term equilibrium relationship between the gross agricultural product (N), the total power of agricultural machinery (J), and the volume of freight transportation (H), and the three variables are subjected to cointegration test, and the result is as follows, according to the above lag is 1.

Table 3.3 Johansen inspect

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.392441	45.39299	29.79707	0.0004
At most 1 *	0.180289	15.99294	15.49471	0.0421
At most 2 *	0.069714	4.263513	3.841466	0.0389

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

From the above table, it can be seen that the P-value is less than 5%, then it can be concluded that at 5% significant level, the trace statistic of the three variables of Gross Agricultural Product (N), Total Power of Agricultural Machinery (J), and Volume of Freight Transportation (H) is 45.39299, which is greater than the critical value of 29.79707, so the original hypothesis of the non-existence of the variables of Gross Agricultural Product (N), Total Power of Agricultural Machinery (J), and Volume of Freight Transportation (H) is rejected, indicating that there is a cointegration relationship among these three variables at 5% significant level. The original hypothesis of cointegration is rejected, which indicates that there is a

cointegration relationship among these three variables at 5% significant level, and the equations are shown below:

LNN = 0.217527894249*LNJ + 1.97908814745*LNH - 12.4950943948

T= -1.373026 9.600901 -11.71298

P-value： 0.0750 0.0000 0.0000

R2=0.961564

From the above, it can be seen that the model R2 value is 0.961564, which is close to 1. This indicates that the goodness of fit of this model is good, and there is a long-term equilibrium relationship among the three, namely, the gross agricultural product (N), the total power of agricultural machinery (J), and the volume of freight transportation (H), which can be seen through the formula that, in the case of the other quantities remaining unchanged, every 1% increase in freight transportation inputs results in an increase in the gross agricultural product by 1.98%; in the case of the other quantities remaining unchanged With other quantities constant, every 1% increase in the total power of agricultural machinery increases the gross agricultural product by 0.22%. This indicates that the volume of freight transportation and the total power of agricultural machinery contribute to the development of agriculture.

Since the three variables, gross agricultural product (N), total power of agricultural machinery (J), and freight transportation (H), are a smooth series in the case of first-order difference, in order to test the stability of the model, the model was subjected to a unit root test, and as can be seen from the figure, all the roots fall inside the circle, which means that the eigenvalue of the unit root is less than 1, and the model is well stabilized.

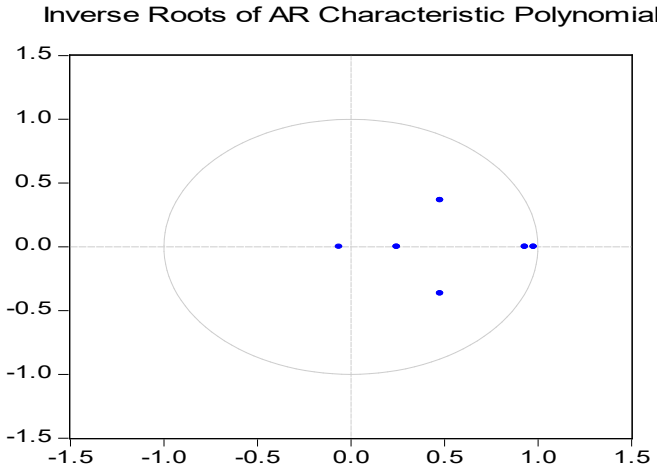

Figure 3.1 VAR model root mode display

3.5 Error Correction Model

An error correction model is an econometric model with a specific form designed to eliminate possible linear multicollinearity between the variables in the model. After regressing first and then making e=resid, the result after regressing the first order difference of each variable is:

Table 3. 4 Error correction model test results

Included observations: 60 after adjustments

	Coefficient	Std. Error	t-Statistic	Prob.

D(LNJ)	-0.434250	0.270246	-1.606870	0.1137
D(LNH)	0.200462	0.090998	2.202931	0.0317
C	0.132750	0.028214	4.705047	0.0000
E(-1)	-0.119511	0.037727	-3.167811	0.0025

The equation is then:

D(LNN) = -0.434249633253*D(LNJ) + 0.200462028634*D(LNH) + 0.132750100019 - 0.119510626302*E(-1)

From the above results can be concluded in the short term freight volume and so on on the development of agricultural economy and trade has a positive role in promoting, the total mechanical power on the development of agricultural economy and trade to promote the role of the more obvious, lagging a period of freight volume, the total power of machinery and agricultural production value of the three also have a great deal of promotion of the current agricultural output value of all three, the three influence each other, each other, indicating that the modernisation of the development of agricultural economy and trade can not be separated from the transport, also can not be separated from the total mechanical power, mutual influence. It is also inseparable from the total mechanical power, mutual influence.

3.6 Granger causality test

Granger causality test is used to analyze the causal relationship between each variable, and the cointegration test can only indicate that the three have a cointegration relationship.

Table 3.5 Granger causality test results

Null Hypothesis:	Lag	F-value	P-value	Conclusion
LNJ does not Granger Cause LNN	1	6.58856	0.0129	Reject theoriginal hypothesis
LNN does not Granger Cause LNJ		0.08362	0.7735	Accept the original hypothesis
LNH does not Granger Cause LNN	1	7.95494	0.0066	Reject the original hypothesis
LNN does not Granger Cause LNH		1.85711	0.1783	Accept the original hypothesis
LNH does not Granger Cause LNJ	1	0.16165	0.6891	Accept the original hypothesis
LNJ does not Granger Cause LNH		18.7760	6.E-05	Accept the original hypothesis
LNJ does not Granger Cause LNN	2	3.28930	0.0449	Reject the original hypothesis
LNN does not Granger Cause LNJ		0.06374	0.9383	Accept the original hypothesis
LNH does not Granger Cause LNN	2	4.47942	0.0159	Reject the original

				hypothesis
LNN does not Granger Cause LNH		1.04373	0.3591	Accept the original hypothesis
LNH does not Granger Cause LNJ	2	4.79013	0.0122	Reject the original hypothesis
LNJ does not Granger Cause LNH		4.09034	0.0222	Reject the original hypothesis

From the data in the table, it can be seen that at lag 1, at 5% level of significance, the volume of goods transported and the total power of machinery are the cause and effect of Granger for the total value of agricultural output. At lag 2 order, the volume of transported goods and total machinery power are the causality of the total agricultural output value of the Granger, and the total machinery power and the volume of transported goods are the Granger causality of each other, then all the three promote each other and influence each other.

3.7 Impulse Response

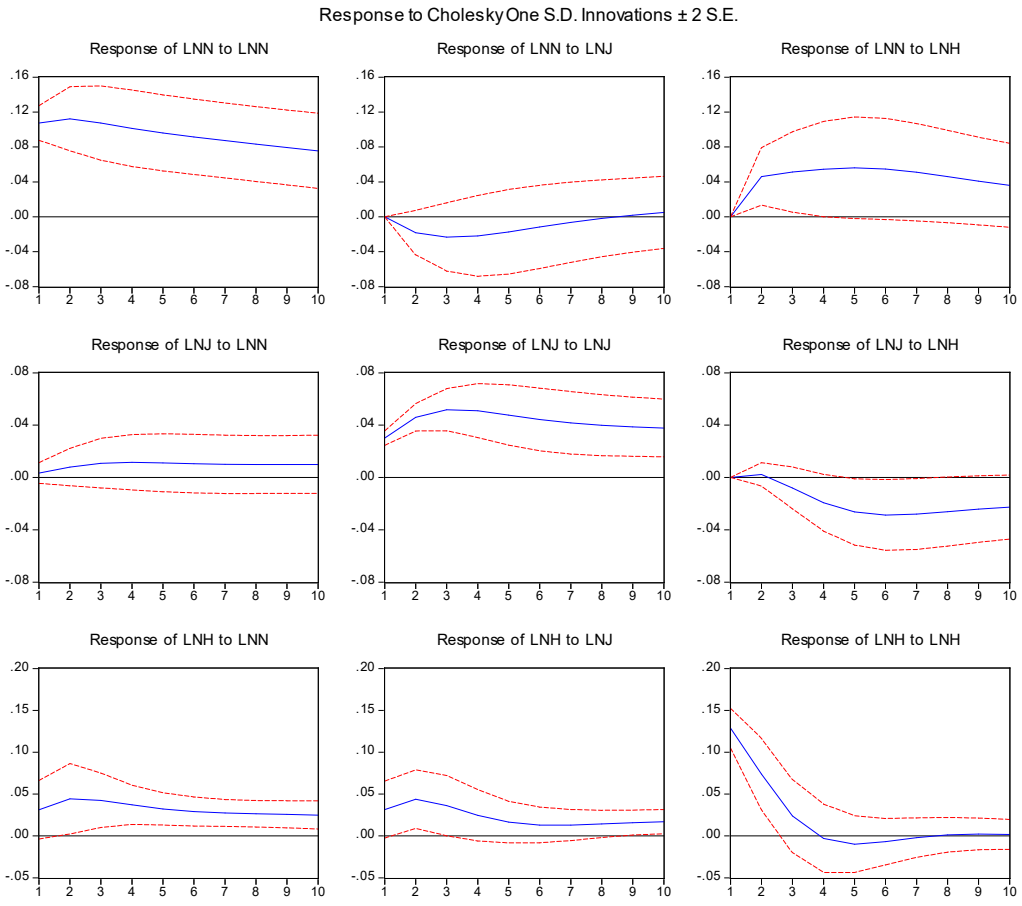

Figure 3.2 Impulse Response Plot

Figure 2 in the first row of the second graph, when the volume of goods transported by the total mechanical power impulse response, the first three periods rise, the third period to reach the maximum, mechanical inputs for the transport industry plays a positive role; the third graph of the volume of goods transported by the impulse response of the agricultural output value of the total value of the impulse response, resulting in a positive impact, the second period to reach the

maximum, indicating that the development of agricultural economy and trade prompted by the development of the transport industry, with a driving effect; the fourth graph In the fourth figure, the total mechanical power is impulsively responded by the transport industry in the first two periods into a positive correlation, the second period reaches the maximum, and then began to be negative, into a negative correlation, indicating that the transport industry's impact on the total mechanical power in the first two periods of the maximum, and then saturation has been reached, it will have the opposite effect. In the 6th figure, the total mechanical power is positively correlated after being subjected to the impulse response from the total value of agricultural output, but it is maximum in the second period and then levels off, indicating that the development of the agricultural economy and trade is forcing the total mechanical power to accelerate and have a certain impact. In figure 7, when agriculture is subjected to the impulse response from the volume of goods transported, agricultural economic trade continues to develop, becomes positively correlated, is maximum in the second period, and then tends to level off, suggesting that the transport sector has an important role to play in contributing to the development of agricultural economic trade.

4. Conclusions

(1) By analysing the relationship between transport and agricultural economy and trade in Xinjiang from 1990 to 2023 in the VAR model to derive the degree of coupling and coordination between these two systems, and based on these two quantitative indicators, the following conclusions are drawn: There is a long-term interactive relationship between agricultural economy and trade and transport in Xinjiang, and in terms of the operating effect, the driving effect of transport on the agricultural economy and trade is more obvious. It carries to improve the level of Xinjiang's agricultural industry, develop agricultural modernisation, make comprehensive use of Xinjiang's agricultural resource advantages, develop intelligent agriculture and digital agriculture, break the traditional agricultural economy and trade mode, and promote agricultural transformation and upgrading.

From the results of the cointegration test, it can be seen that the current level of integration of transport and agricultural modernisation in Xinjiang is not high. As a region with a high level of agricultural mechanisation in the country, Xinjiang still has obvious deficiencies in the construction of agricultural information technology, reflecting the current lack of investment in the field of agricultural science and technology. In order to further enhance the level of agricultural economic trade and agricultural modernisation, the systematic training and education of rural-related professionals should be continuously strengthened. On this basis, it should adhere to the market demand as a guide, actively build a platform for the transformation of scientific and technological achievements, promote the deep integration of science and technology and agriculture, and give full play to the key role of scientific and technological progress in promoting the process of agricultural modernisation.

Under the Granger test, there is a causal relationship between transport and the modernisation of agricultural economy and trade, and the integration of the two is an inevitable trend. From the current research, the role of transport in the modernisation of agricultural economy and trade is not very obvious, and the main problems are: lack of professionals, insufficient policy guidance, the relevant support funds have not been put into practice, and the relevant departments do not have enough guidance for scientific and technological policies, and the infrastructure is not complete. Infrastructure construction is not complete, so strongly support

the infrastructure construction of transport and agricultural modernisation, encourage farmers to start new businesses and innovate agricultural development models, strengthen the training of agricultural employees, train a number of high-quality agricultural employees, the overall quality of labour talent and professional skills, to achieve the standard of management standards and standardisation of services.

(2) In recent years, Xinjiang has been actively promoting agricultural development, playing an important role in ensuring national food security. However, under existing mechanisms, further agricultural development has not fully translated into increased regional economic strength and a significant rise in farmers' incomes. Compared with the path of economic growth through industrialisation in developed coastal regions, their regional economies and farmer groups have not achieved higher economic returns. In the long run, in order to ensure the sustainable development of Xinjiang's agriculture, it is necessary to gradually optimise the agricultural economic and trade policies, further promote the market-oriented reform of agricultural products, reasonably raise the prices of agricultural products, effectively improve farmers' income, and promote the healthy and sustainable development of agriculture.

(3) Through the correlation analysis, it can be seen that the correlation between the per capita net income of farmers and the development of the transport industry is significantly higher than the correlation between the per capita disposable income of urban residents and the development of the transport industry. This shows that by increasing the investment in transport and improving the transport conditions to serve the agricultural economy and trade, it can bring greater marginal benefits to farmers. Therefore, future transport construction should be further tilted towards rural areas to better serve the development of the agricultural economy and trade.

(4) Xinjiang's agriculture is dominated by grain and other bulk commodities, whose main modes of transport are railway, road and air transport. In recent years, with the economic development, Xinjiang region for the transport investment continues to increase, the three modes of transport investment increase in the agricultural economy and trade of transport efficiency shows an upward trend, indicating that the transport investment can greatly promote the development of agricultural economy and trade. In the future, we should strengthen the input of transport industry through policy adjustment and system innovation, so that the transport efficiency of agricultural economy and trade can be further strengthened, and the income of farmers can be really improved.

The shortcomings of this study is that the selection of indicators is relatively small, there are many factors affecting the development of agricultural economy and trade in Xinjiang is not included in the scope of the discussion, the introduction of more influencing factors can more objectively and accurately reflect the degree of integration of agriculture and transport development, so as to better put forward targeted recommendations.

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