The Evolutive Law concerning Relationship between Economic Growth and Farmers' Income Increase in Xinjiang since the Reform and Opening-up: An Empirical Analysis of the VEC Model

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Abstract We select the per capita gross domestic product and rural residents' per capita net income in Xinjiang as the indicator variables to measure economic growth and farmers' income increase in Xinjiang, respectively. We establish the cointegration equation, the vector error correction (VEC) model, and use the impulse response function to conduct empirical analysis of the evolutive law concerning relationship between economic growth and farmers' income increase in Xinjiang during the period 1978 -2010. The results show that there is a cointegration relationship between economic growth in Xinjiang and farmers' income increase; the former plays an important role in promoting the latter, following the evolutive law "first intensify, then abate, intensify again, and finally become stable". We put the following policy recommendations: providing preferential policies for farmers, scientifically and rationally guiding the transfer of rural labor; improving the function of agriculture, increasing the proportion of non-farm income; gradually bridging the widening income gap between urban and rural areas, coordinating urban and rural development.

Key words Economic growth, Farmers' income increase, Evolutive law, Policy enlightenment, VEC Model, Xinjiang

Solving the problem of "livelihood" to make a broader range of farmers share the fruits of economic growth, is the experience summary of China's economy after 30 years of reform and opening, and the objective requirement of adapting to the current economic transition and maintaining continuous, stable and healthy development of China's economy. The growth of farmers' income is an important manifestation of the farmers sharing the fruits of economic growth. At present, the curtain of providing assistance to Xinjiang and implementing leapfrog development strategy for Xinjiang is gradually opened; Xinjiang's economy is facing a severe test of transformation and realization of a new round of rapid growth. Therefore, according to the actual situation of Xinjiang, we take Xinjiang's economic growth and farmers' income increase as the study object, to explore the evolutive law of relations between the two since the reform, which is of important practical significance to further adjusting and perfecting the mechanism of economic operation, fully considering the factor of "people's livelihood", increasing farmers' income, ensuring the farmers' right to share fruits of economic growth, and achieving stable, healthy and rapid economic growth.

From the previous researches, the domestic and international scholars often expound the impact of unequal income distribution on economic growth from the perspective of income distribution theory. However, there are less in-depth researches with economic growth and farmers' income increase as focus point, fully considering the benefit of fruits of economic growth to people's livelihood in the context of "people-oriented" scientific concept of development, based on the current development stage of the Chinese economy and the times background. On the basis of assistance to Xinjiang and leapfrog development strategy for Xinjiang, we take increasing farmers' income and ensuring the farmers to share the fruits of new round of economic growth as the goal, take the reform and opening-up as a starting point, to explore the evolutive law of relations between economic growth and farmers' income increase.

1 Variable selection, data source and research method

1.1 Variable selection, data source We select per capita gross domestic product (PGDP) in Xinjiang and rural residents' per capita net income (PNI) as the indicator variables for measuring economic growth in Xinjiang and farmers' income increase, respectively. The sample interval is the time series data in the period 1978 -2010, from *Xinjiang Statistical Yearbook* in 2011[1]. For the elimination of impact of goods price factor, we have used the price index in 1978 as base period (the year 1978 = 100) for deflator adjustment. On the basis of annual time series data, we convert the annual data to quarterly data, using the method of converting low-frequency data to high-frequency data in Eviews 6.0 software[2]. This treatment can scientifically increase the effective variables, so that the model analysis results are more accurate. In order to eliminate the potential heteroscedasticity in time series, we conduct natural logarithm transformation on the variables selected, respectively, denoted by ln*PGDP* and ln*PNI*.

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1.2 Research method

1.2.1 Stationarity test of time series. Under normal circumstances, the economic time series data in the real life are non-stationary, and especially after the logarithmic transformation, the unit root is generally contained[3]. Therefore, we need to conduct unit root test on the data selected. Using the PP test method advanced by Phillips Perron based on non-parametric correction of the ADF test in 1988, we conduct stationarity test on time series variables selected[4-5]. The basic expression is as follows:

$$\nabla Y_t = \alpha + \gamma_{t-1} + \varepsilon_t \quad (1)$$

In accordance with the different nature of the series, there are three kinds of test form: the form containing constant term; the form containing constant term and trend term; the form not containing constant term and trend term.

Eviews 6.0 uses Newey – West heteroscedasticity and autocorrelation consistency to estimate the PP test statistic.

$$t_{\rho\rho} = \frac{\gamma_0^{1/2} t_\gamma}{\omega} - \frac{(\omega^2 - \gamma_0) TS_\gamma}{2\omega\hat{\sigma}} \quad (2)$$

where $\omega^2 = \gamma_0 + 2\sum_{j=1}^{q}(1 - \frac{j}{q+1})\gamma_j$; $\gamma_j = \frac{1}{T}\sum_{t=j+1}^{T}\hat{\varepsilon}_t\hat{\varepsilon}_{t-j}$; t_γ and s_γ are the test statistic and standard error of coefficient γ, respectively; $\hat{\sigma}$ is the standard error of the test equation; T is the period; q is the censored period. If $t_{\rho\rho}$ is greater than the critical value, it indicates that there is unit root in the series, and it is non-stationary series; if $t_{\rho\rho}$ is smaller than the critical value, it indicates that the series is stationary series.

1.2.2 Cointegration relationship test. Although the economic time series are often non-stationary, their linear combination may be stationary. This stationary series after combination is called cointegration equation, indicating that there is long-term stable equilibrium relationship between the economic variables[6]. We need to conduct the cointegration test to test whether there is cointegration relationship between the variables. In this paper, we adopt the cointegration likelihood ratio (LR) test method developed by Johansen[7-8]. The prerequisite is that the single whole order of non-stationary time series should be the same.

The test hypothesis: (there is 0 cointegration relationship); (there are M cointegration relationships). Now we test the trace statistic.

$$LR_M = -n\sum_{i=M-1}^{N}\log(1-\lambda_i) \quad (3)$$

where M is the number of cointegration vectors; n is the sample size; λ_i is the eigenvalue i arranged according to size. This test is series test, and in the actual operation, the Eviews 6.0 software will give many cointegration relationships increasing one by one from the null hypothesis of no cointegration relationship.

1.2.3 The vector error correction (VEC) model. Vector error correction (VEC) model is the new model established by Engle and Granger who combine the cointegration and error correction model, also known as the VAR model with cointegration constraints[9]. It is applicable to the modeling of non-stationary time series variables with cointegration relationship. The basic expression is as follows:

$$\Delta Y_t = A_1\Delta Y_{t-1} + A_2\Delta Y_{t-2} + \cdots + A_{p-1}\Delta Y_{t-p+1} + \Pi Y_{t-p} + U_t \quad (4)$$

where A_1, A_2, $\cdots$, A_{p-1} are the differential coefficient matrix, reflecting the impact of short-term fluctuation of each variable on the short-term changes of the variables to be explained; Π_{t-p} is error correction term, reflecting the long-run equilibrium relationship between variables; t is the sample size; p is the lag period; U_t is the random disturbance term.

On the basis of stability in the VEC model, we usually need to use the impulse response function to infer the meaning of the model. The analysis method of the impulse response function can be used to describe how the residuals pass the impact to the endogenous variables. Specifically, after imposing the impact of a standard differential on the random error, it will have a dynamic impact on the current value and future value of the endogenous variables. And this kind of impact will be passed to all other endogenous variables through the model system. It can not only give clear time lag interval, but also reflect the extent and direction of impact.

2 Results and analysis

2.1 PP unit root test In order to test the stationarity of the time series ln*PGDP* and ln*PNI* and whether the two are single whole series with the same order, this study uses the PP (Phillips Perron) unit root test method to ensure reliability of the follow-up model analysis. The results are shown in Table 1.

Table 1 PP unit root test of time series ln*PGDP* and ln*PNI*

Variable	PP test value	1% critical value	5% critical value	10% critical value	Test results
ln*PGDP*	-1.981 732	-4.029 595	-3.444 487	-3.147 063	Non-stationary
ln*PNI*	-2.915 596	-4.029 595	-3.444 487	-3.147 063	Non-stationary
Δln*PGDP*	-4.882 664	-3.481 217	-2.883 753	-2.578 694	Stationary
Δln*PNI*	-5.355 171	-3.481 217	-2.883 753	-2.578 694	Stationary

Note: Δ represents the first-order difference; the unit root test of series ln*PGDP* and ln*PNI* contains constant term and time trend term, and the unit root test of series Δln*PGDP* and Δln*PNI* contains constant term but no time trend term; the critical value of PP test is from Eviews 6.0 software.

From the test results, we see that the variables ln*PGDP* and ln*PNI* are both non-stationary series. But after the first-order difference, the variables ln*PGDP* and ln*PNI* become stationary at 1%, 5% and 10% significance level, namely they are both integrated of order I (1), meeting the precondition of the cointegration test. Therefore, we can conduct cointegration analysis on the relationship between per capita gross domestic product in Xinjiang and rural residents' net income.

2.2 Johansen cointegration test In order to eliminate the autocorrelation of error term and maintain a reasonable degree of

freedom so that the model parameters have strong explanatory power, it is necessary to determine the optimal lag order when conducting Johansen cointegration test. And the Johansen cointegration test is to conduct constraint test on the lag period of the first-order differential variable of VAR model without constraint, the lag order is equal to the difference between the lag order of VAR model without constraint and 1.

Therefore, this article takes the AIC, SC information criteria and LR statistic as the test standards for choosing the optimal lag order. We first determine the lag order of unconstrained VAR model, and then determine the lag order of Johansen cointegration test, to conduct cointegration test on the variables ln*PGDP* and ln*PNI*. The judgment results of the lag period of unconstrained VAR model are shown in Table 2.

Table 2 The optimal lag order judgment results of ln*PGDP* and ln*PNI*

Lag	log*L*	*LR*	*FPE*	*AIC*	*SC*	*HQ*
0	7.183 732	NA	0.003 153	-0.083 609	-0.038 120	-0.065 130
1	743.523 5	1437.050	2.34e-08	-11.895 54	-11.759 07	-11.840 10
2	821.974 8	150.575 9	7.04e-09	-13.096 37	-12.868 93	-13.003 98
3	826.456 6	8.457 589	6.98e-09	-13.104 14	-12.785 72	-12.974 79
4	827.109 4	1.210 805	7.37e-09	-13.050 15	-12.640 76	-12.883 85
5	842.881 3	28.745 64	6.10e-09	-13.240 02	-12.739 65	-13.036 76
6	863.286 2	36.531 38 *	4.69e-09 *	-13.504 62 *	-12.913 27 *	-13.264 40 *
7	864.122 3	1.469 918	4.93e-09	-13.453 59	-12.771 26	-13.176 41
8	864.510 7	0.670 166	5.24e-09	-13.395 33	-12.622 03	-13.081 20

Note: " * " signifies the optimal lag order selected by each column of information criterion in Eviews 6.0 software.

Table 2 shows that the information criteria AIC, SC and so on, mainly determining the optimal lag order under Eviews 6.0 software system, all identify the lag period 6 as the optimal results. Therefore, we should choose to establish the VAR model of lag period 6. Therefore, we conduct Johansen cointegration test on the variables ln*PGDP* and ln*PNI*, and the lag period that we should choose is 5. The test results are shown in Table 3.

Table 3 Cointegration test results of variable ln*PGDP* and ln*PNI*

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	5 percent Critical Value	Prob. * *
None *	0.173 498	24.255 05	15.494 71	0.001 9
At most 1	0.001 946	0.245 448	3.841 466	0.620 3

" * " signifies rejecting the null hypothesis at the 5% significance level.

Table 3 shows that under the 5% significance level, the trace statistic (24.255 05) is greater than the critical value (15.494 71), and the probability (0.001 9) is less than 0.05, indicating that there is a cointegration relationship between ln*PGDP* and ln*PNI*. That is to say, there is a long-term stable equilibrium relationship between per capita gross domestic product in Xinjiang and rural residents' per capita net income during the study period.

The cointegration equation is as follows:

$$\ln PNI_{t-1} = 1.247 \ln PGDP_{t-1} - 0.765 \quad (5)$$

This cointegration equation shows that in the long term, the change in Xinjiang's economic growth and the change in farmers' income increase are the same (positive); for every economic growth of 1%, farmers' income will increase by 1.247%. Thus, maintaining and ensuring the economic stability, healthy and rapid development in Xinjiang, plays a significant role in promoting farmers' income increase.

2.3 Estimation results and analysis of VEC model Cointegration test results show that there is a cointegration relationship between ln*PGDP* and ln*PNI*. In addition, since the two are the integrated of order one, according to the representation of Granger theorem, there must be the expression of vector error correction model (VAR model with cointegration constraints) between them[10].

Therefore, we can establish the VEC model. Given that the lag order of unconstrained VAR model is 6, we should establish the VEC (5) model with lag order of 5. By removing the lag differential whose *T*-statistic is not significant under the 5% significance level, we get its expression as follows:

$$\Delta \ln PNI_t = 0.013 + 0.632 \Delta \ln PNI_{t-1} + 0.175 \Delta PNT_{t-2} - 0.519 \Delta \ln PNI_{t-4} + 0.372 \Delta \ln PNI_{t-5} - 0.716 \Delta \ln PGDP_{t-4} + 0.371 \Delta \ln PGDP_{t-5} - 0.067 ecm_{t-1} \quad (6)$$

$$R^2 = 0.655 \qquad AIC = -5.589 \qquad SC = -5.319$$

where $ecm_{t-1} = \ln PNI_{t-1} - 1.247 \ln PGDP_{t-1} + 0.765$. The regression coefficients of all variables pass the significance test. In addition, from the overall test effect of the model, *AIC* value (-13.537) and *SC* value (-12.952) are also small, indicating that the overall explanatory effect of the model is good.

Besides, the coefficient of the model error correction term ecm_{t-1} is negative, in line with the reverse correction mechanism. The error correction coefficient of another expression of the model is positive, in violation of the law of the reverse correction mechanism, and its expression is not offered in this article.

Moreover, the coefficient of the model error correction term ecm_{t-1} is negative, in line with the reverse correction mechanism. The error correction coefficient of another expression of the model is positive, in violation of the law of the reverse correction mechanism, and its expression is not offered in this article. From the AR root test of VEC (5) model (Fig. 1), we see that the reciprocal of all roots is smaller than 1, located within the unit circle, indicating that the VEC (5) model is stable, and meets the requirements of impulse response analysis below.

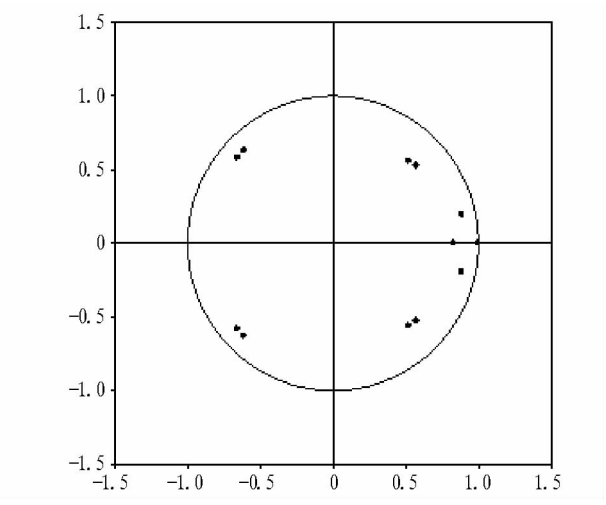

Fig. 1 AR root test of VEC (5) model

The interpretation of VEC (5) model for rural residents' per capita net income can be divided into two parts: short-term fluctuation and long-run equilibrium. And various differential terms reflect that it is affected by the short-term fluctuation. On the one hand, when in period t − 1, t − 2 and t − 5, for every increase of 1% in rural residents' net income per capita, it will promote itself to grow by 0.632%, 0.175% and 0.372%, respectively. On the other hand, rural residents' per capita net income is also positively correlated with the economic growth in period t − 5, with coefficient of elasticity of 0.371.

In the long run, the coefficient of error correction term ecm_{t-1} −0.067 < 0, meeting the conditions of the reverse correction mechanism, which can reflect the adjustment degree when the variables deviate from the long-run equilibrium. It indicates that there is a long-run equilibrium relationship between Xinjiang's economic growth and farmers' income increase (deviating occasionally or temporarily), but the non-equilibrium error of the previous year will reversely correct the rural residents' per capita net income of this year with the ratio of 6.7%, to make it revert to the cointegration relationship.

2.4 Impulse response analysis To further conduct in-depth analysis of the impact and influence of economic growth in Xinjiang on farmers' income increase, we conduct impulse response analysis on the basis of establishing VEC (5) model, and vividly depict this effect trajectory using the curve figure of impulse response function.

The response trajectory of impact of rural residents' per capita net income on per capita gross domestic product is shown in Fig. 2. In the figure, the horizontal axis represents the number of tracking period of the response function (40 is set in this study); the vertical axis represents the degree of response to impact of rural residents' per capita net income on per capita gross domestic product.

It can be seen from Fig. 2 that the response to impact of rural residents' per capita net income on per capita gross domestic product, is in the process of positive response fluctuation within the first 20 periods; after the period 20, this positive response gradually tends to be stable.

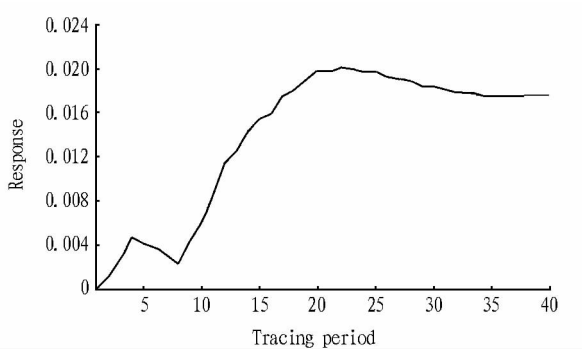

Fig. 2 The response function curve of impact of ln*PNI* on ln*PGDP*

Specific response path is as follows: (1) At the initial stage, the response to the impact of rural residents' per capita net income on increase in per capita gross domestic product rises gradually, and peaks in the period 4 for the first time (about 0.005). (2) Subsequently, this positive response is gradually weakened, and it reaches the trough level in the period 8 (approximately 0.002). (3) After the period 8, the response to the impact of rural residents' per capita net income on increase in per capita gross domestic product is rapidly enhanced, and it peaks in the period 20; then it is gradually stabilized at level of 0.018%.

Thus we can draw the following conclusion: the per capita gross domestic product in Xinjiang has a positive impact on rural residents' per capita net income. It indicates that economic growth in Xinjiang can effectively increase farmers' income; the impact of economic growth on farmers' income shows a fluctuating trend, and this impact will tend to be stable in the long term.

3 Policy recommendations

Based on the above analysis of the dynamic relationship between economic growth in Xinjiang and farmers' income increase, combined with the analysis conclusions, we believe that in the process of the gradual implementation and advancement of leapfrog development strategy in Xinjiang, we should pay attention to the following three aspects, in order to effectively implement the "people-oriented" scientific development concept, make the majority of farmers fully enjoy the fruits of economic growth, steadily increase farmers' income, fundamentally improve people's livelihood, and achieve a win-win situation of economic growth and farmers' income increase.

3.1 Providing preferential policies for farmers, scientifically and rationally guiding the transfer of rural labor When formulating, modifying and implementing new macroeconomic policies, we should timely and scientifically consider the actual situation of Xinjiang's economic development and farmers' life, fully take into account the farmers' right to economic operation participation, and offer preferential policies to farmers within reasonable limits, especially the farmers in relatively backward rural areas of southern Xinjiang.

At the same time, we should adjust economic structure, transform the economic growth mode, and reasonably and orderly

strengthen training, and guide the rural labor forces to transfer to the secondary and tertiary industries, especially the rural labor forces in southern Xinjiang, thereby gradually reducing the agricultural population, enhancing the proportion of non-agricultural population, and improving people's livelihood. Reducing the number of farmers moderately is a fundamental way to increase farmers' income[11]. Only by doing these can we break the rural-urban segmentation and regional segmentation, promote the free movement of labor in rural areas, and speed up the process of urbanization[12].

3.2 Improving the function of agriculture, increasing the proportion of non-farm income We should conform to the actual and objective conditions in Xinjiang, optimize and improve the original operating mechanism and development mode of agricultural industry step by step, to enhance the competitiveness of agricultural industry. We should also scientifically and rationally expand the original agricultural industry chain, build the brand of fruit products, livestock products, and other processed products with Xinjiang's characteristics, strengthen the close relationship between agriculture and secondary and tertiary industries, make the farmers participate in the economic operation process, and increase the wage of migrant workers in the industry that they are engaged in, to steadily increase the proportion of non-agricultural income.

3.3 Gradually bridging the widening income gap between urban and rural areas, coordinating urban and rural development Based on the actual development situation in urban and rural areas of southern Xinjiang and northern Xinjiang, we should fully respect the local customs, habits, and the real gap left by history; progressively and steadily adjust and perfect the mechanism of income distribution in Xinjiang; strictly in accordance with the requirements of ensuring and improving people's livelihood, prevent great fluctuation in farmers' income growth rate, curb the widening urban-rural income gap, and gradually narrow the rural income gap between southern Xinjiang and northern Xinjiang. Only by doing these can we improve the enthusiasm of farmers of all ethnic groups for participating in economic construction, achieve the coordinated growth of the economy and farmers' income, and ensure farmers' right to share the fruits of economic growth.

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(From page 3)

with the tourism companies, catering companies, accommodation companies, popular science companies, science and technology development companies, and other companies, each responsible for a part and each reaping respective returns.

(4) The management of supporting agricultural cooperatives. The park supports the local agricultural cooperatives to conduct joint management and gaining. The members of cooperatives can adopt some ways to cooperate with the park, such as entrusted breeding, planting supported by technology, and development of rural catering.

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