Dynamic Relation between Rural Human Capital and Farmers' Income in Henan Province

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Abstract We use relevant economic and labor force data from 1990 to 2009 of Henan Province to analyze the dynamic relation between stock of rural human capital and farmers' income. Results indicate that a certain causal relationship and long-run equilibrium relation exist between rural human capital and farmers' income, but their interaction shows some lagging characteristic. Increase of farmers' income in Henan Province increases the stock of rural human capital in this province for a short term. However, in the long run, this accumulation effect will decline along with renewal and aging of knowledge. The positive promotion action of rural human capital on farmers' income will appear after a long lag time. Therefore, the policy of strengthening rural human capital input should be long-term and continuous.

Key words Farmers' income, Rural human capital, VAR model, Pulse response function, Variance decomposition, China

Since American economist Theodore William Schultz proposed the human capital theory, people are getting to realize the importance of rural human capital in increase of farmers' income and development of agricultural economy. Human capital is deemed as a significant factor influencing farmers' income[1], and some domestic scholars have carried out empirical test on the relation between rural human capital and farmers' income. For instance, Bai Juhong *et al.* state that the higher rural human capital accumulation, the higher agricultural productivity, and the faster increase of farmers' income[2]. Liu Chunyang analyzed typical poverty-stricken areas. The results show that human capital investment is favorable for improving income of farmers' individual and their family[3]. Li Jianzhong *et al.* use average education years of rural labor force to represent the level of rural human capital. They discussed the influence of human capital on farmers' income and found that human capital is the most essential factor influencing agriculture and farmers' income[4]. Feng Jihong analyzed the function of rural human capital in increase of farmers' income by survey data of farmers in a big agricultural province. The conclusions indicate that average education years of labor force in a family significantly increase net income per capita of farmers[5]. Long Cuihong carried out empirical study on time series data from 1985 to 2005 of the whole country. The study shows that there is a long and stable positive correlation between farmers' net income and educational level of labor force, and input of human capital can effectively increase farmers' income[6]. Zhang Qian[7] and Wang Aimin[8] also use average education years of rural labor force to represent the level of rural human capital. Through building VAR model and pulse response function, they carried out variance analysis and came to the conclusion that accumulation of rural human capital plays an important role in increase of farmers' income. Clearly, researches have demonstrated that investment of rural human capital is helpful to improving income of farmers and their family. However, these researches lay particular emphasis on the relation between farmers' education years and income level, and slightly touch on the relation between stock of rural human capital and farmers' income. What is worse, they neglect defects of other kinds of human capital. In addition, the above researches mainly pay attention to static relation, but without in-depth study of dynamic relation. In view of these, we take an example of Henan Province, adopt the cointegration approach on the basis of VAR model, to solve the following problems: whether there is long-run equilibrium relation between rural human capital and farmers' income in Henan Province, whether this relation is causal relation, one-way causality or two-way causality; whether two-way causality exists, how is the mutual influence and effect of variation of two aspects in a long term.

1 Variable and data

Farmers' income (Y) is expressed by rural per capita net income. We use current year's prices. The stock of human capital (H) adopts widely accepted education years method. The calculation is as per number of employees and their education level of Henan Province in the past years. According to education system of Henan Province, education is divided into 5 levels. We set weight and make proper adjustment in accordance with average education years of employees at all levels. The illiterate and semiliterate take 2, primary school takes 6, junior middle school takes 9, senior middle school (including technical secondary school and technical school) take 12, and junior college and above take 16[9]. Finally, we obtain the total stock of human capital $H = 2 \times H_1 + 6 \times H_2 + 9 \times H_3 + 12 \times H_4 + 16 \times H_5$ by the weight sum method. Where, H_i ($i = 1, 2, 3, 4, 5$) represents number of labor force at respective education level. The specific is as follows: H_1 is number of illiterate and semiliterate people, H_2 is number of people with primary school

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education, H_3 is number of people with junior middle school education, H_4 is number of people with senior middle school (including technical secondary school and technical school) education, and H_5 is number of people with junior college and above education.

The basic data we adopted is relevant economic and labor force data from 1990 to 2009 in Henan Province. The data is mainly selected from *Henan Statistical Yearbook*, *Rural statistical Yearbook of China*, and *Comprehensive Statistical Data and Materials on* 60 *Years of New China*. Since natural logarithm of data will not change the cointegration relation, but will linearize the trend and eliminate heteroscedasticity existing in time series, we follow the convention and use Eviews 6.0 software to transform the original data into natural logarithm. We obtain following two variable trends (Fig. 1): farmers' income ($\ln Y$) and stock of rural human capital ($\ln H$) in Henan Province.

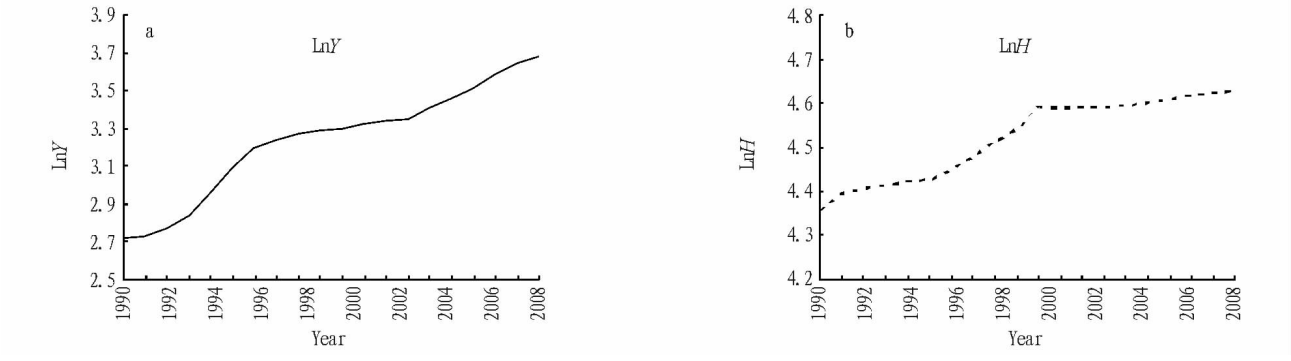

Fig. 1 Trend of farmers' income and rural human capital from 1990 to 2009 in Henan Province

2 Results and analyses

2.1 Stationarity test To avoid problem of "pseudo regression", we firstly carry out stationarity test for variables before conduction of cointegration test. This study adopts ADF test to check the stationarity of $\ln Y$ and $\ln H$. During test, we use Akaike Information Criterion (AIC) to determine the lag order. The results are listed in Table 1. Results of level test show that absolute values of ADF of both variables are lower than absolute value of critical value, indicating that both variables of farmers' income and stock of rural human capital are non-stationary series. However, after first order difference, absolute values of ADF of both variables are higher than absolute value of critical value. Therefore, we can consider that their first order difference is stationary, in other words, $\ln Y$ and $\ln H$ are first order single integration.

Table 1 Test results of $\ln Y$ and $\ln H$ stationarity

Variable	ADF statistic	Test type (C, T, L)	5% of critical value	AIC	Conclusion
$\ln Y$	−1.878 324	(C, 0, 0)	−3.040 391	−4.269 527	Non-stationary
$\Delta\ln Y$	−4.615 694	(C, T, 3)	−3.733 200	−5.267 525	Stationary
$\ln H$	1.638 418	(0, 0, 1)	−1.961 409	−5.715 935	Non-stationary
$\Delta\ln H$	−2.324 948	(0, 0, 0)	−1.961 409	−5.671 945	Stationary

Note: Test type C, T, and L respectively refers to constant term, time trend and lag order in the model; is symbol of first order difference.

2.2 Building of VAR model Before building VAR model, it is necessary to determine the maximum lag period K. The optimum autoregressive order of VAR (p) can be obtained from testing values corresponding to VAR (p) model in accordance with such test criteria as LR, FPE, AIC, SC, and HQ, *etc.* Through a careful selection, we determine that the optimum lag order is 2. The estimated result of VAR (2) model is shown in Table 2, where, coefficients of determination for two regression functions separately reach 0.994 5 and 0.989 6, indicating a high fitting degree of two regression functions. From $\ln Y$, we can see know that lag periods of rural human capital have positive influence on farmers' income, and lag period 2 is significant at 1% level. This indicates that the influence of rural human capital on farmers' income has obvious lagging effect. At significant level of 1%, the influence of lag period 1 for farmers' income on their own is significantly positive, while lag period 2 is significantly negative, reflecting unstable increase of farmers' income in Henan Province. From $\ln H$, we can see that the influence of lag period 2 of farmers' income on rural human capital is positive, and the influence of lag period 1 at 5% level is significantly negative. This indicates that farmers' income in long-term has a positive influence on stock of rural human capital, because rural human capital investment is a long and con-

Table 2 Regression results of VAR (2) model

Explanatory variable	Regression function $\ln Y$	Regression function $\ln H$
$\ln Y(-1)$	1.667 747 (7.958 92)***	−0.118 131 (−1.261 93)
$\ln Y(-2)$	−0.839 756 (−3.160 17)***	0.252 456 (2.126 62)**
$\ln H(-1)$	0.051 450 (0.078 35)	0.080 413 (1.392 83)*
$\ln H(-2)$	0.455 327 (2.993 71)***	0.607 176 (2.069 80)**
C	−1.254 149 (−1.196 74)	1.731 341 (3.698 12)***

Note: Values in brackets are t statistics, and those outside brackets are estimated values of regression parameters. ***, **, and * respectively stands for significance at 1%, 5% and 10% levels. R^2 of regression function $\ln Y$ is 0.994 513, and that of $\ln H$ is 0.989 626. Maximum likelihood functional value of VAR (2) $\mathrm{Log}L = 107.901\,6$, AIC = −10.817 98, and SC = −10.383 33.

tinuous process. Various periods of rural human capital have positive influence on themselves respectively at 10% and 5% levels, indicating that it is possible to raise accumulation of rural human capital through improving education condition.

2.3 Cointegration test From Table 1, we know that $\ln Y_t - I(1)$, $\ln H_t - I(1)$, then we obtain $\ln Y_t$ and $\ln H_t - CI(1,1)$. Through cointegration regression, we obtain:

$$\ln Y_t = -10.326\ 85 + 2.999\ 138 \times \ln H_t \qquad (1)$$
$$(-8.92)^{***} \qquad (11.72)^{**}$$

In equation (1), $R^2 = 0.884\ 188$, $***$ means significance at 1% level.

Meanwhile, we calculate and keep residual error e_t, then test stationarity of e_t. The result is as follows:

$$\Delta e_t = -0.364\ 080 e_{t-1} \qquad (2)$$
$$(-4.36)^{**}$$

In equation (2), $R^2 = 0.864\ 063$, $***$ means significance at 1% level.

Absolute value of $t = -4.36$ is higher than that of critical value -3.66 (significance at 5% level, $k=2$) of cointegration test EG or AEG, so we reject the original assumption of non-stationary e_t. This means that two variables are cointegrated, and there is a long-run equilibrium relation between them. Equation (1) indicates that an increase of 1% in rural human capital will increase farmers' income by 3%.

We carried out a Granger causal relationship test for rural human capital and farmers' income, and the results are listed in Table 3. From Table 3, it is indicated that when lag period is 1 to 4 orders, at 10% significant level, we reject null assumption that "$\ln Y$ is not Granger cause of $\ln H$". This shows that increase of farmers' income produces a significant positive promotion effect in investment and formation of rural human capital, and such effect will appear rapidly. When the lag period is 2, at 10% significant level, the null assumption that "$\ln H$ is not Granger cause of $\ln Y$" is rejected. This again proves that the influence of rural human capital on farmers' income has clear lagging effect. Meanwhile, it also proves that the formation of human capital is a long process. It must depend on sustainable and steady growth of farmers' income. Besides, in lag period 2, $\ln Y$ and $\ln H$ have mutual Granger causal relationship. From this, it is clear that the mutual influence of rural human capital and farmers' income has a certain amount of lag.

Table 3 Test results of Granger causal relationship of $\ln Y$ and $\ln H$

Null assumption	1		2		3		4		5	
	F value	Probability	*F* value	Probability	*F* value	Probability	*F* value	Probability	*F* value	Probability
$\ln H$ is not Granger cause of $\ln Y$	0.833 58	0.374 8	3.210 88	0.073 6*	0.740 13	0.551 9	1.639 66	0.266 3	1.106 02	0.474 3
$\ln Y$ is not Granger cause of $\ln H$	6.050 54	0.025 7**	7.584 44	0.006 6***	4.802 49	0.025 3**	3.349 15	0.078 1*	1.931 95	0.271 6

Note: $***$, $**$ and $*$ separately means rejection of null assumption at 1%, 5% and 10% significant levels.

2.4 Pulse response function and variance decomposition Granger causal relationship test only shows whether there is causality between variables. To clearly understand the dynamic relation between farmers' income and rural human capital, we have a further discussion with the aid of pulse response function and variance decomposition. The pulse response function describes the influence of a standard deviation impact on current and future values of variables. The standard deviation comes from random perturbation (innovation) in VAR model. The response function can objectively depict dynamic interaction and effect between variables. Pulse response curves of variables obtained in Eviews 6.0 are shown in Fig.2.

Following results can be obtained from Fig. 2. First, $\ln Y$ has a strong response to one of its standard deviation innovation in the first period, it increases by 0.021 6. In the third period, it reaches the maximum value 0.041 2 and later gradually decreases. By the eighth period, it is nearly reduced to zero. Then, it slowly rises. These indicate that there is a certain relation between farmers' income and lagged value. At the same time, the short duration of lag shows unstable increase of farmers' income. Second, the influence of a standard deviation innovation of $\ln Y$ upon $\ln H$ is basically zero. From the third period, it starts to increase. By the sixth period, it reaches the maximum value 0.013 7. Later, it gradually decreases. However, values in all periods are positive. These indicate that increase of farmers' income shortly speeds up accumulation of rural human capital. Nevertheless, in the long term, such accumulation must rely on continuous input of capital, because human capital investment is a long and continuous process. Third, as soon as a standard deviation innovation is given to $\ln H$ in current period, $\ln Y$ will have immediate but negative response. In the second period, such influence reaches negative maximum value, making $\ln Y$ reduce by approximately 0.003 9. And this influence will last till the third period. From the fourth period, innovation from $\ln H$ starts to have a positive influence on $\ln Y$ and it reaches the maximum value 0.011 1 in the sixth period. Later, it rapidly falls but still is positive. These indicate that human capital has a considerable positive influence on farmers' income. However, farmers' consumption on education will reduce farmers' income in short term. Therefore, this action has lagging effect. In addition, this positive action has declining trend in a long term, which may be resulted from knowledge renewal and aging. Fourth, $\ln H$ has a strong response to one of its standard deviation innovation in the first period, it increases by 0.009 4. Later, the influence gradually weakens and becomes nearly zero in the fifth period. Then, it gradually restores to original level in later periods. These not only show fast speed of knowledge renewal and aging, but also indicate the long term and accumulation features of human capital investment and its formation.

When studying VAR model, we can have a close look at dynamic characteristics of the model through variance decomposition. The basic idea is to decompose endogenous variables in the system into various compositions related to random per-

turbation of each equation according to causes of variation, so as to know the relative importance of each random perturbation to endogenous variables of the model[10]. The results of variance decomposition of ln*Y* and ln*H* are listed in Table 4.

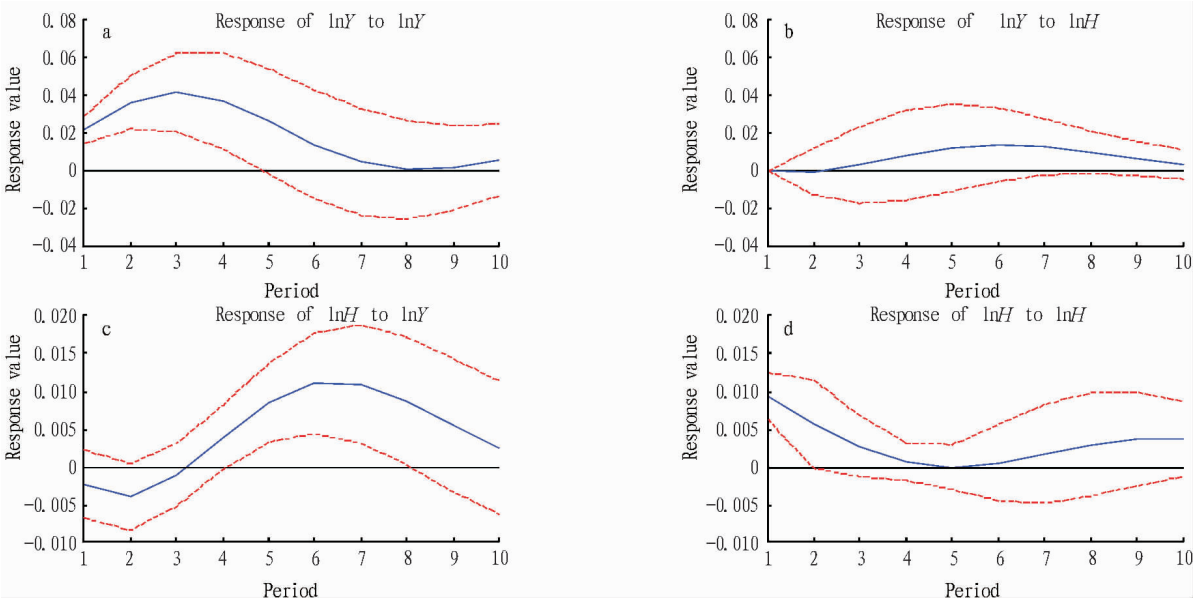

Fig. 2 Pulse response curve of ln*Y* and ln*H*

Table 4 Variance decomposition of ln*Y* and ln*H*

Period	Variance decomposition of ln*Y*			Variance decomposition of ln*H*		
	Expected standard deviation	ln*Y*//%	ln*H*//%	Expected standard deviation	ln*Y*//%	ln*H*//%
1	0.021 554	100.000 00	0.000 000	0.009 629	5.216 94	94.783 07
2	0.042 012	99.986 82	0.013 179	0.011 840	14.198 36	85.801 64
3	0.058 953	99.703 96	0.296 038	0.012 198	14.046 58	85.953 42
4	0.069 958	98.434 80	1.565 202	0.012 838	22.090 18	77.909 82
5	0.075 629	96.085 23	3.914 769	0.015 418	45.979 53	54.020 47
6	0.078 114	93.241 22	6.758 781	0.018 992	64.301 07	35.698 93
7	0.079 275	90.872 03	9.127 967	0.022 006	72.741 07	27.258 93
8	0.079 884	89.497 05	10.502 950	0.023 866	75.232 85	24.767 15
9	0.080 154	88.931 85	11.068 150	0.024 780	74.762 60	25.237 40
10	0.080 445	88.813 06	11.186 940	0.025 198	73.379 18	26.620 82

Table 4 shows that in the variation of farmers' income, over 90% of the fluctuations are contributed by themselves, but it is in a declining trend. The impact of human capital on increase of farmers' income is small at first, but it grows continuously. In the tenth period, it reaches 11.17%. These reflect uncertainty of farmers' income and lagging characteristic of promotion action of human capital on farmers' income. The variance decomposition result of human capital is continuously varying, in which the contribution of farmers' income keeps rising and reaches the minimum value in the eighth period. These fully indicate the importance of continuous investment to formation of rural human capital.

3 Conclusions and policy enlightenment

From the above analyses, we can reach following conclusions and policy enlightenment:

(1) There is a long-run equilibrium relation between rural human capital and farmers' income in Henan Province. In lag period 1 to 4, increase of farmers' income is Granger cause of increase in stock of human capital. Nevertheless, human capital is Granger cause of increase of farmers' income only in lag period 2. These indicate that increase of farmers' income is cause, and increase in stock of human capital is effect. The development of rural human capital in Henan Province is inseparable from increase of farmers' income and continuous investment of farmers in self-education.

(2) Increase of farmers' income in Henan Province shows uncertainty, and positive promotion action of rural human capital on increase of farmers' income will be manifested only after a comparatively long lag time. As to corresponding policies, the investment of Henan provincial government in rural human capital should be long-term and continuous, and should be favorable to accumulation of rural human capital.

(3) The increase of farmers' income in Henan Province raises the accumulation of rural human capital in this province in a short term. Nevertheless, in a long term, with the acceleration of knowledge renewal and aging, marginal effect of such

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ple, we can build low-rent house and cheap house to guarantee that migrant workers have place to stay in cities. Secondly, we can establish proper social security system according to characteristics of migrant workers. For instance, Chongqing handles special endowment insurance for migrant workers on the principle of low premium, transferrable and wide coverage. Migrant workers can work and join insurance in the whole city area. If they stay in cities, they will be shifted to urban social insurance; if they return to countryside, they will be shifted to rural social insurance. At the same time, medical insurance methods for serious disease of migrant workers are issued, and 3 232 injury insurance policies are improved for migrant workers. Thirdly, we should properly solve education problem of migrant workers' children. For example, we can send migrant workers' children to attend schools near their working and living areas. In the whole Chongqing city, 380 public schools have been assigned to receive migrant workers' children for compulsory education. It is strictly prohibited to collect tuition and incidental expenses, text book fees, expenses for transferring school, and temporary student fees in any form. Fourthly, we should establish household registration transferring system for migrant workers. Specifically, we can remove the limitation on migrant workers' household registration in all towns outside the downtown, and all migrant workers and their family members having legal domicile (bought or rented) can apply for household registration. Thus, it is expected to gradually separate distribution functions carried by household registration system, and finally achieve the transition to uniform urban and rural management system for household registration[7].

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accumulation decreases progressively. The self-contribution of human capital keeps on downward trend. Since the human capital investment is a long and continuous process, we should stick to the corresponding policy of increasing input of rural human capital for a long term, not just for a short period.

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