Research on the Influence of Household Operating Income in Heilongjiang from Agricultural Production Material Investment

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Abstract—Heilongjiang, as the major grain producing province, makes outstanding contributions to grain. Farmers mainly engage in food production and their household operating income mainly depends on food income. Therefore, to protect farmers' food income in Heilongjiang has become the key problem of ensuring food security. Through correlation analysis, multiple linear regression and path analysis, the paper using the relevant data from 1995 to 2013 analyzes the relationship between agricultural production material investment and farmers' household operating income in Heilongjiang, analyzes its direct and indirect influences and ultimately comes to the conclusion that production material has a positive impact on farmers' household operating income, but the difference of influencing degree is large with different production material investment.

Keywords- ***production material investment; farmers; household operating income; direct influence; indirect influence***

I. MULTIPLE LINEAR REGRESSIONS

The purpose of the study is to analyze influencing factors of farmers' income and gets its main reason. So the paper analyzes the selected data using multiple linear regression models and specific form of the model is as follows[1]:

$$Y = \mathrm{C} + \sum_{i=1}^{n} \beta_i X_i + \varepsilon \qquad (1)$$

Y represents the farmers' income, C is a constant term, βi is regression coefficients of corresponding variable, Xi is the corresponding variable, ε is a random disturbance, the range of n is between 1 and 21.

II. MODEL INDICATOR SELECTION AND DIRECTION FORECAST

Farmers' household operating income in Heilongjiang consists of the primary industry, secondary industry and tertiary industry. Among them, the primary industry lies in the dominated position and its proportion on household operating income is more than 95%. Also, the proportion of agricultural income is more than 90% in the primary industry. So in order to analyze household operating income in Heilongjiang, the paper mainly studies the influencing factors of agricultural income. The related influencing factors with agricultural income mainly include scale factors, technological factors, human resources factors, infrastructure factors, market factors and planting structure factors. Coupled with urbanization factors, specific indicators of household operating income in Heilongjiang are as follows: X_1 is per capita sown areas of crops, X_2 is the proportion of junior higher education on average hundred labors, X_3 is the number of rural labor force, X_4 is average amount of chemical fertilizer, X_5 is average machinery gross power, X_6 is the effective irrigation areas, X_7 is the proportion of grain sown areas, X_8 is the proportion of agricultural output, X_9 is agricultural production material price index, X_{10} is the agricultural products price index, X_{11} is the proportion of urban population and X_{12} is the proportion of labors in primary industry[3-8]. The direction forecast on influencing farmers' household operating income in Heilongjiang form each factor is as follows:

TABLE I. ASSUMING DIRECTION OF MODEL VARIABLES

variables	assuming direction
per capita sown areas of crops（X_1）	+
proportion of junior higher education on average hundred labors（X_2）	+
the number of rural labor force（X_3）	+/-
average amount of chemical fertilizer（X_4）	+
average machinery gross power（X_5）	+
the effective irrigation areas（X_6）	+
the proportion of grain sown areas（X_7）	-
the proportion of agricultural output（X_8）	+/-
agricultural production material price index（X_9）	-
agricultural products price index（X_{10}）	+
the proportion of urban population（X_{11}）	+
the proportion of labors in primary industry（X_{12}）	-

III. MODEL DATA SELECTION AND RESULT ANALYSIS

The paper chooses influencing factors of per capita net income in Heilongjiang from 1993 to 2010, together with the data of household operating income from 1993 to 2010. Using SPSS, the paper analyzes relevant data through correlation analysis, multiple linear regression and path analysis and arrives at the following conclusions:

TABLE II. CORRELATIONS (1)

	per capita sown areas of crops	junior higher education	the number of rural labor force	average amount of chemical fertilizer	average machinery gross power	the effective irrigation areas
household operating income	.942 (**)	.853 (**)	.678 (**)	.875 (**)	.922 (**)	.943 (**)
	.000	.000	.002	.000	.000	.000
	18	18	18	18	18	18

TABLE III. CORRELATIONS (2)

	the proportion of grain sown areas	the proportion of agricultural output	agricultural production material price index	agricultural products price index	the proportion of urban population	the proportion of labors in primary industry
household operating income	.761 (**)	-.779 (**)	-.091	-.247	.819 (**)	-.883 (**)
	.000	.000	.720	.323	.000	.000
	18	18	18	18	18	18

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

From the result, we can see that household operating income in Heilongjiang has a positive correlation with X_1 per capita sown areas of crops, X_2 the proportion of junior higher education on average hundred labors, X_3 the number of rural labor force, X_4 average amount of chemical fertilizer, X_5 average machinery gross power, X_6 the effective irrigation areas, X_7 the proportion of grain sown areas and X_{11} the proportion of urban population. It has a negative correlation with X_8 the proportion of agricultural output, X_9 agricultural production material price index, X_{10} agricultural products price index and X_{12} the proportion of labors in primary industry. Compared with the expected direction, only X_{10} agricultural products price index is contrast with the prediction and other factors with the forecast keep the same basically. However, the significance of X_{10} agricultural products price index is not very obvious and its sig. value 0.720 is much greater than 0.05, indicating that its correlation coefficient is not credible.

TABLE IV. VARIABLES ENTERED/REMOVED (A)

Model	Variables Entered	Variables Removed
1	the effective irrigation areas	.
2	the proportion of urban population	.
3	proportion of labors in primary industry	.
4	average machinery gross power	.
5	average amount of chemical fertilizer	.

a Dependent Variable: household operating income

As we can see from the regression analysis results, five variable indicators are kept among twelve indicators, which are X_4 average amount of chemical fertilizer, X_5 average machinery gross power, X_6 the effective irrigation areas, X_{11} the proportion of urban population and X_{12} the proportion of labors in primary industry.

TABLE V. MODEL SUMMARIES

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.943(a)	.890	.883	257.87013
2	.980(b)	.960	.955	159.76128
3	.986(c)	.972	.966	138.93508
4	.990(d)	.980	.974	120.37705
5	.995(e)	.989	.985	92.15928

X_6 the effective irrigation areas enters the model first and its determination coefficient is 0.967 which indicates that X_6 the effective irrigation areas can explain the changes of 89% and it is the most important influencing factor. The second variable is X_{11} the proportion of urban population and its determination coefficient is 0.960 which increases by 0.70. The third variable is X_{12} the proportion of labors in primary industry and its determination coefficient is 0.972 which increases by 0.12. The fourth variable is X_5 average machinery gross power and its determination coefficient is 0.980 which increases by 0.08, the fifth variable is X_4 average amount of chemical fertilizer and its determination coefficient is 0.989 which increases by 0.09. The sequence of the variables entering the model represents their significance in this model. The more forward the order is, the more important its significance is.

TABLE VI. ANOVA (F)

	Sum of Squares	df	Mean Square	F	Sig.
Regression	9556310.701	5	1911262.140	225.031	.000
Residual	101920.001	13	8493.333		
Total	9658230.703	18			

TABLE VII COEFFICIENTS (A)

	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-831.133	2313.447		-.359	.726
the effective irrigation areas	.985	.164	1.050	6.015	.000
the proportion of urban population	177.005	27.005	.288	6.555	.000
the proportion of labors in primary industry	-91.210	16.854	-.677	-5.412	.000
average machinery gross power	-2004.043	487.180	-1.103	-4.114	.001
average amount of chemical fertilizer	16.528	5.180	.207	3.191	.008

a Dependent Variable: household operating income

Through regression analysis, we can see that R^2 is 0.989 as the final model and R^2 is 0.985 after adjustment, also is much more than 0.8, indicating that the fitting effect of model is great. F = 225.031 and sig. = 0.000 <0.05, which indicates that the model has passed F test and rejects the null hypothesis. There exists significant linear relationship between independent variables in the model and per capita household operating income (see Tab.VIII). The main factors of influencing per capita household operating income in Heilongjiang are X_6 the effective irrigation areas, X_{11} the proportion of urban population, X_{12} the proportion of labors in primary industry, X_5 average machinery gross power and X_4 average amount of chemical fertilizer. They pass t test at 5% significance level and their sig. value is 0.000, 0.000, 0.000, 0.001 and 0.008 respectively which is less than 5%. Their coefficients are 0.985, 177.005, -91.210, -2004.043 and 16.528 respectively. Finally, we get the decision equation of per capita farmers' household operating income in Heilongjiang:

$$Y = -831.133 + 0.985X_6 + 177.005X_{11} - 91.210X_{12} - 2004.043X_5 + 16.528X_4 + \varepsilon \quad (2)$$

Through path analysis, we can see that direct path coefficient of X_6 the effective irrigation areas is 1.050 (see Tab. IX). The indirect path coefficient is 0.189, 0.607, -1.103, and 0.207 conducted by X_{11} the proportion of urban population, X_{12} the proportion of labors in primary industry, X_5 average machinery gross power and X_4 average amount of chemical fertilizer.

The direct path coefficient of X_{11} the proportion of urban population is 0.288 (see Tab. IX). The indirect path coefficient is 0.689, 0.379, -0.683 and 0.146 conducted by X_6 the effective irrigation areas, X_{12} the proportion of labors in primary industry, X_5 average machinery gross power and X_4 average amount of chemical fertilizer.

The direct path coefficient of X_{12} the proportion of labors in primary industry is -0.667 (see Tab. IX). The indirect path coefficient is -0.941, -0.161, 1.502 and -0.156 conducted by X_6 the effective irrigation areas, X_{11} the proportion of urban population, X_5 average machinery gross power and X_4 average amount of chemical fertilizer.

The direct path coefficient of X_5 average machinery gross power is -1.103 (see Tab. IX). The indirect path coefficient is 1.026, 0.178, 0.646 and 0.175 conducted by X_6 the effective irrigation areas, X_{12} the proportion of labors in primary industry, X_{11} the proportion of urban population and X_4 average amount of chemical fertilizer.

The direct path coefficient of X_4 average amount of chemical fertilizer is 0.207 (see Tab. IX). The indirect path coefficient is 0.887, 0.202, 0.510 and -0.932 conducted by X_6 the effective irrigation areas, X_{11} the proportion of urban population, X_{12} the proportion of labors in primary industry and X_5 average machinery gross power.

TABLE VIII. CORRELATIONS

	the effective irrigation areas	the proportion of urban population	the proportion of labors in primary industry	average machinery gross power	average amount of chemical fertilizer
th effective irrigation areas	1	.656 (**)	-.896 (**)	.977 (**)	.845 (**)
Sig.	.	.003	.000	.000	.000
N	18	18	18	18	18
the proportion of urban population	.656 (**)	1	-.560(*)	.619 (**)	.703 (**)
Sig.	.003	.	.016	.006	.001
N	18	18	18	18	18
the proportion of labors in primary industry	-.896 (**)	-.560 (*)	1	-.954 (**)	-.753 (**)
Sig.	.000	.016	.	.000	.000
N	18	18	18	18	18
average machinery gross power	.977 (**)	.619 (**)	-.954 (**)	1	.845 (**)
Sig.	.000	.006	.000	.	.000
N	18	18	18	18	18
average amount of chemical fertilizer	.845 (**)	.703 (**)	-.753 (**)	.845 (**)	1
Sig.	.000	.001	.000	.000	.
N	18	18	18	18	18

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

TABLE IX PATH COEFFICIENT OF EACH INDICATOR

indicator	direct path coefficient	indirect path coefficient				
		the effective irrigation areas	the proportion of urban population	the proportion of labors in primary industry	average machinery gross power	average amount of chemical fertilizer
the effective irrigation areas	1.050	0	0.689	-0.941	1.026	0.887
the proportion of urban population	0.288	0.189	0	-0.161	0.178	0.202
the proportion of labors in primary industry	-0.677	0.607	0.379	0	0.646	0.510
average machinery gross power	-1.103	-1.078	-0.683	1.052	0	-0.932
average amount of chemical fertilizer	0.207	0.175	0.146	-0.156	0.175	0

IV. CONCLUSIONS

Through model analysis, we can see that the main factors of influencing per capita household operating income are X_6 the effective irrigation areas, X_{11} the proportion of urban population, X_{12} the proportion of labors in primary industry, X_5 average machinery gross power and X_4 average amount of chemical fertilizer.

(1) The effective irrigation area is an infrastructure factor. As a basic factor, it is the most significant factor in influencing household operating income in Heilongjiang[9].

(2) The proportion of urban population is an urbanization factor. It is a main indicator to describe the urbanization rate. The increase of urban population represents the strengthening of urbanization which plays a relatively remarkable role in influencing household operating income. Also, the proportion of urban population plays an indirect role in it.

(3) The proportion of rural labors in primary industry is a labor transfer factor. It is the main factor to measure the transferring of rural labors and its changing direction is opposite to household operating income. Through the linear regression model, when the proportion of rural labors in primary industry increases a unit (one percentage point), per capita household operating income will decrease 91.210 yuan. The direct correlation coefficient between them is 0.677 and the indirect correlation coefficient is 0.206 between them. This indicates that the proportion of rural labors in primary industry has a direct impact on household operating income[10].

(4) The average machinery gross power is a mechanization factor. It is the main factor of mechanization. Using the linear regression model, it is opposite to household operating income. When average machinery gross power increases a unit (per capita increasing one kilowatt power), per capita household operating income will decrease 2004.043 yuan.

(5) The amount of chemical fertilizer is a technological factor. It is one of the main factors in scientific and technological factors which have an obvious positive impact on farmers' household operating income.

ACKNOWLEDGMENT

The paper is funded by the following items. PhD Research Project Started of Harbin University of Commerce (14rw10). This paper is the phase progress of Philosophy and Social Science Project of Heilongjiang Province "Policy Combination and Supporting Measures of Rural Land Transfer（item number 14B115）". This paper is supported by Science Research Foundation of Northeast Agricultural University (item number 2012RCB77).

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