

Empirical Research of Agricultural Mechanization on the Effect of Increasing Farmers' Income

WANG Zhizhang^{[a],*}; SUN Hanlin^[b]

^[a]School of Economic & Management, Southwest University, Chongqing, China.

^[b]School of Economic & Southwest University, Chongqing, China.

*Corresponding author.

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Abstract

Agricultural investments can not only improve the operating efficiency of agricultural production and increase the farmers' family operational income, but also save the labor force of agricultural production, and let farmers be in non-agricultural production and management, and enhance rural residents' income from wage and salary. This paper analyzed the impact of farmers' income from the perspective of agricultural mechanization. The paper selected the data from 1981 to 2011 to establish the model of empirical analysis, to test through the unit root, cointegration and Granger causality and to conduct the VAR analysis. It considered that mechanization had a significant effect on increasing farmers' income. The increase of farmers' income can effectively promote agricultural mechanization. At last, it put forward the corresponding policy suggestion on the basis of empirical results.

Key words: Agricultural mechanization; Farmers' income; Cointegration; Granger causality; VAR

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INTRODUCTION

Farmers' income as one of the core problems of the issue of "agriculture, farmer and rural area" draws the social widespread attention. Since 2003, The No.1 Central Document of the Central Government has been concentrated on the problem of "agriculture, farmer and rural area" for consecutive 10 years. The report at 18th Party National Congress proposed the "income doubling plan". At present, our country has entered a stage of industry re-feeding agriculture. Promoting agricultural mechanization is a significant measure of realizing agricultural modernization and increasing farmers' income. It also can enormously improve overall agricultural productivity and transportation capability of agricultural products. In the role of market mechanism, agricultural mechanization has become an important channel of increasing farmers' income and improving farmers' living standard. It also plays an important role on promoting rural economic development and increasing farmers' income. But from the perspective of research results, the research on agricultural modernization in domestic still stays on the policy levels of agricultural machinery's subsidy. Therefore, deeply exploring the interrelation between agricultural modernization and farmers' income and put forward feasible policy schemes have an important significance on solving the issue of "agriculture, farmer and rural area" and ensuring farmers increase both on production and income. This paper conducted empirical analysis on the impact of farmers' income from the perspective of agricultural mechanization through the method of combining theory and demonstration and using systematic econometrics analysis. It selected the data from 1981 to 2011 to establish the model of empirical analysis, to test through the unit root, cointegration and Granger causality and to conduct the VAR analysis. It considered that mechanization had a significant effect on increasing farmers' income. The increase of farmers' income can effectively promote agricultural mechanization. At last, it

put forward the corresponding policy suggestion on the basis of empirical results.

1. THE INTRINSIC RELATIONS BETWEEN AGRICULTURAL MECHANIZATION AND THE INCREASE OF FARMERS' INCOME

Agricultural mechanization has already become the most important symbol of agricultural modernization. All kinds of agricultural machinery have played an important role on the life of farmers. In 1998, our country successively implemented a series of agricultural machinery's subsidy policies. Subsidy limit has been increasing by years. The number of agricultural machinery has been rising up in a straight line. And the levels of nationwide agricultural machinery equipments have been improved obviously. According to the statistical data of the National Bureau of Statistics, in 2011, the holding quantity of the nationwide agricultural machinery is up to 977.347 million kilowatt, and among them, farm-oriented large and medium-sized tractors are 4406471, and its matching farm tools are 6,989,501. Small tractors are 18,112,663 units, and its matching farm tools are 30,620,134. Farm-oriented diesel engines of irrigation and drainage are 9,683,914.

The use of agricultural machinery liberates the rural productivity, improving the farming quality and changing the construction of soil's fertility and water-holding capacity. And it has effectively enhanced the output of every unit. Under the condition of the same price, it can effectively realize the increase of farmers' income. At the same time, agricultural mechanized farming can replace a large number of manpower and animal powers, and improve the agricultural production efficiency. According to the prediction of statistics, now the agricultural acreage of an agricultural rotary cultivator is 5-10 times of the former animal powers' agricultural acreage within an hour, while the efficiency of the agricultural harvester is higher. In addition, the efficient operating area of agricultural machinery can make farmers effectively save the input of cropland. And it realizes the increase of farmers' income from the perspective of throttling.

High efficiency of agricultural machinery's farming makes farmers have more leisure time to do other producing activities, which improves the farmers' income from wage and salary. In 1991, per capital net income of rural residents is 686.31 yuan, and among them, income from wage and salary is 138.80 yuan. It takes up 20.22%. While in 2011, per capital net income of rural residents is 6977.29 yuan and income from wage and salary takes up 42.47%. Its amplification is over 100%. The increase of the rural residents' income from wage and salary is inseparable from the development of agricultural machinery. Agricultural machinery's contribution to

the rural residents' income from wage and salary come from the following two aspects: First, agricultural mechanization can promote the agricultural industrialized operation and increase additional value of agricultural products. Second, agricultural mechanization can reduce the labor demands of engaging in agricultural production, which can make the farmers have more spare time and surplus rural labor force. Parts of these labor forces can choose an occupation on the spot under the background of agricultural industrialization. Parts of them swarm into cities and work in secondary and tertiary industries. They gain their own profits and at the same time, and agricultural industrialization also becomes an important driving force of urbanization development.

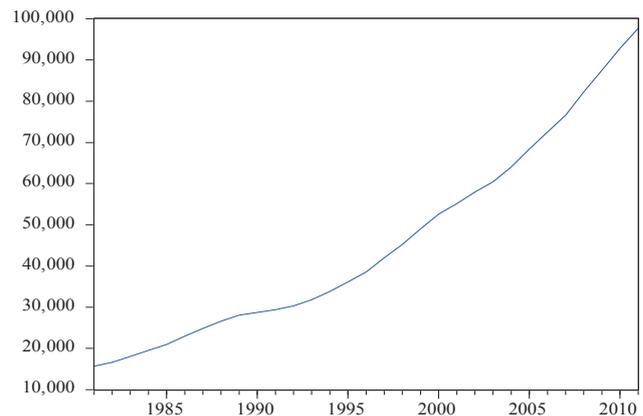


Figure 1
Total Power of Agricultural Machinery and Changing Tendency (Unit: 10000 kW)

The use of agricultural machinery tremendously reduces the demands of agricultural labor forces. The number of surplus rural labor forces who go into town for being engaged in industry or project has been increased. It has effectively increased the rural residents' income from wage and salary. The maintenance of agricultural machinery and labor demands in management largely broadens the boorish range of careers and source of income. It becomes a new growth point of increasing farmers' income.

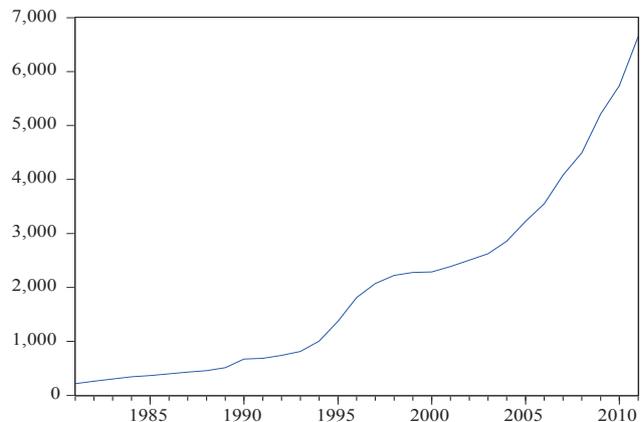


Figure 2
Farmers' Income and Growth Tendency (Unit: yuan)

2. EMPIRICAL RESEARCH OF AGRICULTURAL MECHANIZATION ON THE IMPACT OF FARMERS' INCOME

2.1 Selection of Data Index

Net income of rural households' index (I): Refers to the total income that rural households in that year gained gross income from all kinds of sources and correspondingly deducted the cost, including income from wage and salary, income from household business operation, income from property and income from transitivity. It reflects a rural households' average income level of a region.

Total power of agricultural machinery index(S): agricultural machinery refers to be used for planting industry, animal husbandry, fishery, preliminary working of agricultural products, farm-oriented transportation, farmland capital construction and other activities' machinery and equipments. Total power of agricultural machinery refers to the total sum of entire agricultural machinery's rated power.

2.2 Data Sources and Processing

The data in demonstration of this paper ranges from 1981 to 2010. All original data are from the website of National Bureau of Statistics, *China Statistical Yearbook*, *China Rural Statistical Yearbook*, and *Six Years' Compilation of Statistics in New China*. In order to avoid the heteroscedasticity of time series data, this paper conducts logarithm transformation to variable on the basis of getting rid of price factor. The final indexes are farmers' income index $\ln I$ and rural fixed-asset investment index $\ln S$.

2.3 Empirical Analysis Procedure

2.3.1 Simple Linear Regression Model

First, let's roughly analyze holding quantity of agricultural machinery's impacts on per capita net income of rural households. At this point, holding quantity of agricultural machinery is regarded as explanatory variable, and per capita net income of rural households is considered as explained variable. Apply analytical approach of econometrics to establish single factor regression model:

$$\ln I = \alpha + \beta \ln S$$

I as per capita net income of rural households, S as

holding quantity of agricultural machinery, expressed by total power of agricultural machinery, α , β are estimated parameters. EView6.0 quantitative analysis software's estimated results on models as follows:

$$\begin{aligned} \ln I &= -12.6356 + 1.8685 \ln S \\ &(-21.4801) \quad (33,7015) \\ R^2 &= 0.9751 \quad \bar{R}^2 = 0.9742 \quad F = 1135.79 \end{aligned}$$

According to the estimated results, it can know that the coefficient of determination of this model is $R^2=0.9751$, and the regulatory coefficient of determination is $\bar{R}^2=0.9742$. It shows that this model has a higher goodness of fit on the sample. It also shows that holding quantity of agricultural machinery has a favorable explanatory ability on per capita net income of rural households. $F=311.5518$, it shows that under the significance level of 5%, regression equation is obvious. In other words, holding quantity of agricultural machinery does have a significant impact on per capita net income of rural households. Regression coefficient accompanied probability is less than 0.05, which states this model passes t test with a 95% confidence coefficient. The economic significance of estimated results indicates that under the condition of presuming other variables, holding quantity of agricultural machinery increases by 10,000 kilowatt, per capita net income of rural households will increase 1.8685 yuan. It shows that enhance the degree of agricultural mechanization will effectively increasing farmers' income, which is in accordance with the theoretical analysis and empirical judgment.

2.3.2 Unit Root Test

Because of the inertia of economic system and span problems of time series, simple equation of linear regression is easily to appear "spurious regression". It means when analyzing on time series, due to the non-stationary of time series, T statistic of simple linear regression excessively refuses irrelevant virtual assumption. Therefore, in order to avoid the "phenomenon of spurious regression", and make the results of empirical analysis more dependable. First, we should check on the stationarity of time series. Here we adopt eviews 6.0 software and select ADF(Augmented Dickey-Fuller) method of inspection to conduct unit root test on the involved two variable's stationarity. Inspection results as the following Table 1:

Table 1
Inspection Results of ADF Unit Root

Variable	ADF test value	5% critical value	10% critical value	Conclusion
$\ln I$	-0.2536	-2.9678	-2.6230	Unsteady
$\ln S$	-0.6645	-2.9981	-2.6388	Unsteady
$\Delta \ln I$	-3.2530	-2.9678	-2.6230	Steady
$\Delta \ln S$	-4.4658	-2.9981	-2.6388	Steady

According to the inspection results, it knows that for the two time series of total power of agricultural machinery and farmers' income, under the significance level of 5% and 10%, there are unsteady. After conducting first difference test on variable serial, the results indicate another variable serial under the 5% and 10% critical value of first difference is steady serial. It can conduct cointegration test on both.

2.3.3 Cointegration Test

Cointegration refers to certain linear combination of multiple unsteady economic variables is steady. It means that (I, S) is $I(1)$ or it has d roots of unity, but if their

linear combination $y=I+aS$ has stationarity, then it calls that (I, S) has cointegration relation, a is cointegration coefficient. Cointegration test has two methods. One is the cointegration test based on regression residual error. And another one is based on complete information of regression coefficient's Johansen cointegration test. According to research on OLS model, we adopt cointegration test which is based on regression residual error. The specification is to use ADF test method to inspect the cointegration relation between agricultural mechanization and farmers' income. The testing results as the following Table 2:

Table 2
ADF Testing Results Based on Residual Error

Variable	ADF statistical magnitude	5% critical value	10% critical value	P value	Stationarity
Et	-2.4589	-1.9529	-1.6100	0.0158	Steady

According to the inspection results of the above table, it can know that ADF statistical magnitude is -2.4589, which is less than the critical value of 5% and 10%. It indicates that residual item of regression equation is steady sequence. In other words, there exists cointegration between total power of agricultural machinery (S) and farmers' income. They have a long-run equilibrium relation.

2.3.4 Test on Granger Causality

In order to describe the quantitative relation between variables, we will continue to conduct Granger causality test. The Granger cause is not equal to the cause-and-effect relationship on economic significance. The variable y is the Granger cause of variable x , which can just indicate the changing of x occurs before the changing of

y . It means x or its hysteresis is good for the explanation of the changing of y . We use Granger causality test to verify the relation of these two variables, and significance level takes 10%, and lag phase selects 1-2 phase. The inspection results shows on Table 3. Combining F test and P value test of econometric analysis, during the period of 1-2 lag phase, $\ln I$ is the Granger cause of $\ln S$, while $\ln S$ is not the Granger cause of $\ln I$. It means that total power of agricultural machinery doesn't have a remarkable influence on farmers' income in the period of hysteresis, but farmers' income has a significant impact on total power of agricultural machinery. It can explain farmers' income is the important driving force of total power of agricultural machinery.

Table 3
Inspection Results of Granger Causality

Null hypothesis H_0	Lag phase	observed value	F statistical magnitude	P value	Null hypothesis (10%)
$\ln S$ is not the reason of $\ln S$	1	30	0.1238	0.7276	Accept
$\ln I$ is not the reason of $\ln S$	1	30	7.1347	0.0127	Refuse
$\ln S$ is not the reason of $\ln I$	2	29	1.4170	0.2620	Accept
$\ln I$ is not like $\ln S$	2	29	2.5473	0.0993	Refuse

2.3.5 VAR analysis

In order to further analyze dynamic relevance of farmers' income changes and total power of agricultural machinery,

we further conduct VAR analysis. According to Akaike AIC and Schwart SC, selected optimum hysteresis is 2, and estimated results are as the following Table 4:

Table 4
VAR Analysis Results of Farmers' Income Changes (I) and Total Power of Agricultural Machinery's Changes(S)

Variable	$\ln I$ as dependent variable		$\ln S$ as dependent variable	
LNI(-1)	Regression coefficient	1.436445	Regression coefficient	0.037512
	Standard error	(0.17132)	Standard error	(0.03058)
	T Test value	[8.38481]	T Test value	[1.22675]
LNI(-2)	Regression coefficient	-0.584588	Regression coefficient	-0.006907
	Standard error	(0.18795)	Standard error	(0.03355)
	T Test value	[-3.11038]	T test value	[-0.20588]

To be continued

Continued

Variable	InI as dependent variable		InS as dependent variable	
LNS(-1)	Regression coefficient	0.520033	Regression coefficient	1.542009
	Standard error	(0.85558)	Standard error	(0.15271)
	T Test value	[0.60781]	T Test value	[10.0973]
LNS(-2)	Regression coefficient	-0.238442	Regression coefficient	-0.603311
	Standard error	(0.79064)	Standard error	(0.14112)
	T test value	[-0.30158]	T test value	[-4.27507]
C	Regression coefficient	-1.891790	Regression coefficient	0.453626
	Standard error	(1.19518)	Standard error	(0.21333)
	T test value	[-1.58285]		[2.12640]

In the research results, the first hysteresis of total power of agricultural machinery changes (S) has an obvious positive impact on farmers' income. This is remarkable effect of agricultural mechanization on the increase of farmers' income. Regression coefficient 0.52 indicates the first hysteresis of total power of agricultural machinery changes a unit, and the corresponding farmers' income will change 0.52 units at the same direction, while the second hysteresis of total power of agricultural machinery changes (S) has an obvious negative impact on farmers' income. It reduces the farmers' income. This can explain the maintenance of agricultural machinery and other cost cancels out with the effect of increase. Under the guidance of policies for vigorously promoting agricultural modernization, the investment of agriculture is ever-increasing. The degree of agricultural mechanization remarkably enhances. Because of economic input factors diminishing marginal return, it let the second hysteresis of total power of agricultural machinery changes (S) has an obvious negative impact on farmers' income. T test value is not too big, so this negative effect is not remarkable. Compare to the two phases' regression coefficient, the positive impact on farmers' income is huger than the negative impact. As a whole, it has increased the farmers' income. The former radix also affects the current farmers' income. The first hysteresis is positive effect, and the second hysteresis is negative effect. The reason lies in the customs of farmers' consumption. The increase of income will make farmers take positive consumptive attitude. This is one of the important origins of force to expand domestic demands.

3. CONCLUSION AND POLICY SUGGESTION

3.1 Conclusion

This paper analyzed on the relation between farmers' income and total power of agricultural machinery by applying steady unit root test, cointegration theory, Granger causality test of correlation sequences in econometrics. Through the VAR analysis, it obtains the following conclusion:

A. There exists cointegration relationship between farmers' income and total power of agricultural machinery. From 1981-2011, there exists a long-term balanced relationship between farmers' income and total power of agricultural machinery. Therefore from the perspective of a long-term development, total power of agricultural machinery is one of the impact factors of farmers' income. The increase of total power of agricultural machinery will effectively increase the farmers' income.

B. The farmers' income is the Granger cause of total power of agricultural machinery, but total power of agricultural machinery is not the Granger cause of farmers' income. Agricultural mechanization is one of the important symbols of agricultural modernization. Farmers are the most important running bodies of investment and operation. There exists a spiral escalation's tendency between the farmers' income and total power of agricultural machinery.

C. The current farmers' income is not only affected by the current total power of agricultural machinery, but also affected by the former balanced error term. During the first hysteresis, regression coefficient of the farmers' income on total power of agricultural machinery is 0.52. It indicates the impacts of agricultural machinery on the increase of farmers' income have chronicity and conspicuousness. In addition, the cost of agricultural machinery's maintenance and repair and other costs aggravate the burdens of farmers to a certain extend and reduce the farmers' income. But its effect is quite weak. As a whole, agricultural mechanization has a remarkable effect on the increase of farmers' income.

3.2 Policy Suggestion

At present, the issue of "agriculture, farmer and rural area" is still one of important problems of economic society in our country. The 12th Five-Year Plan comes up with "Store Rich in Farmers". 18th Party National Congress proposes the "income doubling plan". The No.1 Central Document of the Central Government, points out it needs to enhance equipment level of modern agriculture, promote the transformation in agricultural development mode and accelerate the development of agricultural mechanization.

Under a series of policies involving “agriculture, farmer and rural area” for the continuous ten years, the increase of farmers’ income becomes one of the main targets of social development. The agricultural fundamental way lies in mechanization, from the perspective of per capita net income of rural households, the use of agricultural machinery and technological fertilizer has a obvious effect on enhancing agricultural labor productivity and increasing farmers’ income. According to the above empirical results, combine with the opinions of agricultural economics and agricultural policy, it can come up with the following policy suggestion:

A. Carry out the effective agricultural machinery’s subsidy policy and enhance agricultural machinery’s subsidy range. Since 2004, our country has implemented agricultural machinery’s subsidy policy. The holding quantity of agricultural machinery has increased largely. And it has effectively promoted the agricultural modernization and the increase of farmers’ income. But agricultural machinery’s purchasing subsidy range is quite narrow and it just concentrates on the large and medium-sized agricultural machinery. However, the cost of large-scale agricultural implements is very high, individual farmers have difficulties in undertaking the purchase cost of agricultural implements. So the large and medium-sized agricultural implements are limited to use in Barton or flat area. The degree of our countries’ agricultural cultivation and mechanization has a wide difference in territory. A lot of large-scale machinery lack scope for their abilities in many places, so the agricultural machinery’s subsidy policy should sufficient take geography, humanity and other composite factors into account. It should sufficient consider the appeal of the local farmers, formulate different subsidy policy and object aiming at regional difference, use the scientific and systematic methods to enact suitable introducing ways for the local agricultural development, optimize the use of agricultural machinery, broaden the agricultural implements’ subsidy range, increase some small size agricultural implements that farmers have a strong demand and let the agricultural machinery’s subsidy policy can really benefit for farmers and avoid follow the trend in blindness.

B. Raise funds through a multi-channel and establish a multi-variety investment system of agricultural machinery. The purchase cost of agricultural mechanization’s equipments and appliances is quite high, especially for large-sized agricultural implements. Only depending on the farmers’ own capital will be hard to meet the demands of agricultural modernization on agricultural implements. Under the background of industry re-feeding agriculture and China’s series of benefit farming policy, we should positively adopt diversified agricultural machinery’s investment program. That is to say, the method of “national finance gives a few subsidies, and social institutions give a little support, and farmers self-raise a little”, and at the same time, the country should broaden the capital

source of agricultural machinery’s investment. On the large-scale agricultural implements, finance and large-scale agricultural management should give a positive play. Therefore, under the condition of nation and local finance permitting, financial investment should be partial to agricultural machinery’s subsidy and the country should support the farmers to purchase agricultural implements and encourage the farmers to use the agricultural implements and participate in guiding the development of local agricultural machinery. The country should also increase the dynamics of subsidy especially in remote area and gradually incline to small size agricultural implements.

C. Exploring the deepened agricultural machinery’s subsidy policy and ensuring the virtuous circle of agricultural machinery’s system. The deepened agricultural machinery’s subsidy policy refers to subsidy links including agricultural machinery’s research and development, production, marketing, use etc. the entire agricultural machinery’s industry chain. Except for the purchase of subsidy for the complete machine, it should extend agricultural machinery’s important parts, related skills training and agricultural machinery’s policy insurance. The deepened agricultural machinery’s subsidy policy can relieve the farmers’ burdens on agricultural machinery’s related cost, enhance the enthusiasm of purchasing and use of agricultural machinery, and realize agricultural mechanization and effectively increase the farmers’ income.

D. Optimizing and adjusting agricultural input structure. Agricultural scientific research innovation plays an important role on promoting agricultural mechanization’s development and popularization, on reducing the agricultural machinery’s maintenance cost, and optimizing the use of agricultural machinery. At present, China attaches importance to agricultural subsidy in the agricultural input aspect, but ignores agricultural scientific research and agricultural machinery’s input. It is hard to promote the development of agricultural science and technology and agricultural machinery. The government should sufficiently realize that agricultural scientific research has an important role on optimizing the use of agricultural machinery, reducing the maintenance cost and increasing the farmers’ income. The country should also encourage the work of agricultural scientific research through government investment, capital subsidy and other benefit policy. At the same time, it should transfer all around capital of enterprises and individuals and fully explore manpower resource to carry out the construction of agricultural scientific research.

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