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Abstract. Based on the assessment of Agricultural Informationalization level, this paper proposed a model for the Agricultural Informationalization benefit analysis whit the Cobb-Douglas production function, to reveal the connection between agri-information index and the agricultural output, and also we made an empirical analysis of Shandong province. It is proved that the Agricultural Informationalization and the farming population both have a direct and positive impact on the development of rural economy in Shandong Province, especially, the development of the Agricultural Informationalization level has a significant influence on the increase of the rural economy in Shandong province , while the impact brought by agricultural fixed asset investment remains limited. By 1% increase of Agricultural Informationalization level, the rural economy increases by 0.565%, which indicates that Agricultural Informationalization is quite beneficial for the development of Shandong's agricultural economy.

Keywords: Agricultural Informationalization, benefit analysis, Cobb–Douglas production function.

Informationalization has become an increasingly major drive force of economic development and a significant indicator amidst the assessment of the comprehensive national power and the international competitiveness for a nation or region. Agricultural Informationalization is not merely the fundament and a significant component of national economic Informationalization, but the important means of

balancing the urban and rural development and stimulating the agricultural economy. [1] Agricultural Informationalization is going to be the significant symbol of agriculture in the 21st century, and it is an inexorable trend in the contemporary modern agricultural development. [2]

With lately increasing attentions from the local governments, the Informationalization level in agriculture-oriented rural areas has been continuously improved, and the contribution of the developing Agricultural Informationalization has made to the agricultural productivity has been remarkably valued in these places. A number of domestic researchers [3-11] have studied the economic expansion in informationalising regions and its connection to the gross output from economics perspectives, while most of them focused on the analysis of how the general informationalising process has motivated the economic development, rather than any empirical research on the function mechanism and inner relationship.with benefit analysis. This research attempted to examine problems that exist within agri-informationalising, to target any links or stages where no benefit has been made, and also to provide the Agricultural Informationalization investment which has not currently made profits with confidence and scientific suggestions in their decision-making. Moreover, it helps local governments find out their advantages and disadvantages in rural Agricultural Informationalization, to provide the appropriate strategic positioning of Agricultural Informationalization.

This paper established a model to reveal the relationships of Agricultural Informationalization index and agricultural output with Cobb-Douglas production function, and empirically analyzed the Agricultural Informationalization of Shandong Province. It attempted to provide the nation and local governments a significant reference in terms of targeted Agricultural Informationalization investment and Agricultural Informationalization policy making, so that the benefits of Informationalization amidst the construction of socialist new countryside can be better deployed. Hence this research will be remarkably influential for its social and economic meanings.

1 Model Building for Agricultural Informationalization Benefits analysis

1.1 Measurement model

Cobb-Douglas production function for the assessment of Agricultural Informationalization benefits has been widely adopted by both domestic and foreign scholars in empirical researches. Based on the literature review and practical development of Agricultural Informationalization, this paper attempted to assess the Agricultural Informationalization benefits with Cobb-Douglas production function.

For calculation and analyzing the benefit of Agricultural Informationalization, this research modified the Cobb-Douglas production function based on the new growth theory inaugurated by Paul M. Romer. Romer articulated that, the development of science and technology should also be included in the Cobb-Douglas production function, besides capital and labour [12]. Therefore, this research believes that information, the maximum return of technological developmen t, can be regarded to replace technological advance and become the third factor to affect Cobb-Douglas production function in terms of input. Cobb-Douglas production function can be modified as follow [13]:

$$Y=AK^{\alpha}L^{\beta}I^{\gamma} \tag{1}$$

The log-linear model of formula (1) is:

$$log(Y)=log(A)+\alpha log(K)+\beta log(L)+\gamma log(I) \tag{2}$$

where Y, K, L, I, respectively represent the total value of agricultural output, capital output, labor output, and the Agricultural Informationalization index, andα、β、γ respectively indicate the changes of capital output, labor and Informationalization; A is a constant that implies other factors that may affect the agricultural benefits.

1.2 model testing

With SPSS17.0 and the Enter method, *Y', K', L', I'* were all included for the linear regression analysis. The regression result was shown in *Table 1*, based on which the regression model can be built. By categorizing the regression model, a total of three variables, including agricultural fixed asset investment, the farming population and the general agri-informational index, are revealed, as well as the other five

variables of sub-indexes and the total value of agricultural output.

Table 1. The result of regression model (general Agricultural Informationalization index)

Items	Constants	*K'*	*L'*	*I'*
Standardised coefficients		*a*	*j*	*g*
B	*b*	*h*	*w*	*m*
(T-statistic)	*t*	*c*	*f*	*i*
R-squared		*r2*		
F- statistic		*f*		
Durbin-Watson statistic		*d*		

The above regression model reveals both the selected samples' and the overall goodness of fit, and allows F-test to verify the linearity degree of the model and T-test to verify all variables with their explanatory capabilities to economic improvement. If the goodness of fit, the linearity degree and resolution are all high, and variables *K*, *L*, *I* and constants get through the test, it can be generally concluded that the model has been successfully verified, and it has a good fineness to the reality. The model is presented as follow by *Formula 3*:

$$Y'=b+hK'+wL'+mI' \quad (3)$$

Formula 3 can be transformed into:

$$Y_t=e^b K_t^h L_t^w I_t^m \quad (4)$$

Similarly, five more regression model can be established for the other five indexes, including Agricultural Informationalization infrastructure (F), the Informationalization of agricultural production (P), the Informationalization of agricultural operation(C), the Informationalization of agricultural management (M), the Informationalization of agricultural services(S),which would not repeat here.

2 The Agricultural Informationalization Benefit Analysis of Shandong Province

2.1 The assessment of Agricultural Informationalization in Shandong Province

A total of 5 major indexes, including Agricultural Informationalization index, agricultural infrastructure informationalization index, agricultural production informationalization index, agricultural operation informationalization index,

agricultural management informationalization index, and agricultural services informationalization index, should be included to establish of Agricultural Informationalization assessment system, based on which a comprehensive index model for the assessment of Agricultural Informationalization can be built for the study of assessment in Shandong Province from the year 2003 to 2011. The detailed process has been fully developed in my doctoral dissertation; therefore only the result was displayed in this paper, while no explanation will be given to the model building and calculating processes here.

Table 2. The Agricultural Informationalization index of Shandong Province (2003-2011)

	2003	2004	2005	2006	2007	2008	2009	2010	2011
Agricultural Informationalization infrastructure (*I*)	0.047	0.067	0.090	0.110	0.128	0.155	0.178	0.201	0.231
the Informationalization of agricultural production (*F*)	0.083	0.109	0.142	0.193	0.239	0.295	0.358	0.421	0.495
the Informationalization of agricultural production (*P*)	0.003	0.006	0.010	0.015	0.013	0.024	0.029	0.035	0.040
the Informationalization of agricultural operation (*C*)	0.010	0.017	0.024	0.033	0.039	0.045	0.050	0.057	0.064
the Informationalization of agricultural management (*M*)	0.020	0.044	0.067	0.083	0.102	0.133	0.158	0.191	0.254
the Informationalization of agricultural services (*S*)	0.140	0.187	0.242	0.269	0.302	0.345	0.377	0.400	0.415

2.2. Regression Model

The Agricultural Informationalization index in the model (*I*) and the five major indexes to show the Agricultural Informationalization situation in Shandong Province were all well displayed in *Table 2*. By referring to *Shandong Province Statistic Yearbook [Shandong sheng tongji nianjian]* and *China's Rural Statistic Yearbook [Zhongguo nongcun tongji nianjian]*, the statistic data of agricultural gross output value in the period from 2003 to 2011 (*Y*), agricultural fixed asset investment (*K*),

farming population (*L*) could be seen. The gross output value of agriculture, fixed asset investment and farming population in the year of 2012 have not been published yet. The detailed data were displayed in *Table 3*.

Table 3. Data of economic growth in Shandong Province

	Gross output values of agriculture (*Y*/100 million *yuan*)	Agricultural fixed asset investments (*K*/100 million *yuan*)	Farming populations (*L*/10 thousan people)
2003	2902.5	296.0	2638.3
2004	3453.9	116.4	2542.1
2005	3741.8	1491.6	2350.3
2006	4058.6	1186.2	2328.0
2007	4766.2	1141.3	2265.2
2008	5613.0	1304.0	2313.5
2009	6003.1	1586.7	2297.4
2010	6650.9	1823.0	2273.1
2011	7409.8	2470.4	2211.6

As time goes by, comparability of data in different years weakens. For a considerable comparability of the data, the price index has to be invited to eliminate the impacts brought by price fluctuation. In 2003, for the base period, the influence of price fluctuation on gross output values of agriculture and agricultural fixed asset investments had been excluded, so the data in model remained consistency. The organized data were shown in *Table 4*.

Table 4. Gross output values of agriculture and agricultural fixed asset investments excluding the price impacts

	Gross output values of agriculture (*Y*/100 million *yuan*)	General indexof rural residents consumption price (the base: 100)	Gross values excluding price impact (*Y'*/100 million *yuan*)	Agricultural fixed asset investments (*K*/100 million *yuan*)	Price index of fixed asset investments (the base: 100)	Fixed asset investments excluding prince impact (*K'*/ 100 million *yuan*)	Farming population (*L*/10 thousand people)
2003	2902.5	——	2902.5	296.0	——	296.0	2638.3
2004	3453.9	104.6	3302.0	116.4	107.4	108.4	2542.1
2005	3741.8	102.4	3493.4	1491.6	102.9	1349.7	2350.3
2006	4058.6	101.0	3751.7	1186.2	101.8	1054.4	2328.0
2007	4766.2	105.3	4184.0	1141.3	104.0	975.4	2265.2
2008	5613.0	106.2	4639.7	1304.0	107.7	1034.8	2313.5
2009	6003.1	100.1	4957.2	1586.7	96.9	1299.4	2297.4
2010	6650.9	103.5	5306.4	1823.0	103.6	1441.1	2273.1
2011	7409.8	105.9	5582.5	2470.4	106.8	1828.5	2211.6

The data needed in the model of *Formula 3*, after taking the logarithms of gross agricultural output values (*Y*), agricultural fixed asset investments (*K*), farming populations (*L*) and national Agricultural Informationalization index, were organized as below in *Table 5*.

Taking logarithms on Gross output values of agriculture*(Y)*, agricultural fixed

asset investments *(K)* , farming populations *(L)* and national Agricultural Informationalization index ,the log transformation of the data could be rewritten in table 5.

Table 5. Data of agri-economic development model for Shandong Province

	Ln(Y')	*Ln(K')*	*Ln(L')*	*Ln(I)*	*Ln(F)*	*Ln(P)*	*Ln(C)*	*Ln(M)*	*Ln(S)*
2003	7.9733	5.6904	7.8779	-3.0576	-2.4889	-5.8091	-4.6565	-3.8947	-1.9661
2004	8.1023	4.6856	7.8407	-2.7031	-2.2164	-5.1160	-4.1044	-3.1304	-1.6766
2005	8.1586	7.2076	7.7623	-2.4079	-1.9519	-4.6052	-3.7508	-2.6971	-1.4188
2006	8.2300	6.9607	7.7528	-2.2073	-1.6451	-4.1997	-3.4173	-2.4865	-1.3130
2007	8.3390	6.8829	7.7254	-2.0557	-1.4313	-4.3428	-3.2416	-2.2813	-1.1973
2008	8.4424	6.9420	7.7465	-1.8643	-1.2208	-3.7297	-3.0989	-2.0155	-1.0642
2009	8.5086	7.1697	7.7395	-1.7260	-1.0272	-3.5405	-2.9868	-1.8483	-0.9755
2010	8.5767	7.2731	7.7289	-1.6045	-0.8651	-3.3524	-2.8735	-1.6581	-0.9163
2011	8.6274	7.5113	7.7015	-1.4653	-0.7032	-3.2189	-2.7442	-1.3704	-0.8795

To assess the Agricultural Informationalization benefits from different angles, the Agricultural Informationalization index and the five major informationalization indexes were taken as variables, which means *Ln(I)*, *Ln(F)*, *Ln(P)*, *Ln(C)*, *Ln(M)* and *Ln(S)* were taken into the calculation of $I't$ for the analysis of regression model. Due to the similar calculating processes, this article exemplified the model of the general Agricultural Informationalization index, while the other five indexes' models could be adapted to the same procedure.

With SPSS17.0 and the Enter method, the linear regression results of *Ln(Y')*, *Ln (K')*, *Ln (L')* and *Ln (I)* from *Table 5* were displayed in *Table 6* as follows. By building a regression model for the regression results and organizing the regression model, the three variables, including agricultural fixed asset investments, farming populations

and the general Agricultural Informationalization index, along with the total output value of agriculture, finally were used for the equation simulating the economy in Shandong Province.

Table 6. Regression results of Agricultural Informationalization index

Items	Constants	*K'*	*L'*	*I'*
Standardised coefficients		-0.011	0.352	1.323
B	-1.229	-0.003	1.389	0.565
(T-statistic)	(-0.333)	(-0.147)	(2.931)	(13.826)
R-squared		0.994		
F- statistic		265.205		
Durbin-Watson statistic		2.595		

As shown in *Table 7*, the value of R^2 was 0.994, which indicated the relatively satisfying fit of selected samples was good; the value of *F*was 265.205, showing that the considerable linear degree of the whole model was fine; *D-W* was 2.595, indicating the data series was no first-order autocorrelation; numbers below *T* item showed that the variables in the model were accountable to explain their respective influence on economic growth. Based on all verified results, the following model was established.

$$Y' = -1.229 - 0.030K_t' + 1.389L_t' + 0.565I_t' \quad (5)$$

The model could also be transformed into:

$$Y_t = e^{-1.229} K_t^{-0.030} L_t^{1.389} I_t^{0.565} \quad (6)$$

Similarly, models for agricultural infrastructure informationalization index (*F*), agricultural production informationalization index (*P*), agricultural operation informationalization index (*C*), agricultural management informationalization index (*M*) and agricultural services informationalization index (*S*) could be respectively established.

2.3 Interpretation of results

From the regression model, we found that the standardized coefficients of the agricultural fixed asset investment, farming population and Agricultural Informationalization index were -0.011, 0.352 and 1.323 in the Agricultural

Informationalization index model. It indicated that the Agricultural Informationalization, especially the farming population had profounder influence on the rural economic growth in Shandong Province, just in contrast with the agricultural fixed asset investment .From the other 5 regression index models, the results show that the agricultural fixed asset investment had less effect than Informationalization and farming population, that indicates Agricultural Informationalization and farming population played more important role than agricultural fixed asset investment in promoting the rural economic growth in Shandong Province.

From another point of view, we found that the output elasticity of of *K'*, *L'* and *I'* were respectively -0.011, 0.352 and 1.323 in the Agricultural Informationalization index model. According to the concept of output elasticity, each 1% increase in Agricultural Informationalization leads to Shandong's agricultural economic growth by 0.565%, which means the agricultural economic growth in Shandong can enormously benefits from Agricultural Informationalization, while agricultural fixed asset investment improvement bought negative impacts on agricultural productive benefits growth in Shandong Province. Also, the results of other 5 indexes reveal the similar laws that Agricultural Informationalization and farming population had positively promote the rural economy development in Shandong Province.

In summary, these seven models above have revealed similar situation that Agricultural Informationalization has positively accelerated the agricultural economic growth significantly, which says that there is a preliminary success of Agricultural Informationalization development in Shandong Province. On the contrary, the increase of fixed asset investments has not been conducive to the agricultural economic growth, probably because of the lack of legitimate plan in advance of some fixed asset investments, or the absence of strict surveillance over the use of funds which causes a lower utilization of funds and leads to the inadequate capital input in agricultural economic development, so the pull effect of capital input on agriculture economic growth is not obvious.

3 Conclusion

With more inputs from the local governments, the general Agricultural Informationalization level in China is constantly improving, and more and more attention has been paid to the agricultural output benefits, which brought by informationalization development. However, the previous researches and practices have not clarified the relationship between Agricultural Informationalization and agricultural output, which only made the benefit of developing Agricultural Informationalization blurred for local governments. But, the benefit analysis of Agricultural Informationalization can effectively dissect the function mechanism and inner relationsship of how Agricultural Informationalization contributes to agricultural economic growth. Based on that, this paper established the Agricultural Informationalization benefits analytical model to interpret the contribution of Agricultural Informationalization to agricultural economy in Shandong Province. The results show that the problem how Agricultural Informationalization accelerates the agricultural economy can be well solved by this approach, and so this paper laid the

foundation for the future construction of Agricultural Informationalization.

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References

1. Wang Jianguo. Study on the significance and development of agricultural informatization [J], Anhui Agricultural Science Bulletin, 2006, 12(8):181.
2. Huang Tingting, Li Dehua. The Measure and Influence Factors Analysis of Agricultural Informationization Level in China [J]. Information Science. 2008, 26(4) : 565-571.
3. Charles J.2007.Inform action resources and economic productivity[J] . Information Economics and Policy, (1):67-70.
4.Dewan and Kraemer.2008.Information Technology and Productivity: Evidence from Country - evel Data[J]. Management Science (4):53-56.
5. Gurmukh Gill et a1.2006.Dumagan and Isaac Turk [J]. Economy-wide and Industry-Level Impact of Information Technology, (4):51-55.
6.Weill P. 2004.The relationship between investment in information technology and firm performance: a study of the valve manufacturing sector[J]. Information Systems Research, (4):92-94.
7. Yosri A.2007. The relationship between information technology expenditures and revenue contributing factors in large corporations [J]. Doctoral Dissertation, Walden University, (3):38.
8.Zha Zhigang. Empirical study on relationship between informatization and regional economic development [J]. Commercial Times, 2010(12):125-126.
9. Xu Jin. Analysis of Impacts of Regional Informatization on Economic Growth [J].Statistical Research [J], 2010, 27(5):74-80.
10. Wang Shaolin, Liu Weiping. Influence of informatization on economic growth – A case in Guangdong province [J]. Zhishi Jingji, 2010(5):83-84.
11. Ma Mingyuan, Qin Xiangyang. Research on Beijing Rural Informatization Performance Evaluation System [J]. Chinese Agricultllml Sciellce Bulletin, 2011, 27 (30):285-289.
12. Romer,P.M.. The origins of endogenous growth. Journal of Economic Perspectives [J].1994, 8:3-22.
13.Wang Li. Empirical Analysis of Information Contribute to Shandong Rural Economic Growth [D]. Northwest Agriculture and Forestry University, 2010.