Econometric Study of Relationship between Change of Farmland Quantity and Policy of Farmland Protection in China

PENG Ling*, LIAO Tie-jun

College of Resources and Environment, Southwest University, Chongqing 400715, China

Abstract According to the data from Investigation *Report of Land Use Change in China*, *The Land Resources Communique of China* and *Chronicle of Statistical Data for Five Decades of New China* issued from Ministry of Land Resources, we select two indices: change of farmland quantity and policy of farmland protection. According to econometric theory, by using Eviewes 5.1 software, co-integration analysis, Granger causality test, impulse response and other analysis methods, we analyze the relationship between change of farmland quantity and policy of farmland protection in China since the reform and opening-up. The results show that there is long-term balanced relationship between change of farmland quantity and policy of farmland protection, and there is a certain mechanism restricting motion of variables between the two so as to make the two deviate from each other little and step towards balance in the long run; there is unilateral causality relationship between farmland change and policy of farmland protection, namely that the farmland change is the Granger cause of policy of farmland protection, while policy of farmland protection is not the Granger cause of farmland change; impulse response and variance decomposition indicate that farmland change plays the role of promoting policy of farmland protection continuously, and the role is strengthened along with prolonged lag period; the policy of farmland protection has strong inertia, because it is impacted by the former level of itself, and the policy of farmland protection plays insignificant role in promoting farmland quantity. Consequently, the important approach of solving problem of rapid decrease of farmland is to formulate long-term strategy, strengthen theoretical research of farmland protection and reinforce degree of formulation, implementation and surveillance of farmland protection policy.

Key words Change of farmland quantity, Policy of farmland protection, Econometric analysis, Co-integration, Error correction model, Impulse response function, Variance decomposition, China

Farmland, the pith of land, becomes the hot topic of LUCC research. China is a country devoid of farmland resources. Since the reform and opening-up, the quantity of farmland has undergone the process of sharp decrease along with the rapid economic development. The problem of farmland decrease has concerned the government and social circles extensively. The domestic academic world began to research problem of change of farmland quantity from the late 1990s. As for the research of driving force, one of the focuses of farmland quantity change research, the scholars in China, such as Liu Yihua, have chosen different typical regions to conduct many empirical researches from different perspectives. But the recent researches of driving force of farmland quantity change concentrate on economic driving force. The policy subordinate to social plutonomy, especially the public policy is a driving factor that cannot be ignored to farmland quantity change. Answering the question that how regional policy impacts way, method, time and place of land use is thought as the most significant part of driving mechanism research of land use change. Especially in China, the influence of policy is outstanding. Impacted by formerly high-degree centralized planned economy system, the farmland change in China, to much extent, once hinged on formulation and implementation of central government policy. After the reform and opening-up, China stepped into the era of market economy gradually. At micro level, the farmland, driven by economic interest, is transformed into land use type with high profit, but due to that farmland is a kind of special and important resource, China has a brisk demand for farmland resources in order to develop economy rapidly. But meanwhile, farmland also assumes the role of guaranteeing state food security, so at the macro level, the influence of national policy on land use change still exists, and tends to intensify increasingly[1]. It is difficult to quantify the policy factor which is as an important driving force of farmland quantity change. Recently, there is a shortage of researches, and many concentrate on qualitative study and lack systemization[1-5], based on these, in the perspective of quantification, researching the policy driving force and relationship between farmland quantity and policy protection which impact farmland quantity change has become a tendency, drawing much attention. In view of this, the thesis introduces econometric analysis method and tries to test whether there is long-term balanced and causal relationship between farmland quantity and policy protection in from macro perspective in order to provide reference for future work of farmland protection.

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* Corresponding author. E-mail: 1652349621@qq.com

1 Index selection, data source and research method

1.1 Data source and processing The research data are mainly from *Investigation Report of China's Land Use Change* of Ministry of Land and Resources, *Land Resources Communi-*

que of China, *Chronicle of Statistical Data over* 50 *Years in New China*, and relevant statutes, policies and measures issued by Ministry of Land and Resources in China.

1.2 Index selection

1.2.1 Index of farmland quantity change (*CL*). Due to the change of statistical caliber of farmland area in the process of great land survey in 1997 in China, it makes the date after this time point inconsistent with the data of Ministry of Agriculture before 1996. There is no a set of sequence data regarding farmland quantity so far in China, so we correct the statistical data of Ministry of Agriculture before 1996 in order to make the data consistent with data of Ministry of Land and Resources. The data in the years 1996 – 2007 are from *Investigation Report of China's Land Use Change of Ministry* of Land and Resources and *Land Resources Communique of China*; the data in the years 1978 – 1995 are obtained by correcting the data in *Chronicle* of *Statistical Data* over 50 Years in New China. The specific correction method is to use data concerning farmland quantity from 1978 to 1995 to predict the farmland quantity in 1996. The bivariate regression equation is established as follows:

$y = 12.519(t-1977)2 - 515.85(t-1977) + 100\ 614$ ($R = 0.955$, $F = 159.03$). In the equation, t refers to year. The prediction data in 1996 is 9 676.22 hm^2, decreasing by 208 700 hm^2 in 1995. We retrace the farmland area data in land system to 1978 by using the progressively decreasing farmland quantity data annually, so as to form a set of complete sequence data.

1.2.2 Index of farmland protection policy (*PCL*). In the process of choosing the variables of farmland protection policy, in order to quantify variables, the thesis uses Delphi technique method to quantify law and policy measures. The method is to assign value 3 to national law, management system reform and important measures, assign value 2 to documents of CPC Central Committee and State Council, and assign value 1 to documents of former Bureau of Land Management of China and Ministry of Land and Resources[1-3] (Table 1).

Table 1 The implementation of farmland protection policy of China since the reform and opening-up in China

Year	Policies and measures of law	Dynamics variables
1982	The management model transforms scattered management to relatively unified management	3
1986	The implementation of *Land Management Law*	3
	Notice on Strengthening Unified Land Management and Stopping Unauthorized Acquisition of Farmland (Central Committee's Document No. 7)	2
1992	*Urgent Notice on Stopping Unauthorized Acquisition of Farmland Strictly* and *Illegal Use of Farmland of the State Council*	2
1994	*Conservation Regulation of Basic Farmland* issued by the State Council	2
1995	The Farmland Protection Work Meeting of China-Strengthen Land Management and Implement Protection Mechanism of Basic Farmland	1
1996	The monographic study of farmland protection is organized by the Central Committee's Leading Group for Financial and Economic Affairs	1
1997	*Penal Law* adds "crime of destructing farmland", "illegal approval charge of land" and "crime of illegal land transfer"	3
	(*Notice on Further Strengthening Land Management and Protecting Farmland* (Central Committee's Document No. 11) on April 15, 1997	2
	Prescription of Stopping Use of Farmland of Non – agricultural Construction Program of former Bureau of Land Management of China on May 20, 1997	1
1999	Implementation of new *Land Management Law*	3
	Annual Plan and Management Method of Land Use issued by State Asset Regulatory Commission on February 24, 1999	1
	Examination and Approval Management Method of Construction Use Land issued by State Asset Regulatory Commission on February 24, 1999	1
	Notice on Printing and Distributing Overall Planning Outline of China's Land Use issued by General Office of the State Council on March 2, 1999	2
2001	*National Work Meeting of Farmland Protection*	1
2003	*Notice on Checking-up and Rectification of Various Development Regions and Strengthening Construction Use Land Management* issued by General Office of the State Council (NO.2003170)	2
2004	*Suspend Examination and Approval of Agricultural Use Land Transfer* on March	3
	The State Council's Decision on Deepening Reform upon Land Management Strictly issued by The State Council on December 13. 2004	2
	Notice on Implementing The State Council's Decision on Deepening Reform upon Land Management Strictly issued by State Asset Regulatory Commission	1
2005	*General Office of The State Council's Notice on Printing and Distributing Assessment Method of Responsibility and Objective of Farmland Protection of Provincial Government* issued by The State Council (NO. 52) in 2005	
2006	*The State Council's Notice on Some Problems of Strengthening Land Regulation* issued by The State Council (NO. 31) in 2006	2
	The State Council's Notice on Some Problems of Establishing National Supervision System issued by The State Council (NO. 50) in 2006	2
2007	*The State Council's Notice on Conducting the Second National Land Investigation* issued by The State Council (NO. 38) in 2006	2

1.3 Research method The econometric methods of co-integration, Granger causality relation, impulse response, variance decomposition and so on are gradually and extensively used, which provide brand-new theoretical basis and means for researching the balanced relationship and interaction among variables. Testing stationarity of sequence variables is the prerequisite of conducting co-integration analysis. The thesis adopts ADF method to test whether the sequence variables are stationary, namely whether there are unit roots, in order to avoid the phenomenon of spurious regression caused by instability of time sequence. The theory of co-integration lays the theoretical foundation for seeking balanced relationship among variables and establishing dynamic model, reflecting the long-term balanced relationship among variables. There are Johansen test method, E-G two-step test method and so on. Here we adopt Johansen test method. Based on this, we conduct Granger causality test in order to determine the causal direction among variables. Impulse Response Function (IRF) reflects that one standard variance in random disturbance terms impacts present value and future value of endogenous variables; depicts the dynamic response of endogenous variables to random disturbance; displays the dynamic process that the random disturbance of any variable impacts other variables by model and sends feedback to itself. The main thought of variance decomposition, according to cause of formation, is to decompose fluctuation of each endogenous variable in system into all components related to information of all equations, so as to know the relative importance of innovation to all endogenous variables. Impulse Response Function and variance decomposition will qualitatively and quantificationally unravel the impact of change of one variable in system of farmland quantity change and farmland protection policy on itself and another variable. The preceding analysis can be completed by using Eviews 5.1.

2 Results and analysis

2.1 Test of stationarity Farmland quantity and farmland protection policy are the organic components of macro economy, and they may be not stationary. In order to obtain reliable analysis results, the thesis firstly uses ADF method to test stationarity of *CL* sequence and *PCL* sequence. The results can be seen Table 2. ADF statistic of *CL* and *PCL* is −2.672 and −5.885 respectively, both below critical value, so the two time sequences are stationary sequences. They are noted as *CL*(0) and *PCL*(0).

Table 2 The stationary test result of annual net decrease of farmland and annual implementation degree of farmland protection policy

Variable	ADF statistic	Test type	5% critical value	10% critical value	Test result
CL	−2.672	(*C*,0)	−2.972	−2.625	* * *
PCL	−5.885	(*C*,0)	−2.972	−2.625	* *

Note: 1. C refers to the test term with constant term, T refers to tendency term and 0 means that there is no constant term or tendency term; 2. * * * is refusal of former hypothesis at 10% significance level, and * * is refusal of former hypothesis at 5% significance level; 3. Test select lag orders according to minimum principle of AIC and SC.

2.2 Co-integration test In order to probe into whether there is long-term stable co-integration relationship between farmland change and farmland protection policy, we adopt Johansen test method to verify analysis, and the results can be seen in Table 3. Because the trace statistic 16.166 and the trace statistic 6.959 are both bigger than the critical value 15.495 and critical value 3.841 at significance level of 5%, so we can judge that there is co-integration relationship between sequence CL and sequence PCL, namely the two has lone-term balanced relationship, but this correlativity is not tantamount to causality, yet to be further undergone causality test so as to determine causality direction of the two.

Table 3 The co-integration test result of annual net decrease of farmland and annual implementation degree of farmland protection policy

Quantity of co-integration of former hypothesis	Eigenvalue	Trace statistic	5% critical value	Probability
0	0.289	16.166	15.495	0.040
1 at least	0.227	6.959	3.841	0.008

2.3 Granger causality test As for the causality direction of farmland change and farmland protection policy, the thesis uses Granger causality test method to conduct judgment and analysis, and the results can be seen in Table 4. No matter in lag period 1 or lag period 2, *PCL* is not Granger cause of *CL*, namely that the impact of farmland protection policy on farmland change is not significant; accordingly, *CL* is Granger cause of *PCL*, that is to say, the increasing decrease of farmland precipitates the formulation and implementation of farmland protection policy.

Table 4 The causality test result of annual net decrease of farmland and annual implementation degree of farmland protection policy

Former hypothesis	Lag period	Dynamics	*F* statistic	Probability	Result
PCL is not the Granger cause of *CL*	1	28	0.001	0.977	Accept former hypothesis
CL is not the Granger cause of *PCL*	1	28	7.409	0.012	Refuse former hypothesis
PCL is not the Granger cause of *CL*	2	27	0.472	0.630	Accept former hypothesis
CL is not the Granger cause of *PCL*	2	27	3.109	0.065	Refuse former hypothesis

2.4 Impulse response analysis In order to better analyze the relationship between farmland change and farmland policy deeply in the dynamic perspective, the thesis emulates curve of impulse response function. Horizontal axis represents lag order, and vertical axis represents the response degree to new information brunt. Solid-line part is the calculation value and dotted-line part is confidence belt of increased or decreased two-fold standard variance of response function value

From Fig.1, impact of *CL* on its brunt gradually weaken, and it tends to be stable after the fifth period, but has a gradual

reinforced impact on itself; the impact of *PCL* on *CL* is firstly strengthened and then weakened, but the impact is so weak, and it has dwindling impact on itself. On the whole, the impact of *CL* on *PCL* is significant, but the impact of *PCL* on *CL* is not significant. That's to say, farmland decrease has significant impact on farmland protection policy, while farmland protection policy, to some extent, hampers rapid decrease of farmland, but it has insignificant impact on farmland change, which is basically consistent with predecessor's research accomplishments[1,6-7], and also consistent with the practical situation and foregoing analysis.

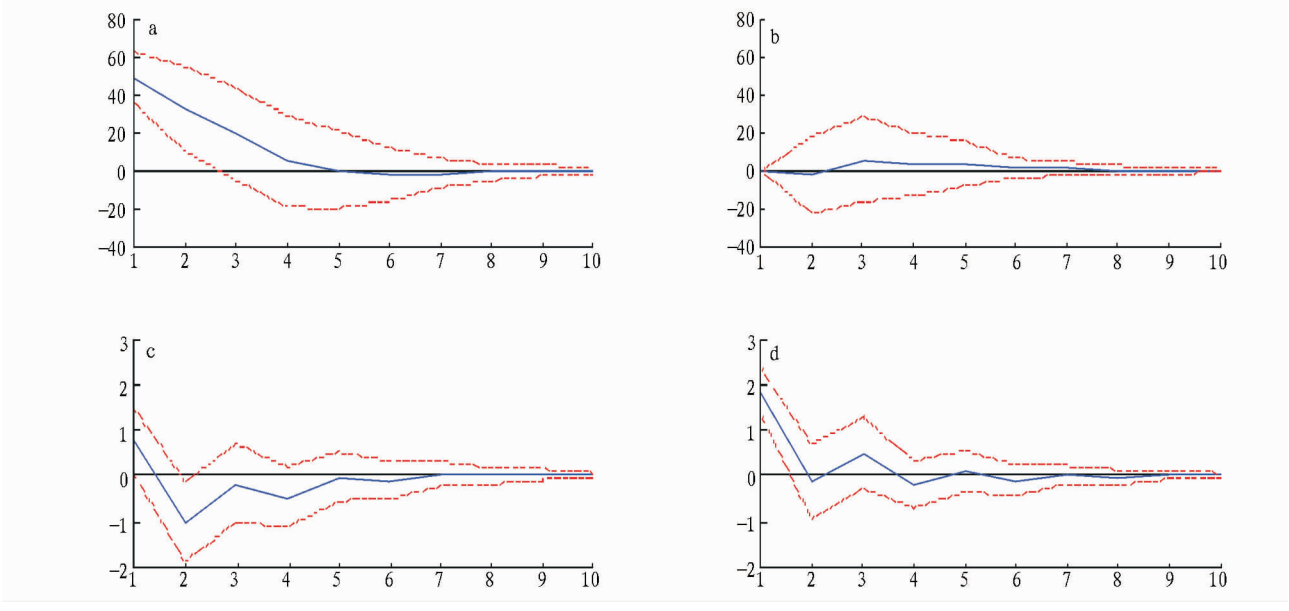

Fig.1 The result of impulse response of *CL* and *PCL* to a standard deviation

2.5 Variance decomposition In order to further research contribution of structure brunt to change of endogenous variables, and appraise importance of brunt of different structures, the prediction variance decomposition model is established. We get the error decomposition results (Table 5).

Table 5 The variance decomposition result of annual net decrease of farmland and annual implementation degree of farmland protection policy

Period	Variance decomposition of *CL*			Variance decomposition of *PCL*		
	S.E.	*CL*	*PCL*	*S.E.*	*CL*	*PCL*
1	48.993	100.000	0.000	1.988	14.386	85.614
2	58.584	99.811	0.189	2.233	31.843	68.157
3	61.867	98.962	1.038	2.294	30.687	69.313
4	62.106	98.725	1.274	2.349	33.223	66.777
5	62.206	98.412	1.588	2.351	33.168	66.832
6	62.256	98.386	1.614	2.355	33.215	66.785
7	62.278	98.373	1.627	2.356	33.240	66.760
8	62.289	98.374	1.626	2.356	33.232	66.768
9	62.290	98.374	1.626	2.356	33.240	66.760
10	62.290	98.373	1.627	2.356	33.240	66.760

Table 5 indicates that in the first period, *CL* is only impacted by its own fluctuation, and henceforth, stays at level of 98%. Although the impact of *PCL* on itself is increasingly strengthened, it merely stays at the level below 1.7%. *PCL* is impacted little gradually by its own fluctuation, but it still keeps the level above 65%. The impact of *CL* on itself is increasingly strengthened, reaching more than 33%. It indicates that *CL* has relatively significant impact on *PCL*, but *PCL* has insignificant impact on *CL*; in the meantime, the impact degree of *CL* reaches 98% and the impact degree of *PCL* reaches 65%.

3 Conclusion and policy suggestions

3.1 Conclusion From the macro perspective, the thesis offers strict mathematic proof of mutual relationship and interaction between farmland change and farmland protection policy. The interaction effect between farmland change and farmland protection policy has outstanding difference: the impact of farmland change on farmland protection policy is strong and the explanation level of farmland change brunt on farmland protection policy reaches more than 33%; the impact of farmland protection policy on farmland change is relatively weak, and the explanation level of farmland protection policy brunt on farmland change is below 1.7%. Further, farmland change and farmland protection policy are both impacted by their own fluctuation, which has not drawn attention extensively in the preceding researches. The preceding research methods have not yet better solved this problem.

Farmland protection policy, to some extent, controls the rapid decrease of farmland, and provides indispensable guarantee for sustainable development of China's society and economy, especially the agricultural production. But there is a shortage of quantitative researches on the two currently, and most of them are simple researches concerning one aspect. As a kind of exploration, according to the relationship between farmland protection policy and farmland change, the thesis uses econometric analysis method to conclude the relationship

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4 Conclusion and discussion

Firstly, since a decade, the farmland area tends to decrease, and it decreased by 5 575.38 hm^2 in the aggregate and decreased by 7.8%. The period with biggest change was from 2002, and it began to decrease gradually from 69 710.03 hm^2. It decreased by 4 164.75 hm^2, and decreased by 6% in the aggregate as of 2008. In the light of annual change rate, the years from 1996 to 2002 are the period of slow decrease; the years from 2002 to 2003, it had the biggest decrease degree; in 2003, it was −0.491 6%, decreasing by 0.339 0%; after 2003, it tended to decrease slowly; in 2008, the dynamic degree of farmland was −0.603 0%.

Secondly, by principal component analysis, the driving forces impacting farmland use change in Ninglang County can be classified as factor of economic development and factor of population. Taking into single factor is in that population increase causes increased demand of farmland and impact on GDP, the secondary industry and the tertiary industry.

Thirdly, in addition to the analysis of driving mechanism of farmland use change in Ninglang County from the influencing factors of population, economic development and so on. The policy factor also has significant impact on farmland area change. For instance, the policy of returning farmland to forests in the recent years has significant influence on farmland area change in Ninglang County and even Yunnan Province, and this policy is the important reason of farmland decrease in this area.

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between the two as follows: on one hand, China's farmland decreases rapidly, which makes the state formulate a series of farmland protection policies; on the other hand, due to the formulation of farmland protection policies, the tendency of farmland decrease is arrested to some extent. Although currently China's farmland tends to decrease, but the decrease speed and amplitude are allayed. The conclusion is basically consistent with the predecessor's research accomplishments, indicating that this method has high reliability and provides new theoretical instrument for future deep research.

3.2 Policy suggestions The conclusion of research indicates that in the system of "farmland quantity change-farmland protection policy", the interaction between farmland quantity and farmland protection policy is merely a part of system contradiction, and it cannot be neglected that the farmland quantity and farmland protection policy are impacted by their own brunt. Consequently, in order to solve contradiction between farmland quantity and farmland protection policy, we should formulate long-term strategy and adopt diverse measures. This means that strengthening research on farmland protection policy, reinforcing formulating degree of farmland protection policy, strengthening supervision of policy implementation and perfecting policy are also the important means to solve farmland problems.

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