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Food Security, Food Prices and Climate Change in China: a Dynamic Panel Data Analysis

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Abstract

This paper provides empirical evidence of the determinants of food security, in which is expressed as a function of various factors, including the per capita disposable income of rural residents, food retail price index, agricultural disaster area, sown area and saving of urban and rural residents, using a dynamic panel data analysis from a sample of 27 provinces over 1985–2007 in China. This paper used POLS, FE (fixed effects), DIF-GMM (difference GMM) and SYS-GMM (system GMM) to estimate the relationship among all the variables. According to the results of SYS-GMM, we found that the climate change will affect the food security significantly in the current year, but food price had no influence on the food security in the current year in China.

Keywords:Food Security; Climate Change; Dynamic Panel Data.

1. Introduction

Food security as a concept originated in the mid-1970s, according to the definition of the Food and Agriculture Organization (FAO), food security is a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. In 2007-2008 the ratio of global cereal stocks to utilization was estimated to be the lowest at 19.4% (FAO, 2008). The total numbers of food insecure people exceeded one billion hungry in mid-2009 (FAO, 2009). Each food crisis seems to stimulate a surge of government and donor activity on behalf of increased food production and better safety nets for the poor (Timmer, 2010). Climate change affects agriculture and food production in complex ways. It is likely to reduce food production directly through changes in agro-ecological conditions and indirectly by affecting growth and distribution of incomes. The world population grew from 2.5 billion in 1950 to 6.1 billion in the year 2000. By the year 2050, the world population is estimated to reach 9.1 billion (Carvalho, 2006). Climate change is considered as posing the greatest threat to agriculture and food security in the 21st century, particularly in many of the poor, agriculture-based countries of sub-Saharan Africa (SSA) with their low capacity to effectively cope (Shah et al., 2008; Nellemann et al., 2009). The World Bank food benchmark index increased 23% between January and December 2009. Sugar prices rose 80% during this period and rice prices rose 9% in December 2009 alone. While the food price index for 2009 was on average 17% lower than the 2008 average. The change of Food prices may affect the domestic markets and remain a significant threat to food security

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and nutrition in the developing world. If these price increases in domestic markets represent a general increase of similar magnitude across the cross section of caloric sources available, then the impact on food security may be significant (World Bank, 2010). Government policy of supply has often been used in an effort to promote price stability and thereby enhance food security for poor consumers (Islam and Thomas, 1996; Timmer et al., 1983; Timmer, 1989; Chabota and Dorosh, 2007). In addition, Land use changes in China are driven by the increasing demand for food (Heilig, 1997).

This paper unfolds as follows. In the next section, we describe the model and econometric approach. In Section 3, we account for the data sources. In Section 4, we report the empirical estimation results. Finally, we conclude in Section 5.

2. Model and Econometric Approach

The panel data has obvious advantages over cross-sectional data or time series dataset: (i) we have more observations which should yield more precise estimates; (ii) it allows us to control for cross-section effects; (iii) it extends easily to a dynamic model and allow us to address potential endogeneity problems of the explanatory variables. The discussion of Dynamic Panel Data (DPD) was opened by Balestra and Nerlove (1966), They proposed to estimate the model with unobserved component using the Generalized Least Squares (GLS) estimator. However, GLS or ML-Random effects (RE) estimators leads to inconsistent if the unobserved individual effects are correlated with the exogenous variables. Our proposal is to employ Difference GMM methodology (Arellano and Bond, 1991) and System GMM methodology proposed by Arellano and Bover (1995) and Blundell and Bond (1998) to deal with the problems. This paper applies the dynamic model to estimate the relationship among the food security, food prices and climate change. Consider the following dynamic panel data model:

$$\ln y_{it} = \delta \ln y_{it-1} + X'_{it}\beta + \alpha_i + \varepsilon_{it} \qquad \varepsilon_{it} \sim N\left(0, \sigma_\varepsilon^2\right) \tag{1}$$

Where $\ln y$ is log forms of the rural per capita food consumption, X is a set of the explanatory variables including the rural per capita food consumption, food retail price index, income of rural residents, agricultural disaster area, sown area and saving of urban and rural residents. α_i is a fixed effect, ε_{it} is a random disturbance, δ and β are estimated coefficients.

Blundell and Bond (1997) show that when δ approaches to one, so that the dependent variable follows a path close to a random walk, the differenced-GMM (Arellano and Bond, 1991) has poor finite sample properties, and it is downwards biased, especially when T is small. Therefore, Blundell and Bond (1997) proposes another estimator – the System GMM–derived from the estimation of a system of two simultaneous equations, one in levels (with lagged first differences as instruments) and the other in first differences (with lagged levels as instruments), the system GMM estimator in dynamic panel data models is more efficient than the first-difference GMM estimator (Blundell and Bond, 1998). This paper will apply system GMM estimators to estimate the dynamic panel data model.

3. Data

Climate change will affect all four dimensions of food security: food availability, food accessibility, food utilization and food systems stability. It will have an impact on human health, livelihood assets, food production and distribution channels, as well as changing purchasing power and market flows (FAO, 2008). The data used in the estimation of the reference model are drawn from China Compendium of Statistics 1949-2004, Agriculture Statistic Data of 60 Years Since the Founding of New China and Rural Statistical Year Book of China etc. The data sets are yearly and cover the period from 1985 to 2007, for 27 provinces, municipalities, and autonomous regions in China, The data for Chongqing municipality was subtracted from Sichuan Province, from which is split to become a separate region in 1997. Therefore, this paper does not take account of Chongqing as well as Hainan province, in addition Tibet, Shanghai and Hainan was eliminated because of the lack of datasets. All Samples is 621. All variables are rural per capita food consumption (kg/person), food retail price index, per capita income of rural residents (yuan), agricultural disaster area (10000 hectares), sown area (10000 ares) and saving of urban and rural residents (hundred million RMB). Table 1 presents the descriptive statistics of all variables.

Table 1 Descriptive Statistics of All Variables

Variable	Mean	Std. Dev.	Min	Max	Observations

lny	5.4775	0.1618	4.6946	5.8751	621
lncl	7.0983	1.0209	3.2581	8.8037	621
lninc	6.4048	0.3738	5.5491	7.6577	621
lnp	4.7018	0.1345	4.4104	5.1144	621
lnsav	6.4550	1.6425	2.0268	10.0098	621
lnsown	8.3213	0.9038	5.6870	9.5600	621

4. Empirical Analysis

We apply the system GMM estimation procedure to the estimation of (1) using balanced panel data from 1985 to 2007 in China. We compare our result with the results from the different estimation approaches, such as POLS, FE, DIF-GMM (difference GMM) and SYS-GMM (system GMM).

Table 2 presents the various estimation results. About SYS-GMM estimators, Arellano-Bond test for AR(1) rejected the Null hypothesis H0: no autocorrelation, but Arellano-Bond test for AR(2) can not reject the Null hypothesis, Because the SYS-GMM only need that there no existed the relationship of AR(2), It is suitable for the estimation. All the specifications pass the Hansen-J statistic test for Over-Identifying Restrictions (OIR), confirming that the instrument set can be considered valid, Hansen test-GMM and Hansen test-IV in Difference-in-Hansen tests also support the exogeneity of instrument subsets. The coefficients of Lnyt-1 may not be the best because the value is out of the (0.7812, 0.9175), but it may be better than DIF-GMM because of negative value. So we think that the SYS-GMM estimation of dynamic panel data is felicitous among the food security, food prices and climate change.

Table 2 Results of the Estimation based on POLS, FE, DIF-GMM and SYS-GMM

Independent variables	POLS	FE	DIF-GMM	SYS-GMM
Lny_{t-1}	0.9175*** (54.16)	0.7812*** (27.42)	-0.1295** (-2.07)	0.5274*** (9.77)
$lnCl_t$	-0.0064 (-1.34)	-0.0067 (-1.24)	-0.0051 (-1.19)	-0.0100*** (-1.98)
$lnCl_{t-1}$	0.0052 (1.09)	0.0046 (0.86)	-0.0004 (-0.06)	0.0061 (1.13)
$lnInc_t$	-0.2537** (-2.49)	-0.2683** (-2.52)	-0.4927*** (-11.45)	-0.4106*** (-6.28)
$lnInc_{t-1}$	0.2377** (2.31)	0.1130 (0.97)	0.0356 (0.65)	0.2833*** (4.17)
lnP_t	-0.0031 (-0.16)	-0.0121 (-0.60)	-0.0076 (-0.38)	-0.0049 (-0.20)
lnP_{t-1}	0.0430** (2.14)	0.0331 (1.60)	0.0257 (1.25)	0.0528** (2.39)
$lnSav_{t-1}$	-0.0066** (-1.98)	0.0126* (1.93)	0.0369*** (3.50)	-0.0014 (-0.18)
$lnSown_{t-1}$	0.0094 (1.46)	0.0566** (2.34)	0.0840 (1.65)	0.0223 (1.41)
const	0.3381** (2.21)	1.5556*** (4.35)		
R^2	0.9035	0.8341		
F-statistic	607.52***	311.77***	36.63***	154.54***
Arellano-Bond test for AR(1)			-2.85***	-4.27***
Arellano-Bond test for AR(2)			-1.95*	-0.69
overid. restrictions				
Sargan test			371.45***	616.77
Hansen test			25.56	25.20
Difference-in-Hansen tests				
Hansen test-GMM				25.03
Hansen test-IV			25.64	24.92

Number of obs	594	594	594	594
Number of groups		27	27	27

Notes: DIF-GMM is one-step difference GMM estimators, SYS-GMM is one-step system GMM estimators. Over-Identifying Restrictions in an over-identified model it is possible to test whether the instruments satisfy the orthogonality conditions, Difference-in-Hansen Tests Non-orthogonality between regressors and errors can arise as a result of a number of sources. * (P<0.10), ** (P<0.05), *** (P<0.01).

According to the results of SYS-GMM, we found that the agricultural disaster area will affect the rural per capita food consumption significantly, that is to say, climate change will reduce the food production and lead to the lack of supply food and have a impact on the food security, so we must pay attention to the weather forecast to bring down the agricultural planting risk. Income of rural residents would affect the food consumption, but the current year would cause the negative effects because of the inelasticity of food and risk for the future. While the last year, a rise in income will create increase purchasing power, thus stimulating demand for goods and service, so there existed a positive relationship. The price had the income effect and substitution effect, but the existence of rigidity of food consumption, the change of food retail price index had no effect on the food security in China in short run, but the last year, the increase of food retail price stimulate to grow more food, would lead to the increase of food consumption in next year. In the light of the estimated coefficients, we found that the sown area and saving of urban and rural residents had no influence on the consumption.

5. Conclusions

This paper empirically estimates the relationship among all variables using dynamic panel data for 27 regions from 1985 to 2007 in China based on POLS, FE, DIF-GMM and SYS-GMM. According to the results of SYS-GMM, we found that the climate change will affect the food security significantly in the current year, but food price had no influence on the food security in the current year in China.

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