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Impact of Market Integration on China's Food Security

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I. Introduction

The food security issues could be viewed from various aspects: 1) the long-term production capacity; 2) the ability to smoothening short-run supply against production fluctuations; 3) the accessibility to food for the rural and urban poor in less-favored areas; and 4) the sanitary and phytosanitary problems related to food safety. This paper will focus on how to secure food supply inter-regionally and inter-temporally through integration of grain market.

Contrary to the fear raised by Lester Brown, China has experienced significant surplus in grain production since December 1996, evidenced by the 40 % decline in market price in a few months, and failures of all measures made by the government to bring the price upward since that time. Even an estimated 8-9 % decline in total grain production in 2000 has not had any impact on the market price yet. It seems that the pong-term production capacity will not be a major issue in the next decade. However, production does fluctuate from year to year in all provinces due to weather conditions, which might influence China's ability to secure food supply at various times and locations.

It is believed that the stability of a grain market depends largely on the scope of the market. The larger a geographic area the market covers, the smaller the total fluctuation will be, as the variations in all sub-regions will cancel each other out. For the same logic, the larger the grain reserves are, the more fluctuations will be absorbed inter-temporally. A further inference is that the larger the market covers in area, the smaller the reserve capacity will be required to achieve the same security level. Therefore, the level of market integration is likely to have significant impact on food security, both inter-regionally and inter-temporally.

Due to administrative difficulties and under-development of infrastructures, the current practice in China is to make each province responsible for its grain supply, as indicated by the "rice bag governor responsibility system". In most cases, this policy implies that each province should try its best to produce enough grain for local consumption. Furthermore, provincial governments are also requested to share responsibility in keeping grain reserves. Such policy may lead to less integrated grain market, or at least prevent further integration in grain market, and resulted in higher policy costs and lower level of food security.

This study attempts to demonstrate the potential gain in improving food security at lower costs resulted from an integrated market. The capacity of grain reserves is estimated under various assumptions, such as a completely integrated national market, or dozens of segmented provincial markets. The difference in the required reserve capacities may be used as a base to further calculate policy costs in achieving the same

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level of food security under various market structures. The findings of this research may help persuade the government to change its grain marketing policy, and to invest more in infrastructures in order to establish a highly integrated grain market.

II. Analytical Framework

Grain reserves are defined as a special stock set aside to smoothen inter-annual supply against fluctuations in production and imports. They serve different policy goals compared with carry-overs, as the later is used to smoothen inter-seasonal supply within a year, or between two crops within a year. Ideally, if the fluctuations are to be fully absorbed to maintain perfectly smooth supply, the capacity of grain reserves should be adequate to store the maximum accumulated surpluses in sequential years plus the maximum accumulated deficits in sequential years. That is, if we start from a kind of "normal" position and face a sequential bad harvests, the original grain reserves should be adequate to fulfil the accumulated gaps between the actual and "normal" or "expected" harvests until the actual harvest reaches "normal" or "expected" level. Applying the same logic, the "extra" capacity above "normal" position should be large enough to store the accumulated surpluses in a row.

The "normal" harvest in this study is defined as the expected value of total annual production derived from a simple linear regression against time:

$$Y_t^* = \alpha + \beta T + \varepsilon_t \qquad (1)$$

where Y_t^* is the expected value of grain output in year i;

T is year; and

ε_t is the random error in year i.

The differences between the reported actual outputs and their expected values are defined as fluctuations, either positive or negative depending on the situations:

$$V_t = Y_t - Y_t^* \qquad (2)$$

where V_t is the fluctuation of grain production in year i;

Y_t is the actual grain output in year i; and

Y_t^* is the expected grain output in year i.

When the quantities of fluctuations are accumulated, some local positive and negative maxims may be found with two extremes in the accumulated fluctuations. The sum of the negative and positive extremes is the maximum capacity of grain reserves if perfectly smooth supply is to be maintained with the reserves as the sole policy instrument.

If there exists an integrated national market, the national grain production data can be used to estimate the maximum grain reserve capacity. On the contrary, if the market is segmented at provincial level, then the same calculation should be applied to each province and the corresponding capacity for the whole country should be the sum of maximum capacities required in all provinces. If the fluctuations do not move in the same direction among provinces, the two estimates will be different. The larger the difference is, the greater the potential gain from market integration will be. Even if the policy goal is not perfectly smooth supply, the conclusion still holds as long as "partial" smoothening is the policy objective for establishing grain reserves.

III. Empirical Results

The estimation in this study is made for the 1965-98 time period. China experienced extreme disasters in grain production during the early 1960s largely due to the policy failures. 1965 is generally recognized as the year by then China had recovered from the crisis. Assuming no such policy failures in the future, 1965 might be taken as the base year for the estimation. 1998 is the last year for which production data are readily available at the preparation of this paper.

The simple linear regression results are as follows (in million metric tons):

$$Y_t^* = -18695.2 + 9.61T \qquad (3)$$

It indicates that the expected grain output increases by 9.61 million metric tons every year on average during the time period.

The actual grain outputs, their estimated expected values, the calculated annual fluctuations, and the accumulated fluctuations are listed in Table 1. It can be found out that the largest accumulated positive fluctuation appears in 1967 at 33.66 million metric tons (mmt), and the largest accumulated negative fluctuation appears in 1981 at 48.64 mmt. If we assume that the original grain reserves started at zero in the beginning of 1965, then the largest quantity in reserves should be 33.66 mmt in 1967. However, the accumulated deficit would be 48.64 mmt by 1981, implying additional imports of 48.64 mmt during the time period if perfectly smooth supply was to be maintained. As this accumulated deficit was not due to inadequate long-run production, one may consider to cover it with reserves. So the original quantity of grain reserves should be 48.64 mmt in 1965 and the maximum capacity should be 82.3 mmt in order to store the additional quantities accumulated between 1965 and 1981.

Therefore, the required maximum capacity of grain reserves is estimated at 82.3 mmt if grain reserves are used as the sole policy instrument to maintain perfectly smooth food supply under the assumption of an integrated national grain market.

Table 1 Fluctuations in Grain production, 1965-99 unit1 mmt

year	Actual output	Expected output	Annual fluctuation	Accumulated fluctuation
1965	194.50	187.94	6.56	6.56
1966	214.00	197.55	16.45	23.02
1967	217.80	207.16	10.64	33.66
1968	209.10	216.77	-7.67	26.00
1969	211.00	226.38	-15.38	10.62
1970	240.00	235.98	4.02	14.64
1971	250.10	245.59	4.51	19.14
1972	240.50	255.20	-14.70	4.44
1973	264.90	264.81	0.09	4.52
1974	275.30	274.42	0.88	5.40
1975	284.50	284.03	0.47	5.87
1976	286.30	293.64	-7.34	-1.48
1977	282.70	303.25	-20.55	-22.03

1978	304.80	312.86	-8.06	-30.09
1979	332.10	322.47	9.63	-20.46
1980	320.60	332.08	-11.48	-31.95
1981	325.00	341.69	-16.69	-48.64
1982	354.50	351.30	3.20	-45.44
1983	387.30	360.91	26.39	-19.05
1984	407.30	370.52	36.78	17.73
1985	379.10	380.13	-1.03	16.69
1986	391.50	389.74	1.76	18.45
1987	403.00	399.35	3.65	22.10
1988	394.10	408.96	-14.86	7.24
1989	407.60	418.57	-10.97	-3.73
1990	446.20	428.18	18.02	14.29
1991	435.30	437.79	-2.49	11.80
1992	442.70	447.40	-4.70	7.10
1993	456.40	457.01	-0.61	6.49
1994	445.10	466.62	-21.52	-15.03
1995	466.60	476.23	-9.63	-24.65
1996	504.50	485.84	18.66	-5.99
1997	494.20	495.45	-1.25	-7.24
1998	512.30	505.06	7.24	0.00

Source: Calculated with data in China Statistical Yearbook, various issues.

However, if the grain market is segmented at provincial level, the required maximum capacity of grain reserves will be much larger. The same estimation approach is applied to each province in China for the same time period and the results are summarized in Table 2. It can be concluded that the maximum capacity of grain reserves should be 320.6 mmt under the assumption of segmented provincial grain market, almost 4 times as high as the level required under an integrated national market.

Table 2 Accumulated Fluctuations at Provincial level unit: mmt

area	Accumulated fluctuations		
	positive	negative	sum
Beijing	1.17	-0.49	1.66
Tianjin	0.89	-1.01	1.90
Heibei	6.11	-7.96	14.07
Shanxi	2.58	-2.29	4.87
Inner Mongolia	9.84	-12.53	22.37
Liaoning	7.12	-6.15	13.27
Jilin	8.43	-7.05	15.48
Heilongjiang	14.11	-17.30	31.41
Shanghai	0.89	-1.17	2.06
Jiangsu	15.10	-12.70	27.80
Zhejiang	11.44	-10.14	21.58
Anhui	8.56	-5.38	13.94
Fujian	2.85	-2.98	5.83
Jiangxi	5.22	-5.02	10.24
Shandong	7.45	-7.40	14.85
Henan	4.61	-5.57	10.18
Hubei	6.71	-6.27	13.98
Hunan	12.65	-9.36	22.01

Guangxi	4.83	-2.38	7.21
Guangdong	4.96	-3.51	8.47
Sichuan	11.26	-13.82	25.08
Guizhou	2.90	-5.05	7.95
Yunnan	1.79	-2.44	4.23
Xizan	0.29	-0.31	0.60
Shaanxi	3.08	-2.08	5.16
Gansu	2.61	-2.42	5.03
Qinghai	0.19	-0.28	0.47
Ningxia	1.10	-1.27	2.37
Xinjiang	3.59	-2.94	6.53
Total			320.60

Source: Ibid.

IV. Implication in Policy Costs

Grain reserves are used to serve policy goals of ensuring food security. As such, certain policy costs are inevitable and acceptable to the public. However, it is socially and politically desirable if the costs are kept at the minimum for the same level of food security. In practice, the lower the costs are, the more likely the policy will be carried to achieve its goal and continuously. The above simple calculation has revealed potential big difference in policy costs between an integrated market and segmented markets, a rough categorized comparison of the policy costs is provided below.

Firstly, the difference between the costs of storage facilities is quite significant. If the maximum level of smoothening annual grain supply is the policy goal set for the reserves, the total storage capacity should be 82 mmt and 320 mmt, respectively, depending the market is integrated at national or provincial levels. In the early case, possible additional costs are related to transportation facilities required to link spatial markets. However, transportation facilities are used by all sectors for different purposes, so their costs are also shared by ever increasing economic activities. The part of the costs to be shared by grain reserves is likely to be reduced gradually with the growth of the whole economy, and as transportation conditions will improve accordingly. In the later case, the costs of building warehouses to store additional 238 mmt of grain, as well as the costs of maintenance and depreciation associated with the warehouses, are extra and are much greater than the above-mentioned additional costs in transportation facilities. And these costs are likely to increase as the maximum reserve capacity is likely to increase with the total grain production and supply.

Secondly, the difference between direct annual storage costs is likely to be even huge. If the maximum quantities of reserves under the two scenarios are 82 mmt and 320 mmt, respectively, the annual quantities in reserves are likely to be 41 mmt and 160 mmt, respectively, on average. The difference is 119 mmt. The day-to-day operation of the reserves requires physical storage and financial costs, and incurs losses in both quantity and quality. All together, such costs are likely to be as high as 20% of the grain in reserves, in value terms. Therefore, the additional operation costs for segmented markets are likely to be as high as 24 mmt of grain, equivalent to almost 5% of annual production or several times of total annual imports.

Thirdly, the difference between marketing costs is not negligible. Grain must be collected and delivered to elevators and then shipped to final warehouses to be stored as reserves, and the procedure will be reversed after some times. An integrated market might lead to longer distance in the shipment, however, the larger quantity of grain to be shipped under segmented market requires much greater marketing costs. If the marketing costs are equivalent to 10% of the grain marketed in value terms, and the average time length in reserves is assumed to be two years, then, the additional annual marketing costs would be equivalent to 6 mmt of grain for markets segmented at provincial level. (119 mmt extra reserves divided by 2, and then multiplied by 10%)

V. Conclusions

It has been demonstrated that segmented grain markets will require much higher extra policy costs to ensure food security. Such extra costs may as high as equivalent to 30 mmt of grain every year, plus the costs to build and maintain extra warehouses for additional 238 mmt of grain. If the policy objective is partially smoothening the production fluctuations, the total policy costs will be reduced accordingly along with the level of food security. This reduction is likely to be proportional to the total quantities to be put in reserves, therefore, even the costs are cut by 50% under both the integrated or segmented market assumptions, the difference is still very significant.

The advantage of largely reduced policy costs for the integrated market is obvious in itself. However, it can be inferred further: with reduced costs, the food security policy and its established goals are more acceptable to the government and the public. Therefore, an integrated market is likely to enhance food security through policy formation and implementation, and may even help to raise the level of security.

One step further will be integration of domestic market into the world one. If the production fluctuations do not occur simultaneously and in the same direction across countries especially major exporters and importers, the world market could be used as special “reserves”. If surplus grain is sold onto the world market during good harvests and additional supply is bought during bad harvests, the spatial market is actually turned into inter-temporal one, or reserves.

Finally, it could be concluded that the larger the market integrates in areas, the lower the food security policy costs will be, and the higher the level of food security will be.