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**The Role of the State in Making a National Market:
The Evolution of the Grain Market in China (1978 – 2000)**

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The Evolution of the Grain Market in China (1978 – 2000)

Abstract:

Purpose – The paper aims to examine Karl Polanyi’s view of market evolution in the context of the emergence of a national grain market in China’s transition economy.

Design/methodology/approach – The dataset used includes information about inter-provincial grain trade on China’ s grain market from November 1999 to October 2000. A priori blockmodelling method is used for hypothesis testing.

Findings – This paper finds that a partially integrated national grain market had emerged at the beginning of the twenty-first century in China in spite of local protectionism. Additionally, the emergence of this market is found to be partly a result of the reform-oriented state’s attempt to create national wholesale grain markets.

Originality/value – The findings of the paper might have implications for market development in both China and other transition economies.

Keywords China, National markets, Economic change, Crops

JEL code: Q13

1. Introduction

There has been a long-lasting interest among social scientists in understanding why and how a market economy emerges (for example, Polanyi, 1957; Weber, 1958; North, 1981; Olson, 1982; Evans, 1995). However, many of the existing studies have focused on either economic development or property rights, but not on the evolution of markets. If the market can be seen as a set of institutions (North, 1990), then it is more important to understand the institutional changes than to explain economic development. And explaining the evolution of markets is as important as understanding the changes in property rights.

Market transition in former state socialist economies provides an unusual opportunity to study the evolution of markets in the contemporary era. Markets in general were eliminated in all these economies but had re-emerged again since the market-oriented economic reforms. Yet, there is little research that has explicitly examined why and how markets have emerged and, subsequently, developed into a national market in these economies. Thus, this study tries to fill in this void based on the case of the grain market development in China's transition economy.

The purpose of this study is twofold. First, this study aims to understand whether an integrated national grain market had emerged by 2000. If the answer to the first question is positive, then the second purpose of the study is to test whether a key central policy (the construction of national wholesale grain markets in each provincial region) had contributed significantly to its emergence. To accomplish this goal, this study uses a unique network dataset on grain trade among all Chinese provincial regions in 2000. A formal social network analytical approach, namely the a priori blockmodelling method, is also used for analyzing the networked grain trade data.

This paper is organized as follows. Section 2 reviews the relevant literature related to the development of markets. Section 3 briefly reviews the history of the grain market reforms in China. Based on both Polanyi's view of the evolution of markets and the history of China's grain market reforms, section 4 proposes the research questions and hypotheses. Section 5 discusses data and methods, while Section 6 reports and discusses the empirical results. Lastly, some concluding remarks are provided in Section 7.

2. Review of Relevant Theories

There is a quite substantial body of historical literature on the evolution of markets in the Western economies. Some notable studies include Gras (1915)'s and Kneisel (1954)'s research on the evolution of the English corn market from the twelfth to eighteenth century, Gibson and Smout (1995)'s research on the evolution of the early modern Scottish grain market and Davis (1965)'s and James (1976)'s research on the emergence of the national money market in the United States in the late nineteenth and early twentieth century. Nevertheless, the previous studies have focused on convergence of prices across regions under the condition of free trade. However, if there is no free trade across regions, then one may not infer the emergence of a national market directly from price convergence. Instead, in order to study the emergence of a national market, the first step is to study whether there exists free trade across regions.

On the other hand, prior studies have approached the evolution of markets from a historical view. As such, they have focused primarily on the evolution process of each individual market, but not the mechanisms behind the emergence of a national market. Thus, the results from these studies, in general, cannot be generalized to other cases of market evolution.

Karl Polanyi is one of the pioneers who attempted to understand the evolution of markets during the emergence of a market economy from a more general, theoretical view. In his

classical work, Polanyi (1957:63-65) argued that the formation of a laissez-faire economy does not result from the spontaneous development of local markets. This is because local markets, usually controlled by territorial powers such as towns, often inhibited burgesses from long-distance trade. It is the “nationalization” of the local markets, Polanyi argued, that creates an integrated national market (internal market) through the deliberate actions of the state that enable laissez-faire. In other words, the emergence of an integrated national market needs the selective intervention of a powerful central government.

Polanyi’s view of market evolution is based on the experience of the great transformation from a feudal economy to a market economy in Western Europe. However, whether this view holds during the ongoing market transition in former state socialist economies is still an open question. The neo-liberal economists, for example, have argued for massive and rapid privatization and liberalization during market transition. According to their liberal view, the development of the remaining market institutions should be left to economic actors (Boycko, Shleifer, and Vishny, 1993; Sachs, 1996; see also discussions in Williamson, 2000). As such, in sharp contrast with Polanyi, the neo-liberal scholars usually argued that many deliberate government interventions, except for introducing private property and rule of law, are unnecessary, if not detrimental, for market development. Nevertheless, the problems that resulted from neo-liberal policy recommendations in some former state socialist countries may suggest that Polanyi’s insight might be still relevant to the contemporary transition economies. With the collapse of the party state and the emergence of a weak central government after the adoption of neo-liberal big-bang policies, a national market did not develop spontaneously. Instead, barter relations between enterprises flourished at least in the first decade of transition in Russia (see, for example, Burawoy and Krotov, 1992).

The evolution of China's grain market during the first two decades of economic reform (1978 – 2000) provides an excellent case to examine Polanyi's view in a market transition economy. This case is appropriate because of the following reasons. Firstly, after two decades of extensive market reforms, surplus grain had been circulated primarily through markets rather than a planned transfer system. Secondly, there were a large number of relatively independent regional grain markets in China. Each province, in fact, can be seen as a regional market for grain trade. Each provincial government also attempted to protect its market by erecting barriers preventing inter-regional grain trade due to stagnant grain supplies and rising grain prices in the 1990s (Findlay, 1998). Thirdly, in spite of barriers preventing inter-regional grain trade, the Chinese state – the central government – had been determined to create an integrated national grain market. And a number of central policies were promulgated to create this market in the first two decades of the reform.

3. Background: China's Grain Market Reforms (1978 – 2000)

Grain was circulated through the Unified Purchase and Sales System (UPSS), but not markets, during the pre-reform era (1949 – 1978). Under the UPSS, all grain surpluses of peasants were collected by the state in a planned price. The state then redistributed grain in planned quantities to urban citizens and peasants who did not grow grain. In 1960, people's communes were formed across the country to ensure that the UPSS was effectively enforced over the peasants. By doing so, the state collected substantial agricultural surpluses for industrial capital. However, because of low incentives for peasants to increase grain output under such a system, national grain output declined steadily. Partly as a result, the Chinese state initiated agricultural reform in 1978.

The state launched a series of fundamental reforms in the rural sector from 1978 to 1984 (Lin, 1992). The reforms at this stage were mostly aimed to increase peasants' incentives to grow grain. The reform measures included abolishing the collective farms under the people's communes, allowing rural households to be the basic agricultural production units, and increasing state purchase prices for grain. The state also allowed peasants to sell surplus grain in the local markets after selling the stipulated grain quota to the state. Urban citizens were also permitted to buy grain directly from peasants in the reemerged small local markets (Rozelle et al., 1997). Since each peasant household did not produce much surplus grain, private grain merchants emerged to take on the role of aggregation of products to supply to larger markets. As a result, a network of trade began to emerge (Findley, 1998). However, the local officials still considered grain outflow to other regions (except for centrally planned transfers) as illegal and destructive to the local economic order due to the legacies of a socialist shortage economy and of the Maoist closed local economy.

As it turned out, the first stage reform policies solved the incentive problem well and thus increased grain output dramatically. As a result, the state was encouraged to take an even bolder reform approach to promoting grain production. Hence, the state started the second stage of grain market reforms during 1985-1993. In 1985, the UPSS was largely replaced by the contract system. Under this new system, the state contracted with each household farm annually on the grain quota to be sold to the state at state-determined prices. Peasants could sell the remaining grain – over-quota grain – either to the state at government-protected prices or on the market at market prices. In 1988, the state issued an order to construct national wholesale grain markets, which meant large-scale physical marketplaces for grain trade in each province. By 2000, the state had already constructed around 150 large wholesale grain markets. (Yan and Shi, 2004;

Wang, 1999). The purpose of this policy was to create an integrated national grain market so that grain could be circulated freely within the whole nation according to market signals (State Administration of Grain, 2005; see also Ma, 1999; Wang, 2000). In 1990, the state also established State Grain Stocks in order to improve its ability of macro-adjustment in the national grain market.

The significant increase in grain output and the creation of national wholesale grain markets had significant effects on the grain consumption pattern of urban citizens. For the first time, quality and variety became more important concerns than quantity. This, in turn, resulted in the official abolishment of the UPSS in 1993 because the UPSS was originally set up to address the problem of long-term grain shortages, which was largely resolved by the early 1990s. For the same reason, the state also liberalized prices for all types of grain in the same year.

In 1993, the central government reformed the inter-provincial grain transfer system as well. There was a dual track system for inter-provincial grain transfer in the 1980s and early 1990s (Findley, 1998). One track was the planned transfer track whereby each province was given a quota for inter-provincial transfer at planned prices, which were lower than market prices. The other track was the market transfer track. Provinces could purchase from or sell grain to other provinces on the market after fulfilling the quota for planned transfer. In 1993, however, the central government began to eliminate the planned transfer track. As a result, inter-provincial grain transfer has since been undertaken primarily at market prices on national wholesale grain markets.

It seems that an internal grain market would have been created if there were no later setbacks in grain market reforms. Unfortunately, however, the development of the national grain market was interrupted during the third stage of the grain market reforms (1994 – 1997). This

interruption was due to several short-term problems on the grain market in 1994. The primary problem was the constant increase in grain prices, which was response to the stagnant grain production since 1985 and the abolishment of the UPSS in 1993 (Chen et al., 1999). And grain prices continued to rise even after the state had tried all the possible macro-adjustment measures, such as the release of the State Grain Stock (Findlay, 1998).

The problem of continuously rising grain prices, among others, resulted in a short period of setbacks in gain market reforms from 1994 to 1997. To deal with the problem, the state re-controlled the prices of quota grain and also attempted to influence market prices by setting price ceilings for grain on the market. In addition, it began to restrict private merchants in grain markets by granting state-owned grain enterprises the rights to monopolize 80 per cent of grain sales and purchases. Besides these measures, the state also divided the responsibilities of the central and regional governments. In 1995, the central government established the Provincial Governor's Responsibility System (PGRS), which required each province to be responsible for balancing the supply and demand for its own grain. On the other hand, the central government itself took the responsibility of using macro-adjustment measures, such as National Grain Stock and National Grain Risk Securities, to balance the supply and demand for grain among provinces (Lin and Wen, 1995). However, these measures did not solve the above problems satisfactorily. Instead, they actually aggravated these problems in provinces where local grain supplies did not meet local demand because the PGRS legitimized provincial-level measures inhibiting inter-regional grain trade.

In 1998, Premier Zhu Rongji initiated the fourth stage of grain market reforms. Under this wave of the reforms, the state began to take control of all grains purchases by allowing only state-owned grain enterprises (SOGEs) to purchase grains from peasants at state-protected prices.

However, it must be noted that the state also lifted the restrictions on entering into the grain sales markets for private merchants. This wave of the reforms was often criticized for simply aiming to bail out the failing SOGEs. However, the state made at least one attempt to promote the development of a national grain market. That is, it made SOGEs autonomous firms by liberating them from the control of regional/local grain administrative bureaus. By liberating the SOGEs, grain sales and purchases would have much less interference from regional/local governments. This would subsequently help to break the barriers preventing inter-regional grain trade, which had been intensified since 1994.

4. Research Questions and Hypotheses

The above historical review suggests that local grain markets came into being spontaneously soon after the Chinese state initiated rural reform in 1978. These markets emerged because peasants were allowed to sell their surplus grain from their household farms in local marketplaces. And some of these markets soon developed into large regional ones because a number of enterprising private grain merchants found profitable opportunities to take on the role of aggregation of surplus grains of rural households to supply to urban consumers. By 2000, it was reported that there were tens of thousands of local markets and hundreds of regional markets in China (State Administration of Grain, 2004).

However, it was not possible for an integrated national grain market to emerge spontaneously from the development of the local and regional grain markets. There are at least two reasons for this. First and foremost, during market development, there are often conflicts of interests between regional/local authorities, which inhibit long-distance trade (Polanyi, 1957). In China, local protectionism had been a serious problem from the time the economic reforms

started, especially since the mid 1980s (Montinola, Qian and Weingast, 1995; Weingast, 1995). The political future of regional bureaucrats was linked to regional economic growth rates and regional welfare. Thus, inter-regional trade for goods was often obstructed because bureaucrats had the incentives to block the import of competing goods or the export of scarce goods in order to protect local interests. Since the mid 1980s, grain was a scarce good in China due to stagnant domestic supplies and increasing demands from an expanding wealthier population (Brown, 1995). Additionally, grain supplies in many provincial regions could barely meet the local demands in China. Thus, many provinces were motivated to block the outflow of grains to other regions, especially after the PGRS was established in 1995.

Secondly, certain institutions and beliefs associated with the previous planned economic system still had a strong influence on political and economic actors due to the gradual reform strategy that the Chinese state had adopted. Institutions such as the UPSS and the planned inter-provincial grain transfer system, although officially “abolished” in 1993, were not completely absent even in the early 21st century. Furthermore, due to the legacy of a socialist planned economy, grain outflow to other territories (except for centrally planned transfers) was seen by many local officials as destructive to the local economic order. Such institutions and beliefs would severely obstruct inter-regional grain trade based on the market mechanism.

As an integrated national market could not develop from regional/local markets spontaneously, intervention of a powerful central government may be indispensable for the emergence of a national market (Polanyi, 1957). During China’s market transition, the central reformers were often hampered by the conservatives. However, in spite of this, the former had indeed shown consistent determination to create an integrated national grain market. This was clearly seen in the 1980s and 1990s when the central government adopted measures to facilitate

grain trade based on the market mechanism. One of the key measures was the construction of the national wholesale grain markets in each provincial region. This measure was crucial because these large-scale marketplaces served as the instruments for long-distance grain trade. Many other central policies, such as the establishment of State Grain Stocks in 1990 and the liberalization of the SOGEs from regional/local governments, all aimed to increase the effectiveness and efficiency of the national wholesale grain markets. Knowing their central importance, the central reformers were determined to construct hundreds of national wholesale grain markets across the country. By 2000, around 150 of such marketplaces had been created with an average constructing speed of about 12 marketplaces per year (Wang, 1999).

The above discussions suggest that there existed both pushing and pulling forces, which tried to lead China's grain market evolution into opposing directions. On the one hand, conflict of interests between local authorities, together with old institutions and beliefs, obstructed the emergence of an integrated national grain market. On the other hand, the central reformers were determined to facilitate the emergence and development of such a market. Given the existence of these antagonistic forces, it may be expected that the emergence of an integrated national grain market (should it occur) will be an incremental, gradual process.

Two questions, therefore, could be asked. The first question is:

Question 1. Given the existence of these opposing forces, what was the status of grain market development in China by 2000 after two decades of grain market reforms? In other words, had an integrated national grain market emerged by 2000?

This question can be further divided into two sub-questions based on the two dimensions of a national grain market. The first dimension is the spatial one. If a national grain market has emerged, then there should be free circulation of grain between different regions. However, free

circulation of grain is only a necessary but not sufficient condition for the emergence of a national market. A planned inter-regional grain transfer system can also achieve smooth grain circulation among regions, as China did before the economic reform. Thus, the market dimension, which was strongly emphasized by Polanyi (1957), should also be introduced. According to this dimension, circulation of grain between different regions should be directed by market prices of grain or by the supply-side and demand-side factors that determine the market prices. Based on both dimensions, we have the following two questions.

Question 1.1. Was inter-regional grain trade spatially integrated by 2000?

Question 1.2. Was inter-regional grain trade directed by the supply-side and demand-side factors that determine market prices of grain?

If the answers to questions 1.1 and 1.2 are positive, then we want to understand how the integrated national grain market emerged. In particular, to examine Polanyi's view of market evolution, we want to know whether the central policy of constructing national wholesale grain markets had facilitated the emergence of this market. Thus, we have the following question:

Question 2. Did the central policy of construction of national wholesale grain markets have a significantly positive effect on inter-regional grain trade and thus the emergence of the national grain market?

According to Polanyi's view of market evolution, and given the existence of both pushing and pulling forces for grain market development in China, it is hypothesized here that, on

condition that the answers to questions 1.1 and 1.2 are positive, the state action to construct national wholesale grain markets should have a positive effect on the emergence of the national grain market. Thus, we have the following hypothesis:

Hypothesis 1. Inter-regional grain trade would more likely exist among provinces with more national wholesale grain markets.

The reasons for the above hypothesis are as follows. Firstly, national wholesale grain markets, which were under the direct control by the central government, could curb local protectionism and render protectionist government behaviors ineffective. Secondly, national wholesale grain markets served as centers for collecting and disseminating market information on both local/regional markets and the national market. Thus, provinces with more national wholesale grain markets had advantages in obtaining market information and would hence respond to the market more swiftly. As a result, the more national wholesale grain markets in a province, the more likely that province will trade with other provinces. Particularly, provinces with more national wholesale grain markets would more likely trade with each other.

5. DATA AND METHOD

The dataset used for answering the questions and testing the hypotheses includes information about inter-provincial grain trade on China's grain market from November 1999 to October 2000. The data were primarily collected from grain trade websites set up by the State Administration of Grain and the web pages of several national wholesale grain markets. The data were supplemented by personal consultations with two grain experts in Beijing. Since Internet trade can greatly reduce transaction costs, especially information-search costs, it had become an

important mode for inter-provincial grain trade. Thus, both the central government and most national wholesale grain markets had created websites for grain trade by 1999. Based on the recommendations made by two grain experts, I relied mainly on the following web pages for data collection: China Net of Grain¹, Igrain Net², China Net of Grain & Oil Information³, China Cereals Trade Net⁴, National grain & Oil Information Web of China Fuzhou Grain Wholesale Market⁵, and Internet Web Pages of Jilin Grain Exchange Market⁶.

In China, grain includes five categories: rice, wheat, corn, soybeans and tubers. The data included only inter-provincial trade of the three primary types of grain: rice, wheat, and corn. These three types of grain accounted for about 86 per cent of China's total grain output and around 85 per cent of grain consumption in the late 1990s (*China Official Annual Report 1998*:1134; Findlay, 1998). The information about inter-provincial trade of these three types of grains was collected from market reports and market information boards of the above web pages every month from November 1999 to October 2000. Unfortunately, in most of the cases, only the information about the direction, but not the quantity, of grain flows among provinces could be located. Thus, the resulting data included only the direction of grain flows on the market among all provinces during the whole research period. In addition, the market reports and market information boards usually only recorded those inter-regional grain trade involving large quantities of grain. As such, the resulting data may be biased because grain transactions

¹ <http://www.cngrain.com>, accessed from November 1999 to October 2000.

² <http://www.igrain.com.cn/igrain>, accessed from November 1999 to October 2000.

³ <http://www.cof.net.cn>, accessed from November 1999 to October 2000.

⁴ <http://www.cctn.com.cn/cctn>, accessed from November 1999 to October 2000.

⁵ http://go5.163.com/~fzlspf/new_page_5.htm, accessed from November 1999 to October 2000.

involving small quantities of grain may be truncated in the data. However, although somewhat coarse and biased, the networked grain trade data were better suited for answering the above questions than traditional trade data. This is because the latter usually includes only information on inflow and outflow quantities of each province but not the origin and destination of each transaction.

Following Wasserman and Faust (1997), I have coded “1” for $A \rightarrow B$ if there was grain flowing from province A to province B on the market during the whole period from November 1999 to October 2000; “0” otherwise. Since there were 30 provincial districts⁷, the resulting network data were a dichotomized, directed, 30×30 matrix (see Appendix 1 for the whole data).

Two quick points can be made on the data. Firstly, as mentioned above, there existed many local grain markets in each province. As such, reflexive relations from each province to itself also existed. Hence, the main diagonal of the matrix is “1”s. The second point is that there are 158 directed arcs (“1”s) in the matrix. Since the total possible number of arcs is 900 for a 30×30 matrix with main diagonal “1”s, the overall density of this matrix is 0.176 (158/900).

A Priori Blockmodelling Method

A priori blockmodelling method, which was first developed by Wayne Baker (1982), is a revision of the basic blockmodelling approach. The basic blockmodelling approach includes three steps. First, the original social network data are permuted into distinct sets (called *blocks*), based on the rule of structural equivalence. This is to make each set homogeneous not only internally but also in its relations to every other set. Second, submatrix density (δ -density) is calculated for each block. A submatrix is called a “dense submatrix” and is thus assigned “1”

⁶ http://6688.ccec.com.cn/new_info/20000808_zjlt1.html, accessed from November 1999 to October 2000.

(oneblock) if its density is no less than the overall density of the whole matrix (called α -density) (Wasserman and Faust, 1997:400). Otherwise, it is called a “sparse submatrix” and is assigned “0” (zeroblock). The resulting image (called *blockmodel*) is a reduced-form representation of the original network. Third, goodness-of-fit index is calculated to judge the validity of the blockmodel. The a priori blockmodelling method is very similar to the basic one. All are the same except for the first step, which is based on a priori aggregation standards in a priori blockmodelling, instead of the rule of structural equivalence.

Variables

Based on the research questions, four variables are used as the a priori aggregation standards to permute the networked grain trade data into blocks. These variables are discussed below.

Spatial differentiation. In order to understand question 1.1, i.e., whether inter-regional grain trade was spatially integrated, I divided the 30 provincial regions into four a priori geographic groups: *North, Southeast, South-central, and West*. There are two reasons for this geographic grouping. The first reason is that provincial regions in each of the four geographic groups are geographically approximate to each other. As such, grain trade naturally should be much easier within each group than between groups. In addition, since 1993, there had been planned, as well as market-based, grain flows among provinces in the same geographic group through the Grain Adjustment Meeting among Spatially Proximate Provinces under the arrangement of the central government. This served to balance the supply and demand within each geographic group (Chinese Academy of Sciences, 1997; Lin and Wen, 1995). See Appendix 2.1 for the group identity of each province based on this variable.

⁷ Chongqing Municipal City was considered a part of Sichuan Province here.

Grain output per capita. The market dimension emphasized by Polanyi suggests that grain should flow from provinces with surplus grain to provinces short of grain if an integrated national grain market has emerged. According to China's National Statistical Bureau, provinces with grain output per capita (GOPC) greater than 385 kg are considered grain-surplus regions (*China Information News*, November 30, 2006). Therefore, I have partitioned the 30 provincial regions into four a priori groups based on their GOPC, which was obtained from *Rural Statistical Yearbooks of China* and was taken as a three-year average from 1996 to 1998. The four groups are as follows. Provinces with GOPC greater than 470 kg are coded as *provinces with sufficient surpluses*. Provinces with GOPC ranging from 385 kg to 470 kg are coded as *provinces with marginal surpluses* and those with GOPC ranging from 320 kg to 385 kg as *self-sufficient provinces*. Lastly, those with GOPC of less than 320 kg are coded as *provinces short of grain*. Different partition schemes were also tried and the results virtually do not change much. See Appendices 2.1 and 2.2 for GOPC and group identity of each province based on GOPC.

Living standard. According to the market dimension, those provinces with higher living standards tend to have more grain inflows if a national grain market has emerged. This would be true even when provinces with higher living standards are themselves grain-surplus provinces because citizens in these provinces tend to be concerned more about quality and varieties of grain. For example, citizens in Jiangsu, a both grain-surplus and affluent province, have a preference for white wheat, which are mainly imported from Henan and Shandong provinces, over red wheat, which is mainly produced in Jiangsu, because white wheat has better quality than red wheat.

Living expenditure per capita (LEPC) is one standard measure for living standards in the literature. Because most peasants can feed themselves and usually only urban citizens buy grain

from markets, I have only used LEPC for urban citizens. This variable is obtained from *Statistical Yearbooks of China* by averaging LEPC of urban citizens in each province from 1996 to 1998. The mean LEPC in the nation was around 4000 RMB (about US\$500 in 2000) in the data. I have coded provinces with LEPC greater than 4500 RMB as *rich provinces*; provinces with LEPC ranging from about 4000 RMB to 4500 RMB as *relatively rich provinces*; provinces with LEPC ranging from 3500 RMB to 4000 RMB as *relatively poor provinces*; and those with LEPC less than 3500 RMB as *poor provinces*. Attempts were also made to use different partition schemes but the results virtually did not change much. The average LEPC and the group identity of each province based on the average LEPC can be found in Appendices 2.1 and 2.2.

Number of national wholesale grain markets (NWGMs). Information on the number of NWGMs in each province was obtained from the web page for “Zhongguo Liangyou Pifa Shichang” (China’s national wholesale grain and oil markets) (see also State Administration of Grain, 2004)⁸. In total, there were 147 NWGMs by 2000 with the average number of NWGMs for each province as 4.8. Based on this variable, I have partitioned all the provinces into four groups: *market most-developed provinces* (with more than 9 NWGMs), *market developed provinces* (with 5-9 NWGMs); *market developing provinces* (with 3-4 NWGMs); *market undeveloped provinces* (with less than 3 NWGMs). I have tried different partition schemes and the results still support the hypothesis. Here I have used number of NWGMs but not number of NWGMs per capita (or number of NWGMs divided by urban population) for answering question 2, as well as testing the hypothesis. The reason is as follows. Virtually, every NWGM was very large and could serve a huge amount of population. Thus, in general, the more the NWGMs, the less effective the provincial government’s efforts were in obstructing inter-regional trade.

This, in turn, allowed market information to be collected and disseminated more efficiently. See Appendices 2.1 and 2.2 for the number of NWGMs and the group identity for each province based on the number of NWGMs.

The correlations between the above variables (excluding spatial differentiation) are as follows. Living standard is negatively correlated with grain output per capita ($r = -0.52$), but has a slightly positive relationship with the number of NWGMs ($r = 0.12$). Grain output per capita has a moderately positive relationship with the number of NWGMs ($r = 0.37$). These patterns might suggest that the central government intentionally constructed more NWGMs in richer provinces (such as Beijing, Tianjin, and Zhejiang) and, particularly, in provinces with more grain output (such as Jilin, Heilongjiang, and Shandong). This served to facilitate inter-regional grain trade because richer provinces were usually short of grain and had to import grain from provinces with more grain output (Wang, 2000).

Indeed, many other variables (e.g., the number of grain enterprises in a region, the development of the transportation system, and other national level grain policies) could also have an effect on the pattern of inter-regional grain trade. Unlike regression analysis, however, the blockmodelling method does not control for these other factors:

Question 3. Will these other variables bias the empirical results reported in this paper?

To answer this question, remember that the main argument of the paper is that the number of NWGMs is one of the immediate causes for the formation of an integrated national grain market. And thus, this paper aims to test the overall effect of the number of NWGMs on inter-regional grain trade. It could be argued that some variables, such as the number of grain enterprises in a region and the development of the transportation system, may have an effect on the number of NWGMs because the central government often took these factors into

⁸ <http://xzhljy12.363.net>, accessed from November 1999 to October 2000.

considerations when making decisions on how many national wholesale grain markets should be constructed in each region. Thus, these variables affect inter-regional grain trade partly through their effect on the number of NWGMs. Other variables, such as the other national level grain policies (e.g., the policy to establish State Grain Stocks), often affect inter-regional grain trade directly through the national wholesale grain markets. Given the above reasoning, we could argue that these other variables may be highly correlated with the number of NWGMs, and they affect inter-regional grain trade through NWGMs at least partly.

Goodness-of-fit Index for Evaluating Blockmodels

The Carrington-Heil-Berkowitz (CHB) index is often used to evaluate how well blockmodels fit the underlying network data (Wasserman and Faust, 1997). For directed social network data whose main diagonal elements are defined, the CHB index is defined as follows:

$$\delta_{b2} = \frac{1}{g(g-1)\alpha} \sum_{k=1}^B \sum_{m=1}^B \left\{ \frac{[(o_{km} - o_{km}^*)^2]}{[o_{km}^* (t_{km})^2]} \right\}$$

Where

g = number of nodes in a matrix

α = matrix density of the whole data

B = number of defined blocks in the matrix

O_{km} = number of “1”s in the $(k, m)^{\text{th}}$ block

O_{km}^* = expected number of “1”s in the $(k, m)^{\text{th}}$ block

= “ $g_k g_m \alpha$ ” if $k \neq m$; or “ $g_k g_k \alpha$ ” if $k = m$

t_{km} = “1”, if $\delta_{km} < \alpha$; or “ $(1 - \alpha)/\alpha$ ”, otherwise;

Here, δ_{km} is the submatrix density of each block.

This index calculates the sum of deviations of the data from the target blockmodel (that is, the reduced form representation of the original network based on steps 1 and 2) and ranges from 0 to 1. The smaller the CHB index is, the better the blockmodel fits the network data. However, there is still no developed standard for evaluating δ_{b_2} (Wasserman and Faust, 1997:684). Wasserman and Faust (1997: 690) treated $\delta_{b_2} = 0.499$ as an evidence of good fit of the blockmodel to the original network data in their example. Thus, I have used $\delta_{b_2} = 0.499$ as the critical value; and the blockmodel would be considered to fit the original network data well if $\delta_{b_2} < 0.499$.

Ideal Image

In a 4×4 blockmodel, if the submatrix densities (δ -densities) in all 16 blocks are the same as the overall density of the whole matrix (α -density) and thus every block is a oneblock, the blockmodel is said to have the amorphous blockmodel image as in Table 1 (Baker, 1992):

Table 1. Amorphous Blockmodel Image

1	1	1	1
1	1	1	1
1	1	1	1
1	1	1	1

Such an amorphous or ideal image would result when the variable used to permute the original data has no significant effect on inter-regional grade trade. Only when the blockmodels deviate significantly from this amorphous image, can we claim that the explanatory variables have significant effects on inter-regional grade trade.

6. Results and Discussions

Following the a priori blockmodeling method, I first permuted the networked grain trade data into distinct blocks based on each of the above four variables. Next, I calculated δ -density for each block, which is then assigned as a oneblock (denoted as “1”) if the δ -density is greater than the overall matrix density (α -density) or a zeroblock (denoted as “0”), otherwise.⁹ In the third step, δ_{b_2} is calculated to evaluate if the blockmodel represents the original network data significantly well. Lastly, I compared the blockmodel with the ideal blockmodel image to see how each variable affects inter-regional grain trade.

Results for Question 1.1.

To answer Question 1.1, namely, whether inter-regional grain trade had been spatially integrated by 2000, the variable – *spatial differentiation* – is used to partition the data. The following blockmodel image is obtained as a result.

Based on the value of δ_{b_2} , this blockmodel fits the original data very well. By comparing this blockmodel image to the ideal image, we see that it deviates from the latter. Thus, overall, the national grain market was not spatially integrated. Nevertheless, it can be seen that the three eastern provincial groups (that is, the north, the southeast, and the south-central) were quite integrated, as the partial blockmodel image that covers these three groups consists of all oneblocks except for the (3,2)th block (from south-central to the southeast).

⁹ Depending on whether we include the main diagonal, there are two values for α -density. One of these values is 0.176 if we include the main diagonal; the other is 0.142, if we exclude the main diagonal. Based on Wasserman and Faust (1997), I have used 0.142 as the standard for α -density in off main diagonal blocks but 0.176 as the standard for α -density in blocks on the main diagonal.

The grain trade among the nine western provinces was somewhat frequent as the δ -density in the (4,4)th block is about 0.20, which is greater than the α -density. However, these provinces were still largely out of the national grain market. By examining the western provinces, however, three provinces were short of grain, three were self-sufficient, and three had surplus grain. Therefore, the western provinces would be better off if they joined the national market. One important reason as to why the western provinces were still out of the national market may be that they had always lagged behind in grain market reforms. As a result, there were still very few national wholesale grain markets in the western region by 2000. In fact, all provinces in this region except Sichuan and Xinjiang were still undeveloped in terms of the development of NWGMs (see Appendix 2.2).

It is also seen that the δ -densities on the main diagonal are much higher than those off the main diagonal. This suggests that grain trade within each geographic group was much more intensive than grain trade among groups. Thus the central government's efforts to facilitate grain flow among provinces in the same geographic group since 1993 were indeed quite effective. The δ -densities also suggest that, contrary to the pre-reform era, grain was flowing primarily from the north to the south in 2000. This may be partly because the rapid development of rural industry reduced the comparative advantage of growing grain in the southern provinces (Naughton, 1995).

Results for Question 1.2.

In order to answer question 1.2., namely, whether inter-regional grain trade was sensitive to supply-side and demand-side factors that determine grain market prices, two variables – *grain*

output per capita and *living standards* – are used to partition the data. As such, the following two blockmodel images are obtained.

Based on the values of δ_{b2} , both blockmodel images fit the original data quite well. In addition, both blockmodel images have been found to deviate significantly from the ideal image, suggesting that both grain output per capita and living standards have significant effects on inter-regional grain trade. From Table 3, it can be seen that provinces with sufficient surplus had grain outflow to all other groups but rarely had grain inflow from other groups. Provinces with marginal surplus had grain inflow from provinces with sufficient surplus, as well as outflow to self-sufficient provinces and provinces short of grain. Self-sufficient provinces and provinces with grain shortages had grain inflow from the above two groups of provinces. However, they rarely had grain outflow to other groups and even other provinces in the same group. This can be seen from the reflexive relations in the (3,3)th and (4,4)th blocks. Therefore, this blockmodel image demonstrates that grain indeed flowed from provinces with surpluses to those with less grain, as one might expect if the national grain market was integrated.

Table 4 suggests that *living standards* also have the expected effects on inter-regional grain trade. Compared to other groups, the group of rich provinces had significantly higher grain inflow from all other groups, as seen in the larger δ -densities in the blocks in column 1. The relatively rich provinces also had significant grain inflow from the two groups of poor provinces. However, the two groups of poor provinces had much less grain inflow, as shown in the small δ -densities in the blocks in columns 3 and 4. These results suggest that those provinces with higher living standards had indeed more grain inflow.

It is true that the pattern in Table 4 may be explained not only by *living standards* (urban citizens in richer provinces had higher demand for not only higher quality but also more

varieties), but also by the fact that most poor provinces were also grain-surplus provinces (the correlation between *living standard* and *grain output per capita* is -0.52; also see Appendix 2.2). However, *living standards* are still important to account for the pattern in Table 3. This is because some rich and relatively rich provinces were also provinces with surplus grain (see Appendix 2.2).

The results above show that although there were still anti-market obstacles from local protectionism, inter-regional grain trade was sensitive to the demand-side and supply-side factors that determine grain market prices. Thus, the results for questions 1.1 and 1.2 suggest that a partially integrated national grain market (which included all provinces except the western ones) had been emerging in China. In the next section, I will test whether the state action of constructing NWGMs had a significantly positive effect on the emergence of the partially integrated national grain market.

Results for Question 2.

To answer question 2, that is, whether the construction of NWGMs had a positive effect on the emergence of the national grain market, I have used *the number of NWGMs* to partition the data. The following blockmodel image is hence obtained.

Based on the value of δ_{b2} , this blockmodel fits the original data well. In addition, Table 5 shows that this image is very different from the ideal image. Thus, the state's attempt to construct NWGMs did have a significant effect on inter-provincial grain trade. To see how *the number of NWGMs* affected inter-regional grain trade, it can be seen from the δ -densities that grain was primarily traded among three groups: market-most-developed provinces, market-developed provinces, and market-developing provinces. However, the market-undeveloped

provinces had very little grain trade with the other groups or even with provinces within the same group (as seen from the reflexive relations in the (4,4)th block). Nevertheless, almost half of the market-undeveloped provinces were ones that were short of grain while the other half were just self-sufficient. This means that this group would definitely benefit from trading with others on the national grain market, rather than continue relying on the central government for grain transfer. Thus, these results support the hypothesis, namely, inter-regional grain trade should exist more likely among provinces with more national wholesale grain markets.

In addition, it is seen that the δ -densities on the main diagonal decrease as NWGMs decreases: 0.52 for market most-developed provinces, 0.45 for market developed provinces, 0.22 for market-developing provinces, and 0.11 for market-undeveloped provinces. As such, provinces with more national wholesale grain markets are more likely to trade with each other. Thus, the state's attempt to construct NWGMs indeed had a positive effect on inter-regional grain trade.

By examining the group of provinces that had less than three NWGMs, it can be seen that seven out of the nine provinces (except Guangxi and Hainan) were located in the western region (see Appendix 2.2). As the relatively smaller western population was sparsely distributed across vast areas and the transportation system was still poor in the western region by 2000, the central government might feel that it was inefficient to construct NWGMs. As a result, market development in this region was rather slow. The lack of NWGMs in this region, therefore, explains why the national grain market was only partially integrated in the east regions, as observed from the patterns in Table 2.

7. Concluding Remarks

This paper has examined Karl Polanyi's view of market evolution in the context of the emergence of a national grain market in China's transition economy. Polanyi argued that a national market would not result from spontaneous development of local markets during economic transformation. Such a market would not emerge mainly due to the conflicts among local interests. According to him, selective government interventions from a nation-state are therefore necessary for the emergence of a national market. Polanyi's view, however, is based on the experience of the great transformation from a feudal economy to a market economy in Western Europe. Whether this view is still useful to understand contemporary economic transformations (especially the ongoing market transition in former state socialist economies) is yet an open question.

Based on the case of the evolution of the national grain market in China's transition economy, this paper suggests that Polanyi's view of market evolution may still hold in contemporary transition economies. This paper finds that a partially integrated national grain market had emerged at the beginning of the 21st century in China in spite of local protectionism. Additionally, the emergence of this market was found to be partly a result of the reform-oriented state's attempt to create national wholesale grain markets.

The significance of central government intervention in China's grain market development may have implications for market development in general in both China and other transition economies. Firstly, central government intervention to create national wholesale markets (or other types of national level markets such as futures market for grain) may be a necessary measure to facilitate long-distance trade and thus, a modern market economic system in China. This is not only because of local protectionism and anti-market institutions and beliefs. When discussing why a modern market economy could not develop during imperial China, Fernand

Braudel (1977) argued that the lack of intricate exchange mechanisms: fairs and bourses (large wholesale markets), together with the hostility of Chinese imperial courts to these higher forms of exchange, was the most important reason because it discouraged long-distance trade. What the contemporary Chinese state did during the reform era, however, is different from its predecessors. For example, it had deliberately created national wholesale markets in order to facilitate a national market. Given that the majority of the people have benefited handsomely from the development of such large wholesale markets, it can be argued that the road to a modern market economic system is irreversible.

A second implication is that this paper's findings imply that central government interventions may be indispensable for a successful economic transformation in transition economies. Regardless of the reform strategies – gradual reform or big-bang policy – that they have adopted, most transition economies had a weak genuine private sector. Local governments in many such economies also usually had the power and incentive to facilitate local development. As a result, local protectionist measures were often in place and this obstructed long-distance trade. The “dukedom local economy” in China was one such example (Montinola, Qian and Weingast, 1995; Weingast, 1995); the flourishing barter relationship between enterprises in the first decade of transition in Russia was another (see, for example, Burawoy and Krotov, 1992). Therefore, government intervention from a reform-oriented state may be necessary to facilitate long-distance trade and the emergence of a national market.

Nevertheless, it should be noted that not all types of government intervention are helpful for market development. As we have learned from the history of grain market reforms in China, the state had also made some anti-reform policies in the name of “grain market reforms”. These policies included excluding private grain merchants from grain trade and permitting state-owned

grain enterprises to monopolize grain purchase since 1994. Such policies often resulted in trade inefficiency in the national grain market (Zheng, 1998). However, these “state interventions in emerging markets aimed to protect state monopolies also contributed to the increased regulatory burden of the state” (Nee, 2000). In 1998, the state had to permit private merchants to enter grain sales markets (but entry to purchase markets was still not permitted) in order to increase the efficiency of grain flows. In 1999, the state also divided the Central Reserve Bureau of Grain, which was both a government bureau and a grain administrative corporation, into two organisations:

- (1) the Central Bureau of Grain that is responsible for macro-control of national grain flows, and
- (2) General Administrative Corporation of National Reserve Grain which is in charge of national grain stock.

These measures suggest that the Chinese state was aware of the negative effects of too much (and often inappropriate) government intervention. Consequently, the government had started developing into a regulatory state, one that selectively intervenes in the economy through relatively independent regulatory bodies.

Since 2000, the Chinese government has accelerated the construction of national wholesale grain markets and there were more than 600 such markets throughout the whole nation by 2007 (*Shanghai Securities News*, September 21st, 2007). Given the increasing and more efficient use of information technology among national wholesale grain markets (Yan and Shi, 2004), one might be able to obtain better inter-regional grain grade data with more detailed information, i.e., not only the information about the direction, but also the quantity of grain flows

among regions. If so, future research may use more recent inter-regional grain grade data to further examine the development of the national grain market in China since 2000.

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Table 2. Blockmodel image based on spatial differentiation

	North	Southeast	South-central	West
North(8)	1 (0.359/23)	1 (0.339/19)	1 (0.250/12)	0 (0.111/8)
Southeast(7)	1 (0.143/8)	1 (0.510/25)	1 (0.167/7)	0 (0.032/2)
South-central(6)	1 (0.167/8)	0 (0.095/4)	1 (0.361/13)	0 (0.093/5)
West(9)	0 (0.056/4)	0 (0.032/2)	0 (0.037/2)	1 (0.198/16)
Goodness of fit	$\delta_{b2} = 0.105 < 0.499$, significant			

Notes:

- (1) The rows represent the outflow provinces and the columns the inflow provinces.
- (2) The numbers in the parentheses beside each category are the number of provincial regions in the category.
- (3) The number “1” or “0” in each block indicates whether the block is a oneblock or zeroblock.
- (4) The numbers in the parentheses within each block are δ -density before “/” and number of ties after “/”, respectively.

Table 3. Blockmodel image based on grain output per capita

	Sufficient surpluses	Marginal surpluses	Self-sufficient	Short of grain
Sufficient surpluses(7)	1 (0.306/15)	1 (0.411/23)	1 (0.286/12)	1 (0.381/24)
Marginal surpluses(8)	0 (0.107/6)	1 (0.344/22)	1 (0.271/13)	1 (0.319/23)
Self-sufficient(6)	0 (0/0)	0 (0.021/1)	Reflexive (0.167/6)	0 (0.056/3)
Short of grain(9)	0 (0/0)	0 (0/0)	0 (0.019/1)	Reflexive (0.111/9)
Goodness of fit	$\delta_{b2} = 0.313 < 0.499$, significant			

Notes:

- (1) The rows represent the outflow provinces and the columns the inflow provinces.
- (2) The numbers in the parentheses beside each category are the number of provincial regions in the category.
- (3) The number “1” or “0” in each block indicates whether the block is a oneblock or zeroblock.
- (4) The numbers in the parentheses in each block refer to the δ -density before “/” and number of ties after “/”, respectively.
- (5) “Reflexive” in (3,3)th and (4,4)th blocks means that each province in these blocks does not trade with other provinces in its own group.

Table 4. Blockmodel image based on living expenditure per capita

	Rich	Relatively rich	Relatively poor	Poor provinces
Rich (8)	1 (0.250/16)	0 (0/0)	0 (0/0)	0 (0.013/1)
Relatively Rich(5)	1 (0.175/7)	1 (0.280/7)	0 (0.086/3)	0 (0.080/4)
Relatively poor (7)	1 (0.339/19)	1 (0.200/7)	1 (0.204/10)	1 (0.243/17)
Poor provinces(10)	1 (0.263/21)	1 (0.180/9)	1 (0.143/10)	1 (0.270/27)
Goodness of fit	$\delta_{b2} = 0.139 < 0.499$, significant			

Notes:

- (1) The rows represent the outflow provinces and the columns the inflow provinces.
- (2) The numbers in the parentheses parenthesis beside each category are the number of provincial regions in the category.
- (3) The number “1” or “0” in each block indicates whether the block is a oneblock or zeroblock.
- (4) The numbers in the parentheses in each block refer to the δ -density before “/” and number of ties after “/”, respectively.

Table 5. Blockmodel image based on the number of national wholesale grain markets

	Most developed	Developed	Developing	Undeveloped
Most developed(5)	1 (0.520/13)	1 (0.257/9)	1 (0.378/17)	0 (0.022/1)
Developed(7)	1 (0.343/12)	1 (0.449/22)	1 (0.444/28)	0 (0.095/6)
Developing(9)	0 (0.067/3)	1 (0.143/9)	1 (0.222/18)	0 (0.124/10)
Undeveloped(9)	0 (0/0)	0 (0.016/1)	0 (0/0)	Reflexive (0.111/9)
Goodness of fit	$\delta_{b2} = 0.220 < 0.499$, significant			

Notes:

- (1) The rows represent the outflow provinces and the columns the inflow provinces.
- (2) The numbers in the parentheses beside each category are the number of provincial regions in the category.
- (3) The number “1” or “0” in each block indicates whether the block is a oneblock or zeroblock.
- (4) The numbers in the parentheses in each block refer to the δ -density before “/” and number of ties after “/”, respectively.
- (5) “Reflexive” in (4,4)th block means that each province in these blocks does not trade with other provinces in its own group.

Appendix 1. Network Data for Inter-Provincial Grain Trade in 2000

		1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 3																														
		1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	
		f	s	s	b	z	g	h	t	g	j	g	q	x	h	j	s	l	n	g	y	n	s	h	a	h	h	s	h	x	j	
		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
1	fujian	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
2	shanghai	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	sichuan	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
4	beijing	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
5	zhejiang	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
6	guizhou	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
7	heilongjiang	1	1	1	1	1	0	1	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	1	1	0	0	
8	tianjin	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
9	gansu	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
10	jiangxi	1	1	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
11	guangdong	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
12	qinghai	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
13	xingjiang	1	0	1	1	0	1	0	1	1	1	1	1	1	0	0	1	0	1	1	1	1	0	1	0	1	0	0	0	0	0	
14	henan	1	1	1	1	0	0	1	1	1	1	1	1	0	1	1	1	1	0	1	0	1	1	1	0	0	1	1	0	0	1	
15	jilin	1	1	1	1	1	0	0	0	0	1	1	0	1	1	1	0	1	0	1	0	1	1	1	1	1	1	1	1	0	0	
16	shaanxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
17	liaoning	1	1	1	1	1	0	0	1	0	0	1	0	0	1	0	0	1	0	0	0	0	1	0	0	0	1	1	0	0	0	
18	ningxia	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
19	guangxi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	
20	yunnan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	
21	neimeng	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
22	shanxi	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	
23	hebei	0	0	1	1	0	0	0	1	0	1	0	1	0	0	0	1	0	0	0	0	0	1	1	1	0	1	1	0	0	0	
24	anhui	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	
25	hunan	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
26	hubei	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0	0	0	0	1	0	0	0	1	0	0	0	
27	shandong	1	0	1	1	1	0	0	1	0	1	1	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	1	1	0	0	1
28	hainan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	
29	xizang	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
30	jiangsu	1	1	0	1	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

Notes: The rows represent the outflow provinces and the columns the inflow provinces.

Appendix 2. Attributes and Blockmodel Identities of Each Province

2.1 Attributes of Each Province based on the Four Variables (Spatial differentiation, Living expenditure per capita, Grain output per capita, Number of national wholesale markets)

	Spatial differentiation	Living expenditure per capita (RMB)	Grain output per capita (kg)	Number of national wholesale grain markets
Beijing	North	6410	190.6	9
Tianjin	North	5118	218.7	6
Hebei	North	3754	433.2	4
Shanxi	North	3177	326.4	8
Neimenggu	North	2968	652.2	3
Liaoning	North	3701	387.9	8
Jilin	North	3298	845.2	7
Heilongjiang	North	3208	816.7	13
Shanghai	Southeast	6816	155.1	3
Jiangsu	Southeast	4493	489	16
Zhejiang	Southeast	6050	337.8	11
Anhui	Southeast	3692	441	6
Fujian	Southeast	4788	292.8	2
Jiangxi	Southeast	3136	411.3	7
Shandong	Southeast	3984	473.5	10
Henan	South-Central	3267	425.1	7
Hubei	South-Central	3881	433.1	4
Hunan	South-Central	4262	421.5	4
Guangdong	South-Central	6881	270.4	4
Guangxi	South-Central	4391	333.4	0
Hainan	South-Central	3851	280.9	0
Sichuan	West	4087	407.8	4
Guizhou	West	3642	292	1
Yunnan	West	4525	314.4	0
Xizang	West	4536	325	0
Shaanxi	West	2440	334	0
Gansu	West	2961	330.5	2
Qinghai	West	3352	257.2	2
Ningxia	West	3229	513.1	2
Xinjiang	West	3686	483.6	3
Mean		4119.467	396.447	4.867

2.2 Blockmodel Identities

(1) Group Identity based on Grain Output Per Capita

Sufficient-surplus provinces	Neimenggu, Jilin, Heilongjiang, Jiangsu, Ningxia, Xinjiang, Shandong
Marginal-surplus provinces	Hebei, Liaoning, Anhui, Jiangxi, Henan, Hunan, Hubei, Sichuan
Self-sufficient provinces	Shanxi, Zhejiang, Guangxi, Xizang, Shaanxi, Gansu
Short of grain provinces	Beijing, Tianjin, Shanghai, Guangdong, Fujian, Hainan, Guizhou, Yunnan, Qinghai

(2) Group Identity based on Living Standard

Rich provinces	Fujian, Shanghai, Beijing, Tianjin, Zhejiang, Guangdong, Jiangsu, Yunnan
Relatively rich provinces	Shandong, Hunan, Guangxi, Sichuan, Xizang
Relatively poor provinces	Hebei, Liaoning, Anhui, Guizhou, Xinjiang, Hubei, Hainan
Poor provinces	Shanxi, Jilin, Heilongjiang, Jiangxi, Henan, Qinghai, Ningxia, Shaanxi, Gansu, Neimenggu

(3) Group Identity based on Number of NWGM

Most developed provinces	Beijing, Heilongjiang, Jiangsu, Zhejiang, Shandong
Developed provinces	Tianjin, Shanxi, Liaoning, Jilin, Anhui, Jiangxi, Henan
Developing provinces	Hebei, Neimenggu, Fujian, Shanghai, Hubei, Hunan, Guangdong, Sichuan, Xinjiang
Undeveloped provinces	Guangxi, Hainan, Guizhou, Yunnan, Xizang, Shaanxi, Gansu, Qinghai, Ningxia