Market Emergence and Transition:

Transaction Costs, Arbitrage, and Autarky in China's Grain Markets

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October 1998

Draft

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I. Introduction

The mixed experience of countries moving from socialist planning to market economies during the past decade has led to growing recognition that healthy systems of market exchange do not emerge overnight (Blanchard, 1997). The inability of managers to develop new market relationships quickly is one explanation given for the large output falls that occurred in formerly socialist countries following the introduction of rapid price and import liberalization policies (Blanchard and Kremer, 1997; Roland, 1997). Some have argued that gradualist reform strategies pursued in countries such as China and Vietnam have been more successful because they recognized that the transition to a market system takes time--for learning by managers and traders, for altering institutions and production systems, for change in social attitudes and ideologies, and for construction of market infrastructure (McMillan, 1995; McMillan and Naughton, 1994).

Such a tidy justification of gradualism from comparative experience overlooks important differences in initial conditions and political context (Sachs and Woo, 1994; Li, 1998), but it highlights a glaring failure of the existing literature—the lack of empirical evidence on how well markets actually function during the transition process. Chinese reforms, in particular, have frequently been praised for promoting market competition among the state-owned, collective, and private sectors (Qian and Xu, 1993). Authors also have described an explosion in exchange activity in China's rural sector (Sicular, 1995). However, a recent paper by Young (1997) argues that changing patterns of provincial economic structure suggest that China's markets were becoming less rather than more integrated during much of the reform period, which he attributes to internal trade barriers. Others studying trade in agricultural commodities using traditional measures of price co-movement have raised similar concerns (e.g., Wan, 1997). Price distortions also have been blamed for preventing the establishment of national markets (Lin, Cai, and Li, 1996).

This emerging debate has focused attention on the need to test rather than assume that markets are working, a question of particular relevance to transition economies but important in many other contexts as well. But how to test? One approach is to look at whether spatial patterns of production are moving in the direction we would expect with freer trade (Young, 1997), although such indirect measures are subject to multiple interpretations.[1] The most common tests of market integration have focused on analysis of price co-movement, such as through used cointegration tests to analyze price co-movements. Based on short time series of price data, authors recently have used cointegration methods to evaluate the performance of markets for agricultural and food commodities in China and Russia (e.g., Wan, 1997; Berkowitz, Dejong, and Husted, 1996). Unfortunately, this research suffers from three problems: the interpretation of price co-movement measures of market integration is conceptually problematic (discussed below), the price series are too short to estimate changing relationships over time, and the authors do not disaggregate potentially important regional and seasonal effects. Examining changes over time, in particular, is essential for studying which Researchers interested in studying how policies and other time-varying factors affect market performance, the questions of greatest interest for understanding market development during economic transition, look at changes over time.

This paper attempts to overcome these shortcomings by developing a method that can characterize how multiple aspects of market performance change over time, enabling inference on the effect of different policies on market outcomes. We employ a maximum likelihood procedure to estimate a parity-bounds model of inter-regional trade for four different sub-periods using a dataset of tri-monthly provincial grain prices during the period 1988 to 1995. The parity bounds model makes it possible to directly estimate: a) the extent to which arbitrage opportunities are realized by traders (*arbitrage rate*); ba) transaction costs of trade between location pairs; and ; b) the extent to which arbitrage opportunities are realized by traders (*arbitrage rate*); and c) the percent of trading periods in which two regions do not trade because price differences are less than transaction costs (*autarky rate*). In being the first study to look at how these different

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[1] For example, specialization may be occurring at lower levels of product aggregation, the socialist system may have had a high level of regional concentration in key sectors, growth processes may

measures change over time, we are able to tell a rich story of how grain markets have developed over time in China, illuminating broader issues of market emergence and transition.

The market for grain in China provides an excellent window for examining market development during transition. Leaders relaxed restrictions on rural market trade at the beginning of China's economic reforms in 1978 and allowed inter-provincial grain market trade in 1983. Institutional reforms improved the profit incentives of state grain traders over time as the government reduced the scope of its grain procurement and ration sales policies and encouraged local grain station managers to engage in commercial trading. Market institutions, such as wholesale markets, futures markets, and information systems, also developed gradually in the early 1990s. The government, however, continued to intervene strongly in grain markets to combat grain price inflation, most notably in 1988-89 and 1994-95. During these retrenchment periods, local governments erected trade barriers, implemented price controls in urban areas, and reasserted control over production and procurement of grain. Grain is one of the commodities for which internal protectionism has been widely reported (Wedeman, 1993). It is shipped long distances and so is affected by China's domestic transport bottlenecks. Commodities such as grain are ideal for studying market integration because their product homogeneity makes prices comparable in different regions and across time.

The paper is organized as follows. The next section describes our strategy for modeling market performance. Section 3 presents the empirical model and estimation procedure. Section 4 describes the data set. Section 5 reviews China's grain market reforms and offers predictions on how reforms should affect market outcomes. The results and discussion are presented in section 6. A final section concludes.

2. Modeling the Market

In well-developed markets, spatial price differences exceeding transaction costs are quickly arbitraged away by profit-seeking traders. Given a fixed transaction cost between two locations, there are three possible trade and price outcomes: the difference between the autarky prices in the two regions is less than the transaction cost and trade does not occur (autarky); trade

confound simple measures of sectoral dispersion over time.

does occur and the price difference between the two locations equals the transaction cost (successful arbitrage); or the price difference exceeds the transaction cost because arbitrage is not occurring (failed arbitrage). Because supply and demand conditions, policies, and transaction costs are likely to fluctuate over time or during different seasons, trade and price outcomes are likely to vary in different periods.

Conventional measures of market integration (e.g., price correlations—Jones, 1968; regression measures of the law of one price— Ravallion, 1986, Richardson, 1978, and Goodwin, Grennes, and Wohlgenant, 1991; and cointegration tests—Alexander and Wyeth, 1994, Berkowitz, DeJong, and Husted, 1996, and Wan, 1997) that focus on examining the co-movement of prices in different locations ignore much of this complexity and so are difficult to interpret (Baulch, 1997). Trade flow switches, alternating periods of autarky and trade, or fluctuating transaction costs can decrease or increase measured integration based on price co-movement even when traders respond quickly to move goods when arbitrage opportunities present themselves. Also, because most locations are linked to more than one market by trade, many trade configurations are possible. These possibilities complicate the relationship between prices in two regions, so that it is unsurprising that price correlations often imply low integration even when competitive trade is observed (Faminow and Benson, 1990). Conventional measures of price co-movement thus cannot distinguish between whether lack of integration is due to failed arbitrage, autarky, or trade flow switches, although these explanations have very different implications for assessing market performance.

The first empirical models to directly examine arbitrage outcomes assess whether two locations are in the same economic market by estimating the probability that their prices differ by the transaction cost, which is stochastic (Spiller and Huang, 1986; Spiller and Wood, 1988). Prices in the two locations either differ by the transaction cost (successful arbitrage) or by less than the transaction cost (autarky). Cases of failed arbitrage are ruled out by assumption. In a transition context, however, measuring the frequency of failed arbitrage may be important if one

suspects that traders are still learning how to arbitrage or are being prevented from taking advantage of arbitrage opportunities.[2]

If we define the number of periods of autarky, successful arbitrage, and arbitrage failure as AU, AR, and AF, Spiller and Huang (1986) report AR/(AU+AR) as a measure of integration. Baulch (1997) suggests that a more appropriate measure of integration is the arbitrage rate, or probability that arbitrage is observed when arbitrage opportunities exist (AR/(AR+AF)). However, this measure, because it excludes autarky observations, can find two regions that only trade once in a thousand years to be integrated as long as arbitrage occurs when the opportunity presents itself. We argue that a single measure of market integration is inevitably incomplete. Rather, market performance has several characteristics that together help describe the development of the market— the arbitrage rate (AR/(AR+AF)), the transaction cost (or parity bound), ~~the arbitrage rate (AR/(AR+AF)),~~ and the autarky rate (AU/(AU+AR+AF)).

A main advantage of the estimation procedure is its ability to estimate transaction costs directly from price data.[3] Learning the actual transaction cost from interviews or secondary sources can be problematic. Individual traders will only be aware of the costs associated with some parts of the marketing chain for some trade routes during some years and seasons. Reported costs of shipping, commonly used in studies of market integration, do not reflect costs of information, insurance, finance, or marketing in transition economies. Traders also may have to pay extra fees and bribes when transport access is rationed or face risks in evading trade barriers erected by local governments. Unsurprisingly, nonparametric tests of arbitrage failure that parameterize transaction costs using freight costs find a large number of observations outside the parity bounds (Goodwin, Grennes, and Wohlgenant, 1990). Sexton et al. (1991) find that transaction costs estimated directly from price data exceed freight rates, which they suggest is due to market power even though other sources of omission are equally plausible. Finally, transport as an input to trading has its own supply and demand, which can vary over time and be

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[2] Sexton et al.(1991) extend the Spiller and Huang (1986) and Spiller and Wood (1986) model to allow for arbitrage failure, but apply the test to a market where failures are not common (U.S. celery) and do not examine whether the probability of arbitrage failure changes over time.
[3] The estimated transaction cost between two locations that have a common trading partner but do not trade with each other is likely to understate the true cost. We thus restrict attention to location pairs that have direct trade flows.

subject to unexpected shocks. Prices predicted by programming models that assume fixed transaction costs often are poorly correlated with actual prices (Faminow and Benson, 1990).

3. Empirical Model and Estimation

Assume that the autarky prices for two markets in a given period, P_t^{1A} and P_t^{2A}, can be defined by the following reduced form equations:

$$P_t^{1A} = d^1 + u_t^1 \tag{1}$$

$$P_t^{2A} = d^2 + u_t^2, \tag{2}$$

where d^1 and d^2 are non-stochastic elements of prices determined by supply and demand conditions in local markets, and u_t^1 and u_t^2 are stochastic disturbances to local supply and demand.

Next, define a transaction cost T_t, which is a random variable with a constant mean (τ):

$$T_t = \tau + v_t, \text{ where } Ev_t = 0, Ev_t^2 = \sigma_v \tag{3}$$

Trade does not occur when the difference in the autarky prices of the two locations is less than the transaction cost ($|P_t^{2A} - P_t^{1A}| < T_t$). We define the probability of this occurring as the autarky rate, denoted γ, Since there is no opportunity for arbitrage, the realized prices in each region are just the autarky prices:

$$P_t^1 = P_t^{1A} \text{ and } P_t^2 = P_t^{2A}. \tag{4}$$

When the difference in autarky prices exceeds the transaction cost, i.e., ($|P_t^{2A} - P_t^{1A}| > T_t$), there is an opportunity for arbitrage. However, due to trade barriers, lack of information, or other impediments, arbitrage opportunities may not always lead to successful arbitrage. We denote the probability of successful arbitrage as λ, which can be interpreted as the arbitrage rate given that

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an arbitrage opportunity exists. With successful arbitrage the realized prices will differ by exactly the transaction cost:

$$Y_t = P_t^{2A} - P_t^{1A} = T_t = \tau + v_t. \tag{5}$$

Here, Y_t is defined as the realized price difference.

If arbitrage is unsuccessful, Y_t reverts to the difference in autarky prices:

$$Y_t = d + u_t, \text{ where } d = d^2 - d^1, u_t = u_t^2 - u_t^1, \text{ and } Eu_t = 0, Eu_t^2 = \sigma_u. \tag{6}$$

Assuming v_t and u_t are independently and normally distributed, the likelihood function for each location pair and each period can be written as:

$$L_t = \gamma(1/\sigma_u)\varphi((Y-d)/\sigma_u) + (1-\gamma)[(1-\lambda)(1/\sigma_u)\varphi((Y-d)/\sigma_u) + \lambda(1/\sigma_v)\varphi((Y-\tau)/\sigma_v)] \tag{7}$$

where

$$\gamma = \text{prob}(|P_t^{2A} - P_t^{1A}| < T_t) = \text{prob}(u_t - v_t < \tau - d \text{ and } u_t + v_t > -\tau - d)$$
$$= \Phi((\tau - d)/(\sigma_u^2 + \sigma_v^2)^{1/2}) - \Phi((-\tau - d)/(\sigma_u^2 + \sigma_v^2)^{1/2})$$

and φ and Φ represent the standard normal density and distribution functions. The model also can be solved assuming a gamma distribution for the error terms v_t and u_t. We also extend the model to look at seasonality by redefining the key parameters (γ, λ, and τ) as linear functions of seasonal dummies (e.g., $\gamma = \gamma_1 + \gamma_2 s_2 + \gamma_3 s_3 + \gamma_4 s_4$).

The estimation of the model follows Sexton et al. (1991), who extend the work of Spiller and Huang (1986) to allow for arbitrage failure. Sexton's model does not include the variable, d, because trade shipments are destined for markets which have no supply, and so there is no meaningful interpretation of an autarky outcome. Our model implicitly assumes that underlying demand and supply conditions in a region are unvarying during each 2-year period.

4. Data

        The data come from a unique price data set collected by China's State Market Administration Bureau (SMAB) in Beijing. More than 180 reporting sites from 28 of China's 30 provinces report prices of different agricultural commodities every 10 days. The prices are the average price of transactions that day in the local rural periodic market. The Ministry of Agriculture's Research Center for Rural Economy (RCRE) constructs provincial average prices by taking the simple average of the 5 to 10 reported individual market prices within each province.

        We examine rice and maize prices from 1988 to 1995. These two crops are produced and consumed in nearly every province in China. Rice price data is available for 23 provinces. Because of quality differences between rice in northern and southern China, and because indica rice (the most common type of rice in southern China) is traded continuously throughout the year, the study focuses on rice markets below the Huai River (see list of net buying and selling provinces in Table 3). For the provinces included in the sample, rice prices are available for over 95 percent of the time periods. Data for Shanghai and Fujian are excluded due to incomplete price series.[4]

        Prices for maize are available for 25 provinces and almost all time periods. Product homogeneity makes it possible to include a broader geographic range of buyers and sellers (listed in Table 3). For example, the sample includes a net selling province in the far northeast (Jilin) as well as a net buying province in the far southwest (Yunnan). Nominal prices from the SMAB data set are deflated using monthly price consumer price indices calculated and reported by the State Statistical Bureau.

        We also carried out extensive field work, visiting every major producing and consuming region in China over several years to gain a better understanding of the institutions and policies affecting rice and maize trade and to collect information on trade patterns and transaction costs (Rozelle et al., forthcoming). Interviews were conducted with participants in nearly every aspect of grain trade, including national, provincial, and county grain officials, traders in buying and selling

regions, transport officials (responsible for rail, trucking, and shipping), futures and wholesale market staff, managers of grain retail outlets, and local private traders in rural periodic markets. Traders in major grain exchange centers and officials in provincial capitals provided estimates of the volume and direction of grain flows and transport, handling, and other transaction costs. Interview data are used to restrict the sample to pairs of provinces that actually trade rice and maize, where appropriate disaggregate results regionally, validate our transaction cost estimates, and interpret the empirical results. [5]

5. China's Grain Market Reforms and Predicted Effects on Market Performance

To facilitate interpretation of the estimation results, in this section we describe the government policies that affected market development during the period 1988-95 and make predictions on how these policies should affect the market outcomes of interest (arbitrage rate, transaction costs, autarky rate). We group government policies into four categories: trade liberalization, institutional reform, market infrastructure investment, and production specialization. These policy categories can affect trade in any good. Here, we focus on grain.

The period 1988-95 was characterized by rapid growth in the volume of grain trade and in the number of traders and market centers (Sicular, 1995).[6] It also was a period of very active institutional and policy changes that affected the grain trade. These included two episodes of policy retrenchments (1988-89 and 1994-95) during which the government pursued grain price stability through trade restrictions, price controls in urban areas, and a return to plan-based production and procurement of grain. Thus, if we divide the 8-year period into four 2-year subperiods, the first and last periods can be considered periods of policy retrenchment. The second and third periods, in contrast, were periods of market liberalization, especially the third period (1992-93), when the government rapidly phased out planned rationing and procurement policies and commercialized the state trading system through institutional reforms. These swings

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[4] Missing prices are troublesome because one cannot distinguish whether there was *no* local trade of the commodity on the survey day or there *was* trade but the price was not reported, a distinction which can affect interpretation of the results.
[5] Because of trade flow switches, transaction cost estimates are only accurate for location pairs which trade directly.
[6] [a couple stats here?]

in policies are summarized in Table 1. To help the reader keep track of the different policy changes, beneath each entry, we denote whether the direction of change in each policy in each period reflects reform (+), retrenchment (-), or no change (0).

Trade Liberalization

Chinese leaders have generally supported market liberalization as a key part of the country's reform strategy. In the grain sector, inter-provincial trade in grain was permitted beginning in 1983, and state traders began trading at "negotiated" (market-based) prices in 1985. In periods of grain price stability, the government has encouraged the free flow of market grain across regions.

In times of grain price inflation, however, government officials have been quick to intervene in markets, usually to protect the purchasing power of urban residents (Rozelle et al., forthcoming; Wedeman, 1993). In late 1988 and 1989, the central government severely restricted trading of rice because of concerns that rapidly rising prices due to rising demand and falling production in coastal provinces would draw rice from interior provinces and put upward pressure on prices nationwide. Inland provinces blockaded the flow of rice and coastal provinces were urged to reduce their reliance on external grain supplies. These market controls led to restrictions on trade of other grains as well.

The controls did not last long. Once prices came down in the early 1990s following record harvests, market liberalization policies were pushed forward again, especially in 1992-93, when the government claimed to have fully liberalized grain market trade by eliminating planned-price procurement and sales of grain, and opening up trade in rural and urban markets (Sicular, 1995).

However, rapidly rising grain prices in late 1993 and 1994 once again led to the imposition of market barriers. Leaders in surplus provinces tried to prevent grain from leaving their localities in hopes of preventing grain prices from rising too quickly. Many urban cities in deficit areas tried to impose price controls. However, in contrast to 1988-89, complaints were voiced by grain officials in both surplus and deficit areas that the retrenchment policies were ineffective. The incentives of grain managers had changed and the market had become much larger and more difficult to control.

Trade liberalization should affect arbitrage rates, transaction costs, and autarky rates--all three dimensions of market development. Reduced barriers to inter-regional trade should make it easier to realize arbitrage opportunities, and should reduce transaction costs. When there are policy barriers to trade, those that continue to engage in trade must spend resources to evade trade barriers and bear higher risk of sanctions, increasing transaction costs. While trade liberalization will not directly affect supply and demand elements, any policy that lowers (raises) transaction costs should also decrease (increase) the autarky rate.[7]

Prediction 1: Trade liberalization (absence of trade restrictions) will increase the arbitrage rate and reduce transaction costs (Table 2, row 1).

Institutional Reforms

In China, most commercial grain trade has been undertaken by state grain managers who manage local grain stations (Sicular, 1995). In addition to executing state procurement and rationing policies, local grain officials were allowed to engage in market trade at "negotiated" prices beginning in 1985. Since that time, the relative importance of negotiated versus planned trade has grown steadily. In the early 1990s, in many parts of China, the contractual incentives of grain managers were altered to link remuneration more closely to profitability (~~Sicular, 1995;~~ Park and Rozelle, 1998~~forthcoming~~). The changes were motivated by a desire to encourage greater self-reliance in meeting state wage obligations in an environment of ~~great~~ scarc~~ity of~~e fiscal resources. The institutional reforms also gave managers more control rights to choose trading partners and diversify business lines. New managerial incentives and market opportunities ~~may have~~ reduced the willingness of grain managers to implement state policies that were unprofitable during the policy retrenchment of 1994-95 (Park and Rozelle, 199~~7~~8).

Institutional reforms should increase arbitrage rates, since the strengthened profit incentives should increase the motivation of managers to actively seek out profitable grain trades. Commercialization also could indirectly lead to lower transaction costs (and lower autarky rates) if improved incentives lead traders to more actively pursue cost savings in shipping grain to increase profit margins.

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[7] We do not describe this indirect effect in the predictions~~,~~; it~~but~~ should be considered implicit whenever the prediction is that transaction costs increase.

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Prediction 2: Institutional reforms will increase arbitrage rates, and to a lesser extent, will lead to lower transaction costs (row 2).

Market Infrastructure and Services

China's government has continuously invested in expanding market infrastructure but has struggled to keep pace with the increasing demand for ~~public infrastructure such as~~ roads, railways, ports, and communication infrastructure that has accompanied rapid growth. Most grain is shipped by rail and barge (for areas on the coast or along the Yangtze). Despite significant expansion of rail lines, railcar utilization remains at near full capacity, with congestion worsening for the rail lines to Guangdong and other parts of southern China (~~Nyberg, 1995;~~ author interviews). Because pricing for rail freight is regulated, side payments and queuing costs for shipping freight are likely to be significant.

The government also has been aggressive in improving other types of infrastructure that underlie well-functioning market exchange. In the 1990s entrepreneurial officials established new grain wholesale markets (beginning in 1991) and futures markets (beginning in 1993). These new market centers have improved the availability of information on prices in different regions and facilitated networking among major traders.

Investments in transport infrastructure should reduce transaction costs by reducing the cost of shipping commodities. Lower transaction costs will indirectly reduce the autarky rate. Investments in better information should increase arbitrage rates by reducing the likelihood that managers will miss profitable trade opportunities.

Prediction 3: Investment in transport infrastructure will reduce transaction costs and investment in information will increase arbitrage rates and reduce transaction costs.

Production Specialization Policies

The government's position towards production specialization has fluctuated over time. After years of central planning that emphasized self-sufficiency, the government significantly relaxed sown area controls in the mid-1980s when grain was plentiful and the government supported greater specialization in production (Carter and Zhong, 1991). Rice price increases in 1988 led to a rethinking of this policy as many blamed reduced grain production in the south for grain price inflation. The government urged provincial leaders to increase local supplies by increasing investments in agricultural infrastructure and adopting other policy measures (Liu,

1991). After the crisis passed, the pressure on local governments to keep up production levels also fell. However, after the new bout of price increases in 1993-94, the government adopted a Governor Responsibility System (GRS) which made provincial governors responsible for safeguarding the consumption needs of their citizens. Under this system, greater self-reliance in meeting grain consumption needs was encouraged.

Specialization and trade generally go hand in hand, so that greater specialization should increase the frequency of trade and reduce the autarky rate.[8] When provincial leaders aim for self-sufficiency, autarky rates should increase by definition.

Prediction 4: Production specialization (self-sufficiency) policies will reduce (increase) autarky rates (row 4).

6. Results and Discussion

The main estimation results are reported in Table 3, which presents the average arbitrage rate, transaction cost, and autarky rate for maize and rice trading pairs for each 2-year period.[9] We discuss the results for each market outcome parameter in turn, and consider the extent to which they are consistent with the predicted effects of different policies. When appropriate, we disaggregate the results by region or trading pairs. For transaction costs, we compare our estimates to costs reported in interviews.

Arbitrage

Mean arbitrage rates for rice grew from 0.58 in 1988-89 to 0.62 in 1990-91 to 0.70 in 1992-93--steady and large increases consistent with trade liberalization and institutional reforms (perhaps not surprising given the retrenchment policies of the first period). In the last period (1994-95), however, there is virtually no change in mean arbitrage rate (0.69). The lack of any negative effect on arbitrage during a retrenchment period which saw the imposition of trade

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[8] Higher trade volume might also affect transaction costs if there are economies of scale.
[9] To test the robustness of our results to assumptions about price expectations, the distribution of the error term, and the importance of seasonality, we estimated alternative specifications in which: 1) prices are transmitted with one period lags (that is, the price in the selling region moves 10 days before that in the buying region (Sexton et al., 1991)); 2) the error terms have a Gamma distribution; and 3) estimated parameters are permitted to differ in each of four seasons. None of these changes altered the results substantially, although there are seasonal differences in arbitrage rates, transaction costs, and autarky rates (results not reported).

restrictions suggests that any such effects were offset by positive effects on arbitrage from ongoing institutional reforms and general learning by traders.

Arbitrage rates for maize were relatively low in 1988-89 (0.69), rose in the second and third periods (0.83), before falling in the retrenchment period, 1994-95 (0.67). Arbitrage rates thus are lower and similar in the two retrenchment periods compared to the middle periods, consistent with the existence of grain blockades during retrenchment periods, and less consistent with a story of steady expansion of institutional reforms.

Arbitrage rates for both commodities are far from 1.00, suggesting that it takes time for traders to build networks and arbitrage away all profit opportunities. The differences in results for rice and maize in the last period can be better understood by disaggregating market development trends for maize into coastal and inland provinces. Almost all of the decline in the average arbitrage rate can be attributed to trading patterns in the inland regions (rice is almost all coastal), areas where institutional reforms were carried out less completely (Table 4). The arbitrage rates between the biggest sellers and buyers (column 1), and between other combinations of buyers and sellers (columns 2 and 3) show that, despite nominal trade restrictions, the highly commercialized trading sector in coastal regions takes advantage of profit-making trades significantly more in 1994-95 than in the 1988-89 period (columns 2 and 3, row 5); while those in inland areas actually have recent arbitrage rates that are less than in the 1980s (row 11). The relative fall of inland compared to coastal regions between 1992-93 and 1994-95 is even more sharp (rows 6 and 12).

Transactions Costs

Mean transaction costs in rice markets fell from 0.19 in 1988-89 to 0.17 in 1990-91, and then remained the same in 1992-93 before jumping to 0.25 in 1994-95 (Table 3). The transaction costs in maize trade are almost identical to those in rice trade in the first two periods, but in the third period, instead of flattening out, they continue to decrease (to 0.12). In the final period, transaction costs increase, just as for rice, but much more modestly (to 0.14).

These patterns also are broadly consistent with the imposition of trade barriers in the early and late periods, but there remain significant differences in the estimates for rice and maize.

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Given that trade liberalization proceeded most rapidly during 1992-93 when the government announced that all state grain trade would be market-based, it is surprising that transaction costs in rice did not fall during this period as for maize. The rice-growing south was probably the most open trading region in the country during this time.

Can other policies, most notably infrastructure investment and institutional reforms, help explain the differences? Both were unidirectional during the period of study, so are consistent with falling transaction costs in periods 2 and 3, but at first glance they cannot explain the rising transaction costs in the last period. The market for transport and other marketing services, however, depends on both demand (from all sectors, not just grain) and supply. If rising demand outpaces supply, which has been described as a key bottleneck to growth in China (World Bank, 1997), transaction costs could increase despite the rapid construction of new infrastructure during the period. Regional bottlenecks could affect transaction costs between different trading pairs differently. In interviews with grain traders, we were told that in the 1990s congestion on China's long-distance train, truck, and shipping networks had risen to such critical levels, especially in the booming south (the center of the rice trade), that traders had to pay high premia to guarantee access to rail car or barge space, which could more than double the freight and handling charges during certain times of the year.

The likely importance of transport bottlenecks rather than trade restrictions in explaining estimated transaction costs is well-illustrated by the case of rice trade in Guangdong, the province adjacent to Hong Kong and one of the largest buyers on China's inter-provincial rice markets. The estimated transaction cost for rice trade with its three major suppliers--Hunan, Jiangxi, and Hubei—rise rapidly in 1992-93 (the period *before* retrenchment) (Table 5). Even in the 1988-89 period, marketing costs from Guangdong's nearest neighbor, Hunan, are above the average transaction cost for all rice trades (0.22 versus 0.19), suggesting that congestion is a persistent problem in southern China. Regional bottlenecks in transport thus can help explain why average transaction costs did not fall in 1992-93 for rice, but continued to fall for maize. Many maize suppliers are northeastern provinces that ship by ocean barge rather than by rail. It is difficult to distinguish how much of the rise in transaction costs in 1994-95 was due to these same factors or

to trade barriers. However, rail bottlenecks in the south is consistent with a greater increase in rice transaction costs compared to maize.

The size and significance of the average transaction cost estimates demonstrate their reasonableness and the value of using our statistical techniques for measuring them (Table 6). Eighteen traders in 10 provinces reported to the authors the costs of moving grain between pairs of markets on a per kilogram (for the average trade) and per metric ton (MT) per kilometer basis. The correlation coefficient between the statistically-estimated and directly-elicited transaction costs for the same provincial pairs is 0.865, which provides confidence that the method is capturing true variation in underlying transaction costs. The survey-based estimates for rice (0.115 per kilogram and 0.103 per MT per kilometer), however, are less than half of the econometrically estimated results (0.254 and 0.234—Table 6, columns 1 and 2). Respondents apparently are not able or willing to quantify all of the variable costs that go into making up the rice price spread between two regions, such as insurance, search costs, bribe fees to get port access, congestion premia, etc. On the other hand, maize estimates calculated by the two methods do not statistically differ.

Autarky

Autarky rates for the two crops change over time in a way that differs from arbitrage rates and transaction costs. For both commodities, autarky rates rise in the second period, fall in the third, and rise in the fourth (Table 3, columns 5 and 6). The increase in autarky in 1990-91 is not predicted by the timing of trade liberalization and institutional reform policies or by the fall in transaction costs. The fall in autarky in rice during 1992-93 also does not correspond with the unchanging transaction cost. These inconsistencies suggest that other policies, such as those affecting production of grain directly, may be influencing autarky rates.

Changes in policies affecting production specialization match observed patterns in autarky rates. Rising incomes, pro-rural policies, and relaxation of mandatory production and marketing quotas in agriculture in the mid-1980s increased the demand for food, including grain, and allowed supplies to fall in some areas along the coast of China. By the late 1980s, national and regional supply and demand imbalances combined with trade restrictions led to spiking grain

prices and wide price gaps among regions, helping to explain the low autarky rates.[10] Before and after the Tiananmen crisis in 1989, ~~and~~ ~~as soaring~~ grain prices soared, ~~which~~ more than doubl~~inged~~ the previous 40-year high, the government decided to cool industrial expansion and refocus investment and organization in agriculture in the south, a reversal of the specialization policies that were designed to increase agricultural production only in those provinces with comparative advantage in grain production ~~(Huang, 1997)~~. New enthusiasm for old-style, agricultur~~e-al~~-first measures, however, quickly dissipated after Deng's famous trip to Guangdong in mid-1991, a move that sent a clear signal to officials, especially those in coastal areas, that they could once again pursue production specialization policies and concentrate on industrial development without fear of political reprisal. In 1994, however, real prices of grain again rose rapidly, and national and regional leaders took decisive steps to regain control of the grain economy using traditional policy tools (Chen, 1994), re-instituting procurement quotas and encouraging greater grain production in the south.

Provinces, however, did not respond uniformly to such policies. Autarky rates in some of the fastest growing coastal provinces either continued to fall (e.g., Guangdong's rate fell by 10 percent) or stayed the same (e.g., Guangxi). In contrast, autarky rates of inland rice buyers all rose; that for Yunnan Province, for example, rose by 50 percent.

7. Conclusions

In this paper, estimation of arbitrage rates, transaction costs, and autarky rates from a parity-bounds model of inter-regional grain trade in China, informed by detailed knowledge of trade flows, policy changes and regional differences, has made possible a rich characterization of market emergence during transition. Our results highlight the dangers of simple attribution of observed outcomes to one factor alone, such as trade barriers, and of regional aggregation without a sensitivity to regional differences.

Even with our multiple measures of market outcomes, a simple reading of our results might lead to the conclusion that markets in 1995 have not developed much since 1988.

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[10] Recall that lack of trade when prices exceed transaction costs is failed arbitrage, not autarky, in our model.

Arbitrage rates and transaction costs have not changed much on average, and autarky rates have increased. Clearly, it is a mistake to take market development for granted; traders take time to learn and policies must be supportive across multiple dimensions for market competition and trade to flourish.

But this also misses much of what is important in a more nuanced interpretation of what is happening in China's grain markets.

China's grain markets have grown dramatically over time in terms of the number of participants and the volume of trade. The development of the market has been uneven over time, with periods of liberalization punctuated by periods of retrenchment. But market development and institutional change, especially in southern China, may have matured to a point that traditional policy interventions are less effective and more costly to be attractive. Arbitrage rates in the south did not fall with retrenchment in 1994-95, and much of the increases in transaction costs may be due to transport bottlenecks in the south. Thus, there is not strong evidence that trade barriers have driven market outcomes during the period under study, although they have received greatest attention (Young, 1998).[11]

Our results suggest that areas that merit attention by policy makers include infrastructure bottlenecks in the south, and production specialization policies that increased autarky rates and reduce gains from comparative advantage, and continued institutional reforms and market deepening in interior regions, where trade appears to be more easily controlled by local government interventions . Here, we see most clearly the advantages of an estimation method that allows us to distinguish among the effects of different policies.

The characterization of market development in China presented here highlights the complexity of the process. In China, grain market development has been gradual, both by choice (i.e., retrenchment) and because of infrastructure bottlenecks. We are unable, however, to consider the extent to which this gradual approach has been optimal. There have been and continue to be obvious costs to policy interventions in the grain trade, but these must be evaluated in the broader context of the political economy of economic reform.

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[11] Young also describes transport bottlenecks and does not attribute all changes to trade barriers. He presents evidence that markets were becoming increasingly integrated by the mid-1990s.

References

Alexander, C., and J. Wyeth. 1994. "Cointegration and Market Integration: An Application to the Indonesian Rice Market," *Journal of Development Studies* 30:303-28.

Baulch, Bob. 1997. "Transfer Costs, Spatial Arbitrage, and Testing for Food Market Integration," *American Journal of Agricultural Economics* 79(2): 477-487.

Berkowitz, Daniel, David DeJong, and Steven Husted. 1996. *Transition in Russia: It's Happening*, mimeo, University of Pittsburgh.

Blanchard, Olivier. 1997. *The Economics of Post-Communist Transition* (New York: Oxford University Press).

Blanchard, Olivier, and Michael Kremer. 1997. "Disorganization," *Quarterly Journal of Economics.*

Carter, Colin A. and Fu-Ning Zhong. 1991. "China's Past and Future Role in Grain Trade," *Economic Development and Cultural Change* 39(4): 791-814.

Chen, Xiwen. 1994. "The Central Government's Politics and Measures are Good, but it is Difficult to Implement them at the Local and Departmental Level," Liaowang 18: 13-16. (in Chinese)

Faminow, Merle D. and Bruce L. Benson. 1990. "Integration of Spatial Markets," *American Journal of Agricultural Economics* 72: 49-62.

Goodwin, Barry K., Thomas J. Grennes, and Michael K. Wohlgenant. 1990. "A Revised Test of the Law of One Price Using Rational Price Expectations," *American Journal of Agricultural Economics* 72: 682-693.

Jones, William O. 1972. *Marketing Staple Food Crops in Tropical Africa* (Ithaca: Cornell University Press).

Li, Wei. 1998. "A Tale of Two Reforms: The Importance of Initial Market Conditions," *Quarterly Journal of Economics.*

Lin, Justin, Fang Cai, and Zhou Li. 1996. *The China Miracle: Development Strategy and Economic Reform* (Hong Kong: Chinese University Press).

Liu, Jiang. 1991. *A Summary of China's Ninth 5-year Plan for Agriculture* (Beijing: China Agricultural Press).

McMillan, John. 1995. "Markets in Transition," in David Kreps and Kenneth Wallis, eds., *Advances in Economics and Econometrics: Theory and Applications* (Cambridge: Cambridge University Press).

McMillan, John and Barry Naughton. 1992. "How to Reform a Planned Economy: Lessons from China," *Oxford Review of Economic Policy* 8(1): 130-43.

Park, Albert and Scott Rozelle. 1998. "Reforming State-Market Relations in Rural China," *Economics of Transition* 6.

Qian, Yingyi, and Chenggang Xu. 1993. "Why China's Economic Reforms Differ: The M-Form Hierarchy and Entry/Expansion of the Non-state Sector," *Economics of Transition* 1(2): 135-70.

Ravallion, Martin. 1986. "Testing Market Integration," *American Journal of Agricultural Economics* 68:102-109.

Richardson, D. 1978. "Some Empirical Evidence on Commodity Arbitrage and the Law of One Price," *Journal of International Economics* 8: 341-351.

Roland, Gerard. 1997. *Transition and the Output Fall*, mimeo, ESCARE.

Rozelle, Scott, Albert Park, Jikun Huang, and Hehui Jin. forthcoming. "Bureaucrats to Entrepreneurs: The Changing Role of the State in China's Grain Economy," *Economic Development and Cultural Change*.

Sachs, Jeffrey, and Wing-Thye Woo. 1994. "Structural Factors in the Economic Reforms of China, Eastern Europe and the Former Soviet Union," *Economic Policy* 18: 101-45.

Sexton, Richard J., Catherine Kling, and Hoy F. Carman. 1991. "Market Integration, Efficiency of Arbitrage, and Imperfect Competition: Methodology and Application to U.S Celery," *American Journal of Agricultural Economics* 73: 568-580.

Sicular, Terry. 1995. "Redefining State, Plan, and Market: China's Reforms in Agricultural Commerce," *China Quarterly* 144: 1020-46.

Spiller, Pablo T. and Ciiff J. Huang. 1986. "On the Extent of the Market: Wholesale Gasoline in the Northeastern United States," *Journal of Industrial Economics* 34: 131-145.

Spiller, Pablo T. and Robert O Wood. 1988. "The Estimation of Transaction Costs in Arbitrage Models," *Journal of Econometrics* 39: 309-326.

Wan, Guanghua. 1997. *Rice Market Integration in China*, mimeo, University of Sydney.

Wedeman, Andrew,ed. 1993. "Regional Protectionism: Translations," *Chinese Economic Studies* 26(5): 3-104.

The World Bank. 1997. *At China's Table: Food Security Options* (Washington, D.C.: The World Bank).

Young, Alwyn. 1997. *The Razor's Edge: Distortions and Incremental Reform in the People's Republic of China*, mimeo, University of Chicago.

ZGTJNJ, *Zhongguo Tongji Nianjian (China Statistical Yearbook)* (Beijing: China Statistical Press), 1990-96.

ZGSYNJ, *Zhongguo Shangye Nianjian (China Commerce Yearbook)* (Beijing: China Statistical Press), 1990-96.

Table 1. Period by Period Summary of Policies Influencing Grain Market Development, 1988-1995.

Year	1988-89	1990-91	1992-93	1994-95
Trade Liberalization	Tight marketing restrictions	Experiments in grain marketing policy in selected provinces	Market liberalization	Local protectionism after rapid rise in food prices
(change in policy from previous period)[a]	n.a.	+	+	-
Institutional Reforms	Grain bureaus primarily run as gov't agency Crack down on private traders	Reduce policy roles in many state grain trading organization; Begin institutional reforms with profit-based contractual incentives	Widespread institutional reform and elimination of quotas and rationing Rise of private grain trade	Reluctant commercialized grain agencies-cum-firms asked to implement policies again
(change in policy from previous period)[a]	n.a.	+	+	0
Market Infrastructure Investment	China still suffering from legacy of Mao's under-investment in transport system; Markets still reviving	← Rail and road system expands → ← Expansion of marketing → ← Communication revolution →		At peak of boom in mid-1990s, reports of serious congestion, especially on north/south trunk lines, despite high investments
(change in policy from previous period)[a]	n.a.	+	+	+
Production Specialization Policies	Supply and demand imbalances. End of lax ag-first policies	Leaders launch party-led invest in agriculture campaign	After Deng's trip to South, period of industry-first begins	Encourage local self-sufficiency (Governor's Responsibility System--GRS)
(change in policy from previous period)[a]	n.a.	-	+	-

[a] Plus signs (+) in row denote that change in policy (or investment) from the previous period should positively affected market development; minus signs (-) denote period of retrenchment; n.a. means no valid comparisons; 0 denotes period of neither progress nor retrenchment.

Table 2. Expected Effects of Government Policies on Market Performance Measures

	Arbitrage Rate (λ)	Transaction Cost (τ)	Autarky Rate (γ)
Trade Liberalization	+	-	[-][a]
Institutional Reforms	+	(-)[b]	[-][a]
Market Infrastructure Investment	(+)[b]	-	[-][a]
Production Specialization Policies			-

[a] The signs in the parentheses in column 3 denote that the impacts on market development are indirect effects of rising or falling transaction costs (in the case of autarky rates).

[b] The sign in the parentheses in column 2, row 2, denotes that there may be a weaker secondary effect of commercialization on market development.

Table 3. Estimates of Parity Bounds Model: China's Rice and Maize Markets, 1988 to 1995.[a]

Time Periods [b]	Arbitrage Rate (λ)		Transaction Cost (τ) (1988 yuan per kilogram)		Autarky Rate (γ)	
	Rice	Maize	Rice	Maize	Rice	Maize
1988-89	0.58 (0.11)[c]	0.69 (0.12)	0.19 (0.03)	0.20 (0.02)	0.07 (0.07)	0.30 (0.10)
1990-91	0.62 (0.25)	0.83 (0.11)	0.17 (0.02)	0.17 (0.02)	0.47 (0.13)	0.45 (0.09)
1992-93	0.70 (0.15)	0.83 (0.09)	0.17 (0.03)	0.12 (0.01)	0.40 (0.11)	0.38 (0.08)
1994-95	0.69 (0.21)	0.67 (0.20)	0.25 (0.04)	0.14 (0.02)	0.57 (0.10)	0.45 (0.13)

Source: Date are from National Market Administration Bureau's (NMAB) Rural Periodic Market Survey. Prices are reported every ten days from a number of markets in each province.   Statisticians from NMAB aggregate the market-level data into a provincial arithimetric average.

[a]   Rice sellers include Hunan, Hubei, Jiangxi, Anhui, and Jiangsu.   Rice buyers include Zhejiang, Guangdong, Guangxi, Guizhou, Yunnan, and Sichuan.   Figures are the "average of all markets," and are calculated by taking the average of the results of analysis of market development of each of the seller with each of the buyer.   The results are average estimates from 30 regressions (5 sellers and each of their 6 buyers).
    Maize sellers include Jilin, Liaoning, Inner Mongolia, Hebei, Henan, Shandong, Shanxi, and Shaanxi. Maize buyers include Zhejiang, Guangdong, Guangxi, Hunan, Guizhou, Yunnan, and Sichuan.   The figures are "average of all markets," and are calculated by taking the average of the results of analysis of market development of each of the seller with each of the buyer. The results are average estimates from 56 regressions (8 sellers and each of their 7 buyers).

[b]   The periods span from the planting period in the year before the given year until the harvest of the second year (e.g., the period 1990 spans the marketing periods from November 1989 to October 1991)

[c]   Standard deviations~~errors~~ are reported in parentheses.

Table 4. Estimated Arbitrage Rates of Parity Bounds Model: Maize Markets in Inland and Coastal Regions, 1988 to 1995.[a]

	Arbitrage Rates between Sellers and Most Important Buyers (λ)		
Time Periods	Sellers and **single** largest buyers	Sellers and **three** largest buyers	Sellers and **five** largest buyers
Coastal			
1988-89	0.28	0.32	0.48
1990-91	0.95	0.73	0.68
1992-93	1.00	0.78	0.76
1994-95	0.85	0.66	0.74
Change from 88-89 to 94-95	0.57	0.34	0.25
Change from 92-93 to 94-95	-0.15	-0.12	-0.02
Inland			
1988-89	0.78	0.68	0.58
1990-91	0.98	0.90	0.76
1992-93	1.00	0.96	0.76
1994-95	0.41	0.61	0.51
Change from 88-89 to 94-95	-0.36	-0.07	-0.07
Change from 92-93 to 94-95	-0.59	-0.35	-0.25

For source, data description, and list of buyers and sellers, see text and Table 3.

[a] Coastal transaction are between coastal sellers (Jilin, Liaoning, and Shandong) and coastal buyers (Zhejiang, Guangdong, and Guangxi). Inland transaction are between all pairs of provinces that include at least one non-coastal buyer or seller.

Table 5. Estimated Transaction Costs for Rice Shipments to Guangdong Province, 1988 to 1995

Supplying Province	Transaction Costs (τ) (1988 yuan per kilogram)			
	1988-89	1990-91	1992-93	1994-95
Hunan	0.22	0.20	0.27	0.39
Jiangxi	0.28	0.24	0.40	0.41
Hubei	0.31	0.28	0.36	0.35

Table 6. Comparison of Estimated Transaction Costs (1994-1995) and Transaction Costs from Trader Interviews (1994).

	Mean Estimated Transaction Cost (T) (Yuan)[a]	Mean Transaction Cost from Trader Interviews(τ) (Yuan)[a]	Mean Percentage Difference between Estimated and Interview Transaction Costs($100(T-\tau)/T$) (Percent)	Correlation between Estimated and Interview Transaction Costs ($\rho(T,\tau)$)
Rice				
Total transaction costs by weight (per kg)	0.254 (0.115)	0.115 (0.016)	+113	0.865
Transaction costs by weight-distance (per MT per km)	0.234 (0.156)	0.103 (0.035)		
Maize				
Total transaction costs by weight (per kg)	0.138 (0.076)	0.164 (0.049)	-17	0.735
Transaction costs by weight-distance (per MT per km)	0.064 (0.030)	0.078 (0.015)		

[a] All costs deflated to 1988 prices.