

How Connected are Chinese Farmers to Retail Markets? New Evidence of Price Transmission

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Abstract

This paper examines the extent to which Chinese farmers are connected to regional agricultural markets by looking at the intensity of price transmission from retail markets to the farmgate. This intensity is indicative of the extent to which farmers might benefit from improved marketing opportunities and be exposed to price risks. We estimate the elasticity of farmgate prices to retail prices using price data for 170 markets, in 29 out of 33 provinces of China, at the detail of 12 main products and for the five-year period 1996 to 2000. In each province we find strong linkages between retail and farmgate prices with elasticities ranging between 0.6 and 1 and intensifying over time. This suggests that Chinese farmers are generally well connected to retail markets and that this connectivity has strengthened in the period considered, creating new opportunities but also new risks. It is also found that linkages are relatively weak in inland provinces, which is a point of concern in view of Chinese policies to create equal opportunities and equitable growth.

Key words: China; farmgate prices; agriculture; price transmission

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1. Introduction

Price transmission in agriculture is the extent to which the changes in retail prices paid by consumers who are seemingly at a great distance from the farmer, will affect farmgate prices received by farmers who supply raw materials and who are situated at the bottom end of the food supply chain from the field to the table. From the viewpoint of cost analysis, price transmission could be considered as a cost accumulating along this food supply chain, that is, the prices of the raw materials at the farmgate are increased by costs associated with food processing, transportation, possibly augmented by taxation and tariffs or diminished by food subsidies (Keyzer 2009). Furthermore, consumer concerns like food safety, labor standards and branding, are increasing and have become a dominant factor in the trade in food products (see for example Zhang et al., 2010 for the case of milk in China). As a result, food supply chains worldwide become ever more tied, involving costly and centralized supervision from the field to the table. Furthermore, the stronger the food supply chains, the more value will be added to a product after it has left the farm. Consequently, the gap between farmgate and retail prices is on the rise, which may have effects on the transmission of changing retail prices to farmers.

In China, price transmission has also been affected by a series of gradual marketing reforms on agricultural commodity trade since 1978, aimed at transforming the centrally-planned marketing mechanism into a more efficient decentralized one where price signals play the dominant role in food production and consumption patterns (Park et al., 1994; Wu & McErlean, 2003; Zhuang & Abbott, 2007). For example, the government increasingly abolishes interventions that used to protect and stabilize farmers' incomes by keeping prices above predetermined floor levels, directly or via compensating payments. In a similar way, China's WTO accession has exposed farmers to world markets where food prices can be very volatile. As a result, some farm households can obtain higher incomes, i.e. those who are able to diversify income towards the more remunerative crops and towards non-farm income, while others who are unable to respond face an increasing risk of impoverishment (Anderson et al., 2004).

Price transmission mechanisms are thus of particular importance for China because they critically affect the eventual impacts of reform on farm incomes, supply response and consumer welfare gains. This has attracted the interest not only of academics but also of reformers and policy makers.

In this study we seek to provide some empirical evidence regarding the price transmission mechanism on China's regional agricultural markets. This is done by investigating the price elasticity of farmgate prices to retail prices during the transition period between 1996 and 2000 for a variety of products and offering both a temporal and spatial view. We base the analysis on prices from 170 markets across 29 provinces of China and corresponding farmgate prices for 12

major commodities, namely rice, wheat, maize, soybean, groundnuts, apple, citrus, pork, poultry, beef, egg and fresh water fish.

The remaining sections are organized as follows. The next section presents a review of the literature. Section 3 presents the econometric framework and estimation strategy. Section 4 describes the data, followed by the presentation and discussion of results in section 5. Finally, section 6 concludes and offers policy recommendations as well as suggestions for future research.

2. Literature review

Several authors have studied the performance of urban grain markets in China during the first transition period from 1988 to 1995. For example, Park et al. (2002) employed an interregional grain trade model to estimate arbitrage margins and transaction costs. Based on these estimates they were able to examine how grain markets in China evolved over time between 1988 and 1995. Their results demonstrated that for both rice and maize, the arbitrage margins were increasing and transport costs were decreasing before the retrenchment period (between 1994 and 1995), while the opposite happened during the retrenchment period whereby arbitrage margins fell and transport became more costly, mainly due to trade blockades in inland China and transport bottlenecks. In another study, Cheng (1996) investigated the degree of commercialization, changes in the state's contract procurement quota, and changes in the marketing channels to demonstrate the degree of market integration in China's grain marketing reform between 1993 and 1994. Based on 938 rural household surveys in five Chinese provinces, this study found some degree of liberalization of the grain markets. By the same token, Wu & McErlean (2003) evaluated efficiency on the wheat market by a cointegration test for two periods: 1978-1985 and 1992-1994. This study found that although quota prices were not cointegrated with free market or negotiated prices in the first period, quota prices were cointegrated with free market or negotiated prices in the second period, which indicated that the Chinese wheat markets had become more efficient over time. Focusing on rice, Awokuse (2007) tested whether market liberalization policies in the 1990s resulted in interregional rice market integration between 1991 and 2000. Based on price data from six provinces in Southern China, the results confirmed the existence of strong market linkages and suggested that prices originated in three dominant net producing markets in Hubei, Hunan and Jiangxi and then transmitted to Guangdong and Fujian. In addition, Guangdong, the largest rice market, had significant influence on price movements in its neighboring provinces, whereas the market in Anhui appeared much less connected, due to the fact that the major product in Anhui is Japonica rice, as opposed to mainly Indica rice in the other five provinces. Employing longitudinal data, Keller and Shiue (2007) compared integration of rice markets between two periods: 1986-1993 and 1723-1735. Their findings indicated that

compared to historical levels, contemporary markets are more integrated. Additional evidence of increasing integration was found by Huang et al. (2004), who demonstrated that the integration in 1996-2000 was higher than that in 1989-1995, with highest integration degree for maize, followed by soybeans, Japonica and Indica rice. Similar results are reported by Huang and Rozelle (2006), who investigated the grain market price co-movement from a temporal-spatial view. These results indicated that markets for maize and soybeans were highly integrated across space between 1996 and 2003. Particularly for maize, the price co-movement is relatively high between Liaoning province, located in Northeast of China, and coastal provinces, Guangdong and Fujian, located in South of China. In addition, for soybeans, the prices' co-movement is high between provinces in Northeast and coastal provinces.

A few studies are less conclusive about increased integration and price transmission in China's agricultural markets. For example, Zhou et al. (2000), employing monthly price data on twelve rice markets across ten provinces in South China, found a general lack of integration among the Indica rice markets between 1992 and 1996, contrary to the evidence discussed above. The major impediments to market integration were attributed to poor transport facilities, government interventions, and limited amount of grain available for arbitrage. Likewise, Young (2000) argued that due to internal trade barriers caused by changing patterns of provincial economic structures, China's markets became less rather than more integrated during much of the reform period. However, Park et al. (2002) attributed the increases in transaction costs and autarky rates to transport bottlenecks, especially in South China, without however, finding evidence of a predominant role of trade barriers during the period under study.

Existing literature on price transmission in China tends to focus on markets located in urban areas, with very few studies considering rural markets. One study by Huang et al. (2004) investigated the connectivity of villages to regional markets using a survey of 1200 households across six provinces in 2000. They found evidence that markets for rice, wheat, maize and soybean were integrated down to village level, suggesting that villages are linked well to regional markets. They also found that the gap between farmgate prices in the village and retail prices in the cities widens considerably with distance, which might be capturing the fact that the length of the food supply chains as well as the number of links may have a negative effect on price transmission.

In addition to focusing mainly on grain markets located in urban area, the forgoing literature review indicates that most studies have been preoccupied with price transmission before 1995. Yet, to understand how overall agricultural markets evolve, and how farmers' profits are affected by all food markets, it would be interesting to see whether markets for non-staple foods follow patterns similar to grain markets. Also, there is a need to examine trends after 1995. Furthermore,

the widening of urban-rural income gaps in China warrant a further study on how well (rural) farmers are connected to (urban) retail markets in the various parts of the country. The current study wants to fill part of these knowledge gaps.

3. Econometric framework and estimation strategy

The retail-price elasticity of the farmgate price will serve as our measure of the extent to which rural households are connected to marketing systems. This elasticity will be denoted by the symbol η and, for the reasons already mentioned in the introduction, it may differ over province (indexed $l = 1, \dots, 29$) and over commodities (indexed $c = 1, \dots, 12$), while also over time (indexed $t = 1996, \dots, 2000$) farmgate prices might become more responsive to retail prices. In a regression framework, the elasticity may be estimated as follows:

$$p_{l,c,t}^f = \eta_{l,c,t} \cdot p_{l,c,t}^m + \varepsilon_{l,c,t}, \quad (1)$$

where $p_{l,c,t}^f$ and $p_{l,c,t}^m$ are differencing on logarithm of the farmgate and the retail price, respectively, between year t and $t-1$, and $\varepsilon_{l,c,t}$ is an error term, which will be assumed to be independently, identically and normally distributed with zero mean (Wooldridge 2001).

The estimation of a separate elasticity for each province and for each year will be done by considering a measure for the infrastructures and a measure for the access to and the distribution of information sources/carriers. These factors are essential for market integration and price transmission to prevail. More information carriers in tandem with improved infrastructures are likely to lead to a higher degree of co-movement of retail prices and farmgate prices. In other words, a situation with abundant and timely information exchange and with good roads will stimulate a quick transmission of prices from the retailer to the farmer and, hence, a high elasticity will be observed. In this paper we will use the population density as a proxy for the availability of information carriers, while per capita length of the roads (transport lines) will be used as a measure of infrastructures in the various provinces. We acknowledge that the use of population density and per capita length of transport lines has some limitations. For instance, population itself need not capture the quality of information carriers, while the length of transport lines might not fully capture the level of infrastructures as it overlooks other aspects such as telephone lines or telecommunications networks. In addition, the data prevent considering the effects of market maturity (i.e. the level of competition in the marketplace) and institutional change on price transmission. For instance, since 1978, the Chinese government gradually removed obstacles to the trade and initiated a series of gradual marketing reforms on agricultural commodity trade, aiming at transforming the centrally-planned marketing mechanism into a more efficient and liberal one. Clearly, as documented in various studies, these reforms had important

impacts on agricultural trade patterns (Cheng 1996; Park et al. 2002; Wu & McErlean 2003; Huang & Rozelle 2006; Awokuse 2007). Nonetheless, following the diminution of direct interventions on agricultural trade and the elimination, to a large extent, of restrictions on marketing since the mid-1990s, policy interventions are no longer a main driver in the period under consideration.

The two proxies, population density and per capita length of the roads, are used in parallel, each having its own possible positive effect on price transmission elasticity. Our hypothesis is that the elasticity is expected to be higher in high population density provinces (at given road length per capita) and also higher in provinces with relatively more roads (at given population density). The comparison of the transmission elasticity in a high dense province with fewer roads (relative to its population size) and low dense province with many roads can go either way.

Finally, we iterate that the elasticity will also tend to be commodity-specific, essentially because the range of commodities considered in this study contains products of different seasonality, transportability and preservation characteristics. These products include grains, soybeans, groundnuts, fruits and animal products all having quite different marketing properties. To reflect this, we introduce commodity-specific dummy variables.

In summary, we specify the elasticity in province $l = 1, \dots, 29$, for commodity $c = 1, \dots, 12$ and in year $t = 1996, \dots, 2000$ as follows:

$$\eta_{l,c,t} = \beta_1 P_{l,t} + \beta_2 LT_{l,t} + \sum_c \beta_{3,c} d_c, \quad (2)$$

where $P_{l,t}$ denotes population density by province and by year; $LT_{l,t}$ denotes per capita length of transport lines (including rail, waterway and highway); d_c is a dummy variable for commodity c , and β_1 , β_2 and $\beta_{3,c}$ are the parameters to be estimated.

Thus, by substituting $\eta_{l,c,t}$ in equation (1) with equation (2), the final regression equation is as follows:

$$p_{l,c,t}^f = (\beta_1 P_{l,t} + \beta_2 LT_{l,t} + \sum_c \beta_{3,c} d_c) \cdot p_{l,c,t}^m + \varepsilon \quad (3)$$

4. Data

Three datasets from different sources are used to derive the intensities of price transmission for each commodity, by year and province. The first, collected by China's National Market Administration Bureau with a ten-day sampling frequency, consists of prices of different commodities from 170 markets distributed across 29 provinces of China. From this we compute a

yearly provincial-level market price. The second dataset comprises annual provincial farmgate prices of different commodities, collected by China's National Committee of Development and Reform. For the purpose of our analysis, we consider twelve major commodities covering grains (rice, wheat and maize), oil plants (soybean and groundnuts), fruits (apple and citrus), meat (pork and beef), aquatics (fresh water fish), poultry (meat chicken) and eggs. The time span is from 1995 to 2000. The third dataset is from National Bureau of Statistics of China (NBSC) and consists of yearly data, by province, on output of farm products, population, area, length of transport routes, and the consumer price index (CPI) that is used to deflate prices.

Although the available data are in a way quite comprehensive, there are several limitations to our analysis. We mention three issues, data currency, data aggregation, and homogeneity of products. On the first point, the use of more recent data would have been preferable, but these are yet unavailable or, at least, the price records that we obtained appeared to be empty for most locations. Nonetheless, because the period 1995 to 2001 is also characterized by fast changes, an analysis of levels and trends in price elasticities might lead to the right conclusions, though, of course, it would be interesting to test these conclusions against the more recent changes in the connection between farmers and markets.

A second limitation is that this study bases itself on aggregated information about annual farmgate and retail prices at provincial level, rather than on explicit point-locations and explicit farm households. A more precise estimation of the various transmission elasticities at the farmers' level would require household panel data. The latter would entail a regression of the change in farmgate price at individual farms on the change in prices at the nearest market. Unfortunately, panel data are unavailable and we have to use aggregated data. This might affect the analysis and lead to less precise estimates. Nevertheless, the estimation would remain unbiased, since it is the overall transmission to farmers that we are interesting by, rather than the optimal routing of the commodities along an explicit transport network.

A third data issue is each good is assumed to be homogeneous and, in fact, the data does not provide for quality information. This need not be very problematic because there seems sufficient detail in the data so that the differences between items (e.g. rice, citrus) can be expected to be more pronounced than the differences within one category (e.g. expensive and cheap rice varieties; oranges, tangerine). For example, for rice, in farmgate, data concerned four kinds of rice, i.e., early rice, middle rice, late rice, and japonica rice, while the data for urban markets report only one price of rice. In this case, we had to aggregate four kinds of rice into one at farmgate level, so as to match with the rice data in urban markets. The same situation happened to citrus. In urban markets, there is only one commodity, that is, tangerine, while at farmgate level, there are four kinds, i.e., general orange, honey orange, red orange, and Guang Gan.

One last point regarding the data concerns the fact that the provincial price data are sometimes scattered and based on few observations. Therefore, prior to estimation, we carried out a certain data trimming in order to focus only on relevant commodities in relevant provinces. Specifically, from the third dataset, we compute the share of provincial in the national production level for each commodity and include only those observations for which the ratio of the provincial output to the national output is larger than 0.05. The corresponding provincial production pattern is shown in Table 1.

The summary statistics used in the regression analysis are reported in Table 2, with all prices deflated by the corresponding year's CPI. The average population density for the whole sample is around 384 persons per square kilometer while the average length of the transport lines is approximately 1.1 kilometers per thousand persons. The commodity prices are expressed in Yuan per kilogram and reveal wide margins between farmgate and retail prices. The latter exceeds the former by a factor that ranges between 1.1-1.2 for poultry and eggs, 1.3-1.4 for wheat, maize and soybeans, 1.7 for pork and fish, 2.1 for rice and groundnuts, 2.1-2.3 for fruits, and, finally, the margin between retail and farmgate price reaches its maximum for beef with a factor of 2.6.

Table 1. Production patterns in China for selected agricultural products

Commodity Province	Rice	Wheat	Maize	Soybean	Groundnuts	Apple	Citrus	Pork	Poultry	Beef	Eggs	Fish
Hebei					X			X			X	
Inner Mongolia			X	X								
Liaoning			X			X				X	X	
Jilin			X	X						X		
Heilongjiang	X		X	X								
Jiangsu	X	X									X	X
Anhui	X	X			X							X
Jiangxi	X											X
Shandong		X	X		X	X		X	X	X	X	X
Henan		X	X		X	X		X	X	X	X	
Hubei	X						X	X				X
Hunan	X						X	X				X
Guangdong	X				X		X	X				X
Guangxi	X						X					X
Sichuan	X						X	X			X	
Shaanxi						X						

Table 2. Summary statistics of the data after data trimming

Variable	Mean (unit)	Standard Deviation	Number of observations
<i>Information and infrastructure</i>			
Population density	383.55 (persons / square kilometer)	13.55	294
Length of transport lines	1.051 (kilometers / thousand persons)	0.2022	294
<i>Commodity market prices (unit: Yuan / kilogram)</i>			
Rice	0.806	0.557	43
Wheat	0.517	0.436	22
Maize	0.425	0.396	28
Soybeans	1.009	0.682	16
Groundnuts	2.113	0.857	26
Apple	1.246	0.701	16
Citrus	1.320	0.752	17
Pork	4.120	1.321	35
Poultry	3.363	1.305	7
Beef	4.924	1.521	19
Eggs	2.624	1.002	30
Fish	3.722	1.095	35
<i>Commodity farmgate prices (unit: Yuan / kilogram)</i>			
Rice	0.388	0.295	43
Wheat	0.400	0.255	22
Maize	0.312	0.251	28
Soybeans	0.714	0.329	16
Groundnuts	1.001	0.439	26
Apple	0.546	0.484	16
Citrus	0.629	0.598	17
Pork	2.411	0.773	35
Poultry	2.769	0.945	7
Beef	1.904	0.817	19
Eggs	2.334	1.020	30
Fish	2.151	0.762	35

5. Results and discussion

In this section we present and discuss the results, considering the variation of the elasticity in three dimensions: over provinces, over commodities, and over time.

Transmission elasticity: effect of population, infrastructure and commodity characteristics

Estimates of the elasticities based on equations (3) are presented in Table 3 below. The estimation strategy we employ involves a step-by-step procedure, in order to consider separately the potential effects of two types of variables, the provincial population and infrastructure on the one hand and the product market itself on the other. We start by introducing population density and per capita transport lines in order to consider the extent to which information and infrastructure affect the price transmission elasticity (column 1, coefficients β_1 and β_2). This is followed by an estimation of the commodity-specific effects without considering separate effects of population and infrastructure (column 2, coefficients $\beta_{3,c}$). Next, the two specifications are merged and all coefficients are estimated jointly (column 3).

Unfortunately, the joint estimation (column 3) leads to considerable loss of significance. For example, the effect of population and infrastructure both disappear, while the dummies for rice, wheat and soybeans become insignificant. One reason might be that these variables exhibit a high degree of interdependence (multi-collinearity), which is known to cause high standard deviations and lack of precision. In particular, the fact that grains (rice, wheat and maize) and soybeans constitute the majority of daily sustenance of the Chinese, and can be shipped over long distances, implies that these commodities are likely to be more affected by the provincial demographics and transportation infrastructure. This means that regarding these commodities both population density and per capita length of transport lines will compete with the discriminatory variables in the explanation of a higher price elasticity, which effectively prevents estimation with reasonable precision. To deal with this problem, we consider dropping the dummy variables for grains and soybeans (column 4) and use this as our preferred specification for commodities other than grain and soybean. For the analysis of the elasticity of rice, wheat, maize and soybean we use the estimates with commodity dummies only (column 2). These results of the step-by-step procedure leave open the question whether provincial differences in price transmission intensity are to a large extent due to the different cropping patterns, or to the differences in population and infrastructure.

Table 3. Estimation of transmission elasticity (see equations 1 and 2)

	(1)	(2)	(3)	(4)
Population density	0.001*** (0.0002)		0.00002 (0.0006)	0.001*** (0.0003)
Per capita length of transport lines	0.040*** (0.008)		-0.013 (0.027)	0.031*** (0.008)
Rice		0.601*** (0.192)	0.737 (0.509)	
Wheat		0.702** (0.278)	0.778 (0.589)	
Maize		0.780*** (0.156)	0.947* 0.535	
Soybean		0.804** (0.394)	1.08 (0.727)	
Groundnuts		0.431** (0.192)	0.523 (0.507)	-0.23 (0.223)
Apple		1.06*** (0.203)	1.18** (0.512)	0.409* (0.227)
Citrus		1.29*** (0.192)	1.43*** (0.494)	0.676*** (0.214)
Pork		0.911*** (0.240)	1.02* (0.530)	0.254 (0.262)
Poultry		0.589 (0.641)	0.656 (0.806)	-0.11 (0.656)
Beef		1.12*** (0.409)	1.21* (0.633)	0.439 (0.426)
Eggs		0.752*** (0.168)	0.854* (0.511)	0.076 (0.202)
Fish		0.470** (0.231)	0.584 (0.555)	-0.23 (0.258)
Observations	294	294	294	294
Adjusted R-square	0.24	0.27	0.27	0.27

Note: Dependent variable: differencing on log farmgate price
Standard errors in parentheses

* significant at 10%; ** significant at 5%; *** significant at 1%.

Column (1) reveals a positive and significant impact of both population density and infrastructure on price transmission elasticity. Results from estimating commodity effects only, reported in column (2), underscore the significance of commodity-specific characteristics in explaining the elasticity further. This implies that there are differences in the price elasticity for different commodities. In the full specification of column (3), we controlled for all three categories of variables simultaneously and the significance of commodity dummies decreases while, more importantly, the population density and the per capita length of transport routes lose their significance. As mentioned earlier, this probably reflects the presence of multicollinearity,

because the shifters for the staples might very well reflect the regional differences in population and infrastructure in China. Indeed, the significance of the two latter effects reappears after dropping the shifters for grains and soybean, which supports our assertion that for these commodities China's demographic distribution and transportation infrastructure are most important. The resulting estimates in column (4) demonstrate that higher population density as well as per capita transport lines facilitate price transmission from markets to rural households and lead to higher transmission intensities. The latter is consistent with Huang et al. (2004) who find that the the market price is reflected more in the farmgate price, the closer the farmer is to the market..

Transmission intensity by commodity

In Figure 1 we illustrate the estimated average transmission intensities of different commodities across all provinces and across all years.

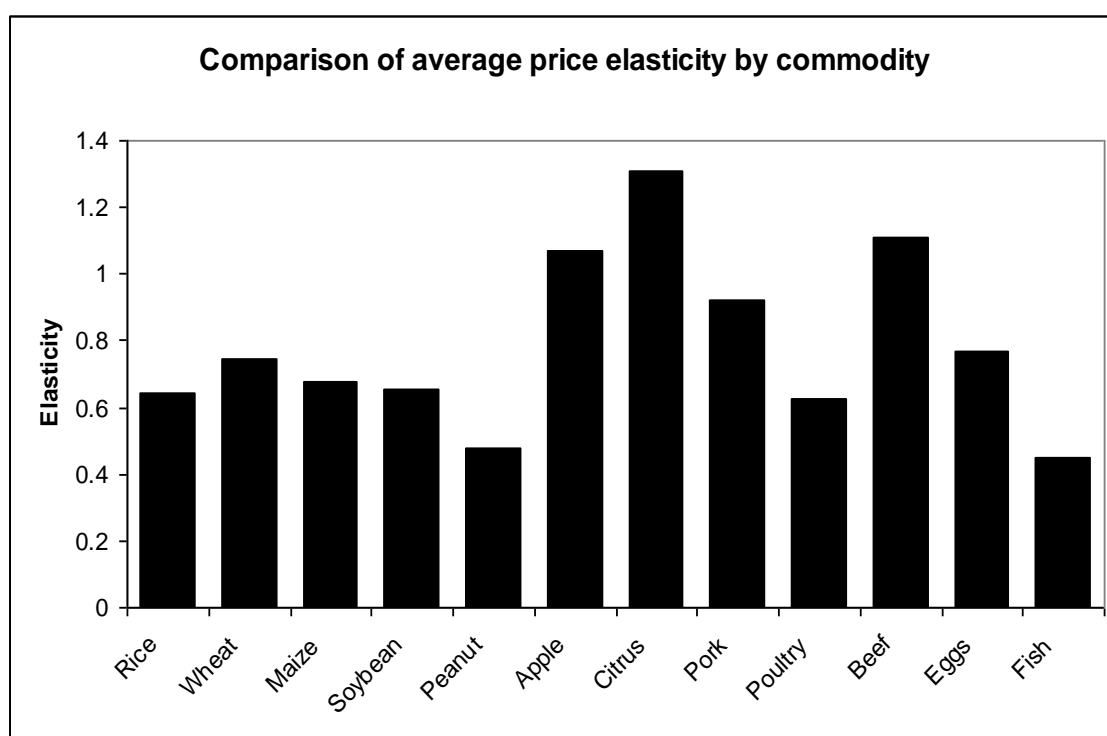


Figure 1. Price transmission intensity by commodity

It can be seen from Figure 1 that the mean transmission intensities are highest for fruits and beef (elasticity exceeding one), while the groundnuts and aquatics rank last (elasticity around 0.4). The elasticities of grains and soybeans are in between (around 0.6 to 0.7), with an estimated farmgate price of wheat that is slightly more elastic to retail prices than the one for rice and maize.

For the purpose of comparison with the results from Park et al. (2002), we made simple averaging computations based on their estimation results, e.g., arbitrage rates and transport cost for rice and maize, respectively. The results showed that the average arbitrage rate for maize is higher than that for rice, while the average transport cost is lower. This suggests that the price transmission on maize markets is somewhat higher than on rice markets, in line with previous findings. In addition, according to Cheng (1996), the shares of state grain procurement in 1994 for maize and soybeans are much less than those for rice, suggesting that maize and soybean markets were more liberal. This supports our findings that the intensity of price transmission is higher for maize and soybeans than for rice. Note however that for wheat, a market where the state used to intervene heavily, the elasticity is now much higher than for rice. According to Huang et al. (2004), who do not consider the wheat markets, the sequence for degrees of market integration, sorted in descending order is: maize, soybeans, Japonica rice, and Indica rice, a sequence that is in accordance with our ordering of price transmission intensities.

Transmission intensity by commodity and by province

In this sub-section, we investigate how the transmission intensities of a given commodity differ across provinces. The transmission intensities of 12 commodities in different provinces are reported in Table 4.

Table 4. Transmission elasticity by commodity and by province

	Rice	Wheat	Maize	Soybean	Groundnut	Apple	Citrus	Pork	Poultry	Beef	Eggs	Fish
Hebei	.	.	.	.	0.37	.	.	0.85	.	.	0.67	.
Inner	.	.	0.82	0.81	.	.	.	.	.	.	.	.
Liaoning	.	.	0.62	.	.	1.03	.	.	.	1.0	0.7	.
Jilin	.	.	0.58	0.58	.	.	.	.	.	1.0	.	.
Heilongjiang	0.56	.	0.56	0.56	.	.	.	.	.	.	.	.
Jiangsu	0.86	0.86	.	.	.	.	.	.	.	.	0.94	0.63
Anhui	0.64	0.64	.	.	0.412	.	.	.	.	.	.	0.40
Jiangxi	0.55	.	.	.	.	.	.	.	.	.	.	0.32
Shandong	.	0.76	0.76	.	0.531	1.17	.	1.02	0.65	1.2	0.84	0.54
Henan	.	0.71	0.71	.	0.483	1.12	.	0.97	0.59	1.1	0.78	.
Hubei	0.61	.	.	.	.	.	1.2	0.86	.	.	.	0.38
Hunan	0.62	.	.	.	.	.	1.3	0.88	.	.	.	0.39
Guangdong	0.81	.	.	.	0.584	.	1.4	1.06	.	.	.	0.57
Guangxi	0.55	.	.	.	.	.	1.2	.	.	.	.	0.31
Sichuan	0.54	.	.	.	.	.	1.2	0.79	.	.	0.64	.
Shaanxi	.	.	.	.	.	0.95	.	.	.	.	.	.

From Table 4, it can be seen that for rice, the price transmission in coastal provinces (Guangdong and Jiangsu) is more intense than that in inland provinces; and for wheat, the same pattern is found, that is, coastal provinces (Shandong and Jiangsu) show higher transmission intensities than inland provinces (Anhui and Henan); also for maize, groundnuts, apple, citrus, pork, beef, eggs and fresh water fish, the price transmission mechanisms along the coast seem more efficient than those prevailing inland. This finding is in line with Park et al. (2002) who state that the decline in the arbitrage rates for maize in the retrenchment period 1994-1995 was attributable to trading patterns in inland regions (rice is produced in almost all coastal provinces) where institutional reforms were carried out less completely and retrenchment policies were better enforced.

Furthermore, based on price data from six provinces in South China, the empirical results from Awokuse (2007) confirmed the existence of strong market linkages and suggested that prices originated in three dominant net producing markets in Hubei, Hunan and Jiangxi and are readily transmitted to Guangdong and Fujian. In addition, Guangdong, the largest rice market, had a significant influence on price movements in its neighboring provinces. However, Anhui is the least integrated of the six provinces, possibly due to the fact that the major product in Anhui is Japonica rice, while the rest of the markets produce mainly Indica rice. Compared to the study by Awokuse (2007), our study is focused on nine major rice producing provinces (Heilongjiang, Jiangsu, Anhui, Jiangxi, Hubei, Hunan, Guangdong, Guangxi, and Sichuan) accounting for practically the entire national rice production.

From Table 5, it can further be seen that Hubei, Hunan and Jiangxi have lower transmission intensities than Guangdong which is the highest among the nine provinces, which suggests that Guangdong, the largest rice market had a significant influence on its rural households. In sum, prices are generally transmitted quicker in coastal than in inland provinces, emphasizing that the spatial aspect is of importance when it comes to the connectivity of Chinese farmers to retail markets.

Transmission intensity trends over time

In this sub-section, we investigate how the transmission intensities of a given commodity in different provinces change over time. This is illustrated in Figure 3-Figure 14 below.

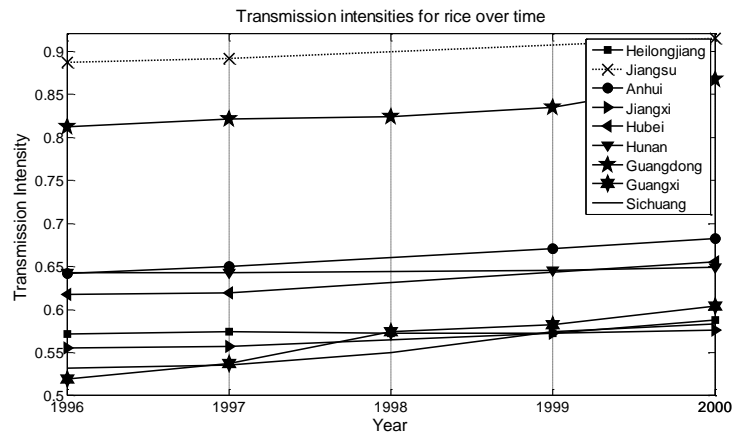


Figure 3. Transmission intensities over time for rice

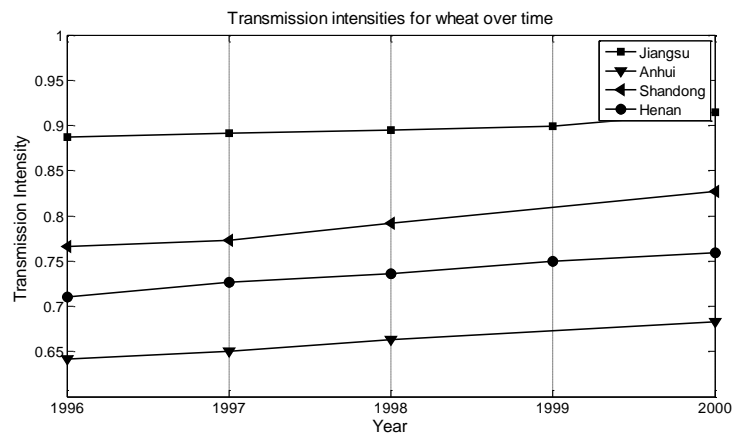


Figure 4. Transmission intensities over time for wheat

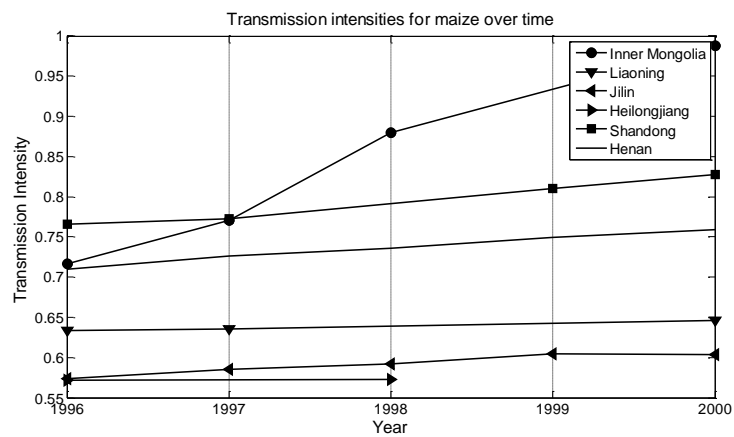


Figure 5. Transmission intensities over time for maize

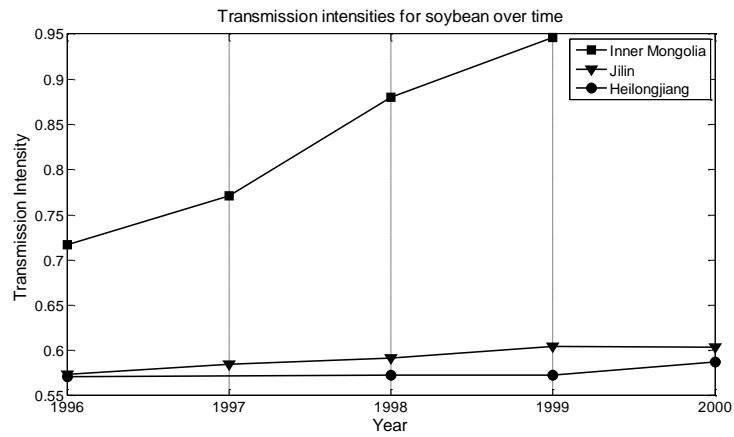


Figure 6. Transmission intensities over time for soybean

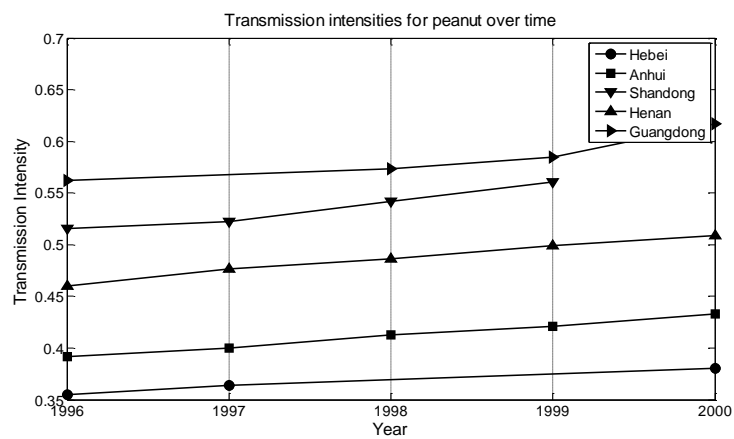


Figure 7. Transmission intensities over time for peanut

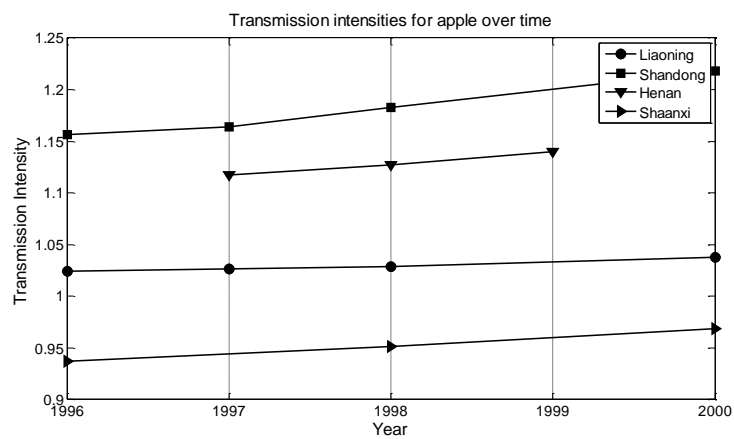


Figure 8. Transmission intensities over time for apple

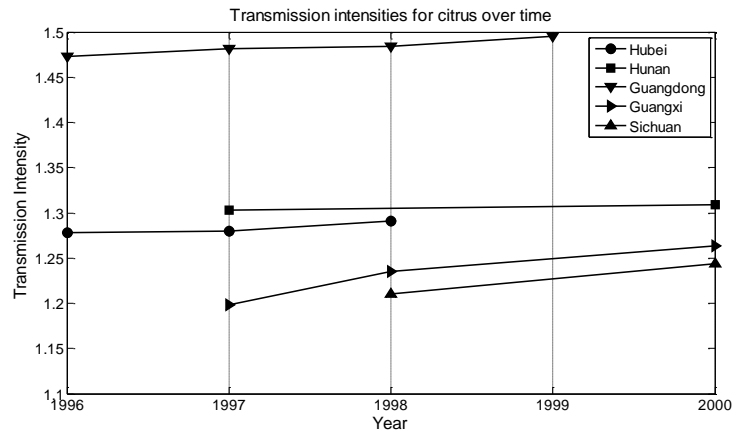


Figure 9. Transmission intensities over time for citrus

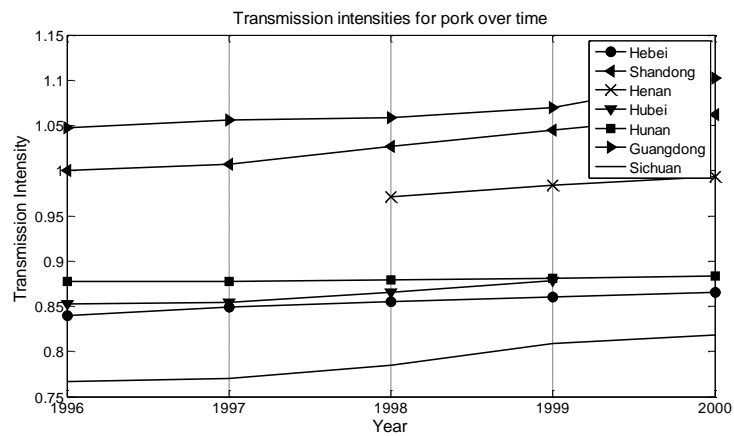


Figure 10. Transmission intensities over time for pork

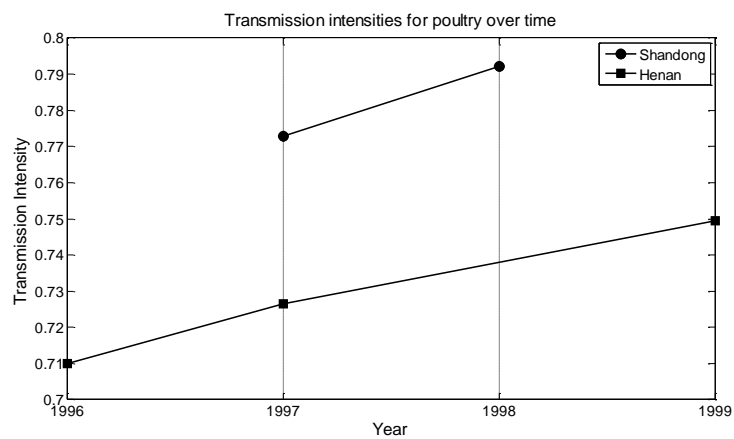


Figure 11. Transmission intensities over time for poultry

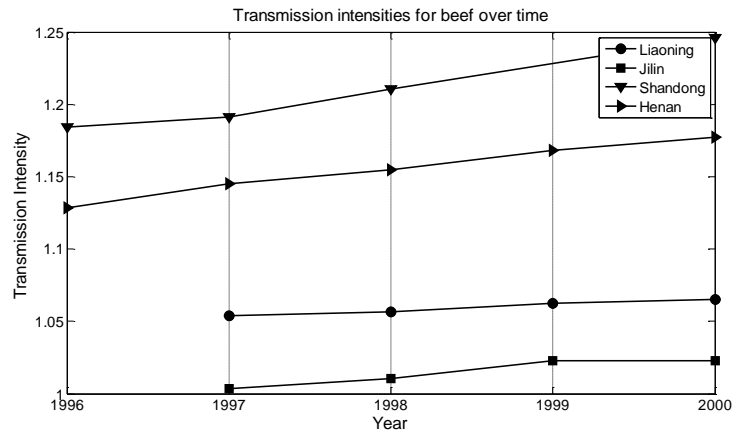


Figure 12. Transmission intensities over time for beef

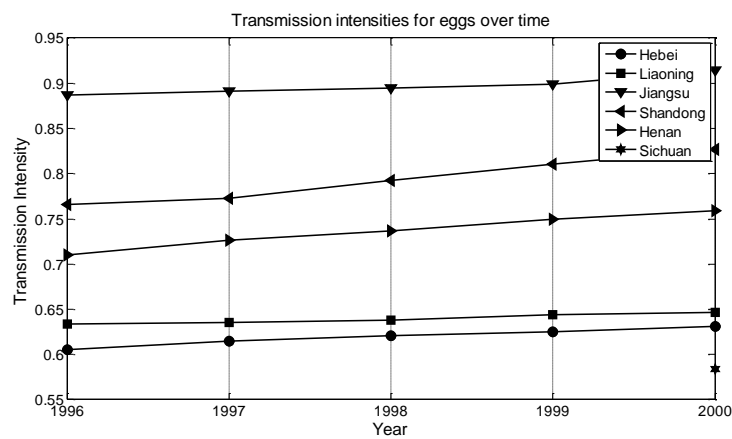


Figure 13. Transmission intensities over time for eggs

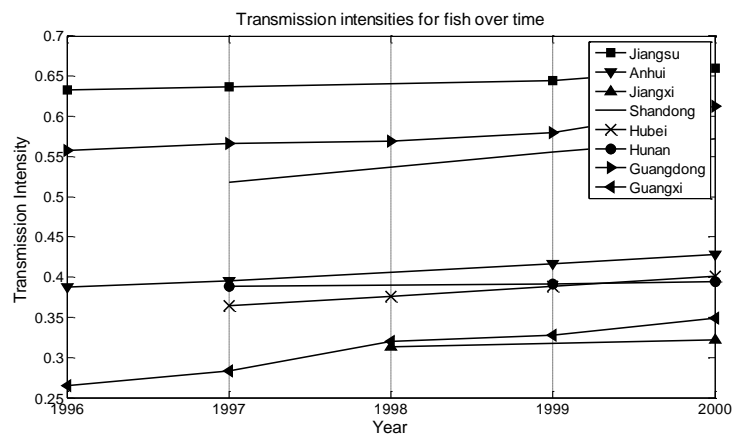


Figure 14. Transmission intensities over time for fish

Figures 3-14 demonstrates that China's agricultural markets continued to evolve and improve in the late 1990s. From 1996 to 2000, the intensity of price transmission for each commodity in each province was increasing, which means that the connection of the Chinese farmers to the

agricultural markets has strengthened. Despite the upward trend for the main rice producing inland provinces, the rice price transmission intensities have remained larger in coastal than in inland provinces. The same patterns are confirmed for wheat and maize. However, for maize and soybeans, the transmission intensities in Inner Mongolia sharply increased between 1997 and 1999, which we attribute to the accelerated infrastructural construction during this period. For example, the length of the highway increased by some 12 and 50 percent, respectively, compared to a length of 50,428 km in the base year 1995.

6. Conclusions

In this paper, we studied the extent to which Chinese farmers are connected to regional agricultural markets by looking at the intensity of price transmission from retail markets to the farmgate. We estimated the elasticity of farmgate prices to retail prices using price data for 170 markets, distributed across 29 provinces of China, and corresponding farmgate prices for 12 major commodities: rice, wheat, maize, soybeans, groundnuts, apple, citrus, pork, poultry, beef, egg and fresh water fish. Annual provincial-level intensities of price transmission during the transition period between 1996 and 2000 were calculated for each commodity.

These new estimates of the elasticities of farmgate prices to retail prices revealed interesting features of the dynamic nature of agricultural markets in China in the five-year period studied. Overall, we found strong linkages between retail and farmgate prices that have continually been intensifying since the policy retrenchment period in 1995. Specifically, for the 12 products considered, our elasticity estimates range between 0.6 and 1, with a few exceptions. Moreover, the results suggested that: 1) China's agricultural markets continued to evolve and improve between 1996 and 2000, with significant increases of transmission of retail prices to farmers for each commodity and in each province; 2) price transmission intensity is relatively high in coastal provinces and most intense for fruits, pork and beef; 3) higher population densities -used as a proxy for information carriers- as well as per capita transport lines -used as a proxy for infrastructure- facilitate a more rapid price transmission to the farmers. Of these findings, the third one should be treated cautiously, because the provincial differences in population and infrastructures appeared to be highly covariate with the provincial differences in cropping patterns. This implies that either of these two factors could be predominant in explaining price transmission intensities.

Be this as it may, the evidence is supportive of the idea that Chinese farmers are generally well connected to retail markets and that the connectivity has strengthened in the period 1996 to 2000. For the Chinese farmers, this has probably created new opportunities but, as we mentioned in the introduction, those households who are unable to diversify income towards the more

remunerative products and towards non-farm income sources might also face an increasing risk of impoverishment caused by exposure to price volatility. We also found evidence that transmission intensity is relatively low in inland provinces and relatively high in coastal provinces, which is a point of concern in view of Chinese policies to create equal opportunities and equitable growth.

One topic for further study might be the possible seasonality in price transmission to see whether transmission during the harvest season is relatively high, which is good for the small-scale farmers, or relatively low, which could point to certain distortions in favor of the large farmers and the traders. More importantly, it seems worthwhile to investigate the connectivity of farmers to markets in the period after 2000, a period of prolonged and unprecedented growth of income and trade associated with a rapid migration from rural to urban areas and corresponding changes in population densities and infrastructures. It would be interesting to see whether, where and for which products the price transmission has continued to increase in intensity and what this means for the new opportunities and, possibly, the new risks that farm households throughout the country are facing.

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