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A Study on Regional Specialization of China's Agricultural Production: Recent Trends and Drivers

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Abstract

The paper examines trends and drivers for regional specialization of China's agricultural production for 2003-2011. We apply the Regional Specialization Index to a data set of commodities that covers 70 percent of China's crop and livestock production. Actual prices at the provincial level are used and a seven-region framework is established that accurately reflects China's agro-ecological characteristics. Our findings show that inequality of specialization among the Chinese regions has narrowed, with the year 2007 as a turning point. We argue that the enhanced regional specialization is due to less government intervention and more openness to international markets. Growing economic freedom, accompanied by intensified internal and external competition, has driven the regions to adjust agricultural production structures closely according to comparative advantages. Recent trends of specialization are identified and explained. Moreover, quantitative evidence to relevant agricultural policies is provided.

Keywords: Regional specialization, agricultural production, China

Introduction

Labor division and specialization are keys to economic growth (Young, 1928). Specialized economies employ more sophisticated technologies that result in significant output increases (Kim, 1995). In particular, regional specialization has long been linked to regional development and economic growth (North, 1955; Perloff *et al*., 1960). With respect to agriculture, specialization allows a farmer to concentrate resources on specific needs (Ilbery, 1984), which increases productivity (Kurosaki, 2009), rural income (Gregson, 1996; Rase and Zhang, 2009) and farmers' welfare (Deininger and Olinto, 2001), and enhances production structure (Huffman and Evenson, 2000). On the negative side, specialization could lead to soil deterioration because the economics of scope and rotation are lost (Ilbery, 1984). Furthermore, once dependent on a limited range of agricultural products, regions might become vulnerable to changes in the level of profitability of those products (Bowler, 1981).

Yao (2004) pointed out that farmers in developed countries tend to specialize and explore their comparative advantages thoroughly, which brings them more profits from trade both in domestic and global mar-

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kets, while developing countries are generally less specialized. The reasons for lower specialization in developing countries are manifold and often related to government interventions that cause market distortions. China's agricultural sector offers an example where policy adjustments made by the central government have been strongly affecting the allocation of resources and influencing the production decisions of farmers throughout decades (Xu, 2001). Reviewing the history of China's agricultural development, a unique and tortuous path, from having tight central control to a much freer market, and from having agriculture sector sacrifice for industry to having industry support agriculture, is observed.

Agricultural development in China was slow until Deng Xiaoping initiated the Chinese Economic Reform and Opening-up in 1978. Tightly restricted by the centralized planning system, regions could hardly produce according to their comparative advantages. Thus, it is widely believed that China remained insufficiently specialized compared with developed countries because of its dual economic structure (Liu, 2004). Agricultural development started to take off after the central government gradually loosened its control over domestic production and released its constraints on the agricultural market. In 1983, the household responsibility system (HRS) was established, and long-term land-use rights were granted to farmers. By 1986, the state monopsony purchase and trade system was abolished for most agricultural commodities, except for grains and cotton, which were considered strategically important for the country. A set of further policy adjustments was initiated before China's accession to the World Trade Organization (WTO) in 2001. After the accession, impressive agricultural reforms were carried on. For example, in 2006, the Regulations for Farmer Professional Cooperatives (FPCs) were implemented, encouraging the establishment of rural producer organizations. Additionally, agricultural taxes were reduced since 2004 and abolished by 2007.

Except for the policy adjustments mentioned above, changes on other aspects are also observed in China's agricultural sector. According to National Bureau of Statistics of China (1981-2012), the importance of agriculture out of the entire economy has fallen from 12.6 percent in 2003 to 8.9 percent in 2011. Correspondingly, the portion of rural population fell considerably during the period. It dropped from 59.5 percent in 2003 to 48.7 percent by 2011. Noticeably, rural labor force shrank substantially in recent years, from 475.1 million in 2003 to 405.1 million in 2011. On the other hand, as shown in Figure 1, the portions of agricultural production value, in the broad sense, has remained rather stable. The value of crop category stays around 50 percent, while livestock accounts for 32 percent and fishery for about 10 percent (National Bureau of Statistics of China, 1981-2012).

Being the world's second largest economy, and the largest food producer and consumer, China's food security, rural development, and agricultural trade issues have considerable global impacts. Despite the impressive achievement in the industrial, service and real estate sectors that China has achieved, its agriculture is still far from being equally successful. In light of the profound changes in agricultural markets and policies, various approaches have been chosen to figure out the reasons for the unbalanced development currently and future path for China's agriculture. Several scholars have tackled the questions from the perspective of agricultural specialization in China (Carter and Lohmar, 2002; Tian, 2012; Xu, 2001; Yao, 2004). They agree that comparative advantages in the Chinese regions are not properly exploited. Carter and Lohmar (2002) were the first to provide statistical evidence for this claim. They showed that the level of specialization is far below that in developed countries. To reveal comparative advantages in the Chinese regions, the authors used the regional specialization index that was proposed in Krugman (1991). Our paper also takes this index as a starting point, and

moves further to make two crucial modifications that improve the method to acquire a more precise picture of regional specialization in China's agricultural sector.

This paper is divided into four sections. In the next section, we discuss the literature relevant to agricultural specialization and comparative advantages of China's regions. We continue in the third section with an overview of the methodology and the improvements achieved through our adjustments. Details of our dataset are also included in this section. Our main findings are presented in the fourth section that also comprises a comprehensive discussion, which links to recent policy adjustments and market changes. The last section wraps up the paper with our core conclusions as well as remarks for future research.

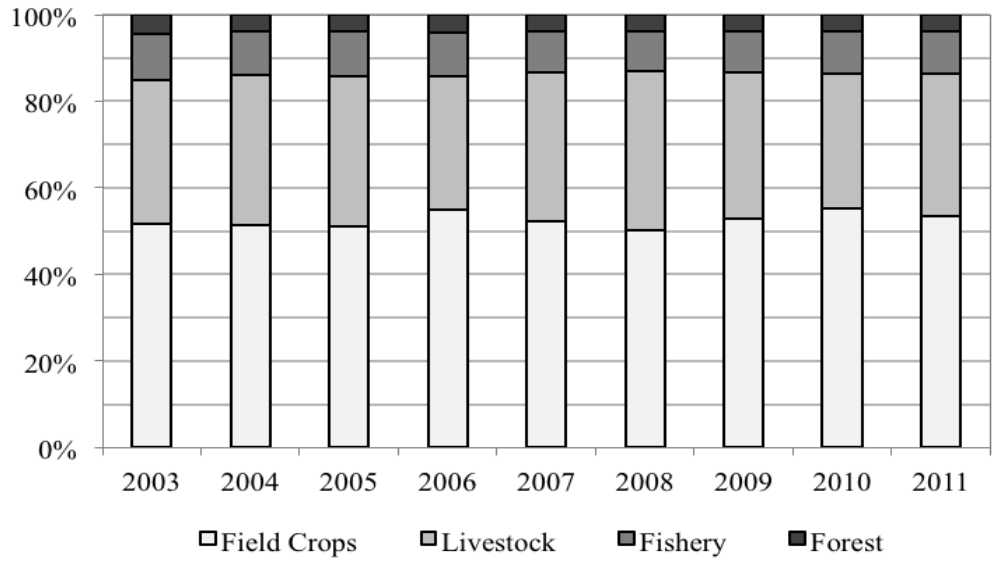

Figure 1: Structure of China's agricultural production (2003-2011)
Source: Data from the National Bureau of Statistics of China (1981-2011).

Literature review

Realizing comparative advantages allows producers in competitive markets to outperform others and maximize profits (Carter and Li, 2002). Producers are motivated to specialize in the production of goods for which they have the lowest opportunity costs relative to competitors. Hence, regional specialization may arise when regions exploit their comparative advantages, and/or take advantage of economies of scale (Kim, 1995). Specialization is closely linked to the concept of comparative advantages that is widely used to explain production and trading patterns. One famous example is the Heckscher-Ohlin model, which suggests that the comparative advantages of an entity are determined by its relative abundance of resources endowment. Moreover, it is important to realize that specialization has multiple layers. The broadest is the country level where different countries have different major commodities in the international market. The second layer is the region level where different regions within countries specialize in the production of certain goods. Additionally, further specialization occurs at the farm and household level (Yao, 2004).

Particularly regarding China's agriculture, it is argued that provinces are not able to have

their comparative advantages effectively exploited, leading to a relatively low degree of regional specialization (Tian, 2012). Various constraints, such as the central government's equalization policy, stereotypes of self-sufficiency, and deficient infrastructure, have been argued to be the reasons for the insufficient specialization (Xu *et al*., 2008). Yet, as China goes through substantial economic changes, accompanied by a considerable alteration in the global environment, significant adjustments in agriculture have been conducted (Carter *et al*., 2012).

After China joined the WTO in 2001, a number of papers discussed whether the accession would lead China to follow its comparative advantages more accurately (Carter and Li, 2002). Scholars have also analyzed the endowment of input factors in China's agriculture and their roles regarding regional productivity growth (Cho *et al*., 2010). These scholars applied various indices to measure the comparative advantages of agricultural production in different provinces (Xu, 2001; Yao, 2004; Ye, 2004). Based on the concept of regional comparative advantages, several papers investigated the production centralization of China's major agricultural commodities (Li *et al*., 2012; Tian, 2012; Zheng and Cheng, 2005). None of them, however, depicted the macro picture of regional specialization sufficiently. The most thoughtful and recognized analysis of China's regional specialization in agriculture is found in Carter and Lohmar (2002). The authors argue that the policy adjustments strongly affected regional specialization of agriculture since the 1980s. Their methodology, though, has several disadvantages that will be discussed in the following section.

Methodology and data

The literature provides a number of indices to measure the degree of economic specialization. According to previous research, the concept of specialization takes two complementary perspectives. The first perspective describes the absolute specialization. Under this approach, a subject is considered as specialized if a relatively small number of industries exhibit high shares of the subject's overall employment or production value (Aiginger and Davie, 2004). Italy and its textile and food industry is a good example for such type of specialization. The perspective is also called as *intraregional specialization*, because only the internal production structure counts for the specialization degree of a region, regardless of how competitors perform. Notably, specialization measured in this way tends to show a U-shaped pattern over time (Zhang & Cheng, 2012). For this perspective, widely used indices include the Hirschman-Herfindahl Index (Herfindahl, 1950; Hirschman, 1964), the Shannon Entropy Index (Shannon, 1948), the Diversification Index (Rodgers, 1957), and the Absolute Gini Index (Gini, 1921). On the other hand, specialization can be measured from a comparative perspective, called as *interregional specialization* (Fan, 2007). This approach focuses on quantifying the deviation or heterogeneity of the subject's production structure in comparison with a selected benchmark or competitors. Under this approach, a revered U-shape pattern is usually found for the subject's regions over time (Kim, 1995). Frequently used indices include the Krugman Specialization Index, or the KSI (Krugman, 1991), the Index of Inequality in Productive Structure (Cuadrado-Roura *et al*., 1999), the Theil Index (Theil, 1967), and the Relative Gini Index (Hoover, 1936).

In fact, no index could ever reflect full information of the subject; but each catches a unique portion. It is crucial to choose the most appropriate index to the key question of the research. Our focus is to investigate how Chinese regions have enhanced their agricultural production structure based on comparative advantages in the course of recent agricultural reforms in China. Hence, it is of most importance to directly measure how dissimilarity degree has changed gradually among regions after they were allowed to produce according to comparative advan-

tages in a competitive market. In other words, an index that takes the comparative perspective should be picked.

Therefore, the KSI is chosen as the measure of specialization in this paper since it catches the core information to the research question. According to Palan (2010), the KSI is a superior measure for relative specialization, because it is the only index that possesses the criterion of anonymity, progressive transfers, merging, and bounds. In recent years, the KSI has received broad attention and been used in various studies of regional specialization (Kim, 1995; Krieger-Boden *et al*., 2008; Liang, 2004; Xian & Wen, 2006, Wolf, 2007). As mentioned, the measure has two potential references, a selected benchmark and all other regions. Application examples are found using both alternatives compared among regions (Krugman, 1991; Palan, 2010). Regarding our topic, KSI was applied to the agricultural sector in Kim's paper (1995) that unfortunately focused on manufactory industries. In 2002, Carter and Lohmar used the KSI to measure regional specialization of China's agriculture used it. They proposed to calculate the index by comparing among regions.

For this paper, since we are essentially interested in explicitly studying the structural distinction between one region and another in order to focus on the concept of comparative advantage, Carter and Lohmar's specification is used as the final measure formula[2]. The pairwise index is defined as the sum of absolute differences over all sectors in the share of a sector in the agricultural production of a region minus the share of that sector in another region's agricultural production. The range of the index is zero to two. If the index equals zero, two regions have identical agricultural structures, while two regions are completely specialized if the index is equal to two.

We compiled a dataset that covers provincial production and price data of seventeen commodities for all Mainland China provinces and equivalents[3]. The dataset covers the period 2003-2011 and builds on the specification presented in Carter and Lohmar (2002). We focus on the period because price data at the provincial level are not published for earlier years. Also, even national price data for earlier years are not comparable, because the data collection method changed in 2001. Hence, we have derived the data for 2003 to 2011 from the China Yearbook of Agricultural Price Survey (Department of Rural Survey, National Bureau of Statistics of China, 2003-2011), Compendium of Agricultural Commodity Prices and Costs (Committee of Development and Reform, 2003-2011), the Agricultural Economics Yearbooks (Ministry of Agriculture of China, 1981-2011), and China's Statistics Yearbook (National Bureau of Statistics of China, 1981-2012). These data sources are the only trustworthy ones for regional comparison as they are published by the central government. Indeed, other sources of data are not useful because of the inconsistent data collecting methods or limited scope. Notably, when a province reported the production of a commodity but no price data were available for a given year, we calculate the average price for the region that the province belongs to, and use it as the province's commodity price in that year. Less than 1 percent of the price data is calculated by this method.

We included seventeen commodities from crop and livestock category. The two categories account for more than 80 percent of China's total agricultural output value which also includes fishery and forestry. To be specific, the commodities from crop category are: apples, bananas, citrus fruits, corn,

[2] To make a sensitivity test, we also calculate the KSI using national average as the reference. The results show highly similar trend, though the absolute values are smaller. For details, please refer to Figure 2.

[3] Municipalities (e.g. Beijing) and Autonomous Regions (e.g. Guangxi) are of the equivalent administration level as provinces in China.

cotton, flue cured tobacco, peanuts, rapeseed, rice, soybeans, sugar beets, sugarcane and wheat; and from livestock category: beef, mutton, pork and poultry. Throughout the examined period, the commodities contribute to over 70 percent of the total annual production value of crop and livestock category. The value of vegetables has been growing rapidly in recent years, and now occupies a considerably higher share in China's agricultural production value. The regional specialization index would be even higher had we included vegetables, given the substantial production differences among provinces. Unfortunately, the complete production data at the province level are not available, and hence we have to exclude the value data of vegetables from the calculation.

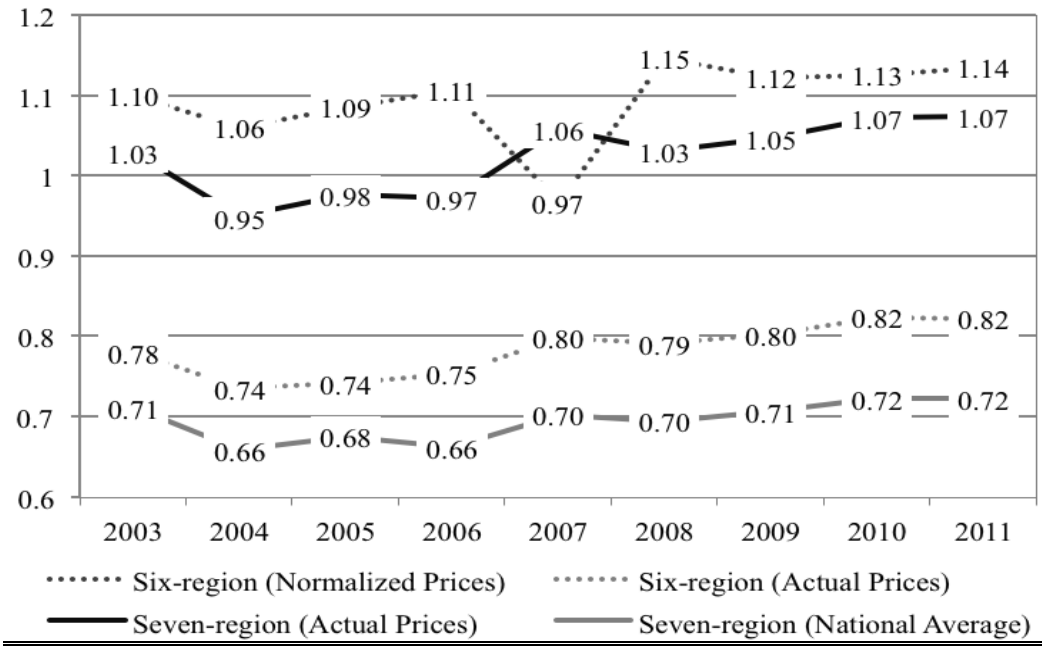

Figure 2: Average KSI for China's agricultural production (2003-2011)
Source: Authors' own calculation. The definition of regions is presented in Appendix.

Actual prices at the province level, instead of normalized ones as earlier works did, are used. This adjustment is important because price differences are large among the commodities (i.e. it can be as much as a 74.4-time difference) and among provinces (i.e. it can be as much as 6.1 times, and on average 2.3 times). Thus, it makes better sense to use actual prices. As shown in Figure 2, using normalized price for cross-sectional commodities results in a considerable upward bias compared with outcomes generated from using actual price data. In other words, the bias leads to an overestimation of the degree in terms of China's agricultural specialization. Such a bias is expected, because normalized prices can enlarge the value differences of a particular commodity as the difference is based on quantity only. In fact, regions with a lower quantity tend to have a higher price, or the other around. Hence, the difference of production value is not as large as it should be if using normalized prices.

Furthermore, we argue that it is more appropriate to define agricultural regions according to natural conditions (e.g. rainfall, soil type and temperature) and historical agricultural production patterns. Thus, we redefine China into seven regions rather than using

the popular division of six regions, which was used by Carter and Lohmar (2002). However, there was no convincing argument for the validity of this division in the context of agriculture. For our seven-region framework, we rely upon the definition proposed by the Chinese Committee of National Agricultural Regional Planning (1981). The thirty-one Mainland provinces or equivalents are grouped into Northeast (NE), middle-lower division of Yellow River (YR), middle-lower division of Long River (LR), South (S), Southwest (SW), Tibet-Qinghai (TQ), and Northwest (NW) Regions. An illustration of the six- and seven-region framework is provided in the Appendix. Notably, the seven-region framework generates larger indices and clearer trends over the period studied compared with the six-region framework as shown in Figure 2

Results and discussion

Regional specialization is driven by a variety of factors. Theories of regional specialization in agriculture classify the drivers as internal and external in respect to production. Internal drivers include most fundamentally, natural endowment, technologies and labor force structure. To be specific, natural endowment refers to arable area, landscape, climate conditions and so on. On the other hand, external factors contain market conditions, infrastructure, and policies. For instance, market conditions refer to the openness of the market, the structure of the market, and the organizational structure of trading entities in the market. Policies include domestic taxes, international trade regulations, and agricultural investments. Note that, natural endowment and labor source are rather stable over years, while technologies and policies can have considerable changes in a short period of time. Especially for China, market conditions and agricultural policies have had dramatic changes during the period 2003-2011 as mentioned earlier. Thus, the following discussion is developed from an analysis of agricultural market and policies changes in recent years in order to explain the three major observations and other concerns with respect to the results. We argue that the liberalized agricultural market and supporting policies generate the major drivers, such as intensive competition and financial subsidies, for specialization enhancement in China. The major observations and some concerns on the negative side are analyzed as follows.

Major findings

Firstly, as a whole, China's agriculture production has become more regional specialized; and each region in China has become more specialized since 2003, expect for NE. Table 1 provides all average and pairwise KSI figures for the regions. The average national degree of specialization, which equals the KSI divided by two, went up from 47.5 percent to 53.5 percent over nine years. We argue that the change is largely due to increased economic freedom both in domestic and international agricultural markets. Although the central government still controls the production and trade of staple foods, trade for other commodities is generally not distorted. Particularly since China joined the WTO in 2001, international agricultural markets have pushed China to move from emphasizing on self-sufficiency to balancing profit maximization. China no longer has a comparative advantage in the production of land-intensive agricultural goods (e.g. rice and wheat), while its competence in labor-intensive commodities (e.g. fruits and meats) has strengthened (Ye, 2004).

Table 1: Average and pairwise KSI, using actual price data and the seven-region framework

	2003	2004	2005	2006	2007	2008	2009	2010	2011
National Average	1.03	0.95	0.98	0.97	1.06	1.03	1.05	1.07	1.07
Regional Averages									
NE	0.95	0.87	0.84	0.86	0.87	0.89	0.87	0.89	0.91

YR	0.96	0.88	0.93	0.92	1.01	0.97	1.00	1.03	1.02
LR	0.87	0.81	0.85	0.84	0.94	0.91	0.94	0.95	0.95
S	1.02	1.00	0.95	0.95	1.05	1.03	1.06	1.08	1.08
SW	0.86	0.81	0.82	0.81	0.88	0.86	0.88	0.89	0.91
TQ	1.50	1.34	1.43	1.35	1.51	1.44	1.46	1.49	1.48
NW	1.05	0.94	1.01	1.07	1.15	1.11	1.12	1.16	1.16
Region Pairs									
NE-YR	0.80	0.82	0.79	0.81	0.76	0.75	0.77	0.81	0.81
NE-LR	0.85	0.76	0.72	0.74	0.71	0.77	0.73	0.72	0.71
NE-S	0.93	0.86	0.75	0.80	0.76	0.83	0.79	0.78	0.81
NE-SW	0.79	0.65	0.60	0.62	0.58	0.62	0.57	0.59	0.67
NE-TQ	1.51	1.39	1.43	1.38	1.51	1.45	1.46	1.50	1.53
NE-NW	0.80	0.73	0.77	0.79	0.91	0.90	0.91	0.94	0.95
YR-LR	0.90	0.80	0.90	0.92	0.96	0.93	0.98	1.01	0.98
YR-S	1.08	1.08	1.03	1.08	1.17	1.11	1.19	1.23	1.18
YR-SW	0.86	0.80	0.84	0.87	0.90	0.87	0.89	0.91	0.91
YR-TQ	1.44	1.17	1.37	1.22	1.50	1.42	1.43	1.47	1.48
YR-NW	0.69	0.61	0.66	0.65	0.78	0.76	0.71	0.78	0.78
LR-S	0.37	0.41	0.38	0.43	0.48	0.46	0.49	0.52	0.54
LR-SW	0.26	0.34	0.36	0.44	0.42	0.43	0.46	0.47	0.49
LR-TQ	1.60	1.51	1.56	1.35	1.66	1.59	1.62	1.63	1.59
LR-NW	1.21	1.05	1.17	1.16	1.33	1.30	1.34	1.36	1.37
S-SW	0.53	0.57	0.51	0.56	0.54	0.54	0.57	0.60	0.60
S-TQ	1.76	1.66	1.64	1.42	1.76	1.68	1.71	1.75	1.75
S-NW	1.45	1.41	1.37	1.38	1.57	1.53	1.58	1.62	1.60
SW-TQ	1.59	1.48	1.54	1.33	1.61	1.54	1.55	1.57	1.53
SW-NW	1.10	1.00	1.06	1.07	1.24	1.18	1.20	1.22	1.25
TQ-NW	1.08	0.82	1.04	1.39	1.05	0.98	1.00	1.04	1.02

Source: Authors' own calculation and illustration. The definition of abbreviations is given in the Appendix.

Competition has motivated China to adjust its national production structure, moving from a crop-dominant to a crop-livestock-dominant agriculture with forestry and fishery included. For instance, before 1978, grain production occupied over 80 percent of the total production value (National Bureau of Statistics of China, 2005). From 2003 to 2011, the share of crops made up around 50 percent of the total value, while that of livestock commodities contributed over 30 percent. In addition to the intensified competition, higher international prices as well as the growing domestic consumption of higher-quality and high-protein food are argued to be drivers for the structural changes (Carter *et al*., 2012). The high value added to livestock commodities, fruits and vegetables stimulates commercialization. Thus, an increasing number of business chains have been established to support the cycle from production to sales to services, which has resulted in more specialized agricultural markets.

Secondly, the year 2007 is a turning point for China's regional specialization. Since that year, the specialization degree moved up to a higher stage for most regions. Table 1 provides regional averages of specialization for each region. Kernel Density Estimation (see Figure 3) also shows an obvious shift of specialization degree towards a higher level after 2007. The improvement did not happen overnight. Instead, several key pushing factors that were implemented in prior years gradually led to the impressive leap in 2007. These factors include the preparation and accession to the WTO in 2001, a jump in terms of national agricultural finan-

cial support, the reduction of agricultural taxes in 2004, and the complete nationwide abolishment of agricultural taxes in 2006. Overall, China's switch from an agriculture-support-industry to an industry-supporting-agriculture economy greatly impacted the domestic agricultural pattern (Carter *et al*., 2012). The central government's investments in agriculture have grown at an annual rate of 20 to 38 percent since 2004. As a result, China spent 9.6 percent of its entire budget on agriculture in 2011 (Ministry of Agriculture of China, 1981-2011). This corresponds with a nearly six-fold increase in agricultural investments in the investigated period. The financial support includes subsidies on agricultural production, the supply of high-quality seeds and fertilizers, the construction of infrastructure, and loans provided by rural credit systems. Consequently, farming entities have less financial burden and enjoy improved producing conditions.

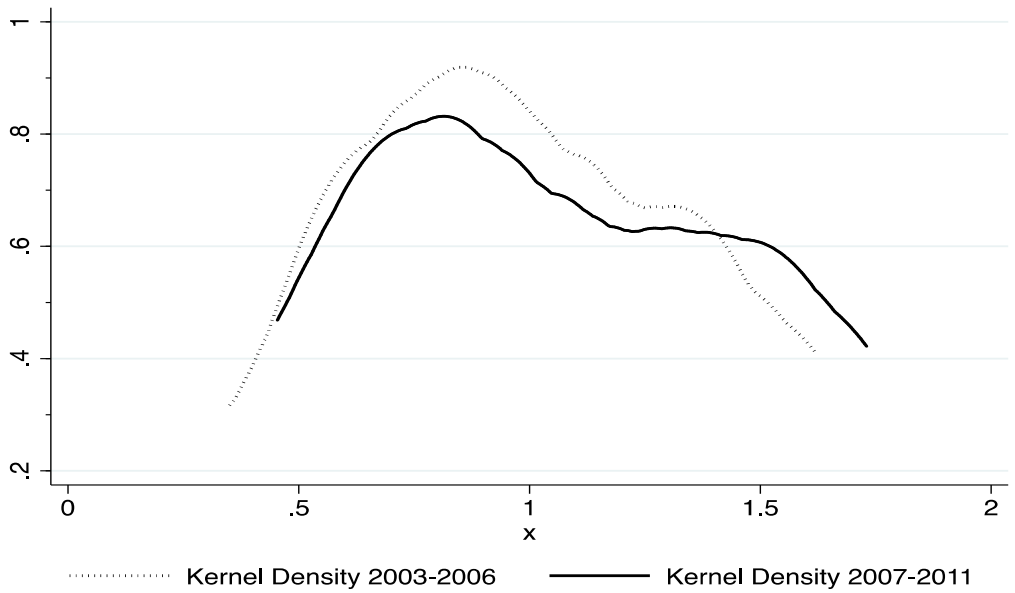

Figure 3: Kernel density estimation for regional average KSI
Source: Authors' own calculation. The Kernel Density Estimation (KDE) is a non-parametric way to estimate the probability density function of a random variable. KDE is a fundamental data-smoothing problem where inferences about the population are made, based on a finite data sample.

Thirdly, we notice that the most similar region pairs distinguish themselves most rapidly, leading to substantial increases in their own overall specialization degree (see Table 1). Actually, the coefficient of variance for regional average KSI also drops from 0.213 in 2003 to 0.189 in 2011.[4] Since the coefficient of variance measures the deviation of the region's specialization level from the national average as the standard deviation divided by the mean, the decrease shows that the gap of specialization levels among regions has narrowed. In other words, specialization has increased in every region, and the inequality of regional specialization degrees has decreased.

To be specific, the least distinguished region pair is LR and SW in 2003, whose index went up from 0.26 to 0.49 after nine years. An ana-

[4] The coefficient of variance is a normalized measure of dispersion of a probability distribution or frequency distribution.

logous trend is observed for the LR and S pair. Looking into details, it is found that in 2003, the production patterns of staple food and meat in LR and SW were highly similar. Staple food accounted for 36 percent and meat 47 percent of LR's total production value, while the shares were 37 percent and 47 percent for SW, respectively. In the investigated period, LR gradually specialized in the production of staple food, which is considered as more land-intensive. The region's comparative advantages include better irrigation systems and flatlands, which are more suitable for rice production. Moreover, the coastal provinces in LR have prosperous economies, leading to a booming food demand. Additionally, the region has the highest machinery level that allows for lower productions costs, and potentials for economies of scale. On the other hand, SW shifted from being staple-food-dominant to focusing on meat production, which is generally more labor-intensive. The comparative advantages of SW lie in their lower labor and feeding costs. Therefore, in 2011, the production of staple food accounted for 44 percent of total production value in LR and only 29 percent in SW, while the production of meat contributed 40 percent in LR but 53 percent in SW. A similar pattern is observed for tobacco production in LR and SW.

In fact crop and livestock category in the two regions have traditionally had similar patterns due to their somewhat similar natural conditions, while noticeable differences are found only in forestry and fishery. To be specific, with rich water resources, LR has a much stronger fishery than SW, while the mountainous landscape of SW contributes to its strength in forestry. Knowing that the distinction of production structures cannot be brought only by natural condition changes given the short time span, we argue that the increasing interregional and international competition is driving the regions to focus on their comparative advantages. Thus, the regions ended up differentiating their production structures.

Our argument is supported by China's international trade data both at the national and regional levels. China's agricultural trade growth was substantial in the investigated period. Imports grew 397 percent, reaching almost US$ 109 billion in 2011, while exports grew 179.3 percent, equal to US$ 58.1 billion (United Nations, 2013). The export growth is driven by horticultural (i.e. vegetables and fruits) trade, which has grown by 316.7 percent, with its share in total agricultural trade increasing from 9.8 percent in 2003 to 14.8 percent in 2011. Export growth rates regarding other commodities are substantially smaller. The fact indicates a shift towards export trade in high-value products. On the import side, a similar trend is observed, but rates are significantly larger. These changes reflect the comparative advantages in China's regions have regarding international markets on average. Out of all the seven regions, LR, S, and SW record the fastest trade growth rates, increasing their aggregated agricultural trade by roughly 300 percent in the period 2003-2010 (Ministry of Agriculture of China, 1981-2011). For example, total exports and imports for S reached a historic height of US$ 27.1 billion in 2010. The fact indicates that the three regions are influenced by the intensified international competition the most, which gives the producers strong incentives to focus on their comparative advantages.

Meanwhile, it is important to notice that although international trade in China is growing, domestic trade still dominates. In 2010, only 1.8 percent of China's total agricultural production value was from international trade (Ministry of Agriculture of China, 1981-2011). This implies that specialization is still mainly pushed forward by interregional competition. We find that the number of FPCs and the total assets of township agribusinesses have increased impressively recently. In 2006, the Regulations for Farmer Cooperatives were implemented. Thus, legal assurance was provided that motivated the development of FPCs, contributing to an increased ability of small-scale farmers to benefit from economies of scale (Chen, 2009). The num-

ber of FPCs in China reached 521,700 by 2011 (Xu, 2012).

Finally, LR, S and SW are pioneering the expansion of FPCs and township agribusiness. For example, by 2010, the total assets owned by township agribusinesses in China already doubled in comparison with the record of 2003, and that of LR reached a record of US$ 17.2 billion (National Bureau of Statistics of China, 1981-2012). Clearly, even though households still mainly conduct farming, the boom of FPCs and agribusinesses indicate that the value-chain integration is strengthened, both horizontally and vertically. Larger groups of producers have more bargaining power and are more capable of acquiring technology, market access and economies of scale. Having more economic freedom and closer market relations causes organized producers to compete more intensively, which forces producers to focus on comparative advantages, resulting in regional specialization (Yang, 2011).

Impediments and opportunities for future regional specialization

In spite of the observed improvements, China's regional specialization lags behind that of developed countries, implying huge agro-economic potentials from further specialization. Taking the USA as an example, the national specialization index was 62.5 percent in 1987 (Kim, 1995). This is substantially higher than that of China in 2011 (53.5 percent). There are a number of key factors that negatively affect agricultural specialization in China.

Firstly, the central government still controls most of the staple food production and trade, and sets the food self-sufficiency requirements. In terms of global markets, state-owned companies dominate trading relations. In addition, it is a major obstacle for further specialization that agribusinesses are not granted the full authority to participate in international markets. Basically, they are merged as part of state-owned companies through contracts, and the companies will then trade for them. For instance, the most powerful Chinese food company is Cereal, Oil and Foodstuffs Importing and Exporting Corporation (COFCO). On the positive side, it is safer for small-scale producers to specialize when revenues are guaranteed by contract farming. On the negative side, however, farmers may not be able to produce according to their comparative advantages. Furthermore, though Chinese farmers are now free to lease and transfer their land, selling land is not yet legal according to China's Land Law. Thus, overall, land fragmentation is still serious (Xu *et al*., 2008). The average arable land per capita remained at only 0.153 hectare by 2011 (National Bureau of Statistics of China, 2011). The uncertainty of long-term land use rights leads to low land integration, deters rural households from investing in land and limits production specializing.

It is noticeable that the Chinese government has released strong signals of modernizing agriculture and enhancing agricultural specialization. For example, as described in the National Plan for Modern Agricultural Development 2011-2015, Beijing announces the establishment of national production centers and production-belts (The Central Committee of the Communist Party of China and State Council, 2012). The plan includes bring in more investments to agricultural research and development, the improvement of agricultural infrastructure, increasing rural income, and enhancing industrialization of agricultural production. Such policies are expected to motivate specialization of agricultural production in the coming years.

Conclusion and further thoughts

The scope of this paper is to explore the trends and drivers of regional specialization in China's agriculture. Krugman's regional specialization index is employed and modified. First, instead of normalizing prices as did in earlier studies, we use actual price data on provincial level. In addition, we argue that it is more appropriate to define agricultural regions in China based on their natural conditions and agricultural production patterns. Thus, our new seven-region framework draws

a more precise picture of regional specialization. We apply the augmented index to a database, which covers more than 70 percent of China's crop and livestock production value for the period 2003-2011. Our findings show that Chinese agriculture has moved to a higher level of regional specialization, especially after 2007. We have identified several drivers of these changes. Firstly, the considerable increase in agricultural specialization has resulted from less government intervention, which has led to more economic freedom, prompting regions to adjust their production patterns. Secondly, the liberalized domestic market and increased exposure to international markets have resulted in intensive internal and external competition, forcing regions to produce based on comparative advantages. Thirdly, the commercialization of agriculture, accompanied by the horizontal and vertical integration of the value-chain, motivated a structural change in China's agriculture. The change is also reflected by the prosperity of FPCs and agribusinesses during the period It is worth mentioning that the paper has several limitations that hold good potentials for future research. Firstly, the time span of the study is relative short. A longer period is desired to figure out a general developing pattern of regional specialization in China. Secondly, value data of vegetables and some fruits are lacked with current data source.

Adding in those data can be particularly helpful, given that vegetables and fruits are increasingly more important of China's agriculture. In addition, since the paper is mostly descriptive, it requires more rigorous proof to formulize the structural changes or thresholds of regional specialization over time. Lastly, as we discussed earlier, there are other indices that can be used to study specialization from different perspectives. Especially given the multi-dimensions of specialization, it is promising to use other indices and look for more insight of regional specialization with alternative approaches. Regional specialization goes hand in hand with higher agricultural production values. Hence, it is crucial for China to increase the attractiveness in farming to ensure a sufficient level of farm labor in rural areas, especially as rural labor flooding to cities. Besides, since the 1980s, China's industrial, service and real estate sectors have grown rapidly, while agriculture has been left behind, resulting in a great urban-rural development gap. Closing up the ever-widening gap is a historical challenge for China. To tackle the task, Beijing has already announced a series of policies that enhance agricultural infrastructure, improve agricultural research and development, and encourage deeper regional specialization in agricultural production. These policies promise a higher level of regional specialization in agriculture, with their implications far-reaching. All in all, China has substantial growth potentials in agriculture that promise a more balanced and sustainable development.

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Appendix

Definition of China's regions (six- and seven-region framework).

Northeast (NE): Heilongjiang, Jilin, and Liaoning; North (N): Beijing, Hebei, Henan, Shandong, Shanxi, and Tianjin; Northwest (NW): Gansu, Inner Mongolia, Ningxia, Qinghai, Shaanxi, Tibet, and Xinjiang; East (E): Anhui, Jiangsu, Shanghai, and Zhejiang; Central (C): Chongqing, Hubei, Hunan, Jiangxi, and Sichuan; and South (S): Fujian, Hainan, Guangdong, Guangxi, Guizhou, and Yunnan.

Northeast (NE): Heilongjiang, Jilin, and Liaoning; Northwest (NW): Gansu, Inner Mongolia, Ningxia, and Xinjiang; middle-lower division of Yellow River (YR): Beijing, Hebei, Henan, Shaanxi, Shandong, Shanxi, and Tianjin; middle-lower division of Long River (LR): Anhui, Hubei, Hunan, Jiangxi, Jiangsu, Shanghai, and Zhejiang; South (S): Fujian, Guangdong, Guangxi, and Hainan; Southwest (SW): Chongqing, Guizhou, Sichuan, and Yunnan; and Tibet-Qinghai (TQ): Tibet and Qinghai.

Source: Authors' own illustration